

**Tree Farm Licence 41**

**Vegetation Resources Inventory**

**Strategic Inventory Plan**

**PREPARED BY:**

**TIMBERLINE NATURAL RESOURCE GROUP LTD.**

**WEST FRASER MILLS**

**September 2007**

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## EXECUTIVE SUMMARY

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This Vegetation Resources Inventory (VRI) Strategic Inventory Plan (VSIP) outlines the VRI activities and products that address the forest management and inventory issues in Tree Farm Licence (TFL) 41. The stakeholders for this project include West Fraser Mills Ltd., and the Ministry of Forests and Range (Forest Analysis and Inventory Branch and Northern Interior Forest Region).

This VSIP was prepared by the Timberline Natural Resource Group Ltd. and West Fraser Mills Ltd. The stakeholders should review this VSIP prior to developing the VRI Phase II Project Implementation Plan (VPIP) to ensure that it is consistent with their business needs.

The priority forest management issues identified by stakeholders are to address the taper, decay, and merchantability of hemlock and balsam on the TFL, and update the existing forest cover to VRI standards. Studies in the Kalum TSA indicate taper is overestimating volume, loss factors are missing decay, and conk and blind conk affected trees are yielding more volume than estimates predict. West Fraser believes this is also the case on TFL 41, and as such, intends to pursue a Phase II and Net Volume Adjustment Factor (NVAF) program. West Fraser intends to pursue the following VRI activities and products:

1. Install approximately 65 Phase II VRI timber emphasis ground plots in polygons greater than 30 years in the operable portion of the vegetated treed (VT) land base of TFL 41 to provide statistically valid timber volumes and polygon-specific tree attributes. This will likely follow a two-stage approach (to be completed in a single field season) whereby initially approximately 40 plots will be installed in the first stage to meet NVAF data needs. The second stage will focus on achieving a target sampling error of  $\pm 10\%$  at a 95% confidence level, which may require more or less than 25 additional samples (i.e., a total of 65 samples) to be completed.
2. Complete NVAF destructive sampling on the operable portion of the VT area in the TFL 41 to provide improved estimates of decay used for adjustment of the Phase II samples.
3. Consider implementing a Change Monitoring Inventory (CMI) to provide improved information on the growth & yield performance of second growth stands.

The VRI Phase II/NVAF VPIP will be completed following discussion and approval of this VSIP. The VPIP will provide details for implementation of VRI ground sampling in terms of geographic areas, scheduling, priorities, and plot location coordination, estimated inventory costs by year, and roles and responsibilities.

The proposed cost for completion of the full suite of Phase II, NVAF, statistical adjustment and a CMI program is \$410,000.

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## 1. INTRODUCTION

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### 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 Tree Farm Licence (TFL) 41. The VSIP provides details for photo interpretation, ground sampling, and statistical adjustment of the inventory. Following VSIP approval, the next steps include preparation of VRI Project Implementation Plans (VPIP) based on this VSIP, and implementation of the VPIPs.

The TFL 41 stakeholders group is comprised of participants operating within the Kalum Forest District, including Skeena Sawmills Ltd. – a division of West Fraser Mills Ltd., BC Timber Sales (BCTS) and the Ministry of Forests and Range (MoFR) represented by the Kalum Forest District, the Northern Interior Forest Region, and the Forest Analysis and Inventory Branch. The stakeholders are as follows:

- West Fraser Mills Ltd.
- MoFR

This VSIP follows a conference call with stakeholders that took place on September 26, 2006 in Terrace, BC. The following is a list of attendees for this meeting:

- Kim Haworth (Kingfisher Forest Sciences Co. Inc.)
- Damian Keating (West Fraser Mills)
- Gail Campbell (BCTS)
- Gary Johansen (MoFR – Victoria)
- Laurence Bowdige (MoFR – Victoria)
- Sam Otukol (MoFR – Victoria)
- Will Smith (MoFR – Victoria)
- Dick Nakatsu (MoFR – Prince George)
- George Burns (MoFR – Kalum Forest District)
- Hamish Robertson (Timberline Natural Resource Group Ltd.)
- Hugh Carter (Timberline Natural Resource Group Ltd.)
- Mike Sandvoss (Timberline Natural Resource Group Ltd.)

### 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*.<sup>1</sup>

The VRI consists of several components<sup>2</sup>:

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. Change Monitoring Inventory (CMI).
5. Statistical Adjustment.

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<sup>1</sup> Forest Resources Commission. 1991. *The Future of Our Forests – Executive Summary*. Unpublished, Victoria. 41 pp.

<sup>2</sup> A glossary of technical terms is provided in Appendix I.

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.<sup>3</sup>

### 1.3 VRI PLANNING

The VRI planning process requires that a VSIP and VPIP be developed for defined units (e.g. TSAs and TFLs). 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 is to ensure that baseline products meet a range of applications and are efficiently implemented. These processes and activities include:

1. Forest management decision processes (land integration planning);<sup>4</sup>
2. All agencies and stakeholders meet to explain and specify issues and to determine how VRI activities may assist in resolving 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. Licencee stakeholders work with MoFR staff to develop issue statements related to the 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. Identify new issues and address existing ones;
  - 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 2 and 3 and is signed off by stakeholders.

