Invermere
Timber Supply Area

Vegetation Resources Inventory

Strategic Inventory Plan

PREPARED BY:
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Executive Summary

This Vegetation Resources Inventory (VRI) Strategic Inventory Plan (VSIP) outlines VRI activities and products needed to address forest management and inventory issues in the Invermere Timber Supply Area (TSA). The TSA is located within the Southern Interior Forest Region – Rocky Mountain Forest District, in southeast BC.

The main forest management and inventory issues identified by the attendees at the July 6, 2005 stakeholders meetings include:

- Net merchantable volume;
- Height, age, and site index;
- Dead trees with a potential commercial use;
- Coarse woody debris to provide decision support on landscape-level biodiversity and sustainable forest management planning;
- Levels of mountain pine beetle (MPB) attack, current attributes, and volumes on MPB stands; and
- Problem forest types.

To address these issues, this VRI program will include Ground Sampling (Phase II), Statistical Adjustment, and Net Volume Adjustment Factor (NVAF) programs on the Vegetated Treed (VT) land base established in or prior to 1977. A Change Monitoring Inventory (CMI) program will also be implemented in stands less than 40 years of age.

It is anticipated that approximately 100 VRI Phase II plots will be installed, approximately 100 NVAF trees will be destructively sampled, and approximately 60 CMI plots will be established. The total expected cost for all VRI activities is approximately $455,000. The goal is to complete this program by the end of the 2007-08 fiscal year, but this will depend upon available Forest Investment Account (FIA) funding and other investment priorities of the Invermere TSA licensees.

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1. INTRODUCTION

1.1 BACKGROUND

This Vegetation Resources Inventory (VRI) Strategic Inventory Plan (VSIP) outlines VRI activities and products needed to address forest management and inventory issues in the Invermere Timber Supply Area (TSA). The VSIP provides details for photo interpretation, ground sampling, and statistical adjustment of the inventory. Following VSIP approval, the next steps include preparation of Project Implementation Plans (VPIPs) based on this VSIP, and implementation of these VPIPs.

The Invermere TSA stakeholders include willing participants operating within the TSA. The TSA stakeholders are:

- Ministry of Forests and Range (MOFR)
- BC Timber Sales
- Ministry of Environment
- BC Parks
- First Nations
- Tembec Industries Inc (Tembec).
- Canadian Forest Products Ltd. (Canfor) Radium

This VSIP follows a meeting with stakeholders that occurred on July 7, 2006 in Cranbrook, BC. The following is a list of attendees for this meeting:

- Chris Mulvihill, MOF, Southern Interior Region
- Laurence Bowdige, MOF, Victoria
- Brian Dureski, Tembec, Cranbrook
- Dave Brown, Tembec, Cranbrook
- Marcie Belcher, Tembec, Cranbrook
- Joanne Leesing, Consultant

1.2 VRI OVERVIEW

The VRI is a vegetation inventory process that has been approved by the former Resources Inventory Committee (RIC) to assess the quantity and quality of BC's timber and vegetation resources. The VRI estimates overall population totals and averages, as well as individual polygon attributes, for timber and non-timber resources. Its design is simple, reasonably efficient, statistically-defensible, and addresses issues raised by the Forest Resources Commission in its 1991 report, *The Future of Our Forests.*[1] The VRI is broader in scope and more reliable than past inventories because it uses statistically accurate procedures and detailed ground sampling to augment the photo-interpreted estimates.

The VRI consists of several components:[2]

1. Photo Interpreted Estimates (Phase I).
2. Ground Sampling (Phase II) – timber emphasis, ecology, coarse woody debris.
3. Net Volume Adjustment Factor (NVAF) sampling.
4. Within Polygon Variation (WPV) sampling.
5. Change Monitoring Inventory (CMI).
6. Statistical Adjustment.

One or more of these components can address specific forest management or inventory issues. For more detailed information, VRI manuals are available on the MOFR – Forest Analysis and Inventory Branch website.[3]

[1] Forest Resources Commission. 1991. The Future of Our Forests.

[2] A glossary of technical terms is provided in Appendix I.

1.3 VRI PLANNING

The VRI planning process requires that a VSIP and VPIP be developed for defined units (e.g. TSA, Tree Farm Licence [TFL]). A VSIP outlines VRI products to address forest management issues and provides strategic direction for implementing the inventory activities. A VPIP details the operational activities identified in the VSIP (e.g., ground sampling or photo interpretation projects) and identifies project areas, priorities, and roles and responsibilities.

The VRI planning process is an important component of the overall VRI process and related activities (Figure 1). The intent of the VRI planning process is to ensure that baseline products meet a range of applications and they are efficiently implemented. These processes and activities include:

1. Forest management decision processes (land integration planning);
2. Identifying forest management issues;
3. VRI strategic planning (prepare a VSIP);
4. VRI operational planning (prepare VPIP); and
5. Implementation, including development and maintenance of procedures and standards:
    a. Management inventories;
    b. Database management;
    c. Data interpretation.

