Vegetation Resources Inventory

Lillooet TSA – Project Implementation Plan for Re-Inventory

Prepared by
Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Forest Analysis and Inventory Branch

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Section 1 - Introduction

Background Information

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRO) has identified a need to complete a new inventory in the Lillooet Timber Supply Area (TSA). The new inventory will be conducted using a traditional photo interpretation following the Vegetation Resources Inventory (VRI) Phase 1 methodology.

The plan is to complete this inventory by Summer 2021, and to have it available by January 2022. This document details the planning necessary for the project to commence.

The mountain pine beetle (MPB) has had a noticeable impact on the forest cover in the Lillooet TSA. This, in combination with the overall vintage of the current inventory (1988-1990), means the new inventory will provide much needed current information on (among other things) species composition, the spatial distribution of live and dead stands, and an estimate of the amount of dead volume in the TSA.

Document Objectives

This VRI Project Implementation Plan (VPIP) is a working document that states the critical reasons and objectives for carrying out a new inventory in the Lillooet TSA. It includes details on the area to be inventoried, issues with the current inventory, objectives, and key steps required to be carried out for a successful completion of the Phase 1 (photo interpretation). Necessarily, this VPIP primarily describes the higher-level details of the projects, whereas the finer details and specifics will be contained within the respective contract documents.

Overview of the VRI Phase 1 Process

The VRI provides a strategic inventory at the management unit level (e.g., District, TSA or TFL) designed to answer two basic questions: where is the resource, and how much is there? The VRI consists of two phases: air photo interpretation (Phase 1) and ground sampling (Phase 2). These phases may be undertaken in combination or, in certain situations, individually.

Phase 1 involves acquisition of new aerial photos, delineation of new polygons, and estimation of polygon attributes, with the final product being the corporate inventory. Phase 2 involves a network of forest growth monitoring plots established across the target unit, supplemented by ground sampling a random subset of the new polygons. This serves to verify the level of confidence in the Phase 1 inventory, and to provide detailed information on stand characteristics (such as tree size distribution and condition) that is not available from the Phase 1 inventory.

The individual stages of a VRI Phase 1 project include the following:

- Image acquisition: Images used for VRI photo interpretation projects must be less than five years old. The photos for this project were acquired in the summer of 2017.
- Historical data source transfer: The existing data sources in the project area are evaluated and captured digitally if they are deemed to be useful for the current project.
- Delineation: New line work is delineated on the images. Polygon delineation is based on the B.C. Land Cover Classification Scheme (BCLCS). This land classification scheme includes both vegetated and non-vegetated cover classes. Polygons identified by the land classification scheme are further divided into similar vegetated or non-vegetated polygons based on mensurational attributes (species, age, height and crown closure) and/or ecological attributes where appropriate.

- Fieldwork: A series of calibration points are established for use by the interpreters. These calibration points are a combination of air calls via helicopter, and ground calls. The calibration program allows the interpreters to gain some familiarity with the project area, and the data acts as reference points while attributing neighbouring polygons.
- Attribute estimation: All delineated polygons are assigned attributes which describe the vegetative or non-vegetative characteristics of the polygon. A complete description of the attributes described is available in the *VRI Photo Interpretation Procedures*.

More details regarding the VRI process and the VRI procedures and standards are available at the Forest Analysis and Inventory Branch (FAIB) website:

https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory/forest-cover-inventories/photo-interpretation.

Lillooet TSA "Target Area" Landbase

In recent years, VRI Phase 1 projects have typically been conducted for entire TSAs or Districts. The primary benefit of this is generating a consistent inventory product (both in quality and vintage) to be used in timber supply analyses. This project is an exception. The re-inventory ("target") area contains the majority of the Lillooet TSA (See Figure.1) while some areas are exempt due to being included in previous VRI's, such as the Kamloops TSA inventory (2012), Williams Lake (2013), Merritt TSA (2017), Churn Creek (2018). The project area stops in the east, and north along the surrounding TSA map sheet boundaries.

Note that all tables in this section represent data based specifically on the project area, which does not exactly match the area of the Lillooet TSA (for the reasons discussed above).