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<sup>3</sup> <http://www.for.gov.bc.ca/hts/vri/>

<sup>4</sup> The TFL 41 Sustainable Resource Management Plan (SRMP) is ongoing at this time.

5. VPIP process begins.

The VPIP details the activities identified under the VSIP (Phase I Photo Interpretation or Phase II Ground Sampling) by providing project areas; priorities; scheduling; identifying the population and strata for sampling; and sample size. The steps for preparing the VRI Phase I and Phase II/NVAF VPIPs include:

1. Review and update VSIP recommendations as necessary.
2. Secure funding.
3. Identify project activities, geographic areas, and costs.
4. Specify roles and responsibilities for project implementation.
5. Prepare the VPIP.

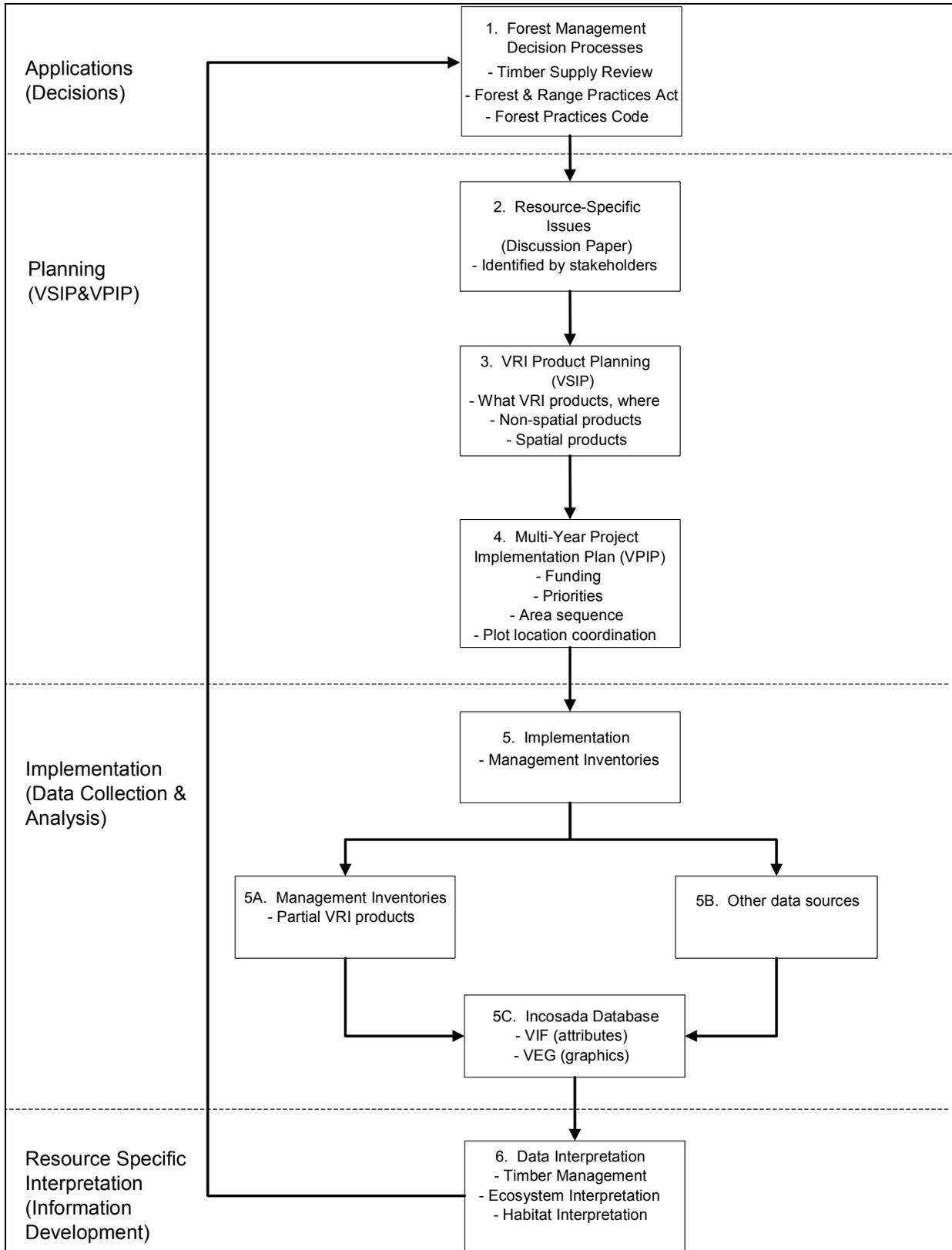


Figure 1. VRI planning process.