The steps for preparing a VSIP include:

1. Licensee stakeholders work with MOFR staff to develop TSA issue statements related to VRI.
2. All agencies and stakeholders meet to refine issues and discuss why these issues need to be considered fundable. The purpose of this meeting is to:
    a. Introduce the VRI tools and process;
    b. Table new issues and issues recorded to date;
    c. Discuss issues that can be funded or not (under current funding mechanisms); this discussion provides general direction for developing the VSIP. This discussion also affects the extent of photo interpretation and the number and type of VRI plots.
    d. Suggest the VRI tools to address currently fundable issues as well as those issues that may be funded in the future.
3. Meeting minutes are prepared and circulated to all participants for review and feedback.
4. A final VSIP is prepared. This VSIP incorporates items agreed to in Step 5 of the planning process and is signed off by committee members.
5. VPIP process begins.

The steps for preparing a VPIP include:

1. Review and update VSIP recommendations.
2. Secure funding.
3. Identify project activities, scheduling, geographic areas, and estimated costs.
4. Specify roles and responsibilities for project implementation.
5. Prepare VPIP.[4]

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[3] http://www.for.gov.bc.ca/hts/vri/

[4] Separate VPIPs are required for the Photo-Interpretation and Ground Sampling programs. The ground sampling VPIP covers both the NVAF and analysis and statistical adjustment projects.

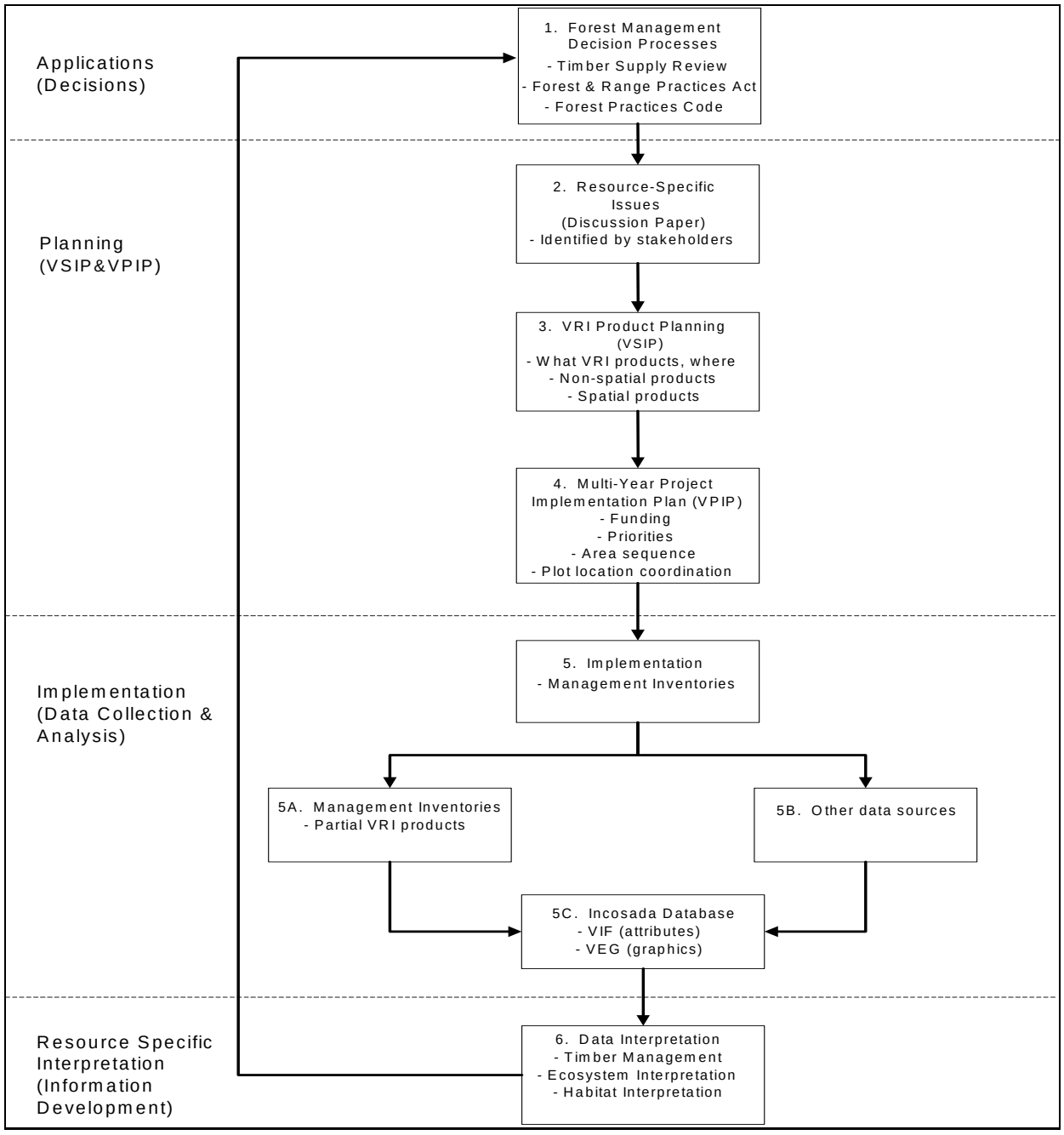

Figure 1. VRI planning process.

