An Integrated
G&Y Monitoring and Timber Inventory
Program for TFL 5

Prepared for

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Weldwood

FOREST RENEWAL BC

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EXECUTIVE SUMMARY

This report describes an integrated plan to complete growth and yield monitoring and forest inventory activities to meet the business needs of Weldwood of Canada Ltd. for TFL 5. These primary business needs include:

1) To periodically check and report on the growth and yield of all stands in the TFL against predictions used in timber supply analysis.

2) To periodically check and report on the change over time in timber and non-timber attributes for all stands in all Weldwood operating areas for Canadian Standards Association (CSA) certification.

3) To replace the existing forest-cover inventory for the TFL with one based on Vegetation Resources Inventory (VRI) standards for use in Management Plan 11 and subsequent plans. This will address concerns identified in the 1995 inventory audit, subsequent concerns and requests of the Chief Forester, and will provide a basis for improved management on the TFL.

This integrated plan includes five-steps:

Step 1   Complete a Change Monitoring Inventory (CMI) sample in TFL 5 following Ministry of Forests (MOF) procedures. This would involve establishing 100 randomly located fixed-area plots across the TFL in 2001 and 2002. These permanent plots would be remeasured every 5-10 years to provide continuous feedback on the growth and yield of the TFL.

Step 2   Complete a Vegetation Resources Inventory (VRI) Phase I for the mature stands in the TFL during 2001 and 2002. This will complete a Phase I for the TFL to supplement the work currently underway by Timberline Forest Inventory Consultants Ltd. to reinventory managed stands.

Step 3   Check the overall accuracy of the Phase I inventory using the CMI plots (i.e., complete an audit using the CMI plots).

Step 4   If needed, obtain data to complete a statistical adjustment of the Phase I inventory. This could be done using the CMI plots or by installing approximately 150 new VRI Phase II plots over the TFL. We suggest that using new plots for the adjustment will provide higher long-term value to Weldwood and that the CMI plots should remain independent from the inventory for future monitoring.

Step 5   Complete the statistical adjustment if needed. This would result in a statistically valid inventory for the TFL and should satisfy all requirements of the MOF, the Provincial Chief Forester, requirements for CSA certification, and the scrutiny of other external agencies.

The total cost of the integrated program could be about $375,000 if adjustment is not needed. If adjustment is needed, and Weldwood elects to install the 150 new VRI Phase II plots for the adjustment, this could add an additional cost of $340,000 to the program. The possibility of incurring this significant additional expense, if the comparison with CMI plot data shows that an adjustment is needed, provides a strong incentive to Weldwood to increase the accuracy and precision of the Phase I so that an adjustment is not needed.

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1. INTRODUCTION

1.1 TERMS OF REFERENCE

This report was developed under contract to Weldwood of Canada Ltd. by A.Y. Omule *PhD RPF*, Guillaume Thérien *PhD,* and Jim Thrower *PhD RPF* of J.S. Thrower and Associates Ltd. (JST). This plan is based on information about Weldwood's business needs for TFL 5 and adjacent areas obtained in a meeting between A.Y. Omule and Peter Andrews, *RPF* of Weldwood on Dec. 13, 2000. Additional information was obtained from the strategic[1] and operational[2] growth and yield (G&Y) plans prepared by JST for Weldwood in the previous two years. This plan was funded through Forest Renewal BC.

1.2 BACKGROUND

Management Plan (MP) 10 for TFL 5 is scheduled for completion in 2002. This plan will cover the period Jan. 2003 to Dec. 2008 and will be developed using the current forest inventory. This inventory was completed in 1986 and has been regularly updated for growth and depletion. An audit[3] by the Ministry of Forests (MOF) in 1995 showed that the TFL inventory adequately represented forest conditions. A subsequent review by the Provincial Chief Forester resulted in approval to use the current inventory for MP 10, with the condition that Weldwood plan to update or replace the inventory in MP 10.

To address the concerns of the Chief Forester, and to maintain a solid technical base of inventory, growth and yield (G&Y) information to manage the TFL, Weldwood contracted JST to develop a strategic G&Y plan in 1999.[1] This plan identified several strategic inventory, G&Y, and related components that JST considered important to achieve Weldwood's goals. This was followed by an operational plan[2] to give more details of the needs identified in the strategic plan. These plans suggested that Weldwood should consider integrating a new inventory for the TFL with a G&Y monitoring program. Weldwood is now also pursuing certification with the Canadian Standards Association (CSA), which provides additional need for monitoring on the TFL and in other Weldwood operating areas in the Quesnel TSA.