## **1.4 VRI METHODOLOGY**

### **1.4.1 Phase I – Photo-Interpretation**

Prior to commencing a VRI Phase I, a *VPIP for Photo Interpretation* must be completed and approved by the MoFR. This plan details photo acquisition requirements, the VRI Phase I process, standards for adherence, and a photo interpretation plan to implement the program.

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 digital 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 from field reference points 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* and NVAF destructive sampling plan must be completed and 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;
- Identify target and sample populations, sample selection, and sample size details;
- Quantify additional sample data that needs to be collected to address information gaps;
- Include discussion of the field program;
- Discuss the proposed data compilation, analysis, and statistical adjustment; and,
- Include the proposed implementation schedule.

The samples (samples are “plot clusters” and consist of a main plot and up to four associated auxiliary plots) 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 target population are provided for key inventory attributes.

### **1.4.3 Net Volume Adjustment Factor**

The MoFR VRI standards require all new VRI’s to complete an NVAF sampling program. This program involves detailed stem analysis of sample trees that have been randomly selected from the Phase II auxiliary 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 process is the statistical adjustment of the Phase I using the results of the Phase II sampling data.

NVAF data is used 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-adjusted photo-estimated attributes based on ground samples.

### **1.4.5 Change Monitoring Inventory**

A Change Monitoring Inventory (CMI) program takes measurements at timed intervals with the intent of monitoring change over time of key forest inventory attributes. These change estimates can then be compared to predictions derived from growth and yield models. One of the objectives 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. Specific studies can 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.

## 2. BUSINESS CONSIDERATIONS

### 2.1 LAND BASE

TFL 41 is situated on the north coast of B.C. in the Kitimat area (Figure 2) and covers approximately 750,000 hectares (Table 1). The total productive land base (treed and non-treed) used in the timber supply analysis was 332,924 ha (47% of the TFL area). The remaining 53% is composed mostly of salt water, alpine tundra, non-productive brush and other areas which do not support commercial forestry.<sup>6</sup>

The TFL is characterized by a mixed topography of rugged shorelines, steep mountainous terrain and round-topped ridges. The productive forest lies predominantly within the Coastal Western Hemlock (CWH) biogeoclimatic zone (wet subarctic and very wet subarctic subzones) with a smaller portion of the land base situated in the Mountain Hemlock (MH), Englemann Spruce Subalpine Fir (ESSF), and Alpine Tundra (AT) biogeoclimatic zones. The licence area supports a variety of commercial species including western hemlock (Hw), mountain hemlock (Hm), western red cedar (Cw), yellow cedar (Yc), lodgepole pine (Pl), Sitka spruce (Ss), Douglas-fir (Fd), and subalpine fir (Bl).<sup>6</sup>

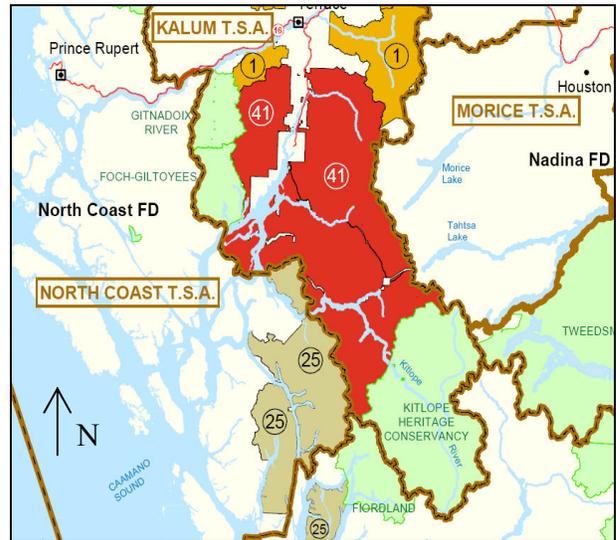


Figure 2. Overview of TFL 41.<sup>5</sup>

Table 1. TFL 41 Area breakdown.<sup>7</sup>

Land Class	Area (ha)	% of TFL
Total TFL	751,213	
Non-productive Area	410,590	55%
Productive Treed Area	284,188	38%
Parks	64,218	9%
THLB	69,020	9%

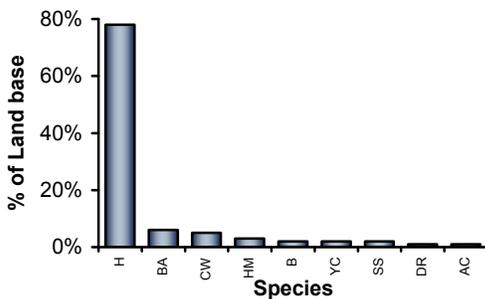


Figure 3. Species distribution in the vegetated treed portion of the TFL 41.<sup>7</sup>

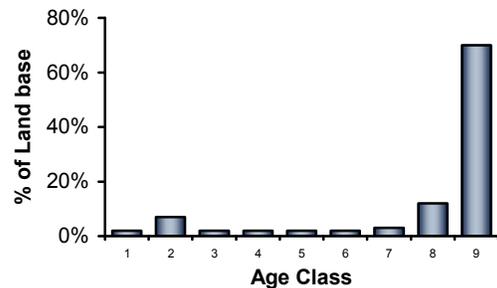


Figure 4. Age class distribution in the vegetated treed portion of the TFL 41.<sup>7</sup>

<sup>5</sup> This map is from the MOFR website: <http://www.for.gov.bc.ca/hth/timten/provincial-map.htm>

<sup>6</sup> BC Ministry of Forests. 1999. Tree Farm Licence 41: Rationale for Allowable Annual Cut (AAC) Determination. Unpublished Report, June 1999. p. 3.

