

Tree Farm Licence 14

Vegetation Resources Inventory

Phase I Project Implementation Plan

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EXECUTIVE SUMMARY

This Vegetation Resources Inventory (VRI) Phase I Project Implementation Plan (VPIP) was prepared for Tembec's Tree Farm Licence (TFL) 14 and is consistent with the Ministry of Forests (MFR) standards for developing a Phase I VPIP. The project covers Phase I VRI activities that will be completed in TFL 14.

Deficiencies in the current forest inventory include, but are not limited to:

1. The vintage of the current inventory is such that it is losing reliability for continued projection and the existing class based attribute estimates are coarse when compared to the current standards.
2. The species composition and other critical attributes¹ are a concern in the current inventory. The critical attributes are the inputs for the growth and yield model VDYP7.
3. The existing inventory is not consistent with the current MFR inventory standards.
4. The volume estimates for existing stands are underestimated which is supported by two audits completed on the TFL.
5. Problem forest types may be mislabeled and need to be verified. This also includes the information needs related to the spatial distribution and productivity of stands with balsam intermediate utilization.
6. There is uncertainty around volumes left in partially harvested stands. A considerable amount of partial harvesting has occurred on the TFL since the completion of the last inventory which has changed the polygon descriptions throughout the landbase.

A new Phase I VRI will address the following key issues as outlined in the VRI Strategic Implementation Plan VSIP²:

- Provide new delineation and improve species composition, as well as other critical attribute estimates (using discrete values) which will allow for more accurate volume estimates;
- Ensure the TFL inventory is consistent with current provincial standards;
- Provide updated information that can be used to further manage and mitigate Tembec's concerns with MPB through identifying adjacent and susceptible stands.
- Provide updated information around stands with BI intermediate utilization, particularly related to their spatial distribution and attribute estimates; and,
- Provide improved quantification of partially harvested stands through new delineation and integration of RESULTS data.

The Phase I VRI target area is the entire TFL 14 land base including private land and protected areas within the boundary of the TFL. The Bugaboo Alpine Recreation Area is excluded from the target area.

In their 2008 VSIP Tembec expressed interest in exploring the use of Light Detection and Ranging (LiDAR) technology for use in their VRI Phase I for TFL 14. Tembec understands that the MFR is

¹ This includes, height, age, basal area, and stems per hectare.

² Tembec Industries Inc. June 2008. *Vegetation Resources Inventory – Strategic Inventory Plan*. Unpublished. Pg. 20.

reviewing the use of LiDAR and hyper spectral imagery for vegetation assessments; however if an opportunity to pilot this technology arises, Tembec requests that TFL 14 be flagged as an area of opportunity for LiDAR related work.

This project will be implemented over two fiscal years and is expected to cost approximately \$278,500.

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1.0 INTRODUCTION

This Vegetation Resources Inventory (VRI) Phase I Project Implementation Plan (VPIP) was prepared for Tembec and covers all Phase I VRI activities that will be completed in the Tree Farm Licence (TFL) 14. The project includes the entire land base of TFL 14. This document was prepared and submitted in accordance with current Ministry of Forests and Range (MFR) Phase I VPIP standards and guidelines and will be approved by the MFR prior to implementation.¹

1.1 Objectives

The specific objectives of this proposed inventory program include:

- Addressing the issues outlined in the Forest Management Considerations section of the TFL 14 VRI Strategic Inventory Plan (VSIP)²;
- Improving the TFL 14 vegetation polygon delineation and vegetation polygon descriptions;
- Updating the inventory to current VRI standards;
- Updating the silviculture and free growing information with RESULTS and any other relevant data recognized in the gap analysis.

1.2 Information Needs

The inventory was completed in 1986 using 1984 imagery. Existing critical inventory attributes are class-based and were converted to discrete values using the class midpoints. This class conversion provides a very coarse estimate of the attributes and is not consistent with the current VRI standards. A Phase I VRI will provide new information that is consistent with the MFR standards and will provide updated and discrete estimates for critical attributes (i.e., height, age, basal area, and stems per hectare).

The spread of the mountain pine beetle (MPB) is a priority concern on the TFL and could threaten mid term timber supply if it spreads. Tembec has been proactive in managing this forest health issue and thus far have kept it under control. Tembec needs to remain current on the level of the mountain pine beetle (MPB) impact on the TFL. A Phase I VRI will provide current information related to species distribution and aid Tembec in their continued effort to mitigate MPB spread on the landbase.

Approximately 6,000 hectares (ha) of problem forest types were identified within the TFL. These stands include tree species not currently utilized, or of low quality, small size and/or low volume, or steep topography, or low stocking. A new Phase I VRI with more accurate attribute estimates could verify the current status of these stands and whether they are a viable part of the timber supply. A portion of these stands will be ground calibrated to ensure the estimates are accurate.

Balsam intermediate utilization practices were implemented throughout the TFL in the past. The residual stands are extremely variable as it relates to height and age (i.e. suppressed trees released after harvest) and reliable site indices are difficult to determine. Tembec needs information on

¹ Ministry of Forests and Range. April 2009. *Vegetation Resources Inventory – Preparing a Project Implementation Plan for Photo Interpretation*. Unpublished. Pg. 26.

² Tembec. June 2008. *Tree Farm Licence #14 Vegetation Resources Inventory – Strategic Inventory Plan*. Unpublished. Pp. 20.

the spatial distribution of these stands and better estimates to aid in determining the true site potential of these stands.

Partial harvesting has occurred throughout the TFL and Tembec requires estimates of the volume left in these stands. A Phase I VRI will use RESULTS data and photo interpretation to delineate all blocks including those that were partially harvested. Ground calibration in these stands will provide more accurate estimates of critical attributes (height and basal area).³ All available information related to the disturbance history is assumed to be available in the RESULTS data.

1.3 State of Current Inventory

The current TFL 14 forest inventory was completed in 1986 based on aerial photography and field sampling. The majority of the photography used was from 1984 (Table 1). Inventory attributes are class-based and when converted to discrete values, class midpoints were used. The existing inventory volumes were assigned using models that represent the average volume for aggregate species and site classes that display similar silvicultural and management regimes.

Table 1. Reference year and associated area.⁴

Reference Year	Area (ha)	Percent of Total	Reference Year	Area (ha)	Percent of Total
1968	568	0.4	1993	327	0.2
1975	15,173	9.4	1994	1,029	0.6
1979	7	0.0	1995	790	0.5
1981	30	0.0	1996	543	0.3
1982	91	0.1	1997	1,016	0.6
1983	1	0.0	1998	959	0.6
1984	128,517	79.6	1999	1,432	0.9
1985	6	0.0	2000	2,000	1.2
1987	24	0.0	2001	1,727	1.1
1988	75	0.0	2002	1,115	0.7
1989	29	0.0	2003	1,482	0.9
1990	155	0.1	2004	587	0.4
1991	117	0.1	2005	1,614	1.0
1992	111	0.1	2006	1,930	1.2

The MFR inventory audit results in 1994 indicated that the inventory volume was underestimated when compared to the audit volume. In particular, the audit found that inventory volumes for existing natural stands older than 60 years might be underestimated by 26%.⁵

³ All applicable and available information will be used to get improved estimates in these stand types. When doing ground calibration in these stands 3 point calls will be used to get representative estimates of basal area and height.

⁴ The data used for this summary is the VRI data provided by Timberline and is the inventory update used in MP9. The boundaries of the TFL and Bugaboo Provincial Park were obtained from the LRDW.

⁵ Ministry of Forests and Range. August 1994. *Forest Inventory Audit Report – TFL 14 Crestbrook Forest Industries*. Unpublished. Pg. 4.

In the mid 1990's it was recognized that site index in managed stands is often underestimated where productivity was derived from old-growth stands. To address this issue a site index adjustment using SIBEC was completed in 1999.

A Terrestrial Ecosystem Map (TEM) was also completed within the TFL and provided the SIBEC project with ecological values as first estimates. The TEM underwent a formal accuracy assessment in 2007.