1.3 DOCUMENT OBJECTIVES

This report presents the next steps in the recommendations of the strategic G&Y plan to complete a new inventory for use in MP 11 and to consider integration with a G&Y monitoring program. The intent is that after review and approval by Weldwood, this plan will be forwarded to the Cariboo Forest Region for review and approval prior to commencing activities under this plan.

1.4 BUSINESS NEEDS

This report addresses three primary business needs identified by Weldwood. The first two business needs relating to monitoring are:

    1) To periodically check and report on the growth and yield (separately) of all stands in the TFL to compare with predictions used in timber supply analysis.

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[1] J.S. Thrower and Associates Ltd. 1999. Program components for a strategic growth and yield program for Weldwood's TFL 5. Contract Report for Weldwood of Canada Ltd., Quesnel BC. April 12, 1999. 34 pp.
[2] J.S. Thrower and Associates Ltd. 2000. Weldwood TFL 5 operational growth & yield plan for management plan 10. Contract report for Weldwood of Canada Ltd., Quesnel BC. March 31, 2000. 16 pp.
[3] www.for.gov.bc.ca/resinv/audits/tfl5.htm

2) To periodically check and report on the change over time in timber and non-timber attributes for all stands in all Weldwood operating areas for CSA certification.

The third business need identified by Weldwood is:

3) To replace the existing forest-cover inventory for the TFL with one based on Vegetation Resources Inventory (VRI) standards for use in MP 11 and subsequent plans. This will address concerns identified in the 1995 inventory audit, subsequent concerns and requests of the Chief Forester, and will provide a basis for improved management on the TFL.

2. OVERVIEW OF APPROACH

Weldwood is fortunate to have the time to build the inventory and monitoring program in a series of coordinated and integrated steps over several years, before the information is needed for MP 11 (due in 2008). This allows the flexibility to schedule components to maximum potential benefit and integration between the two programs. To maximize flexibility and to potentially minimize the total cost of the G&Y monitoring and inventory program, we suggest that Weldwood proceed as follows.

Step 1   Complete a Change Monitoring Inventory (CMI) sample in TFL 5 following MOF procedures.[4] This involves establishing 100 randomly located fixed-area plots across the TFL in 2001 and 2002. These permanent plots should be remeasured every 5-10 years as needed to provide feedback on the G&Y in the TFL for preparation of MPs. Some of these plots can be upgraded to CSA standards when needed.

Step 2   Complete a VRI Phase I inventory for the TFL. This would replace the current forest-cover inventory with typing of new photos to VRI standards and would generate a new GIS coverage with forest-cover attributes. This could be done during 2001 and 2002.

Step 3   Check the overall accuracy of the Phase I inventory using the CMI plots (i.e., complete an inventory audit). If the photo-estimated attributes from the Phase I are not significantly different from the ground sample of CMI plots, no further work is needed. However, if comparison shows a significant difference, then Weldwood will need to statistically adjust the Phase I inventory for MOF approval. Weldwood may want to consider the costs and benefits of completing a statistical adjustment if a significant difference is not found, but where adjustment may result in uplift to the inventory.

Step 4   If needed, obtain data to complete a statistical adjustment of the Phase I inventory. If a significant difference is found in the comparison (i.e., audit), an adjustment of the Phase I attributes must be completed. There are two options to obtain the data for the adjustment; both options are technically feasible, but each has pros and cons that must be evaluated by Weldwood. The first option is to use the CMI plots to provide the ground data for the adjustment. This is the least cost option; however, we do not recommend this because it eliminates the independence of the CMI plots from the inventory. The other option is to install

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[4] Ministry of Forests. 2000. Change monitoring inventory. Ground sample procedures for the provincial change monitoring and the national forest inventory. Draft document. July 2000. 201 pp. (http://www.for.gov.bc.ca/resinv/standard/CMI.pdf)

approximately 150 VRI Phase II plot clusters across the TFL to provide an adequate sample size to complete the adjustment. This requires the additional cost of extra plots, but preserves the independence of the higher cost CMI plots for future G&Y monitoring in the TFL.