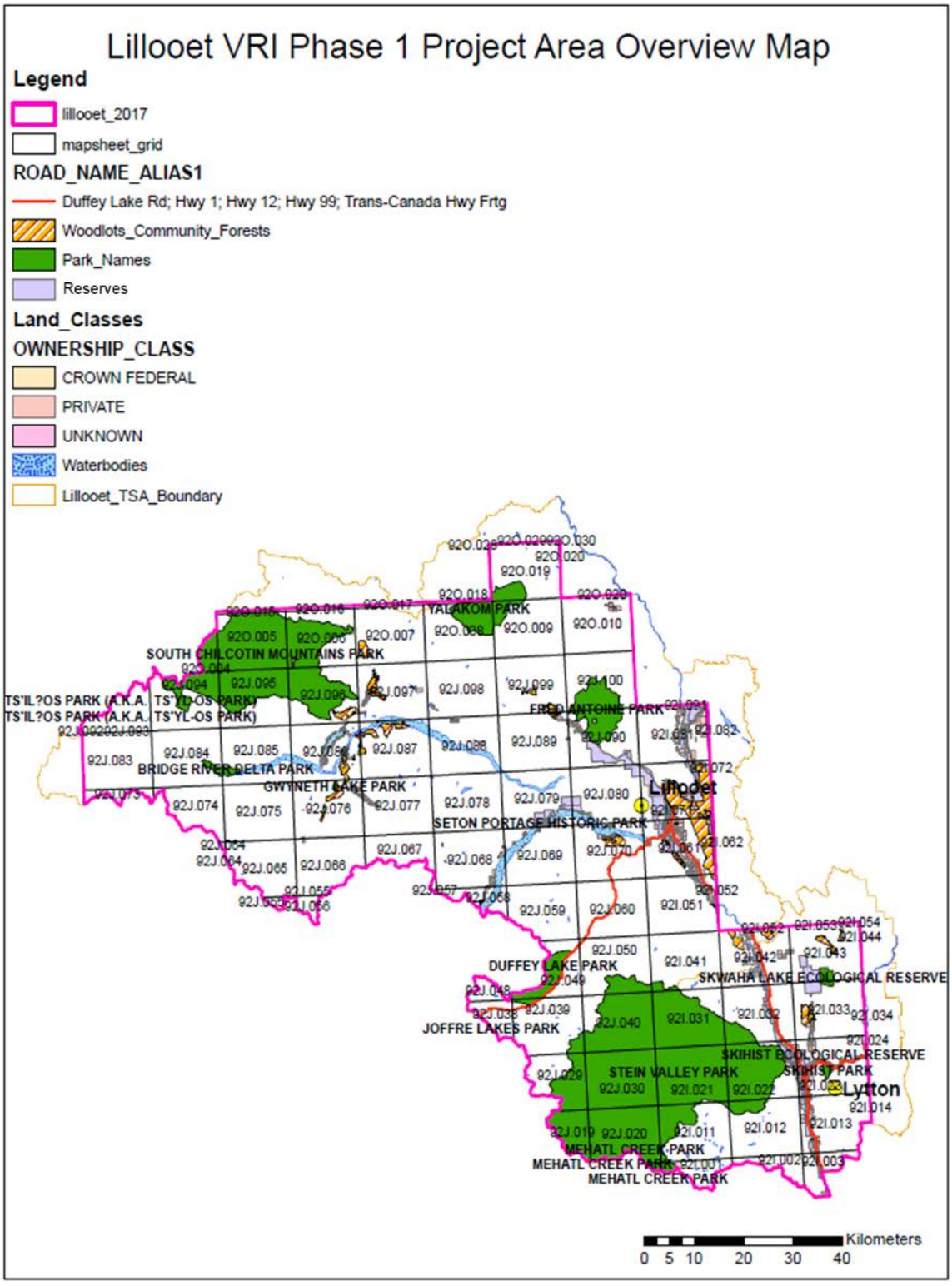

Figure 1. Overview of the Lillooet project area.

Table 1. TSA breakdown for the Lillooet project area.