In September 2000 Timberline Forest Inventory Consultants Ltd. (TFIC) completed an inventory audit and adjustment for TFL 14. One hundred seventy-five (175) nine-point clusters were established in the operable, productive, coniferous, free growing stands > 40 years of age. The results of the audit and adjustment showed that age was overestimated by approximately 10%, height was underestimated by approximately 7%, and merchantable volume was underestimated by approximately 11%.⁶

In the 2008 Annual Allowable Cut (AAC) Determination the Chief Forester recognized that there was uncertainty associated with the volume estimates in the existing inventory.⁷

Deficiencies in the current inventory include, but are not limited to:

1. The vintage of the current inventory is such that it is losing reliability for continued projection and the existing class based attribute estimates are coarse when compared to the current standards.
2. The species composition and other critical attributes⁸ are a concern in the current inventory. The critical attributes are the inputs for the growth and yield model VDYP7.
3. The existing inventory is not consistent with the current MFR inventory standards.
4. The volume estimates for existing stands are underestimated which is supported by two audits completed on the TFL.
5. Problem forest types may be mislabeled and need to be verified. This also includes the information needs related to the spatial distribution and productivity of stands with balsam intermediate utilization.
6. There is uncertainty around volumes left in partially harvested stands. A considerable amount of partial harvesting has occurred on the TFL since the completion of the last inventory which has changed the polygon descriptions throughout the landbase.

A new Phase I VRI will address the following key issues as outlined in the VSIP⁹:

- Provide new delineation and improve species composition, as well as other critical attribute estimates (using discrete values) which will allow for more accurate volume estimates;
- Ensure the TFL inventory is consistent with current provincial standards;
- Provide updated information that can be used to further manage and mitigate Tembec's concerns with MPB through identifying adjacent and susceptible stands.

⁶ Timberline Forest Inventory Consultants Ltd., September 2000. *TFL 14 MP No. 8 Inventory Audit and Adjustment Strategy*. Unpublished. Pg. 33.

⁷ Ministry of Forests and Range. Craig Sutherland. 2008. *Tree Farm Licence 14 Tembec Industries Inc. - Rationale for Allowable Annual Cut (AAC) Determination*. Unpublished. Pg. 37.

⁸ This includes, height, age, basal area, and stems per hectare.

⁹ Tembec Industries Inc. June 2008. *Vegetation Resources Inventory – Strategic Inventory Plan*. Unpublished. Pg. 20.

- Provide updated information around stands with BI intermediate utilization, particularly related to their spatial distribution and attribute estimates; and,
- Provide improved quantification of partially harvested stands through new delineation and integration of RESULTS data.

Overall, the above data updates and improvements will give greater confidence to users when completing timber supply analysis and operational and strategic planning.

1.4 VRI Background Information

1.4.1 The VRI Planning Process

The MFR has developed a business plan to ensure the successful implementation of VRI ground sampling and photo interpretation projects. The process includes the preparation of a strategic inventory plan (VSIP) and Phase I and Phase II project implementation plans (VPIPs) (Figure 1).

A VSIP provides general strategic direction for implementing the VRI. The TFL 14 VSIP was approved in June 2008¹⁰ and identifies background and inventory products needed to address the TFL's forest management issues identified by Tembec and the MFR.

A Phase I VPIP is a working document that:

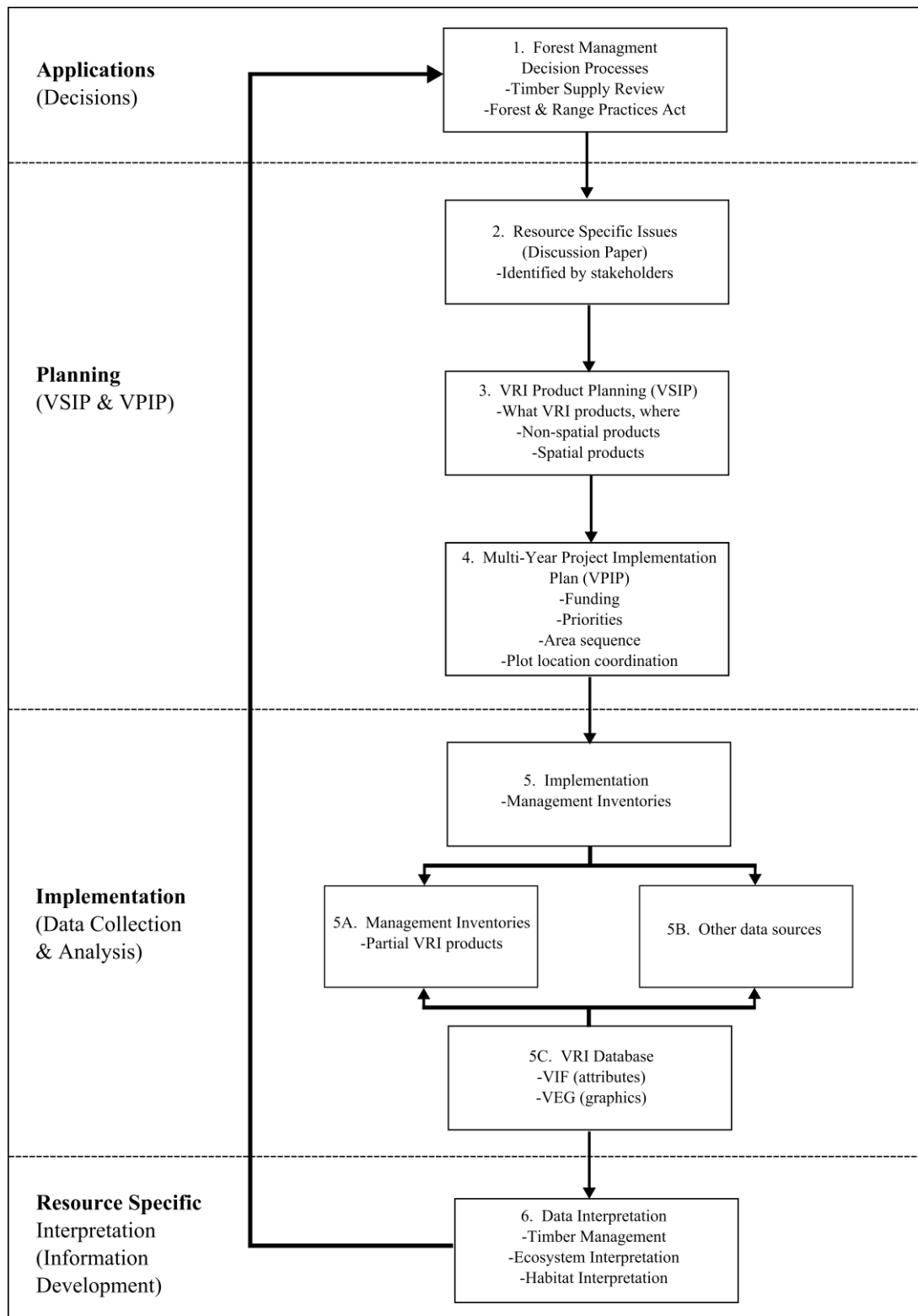
- Details the specific operational activities associated with the implementation and documentation of a VRI project;
- Identifies the target areas for new photo-interpretation;
- Documents availability of existing aerial photographs or acquisition plan for new aerial photographs, data sources, fieldwork, format of base files, project scheduling, and deliverables; and
- Describes the quality control and quality assurance requirements that will ensure all work is done to provincial VRI mapping standards.

1.4.2 The VRI Process

The VRI is a vegetation (forest) inventory process that was approved by the former Resources Inventory Committee (RIC) to assess the quantity and quality of BC's timber and vegetation resources (Figure 1). The VRI estimates overall tree species population totals and averages, as well as individual polygon attributes, for timber and non-timber resources. Its design is simple, reasonably efficient, statistically defensible, and addresses issues raised by the Forest Resources Commission in its 1991 report, *The Future of Our Forests*. The VRI consists of several components:

- BC Land Cover Classification Scheme (BCLCS)
- Photo interpreted estimates (Phase I)
- Ground sampling (Phase II) – timber emphasis, ecology, coarse woody debris
- Net Volume Adjustment Factor (NVAF) sampling
- Statistical adjustment.