Step 5   Complete the statistical adjustment if needed. This would give a statistically valid inventory for the TFL to satisfy the requirements of the MOF, the Provincial Chief Forester, CSA certification, and to provide a solid technical base to withstand the scrutiny of other external agencies.

3. STEP 1 – G&Y MONITORING

3.1 BUSINESS NEEDS

The G&Y monitoring program described here addresses two business needs for Weldwood. First, the program will give information to provide a high level-of-comfort that yield estimates used in timber supply analysis adequately reflect actual G&Y of stands in the TFL. The monitoring program will be the early warning system to help identify significant deviations from predicted G&Y, so that corrective action can be taken if warranted. This is important to ensure the AAC on the TFL reflects the growth potential and to instill confidence in the MOF and the public.

The second business need addressed by this program is to contribute to more general monitoring of Weldwood's operating area for CSA market certification. This certification will be for the entire Quesnel Woodlands area, called the *Defined Forest Area* (DFA) under CSA terminology. This DFA includes TFL 5 and the Quesnel and Westlake planning cells (Appendix I). Weldwood plans to install a monitoring program to provide data to report on specified Criteria and Indicators (C&I) of sustainable forest management for the DFA. These indicators are based on the Canadian Council of Forest Ministers (CCFM) C&I and include non-timber values indicators such as coarse woody debris, noxious and uncontrolled weeds, foreign tree species, botanical plant diversity, and forest health.

3.2 GOALS & OBJECTIVES

The primary goal of a G&Y monitoring program for TFL 5 is to provide data from periodic remeasurements of a representative sample of points to:

1)   Compare actual G&Y with predictions used in forest-level timber supply analysis and other applications.

2)   Provide some plots that can be upgraded and incorporated into a sample of the DFA to meet CSA certification requirements.

Under this plan, data from the monitoring program will also provide information to complete an audit of the new VRI Phase I to determine if a statistical adjustment is needed.

The objectives of the G&Y monitoring program to achieve these goals should be to:

1)   Install 100 CMI plots over two years to cover the entire TFL landbase.

2)   Develop a database to store and manage the CMI data.

3) Remeasure the plots on a 5 or 10 year interval (depending on results and to correspond with preparation of MPs) to compare actual and predicted G&Y to ensure yield curves accurately reflect growth on the TFL.

3.3 TARGET POPULATION

The target population for the TFL 5 monitoring program is the entire TFL area. No stratification should be done so the plots represent the entire TFL area and all plots have the same statistical weight.

3.4 SAMPLE PLOTS

The sample plots should be the 400 m^2 (11.28 m radius) circular plots described in the MOF CMI manual. The existing permanent sample plots located on the TFL cannot be incorporated into this G&Y monitoring program. The existing plots were not installed to the current CMI standards and their subjective location in target stand types precludes their use in statistically based applications.

The CMI manual describes procedures to collect information for: i) trees; ii) site, soil, plants, and succession; iii) coarse woody debris; and iv) range resources. We suggest that Weldwood collect only the tree information in the TFL 5 sample. These plots can be upgraded to include other non-timber attributes in the future if needed for CSA standards or other for other needs.

We suggest that the standard CMI plot design is used with some modifications including:

1) Taking more site tree information than described in the CMI standard. This will provide Weldwood with better information on the stand productivity in the TFL. This will also increase the flexibility to reduce the potential negative impact of future changes in MOF definitions of site trees and site index.

2) Taking extra information on tree value and grades for Weldwood internal use. Log grades can be designed and used in the call-grading to provide information specific to Weldwood processing plants and for the stand conditions of the TFL.

3) Tagging trees at the breast height. The CMI manual describes tagging trees at the base; we suggest that this is not necessary and that tagging trees at breast height is adequate. [5]

4) Use a 4.0 cm tagging limit in the 11.28 m radius plot. The CMI manual suggests using a tagging limit of 9.0 cm. The smaller tagging limit will provide Weldwood with more information on small trees than the CMI standard.

3.5 SAMPLE SIZE

We suggest a sample of 100 plots randomly located throughout the TFL. This sample size should give reasonable statistical power to check overall analysis unit G&Y predictions. A smaller sample will reduce costs, however, fewer than 100 total samples may eliminate the ability to post-stratify the sample and

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[5] The intention of tagging trees at the base is to hide the plots from people who may bias the treatment of the area if the plot is visible. However, tagging at the base requires considerably more work at installation and at each subsequent remeasurement. We believe the potential for bias in how plots are treated is small when trees are tagged at breast height, if the program is properly managed by Weldwood.

have enough plots to examine specific components of the inventory (e.g., regenerated stands or stands of a given species).