1.4 VRI METHODOLOGY

1.4.1 Phase I – Photo-Interpretation

Prior to commencing the Phase I of a VRI project, a *VPIP for Photo Interpretation* must be completed and subsequently approved by the MOFR. This plan will detail photo acquisition requirements, the VRI Phase I process, standards for adherence, and a photo interpretation plan to carry out the Phase I of the VRI.

Phase I is the photo interpretation phase of a VRI and entails polygon delineation and attribute estimation by certified photo interpreters using aerial photographs or softcopy images. The delineation identifies the location of

the forest resources and the attribute estimation component provides estimates of numerous attributes including land cover type, crown closure, tree species, height, age, stand structure, basal area, density, slope position, moisture and nutrient regime, snags, shrubs, herbs, and bryoids. Estimation of attributes is based upon field procedures using a combination of air and ground calibration points.

1.4.2 Phase II – Ground Sampling

Prior to commencing Phase II, a *VPIP for Ground Sampling* must be completed and subsequently approved by the MOFR. This plan details the Phase II sample selection process and standards for adherence.

Specifically the Phase II VPIP plan will:

- Detail the Phase II project and sampling objectives;
- Target and identify sample populations and sample selection and sample size details;
- Discuss how existing Phase II sample data will be applied to the new inventory;
- Identify gaps in the sample coverage;
- Quantify any additional sample data that will need to be collected to address these gaps;
- Include discussion of the field program;
- Discuss the proposed data compilation, analysis, and statistical adjustment;
- Include the proposed implementation schedule; and
- Identify the timing and submission of annual deliverables including the Phase II and NVAF data, adjusted Phase I data, and final analysis report.

The ground sampling objectives are to install an adequate number of samples to provide statistically sound information on volume and other attributes, which can be used to adjust the inventory. The samples (samples are "plot clusters" and consist of a main plot and up to four associated auxiliaries) selected for the Phase II ground sampling are based on the delineated polygons and attributes estimated during Phase I. Samples are selected randomly using a two-step process. First, polygons are selected proportional to area. Second, a random point is selected within the polygon. Comparison between the sample and the population are provided for key inventory attributes.

1.4.3 Net Volume Adjustment Factor

As per the MOFR VRI standards, all new VRI Phase II must complete an NVAF sampling program. The NVAF sampling is the destructive tree sampling process that accounts for taper bias and hidden decay in the trees and is used to adjust the cruiser's net factor calls. This sampling involves detailed stem analysis of sample trees that have been randomly selected from the Phase II plots. The NVAF is used to correct the VRI estimates of net close tree utilization for all species.

1.4.4 Statistical Adjustment

The final phase in the VRI is the Statistical Adjustment of the Phase I using the results of the Phase II sampling data for the entire VRI project area. The NVAF information is utilized to adjust the Phase II sample estimates for hidden decay and taper equation bias and the Phase II plot estimates are used to adjust the Phase I photo interpretation attribute estimates. The final product is a statistically valid new inventory, supported by re-adjustment of photo-estimated attributes based on ground samples.

1.4.5 Change Monitoring Inventory

A CMI program monitors change over time in key forest inventory attributes. These change estimates can then be compared to predictions from growth and yield models. One objective of the CMI program is to act as an early

warning system if assumptions used in growth and yield models are inaccurate. The CMI will only indicate that there is a problem with the model(s); it will not give information about the source of the problem. Special studies must be undertaken to investigate the source of the problem identified by the CMI program.

1.5 FUNDING

Funding for VRI activities is provided by the Forest Investment Account (FIA) Land Base Investment Program for the fiscal years 2006-07 and 2007-08.

2. BUSINESS CONSIDERATIONS

2.1 LAND BASE

The Invermere TSA is within the Southern Interior Forest Region – Rocky Mountain Forest District and is administered out of the District office in Cranbrook. The Rocky Mountain Forest District is situated in the southeastern corner of BC (Figure 2) and was created in 2003 by amalgamating the former Invermere and Cranbrook Forest Districts. The District contains approximately 2.63 million hectares, of which 1.15 million ha falls within the Invermere TSA (Table 1). The TSA includes one national park and 11 provincial parks. The timber harvesting landbase (THLB) in Timber Supply Review (TSR) 3 was 233,873 ha (or 20% of the TSA).[5]

Table 1. TSR 3 Land Base Summary

Land Class	Area (ha)	% of TSA
Total	1,153,073	
Non Crown Ownership	90,298	8%
Crown Ownership	1,062,775	92%
Non-Forested	508,125	44%
Forested	554,650	48%
Non-THLB	320,777	28%
THLB	*233,873*	*20%*