¹⁰ Tembec Industries Inc. June 2008. *Vegetation Resources Inventory – Strategic Inventory Plan*. Unpublished. Pp. 20.

Figure 1. The VRI management inventory process.¹¹

¹¹ Ministry of Forests and Range. April 2009. *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Photo Interpretation – Version 2.3*. Unpublished. Pg. 34.

1.5 Project Area Land Base

TFL 14 is within the Southern Interior Forest Region – Rocky Mountain Forest District and is administered out of the district office in Cranbrook (Figure 2). The TFL covers approximately 150,000 ha.¹²

TFL 14 is situated between the height of land of the Purcell Mountains, to the west, and the Columbia River valley, also known as the Rocky Mountain Trench, to the east. TFL 14 is bounded to the south and east by the Invermere Timber Supply Area (TSA), to the west and southwest by the Kootenay Lake TSA, and to the North by the Golden TSA. The TFL also borders three protected areas which include: Glacier National Park, Bugaboo Alpine Recreation Area, and the Columbia Wetlands Wildlife Management Area.¹³

Approximately 57% of the TFL is forested. The species and age class distribution are presented in Table 2.

Table 2. TFL 14 species and age distribution for forested stands.¹⁴

Species	Age Class (%)									
	1	2	3	4	5	6	7	8	9	Total
Pl	5.9	3.7	6.5	3.6	7.2	2.0	1.2	1.4	0.1	31.5
B	4.2	1.1	2.4	1.2	4.3	2.1	0.8	7.7	2.0	25.6
S	3.0	0.3	0.2	0.8	1.7	0.9	0.9	6.7	2.8	17.3
Fd	2.7	2.1	3.2	2.0	3.2	1.0	0.3	1.6	0.1	16.2
Pa	0.0	0.0	0.1	0.6	1.0	0.6	0.1	3.0	1.7	7.1
At	0.6	0.2	0.3	0.0	0.3	0.0	0.0	0.0	0.0	1.4
L	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.7
Cw	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2
Total	16.6	7.4	12.6	8.2	17.7	6.6	3.3	20.7	6.9	100.0

¹² This area excludes the Bugaboo Alpine Recreation Area. The boundaries for the TFL and the recreation area were obtained from the LRDW.

¹³ Forsite Consultants Ltd. September 2007. *Tree Farm License 14 Management Plan 9 Analysis Report Version 2.2*. Unpublished. Pg. 72.

¹⁴ Data was sourced from Tembec's 2006 inventory update data and this table represents all stands in the entire TFL that had a species 1 present, regardless of operability or productivity class.

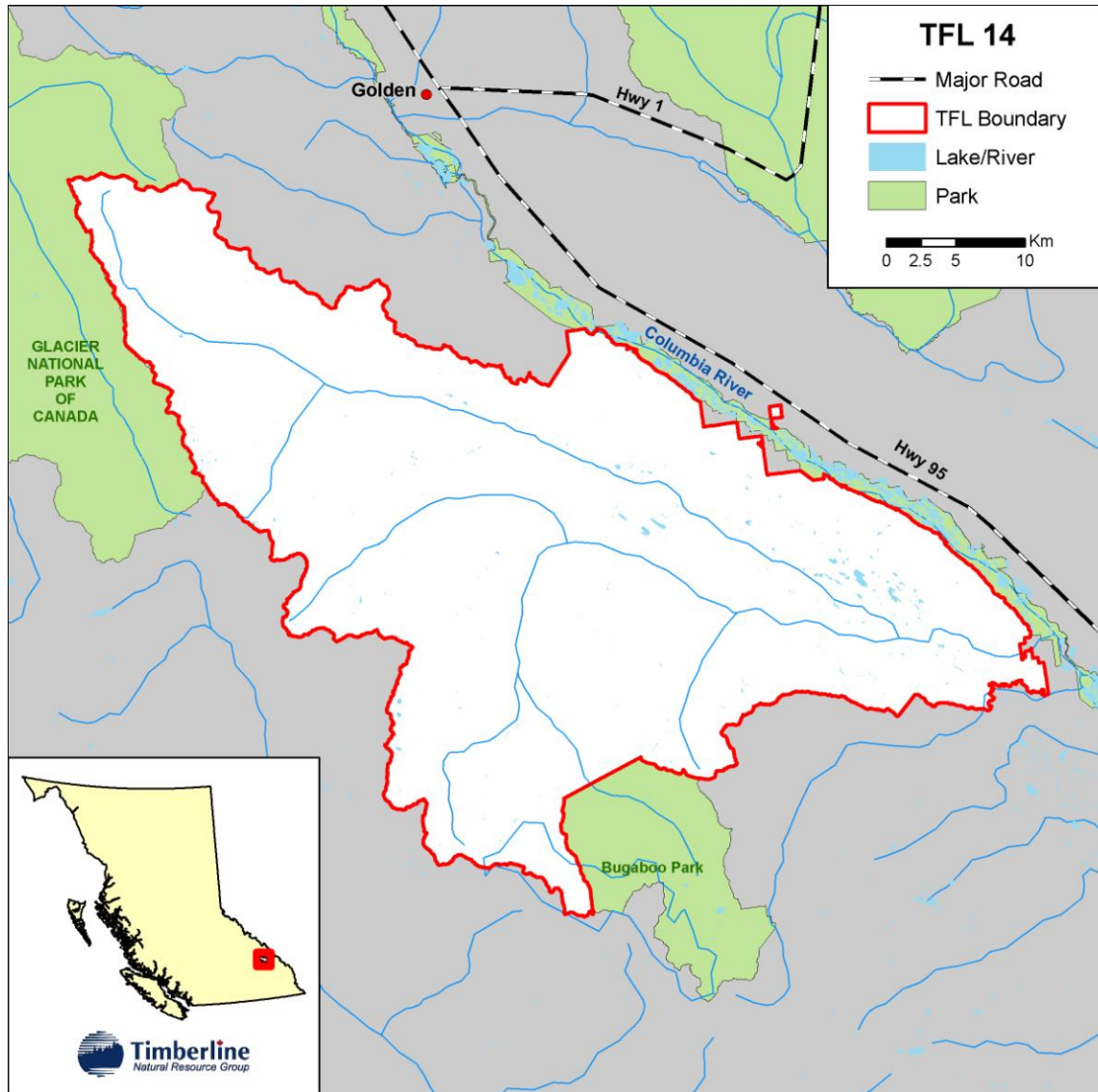


Figure 2. Overview map of the TFL 14.

1.5.1 Land Classification

Land classes within the TFL were separated based on current productivity and operability attributes. Table 3 provides the area breakdown for these portions of the land base using the most current VRI and boundary data obtained from the LRDW. Productive area not in Alpine or Park comprises approximately 45% of the TFL, while 15% is Non-productive and not in the Alpine or Park. Overall approximately 83% of the non-alpine and non-park is considered operable.

If funding constraints limit the amount of Phase I interpretation allowed in TFL 14, the areas labeled as “High” would be the top priority for Phase I followed by the areas labeled “Medium” and finally the areas labeled “Low”. Refer to Appendix II for spatial representations of these land classes.

Table 3. Land base classification.

Area description	Query Criteria ¹⁵	TFL area (ha)	% TFL Area	Priority for Phase I
Productive	npforestdesc = ""	71,888	45	High
Operable	npforestdesc = "" AND Inoperability <> "I"	68,138	42	High
Inoperable	npforestdesc = "" AND Inoperability = "I"	3,750	3	High
Non-productive	npforestdesc <> "" AND <> "A"	23,789	15	Medium
Operable	npforestdesc <> "" AND Inoperability <> "I"	12,116	8	Medium
Inoperable	npforestdesc <> "" AND Inoperability = "I"	11,673	7	Medium
Alpine	Npforestdesc = "A"	54,747	34	Low
Parks	Bugaboo Alpine Recreational Area	11,033	7	NA
Total TFL area		161,457	100	

¹⁵ These queries are based on the existing inventory information used by Tembec in Management Plan 9, with the exclusion of areas with no typing available (npforestdesc = "NTA").