<sup>7</sup> Data used was obtained from the LRDW via Meg Hoole from the MoFR.

## 2.2 FIRST NATIONS

TFL 41 is situated within the traditional territory of the Haisla First Nation. In a written submission to the licensee, the Kitimaat Village Council expressed general concerns regarding aboriginal title and rights to the lands and resources within its traditional territory.<sup>8</sup>

First Nations were consulted in preparation of this strategic inventory plan, and a letter from the District Manager has stated that all information sharing obligations with First Nations as per the FIA protocol have been satisfied.<sup>9</sup>

## 2.3 CURRENT FOREST COVER INVENTORY

The TFL 41 inventory was completed in 1998 using aerial photography taken in 1996 and 1997 and was completed on a TRIM base. An Inventory audit (sample-based field audit) was completed in 1997 on the previous inventory. Neither an inventory audit nor a VRI Phase II program has been completed on the current inventory. Implementing a new VRI Phase 2 sampling will provide an accuracy evaluation of the current inventory. Depletions for the inventory have been updated to 1998. Factors such as the 20% BCTS take-back have not yet been considered in Timber Supply Review (TSR).

A significant portion of the TFL (315,996 ha) was removed prior to the 1999 TSR, largely for the Kitlope Heritage Conservancy.

## 2.4 FOREST MANAGEMENT CONSIDERATIONS

The following forest management issues have been identified and discussed by the stakeholders:

ISSUE	PHASE I IMPACT	PHASE II IMPACT	COMMENT
<i>1. Hemlock and balsam volume estimation</i>	Low	High	<p>The majority of stands in the TFL 41 are hemlock or balsam leading (Figure 3). West Fraser identified the need to produce better estimates of merchantable volume (i.e., hemlock taper and decay, waste, and breakage) in these stands.<sup>10</sup> Studies in the Kalum TSA indicate taper is overestimating volume, loss factors were understating decay, and conk and blind conk affected trees were yielding more volume than estimates predict.</p> <p>A well-designed NVAF program should address these issues.</p>

<sup>8</sup> Tree Farm Licence 41 – Rationale for Annual Allowable Cut (AAC) Determination (December, 1999)

<sup>9</sup> Kim Haworth – e-mail communication regarding first nations interests in TFL 41.

<sup>10</sup> Measurements to obtain information on merchantability are currently outside the scope of a standard NVAF program. This being said additional measurements for these attributes should be considered during the development of the Phase

<b>2. Monitoring</b>	Low	High	<p>Monitoring is used to track the performance of modeling assumptions, and to help develop and/or modify yield curves used for timber supply analysis.</p> <p>A well-designed CMI program can help the development and/or modification of yield curves, and is an effective way to quantify attributes in managed stands.</p>
<b>3. Site productivity</b>	Med	Med	<p>The 1999 AAC Determination<sup>11</sup> suggested that the inventory might under-estimate site productivity in old-growth stands. Height and age will be adjusted in the existing inventory based on the information collected in the field. Height and age are used to determine site index in the inventory.</p>
<b>4. Operable land base</b>	Low	Low	<p>West Fraser intends to focus their ground-sampling program in the operable land base, and have confirmed that the operable land base definition is stable. This is economically more efficient and safer than sampling in the inoperable land base.<sup>12</sup></p>
<b>5. Operational information</b>	Low	Moderate	<p>West Fraser is interested in better information on sawlog volume and other operational attributes. They prefer to use coastal grades to compliment the standard VRI grades used in the ground sampling.</p> <p>Variances are available for the collection of non-standard data and can be considered at the project implementation plan stage.<sup>13</sup></p>

## 2.5 SUMMARY OF INVENTORY ISSUES

The following list summarizes the inventory requirements identified by West Fraser. These include the need for the inventory to:

- Adjust inventory attribute information on all polygons in the TFL.
- Provide updated information on decay and potentially identify taper issues for hemlock and balsam.
- Be consistent with adjacent Management Units that are in the process of being updated to VRI standards.
- Satisfy forest certification requirements.
- Be in a consistent and accessible format.
- Provide more accurate overall age and height estimates for determining site index.

<sup>11</sup> BC Ministry of Forests. 1999. Tree Farm Licence 41 Rationale for Allowable Annual Cut Determination. June 11, 1999.

<sup>12</sup> The definition of the operable land base used for the target population will be finalized during the development of the Phase II VPIP.

