

Prince George Timber Supply Area – TSA 24

Vegetation Resources Inventory Project Implementation Plan Including Volume Audit Sampling and Young Stand Monitoring

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Executive Summary

This Vegetation Resources Inventory (VRI) Project Implementation Plan (VIP) is the planning document that will be used as a guide for VRI Volume Audit (VA) and Young Stand Monitoring (YSM) sampling projects in the Prince George Timber Supply Area (TSA). The details recorded in this plan regarding each activity include:

- an outline of the land base including the netting down process;
- documentation of the sample selection;
- a listing of all sample locations; and
- confirmation of the sampling protocols for each planned VRI activity.

This Project Implementation Plan has been prepared following the documents:

- *Vegetation Resources Inventory Sample Selection Procedures for Ground Sampling v4.0 DRAFT*
- *VRI Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling (Version 3.1)*
- *Streamlining VRI Ground Sampling Volume Audit (VA) Sampling*
- *A Framework for Implementing Young Stand Growth Monitoring in British Columbia (2012)*

The Volume Audit samples were selected from the Vegetated Treed (VT) land base greater than 50 years with the following exclusions:

- The area in Prince George TSA north of NTS Letter Block 093M;
- BEC zone BAFA and all BEC zone ESSF except subzones mm1, mv1, wk1 and xv1;
- Private land, parks, and federal lands including Indian Reserves and Military Reserve; and
- Tree Farm License (TFL) 30 and TFL53.

The Volume Audit ground sample selection has been completed based on an initial stratification of the population by leading species representation. The strata are:

- Stratum 1: Pine
- Stratum 2: Spruce
- Stratum 3: Balsam
- Stratum 4: Other

The VA strata have been further stratified into three (3) sub-strata, based on volume. The VA sample list is made up of one hundred (100) initial samples and thirty (30) alternates.

A separate sample selection process is also outlined in the plan for the establishment of Young Stand Monitoring samples in stands ≥ 15 years and ≤ 50 years. The land base for the Young Stand Monitoring samples is NOT restricted to the Vegetated Treed land base. The 'net down' process for the YSM sample selection included the exclusion of the area in the TSA north of NTS Letter Block 093M, TFLs 30 and 53, private land, parks and federal land including Indian reserves and Military Reserve. The YSM sample selection does not involve any pre-stratification of the population. The sample selection is grid based. In this TSA a 10 X 10 km grid provided by Forest Analysis and Inventory Branch (FAIB) staff yielded 74 samples.

Table of Contents

1.0 Introduction	1
1.1 Document Objectives	1
1.2 Project Land base	2
1.3 State of the Inventory	4
2.0 Ground Sampling Plan	5
2.1 Sampling Objectives	5
2.2 Target Population	6
2.3 Sample Size	8
2.4 Strata	8
2.4.1 Prince George TSA – YSM Population	8
2.4.2 Prince George TSA – Volume Audit Population	8
2.5 Sample Selection	10
2.5.1 Ground Sampling	10
2.6 Sample Establishment Methodology	11
3.0 Implementation Plan	11
3.1 Sample Packages	11
3.2 Standards	11
3.3 Sample List	12
3.4 Project Files	12
3.5 Project Analysis	12
Bibliography	12
VRI Standards and Procedures	13
Appendices	
Appendix A: Sample List for Ground Samples	15
Appendix B: Comparison of Sample to the Population	24
Appendix C: Sampling Selection Process and Methodology	27
List of Figures	
Figure 1. Map of Prince George TSA	3
List of Tables	
Table 1. Prince George TSA Land Base Summary	4
Table 2. Species Distribution- VT- VA	7
Table 3. Species Distribution- YSM – Ages 15-50	7
Table 4. Age Class Distribution – All Species – VA	7

Table 5. Age Class Distribution – All Species – YSM	8
Table 6. Criteria for Sub-stratification – VA Population	9
Table 7. Ground Sample Distribution – VA Population	9
Table 8. Sample Distribution by Volume – VA Population	10

1.0 Introduction

The Vegetation Resources Inventory (VRI) is the standard for forest cover inventory in the province of British Columbia (BC). It follows a set of procedures with associated standards, administered by the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO or 'the Ministry'). The VRI was designed to answer two questions: "Where is the resource located?" and "How much of given vegetation resource is within an inventory unit?"¹

The VRI is a photo based, 2-phase program. Phase 1 involves photo interpretation, delineating polygons of homogenous land cover types and providing estimates of the vegetation attributes for each polygon. Phase 2 includes several ground sampling activities. The Volume Audit (VA) activity samples a random subset of polygons to verify the confidence in the accuracy of the Phase I volumes as well as some of the other key vegetation attributes. It provides detailed information on tree size and condition. Ground sampling may also include the Young Stand Monitoring (YSM) activity. YSM involves the establishment of long term monitoring plots following the Change Monitoring Inventory (CMI) standard. It is intended that these plots will be remeasured at a fixed interval.

To date, Vegetation Resource Inventory activities for the Prince George Timber Supply Area (TSA) have been planned and implemented independently in each of the three Natural Resource Districts that make up this TSA. This Project Implementation Plan (VIP) has been prepared to outline VRI ground sampling activities for the entire Prince George TSA. It provides details to undertake Volume Audit sampling and for the establishment of a Young Stand Monitoring program.

1.1 Document Objectives

The objectives of preparing this Project Implementation Plan are two-fold. This document provides a record of the decisions made to develop the Volume Audit and Young Stand Monitoring sample lists. It also serves as a guide for those undertaking these projects.

Specific details provided in this VIP include the identification of:

- decisions made in the development of the sampling population and sample lists;
- the sampling population;
- sample lists for the Volume Audit and Young Stand Monitoring populations;
- VRI data collection methodology for the VA and YSM sampling; and
- deliverables for the VRI activities.

¹ From the MFLNRO, Forest Analysis & Inventory Branch, Vegetation Resources Inventory website – Overview - <http://www.for.gov.bc.ca/hts/vri/intro/overview.html>

1.2 Project Land base²

The Prince George TSA is located in the north-central interior of British Columbia. Geographically, it stretches from near the Alberta border in the southeast to Tweedsmuir Provincial Park in the southwest and the Spatsizi Plateau Wilderness Park in the northwest. The TSA includes the City of Prince George, the larger communities of Vanderhoof and Fort St. James and several smaller communities such as Fraser Lake.

The project area does not cover the entire TSA landbase. The northern portion of the Fort St James Natural Resource District has been excluded from sampling activities. The area is not currently being used for forest operations and there is not a strong business case to sample it for Timber Supply Review (TSR) purposes.

The Prince George TSA is part of the Ministry of Forests, Lands and Natural Resource Operations' Omineca Region. There are three Natural Resource Districts within the TSA: Prince George, Vanderhoof and Fort St. James. Each district is responsible for the administration of the forest management activities within its borders.

Figure I provides a map of Prince George TSA illustrating the three Natural Resource Districts administered within the TSA and the TSA's general location in the province of BC.

² Text adapted from the Prince George TSA Rationale for Allowable Annual Cut (AAC) Determination – Jan 11/11.