2.0 PHOTO INTERPRETATION PLAN

In their 2008 VSIP Tembec expressed interest in exploring the use of Light Detection and Ranging (LiDAR) technology for use in their VRI Phase I for TFL 14. Tembec understands that the MFR is reviewing the use of LiDAR and hyper spectral imagery for vegetation assessments; however if an opportunity to pilot this technology arises, Tembec requests that TFL 14 be flagged as an area of opportunity for LiDAR related work.

2.1 Target Area

The Phase I target area is the entire TFL 14 land base including private land and protected areas within the boundary of the TFL. The Bugaboo Alpine Recreation Area is excluded from the target area.

2.2 Inventory Documentation and Archive

2.2.1 New Aerial Photography

New aerial photography will be obtained for the entire TFL excluding the Bugaboo Alpine Recreational Area (approximately 10 mapsheet equivalents). Colour digital photography will be used at a resolution of 33 cm Ground Sampling Distance (GSD) (approximately 1:27,500 scale).¹⁶ Upon completion of the flights, the aerial triangulation (AT) will be completed, and orthophotography and softcopy data will be generated. Scanning is not required for digital imagery.

The photography program (including AT and data generation) is scheduled for completion in Fiscal Year 1 of implementation (depending on available funds, flight times, and weather). Table 4 is a list of mapsheets that need to be flown with their associated areas. Appendix I is a map showing the mapsheet grid overlaid on the TFL.

Table 4. List of TFL 14 mapsheets.

Mapsheet	Area (ha)	% of TFL	Mapsheet	Area (ha)	% of TFL
082K076	734	0.5	082N004	887	0.6
082K085	4,226	2.8	082N005	13,886	9.2
082K086	10,508	7.0	082N006	15,590	10.4
082K087	3,633	2.4	082N007	11,624	7.7
082K088	3,473	2.3	082N008	1,138	0.8
082K089	66	0.0	082N014	5,263	3.5
082K095	6,948	4.6	082N015	14,324	9.5
082K096	15,612	10.4	082N016	5,451	3.6
082K097	15,623	10.4	082N017	1,264	0.8

¹⁶ The use of digital photography is based on an e-mail communication between Marcie Belcher and the MFR (Jim Grace, RPF), December, 2008. Jim Grace suggested he would prefer digital imagery for VRI. It is estimated that the cost for digital photography (including AT, orthophotography, and softcopy data) could be 20-30% more per mapsheet equivalent when compared to film. Funding availability will determine whether imagery is captured digitally or by conventional photography.

Mapsheet	Area (ha)	% of TFL	Mapsheet	Area (ha)	% of TFL
082K098	11,553	7.7	082N024	6,845	4.6
			082N025	1,778	1.2

2.3 Polygon Delineation

2.3.1 VRI Polygon Delineation

Provincially Certified Photo Interpreters will complete new VRI Phase I polygon delineation (which will be based on the BC Land Cover Classification Scheme) according to the most current MFR VRI standards.¹⁷

All roads and landings will be digitized and kept on a separate layer and provided to Base Mapping and Geomatic Services (BMGS) for updating the TRIM base if needed.

2.3.2 Results Integration

Integrating RESULTS opening information is an important aspect of VRI polygon delineation and attribution. RESULTS integration will follow the MFR standards at the time of delineation and attribution. Figure 3 illustrates the 2009 process for integrating RESULTS data into VRI. The MFR will provide a copy of the RESULTS shapes to the contractor at the start of the Photo Interpretation contract. Appendix III provides a summary of more detailed procedure as outlined by the MFR.

¹⁷ Ministry of Forests and Range. March, 2009. *Photo Interpretation Procedures Version 2.5*. Unpublished. Pp. 135.

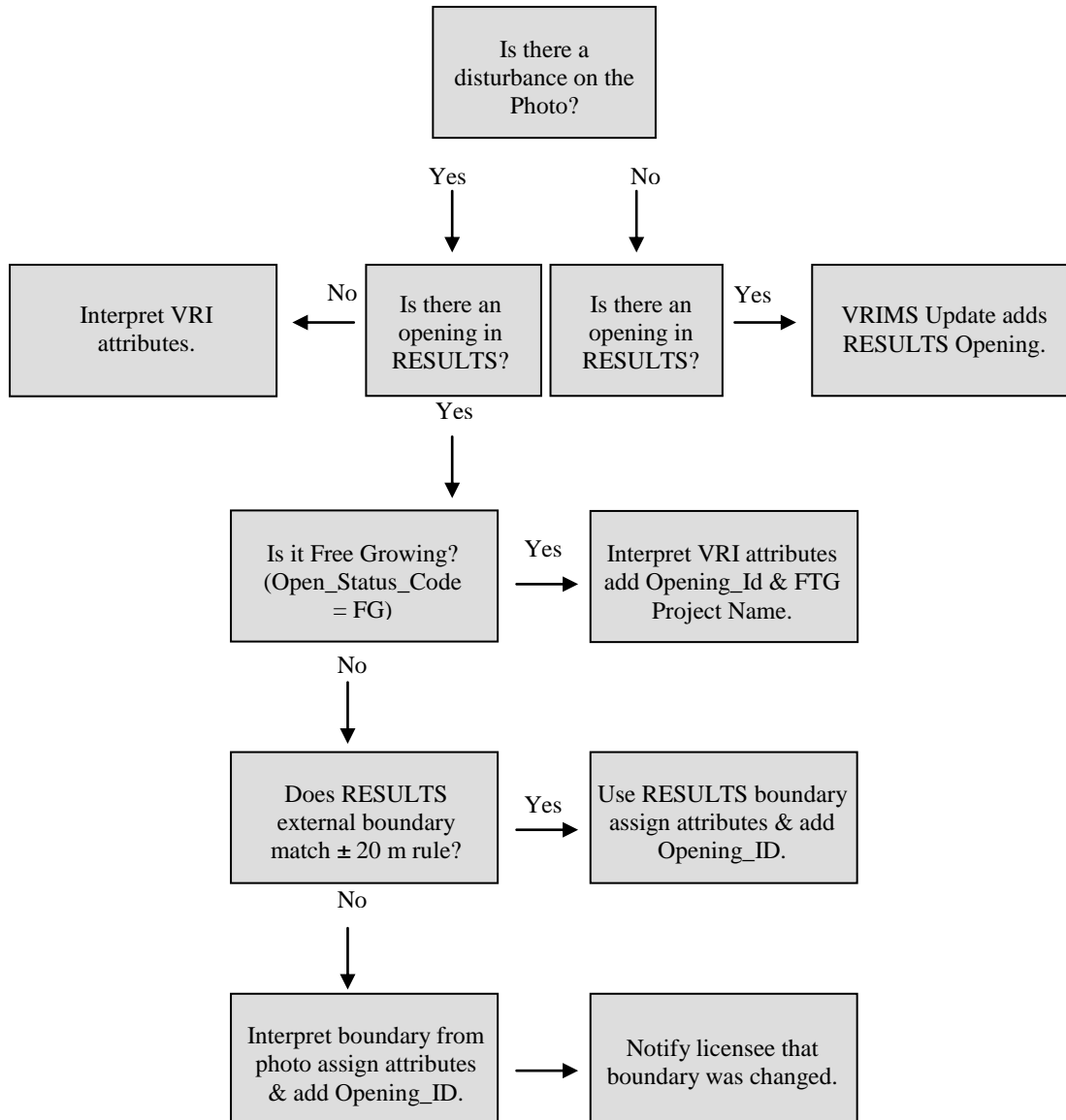


Figure 3. Integration of RESULTS openings in VRI projects.