3.6 SAMPLE SELECTION

The sample polygons can be selected with *probability proportional to size and with replacement* (PPSWR) as mandated by the MOF. These polygons should be selected from the current forest-cover inventory. Sample locations within the selected polygons should then be selected randomly from the provincial 100 m grid using a geographic information system (GIS). This will result in each sample point having the same statistical weight.

3.7 MONITORING FOR CSA CERTIFICATION

Some of the 100 CMI monitoring plots can be identified and upgraded to measure non-timber values for CSA certification.[6] This can be done when the CSA monitoring for the DFA will be implemented. These CMI plots can be upgraded to include the additional measurements required by CSA such as plant lists (including noxious weeds, foreign tree species, and botanical plants), ecological site description, soil description, range, and coarse woody debris.

4. STEP 2 – VRI PHASE I PHOTO INTERPRETATION

4.1 BUSINESS NEED

The business need addressed by the program in this report is to replace the existing inventory with one designed under the new VRI standards. This new inventory will address the concerns raised in the 1995 inventory audit and those of the Provincial Chief Forester. A new inventory to VRI standards will also allow Weldwood to use the new version of VDYP to update and project the G&Y of natural stands. This new model should provide higher resolution of stand-level volume projections and allow for more accurate inventory updates than are possible with the current version of VDYP.

4.2 GOALS & OBJECTIVES

The goal of this step is to provide an updated and upgraded inventory to meet the needs of both the MOF and Weldwood for management of the TFL. The specific objectives to meet this goal are to:

1) Fly new air photos for the VRI Phase I.

2) Complete air and ground calls as needed.

3) Type photos to VRI Phase I standards.

4) Transfer the linework to GIS in the NAD83 base.

5) Assign attributes to the database, estimate volume, and assign cultural attributes.

6) Develop map and polygon labels.

7) Deliver the complete Phase I inventory in digital and hardcopy format.

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[6] We assume that 100 plots will be established in the entire DFA area, and that approximately 10% of these will be installed in TFL 5; thus approximately 10 plots would be needed from the TFL to contribute to the overall DFA monitoring program.

4.3 TARGET POPULATION

The target population for the Phase I inventory is mature stands only as Weldwood is currently completing a VRI Phase I for managed stands (using 1996 photos) in conjunction with work to address spruce weevil issues.[7] Consequently, inventory for about 24,000 ha of additional area is required to upgrade the TFL to full VRI Phase I status.

4.4 TARGET ATTRIBUTES

All attributes listed on the VRI photo interpretation attribute form should be estimated to VRI standards. The reliability indices should be used to provide additional information for auditing and adjustment (if needed).

4.5 METHODS

The new Phase I information should be done using new photos. Existing bio-terrain mapping and ecological mapping may also provide some data to assist in the estimation phase. The inventory for the mature stands must be combined with the current VRI Phase I for regenerated stands in the TFL.

5. STEP 3 – INVENTORY AUDIT USING CMI PLOTS

5.1 BUSINESS NEED

The business need addressed by this phase is to determine whether or not a statistical adjustment of the Phase I inventory is needed. This is an important step that could save Weldwood over $300,000 in unnecessary costs for additional sample plots.

5.2 GOALS & OBJECTIVES

The primary goal of this step is to determine if a statistical adjustment of the inventory is needed. The objectives to achieve this goal are to:

1) Collate the CMI and Phase I data into a common format.

2) Compare the key attributes needed to evaluate the inventory.

3) Complete statistical tests (similar to an inventory audit) to evaluate the need for an adjustment. Consider using the reliability indices for the comparison.

4) Complete a cost-benefit analysis to evaluate a potential inventory uplift, even if a statistical difference is not detected.

5.3 TARGET POPULATION

The target population will be the entire TFL area. The CMI sample size of 100 plots will also allow sub-populations to be examined, such as mature and immature polygons (similarly to the MOF inventory audit program).