Figure 1. Map of Prince George TSA

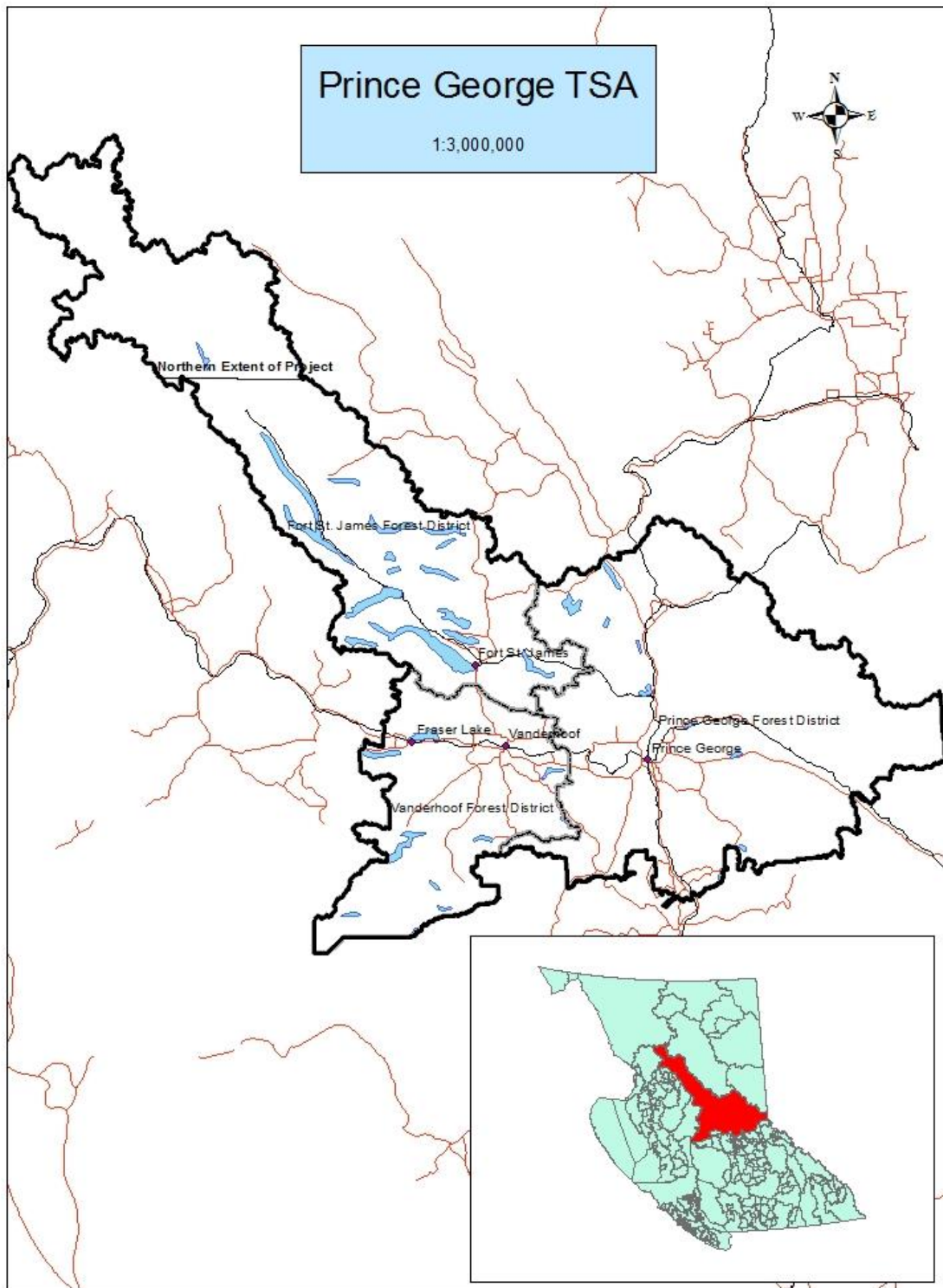


Table 1 is a summary of the project area land base.

Table 1: Prince George TSA Land base Summary

Land Classification	Area (ha)	% of Project Area
Total Project Area	6,509,204	100
Net-downs	857,924	11.15%
Parks	448,951	5.83%
Private	381,171	4.95%
Federal	9,093	0.12%
Indian Reserve	18,709	0.24%
Net Area	5,651,280	73.42%
Non Vegetated	378,632.00	4.92%
Vegetated	5,272,648.00	68.50%
Non-Treed	989,921.00	12.86%
Treed	4,282,727.00	55.64%

The central and southwestern portion of the TSA is fairly flat and rolling with gentle slopes and supports forests of predominantly lodgepole pine and white spruce. The eastern part of the TSA is along the Rocky Mountains where spruce and subalpine fir dominates the higher elevations and forests of large old western red cedar and western hemlock dominate the lower elevation. The northwestern portion of the TSA is covered by the Omineca and Skeena mountain ranges. In this part of the TSA, pine dominates the valley bottoms, spruce the lower and mid-slopes and subalpine fir on the upper slopes.

The dominant BEC zone in the TSA is the Sub-boreal Spruce (SBS). The Engelmann Spruce – Sub-alpine Fir (ESSF) subzone also has a significant presence. The dominant tree species in the TSA's Timber Harvesting Land Base (THLB) are lodgepole pine (about 49% of the volume) and spruce (33%).

1.3 State of the Inventory

In 1997 and 1998 an Inventory Audit was undertaken in the TSA on the 'current' (1975 to 1993) inventory. The Audit results for the mature component of the inventory suggested that the inventory may overestimate volume. Post-stratification of the audit data pointed to the overestimation bias being within the Prince George District. Further analysis indicated height overestimation in spruce stands to be an issue in the inventory.

A number of VRI projects by District have since been planned and undertaken starting in 2000. The initial objective of the Stakeholders was to upgrade the Districts' inventories to Provincial standards. Phase 1 was completed to provide a VRI standard inventory in each of the three Districts administered in the Prince George TSA by 2005

Vanderhoof was a VRI retrofit project, which involved estimating new VRI attributes on the existing polygon delineation. The others two Districts were standard VRI Phase 1 projects. Phase 2 projects and statistical analysis by District have also been completed. Most recently, new photos were flown in 2012 for a VRI Phase I Photo Interpretation project in the Vanderhoof District.

Mountain pine beetle (MPB) has been active in the TSA. The pine stands have been impacted by an unprecedented high level of infestation that occurred in British Columbia over the past decade. MPB peaked in the Prince George and Vanderhoof Districts in 2004 and in the Fort St. James District in 2006. The inventories in the three Districts should be redone to capture the change that has occurred.

The inventory files used for this project's sample selection reflect the following updates:

- Vanderhoof District - harvest and reforestation updates current to 2011
- Vanderhoof District – polygon volumes adjusted to reflect MPB mortality
- Fort St. James District – depletion updates completed to November 2013
- Prince George TSA (all Districts) - ages projected to 2014

2.0 Ground Sampling Plan

2.1 Sampling objectives

The state of the forest inventory in the Prince George TSA has seen ongoing discussion since 2000 in the numerous Vegetation Resourced Inventory Implementation Plans (Strategic Inventory Plans or VSIPs and VPIPs), some of which are available on the Ministry's VRI website. There were numerous projects designed to resolve various sampling objectives. These activities were planned by Forest District. Then, in the past decade, a catastrophic level of infestation of mountain pine beetle in the healthy vigorous pine of the TSA left the Stakeholders with questions regarding the utility of the existing inventory for TSR and daily management. From a review of the District-focused planning documents and the most recent Annual Allowable Cut determination for the TSA, a number of information requirements appear to exist across the TSA regarding the following issues:

1. Live volume for all species.
2. Mid-term timber supply.
3. Post Harvested Regenerated (PHR) stands – Will these be a source of future long-term timber. Are they achieving expected site productivity? Extent of the mortality in the pine types?
4. Merchantability and 'shelf life', particularly in the 'pure' dead standing timber.
5. Biodiversity/habitat management.

An over-riding objective is to provide the Chief Forester with an inventory that he can use with confidence when making TSR decisions.

This plan outlines the undertaking of a Volume Audit sampling project to verify the accuracy of volumes and other key attributes in the inventory. It will provide a statistically valid analysis of the volumes in the mature population. A sampling error of 15% (net volume) is the target set for the Volume Audit population.

A Young Stand Monitoring program is also to be initiated across the TSA, following the CMI procedures and standards. The primary focus of the YSM program is to check the accuracy of growth and yield (G&Y) predictions of key timber attributes in young stands, to support management unit timber supply review. No sampling error target will be set for the Young Stand Monitoring. The YSM program targets a statistical power and difference between actual and predicted G&Y estimates.

2.2 Target Population

The project uses two different areas and populations within the Prince George TSA for sampling. They are as follows:

1. Volume Audit sampling will occur on the Vegetated Treed component of the land base. The Volume Audit population includes stands ages 51 years and older.
2. The Young Stand Monitoring project population is not restricted to the Vegetated Treed component of the land base. This allows for the inclusion of silviculture openings where the crown closure in the database is less than 10%. These openings are an important portion of the YSM population. The age of the stands is 15 to 50 years.

The exclusions from both the Volume Audit and the YSM land base have included area in the TSA north of NTS Letter Block 093M, private land, parks and federal lands including military reserves and Indian reserves. Community Forests and Woodlots have been retained.

An additional exclusion to the Volume Audit population land base is BEC based and is related to operability. This exclusion includes BEC zone BAFA and all BEC zone ESSF except subzones mm1, mv1, wk1 and xv1.

Tables 2, 3, 4 and 5 provide land base figures.³ For the Volume Audit population, figures in Table 2 have formed the basis for the decisions regarding the stratification of the population.

³ Numbers related to identifying the sampling population are the result of analytical work completed by Nona Phillips Forestry Consulting, using current data files provided by the Ministry. All work has followed the *VRI Sample Selection Standard* and has been documented in a Sample Selection Report provided to the government.