All delineation will be checked, quality-controlled, and audited to ensure adherence to project objectives and MFR standards.¹⁸

2.3.3 Polygon Size

Tembec requires an overall average polygon size of approximately 23 ha. The average size of the delineated polygons is based on information needs. Thus an average of 7ha, 10ha, and 50+ha will

¹⁸ Ministry of Forests and Range. April 2009. *Photo Interpretation Standards and Quality Assurance Procedures Version 3.2*. Unpublished. Pp. 30

be targeted for the productive¹⁹, non-productive, and alpine portions of the landbase respectively. Table 5 provides the average polygon sizes required for TFL 14 based on the land classification while still keeping an overall average polygon that is cost effective.²⁰

Table 5. Average polygon size by priority land class.

Land Classification	Proportion of the TFL (%)	Average Polygon Size
Productive	48	7 ha
Non-productive non-alpine	16	10 ha
Alpine	36	50+ ha
Overall area weighted average		23 ha

2.4 Calibration Program

Field calibration is a critical component of a Phase I VRI and has direct impacts on the accuracy of the resulting VRI data. The field calibration program will be focused on areas of interest that were identified as issues in the TFL 14 VSIP. The following are the forest types that require particular attention (in order of importance):

1. *Mature stand attributes* – Tembec requires improved species composition, height, age, basal area, and stems per hectare estimates in stands greater than 50 years as this is the short and mid-term timber supply.
2. *Species* – TFL 14 has a relatively large number of species present and this could require extra calibration (ground or air)²¹ to ensure proper estimates related to species calls and composition.²²
3. *Balsam Intermediate Utilization Stands* – Tembec requires reliable information related to areas where intermediate utilization practices were implemented including reliable heights and ages to use for productivity measures.²³
4. *Partially Harvested Stands* – Tembec requires improved estimates of critical attributes (particularly height and basal area). Where necessary 3-point ground calls will be used in these stand types.

The VRI standards do not specify the maximum number of calibration points required in a Management Unit to support photo interpretation. Each case is unique and depends on:

- The amount and composition of productive forest;
- The amount of existing, usable calibration data;
- The distribution of existing calibration data;

¹⁹ This average polygon size is consistent with the current average polygon size for the productive area on the TFL.

²⁰ While there are no MFR standards related to average polygon size Tembec has identified a desired average size to hold contractors accountable for their work in an effort to monitor quality control. Tembec understands that these polygon sizes are not always achievable; however they would like rationales from contractors as to why they are not able to achieve the sizes or why the sizes might be inappropriate (e.g. as in the alpine).

²¹ Air calls are typically better suited for species composition than ground calls.

²² Contractors should consider this when budgeting for air and ground calibration.

²³ It is difficult to interpret heights and ages in these stands.

- The knowledge and skill of the interpreter(s) and their familiarity with the area; and
- Other considerations, including available budget.

Air and ground calibration points will be completed by the photo interpreters responsible for assigning polygon descriptions.

2.4.1 Calibration Data Sources

Calibration data sources are field data reference points established across the land base, such as ground and air calibration points, ground observations, ground samples, cruise plots, and any other historical information that may be useful for determining polygon attributes. Field data measurements or estimates at these points are used to assist in the delineation and interpretation of forest vegetation types. Previous or historical data sources will be reviewed and those air and ground calls/observations that are still valid will be utilized in the new stand delineation.

Photo-interpreters will meet with Tembec and the MFR before the project begins to obtain access to supporting data sets, incorporate local knowledge, and help familiarize photo-interpreters with issues specific to TFL 14. Table 6 identifies potential data sources and where they could be obtained (this is not an inclusive list).

Table 6. TFL 14 potential data sources

Data Source	Custodian
Inventory Audit Data (c. 1994)	MFR
Past Calibration Data (c. 1984)	MFR
Document Photo's (including old linework)	MFR
Recce Data	MFR
Permanent Sample Plot Data	MFR
Cruise Data (non-logged only)	Tembec
Adjustment Data (c. 2000)	Tembec
SIBEC Data	Tembec
Terrestrial Ecosystem Mapping	Tembec
Roads, Trails, and Landings Database (c. 2006+)	Tembec
TFL classified streams, wetlands, and lakes (c. 2006+)	Tembec
TRIM	BMGS

2.4.2 VRI Field Calibration Plan

VRI Gap Analysis (or data source analysis) will be completed to identify target vegetation types prior to the implementation of the VRI field calibration program. A VRI Field Calibration Plan showing the potential distribution of the calibration points will be submitted to the MFR for comment and approval (Refer to Appendix IV for the MFR Field Calibration Plan Requirements).

The desired allocation of ground calibration points and air calibration points is presented in Table 7. The number and distribution of ground observations and air observations will be finalized through gap analysis and will be at the discretion of the contractor. Ground calibration points will not be established in non-forested or protected areas within the TFL.

Table 7. Minimum required ground and air calibration points and observations.

Type of VRI Calibration Point	Number Required per Mapsheet Equivalent (MSE)
Ground Calibration Points	10
Air Calibration Point	20

2.4.3 Field Calibration Procedures

The MFR suggests a minimum field calibration intensity of 10 ground calls²⁴ and 20 air calls, per full BCGS map sheet equivalent. It is recommended that the contractor increase the number of calibration points to allow for more accurate estimates, and interpretation support within the areas identified in Section 2.4. The majority of any extra field and ground calibration points should be concentrated in the high priority areas (as identified in Table 3), followed by the medium priority areas, and few calibration points should be located in the low priority area.

Field calibration (air call and ground call) data collection is to be completed as per the VRI Air Call Data Collection Procedures²⁵ and the VRI Ground Call Data Collection Procedures²⁶. Field calibration data collection is to be documented and recorded in a format acceptable to the MFR. The actual number of calibration points could vary on a map by map basis and more points may be completed.

The spatial coordinates (UTM) for all field plots will be recorded on the field cards. The plot locations will subsequently be loaded as a separate spatial coverage. A digital listing of field work data in a suitable format will be supplied to the MFR for all VRI field work.

Document photos and supporting information are needed for the historical calibration points. The MFR will supply a digital file with locations, and air and ground call books, as well as the document photos.

2.4.4 Attribute Estimation

Photo-interpretation and polygon delineation will be completed utilizing Softcopy technology. Orthophotos will be produced from the digital photography and will be available for planning purposes prior to inventory field work. Softcopy based heights will be measured in every treed polygon where possible and/or reasonable.

At a minimum, one in five treed polygons will be marked showing that a tree height had been measured using the digital imagery and labeled as “data_src = 22”. These marked polygons will be audited throughout the project.

²⁴ 1 or 3 – point calls are available and the use of one over the other will be at the discretion of the photo-interpretation contractor, except in the partially harvested stands where 3 – point calls will be used.

²⁵ Ministry of Forests and Range. April 2009. *Air Call Data Collection Procedures version 1.0*. Unpublished. Pg. 15.

Ministry of Forests and Range. April 2009. *Air Call Quality Assurance Procedures and Standards version 2.2*. Unpublished. Pg. 17.

²⁶ Ministry of Forests and Range. April 2009. *Ground Call Data Collection Procedures version 1.0*. Unpublished. Pg. 17.

Ministry of Forests and Range. April 2009. *Ground Call Quality Assurance Procedures and Standards version 3.2*. Unpublished. Pg. 18.

2.5 Polygon Descriptions

All VRI polygon descriptions will be completed to MFR VRI standards.²⁷ Certified VRI photo interpreters who complete the field calibration phase will complete the polygon classification.²⁸ Initial polygon delineation will be re-assessed during the final polygon description phase to ensure consistency and that VRI standards are achieved.

There are five general categories of data that are produced during the attribute estimation of polygons:

1. **Ecology:** includes surface expression, modifying process, slope position, alpine designations, and soil nutrient regime;
2. **Land Classification – Land cover component:** includes treed (broadleaf, coniferous, mixed) and terrain identification if trees are absent including snow, water, rock, and soil moisture regime;
3. **Site Index:** includes species, source, and site index;
4. **Tree Attributes:** includes crown closure, tree layer, vertical complexity, species and age of leading and second species, basal area, density, and snag frequency; and
5. **Non-treed attributes:** includes shrub height and crown closure, herb type and percent cover, and bryoid percent cover.