5.4 SAMPLE PLOTS

The samples will be the 400 m^2 circular CMI plots. Under the CMI program, the entire plot area will be sampled, even when plots are located near polygon boundaries. The CMI plots will be installed under the

old inventory linework, thus it will not be possible to determine what portion of the plots may fall in other polygons. This will be an important consideration in the use of these plots for audit purposes. This problem could be avoided by completing the Phase I before installing the CMI plots; however, this may not meet Weldwood's business needs to have the monitoring program in place first.

5.5 SAMPLE SIZE

The CMI program should include 100 plots randomly located across the entire TFL area. This will result in approximately 40% of these plots being located in regenerated stands and 60% in mature natural stands.

5.6 METHODS

The methods to complete this inventory audit should be similar to the former MOF inventory audit program. Several key attributes, such as net merchantable volume, species composition, and site index can be compiled for each CMI plot and compared to the Phase I attributes for the polygon where the CMI plot was taken. This comparison must consider edge effects for plots that straddle more than one polygon.

The process of using CMI plots for an inventory audit has not been done before. This will add considerable value to the CMI program and could result in a large reduction on total program cost to Weldwood. Consequently, some new methods may be required to deal with the new process. In addition, reliability indices have never been used in an audit process. This will also require developing some new methods in conjunction with the MOF; however, the benefits could be significant for Weldwood.

6. STEP 4 – VRI PHASE II GROUND SAMPLING

6.1 BUSINESS NEED

If the inventory audit in Step 3 (above) shows that the Phase I attributes are significantly different from the average or the CMI plots, then a statistical adjustment is needed. This step will then address the business need to obtain data for the adjustment. As noted in Section 2, there are two options to provide this data: i) use the CMI plots; or ii) install new VRI Phase II ground sample plot clusters. We recommend that new VRI plots are used to provide the data for the adjustment. This will preserve the independence of the CMI sample, which will have considerable value in the future.

Use of the CMI plots for the adjustment will result in short-term savings as new plots are not required; however, additional plots will be required each time an inventory audit for yield is needed in the future. Thus, the long-term cost of using the CMI plots could be much higher than installing new VRI Phase II plots for this adjustment. This will be a difficult decision for Weldwood, especially now that forest products markets are low and the uncertainty of adequate market recovery because of the U.S. Softwood Lumber Agreement. However, the long-term potential for the TFL must be carefully weighted against apparent short-term savings. Weldwood's operations in Hinton provide a good example of the considerable long-term value of a well-designed, representative base of sample plots across a management area.

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[7] This work is being completed by Timberline Forest Inventory Consultants Ltd., Prince George, B.C.

The total cost of the integrated monitoring and inventory program will almost double if an inventory adjustment is needed (Section 8). Consequently, there is considerable incentive to increase the accuracy and precision of the Phase I estimates to reduce the chance of an adjustment being needed. Thus, all possible methods should be used to develop the most accurate estimates of polygon attributes for the Phase I.

6.2 GOALS & OBJECTIVES

The goal of installing Phase II sample plots is to provide an adequate sample across the TFL to achieve a statistical adjustment of the Phase I attributes. The specific objectives to achieve this goal are to:

1) Select polygons at random to represent the entire TFL.

2) Install enough Phase II plots (approximately 150) to achieve a sampling error of 10-12% for net volume at 95% probability.

6.3 TARGET POPULATION

The target population for the Phase II sample is the entire TFL. There should not be any stratification to ensure that all samples have equal statistical weight. This simplifies the analysis and improves the long-term value of the plots for the TFL.

6.4 SAMPLE SIZE

We estimate that the coefficient of variation (CV) will be between 60-70%. With this variation, a sample of 150 randomly located Phase II plot clusters should achieve a sampling error of 10-12% (at 95% probability) (Figure 1). This sample size should also be adequate to support statistical adjustment by leading species (Table 1). A somewhat smaller sample of 100 plots would achieve a sampling error of approximately 12-15% with a CV of 60-70%.
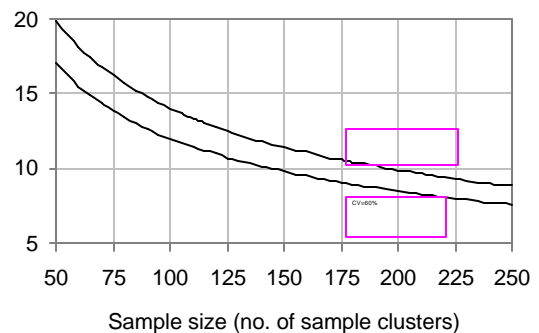
Figure 1. Sample size needed to achieve different sampling errors with CVs of 60-70%.