Table 2: Species Distribution – Volume Audit Population - Vegetated Treed Land base, Ages 51+

SPECIES_CD	Sum_NewAre	%
P	1,220,400.72	41.64%
S	1,034,964.93	35.31%
B	336,193.90	11.47%
AC	192,862.80	6.58%
FD	56,336.31	1.92%
CW	38,146.56	1.30%
H	25,393.51	0.87%
EP	25,370.22	0.87%
LT	1,375.54	0.05%
WS	73.13	0.00%
QG	11.23	0.00%
L	7.54	0.00%
W	7.15	0.00%
Total	2,931,143.54	100.00%

Table 3: Species Distribution – Young Stand Monitoring Population, Ages 15-50

Species	Area (ha)	%
S	302,510	43.34%
P	291,118	41.70%
AT, ACT	44,957	6.44%
B	36,210	5.19%
EP	13,078	1.87%
FD	8,878	1.27%
CW	653	0.09%
HW	610	0.09%
DR	33	0.00%
LT	15	0.00%
QG	9	0.00%
Total	698,071	100.00%

Table 4: Age class Distribution, All Species – Volume Audit Population, Ages 51+

Age Class	Area (ha)	%
51-60	70,822	2%
61-80	178,247	6%
81-100	470,642	16%
101-120	292,893	10%

121-140	419,721	14%
141-160	1,354,798	46%
161+	144,021	5%
Total	2,931,144	100%

Table 5: Age class Distribution, All Species – Young Stand Monitoring Population, Ages 15 – 50

Age Class	Area (ha)	%
15-20	166,722	24%
21-40	452,388	65%
41-50	78,961	11%
Total	698,071	100%

In summary, in the Prince George TSA, the land base in the Volume Audit population is 2,931,144 hectares while the Young Stand Monitoring population encompasses a total area of 698,071 hectares.

2.3 Sample Size

In the Prince George TSA, the contract *Schedule A* stated that a total of 100 ground samples would be established in the Volume Audit population. The sample list includes the original 100 samples selected plus an additional 30 Volume Audit samples, to be available as alternates, if required.

The Young Stand Monitoring sampling project population was determined by overlaying a number of grids provided by the Ministry over the land base. From this exercise, a 10 X 10 km grid size was selected, which resulted in a sample list of 74 YSM samples.

2.4 Strata

2.4.1 Prince George TSA - Young Stand Monitoring Population

There was no pre-stratification of the Young Stand Monitoring population in the sample selection process.

2.4.2 Prince George TSA -- Volume Audit Population

The Volume Audit population has been stratified based on species distribution. An analysis of Table 2 resulted in four species groupings as follows:

- Stratum 1: Pine
- Stratum 2: Spruce
- Stratum 3: Balsam

- Stratum 4: Other

Each stratum was further divided into 3 sub-strata with roughly equal numbers of polygons, based on Volume. Table 6 below describes the criteria used for sub-stratification of the population into Volume classes. Appendix C discusses how the strata and Volume class sub-stratum are defined and how samples were distributed among them.

Table 6: Criteria for Sub-stratification of Volume Audit Population

Strata	# of Polygons	Div by 3	Sub Strat	Target Polygon Range	Volume
Pine	106411	35470	1	1-35470	0-68.811
			2	35471-70941	68.812-154.236
			3	70942+	>154.236
Spruce	102563	34188	1	1-34188	0-157.085
			2	34189-68377	157.086-275.468
			3	68378+	>275.468
Balsam	25405	8468	1	1-8468	0-119.546
			2	8469-16937	119.547-206.097
			3	16938+	>206.097
Other	34010	11337	1	1-11337	0-154.452
			2	11338-22675	154.453-251.875
			3	22675+	>251.875

Table 7 shows the distribution of samples in the Volume Audit population.

Table 7: Volume Audit population - Distribution of Ground Samples

Stratum	Population Area	% of Area	No of Samples	# of Hectares Represented by each plot	Replacement Samples
Pine	1,220,400	41.6%	42	29057	13
Spruce	1,034,965	35.3%	35	29570	11
Balsam	336,194	11.5%	11	30563	3
Other	339,584	11.6%	12	28299	3
Total	2,931,143	100.0%	100	29311	30

Table 8 shows the division of the Volume Audit population stratum into sub-strata based on 3 Volume classes.

Table 8: Volume Audit Population – Sample Distribution by Sub-Strata

Strata	Sub-strata	Area	%	Samples	Replacements
Pine	1	450,860	37%	15	5
	2	422,263	35%	15	4
	3	347,277	28%	12	4
Total		1,220,400	100%	42	13
Spruce	1	286,037	28%	10	3
	2	362,888	35%	12	4
	3	386,040	37%	13	4
Total		1,034,965	100%	35	11
Balsam	1	104,335	31%	3	1
	2	109,912	33%	4	1
	3	121,947	36%	4	1
Total		336,194	100%	11	3
Other	1	103,207	30%	4	1
	2	110,404	33%	4	1
	3	125,973	37%	4	1
Total		339,584	100%	12	3
Grand Total		2,931,143		100	30

2.5 Sample Selection

The Standard *VRI Sample Selection Procedures for Ground Sampling – Draft Version 4.0* outlines the process for sample selection in detail and has been used as the guideline for this plan. Documentation of the Sample Selection process followed is included in Appendix C.

2.5.1 Ground Sampling

The initial step in preparing this plan was to define the land base for the two sampling populations. Appendix C outlines the various sample selection processes. It details the identification of the population areas, development of the strata and sub-strata for the Volume Audit population, and the distribution of the VA samples.

The Young Stand Monitoring sample selection in Prince George TSA was grid based. A series of grids were overlaid on the land base and the number of potential samples was identified. The Ministry staff reviewed the outcome of various grids and it was decided that a 10 X 10 km grid met the sampling list development requirement. Seventy-four (74) points fell within the YSM population. The YSM samples are numbered 200 to 273.

For the Volume Audit sampling, the list contains the initial samples and replacement samples available in the event that some of the initial samples are rejected in the field. In Prince George TSA, there are 100 initial samples and 30 replacement samples in the Volume Audit population.

For the Volume Audit population, sample polygons were selected according to procedures outlined in *Vegetation Resources Inventory –Draft Version 4.0 - Sample Selection Procedures for Ground Sampling* - Section 3.0. That is by “probability proportional to size with replacement” (PPSWR). Sample points were located randomly within the sample polygon using ARCMAP 10 GIS techniques and random numbers generated by Excel. Sample locations were reviewed against recent Landsat imagery. No samples fell within recent cutover. The Volume Audit samples are numbered 1 to 100. The alternates included in the list are numbered 101 to 130. Where there is a need to replace a sample in the field, the replacement should be from the same stratum or strata and sub-stratum.

The sample lists for each activity are provided in Appendix A.

2.6 Sample Establishment Methodology

The ground samples established for the Prince George TSA in the Volume Audit population will be completed by certified VRI Timber samplers following ‘Timber Emphasis’ procedures. Coarse Woody Debris (CWD) data will not be collected at each sample.

The sampling design for the 74 samples in the Young Stand Monitoring will follow the CMI Procedures. Any changes or additions to the CMI Procedures will be clearly outlined at the outset of the project. Again, certified VRI Timber samplers are required to complete this field work.

3.0 Project Implementation

3.1 Sample Packages

Sample packages will be prepared following Ministry direction for all samples selected in this Prince George TSA Project Implementation Plan for Volume Audit and Young Stand Monitoring. They will include tools that support the field crews in their efforts to navigate to, and establish each sample in the correct location.

3.2 Standards

The current edition of the appropriate Ministry Standard will be followed to complete this project for each sampling activity. The Standards relevant to this project are listed in

this document, following the Bibliography. When the project is initiated, the participants should access the Forest Analysis and Inventory Branch website to confirm that they are using the latest version of each Standard.

3.3 Sample List

A complete sample list for the VA sampling and the YSM sampling is provided in Appendix A. A description of how samples were distributed across the population is included in Appendix C.

3.4 Project Files

The original population files used to determine the selection will be provided to, and kept on file by, Forest Analysis and Inventory Branch staff.

3.5 Project Analysis

Statistical analysis projects will be conducted on all of the data collected. Other sampling occurring in the area may be used in the analysis projects as well.