All VRI attribute files will be validated and delivered in a format consistent with MFR standards.

2.6 Mapping Deliverables

All VRI mapping and databases products will be delivered in the acceptable format for submission and storage at the end of each fiscal year.

²⁷ Ministry of Forests and Range. April, 2009. *Photo Interpretation Procedures Version 2.5*. Unpublished. Pp. 126.

²⁸ This may also include non-certified interpreters under the direct supervision of a certified interpreter.

3.0 PROJECT IMPLEMENTATION PLAN

3.1 Scheduling

This project is scheduled for implementation over two fiscal years (Table 8). The timing and completion of this project is dependent upon Tembec's available FIA funding. Activities will include:

- Photo acquisition;
- Analysis of existing data sources;
- Polygon delineation (using Softcopy)
- Field Calibration Plan;
- Field data collection;
- Polygon descriptions (using Softcopy);
- Final digital mapping;
- Final deliverables; and
- Project completion report.

Table 8. TFL 14 summary of estimated delivery schedule by phase.

Fiscal Year ²⁹	Photos flown	Viewer Set Preps.	Polygon Delineation	Field Calibration Plan Design	Field Data Collection	Polygon Descriptions	Final Digital Mapping and Deliverables	Fiscal Completion Report	Quality Control
Year 1	Summer	Summer-Fall	Fall – Winter	Fall – Winter				Spring	Ongoing
Year 2					Spring – Summer	Fall – Winter	Spring	Spring	Ongoing

3.2 Project Coordinator

The project coordinator will:

- Coordinate the project;
- Monitor quality control;
- Monitor and communicate project progress; and
- Liaise with the project manager to ensure all expectations are met.

3.3 Personnel

All VRI photo interpretation work will be completed or directly supervised by a VRI Certified Photo Interpreter. At least half of the photo interpreters working on the project will be certified for VRI photo interpreters and those not certified will be directly supervised by a certified photo interpreter working on this project.

²⁹ The fiscal year cannot be determined until the project has been approved and funding is made available through the Forest Investment Account or its equivalent.

3.4 Quality Assurance

Quality assurance (QA) for the TFL 14 Phase I VRI project will follow the MFR standards.³⁰ An independent third-party auditor, MFR staff, or both will provide QA services during the polygon delineation, polygon attribute estimation, and field data collection phases of the project. Audits will be completed in batches throughout the life of the project to identify issues as they arise and ensure they will not carry through the remainder of the project. Reworks (if needed) can then be applied to batches, instead of having to complete landbase or landscape unit reworks.

If a third-party auditor is chosen to provide QA, the selection process will be by a tendered Request for Proposal. QA results will be forwarded to the MFR Regional representative during or after completion of each phase of the project.

Tembec will hold a pre-project meeting with the photo interpretation contractor, QA contractor, and MFR representatives (both Regional and Forest Analysis and Inventory Branch staff) to discuss the project goals, objectives, methods, quality control strategy, timing of activities and deliverables, and roles and responsibilities.

3.5 Quality Control

Quality control is a critical aspect of the Phase I VRI project. Internal quality control reports will be provided at regular intervals to the project coordinator to ensure any identified issues have been rectified and future quality control reports will show any relevant changes. The contractor will provide their quality control process for evaluation and approval following contract award.

3.6 Deliverables

The following products will be delivered to the MFR upon completion of the TFL 14 Phase I VRI project:

- Complete VRI data files in the most current MFR format;
- MFR validation reports for each mapsheet;
- Hardcopy tally sheets or digital equivalent for each ground and air calibration point;
- Field Calibration Plan;
- Digital field data summaries for all calibration points in a format provided by the MFR;³¹
- Digital field data point locations (XG/AC) with final UTM co-ordinates and all (air and ground) call extents included;
- All Softcopy system files including digital SIS (or SJS) image files, MOD files and SDT surface files on portable IDE hard drives;
- Internal quality control documentation for each phase of the VRI project;
- Quality assurance documentation for each phase of the VRI project;
- Annual progress report for projects being completed over more than one fiscal year;
- A project completion report.

All project deliverables will be signed off by a qualified Registered Professional Forester. Deliverables will be delivered annually reflecting the activities of that fiscal year.

³⁰ Ministry of Forests and Range. April 2009. *Photo Interpretation Standards and Quality Assurance Procedures Version 3.2*. Unpublished. Pp. 30

³¹ The MFR will provide a template at the project pre-work meeting.

3.7 Reference Material

The following material is readily available for the project³²:

- VRI BC Land Cover Classification Scheme (current version);
- VRI Photo Interpretation Procedures (current version);
- VRI Quality Assurance Procedures for Photo Interpretation (current version);
- VRI Photo Interpretation Standards (current version);
- VRI Air Calibration Data Collection Procedures and Standards (current version);
- VRI Ground Calibration Data Collection Procedures and Standards (current version);
- MFR Vector Cleaning Specifications (current version);
- BC MFR Forest Inventory Manual;
- BC MFR Biodiversity Guidebook;
- BC MFR Color Stereogram Handbook;
- BC MFR Black and White Stereogram Handbook;
- Several tree and plant identification field guides; and
- RESULTS Silviculture data.³³

3.8 Cost

Table 9 shows the estimated costs for photo acquisition and Phase I VRI in TFL 14 (150,000 ha or 10 mapsheet equivalents). The overall estimated cost for photo acquisition and Phase I VRI is approximately \$278,500.

Table 9. Estimated costs for TFL 14.

Task	Estimated Cost per Mapsheet Equivalent	Estimated Cost per Ha	Total Cost for 150,000ha
Acquisition (digital, colour)	\$3,900	\$0.260	\$39,000
Aerial Triangulation	\$800	\$0.053	\$7,950
Orthophotography	\$400	\$0.027	\$4,050
Softcopy dataset	\$250	\$0.002	\$300
Subtotal	\$5,350	\$0.357	\$53,500*
Air Calibration*	\$2,500	\$0.167	\$25,050
Ground Calibration*	\$5,500	\$0.367	\$55,050
Delineation and Classification	\$14,500	\$0.966	\$144,900
Subtotal	\$22,500	\$1.500	\$225,000
Grand Total	\$27,850	\$1.857	\$278,500

Note: Due to the small size of the TFL certain efficiencies could be lost which could increase costs by as much as \$25,000.

* Calibration costs could be higher if there is a requirement for enhanced species identification.

³² The material listed is readily available; however gap and/or data source analysis will determine the availability and relevance of other reference material.

³³ Special considerations will be made for polygons with existing silviculture records as outlined in the VRI Guidelines for preparing a Project Implementation Plan for Photo Interpretation – April 2009.

4.0 APPROVAL/SIGN-OFF OF PHASE I VPIP

I have read and concur that the TFL 14 VRI Strategic Inventory Plan dated January 2010 meets current VRI standards. It is understood that this is an agreement-in-principle and does not commit the signatories to completing the inventory activities outlined within the plan.