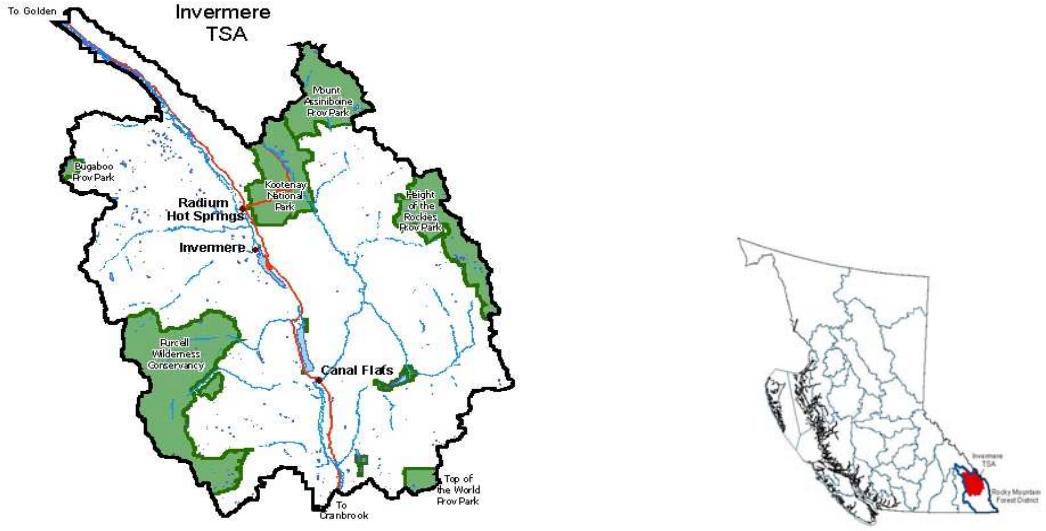

Figure 2. Overview map of the Invermere Timber Supply Area.

Approximately 48% of the total area of the Invermere TSA is considered Crown Forested Land Base (CFLB). The remaining 52% is considered non productive (i.e., rock, ice, alpine, etc), or is not managed by the MOFR (i.e., private, First Nations, woodlots, etc). Within the CFLB, only about 42% (or 20% of the total TSA), is considered available for timber harvesting. The TSA includes one national park (Kootenay) and eleven provincial parks.

The Invermere TSA is located in the interior dry-belt of the province and contains six biogeoclimatic (BGC) zones. These zones reflect distinct differences in terrain, climate and tree species. The BGC zones, in order of relative proportion of the THLB are: Montane Spruce (MS), Engelmann Spruce-Subalpine Fir (ESSF), Interior Douglas-fir (IDF), Interior Cedar-Hemlock (ICH), Ponderosa Pine (PP), and Alpine Tundra (AT). Lodgepole pine (Pl) and Douglas-fir (Fdi) are the main species in the TSA (Figure 3). Interior spruce (Sx), western larch (Lw), and subalpine fir (Bl) are also important. Minor species include ponderosa pine, western hemlock, western redcedar,

[5] Forsite Consultants Ltd. 2004. Invermere Timber Supply Area Timber Supply Review #3 Analysis Report Version 3. Unpublished Report, May 12, 2004, Salmon Arm BC. p. 13.

whitebark pine, cottonwood, aspen, and birch. The age distribution is relatively uniform across all age classes (Figure 4).

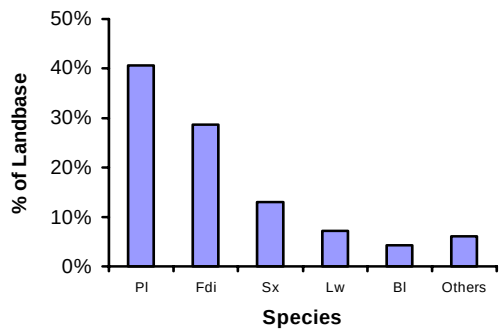

Figure 3. Species distribution in the Invermere TSA.

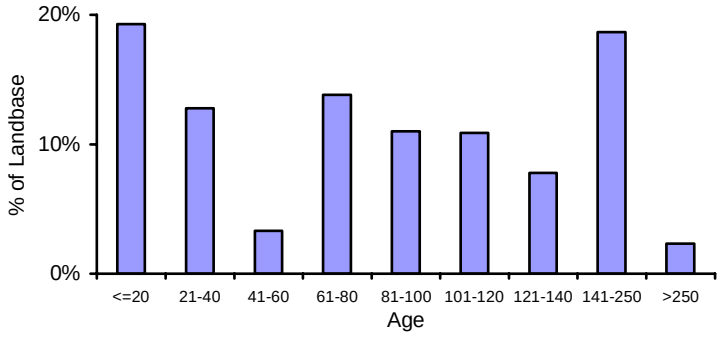

Figure 4. Age class distribution in the Invermere TSA.

2.2 First Nations

The Invermere TSA is located within the "Traditional Territory of the Ktunaxa Nation" which covers approximately 70,000 square kilometers in southeastern BC and historically included parts of Alberta, Montana, Washington and Idaho.

The Ktunaxa Nation Council (KNC) originated to promote the political and social development of the Ktunaxa Nation. The KNC is accountable to the Chiefs and Council of the Ktunaxa Nation. Ktunaxa citizenship is comprised of Nation members from seven Bands located throughout historic traditional Ktunaxa territory. Five Bands are located in BC, and two are in the United States. The five BC bands are: Columbia Lake Band (Windermere), St. Mary's Band (Cranbrook), Tobacco Plains Band (Grasmere), Lower Kootenay Band (Creston), and the Shuswap Band (Invermere). The Shuswap Indian Band has most recently joined the Shuswap Nation Tribal Council (SNTC).

The KNC has submitted a comprehensive land claim that covers the southeast corner of the province, including the Invermere TSA. The Shuswap are not currently involved in the treaty process.