Bibliography

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3. Ministry of Forests, Resources Inventory Branch. Prince George TSA Inventory Audit Report. 1999.
4. Ministry of Forests, Lands and Natural Resource Operations website for VRI - www.for.gov.bc.ca/hts/VRI/
5. Ministry of Forests, Lands and Natural Resource Operations. A Framework for Implementing Young Stand Growth Monitoring in British Columbia. 2012.
6. Ministry of Forests, Lands and Natural Resource Operations. Streamlining VRI Ground Sampling -Volume Audit Sampling. 2011.

7. Ministry of Forests, Lands and Natural Resource Operations. Vanderhoof Project Implementation Plan for Photo Interpretation. March, 2013.
8. Ministry of Forests, Resources Inventory Branch. Strategic Inventory Plan for Prince George Forest District and Strategic Inventory Plan for Vanderhoof Forest District. January 3, 2000.
9. Nona Phillips Forestry Consulting. Cranbrook TSA, TFL18, Mackenzie TSA, TFL53, Kootenay Lake, Morice and Williams Lake TSA Vegetation Resources Inventory Project Implementation Plans. February 2011 (Cranbrook), March 2011 (TFL18), June 2011 (Mackenzie), July 2011 (TFL53), July 2011 and March, 2012 (Kootenay Lake), March 2012 (Morice) and March 2013 (Williams Lake).
10. Timberline Natural Resource Group Ltd. Fort St. James Forest District Vegetation Resources Inventory Statistical Analysis and Adjustment and Prince George Forest District VRI Statistical Analysis & Adjustment. January 2010.
11. Various. Personal Communication with Ministry of Forests, Lands & Natural Resource Operations staff member Chris Mulvihill regarding issues related to the preparation of the Prince George TSA VIP.

VRI Standards & Procedures

The list of VRI Standards and Procedures that have been followed in the preparation of this plan and project to date and that must be followed to complete the Prince George TSA VRI ground sampling projects is provided below. The most current edition should be used when this project is undertaken. They will be found at the VRI website:

<http://www.for.gov.bc.ca/hts/VRI/>

Planning and Sample Selection:

Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Ground Sampling and Net Volume Adjustment Factor Sampling Version 3.1, March 2010

VRI Phase 2 Post-Project Documentation and Deliverables, June, 2007

Vegetation Resources Inventory Sample Selection Procedures for Ground Sampling
DRAFT Version 4.0 May 2011

Ground Sampling, Vegetation Resources Inventory (VRI):

Vegetation Resources Inventory Ground Sampling Procedures Version 4.9.1, June 2012

Ground Sampling Procedures' Appendices Version 4.6, March 2010

Vegetation Resources Inventory Ground Sampling Quality Assurance Procedures and Standards for VRI Ground Sampling Version 3.1, March 2008

Vegetation Resources Inventory Ground Sampling Data Collection Procedures for Inaccessible Samples Version 1.0, March 2003

Ground Sampling, Change Monitoring Inventory (CMI):

Change Monitoring Procedures for Provincial Reporting. Version 1.0, June 2012

Change Monitoring Procedures for Provincial Reporting Appendices. Version 1.5, June 2012

Change Monitoring Inventory Ground Sampling Quality Assurance Procedures. Version 1.1, March 2002

Change Monitoring Inventory Ground Sampling Quality Assurance Standards. Version 2.2 June 2012

VRI – Data Analysis

VRI Sample Data Analysis Procedures and Standards. Version 1.0, June 2011

Appendix A

Sample Lists for Prince George TSA Ground Samples

- 1. Volume Audit Samples**
- 2. Young Stand Monitoring Samples**

Sample Lists

The following are sample lists for each of the two populations. Only the Volume Audit list contains initial samples for data collection and alternate samples in the event that some of the initial samples need to be replaced during the data collection phase.

Prince George TSA - For the Volume Audit population (ages 51+) there are 100 initial samples and 30 alternate samples. The initial samples are number 1 to 100. The alternates are numbered 101 to 130.

Prince George TSA – For the Young Stand Monitoring (ages 15-50) there are 74 samples. These are numbered 200 to 273.

The shapefiles for each of the populations include all of the data fields from the originally supplied VRI database.

In the Volume Audit population, samples can be rejected at the field sampling stage if they are in an unsafe location or in a cutover. When replacing samples they must be from the same stratum and sub-stratum (Volume class). The project manager must be consulted if samples are rejected.

For the Young Stand Monitoring samples, *A Framework for Implementing Young Stand Growth Monitoring in British Columbia* should be referenced if there is any consideration of rejecting a sample. Also, the project manager should be consulted.

Below is a description of the strata, for reference.

PGTSA Volume Audit Population Strata Definition

Strata	Leading Species
1	Pine
2	Spruce
3	Balsam
4	Other

Prince George TSA Volume Audit Sample List

Samp #	Sub Strat	MAP_ID	Polygon	Zn	Easting	Northing	Sp1	Sp1 %	Sp2	Sp 2%	Sp3	Sp 3%	Age	Ht	BA	Vol/ha	Stems /Ha
1	PINE-1	093F048	316	10	404367	5924590	PL	90	SW	10		0	193	24.3	30	22	79
2	PINE-1	093F055	66998805	10	366739	5935505	PL	90	SW	10		0	153	23.6	30	66	228
3	PINE-1	093K100	82968093	10	427016	6084512	PL	90	SW	10		0	230	28.2	38	35	74
4	PINE-1	093J036	1525	10	502930	6019524	PL	95	SXW	5		0	76	22.7	45	28	117
5	PINE-1	093J052	695	10	454243	6041347	PL	90	SW	10		0	141	26.5	41	67	213
6	PINE-1	093J041	334	10	437722	6034736	PL	85	SW	8	AT	7	91	24.4	47	63	319
7	PINE-1	093C092	38	10	315285	5875616	PL	100		0		0	113	18.0	33	63	565
8	PINE-1	093F015	620	10	356131	5886035	PL	80	S	20		0	153	18.6	29	41	388
9	PINE-1	093G071	179	10	439606	5958975	PL	90	SX	5	BL	5	93	17.3	23	11	90
10	PINE-1	093K090	543	10	424273	6081323	PL	100		0		0	230	24.2	36	55	161
11	PINE-1	093J053	34	10	462067	6048532	PL	50	SXW	30	AT	20	81	19.4	25	52	310
12	PINE-1	093K070	630	10	429195	6055750	PL	75	AT	25		0	96	19.7	27	24	238
13	PINE-1	093J022	619	10	457870	6011222	PL	100		0		0	91	24.3	37	12	55
14	PINE-1	093F018	388	10	396998	5892628	PL	70	S	20	BL	10	173	23.4	32	64	245
15	PINE-1	093F060	1563	10	424816	5931740	PL	100		0		0	53	11.7	23	33	1915
16	PINE-2	093J003	8515490	10	461621	5993419	PL	65	SX	27	AT	6	128	25.8	41	138	328
17	PINE-2	093K048	996	10	403133	6029894	PL	60	AT	25	SW	15	116	23.8	46	99	468
18	PINE-2	093N054	573	10	360852	6161526	PL	80	SX	20		0	116	23.2	31	89	306
19	PINE-2	093K090	75091554	10	425337	6073355	PL	90	SB	10		0	81	18.7	31	71	776
20	PINE-2	093F018	342	10	399213	5890428	PL	60	S	40		0	143	19.6	30	150	1235
21	PINE-2	093G082	332216	10	458983	5971480	PL	70	AT	30		0	153	25.0	31	142	518
22	PINE-2	093F086	8737306	10	374971	5966532	PL	80	SX	10	SB	10	143	20.6	19	82	439
23	PINE-2	093K095	42558973	10	368942	6088500	PL	50	BL	35	SW	10	130	18.6	27	80	348
24	PINE-2	093K097	848	10	397245	6086888	PL	75	SW	20	AT	5	130	27.6	41	88	203
25	PINE-2	093F087	16650086	10	393697	5970752	PL	60	AT	35	SX	5	73	20.1	37	73	773
26	PINE-2	093N020	342	10	424891	6112170	PLI	90	SB	10		0	85	15.1	34	102	1436
27	PINE-2	093N019	530	10	423110	6115051	PLI	60	AT	40		0	85	22.2	29	125	577
28	PINE-2	093K087	1391	10	389607	6077089	PL	58	SW	42		0	136	26.6	33	110	408
29	PINE-2	093F079	41440096	10	414282	5952733	PL	90	SX	10		0	123	19.8	37	101	602
30	PINE-2	093G035	15618538	10	493858	5912666	PLI	70	AT	20	SW	10	121	24.7	41	136	405