David PC Brown, RPF
Divisional Forester – Western Canada BC Division
Forest Resource Management
Tembec

Date

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

Date

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APPENDIX I – PROJECT AREA MAPSHEET NUMBERS

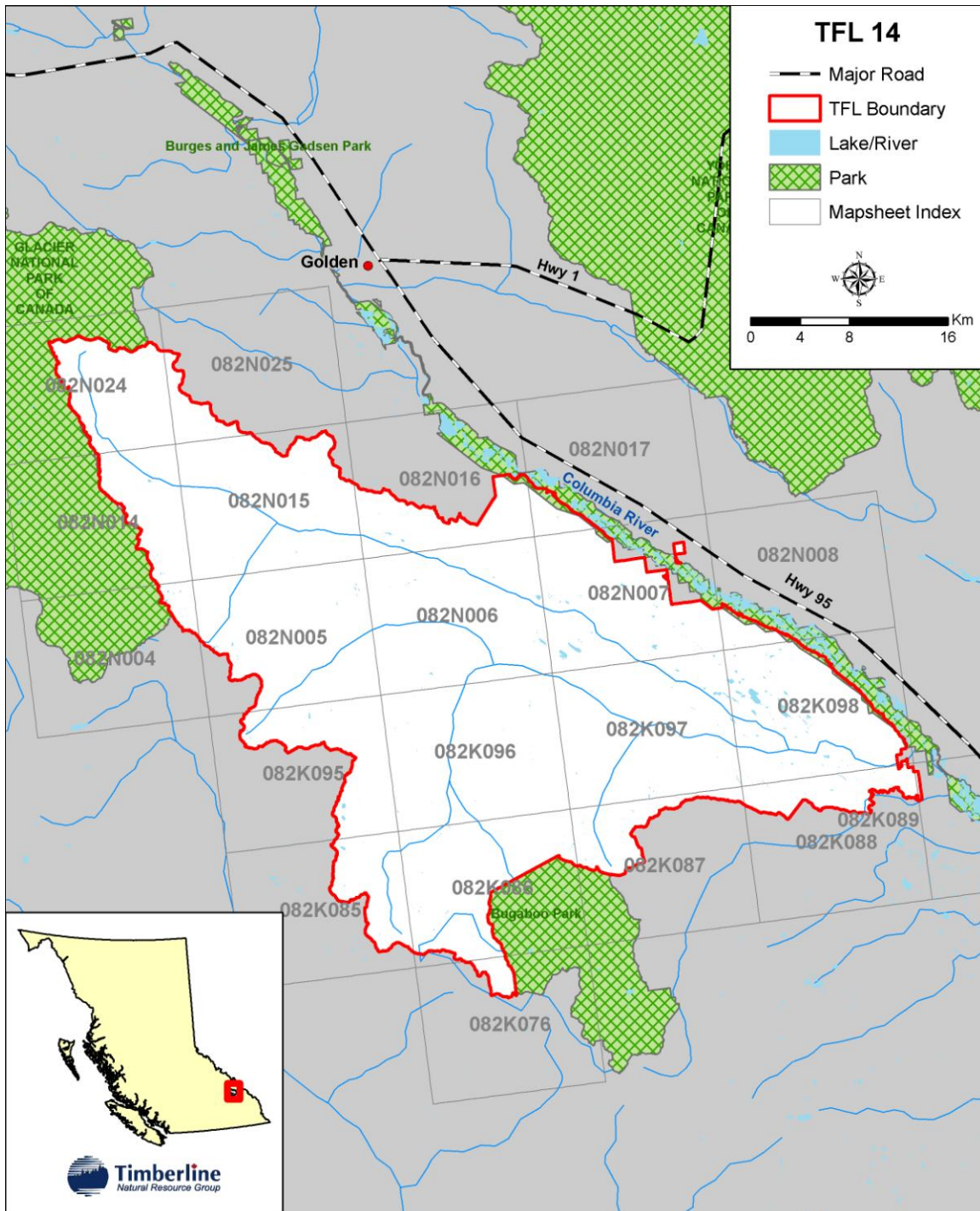


Figure 4. TFL 14 mapsheets.

APPENDIX II – LAND CLASSIFICATION MAPS

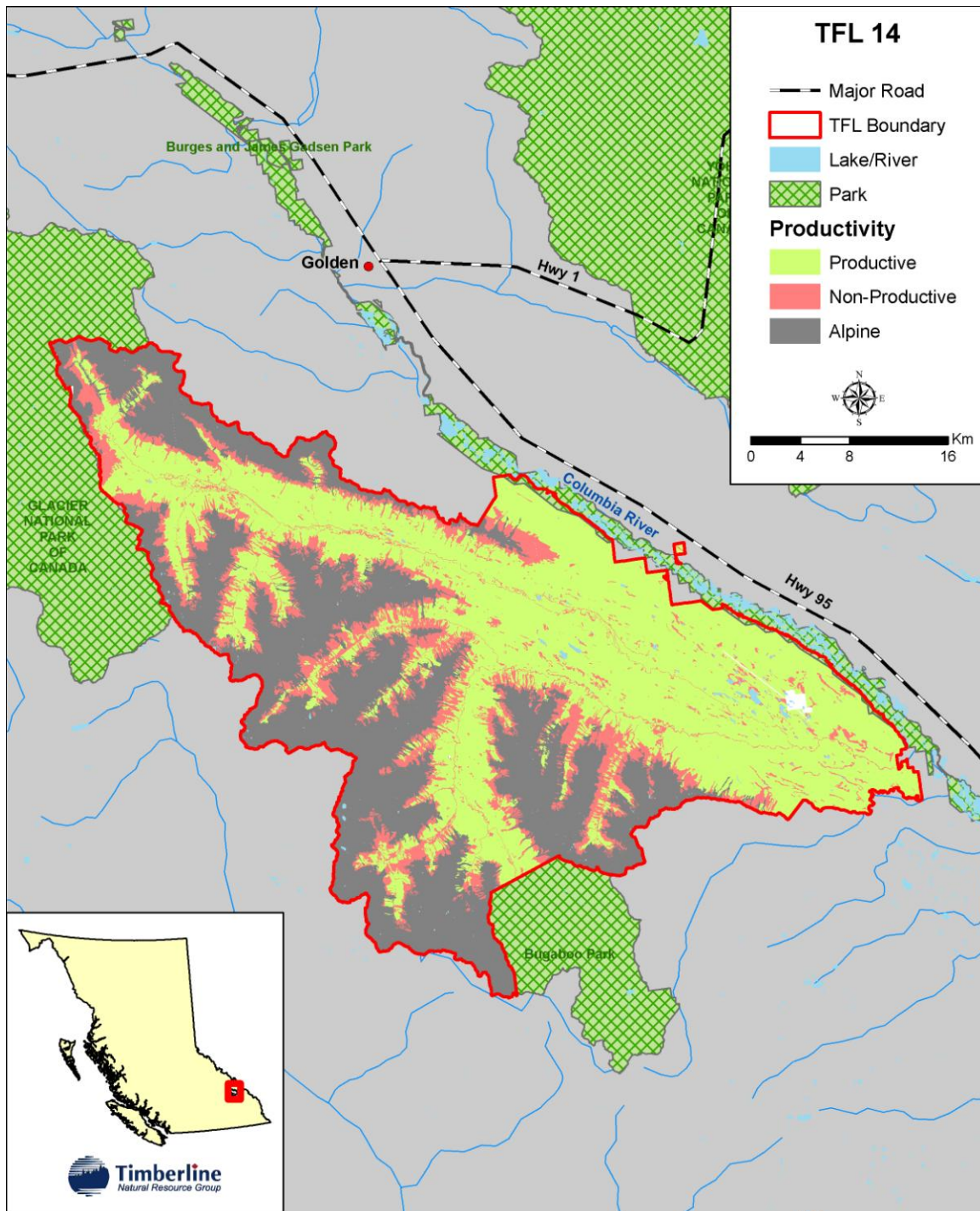


Figure 5. TFL 14 productivity land classification map.