2.3 Current Forest Cover Inventory

The most recent photo-interpreted inventory for the Invermere TSA was completed in 1995 using the standards at the time. The Forest Inventory Planning (FIP) lines and attributes were rolled over to the VRI format in 2000. The inventory is missing VRI attributes that were not included in the FIP database. Legacy attributes from the FIP database are still available, however they are not in the VRI. The disturbance update is current to September 2003.

An inventory audit was completed on the original inventory in 1993.[6] The audit samples were recompiled in 1996 to correspond to the stratification of the current inventory. Due to new stratification the recompilation must be viewed with some caution, as some of the strata do not have an adequate number of plots.

[6] BC MInistry of Forests Inventory Branch. Invermere TSA Inventory Audit Revised November 1996. Unpublished Report, no date. 5 p.

The recompilation onto the current inventory shows that the inventory volumes are within 3% of the volumes found on the ground for both the entire TSA and the operable portion of the TSA. The inventory also showed that 60% of the samples correctly identified the leading species, inventory age is within 20% of ground age in 58% of the samples, inventory height is within 15% of ground height on 65% of the samples.

2.4 FOREST MANAGEMENT CONSIDERATIONS

The following items have been identified as the main VRI-related forest management and inventory issues in the Invermere TSA:

	ISSUE:	Phase I Impact	Phase II Impact	COMMENT
1.	***Mountain Pine Beetle Impacted Areas***	Low	Moderate-High	Pl comprises 65 percent of the Invermere TSA harvest. Pl-leading stands make up over 40 percent of the TSA's THLB and is often a minor species in the remaining THLB. New photo-interpreted estimates (Phase I) will not be useful in management of MPB but will be useful once the infestation is finished. Ground sampling (Phase II) provides good volume estimates in stands affected by MPB.[7] CMI samples can also be used to monitor the long-term effects of the MPB infestation.
2.	***Mountain Pine Beetle Shelf Life***	Not Applicable	Moderate-High	It is unlikely that dead Pl stands will retain economic value for up to 10 years. Licensee staff suggest that under current drought conditions salvage operations may only be for two to five years following attack. The MoFR is piloting collection of shelf-life attributes in other VRI and CMI projects in order to build a shelf-life model. Data collection can be incorporated for the Invermere TSA.[7]
3.	***Volume of Dead Wood***	Low	High	Changes in Interior log grades may require the Provincial Chief Forester to consider dead wood volumes in TSR Determinations. Phase II data would provide improved information on dead potential volumes.[7] Alternatively, the inventory audit estimates can be used to estimate dead wood volumes.
4.	***Ungulate Winter Range (UWR)***	Moderate	Low	The UWR maps in the TSA are PEM based. Phase I may provide more detailed information on non-forest attributes for input into the PEM. The effectiveness depends on how the PEM incorporates forest cover attributes into the prediction process.
5.	***Landscape-Level Biodiversity***	Moderate	High	Phase I can provide more detailed information on non-forest attributes. Phase II will provide data on coarse woody debris, forest succession, and (potentially) ecological attributes.

[7] These are currently non-standard data and new standards are expected to be established by MoFR for the 2007 field season. Any variance will have to be obtained from MoFR and FIA.

6.	***Cut-Block Adjacency and Green-up***	Low	Low	Polygon delineation and species composition in younger age classes. CMI can provide feedback on whether regenerating stands are meeting expected green-up projections. Data collected through other survey methods may better address this issue (i.e., silviculture type survey). New Phase I can improve delineation and species composition estimates on openings older than those populated by RESULTS. Phase II will provide attribute information for openings greater than 30 years.
7.	***Site Productivity Estimates in Managed Stands***	Low	High	The Provincial Chief Forester wants Licensees to "continue to monitor growth and yield from their second growth stands to track against the expected productivity as predicted from SIBEC." CMI samples in less than 40 years will provide very good information on whether the stands are performing as expected. Phase I provides better height estimates to determine site index and the Phase II provides improved data for estimating site index of current stands. Target populations (managed stands) can become strata in either sampling process.
8.	***PEM Validation***	Moderate	Moderate	The Provincial Chief Forester wants Licensees to "continue to refine their PEM to allow continued improvement and better estimates of site index." New Phase I can provide better attributes to use as input to the PEM. Phase II can collect site series information at sample locations as a random check (validation/calibration) on the existing PEM.
9.	***Volume Estimates for Unmanaged Stands***	Moderate	High	Overestimation of volume in older age classes and the underestimation of volume in younger age classes. New Phase I may provide better attributes for VDYP to use in deriving volumes. Phase II will provide very good data on actual volumes and can be used to adjust the existing inventory.
10.	***Errors in Inventory Attributes***	High	Moderate	Potential errors in species composition, age, and height attributes. Both the Phase I and Phase II may improve individual polygon values and reduce errors in attributes. Further analysis by age and species could also identify trends within the inventory.
11.	***Environmentally Sensitive Areas, Especially ESAp***	Low	Low	ESAs are not part of current Phase I procedures. Other survey methods will provide better information on ESAp.
12.	***Problem Forest Types***	Moderate	High	A total of 9,828 hectares of problem forest types (PFTs) do not contribute to timber supply. Considering netdown order, 6,893 hectares were deducted from the THLB. New Phase I can verify/improve the estimates in these stands. These areas can be set as separate stratum for Phase II, which will improve attributes and volume estimates.
13.	***Low Sites***	Moderate	High	New Phase I can verify or improve the attributes in these stands. These areas can be set as separate stratum for Phase II, which will provide improved attributes and volume estimates.
14.	***Forest Health Issues***	Low	Moderate	Armillaria. Phase II sampling provides data on the occurrence of Armillaria.[7]