31	PINE-3	093G066	1659	10	511069	5940192	PL	70	AT	30		0	177	27.5	26	204	470
32	PINE-3	093G063	73385641	10	470286	5942734	PL	60	SW	40		0	151	25.5	43	170	332
33	PINE-3	093J076	1172	10	500664	6072144	PL	70	SXW	20	SB	10	181	28.3	43	364	343
34	PINE-3	093J051	326	10	441145	6046818	PL	80	SW	15	AT	5	166	25.4	36	277	705
35	PINE-3	093G046	68972834	10	502985	5919790	PLI	80	SW	15	FDI	5	121	27.7	56	180	314
36	PINE-3	093K060	309	10	430669	6047967	PL	40	SW	35	SB	25	141	25.5	35	247	567
37	PINE-3	093G048	18953719	10	528347	5920011	PLI	40	SW	20	FDI	15	91	23.2	46	160	330
38	PINE-3	093G028	43159886	10	531452	5896527	PLI	85	FDI	10	SW	5	101	29.1	51	224	333
39	PINE-3	093J083	819	10	472753	6080450	PL	90	SXW	10		0	141	27.6	42	179	207
40	PINE-3	093K076	445	10	378115	6073269	PLI	100		0		0	113	25.3	43	174	463
41	PINE-3	093M087	703	9	646537	6187811	PLI	85	SX	10	AT	5	85	20.9	38	231	1072
42	PINE-3	093M079	56086013	9	666433	6186766	PLI	50	SX	40	AT	10	295	27.2	45	231	516
43	SPRUCE-1	093G099	35821815	10	550919	5983794	SW	60	EP	15	BL	10	91	20.3	27	151	523
44	SPRUCE-1	093G069	600	10	550493	5941013	SW	60	BL	40		0	57	11.7	16	25	1559
45	SPRUCE-1	093F014	646	10	339670	5887830	S	60	PL	40		0	183	25.2	34	128	505
46	SPRUCE-1	093J025	80635295	10	491568	6009283	SB	80	SXW	10	PL	10	176	17.9	15	55	383
47	SPRUCE-1	093J069	1994	10	551184	6050942	SXW	60	AT	30	BL	10	120	28.0	40	0	319
48	SPRUCE-1	093H087	656	10	645534	5969313	SX	60	BL	20	HW	10	92	15.3	8	30	163
49	SPRUCE-1	093J091	74	10	446145	6084094	SB	100		0		0	70	7.1	1	0	300
50	SPRUCE-1	093F025	576	10	363251	5905180	S	40	BL	30	PL	30	203	16.1	26	47	1026
51	SPRUCE-1	093K090	65702615	10	423606	6075134	SB	90	SW	10		0	151	17.0	26	86	1518
52	SPRUCE-1	093K075	863	10	371195	6070858	SW	65	PL	20	AT	15	70	21.0	8	40	82
53	SPRUCE-2	093H066	80204358	10	642305	5950204	SW	40	EP	30	CW	20	216	29.1	34	213	338
54	SPRUCE-2	093H091	920	10	573813	5972991	SX	60	BL	30	HW	10	137	25.2	42	259	533
55	SPRUCE-2	093F038	322	10	401877	5913167	SW	95	PL	5		0	173	27.2	35	238	738
56	SPRUCE-2	093G080	106	10	558453	5960717	SW	50	BL	40	AC	5	111	26.8	36	256	445
57	SPRUCE-2	093G078	68854331	10	538347	5954663	SW	60	BL	20	PLI	15	51	20.2	46	267	1199
58	SPRUCE-2	093N042	578	10	330891	6150290	SW	100		0		0	266	32.7	25	205	247
59	SPRUCE-2	093I051	385	10	572400	6047733	SX	90	BL	10		0	347	32.6	25	243	350
60	SPRUCE-2	093N007	55948559	10	388946	6103783	SW	50	BL	25	PLI	20	120	24.5	41	229	594
61	SPRUCE-2	093J058	1974	10	538660	6048771	SXW	80	BL	20		0	186	27.0	28	198	287
62	SPRUCE-2	093J084	1084	10	474400	6079077	SXW	60	BL	20	PL	20	142	24.5	33	177	494
63	SPRUCE-2	093J055	75467979	10	492501	6047531	SB	70	PL	20	SXW	10	161	24.0	30	161	455

64	SPRUCE-2	093J084	91778641	10	479489	6083271	SXW	70	BL	30		0	161	28.1	36	269	342
65	SPRUCE-3	093H075	101	10	631429	5963104	SW	60	BL	30	CW	10	106	27.0	44	297	487
66	SPRUCE-3	093J025	5587854	10	496258	6013492	SXW	70	PL	20	SB	10	166	35.8	53	527	308
67	SPRUCE-3	093G028	19301444	10	527652	5899096	SW	45	PLI	30	FDI	15	101	31.1	52	337	427
68	SPRUCE-3	093H062	423	10	586005	5948711	SW	69	HW	25	CW	6	216	45.4	63	620	482
69	SPRUCE-3	093K057	996	10	393509	6044039	SW	65	FD	20	BL	10	186	33.7	35	310	443
70	SPRUCE-3	093F098	283	10	395615	5975779	SX	50	PL	30	AT	20	102	27.5	35	290	779
71	SPRUCE-3	093K076	1029	10	378413	6066138	SW	60	BL	15	PL	10	170	32.8	36	297	363
72	SPRUCE-3	093J008	617	10	526283	5986549	SW	40	AT	40	PLI	10	127	34.2	42	372	439
73	SPRUCE-3	093G055	1219	10	496651	5928781	SW	80	PLI	10	AT	10	141	31.2	35	302	474
74	SPRUCE-3	093G070	363	10	561830	5945940	SW	80	PL	10	BL	10	201	32.7	45	397	422
75	SPRUCE-3	093J076	1554	10	507001	6070267	SXW	60	AT	20	PL	20	81	24.9	50	282	779
76	SPRUCE-3	093J087	1251	10	514840	6080161	SXW	70	AT	20	BL	10	141	29.3	40	301	314
77	SPRUCE-3	093H052	497	10	586828	5937550	SW	90	BL	10		0	206	33.9	34	310	247
78	BALSAM-1	093I032	1141	10	585053	6017821	BL	80	SX	20		0	217	23.0	20	118	550
79	BALSAM-1	093J037	668	10	516872	6017423	BL	70	EP	20	SXW	10	86	10.6	21	28	2128
80	BALSAM-1	093I044	528	10	609726	6034505	BL	80	SX	20		0	157	13.5	3	11	125
81	BALSAM-2	093I011	595	10	568532	5997174	BL	45	SX	35	FDI	10	157	26.4	23	172	197
82	BALSAM-2	093H062	942	10	592264	5949747	BL	60	SW	30	HW	10	186	24.1	30	199	313
83	BALSAM-2	093N034	1032	10	353773	6139178	BL	65	SW	30	PL	5	131	25.8	26	176	393
84	BALSAM-2	093K046	1483	10	381193	6032633	BL	50	SX	30	PL	20	203	25.4	34	185	676
85	BALSAM-3	093H084	244	10	608317	5971112	BL	50	SX	30	EP	15	137	22.9	36	232	557
86	BALSAM-3	093H084	240	10	608559	5969803	BL	50	SX	35	AC	10	147	29.5	51	436	738
87	BALSAM-3	093M098	821	9	660017	6198318	BL	60	SX	30	AT	10	155	28.2	54	408	734
88	BALSAM-3	093M069	139	9	667315	6173272	BL	60	SX	30	PLI	10	195	22.1	44	245	1143
89	OTHER-1	093G094	2616	10	485866	5979055	AT	90	S	10		0	96	15.1	35	78	1770
90	OTHER-1	093G086	1452	10	502110	5972148	AT	60	AC	20	SW	20	120	27.9	16	97	196
91	OTHER-1	093N082	589	10	336225	6194875	AT	40	PLI	30	SX	20	85	18.0	31	94	746
92	OTHER-1	093J078	1446	10	531097	6068841	AT	80	SXW	20		0	51	18.9	23	104	488
93	OTHER-2	093H091	677	10	577772	5978835	HW	65	CW	25	SX	5	107	20.7	44	212	702
94	OTHER-2	093H082	260	10	583800	5967450	HW	60	CW	30	FD	10	213	24.4	43	197	698
95	OTHER-2	093J068	1636	10	529793	6051354	AT	60	SXW	20	PL	20	81	23.7	40	251	723
96	OTHER-2	093M088	152	9	657273	6194491	AT	80	PLI	15	SX	5	105	26.6	44	218	594