Timber Supply Areas	Area (ha)	% of Project Area
Lillooet TSA	966,886	
Williams Lake TSA	3,257	
Fraser TSA	4201	
Soo TSA	4880	
Total	***979,224***	***100.0%***

The Lillooet TSA is located in Southwestern BC between the Coast Mountains and the Thompson-Okanagan Plateau and covers approximately 1.126 million hectares. The project area is 979,224 ha. Approximately 24% of the entire project area is classed as private land, provincial parks, community forests, Indian reserves, and woodlots (Table 2). According to the most recent TSR document[1], of the total TSA area, ~528,096 ha (~47%) are productive forest under Crown ownership (described as the Crown forest management land base [CFMLB]), with ~250,426 ha (approximately 22% of the CFMLB) comprising the current timber harvesting land base (THLB).

Table 2. Land classifications within the Lillooet project area.

Land Classification (Legal)	Area (ha)	% of Project Area
Project Area	979,224	100.0%
Private Land, Indian Reserves and Federal Lands	50,653	5%
Parks, Woodlots, and Community Forest	240,243	24
Net down Subtotal	***290,896***	***29%***
Crown Forest Land Total	***688,328***	***71%***

The major population center in the Lillooet TSA is Lillooet, with smaller communities and First Nations reserves with in the TSA including: Seton Protage, Shalalth, Xaxli'p, Lytton, Pavillion, Spences Bridge, Bralorne and Gold Bridge.

A large First Nations population is present in the TSA and interests come from four broad cultural groups: St'at'imc, Nlaka'pamux, Secwepemc and Tsilhqot'in. These groups have traditional territory within the TSA,and archaeological evidence suggests that they have inhabited the Lillooet region since the last glaciation over 10,000 years ago. The St'at'imc, Nlaka'pamux, Secwepemc and Tsilhqot'in people are further subdivided into twenty-eight First Nations communities, twelve of which reside within the TSA. The remaining sixteen communities are located outside the Lillooet TSA but also use the area for sustenance, cultural and spiritual activities.

- The traditional territory of the St'at'mic First Nation covers most of the central and northern part of the TSA.
- The territory of the N'laka pamux is in the south-eastern portion of the TSA,

[1] Lillooet Timber Supply Area Timber Supply Review #3 Analysis Report, Version 1.0 BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development. March 31, 2005.

- The Secwepemc and Tsilhquot'in Nations have interests in the north and north-eastern portions of the TSA.

The Lillooet TSA is characterized by rugged topography and dramatic climatic variations resulting from the mountainous terrain found in this region. In the western portion of the TSA, temperate rain forest conditions persist, while the eastern portion is dominated by the dry grasslands and semi-arid landscapes that comprise the interior dry belt.
The forests of the Lillooet TSA are dominated by Douglas-fir (20%), pine (13%), and spruce/balsam (17%) stands. Other tree species that occur less commonly in the TSA include western hemlock, western red cedar, larch and several deciduous species (3).
The recent MPB outbreak peeked in the Lillooet TSA between 2006 and 2009 and has largely run its course at this time. Thus, both the MPB and pine tree populations should be mostly stabilized within the project area.

Table 3. Leading Species in Lillooet project area.

Leading Species	Area (ha)	% of Project Area
Pine (PL, PLC, PLI, PA, PW, PY)	182,507.12	18.6%
Fir (FD, FDI)	199,185.48	20.4%
Spruce (S, SE, SX, SXW)	68,340.87	7%
Balsam (B, BL)	99,251.33	10%
Larch (L, LA, LT, LW)	38.36	0%
Deciduous (AC, ACT, AT, E, EP)	4,204.74	0.4%
Cedar (CW)	206.92	0.01%
Hemlock (H, HW,HM)	1,048.50	0.01%
Total	***979,224***	***100%***
Non Treed Area:	***424,437***	***43%***

The Lillooet TSA contains ten biogeoclimatic zones that range from dry grasslands at lower elevations to coniferous forests at middle elevations, and alpine tundra at higher elevations. These ten zones are further subdivided into variants, giving further indication of the climatic and biological diversity in this area. Refer to Table 4 for an area breakdown by biogeoclimatic zones.

Table 4. Biogeoclimatic zones in the Lillooet project area.