15.	***Criteria & Indicators for Sustainable Forest Management***	Moderate	Moderate-High	The Phase II can provide timber, ecological, range and coarse woody debris data to provide spatial and non-spatial baseline data for use in Criteria & Indicator development, monitoring, and reporting as defined by the Canadian Council of Forest Ministers (CCFM). Monitoring involves measuring changes and trends in indicators, including percent and extent of area by forest type and age class, and mean annual increment by forest type and age class.
16.	***Partial Harvesting***	Low-Moderate	Moderate-High	Need information on the volume left in partially harvested stands and the performance of the new stands growing in the understory. Phase I can provide spatial information on the blocks and estimated attributes. Phase II will provide data on current standing volume. CMI samples can track performance, though other survey methods may provide better information.
17.	***Forest Cover in Parks is Needed for Planning Purposes***	High	Low	New Phase I may be needed if the existing information is not suitable. The applicability of Phase II depends on the level of information necessary. The ability to use FIA investment funds on this part of the land base will have to be reviewed with MOFR and FIA staff.
18.	***Operational Adjustment Factor (OAF)***	Low	Moderate	Deductions for OAF1 may be too high. OAF1 sampling procedures may be incorporated into Phase II and CMI plots.
19.	***Ownership***	Low	Low	An up-to-date ownership coverage is required. The VRI cannot help with this issue. The ownership data is needed so that VRI activities do not occur on private land.
20.	***Implementation of VDYP7***	Low	High	VDYP7 is scheduled for release in the next year and will produce different volumes than VDYP6, the current yield model. Key factors in this model are basal area and height. Phase II will provide validation of the volume estimates produced by VDYP7.
21.	***Taper Equation***	Low	High	Potential problems with the taper equations for some species (especially Pl) on the TSA. NVAF sampling should correct potential problems with taper estimates and will be investigated during the Phase II VPIP development as part of the NVAF program.
22.	***Implications for Managing Species at Risk***	Moderate	Low	Phase I can provide finer delineation and specific attributes for non-forest areas.

2.5 SUMMARY OF INVENTORY ISSUES

The completion of VRI activities could provide better information on:

- Net merchantable volume;
- Height, age and site index;
- Dead trees with a potential commercial use;
- Coarse woody debris to provide decision support on landscape-level biodiversity and sustainable forest management planning;
- Levels of MPB attack, current attributes and volumes on MPB stands; and
- Problem forest types – this population can be better identified and analyzed in the inventory.

3. STRATEGIC INVENTORY PLAN

3.1 OVERVIEW

This section outlines a strategic inventory plan to develop the VRI program. The main product of the VRI program is a statistically unbiased vegetation inventory. This will require Ground Sampling, NVAF, and Statistical Adjustment. In addition, a CMI program will be initiated to monitor second-growth stand performance.

The Invermere stakeholders assessed the need to complete Phase I in the non-treed and Parks areas within the Invermere TSA and determined that the current information suitably addressed the stakeholders information needs at this point in time.

3.2 GROUND SAMPLING (PHASE II)

3.2.1 Target Population

The target population will be the Vegetated Treed (VT) area within the TSA, 30 years or older. If the BC Land Classification Scheme (BCLCS) information is not fully available, VT will be defined as a polygons where a leading species exists and crown closure is greater than or equal to 10%. Polygons with stands established prior to 1978 will be used as the lower limit of the target population. This definition will be refined during development of the Phase II VPIP.

3.2.2 Sampling Objective

The objective of the ground-sampling component of the VRI program is to install an adequate number of samples to estimate the average net merchantable volume in the target population with a sampling error of ±10% at a 95% confidence level.

3.2.3 Sample Size

Approximately 100-120 VRI ground samples are needed to meet the ±10% sampling error requirement. Additional samples may be added if the TSA group determines (through interim analysis) that 100 samples do not meet required sampling error. Samples will be selected from three or four strata, which are typically based on leading species groups. Age or BGC zone may also be used for defining strata. The specific strata and exact distribution of the samples will be determined through the Phase II VPIP.

3.2.4 Sampling Approach

VRI Timber Emphasis Plots (TEP) and Coarse Woody Debris (CWD) data will be collected using MOFR standards. This information corresponds to a plot type D. The Phase II VPIP and sample packages will be completed before the end of March 2007, and the Phase II field program is scheduled for implementation during the 2007 field season.

3.2.5 Sample Selection

Sample locations will be selected using provincial standards. Polygons will be selected using probability proportional to size with replacement (PPSWR), and a random point will be selected within the polygon using the provincial 100-m grid. If no 100-m grid point falls within the selected polygon, the grid will be halved until at least one point falls within the polygon.