97	OTHER-3	093G100	557	10	558535	5974346	FDI	50	SW	35	BL	15	191	28.6	47	324	301
98	OTHER-3	093J007	972	10	523029	5987894	AT	45	EP	35	SW	10	101	25.2	44	268	655
99	OTHER-3	093H076	32559890	10	634604	5959956	CW	60	HW	30	SW	10	316	30.9	81	394	395
100	OTHER-3	093J007	1036	10	521226	5985563	EP	60	AT	25	SW	10	91	23.4	41	264	631
101	PINE-1	093J022	1133	10	460807	6009592	PL	95	SW	5		0	91	25.3	26	25	78
102	PINE-1	093K095	19630573	10	365253	6091367	PL	100		0		0	130	25.6	38	5	12
103	PINE-1	093H081	685	10	575001	5965624	PL	90	SW	5	EP	5	51	15.2	22	62	1784
104	PINE-1	093F017	169	10	381863	5890162	PL	90	SW	10		0	88	16.4	24	27	284
105	PINE-1	093G045	31	10	490681	5927433	PLI	90	SW	10		0	101	27.0	56	52	90
106	PINE-2	093N019	997	10	422719	6108252	PLI	100		0		0	85	18.2	31	122	658
107	PINE-2	093G082	87181511	10	456853	5970249	PL	85	SX	10	AT	5	78	18.9	35	127	1086
108	PINE-2	093J023	1363	10	464702	6016344	PL	60	SXW	30	BL	10	91	23.2	39	110	321
109	PINE-2	093F036	397	10	373130	5913582	PL	100		0		0	163	16.5	33	98	2618
110	PINE-3	093K087	545	10	387189	6076791	PL	70	SW	20	SB	10	115	21.7	36	209	824
111	PINE-3	093G084	48499666	10	484203	5965895	PL	100		0		0	101	25.1	37	214	363
112	PINE-3	093J043	96800188	10	461212	6035537	PL	90	SXW	10		0	171	30.4	33	157	333
113	PINE-3	093M050	393	9	687620	6151190	PL	40	EP	30	SW	15	101	23.5	42	195	567
114	SPRUCE-1	093J044	93211130	10	477694	6036537	SB	90	SXW	10		0	181	16.9	29	93	1515
115	SPRUCE-1	093I062	826	10	580255	6051006	SB	80	EP	10	SX	5	177	9.9	10	6	1329
116	SPRUCE-1	093H085	843	10	627323	5967790	SX	50	BL	50		0	197	28.3	15	116	80
117	SPRUCE-2	093H076	187	10	638514	5962296	SW	95	EP	5		0	216	35.8	20	198	147
118	SPRUCE-2	093J097	2228	10	524757	6084748	SXW	80	BL	20		0	181	28.9	35	263	283
119	SPRUCE-2	093J090	1169	10	556558	6073564	SX	50	BL	50		0	237	25.2	35	212	891
120	SPRUCE-2	093M097	591	9	638311	6201891	SX	70	BL	30		0	155	27.6	35	257	582
121	SPRUCE-3	093K026	2196	10	380738	6018418	SX	90	PL	10		0	211	30.4	39	278	628
122	SPRUCE-3	093K099	695	10	413407	6085093	SW	60	BL	40		0	240	32.5	44	385	644
123	SPRUCE-3	093J100	615	10	551428	6089625	SX	90	BL	10		0	145	27.0	41	306	518
124	SPRUCE-3	093J089	100	10	539015	6078223	S	60	BL	20	EP	20	208	32.7	34	295	758
125	BALSAM-1	093M030	341	9	685962	6126851	BL	70	PL	20	SW	10	161	14.5	19	51	401
126	BALSAM-2	093J079	1536	10	543146	6064615	BL	70	SXW	30		0	161	23.9	25	169	347
127	BALSAM-3	093G086	86	10	509818	5971918	BL	40	EP	20	FD	20	109	28.8	34	295	773
128	OTHER-1	093G066	380	10	511971	5944861	AT	60	BL	40		0	62	13.2	26	75	1176
129	OTHER-2	093K066	1084	10	383411	6054095	AT	60	SW	25	PL	15	141	23.7	38	173	750

130	OTHER-3	093J041	277	10	445854	6037392	AT	65	SW	25	PL	10	141	32.5	42	263	760
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Prince George TSA YSM Sample List

Samp #	MAP_ID	Polygon	Zone	Easting	Northing	Sp1	Sp1%	Sp2	Sp2%	Sp3	Sp3%	Age	Height	BASAL AREA	Vol/ha	Stems/ha
200	093F004	527	10	348859	5877718	PLI	72	SX	13	AT	10	16	4.2	0	0	1548
201	093F028	72676248	10	399726	5895616	PLI	64	BL	33	SX	2	16	4.2	0	0	2619
202	093F025	460	10	359707	5897307	PL	100		0		0	16	4.2	0	0	1315
203	093G023	81971539	10	470176	5902647	PLI	100		0		0	17	5.9	0	0	657
204	093F028	67371884	10	400151	5905620	SX	90	BL	10		0	26	3.3	1	0	1280
205	093H032	27468009	10	580643	5907946	SX	40	PLI	40	BL	20	20	3.2	4	2	468
206	093F038	117	10	400575	5915625	PL	50	S	50		0	33	10.2	8	8	885
207	093H043	43894699	10	601082	5917090	SX	70	BL	20	AT	10	27	4.0	0	0	1800
208	093H042	190	10	581073	5917950	S	82	BL	9	AT	4	22	3.4	0	0	1634
209	093H041	737	10	571069	5918380	S	100		0		0	21	1.8	0	0	1403
210	093G043	85443820	10	471028	5922655	PLI	80	SX	10	AT	10	29	12.7	13	25	1134
211	093G042	64863888	10	451021	5923506	PL	100		0		0	17	6.8	0	0	1150
212	093F045	36713904	10	360975	5927326	PL	98	AT	2		0	15	3.8	0	0	1445
213	093H042	86339332	10	591506	5927525	PL	81	SX	9	BL	8	36	13.5	12	25	1015
214	093H041	152	10	571497	5928385	S	50	PL	50		0	25	3.0	0	0	0
215	093G060	1198	10	561492	5928813	SW	96	BL	4		0	31	4.7	0	0	1040
216	093G059	51169538	10	551488	5929242	SW	93	AT	4	PLI	2	23	3.8	1	0	897
217	093G053	83109665	10	471454	5932660	EP	50	FD	30	AT	10	15	7.0	0	0	5742
218	093G053	21229723	10	461451	5933085	PL	100		0		0	16	4.2	0	0	3825
219	093F057	9939778	10	391417	5936061	PL	100		0		0	15	3.8	0	0	918
220	093G060	111	10	561920	5938818	SW	60	BL	20	PLI	20	43	20.8	38	244	777
221	093G059	38	10	551916	5939247	SW	100		0		0	20	2.4	1	0	2350
222	093G066	17035554	10	511899	5940956	BL	47	S	23	PL	18	48	17.6	32	132	1967
223	093G063	20995446	10	461877	5943090	PL	65	SX	31	AT	4	32	9.9	7	7	799
224	093H067	1039	10	652402	5944960	EP	50	SX	40	AT	10	23	11.5	5	6	512
225	093H066	338	10	632388	5945817	SW	100		0		0	33	5.3	0	0	1864
226	093G076	59651602	10	502321	5951388	SX	50	PLI	30	AC	20	34	7.5	0	0	1100
227	093G071	3251571	10	442293	5953946	SX	80	BL	10	PLI	10	20	1.9	0	0	1182