Biogeoclimatic Zones	Area (ha)	% of Project Area
Boreal Altai Fescue Alpine (BAFA)	3,300	0.3
Bunchgrass (BG)	5,602	0.6
Coastal Mountain-heather Alpine (CMA)	964	0.0
Coastal Western Hemlock (CWH)	2,230	0.2
Englemann Spruce-Subalpine Fir (ESSF)	474,763	48.5
Interior Douglas-Fir (IDF)	231,769	23.7
Interior Mountain-heather Alpine (IMA)	110,558	11.3
Mountain Hemlock (MH)	10	0
Montane Spruce (MS)	119,436	12.2
Ponderosa Pine (PP)	30,587	3.1

Total	***979,224***	***100.0%***

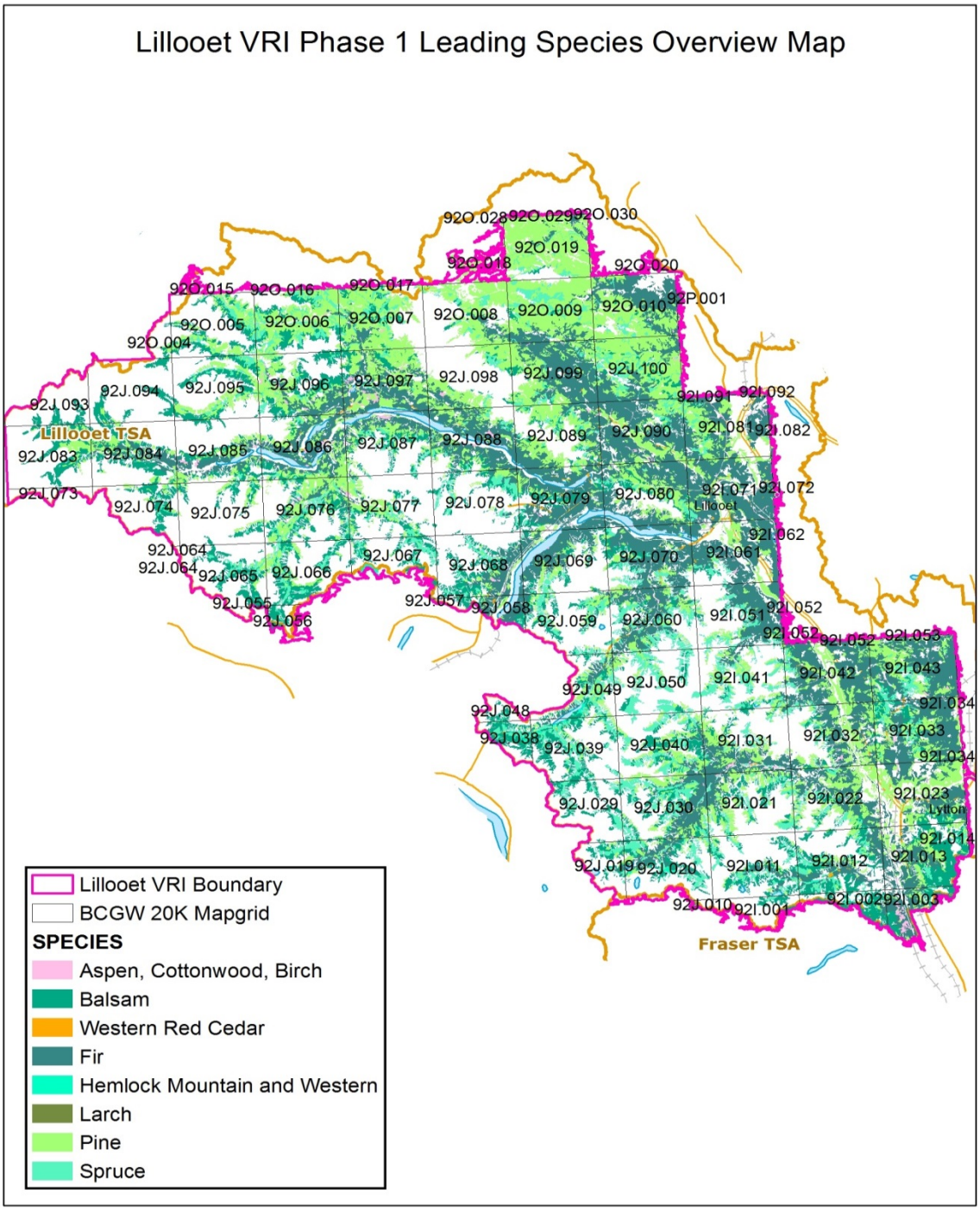

Figure 2. Leading species in the Lillooet project area.