<sup>13</sup> This will be finalized through discussion with the MoFR during the development of the Phase II VPIP to ensure that the appropriate attributes are being measured to satisfy the information needs of the licensee.

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## 3. STRATEGIC INVENTORY PLAN

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### 3.1 OVERVIEW

This section outlines the strategic inventory plan to implement VRI products to address the business issues discussed in Section 2.4. West Fraser intends to complete a Phase II timber emphasis ground sampling and NVAF program. The Phase II field data will be used in the statistical adjustment of the existing inventory. Most of the identified business needs will be addressed through completion of the ground sampling, and statistical adjustment.

### 3.2 PHASE I – PHOTO-INTERPRETATION

#### 3.2.1 Objective

West Fraser has decided that a Phase I VRI on TFL 41 is not required at this time. In the last Determination, the Chief Forester suggested that the inventory was accurate. Photos were flown in 2001 and 2003 and are either out of date or not acceptable for use. If West Fraser were to proceed with developing a new inventory, they would require new aerial photos.

### 3.3 PHASE II – GROUND SAMPLING

#### 3.3.1 Objective

The primary objective of the Phase II Ground-Sampling is to install enough plots to:

1. estimate the average net merchantable volume in the target population with a sampling error of  $\pm 10\%$  at a 95% confidence level, and
2. install enough Timber Emphasis Plots (TEP) to provide sufficient data to support the NVAF destructive sampling program.

#### 3.3.2 Target Population

The target population will be the operable portion<sup>14</sup> of the Vegetated Treed (VT) area within TFL 41, 30 years or older. If the BC Land Classification Scheme (BCLCS) information is unavailable, VT will be defined as polygons where a leading species exists and crown closure is greater than or equal to 10%.

#### 3.3.3 Sample Size

The coefficient of variation (CV) for the ratio of means of the inventory audit versus the operable volume of the inventory was 30%.<sup>15</sup> The MoFR suggests based on experience that the CV be increased by 10% to 40%; this means that 65 samples are required to achieve the target sampling error of  $\pm 10\%$ . Conversely, if the CV is 30%, then the sampling error would be  $\pm 8\%$ .

#### 3.3.4 Sampling Approach

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<sup>14</sup> The definition of the operable land base used for the target population will be finalized during the development of the Phase II VPIP.

<sup>15</sup> The CV of the ratio of means was calculated using the 1997 TFL 41 inventory audit results for the analysis of the operable area volumes, including additional 1995 samples. A new inventory has since been completed.

Phase II certified timber samplers will install all VRI TEPs to VRI ground sampling standards.<sup>16</sup> Sampling will follow a two-stage approach (to be completed in a single field season). The first stage is to install a minimum number of TEPs (approximately 40) to support NVAF information needs. The second stage will be to install enough TEPs to achieve a target sampling error of  $\pm 10\%$  at a 95% confidence level (likely 25 plots). This approach will be refined and updated in the Phase II VPIP.

### **3.3.5 Sample Selection**

Sample locations will be selected using the standard MoFR method. First, polygons will be selected using the probability proportional to size with replacement (PPSWR) method. Second, a random point will be selected within the selected 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.

## **3.4 NET VOLUME ADJUSTMENT FACTOR**

### **3.4.1 Objective**

The objective of the NVAF component is to estimate NVAF ratios with a sampling error of  $\pm 7.5\%$  at a 95% confidence level.

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.

### **3.4.2 Sample Size**

The MoFR requires a minimum sample size of 100 NVAF trees of which 75 are live and 25 dead. The final sample size and distribution by species will be determined during development of the Phase II VPIP. The relative species distribution (in terms of net merchantable volume) will be estimated and the actual sample size for each species group determined based on the species distribution.

The stakeholders specifically noted that hemlock and balsam tree taper is an area of uncertainty and believe that current taper equations do not adequately model trees on TFL 41. The NVAF will be able to provide some certainty to the size of the errors due to the taper and loss, which can guide future sampling efforts that would be required to adjust the taper and net factors.

### **3.4.3 Sample Selection**

The number of VRI Phase II plots that will be enhanced for NVAF sampling will be determined following discussion with MoFR and will be provided in the VRI Phase II VPIP.

Following completion of the first stage of the Phase II ground sampling program, a tree matrix will be built with all trees from the auxiliary plots of the NVAF-enhanced samples. The sample in each matrix cell will be selected systematically with a random start after the tree list in the cell is sorted by species and diameter at breast height (DBH).

## **3.5 CHANGE MONITORING INVENTORY**

CMI is considered an important tool to track the modeling assumptions used for second-growth stands. The stakeholders intend to implement a CMI program in stands less than 30 years of age as information on the mid to long-term timber supply was identified as a business priority.