6.5 SAMPLE SELECTION

The ground sample polygons should be selected with *probability proportional to size and with replacement* (PPSWR) as mandated by the MOF. This will result in all sample points having the same statistical weight. Other methods to ensure the sample adequately represents the TFL are no longer approved by the MOF (e.g., sampling from a sorted list), thus the PPSWR sample should be compared carefully with the inventory to ensure the sample adequately represents the TFL.

Table 1. Approximate distribution of a sample of 150 plots by leading species.

Leading Species	% TFL Area	Number of Plots
Douglas-fir	38	57
Lodgepole pine	26	39
Spruce	25	38
Deciduous (+NP)	11	16
Total	*100*	*150*

6.6 SAMPLE PLOTS

The standard timber emphasis plot (TEP) clusters should be used for this sample according to VRI standards. These clusters include five variable radius plots located on a 50 m grid centered at an integrated plot point (i.e., plot cluster center).

6.7 NVAF SAMPLING

Net Volume Adjustment Factor (NVAF) sampling is done to adjust the VRI net volume to account for hidden decay and possible taper equation bias. A subset of the Phase II plots should be enhanced by establishing auxiliary plots[8] to create a matrix from which to select trees for destructive sampling. A minimum of 90 live trees and 10 dead trees should be selected by leading species proportional to area (Table 2). At least 20 Phase II plots should be enhanced and actual net and gross volume measured to compute the NVAF.

Table 2. Number of NVAF sample trees.

Leading Species	Live Mature	Live Immature	Dead
Douglas-fir	22	11	4
Lodgepole pine	16	8	3
Spruce	15	8	2
Deciduous (+NP)	7	3	1
Total	*60*	*30*	*10*

6.8 WITHIN POLYGON VARIATION SAMPLING

Procedures for Within-Polygon Variation (WPV) sampling are also part of the VRI toolbox. The procedure is to intensively sample some the polygons selected in the VRI sample. The intent is to provide information to partition the overall variance in the adjustment ratio that can be attributed to WPV variation. This information helps to estimate the true error of the inventory. We suggest that this is not a high priority for Weldwood and the information can be taken at a later time if needed.

7. STEP 5 – INVENTORY ADJUSTMENT

7.1 BUSINESS NEED

The business need addressed by this final step in the integrated plan for TFL 5 is to adjust the inventory to provide the final adjusted attributes for use in forest management. This will provide an unbiased estimate of known precision of the overall inventory for the TFL. This will provide the statistical rigor to defend the inventory to the MOF, CSA, the public, and other non-government agencies.

7.2 GOALS & OBJECTIVES

The goal of this step is to provide an inventory that is statistically valid overall by adjusting the attributes of the Phase I to reflect the results of the Phase II ground sampling. The specific objectives to achieve this goal are to:

1) Collate the Phase I and Phase II data in a common format.

2) Compute the statistical adjustment ratios using an MOF approved method.

3) Adjust the Phase I inventory using this adjustment.

4) Replace the database with one including the adjusted attributes.

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[8] As described in the VRI ground sampling manual (Version 4.0, March 1999).

7.3 TARGET POPULATION

The target population for the adjustment is the entire TFL area.

7.4 SAMPLE SIZE

The sample size for the adjustment is that achieved in the Phase II sample (approximately 150 sample plot clusters).

7.5 METHODS

The current adjustment method approved by the MOF is the Fraser Protocol; however, this will likely be replaced with a new method by the time Weldwood is ready to consider an inventory adjustment. The new method may be the modified Fraser Protocol (also called sequential balancing). The modified Fraser Protocol is currently under review by the MOF, and if approved by the time this adjustment is needed, will provide advantages and is the preferred approach.

8. SUMMARY OF COSTS

We estimate the costs to implement the G&Y and inventory program as described in this report could be about $375,000 if a statistical adjustment is not required. If the adjustment is required, and Weldwood chooses to install new VRI Phase II plots for the adjustment, this could add an additional $335,000 to the program cost (Table 3).

Table 3. Approximate costs to implement the integrated G&Y monitoring and inventory program for TFL 5.