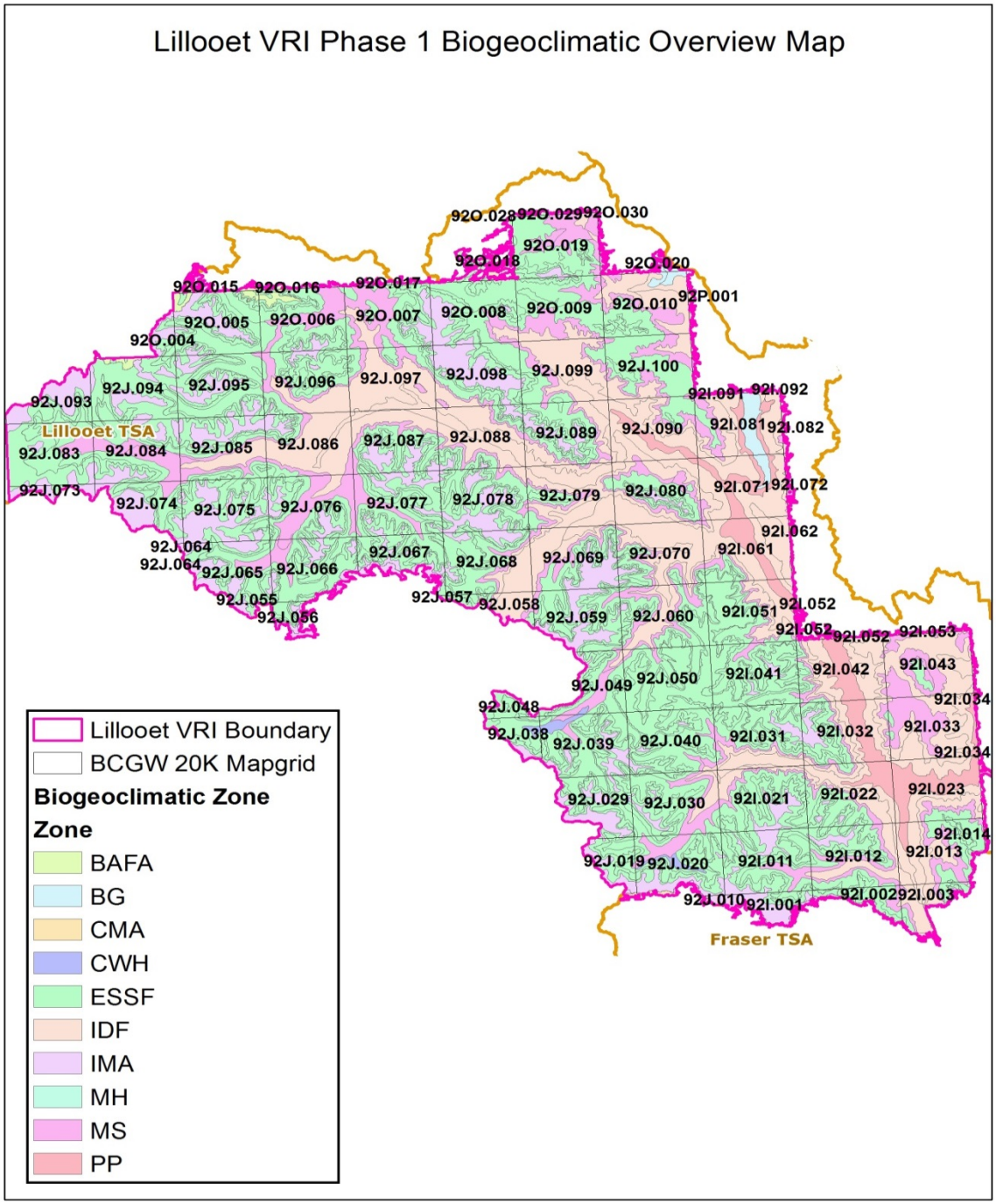

Figure 3. Biogeoclimatic zones in the Lillooet project area.

State of the Current Inventory

The current forest cover inventory for the Lillooet TSA was completed in four separate inventory projects between 1988 and 1990. Thus, the forest cover attributes for the vast majority of the project area conform to the older (pre-VRI) FIP inventory standard (F-records). The small remainder of the area is comprised of either newer VRI polygons (V-records), or RESULTS-based polygons (I-records) (Figure 5). The I-

records are generated via annual updates for depletions, regeneration, and free-growing declarations sourced from the RESULTS (Reporting Silviculture Updates and Land status Tracking System) database.