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<sup>16</sup> [http://ilmbwww.gov.bc.ca/risc/pubs/teveg/vri\\_gs\\_2k4/vri\\_gs\\_2k4.pdf](http://ilmbwww.gov.bc.ca/risc/pubs/teveg/vri_gs_2k4/vri_gs_2k4.pdf)

### 3.6 ESTIMATED COSTS

The costs provided below include the additional costs for re-flying the entire TFL and the cost of a Phase I program (Table 2). However, West Fraser intends to proceed with a Phase II/NVAF Program only. The total project cost for a Phase II Ground Sampling program is approximately \$439,000. If West Fraser decides to complete a Phase I program the total approximate cost will be \$1,104,500, of which approximately \$324,000 will be spent on new photo acquisition.

Table 2. Estimated costs for VRI activities in the TFL 41.

VRI Activity	Units	Unit Cost (\$/Unit)	Total Cost (\$)
PHOTO ACQUISITION (100% COVERAGE)	100 @ 1:15,000 Colour	\$3,245/Sheet	\$324,500
<i>Sub-Total</i>			<i>\$324,500</i>
PHASE I (PROJECTED FUTURE COSTS)			
Phase I VPIP	1	\$7,500	\$7,500
Phase I VRI		\$1.00/ha	\$750,000
Quality Assurance	1	\$0.03/ha	\$22,500
<i>Sub-Total</i>			<i>\$780,000</i>
PHASE II			
Phase II VPIP <sup>a</sup> and Sample Packages	1	\$17,500	\$17,500
Timber Emphasis Plots	65	\$1,700/plot	\$110,500
Helicopter	50	\$1,000/hr	\$50,000
Quality Assurance	7	\$1,700/plot	\$11,900
<i>Sub-Total</i>			<i>\$190,000</i>
STATISTICAL ADJUSTMENT			
Data compilation	1	\$1,000	\$1,000
Adjustment, NVAF Analysis & Report	1	\$20,000	\$20,000
<i>Sub-Total</i>			<i>\$21,000</i>
NVAF			
VPIP Update / Tree Selection	1	\$2,000	\$2,000
Destructive Sampling	100	\$750/tree	\$75,000
Helicopter	30	\$1,000/hr	\$30,000
<i>Sub-Total</i>			<i>\$107,000</i>
CMI			
CMI VPIP <sup>a</sup> and Sample Packages	1	\$17,500	\$17,500
Plot Establishment	50	\$1,700/plot	\$85,000
Quality Assurance	8	\$1,700/plot	\$13,600
Installation Report	1	\$5,000	\$5,000
<i>Sub-Total</i>			<i>\$121,100</i>
<b><i>Phase II / NVAF Total Estimated Cost</i></b>			<b><i>\$318,000</i></b>
<b><i>CMI Total Estimated Cost</i></b>			<b><i>\$121,100</i></b>
<b><i>Photo Acquisition Cost (when completed)</i></b>			<b><i>\$324,500</i></b>
<b><i>Phase I Cost (when completed)</i></b>			<b><i>\$780,000</i></b>
<b><i>Approximate Total Cost</i></b>			<b><i>\$1,553,500</i></b>

<sup>a</sup> This should be done in conjunction with a Phase II VPIP.

#### 4. SIGN-OFF SHEET

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I have read and concur that the TFL 41 VRI Strategic Inventory Plan dated March 2007 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.

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Jon Vivian, R.P.F. Manager,  
Vegetation Resources Inventory Section,  
Forest Analysis and Inventory Branch,  
Ministry of Forests and Range

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*Date*

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West Fraser Mills. (lead proponent)

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*Date*

## **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:

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

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 land base) 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.,  $\pm 10$  at the 95% probability level). This means that 95% of the time we are confident that the volume estimates are within 10% 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.

- *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 land base. 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.