	Program Component	Cost
Step 1	G&Y Monitoring Program • 100 CMI plots @ $2,000 plus OH, mgmt, and QA	$250,000
Step 2	VRI Phase I – Photo Interpretation • Typing new photos, ground calls, air calls, and GIS work for 24,000 ha.	$100,000
Step 3	Inventory Audit Using CMI Plots • Statistical analysis and reporting	$25,000
Total Cost if Adjustment is Not Needed		**$375,000**
Step 4	VRI Phase II – Ground Sampling • 150 plot clusters @ $1,500 plus OH, mgmt, and QA • 100 NVAF trees @ $300 plus OH and mgmt	$275,000 $40,000
Step 5	Statistical Adjustment • Statistical analysis and reporting	$25,000
Additional Cost if Adjustment is Needed		**$340,000**
Total Cost if Adjustment is Needed		*$715,000*

9. SCHEDULE

Implementation of the five steps described above should aim to have the entire process completed by the end of 2006. This will allow enough time to prepare the data package and include the information in the timber supply analysis of MP 11. To achieve this goal, these steps could be implemented as follows:

2001-2002	Complete CMI samples (100 plots over two years).
	Complete VRI Phase I (photo interpretation and GIS work).
2003	Complete audit of Phase I inventory using CMI plots.
	Process is complete and information ready for MP 11 if statistical adjustment not needed.
2004-2005	Complete VRI Phase II samples – if needed (150 plot clusters and NVAF samples).
2006	Statistical adjustment of the Phase I using the Phase II plots.
	Process complete and ready to use information in MP 11.

10. APPENDIX I – DEFINED FOREST AREA LANDBASE

Planning Cell	BEC Subzone	Area (ha)
TFL 5	SBSmh	11,492
	SBSmw	25,415
Subtotal		*36,917*
Quesnel	ESSFwc3	27,547
	ESSFwcp	364
	ESSFwcp3	282
	ESSFwk1	50,145
	ESSFxv1	28
	ICHw4	37
	ICHwk4	18,367
	IDFdk3	13,154
	IDFxm	389
	MSxv	10,498
	SBPSdc	20,135
	SBPSmk	18,005
	SBSdw1	64
	SBSdw2	41,916
	SBSmc1	693
	SBSmh	4,066
	SBSmw	41,619
	SBSwk	37
	SBSwk1	22,099
Subtotal		*269,442*
Westlake	ESSFwc3	58
	ESSFwk1	1,363
	SBSdw1	1,636
	SBSdw2	7,755
	SBSdw3	907
	SBSmh	839
	SBSmk1	604
	SBSmw	279
	SBSwk1	838
Subtotal		*14,278*
Total		*320,637*

11. APPENDIX II – TFL 5 LANDBASE SUMMARY

Subzone/ Species	Age Class										Total
	0	1	2	3	4	5	6	7	8	9	
SBSmh											
Ac	0	5	4	33	17	34	8	59	101	0	261
At	0	10	17	3	18	34	22	130	0	0	234
Bl	0	0	31	2	0	0	0	0	1	0	34
Ep	0	121	83	185	44	175	151	67	4	0	830
Fd	0	269	76	196	170	422	555	658	1,265	98	3,710
Pl	0	177	0	0	0	14	77	18	13	0	300
Sw	0	308	105	130	5	32	19	108	592	0	1,299
NP	308	0	0	0	0	0	0	0	0	0	308
Subtotal	*308*	*890*	*316*	*550*	*253*	*711*	*832*	*1,041*	*1,976*	*98*	*6,975*
SBSmw											
Ac	0	101	12	15	0	0	9	4	7	0	147
At	0	204	13	8	20	26	10	8	1	0	290
Bl	0	129	196	108	5	9	13	21	58	0	538
Ep	0	709	137	195	5	75	55	9	0	0	1,185
Fd	0	2,134	970	202	1,161	1,601	361	442	1,702	85	8,657
Pl	0	1,721	144		898	2,706	1,034	562	1,262	0	8,324
Sb	0	0	0	0	0	0	0	0	113	0	113
Sw	0	2,039	1,004	323	379	792	262	236	1,959	44	7,038
NP	1,133	0	0	0	0	0	0	0	0	0	1,133
Subtotal	*1,133*	*7,037*	*2,475*	*850*	*2,467*	*5,209*	*1,743*	*1,281*	*5,101*	*129*	*27,426*
All TFL											
Ac	0	106	16	48	17	34	17	63	108	0	408
At	0	214	30	11	38	60	31	138	1	0	523
Bl	0	129	226	110	5	9	13	21	59	0	572
Ep	0	830	221	380	48	250	207	76	4	0	2,015
Fd	0	2,403	1,046	399	1,331	2,023	916	1,100	2,967	183	12,368
Pl	0	1,898	144	0	898	2,719	1,111	580	1,275	0	8,624
Sb	0	0	0	0	0	0	0	0	113	0	113
Sw	0	2,347	1,109	453	384	824	280	344	2,551	44	8,337
NP	1,441	0	0	0	0	0	0	0	0	0	1,441
Total	*1,441*	*7,927*	*2,791*	*1,401*	*2,720*	*5,920*	*2,575*	*2,322*	*7,077*	*227*	*34,401*
	4%	*23%*	*8%*	*4%*	*8%*	*17%*	*7%*	*7%*	*21%*	*1%*	*100%*