Depletion and regeneration updates to the inventory from the RESULTS database are current to August 2017. The provided inventory file will include updates and be projected to 2017. Another provided file will include spatial updates for all fire disturbances with fire intensity attributes, up to and including the 2017 fires.

An inventory sampling program (VRI Phase 2) was completed within the Lillooet TSA by MoF in 2003-2004 post 1990 re-inventory. The 2000 Preliminary Analysis document focussed on the development of adjustment factors for height, age and volume to support the timber supply analysis. A final volume adjustment was then determined using stand volumes projected using updated site index information for TSR (2005) purposes.

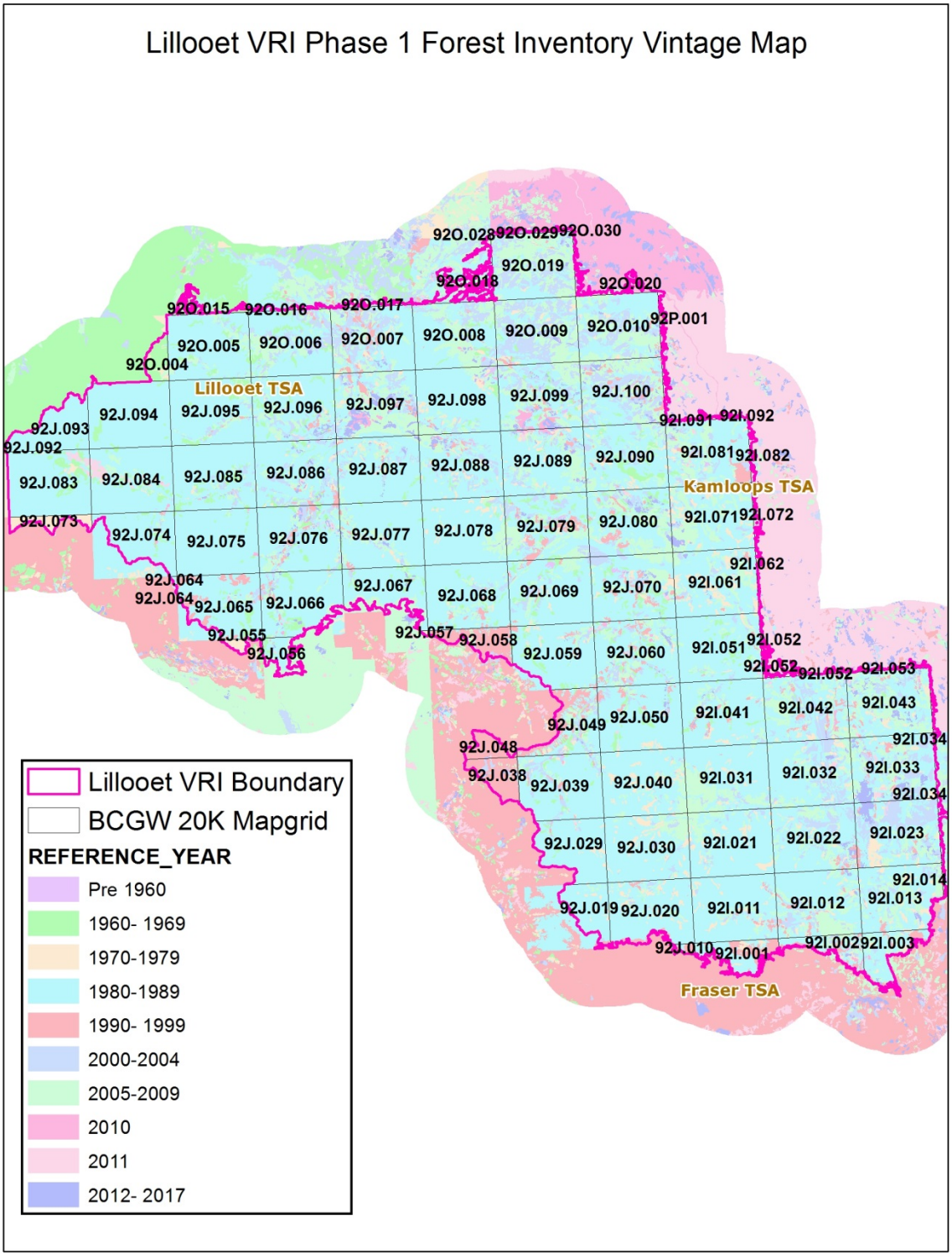

Figure 4. Inventory vintage (reference year) for the Lillooet project area.