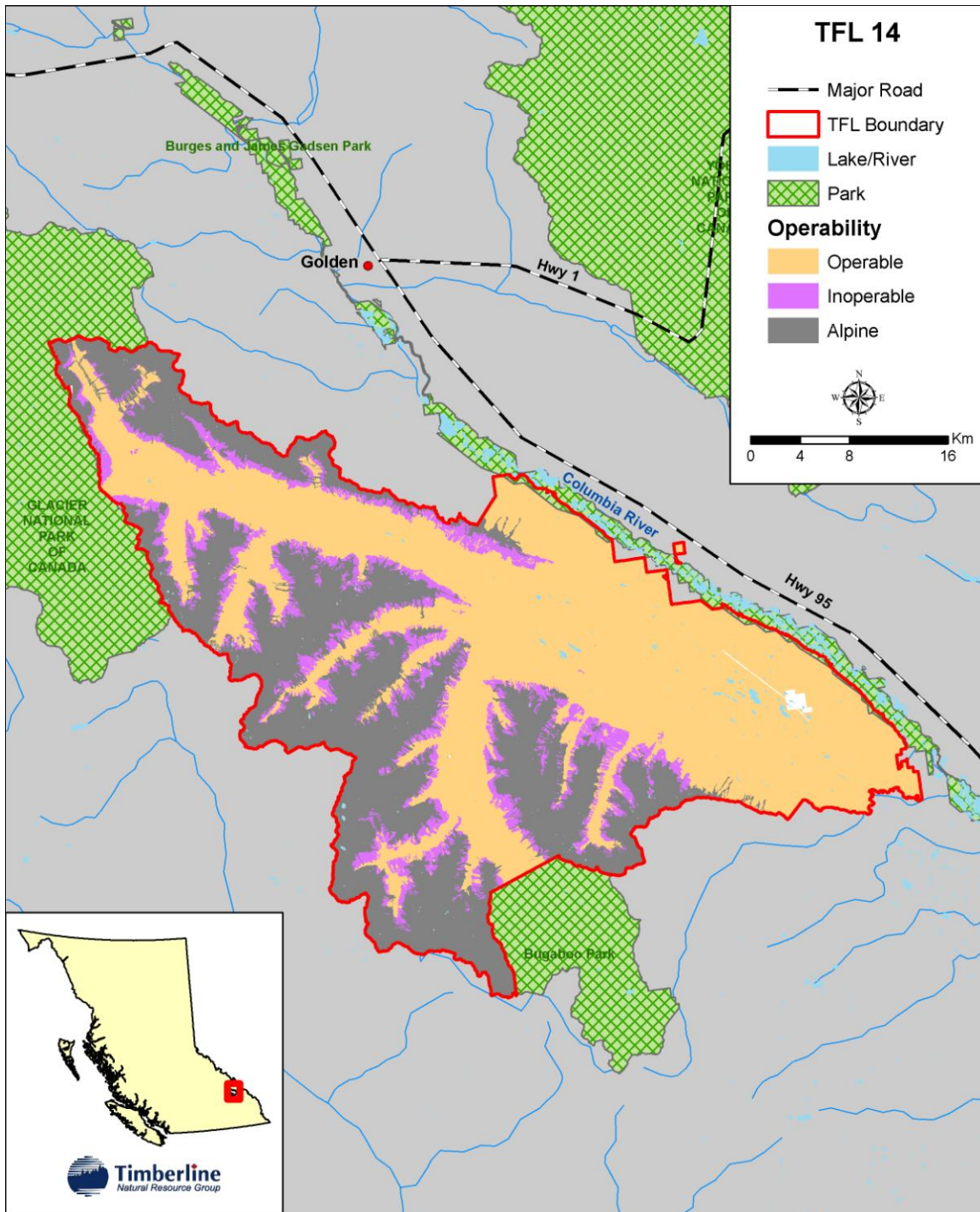


Figure 6. TFL 14 operability land classification map.

APPENDIX III – INTEGRATING RESULTS INFORMATION

The following summarizes the procedures for integrating RESULTS information into the VRI.¹

- The VRI is a photo-based inventory therefore any external polygon (opening) boundaries that exist on the current imagery will be maintained.
 - The most recent version of the RESULTS external boundary will be used to assess the accuracy and acceptability of the RESULTS external boundary against the imagery (photo interpreted) external boundary. RESULTS external boundaries that are within $\pm 20\text{m}$ rule will be used or replaced at the discretion of the photo interpreter. RESULTS external boundary lines that exceed the $\pm 20\text{m}$ rule must be replaced.
 - If the RESULTS boundary is used, the adjacent VRI polygon type lines must be “snapped to the RESULTS boundary.”
 - Where an opening shape does not exist in the RESULTS file, the external boundary from the imagery will be used.
 - Licencees will be notified when their RESULTS external boundary was not used and will be provided with a spatial file of the external boundary used in the VRI.
- RESULTS opening information that is newer than the current imagery will not be included in the VRI photo interpretation.
 - There is no requirement for the photo interpretation contractor to incorporate RESULTS information that occurs after the date of photography unless otherwise instructed by the licensee. The MFR will integrate all RESULTS information that occurred after the date of photography after the photo interpretation project has been delivered to the MFR.
- RESULTS Openings not declared Free Growing (FG) will have minimum attributes assigned. In the absence of extraction of attribute data from RESULTS the contractor will follow the following rules:
 - Attributes will be taken from RESULTS where possible and will include:
 - Estimated site index;
 - Estimated site index species;
 - Estimated site index source;
 - BC Land Cover Classification code (assigned by the interpreter);
 - Opening ID number (contact the licensee if there is no opening ID in RESULTS).
 - Disturbance type, disturbance start and end years;
 - Inventory Standard will be “T” for these records.
 - Wildlife Tree Patches (WTP) or reserves larger than 1 ha will be delineated and assigned the full suite of VRI attributes.
 - New openings that are partially disturbed (such as those with selective logging or having numerous seismic lines) will require the full suite of VRI attributes

¹ Ministry of Forests and Range. May 2008. *Vegetation Resources Inventory Guidelines for Preparing a Project Implementation Plan for Photo Interpretation Version 2.2.* (Unpublished). Pp. 7.

estimated by the photo interpreter as RESULTS may be inconsistent in providing sufficient data for these areas.

- RESULTS openings that have been declared Free Growing will have the polygon delineation and attribute estimation completed to VRI standards.
 - RESULTS free growing attributes should be used as a reference for the VRI photo interpretation.
 - Each free growing polygon must have the code “FTG” entered in the Project Name field.
 - External boundaries may be modified unless they are shared with a non-free growing opening.
- Openings may be split by map sheet boundaries as per previous standards.
- Opening ID numbers must be provided for each silviculture opening polygon including WTP.
- For areas identified as large openings (such as historic fires) with a number of diverse vegetation types, the full suite of VRI attributes is to be provided.
- For VRI/terrain projects, divide the opening by terrain lines. Internal polygon delineation of the opening is governed by RESULTS guidelines therefore the terrain lines will disappear after the integration of the next RESULTS submission.
- Note that there is an anomaly in the BC Land Classification Scheme where polygons that have tree crown closure between 5 and 9% with no other vegetation identified do not fit into the Scheme. For these situations, a minimum crown closure of 10% is to be assigned to these polygons.

APPENDIX IV – FIELD CALIBRATION PLAN GUIDELINES

Objectives

Field Calibration Plans (FCP) are required to ensure consistency between the proposed field calibration points and the requirements for additional information in the project area. The FCP is based on the VSIP and/or Phase I VPIP which will include:

- a) Data source analysis from previous inventories. This is carried out to indicate where data sources may be considered less reliable or non-existent.
- b) Consultation with proponents regarding management concerns

The FCP will include calibration points that will assist the photo interpreter to correlate the vegetation attributes on the ground with those on the air photos (e.g., complex multi-layered stands).

Approval process and plan content

Prior to the commencement of any field data collection, the recipient must submit to their respective Ministry of Forests and Range (MFR) Inventory Forester the FCP for approval. After successful review, written approval will be provided to the recipient. The plan should include:

- a) An Excel spreadsheet showing the distribution of calls by age class, leading species and any calibration points pertaining to items identified in the VSIP.
- b) The number and type (1 point/3 point clusters) of calibration points proposed. Often more points than required to meet the target may be pre-selected to allow for operational issues such as limited access.
- c) Designated staff who will be carrying out the field work including both air and ground calls.

Mapping Requirements

- a) A submission format of a single shape file (.shp).
- b) All map sheet boundaries and map sheet ID.
- c) Include the following map features:

• Major Water Features	-solid blue, line weight 0.5
• Major Roads	-dashed red, line weight 0.5
• Proposed Air Calls with call #	-orange, Font 8
• Proposed Ground Calls	-yellow, Font 8

Each air call and ground call will be indicated with the following symbol:

Air Calls - ◇

Ground Calls- •