## APPENDIX II – MAPSHEET AREA SUMMARY

Mapsheet	Total Area in TFL (ha)	Treed Area* (ha)	Productive Treed Area (ha)	THLB Area (ha)	Non-Productive Area (ha)	Park Area (ha)
093E011	161.8	161.8	-	-	161.8	8.8
093E021	6,224.1	6,224.1	1,581.2	75.5	4,059.0	4.4
093E031	9,518.0	9,518.0	2,388.7	150.7	6,330.6	12.6
093E041	13,958.4	13,958.4	3,149.9	373.2	9,026.5	2.5
093E042	5,151.5	5,151.5	1,068.1	84.6	3,557.3	3.5
093E043	1,941.4	1,941.4	5.1	-	1,935.8	105.4
093E051	14,753.7	14,753.7	5,435.9	972.9	6,275.4	-
093E052	8,292.1	8,292.1	1,754.6	45.7	6,236.0	-
093E053	1,113.3	1,113.3	13.3	-	1,072.9	-
093E061	14,140.4	14,140.4	5,829.8	1,136.9	7,413.2	-
093E062	1,357.4	1,357.4	30.1	-	1,195.3	-
093E071	9,025.0	9,025.0	2,073.4	282.3	6,469.2	-
093E081	1,621.3	1,621.3	36.3	-	1,541.6	-
093L001	38.8	38.8	-	-	38.8	-
093L011	158.9	158.9	-	-	158.9	-
093L021	307.7	307.7	-	-	307.5	-
103H010	4,482.0	4,482.0	488.0	-	3,719.8	10.9
103H019	63.9	63.9	-	-	62.1	-
103H020	11,035.4	11,035.4	2,934.8	347.8	7,565.2	14.5
103H029	4,397.9	4,397.9	116.9	-	4,172.9	-
103H030	14,857.2	14,857.2	4,350.2	610.9	9,595.7	-
103H039	7,810.6	7,810.6	1,014.8	30.2	6,096.1	-
103H040	14,822.5	14,822.5	4,807.5	827.8	9,228.6	-
103H048	4,453.5	4,453.5	1,296.3	-	2,959.5	-
103H049	14,686.4	14,686.4	4,389.2	613.7	9,303.7	-
103H050	14,788.2	14,788.2	3,482.2	267.9	10,028.8	-
103H056	3,983.9	3,983.9	2,273.3	891.0	1,650.8	-
103H057	702.1	702.1	423.3	267.6	278.8	-
103H058	8,935.6	8,935.6	2,059.6	-	5,884.2	604.8
103H059	14,753.7	14,753.7	2,858.5	202.7	10,212.1	403.6
103H060	14,753.7	14,753.7	3,655.1	889.2	9,376.7	-
103H065	4,740.9	4,740.9	2,338.7	459.1	2,241.4	-
103H066	14,351.9	14,351.9	6,613.8	1,691.4	7,029.4	12.4
103H067	13,386.9	13,386.9	7,101.3	1,216.3	5,102.4	31.1
103H068	12,791.1	12,791.1	4,097.1	788.2	7,888.9	-
103H069	14,719.2	14,719.2	2,200.7	92.9	9,796.2	-
103H070	14,719.1	14,719.1	2,722.6	192.5	10,464.6	-
103H074	1,760.9	1,760.9	37.6	-	1,707.9	1,760.8

103H075	9,651.5	9,651.5	3,505.8	718.4	6,069.7	6,907.8
103H076	14,640.9	14,640.9	4,723.9	589.5	9,911.2	1,087.8
103H077	14,684.6	14,684.6	7,824.4	1,500.9	5,047.5	112.4
103H078	14,684.5	14,684.5	7,583.3	1,888.5	5,989.0	-
103H079	14,684.6	14,684.6	6,854.6	1,052.8	6,440.5	-
103H080	14,684.5	14,684.5	3,604.0	574.9	9,369.4	-
103H084	6,945.0	6,945.0	429.0	-	5,946.0	6,944.9
103H085	14,649.9	14,649.9	3,844.0	218.9	9,529.2	14,636.1
103H086	7,289.0	7,289.0	3,938.7	872.9	3,226.7	3,669.6
103H087	13,245.9	13,245.9	5,980.1	2,883.0	6,907.8	183.4
103H088	14,649.9	14,649.9	9,424.6	4,336.4	4,460.6	742.0
103H089	14,649.8	14,649.8	4,839.8	899.9	8,469.0	-
103H090	14,102.1	14,102.1	1,597.3	-	11,242.5	-
103H094	4,692.2	4,692.2	53.1	-	4,414.9	4,692.2
103H095	14,615.1	14,615.1	3,457.5	-	8,935.2	13,333.9
103H096	12,053.1	12,053.1	5,213.4	1,357.8	6,204.3	599.1
103H097	8,847.5	8,847.5	5,287.0	2,328.5	2,934.2	-
103H098	14,389.0	14,389.0	8,427.0	2,895.6	5,404.1	-
103H099	14,615.3	14,615.3	6,755.1	1,934.8	6,791.3	-
103H100	10,554.6	10,554.6	1,843.2	190.5	6,871.5	-
103I004	2,816.7	2,816.7	283.1	-	2,097.5	2,816.7
103I005	6,943.8	6,943.8	876.2	-	5,391.1	4,932.8
103I006	14,292.6	14,292.6	5,173.9	814.2	8,205.6	30.9
103I007	5,354.4	5,354.4	3,031.4	349.6	2,155.9	-
103I008	9,987.2	9,987.2	7,174.0	2,857.9	2,760.5	-
103I009	14,580.4	14,580.4	8,426.8	2,473.1	5,567.3	-
103I010	12,276.4	12,276.4	3,534.7	738.1	8,186.2	-
103I015	650.9	650.9	-	-	645.9	142.6
103I016	13,695.4	13,695.4	5,047.7	198.1	7,674.6	26.3
103I017	9,905.7	9,905.7	8,150.5	3,113.9	1,253.3	1.3
103I018	9,514.5	9,514.5	5,980.3	1,861.6	3,383.3	66.8
103I019	14,545.7	14,545.7	7,257.1	896.9	6,752.5	-
103I020	14,274.2	14,274.2	7,078.5	3,669.5	6,150.1	-
103I025	451.1	451.1	-	-	441.1	7.9
103I026	12,195.2	12,195.2	4,374.2	610.8	5,834.9	-
103I027	10,949.6	10,949.6	7,877.5	3,307.4	2,674.1	-
103I028	8,807.8	8,807.8	7,202.3	3,541.0	1,267.3	-
103I029	14,510.9	14,510.9	10,049.6	3,519.2	4,228.0	-
103I030	10,069.5	10,069.5	3,707.8	730.5	5,591.5	-
103I036	864.4	864.4	114.0	-	635.9	-
103I037	5,136.5	5,136.5	3,218.3	669.3	1,587.2	30.9