3.3 NET VOLUME ADJUSTMENT FACTOR

3.3.1 Overview

NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume. This ratio is used to statistically adjust the estimate of net merchantable volume of VRI ground samples.

3.3.2 Sampling Objective

The objective of the NVAF component is to estimate NVAF ratios with a sampling error of ±10% at a 95% confidence level.

3.3.3 Sample Size

The sample size of the NVAF component will be determined after the Phase II data is collected. The relative species distribution (in terms of net merchantable volume) will be estimated and the sample sizes for each species group will be determined based on the species distribution. The MoFR recommends a minimum of 100 NVAF trees, including 25 dead and 75 live trees.

The stakeholders noted that tree taper is an area of uncertainty and believe that current taper equations do not adequately model trees in the Invermere TSA. A well-designed NVAF program will identify taper issues and increased NVAF sampling may be required if localized taper equations are needed. This increased sampling would most likely be specific to individual strata. Discussion with the MOFR-Revenue Branch will be required before collecting data to localize taper equations.

The NVAF program will start at the conclusion of the Phase II field program, likely at the end of the 2007 field season.

3.3.4 Sample Selection

Approximately 25 VRI Phase II plots will be enhanced for NVAF sampling, which will be completed during the Phase II ground sampling portion of the VRI. A tree matrix will be built with all trees from the auxiliary plots of the NVAF-enhanced samples. NVAF samples will be selected systematically, with a random start, from a list of trees (the matrix) sorted by species and diameter at breast height (DBH).

3.4 CHANGE MONITORING INVENTORY

CMI can be used to track and calibrate the modeling assumptions used for second-growth stands and is a key component of sustainable forest management planning. The Invermere stakeholders intend to implement a CMI program in stands less than 40 years of age, which comprises a significant portion of second-growth stands on the TSA. The sample size must be both cost-effective and large enough to allow some post-stratification. It is expected that the sample size of the CMI program will increase over time as the population of second-growth stands increases. In the first time period, the program should include establishment of approximately 60 plots.

The CMI sample plan and sample packages will be completed in the 2006-07 fiscal year. The goal is to implement CMI field program during the 2007 field season and complete the analysis by March 2008.

3.5 ESTIMATED COSTS

The total cost of all the different activities is expected to be approximately $455,000(Table 2). This cost includes project administration and quality assurance requirements.

Table 2. Estimated costs for VRI activities in the Invermere TSA.

VRI Activity	Units	Unit Cost ($/Unit)	Total Cost ($)	Projected Year
PHASE II				
Project Management	1	$10,000	$10,000	2007-08
Phase II VPIP	1	$7,000	$7,000	2006-07
Sample Packages	100	$100	$10,000	2006-07
Ground Plots	100	$1,600	$160,000	2007-08
Helicopter			$35,000	2007-08
Quality Assurance	10	$1,600	$16,000	2007-08
Sub-Total			*$238,000*	
STATISTICAL ADJUSTMENT				
Project Management	1	$2,000	$2,000	2007-08
Data compilation	1	$1,000	$1,000	2007-08
Report	1	$15,000	$15,000	2007-08
Sub-Total			*$18,000*	
NVAF [a]				
VPIP Update / Tree Selection	1	$2,000	$2,000	2007-08
Destructive Sampling	100	$600/tree	$60,000	2007-08
NVAF Analysis and Reporting	1	$5,000	$5,000	
Sub-Total			*$67,000*	
CMI				
Project Management			$10,000	2007-08
CMI VPIP	1	$5,000	$5,000	2006-07
Plot Establishment	60	$1,600/plot	$96,000	2007-08
Sample Packages	60	$100	$6,000	2006-07
Quality Assurance	6	$1,600/plot	$9,600	2007-08
Analysis & Installation Report	1	$5,000	$5,000	2007-08
Sub-Total			*$131,600*	
Total			***$455,000***	

[a] The timing of NVAF implementation will depend upon the available FIA funding once the Phase II program is complete.

4. SIGN-OFF SHEET

I have read and concur that the Invermere TSA VRI Strategic Inventory Plan dated October 29, 2006 meets current VRI standards and business needs and considerations. It is understood that this is an agreement-in-principle and does not commit the signatories to completing the inventory activities outlined within the plan.

_____ _____

Tembec Industries Inc. (lead proponent) *Date*

_____ _____

Jon Vivian, RPF *Date*
Manager Vegetation Resources Inventory
Forest Analysis and Inventory Branch
Ministry of Forests and Range

APPENDIX I – GLOSSARY OF TERMS

Ground Sampling
VRI ground sampling (Phase I) is the field measurement of timber, ecology, range, and/or coarse woody debris values at one or more locations within each sample polygon. To accommodate the wide variety of resources, various types and sizes of sampling units (e.g., fixed and variable plots, transects) are used to make the measurements.

Landcover Classification
The BC Landcover Classification Scheme (BCLCS) was designed specifically to meet the requirements of the VRI, in addition to providing general information useful for "global vegetation accounting" and "integrated resource management". The BCLCS is hierarchical and reflects the current state of the landcover (e.g., presence or absence of vegetation, type and density of vegetation) and such fixed characteristics as landscape position (i.e., wetland, upland, alpine). There are two main classes of polygons: Vegetated and Non-Vegetated.