228	093F077	54591519	10	382259	5956497	PLI	50	AT	50		0	15	3.8	0	0	2297
229	093G079	50237690	10	552773	5959255	PLI	70	SX	20	AT	10	23	9.9	6	5	615
230	093G086	980	10	502748	5961393	SW	40	SB	30	AT	20	40	15.7	21	54	1750
231	093H086	20663247	10	633245	5965832	SX	80	BL	10	EP	10	31	7.0	0	0	5000
232	093H081	298	10	573210	5968404	PL	100		0		0	46	4.9	3	0	300
233	093G088	381	10	533190	5970116	SW	30	BL	20	AT	20	46	15.0	28	87	1696
234	093F094	77623334	10	353086	5977786	PLI	100		0		0	16	1.9	0	0	2708
235	093G100	54949089	10	553628	5979265	PL	40	AT	30	EP	20	22	6.5	1	0	2929
236	093K005	1130	10	363519	5987367	FDI	50	PLI	20	SX	20	21	5.9	0	0	2146
237	093I004	553	10	614090	5986704	SX	70	BL	30		0	23	2.5	0	0	2011
238	093I003	47565028	10	604085	5987131	BL	63	SW	37		0	29	4.8	0	0	380
239	093K020	614	10	434416	6004399	AT	62	PL	27	BL	6	17	7.9	2	1	213
240	093K018	71690997	10	404399	6005678	PLI	100		0		0	15	2.5	0	0	2523
241	093I024	410	10	604941	6007143	S	81	BL	15	EP	2	43	8.5	4	2	542
242	093J025	99126863	10	494878	6011846	PLI	80	BL	10	SX	10	29	12.7	17	22	1516
243	093K029	304	10	414831	6015260	PL	66	SX	22	AT	7	20	5.7	0	0	6497
244	093J037	16452811	10	515317	6020998	SXW	36	FDI	30	PLI	26	20	2.7	0	0	1770
245	093J035	482695	10	495306	6021852	PL	68	AT	24	SXW	6	24	10.4	6	7	631
246	093J031	817	10	445277	6023985	PL	80	AT	10	SX	10	24	10.4	6	7	706
247	093J046	58368568	10	505738	6031429	SX	100		0		0	20	2.4	0	0	1735
248	093J045	718	10	495733	6031857	AT	50	PL	25	SXW	25	24	16.2	21	50	1737
249	093J042	563	10	455710	6033564	S	45	AC	18	EP	14	25	3.0	3	0	5837
250	093I041	86	10	576206	6038444	S	70	EP	30		0	26	3.5	3	0	3672
251	093J050	56	10	556194	6039299	SXW	80	AT	20		0	32	5.0	0	0	2062
252	093J058	274	10	526176	6040580	SXW	40	PL	40	BL	20	41	7.0	13	21	1361
253	093J055	3094894	10	496160	6041861	PL	70	SXW	10	BL	10	25	9.8	7	6	719
254	093K057	769	10	386091	6046559	PL	64	S	25	AT	6	26	10.2	8	9	945
255	093K054	76344765	10	356068	6047841	S	90	BL	10		0	23	2.5	0	0	2069
256	093J067	18000692	10	516598	6051012	SXW	100		0		0	17	2.0	0	0	1400
257	093J066	644	10	506593	6051440	SXW	70	FD	10	BL	10	31	4.7	6	0	2350
258	093K070	501	10	426545	6054858	PL	67	AT	24	S	9	34	10.5	7	9	647
259	093J068	449	10	537035	6060164	SXW	54	EP	31	ACT	7	36	6.2	0	0	4750
260	093J074	1283	10	487009	6062300	SXW	97	PLI	2	BL	1	22	2.8	0	0	1250

261	093K079	2231	10	416966	6065291	SW	50	BL	30	FD	20	37	10.0	8	0	3631
262	093J080	294	10	557475	6069314	SXW	90	BL	10		0	40	1.7	0	0	2550
263	093J078	1049	10	527457	6070596	SXW	70	EP	20	BL	10	26	4.0	5	0	2600
264	093K088	1393	10	407387	6075725	SW	90	PL	10		0	26	3.3	2	0	2094
265	093K086	94082555	10	377366	6077009	SW	50	PLI	20	AT	10	33	5.5	20	0	1907
266	093K085	573	10	367358	6077437	PLI	30	SW	30	AT	30	25	8.1	3	2	413
267	093J086	57608061	10	507873	6081456	SX	90	PLI	10		0	29	6.1	0	0	1391
268	093J097	288	10	518306	6091033	AT	80	SXW	20		0	26	11.2	10	9	1141
269	093N004	18274334	10	348200	6098309	PLI	70	AT	20	BL	10	20	8.3	3	2	318
270	093N001	283	10	318604	6109607	S	33	AT	25	PL	24	25	4.8	0	0	4292
271	093N014	265	10	359068	6117895	PL	62	BL	32	SW	6	24	7.2	0	0	2429
272	093N014	445	10	349060	6118324	BL	60	PL	30	SW	10	34	6.4	10	0	9021
273	093N061	84335562	9	688798	6170087	SW	80	AT	10	BL	10	21	2.1	0	0	1720

Appendix B

Comparison of the Sample Characteristics to the Population

Sample-Population Comparison

The following tables show how the sample distribution compares to the population distribution for age class, height class, leading species, and (for Volume Audit only) strata. Sample and populations compare quite closely.

Table 1: Volume Audit Age Class Comparison

Age Class	Samples	Sample %	Population Area	Population %
3	4	4%	70,822	2%
4	4	4%	178,247	6%
5	18	18%	470,642	16%
6	15	15%	292,893	10%
7	11	11%	419,721	14%
8	44	44%	1,354,798	46%
9	4	4%	144,021	5%
Total	100	100%	2,931,144	100%

Table 2: Volume Audit Height Class Comparison

Ht Class	Samples	Sample %	Population Area	Population %
1	1	1%	44,385	2%
2	18	18%	588,692	20%
3	64	64%	1,566,527	53%
4	16	16%	712,545	24%
5	1	1%	18,813	1%
6			151	0%
7			29	0%
8			2	0%
Total	100	100%	2,931,144	100%

Table 3: Volume Audit Species Comparison

Species	Samples	Sample %	Population Area	Population %
AT	7	7%	192,863	7%
BL	11	11%	336,194	11%
CW	1	1%	38,147	1%
EP	1	1%	25,370	1%
FDI	1	1%	56,336	2%
HW	2	2%	25,394	1%
P	42	42%	1,220,401	42%
S	35	35%	1,034,965	35%
W & QG	0	0%	91	0%
L	0	0%	1,383	0%
Total	100	100%	2,931,144	100%

Table 4: Volume Audit Strata Comparison

Strata	Samples	Sample %	Population Area	Population %
Pine	42	42%	1,220,400	42%
Spruce	35	35%	1,034,965	35%
Balsam	11	11%	336,194	11%
Other	12	12%	339,584	12%
Total	100	100%	2,931,143	100%

Table 5: YSM Age Class Comparison

Age Class	Samples	Sample %	Population Area	Population %
1	21	28%	166,722	24%
2	47	64%	452,388	65%
3	6	8%	78,961	11%
Total	74	100%	698,071	100%

Table 6: YSM Height Class Comparison

Ht Class	Samples	Sample %	Population Area	Population %
			20	0%
1	63	85%	538,285	77%
2	10	14%	149,976	21%
3	1	1%	9,681	1%
4			75	0%
7			35	0%
Total	74	100%	698,071	100%

Table 7: YSM Species Comparison

Species	Samples	Sample %	Population Area	Population %
AT	3	4%	44957	6%
BL	3	4%	36210	5%
CW	0	0%	653	0%
EP	2	3%	13078	2%
FDI	1	1%	8878	1%
P	28	38%	291117	42%
S	37	50%	302510	43%
Other	0	0%	668	0%
Total	74	100%	698071	100%

Appendix C

Sample Selection Process and Methodology for Prince George TSA

Sampling Process and Methodology for Prince George TSA

1) Data assembly Process

All the shapefile data was obtained from Chris Mulvihill, the project coordinator with Ministry of Forests, Lands & Natural Resource Operations ('the Ministry'). This included veg_comp_lyr_R1_poly files for both VA and YSM clipped to the outside TSA boundary.

Exclusions:

Some of the exclusions were already completed before the VA and TSM gross populations were provided by the government. These included:

- Area north of NTS letter block 093M
- BEC zone BAFA
- BEC zone ESSF except wubzones mm1, mv1, wk1, and xv1

From the TSA, private land (code 40), Parks (code 51, 63, 67), Federal (code 50 & 53), Indian Reserve (52), TFLs 30 & 53 were erased. This file was called PGTFL_Net. The provided VRI data for each population was clipped to PGTFL_Net. A "repair geometry" was then run on the new files. The files were called "**VA_VRI_Prelim**" and "**YSM_VRI_prelim**". A new field called "New_area" was added and geometry calculated for each file.

Consistent with the process for previous sample selection projects, polygons less than .01 ha were eliminated (called these **VA_VRI_Net** and **YSM_VRI_net**). The total area of polygons that were less than .01 ha was less than 1 ha.

The following table is a summary of the project area landbase.

Table 1: PGTSA Landbase Summary

Land Classification	Area (ha)	% of Proj Area
Total Project Area	6,509,204	100
Net-downs	857,924	11.15%
Parks	448,951	5.83%
Private	381,171	4.95%
Federal	9,093	0.12%
Indian Reserve	18,709	0.24%
Net Area	5,651,280	73.42%
Non Vegetated	378,632.00	4.92%
Vegetated	5,272,648.00	68.50%
Non-Treed	989,921.00	12.86%
Treed	4,282,727.00	55.64%

2) Creation of Population Shapefiles

Volume Audit: From the VA_VRI_Net file VT with a projected age greater than or equal to 51 was selected and exported to a new file (called this **VA_Pop**). The total area of the volume audit population is 2,931,144.