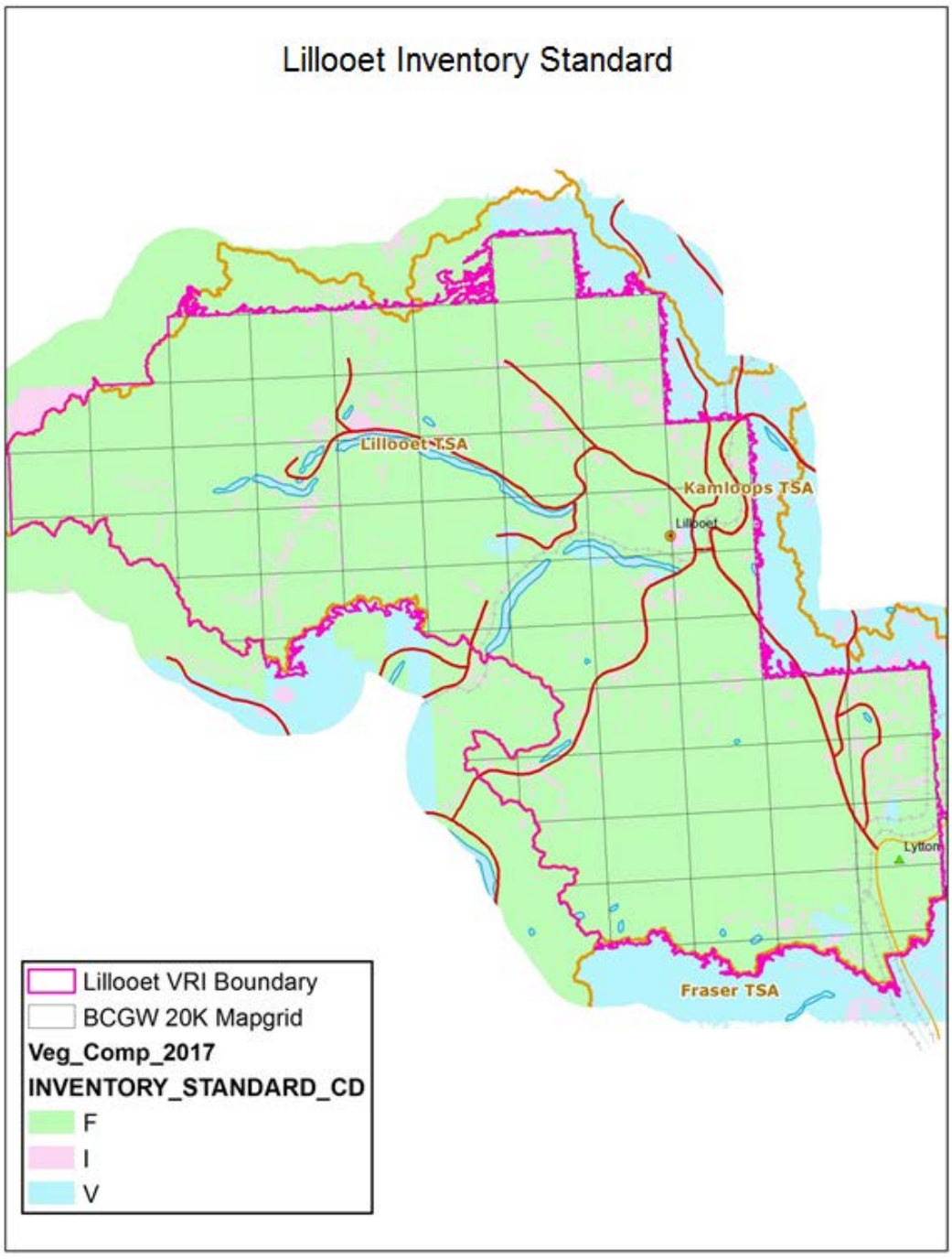

Figure 5. Inventory standard for the Lillooet project area.