12. APPENDIX III – G&Y MONITORING IMPLEMENTATION

Overview

This section describes the implementation for the G&Y monitoring program. The main activities are:

1) Assemble inventory file to generate the sample list.

2) Identify the 100 sample polygons for TFL monitoring.

3) Establish the monitoring plots according to the sample plan.

4) Prepare an establishment report.

Sample Packages

Field sample packages must be prepared and approved prior to commencing fieldwork. The packages should include a stereo pair of the most recent air photos for access, a copy of the document photo (where possible), plot location maps (1:10,000), access maps (1:20,000) clearly indicating sample cluster location and polygon boundaries, and overview maps (1:250,000) for general polygon location. Maps should be plotted showing the VRI grid overlays and selected sample locations. Sample locations within polygon should be selected using GIS. We recommend that orthophotos be used for access where ever possible. This can greatly decrease sampling and access cost.

Project Support

Provision of field supplies such as aluminum stakes, field maps, photos, field cards, and equipment (including GPS) should be supplied by the contract field crews. A Project Coordinator appointed by Weldwood should arrange for helicopter use, with the cost being paid directly by Weldwood.

Fieldwork

Fieldwork will be completed using CMI measurement protocols and certified crews. The VRI Card Types 1-3 and 8-11 will be completed according the current CMI manual. The Project Coordinator will manage the fieldwork contracts and quality assurance.

Quality Assurance

Quality assurance (QA) checking should be conducted by an approved and independent subcontractor. The VRI QA standards require inspection of at least 10% of the samples. The field contract crews are responsible for the quality control of their own work.

Data Compilation, Analysis, and Adjustment

Data entry should be done by the field contract crew. Data compilation will be completed by the MOF.

Roles & Responsibilities

Ministry of Forests

The MOF should be asked to:

1) Approve the monitoring sample plan (Cariboo Forest Region).

2) Mentor field crews at the start of fieldwork (Cariboo Forest Region).

3) Validate and compile data (RIB).

4) Check data after initial compilation (Cariboo Forest Region).

Project Coordinator

Weldwood should appoint a coordinator for the project to:

1) Oversee all aspects of the project.

2) Liaise with the MOF.

3) Monitor and communicate project progress.

4) Ensure all contractors are qualified and certified, and manage fieldwork contracts.

5) Assess the need and coordinate the use of helicopters.

6) Monitor the budget.

7) Ensure the sample packages are assembled and complete.

8) Obtain approval of sample packages by the MOF.

9) Obtain approval of ground sampling plan.

10) Oversee all ground sampling activities.

11) Ensure QA is completed.

12) Assist in coordinating technical expertise where required.

Fieldwork contractors

The field contractors should:

1) Complete the field sampling.

2) Conduct internal quality control.

3) Enter the sampled data.

Check-cruiser

The check-cruiser should:

1) Complete QA work for 10% of the CMI samples.

2) Data entry of the QA sample data.

3) Prepare the QA report.

Completion

Overall monitoring sampling requires a certified field crew, approved access packages, and adherence to the CMI standards. Difficulties in the sampling process or adherence to the schedules defined in this plan, or concerns raised during the QA process, must be resolved between the Project Coordinator, the MOF Cariboo Region, and Weldwood staff.