Young Stand Monitoring (YSM): From the YSM_VRI_net (**not** limited to VT), projected age greater than or equal to 15 and less than 51 years was selected and exported to a new shapefile (called this VRI_YSM_Pop). The area of Young Stand Monitoring population is 698,071 hectares. The species distribution within the Young Stand Monitoring population is shown in the table below.

Table 2: Species Summary for YSM Population

Species	Area (ha)	%
SX	302,510	43.34%
PW	291,118	41.70%
AT	44,957	6.44%
BL	36,210	5.19%
EP	13,078	1.87%
FD	8,878	1.27%
CW	653	0.09%
HW	610	0.09%
DR	33	0.00%
LT	15	0.00%
QG	9	0.00%
Total	698,071	100.00%

Table 3: YSM Age Class Summary

Age Class	Area (ha)	%
1-20	166,722	24%
21-40	452,388	65%
41-60	78,961	11%
Total	698,071	100%

3) Sample Selection for The Volume Audit Population

3.1 Stratification

In order to make decisions about stratification, a summary by leading species was run. This provided the leading species distribution shown below.

Table 4: PGTSA VA Species Summary

SPECIES_CD	Area	%
P	1,220,400.72	41.64%
S	1,034,964.93	35.31%
B	336,193.90	11.47%
AC	192,862.80	6.58%
FD	56,336.31	1.92%
CW	38,146.56	1.30%
H	25,393.51	0.87%
EP	25,370.22	0.87%
LT	1,375.54	0.05%
WS	73.13	0.00%
QG	11.23	0.00%
L	7.54	0.00%
W	7.15	0.00%
Total	2,931,143.54	100.00%

Table 5: VA Age Class Summary

Age Class	Area (ha)	%
41-60	70,822	2%
61-80	178,247	6%
81-100	470,642	16%
101-120	292,893	10%
121-140	419,721	14%
141-160	1,354,798	46%
161+	144,021	5%
Total	2,931,144	100%

Based on this information, the Ministry staff identified the following strata for the Prince George TSA VA ground sampling project.

Table 6: Volume Audit population Strata Definition

Strata	Leading Species
1	Pine
2	Spruce
3	Balsam
4	Other

Shapefiles were created for each stratum.

The number of samples for the Volume Audit population was specified by the Ministry in the Contract Schedule A document. They specified that there would be 100 initial samples and 30 replacements in the Volume Audit population.

Table 7: Distribution of Ground Samples -Volume Audit Population

Stratum	Population Area	% of Area	No of Samples	# of Hectars Represented by each plot	Replacement Samples
Pine	1,220,400	41.6%	42	29057	13
Spruce	1,034,965	35.3%	35	29570	11
Balsam	336,194	11.5%	11	30563	3
Other	339,584	11.6%	12	28299	3
Total	2,931,143	100.0%	100	29311	30

3.2) Sub-stratification

For the Volume Audit population sub-stratification was carried out the same way for all 4 strata. The process is described below.

- Exported the attribute table from each of the stratum shapefiles.
- Determined the number of polygons in each stratum (do a “statistics” report on the New_Area field)
- Divided total number of polygons by 3 to determine the number of polygons (approx) that should be in each sub-stratum.
- In these new worksheets, sorted data by volume
- The “number of polygons per sub-strata” figure determined above was used in the table sorted by basal area to find the volume figure that would be used to divide the sub-strata. As directed by the Ministry, the closest BA to the dividing polygon was chosen.

The table below shows the criteria defining the sub-strata.

Table 8: Criteria for Sub-stratification of Volume Audit Population

Strata	# of Polygons	Div by 3	Sub Strat	Target Polygon Range	Volume
Pine	106411	35470	1	1-35470	0-68.811
			2	35471-70941	68.812-154.236
			3	70942+	>154.236
Spruce	102563	34188	1	1-34188	0-157.085
			2	34189-68377	157.086-275.468
			3	68378+	>275.468
Balsam	25405	8468	1	1-8468	0-119.546
			2	8469-16937	119.547-206.097

			3	16938+	>206.097
Other	34010	11337	1	1-11337	0-154.452
			2	11338-22675	154.453-251.875
			3	22675+	>251.875

Sample distribution in the Volume Audit population was based on area representation of the sub-strata. The table below shows this distribution.

Table 9: Distribution of Samples in VA Sub-strata

Strata	Sub-strata	Area	%	Samples	Replacements
Pine	1	450,860	37%	15	5
	2	422,263	35%	15	4
	3	347,277	28%	12	4
Total		1,220,400	100%	42	13
Spruce	1	286,037	28%	10	3
	2	362,888	35%	12	4
	3	386,040	37%	13	4
Total		1,034,965	100%	35	11
Balsam	1	104,335	31%	3	1
	2	109,912	33%	4	1
	3	121,947	36%	4	1
Total		336,194	100%	11	3
Other	1	103,207	30%	4	1
	2	110,404	33%	4	1
	3	125,973	37%	4	1
Total		339,584	100%	12	3
Grand Total		2,931,143		100	30

3.3 Sample Polygon Selection

Volume audit samples were chosen using the probability proportional to size with replacement technique (PPSWR).

- An Excel random number spreadsheet was obtained from the Ministry that creates random numbers from a “seed”. Random numbers between 0 and the total area of each sub-stratum were produced for samples and replacement samples in each of the sub-stratum. As well, one extra random number per stratum was produced for a contingency sample in the event that a sample was eliminated during the sample location stage.
- Accumulated area tables were produced for each of the sub-stratum. This was done by selecting for the sub-strata criteria in the strata shapefiles and exporting the table.

- Two new columns were added to the accumulated area table for recording the samples that were chosen (I for initial, R for replacement and C for contingency) and sample number. The accumulated volume table was then sorted by I/R and then by sample number. All other rows were deleted (saved as Samp list full – sub-stratum). Another table was created from this with just mapsheet, polygon, selection, and area columns (called Samp list part-sub-strat). Using the random numbers generated for each sub-stratum, polygons were selected. A polygon was selected from the accumulated area table if the random number was larger than the accumulated area of the polygon immediately preceding it and less than or equal to its accumulated area.
- Initial Sample Polygons were selected first followed by replacement sample polygons then by contingency samples.

Initial sample numbers were numbered 1 to 100 and alternate samples were numbered 101 to 130.

3.4 Location of Samples Within Polygons

For each population, samples were located within selected polygons using an Arcmap 10.1 GIS program as follows:

- A new shapefile was created for samples with the following fields:

FID_1	Sample_no	Strata	Sub-strat	X	Y

*FID_1 is to link with the Objectid field in the immature VRI shapefile for joining these two files later on.

- The population, 100m grid (obtained from the Ministry), and Landsat shapefiles were displayed on an Arcview map.
- Sample polygons were displayed using the selection tool in the population attribute table.
- For each polygon to be sampled, random numbers were generated (with a range between 1 and the total number of dots in the polygon) for each selected polygon using “=Randbetween(1,X)” function in an Excel spreadsheet. The random numbers were recorded in a new column in this spreadsheet.
- The sample was located at the location of the randomly selected dot.
- The location was then checked against the Landsat image to see if any samples fell in a recent cutover. No samples fell in recent cutover.
- After sample location was complete for a population, UTM coordinates were calculated then the sample shapefile was joined to the population VRI shapefile so that all veg information would be included in the sample file.

4) Sample selection for Young Stand Monitoring (YSM) Samples

The Young Stand Monitoring population was not subdivided into strata or sub-strata.

Direction from the Ministry was to select Young Stand Monitoring samples based on a grid provided by them. Five grids were tested to determine how many samples fell in the population. The following table shows the results.

Table 10: List of Points Per Grid for YSM Population

Grid (KM)	Points in Population
10 X 10	74
4 X 20	78
5 X 10	130
4 X 10	158
5 X 5	268

The Ministry directed that the 10 km by 10 km grid would be used. This totaled 74 samples with no alternates. These were numbered 200 to 273.

The clipped 10km grid was used as the base for the sample shapefile. Two new fields were added to this attribute table. One was called FID2 to allow joining the VRI attributes to the sample table. The other was for sample numbers. UTM coordinates were calculated.

The VRI attributes were then joined to the sample shapefile. From this the sample lists were developed.