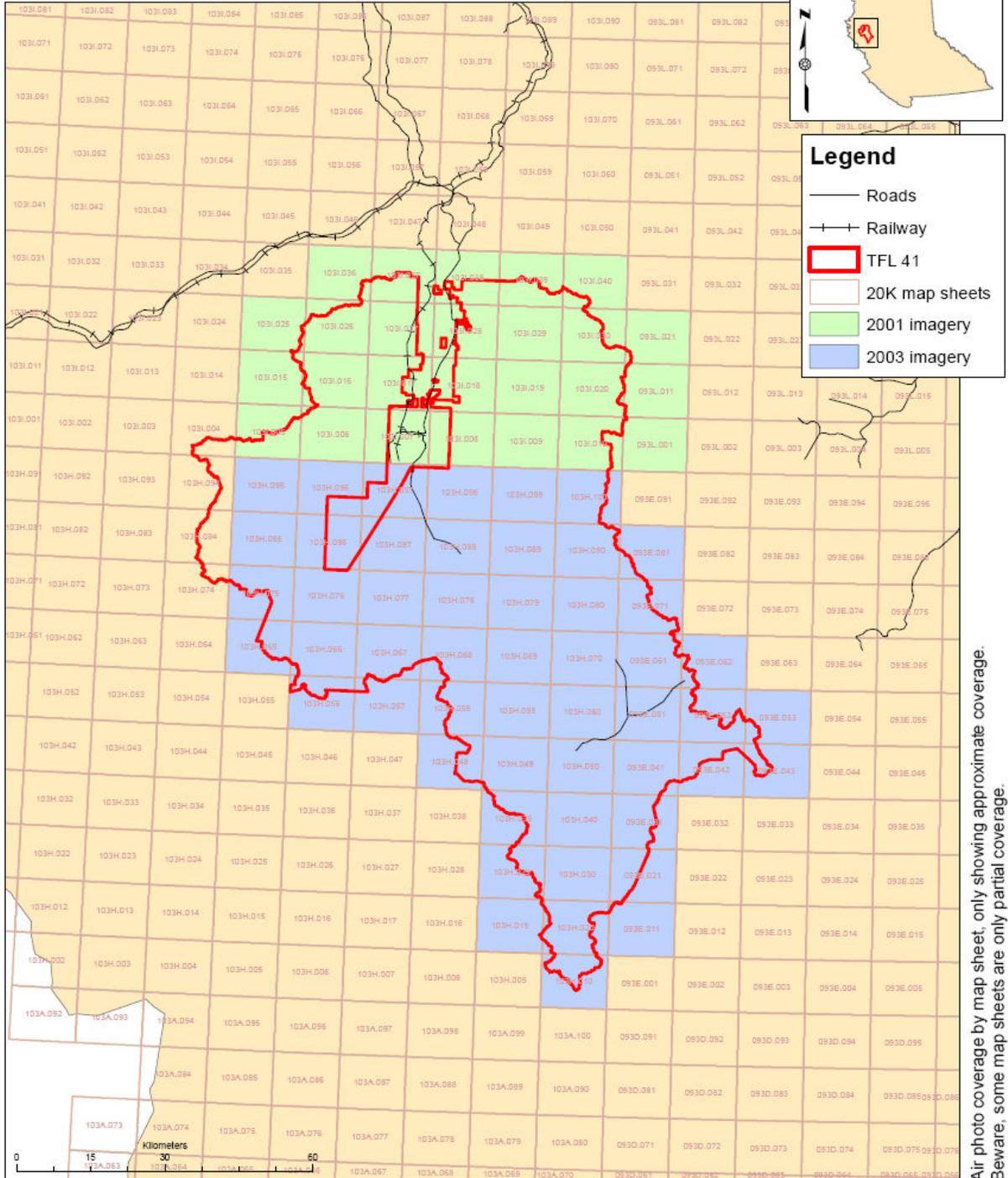
103I038	4,810.1	4,810.1	3,601.9	1,534.6	760.2	278.2
103I039	5,984.4	5,984.4	3,913.5	1,334.5	1,974.2	-
103I040	1,506.6	1,506.6	301.7	46.1	1,062.5	-
Total	751,213.2	751,213.2	284,188.0	69,020.4	410,590.3	64,218.5

\*Treed Area includes Alpine Forest, Productive Treed Area does not

APPENDIX III – TFL 41 AIRPHOTO COVERAGE MAP

TFL 41 Air Photo Coverage

1:1,000,000



Air photo coverage by map sheet, only showing approximate coverage. Beware, some map sheets are only partial coverage.

\*Note map has been refit to fit on this page.