Net Volume Adjustment Factor (NVAF) Sampling
NVAF sampling provides factors to adjust net tree volume estimated from net factoring and taper equations. The adjustment accounts for hidden decay and possible taper equation bias. NVAF sampling involves detailed stem analysis of sample trees, calculation of actual net volume, and calculation of the ratio between actual net volume and estimated net volume (where estimate net volume is obtained from net factoring and taper equations).

Photo-Interpretation (Phase I)
Photo-interpretation (Phase I) involves the subjective delineation of polygons and the photo estimation of attributes for all polygons in an inventory unit. Medium scale aerial photographs (1:15,000) are most often used in the photo-interpreted estimates inventory.

Post-Stratification
Post-stratification involves the division of an inventory unit into mutually exclusive sub-populations (strata) *after* ground sampling has been completed. Samples that fall in each post-stratum are analyzed separately and the results are applied to the corresponding population post-strata.

Pre-Stratification
Pre-stratification involves the division of an inventory unit into mutually exclusive sub-populations (strata) *before* ground sampling to provide estimates for specific areas, or to increase the confidence in the overall estimates by considering the special characteristics of each stratum.

Sample Size
The sample size for an inventory is the minimum number of ground samples to be established in an inventory unit to meet specified target precision or cost. Calculation of a theoretical target sample size requires an estimate of the CV of the key attributes of interest under the proposed sampling procedures and a statement of the precision desired in these attributes.

The formal process for determining sample size for an inventory unit is to anticipate the results (e.g., target sampling error for timber volume) and then determine the approximate sample size corresponding to this desired result. This process would, for example, involve the following steps:

1. Set the target accuracy for the overall inventory unit accuracy to *E* for timber volume (i.e., the sampling error, or half the confidence interval associated with a given probability, e.g., ±15% at the 95% probability level). The number of samples should be adequate to meet the target precision.
2. Estimate the population coefficient of variation (CV_{sample}) of the attribute of interest based on a small sample. This CV_{sample} is defined as a relative measure of the average difference between a polygon ground measurement (assumed the true value) and its corresponding estimate from the inventory.
3. The following formula would then be used to estimate sample size:

$$n = [\frac{t * CV_{sample}}{E}]^2$$

where *t* is the "*t*-value" associated with a given probability and degrees of freedom, and CV_{sample} is a sample-based estimate of the population CV.

The sample size calculations suggested here are general guidelines, not exact requirements. The sample size used in practice is usually a trade-off between the calculated sample size and the expected cost, timing, credibility, flexibility, and comparability of the inventory. The size of the population is usually large enough that it does not affect sample size. The calculated sample size may be increased arbitrarily to allow for post-stratification, increased credibility, more flexibility, and a better starting point for growth projections.

Statistical Adjustment

Statistical adjustment (or analysis) is the process of adjusting the values of the photo-interpreted estimates variables using the ground sampling observations. For each sampled polygon, the ground observations are compared to the photo-estimated values to develop an adjustment factor. This factor is then applied to all polygons in the photo-interpreted estimates database to produce the final adjusted database.

Sub-unit

The term sub-unit describes the inventory unit within a management unit. A sub-unit may be defined by a specific geographic area (e.g., operable landbase) or stand type (e.g., problem forest types) within the management unit.

Target Population

The target population is the unit from which the samples are chosen. For management inventories, the inventory unit is a TSA, TFL or other geographic area or specific attribute set, depending upon the sampling objectives.

Target sampling error

Target sampling error expresses the desired accuracy of the attribute of interest (e.g., timber volume). It is usually expressed as a percentage value at a given probability level (e.g., ±15 at the 95% probability level). This means that 95% of the time we are confident that the volume estimates are within 15% of the actual volume. Target sampling error is used to calculate the minimum sample size for subsequent ground sampling; see ***Sample Size***.

Vegetation Resources Inventory (VRI)

The VRI is an improved vegetation inventory process for assessing the quantity and quality of BC's vegetation resources. The VRI process is designed to include a flexible set of sampling procedures for collecting vegetation resource information. The VRI is essentially a toolbox of procedures, which include:

- BC Landcover classification scheme (BCLCS).

- *Photo-interpreted estimates (Phase I)*: the delineation of polygons from aerial photography and the estimation of resource attributes.
- *Ground sampling (Phase II)*: the establishment of plot clusters in selected polygons to measure timber, ecological, and/or range attributes. The data are used for the adjustment of the photo-interpreted estimates for all polygons in an inventory unit or management unit.
- *NVAF Sampling*: Stem analysis sampling of individual trees for net volume adjustment.
- *WPV Sampling*: Intensive sampling of selected polygons to determine the error between the estimated attribute values and the "true" attribute values.
- *Change Monitoring Inventory (CMI).*

The VRI can be deployed over the entire province (provincial VRI) measuring timber and non-timber resources, or over a large management unit (management VRI) measuring selected resources in specific portions of the landbase. The VRI sampling process produces spatial and non-spatial databases that can be used in multiple resource management applications including timber, ecosystem, and wildlife habitat management.