Section 2 - Photo Interpretation

Project Objectives

The objective of this re-inventory project is to produce a new photo interpreted inventory to account for the accumulated change in the Lillooet TSA since the last re-inventory for this project area. This change is attributable to such things as annual harvesting and planting, MPB mortality, salvage harvesting, wildfires, and realized differences between modelled growth since the last re-inventory and actual growth on the land base.

The new inventory will provide much needed current information on the spatial distribution of live and dead stands, update species compositions to reflect MPB mortality and harvesting, and provide an estimate of the amount of dead volume in the project area. It will also be conducted to the VRI standard, so it will include the full suite of variables, which are not available in the current inventory. One of the key outcomes of the project is to acquire improved inventory information in order to better inform mid-term timber supply analyses.

Project Area

The entire Lillooet VRI project area (Figure 1) will be re-inventoried, including all private land, Indian reserves, parks, protected areas, community forests, and woodlots.

The total project area is 979,224 ha covering 97 individual BCGS 1:20,000 full and partial mapsheets. For Contractor planning purposes, this equates to 62.37 full map sheet equivalents (FMEs) based on an average of 15,700 ha/FME

Current Inventory Issues

Several issues with the current inventory are known and/or were identified that should be taken into account, where practicable, when planning and implementing the project:

- Douglas-fir species under estimated
- Height, Age and Site Index
- Levels of Mountain pine beetle (MPB) attack, and volumes of MPB stands
- Volume of Dead Trees

Aerial Photography

Digital frame camera imagery of the project area was acquired to GeoBC photo standards and specifications in the summer of 2017. Flight lines were oriented in an east/west direction and captured at 25 cm GSD (ground sampling distance), approximately a 1:15,000 scale. Digital image sets will be available as 4-band 8-bit RGBnIr JPEG compressed TIF. This will allow for natural colour display of imagery as well as colour infrared display using the same image file and softcopy setup.

The use of the infrared display should make it easier for photo interpreters to identify live vs. dead trees. It may also be able to help identify the presence of understory vegetation.

Generated supporting products include an ISSD Z\I stereo project file in UTM projection, and a photo index shape file with image names. No hardcopy set of the digital photos is being produced.

Historical Data Sources

Data sources are used as calibration points for improving the quality of air photo interpretation. Existing data sources include air calls, ground calls, permanent and temporary samples and observations distributed across the project area during previous inventories.

An unknown number of the established data sources will have been destroyed over the years through harvesting, fires, and other disturbances. The actual number of data sources still available will be determined at the data source transfer stage.

There are a potential 2000 historical calibration points in the Lillooet project area.

All data sources that were available in the last re-inventory project are recorded on the earlier document photos. A digital spatial location of these points will be made available to the Contractor in a shape file. All data sources will be reviewed by the Contractor to determine if they are still relevant before they are used. Those that are still relevant to a new inventory on the 2017 imagery will be transferred to a digital format provided by the Ministry.

Situations that would justify removal of existing data sources include a major disturbance (such as a large fire, harvesting), and large stand structure changes due to insect or disease damage. Data sources in MPB-impacted stands will have to be examined closely to determine how relevant they are.

Any data can be used as a calibration data source so long as it has X and Y coordinates. Permanent sample plots, cruise plots, timber recce information, terrestrial ecosystem mapping (TEM), predictive ecosystem mapping (PEM), and SIBEC plots are examples of other data that can be used. This data would first need to be obtained and then assembled into a format that the Contractor could easily use.

Polygon Delineation

Polygon delineation is to be completed to VRI standards. Any deviation from these standards must be agreed to by the Ministry Project Manager.

The *VRI Photo Interpretation Procedures* contain detailed procedures for dealing with dead stands and stands with significant amounts of dead trees resulting in a “dead” (“D”) tree layer.

The Lillooet TSA is adjacent to 3 “newer” VRI’s (Kamloops, 100 Mile and Churn Creek). The Lillooet project boundary adjacent to these inventories will utilize existing polygon boundaries rather than map sheet neatlines, this will enable a seamless inventory for the unit. The “puzzle piece” boundary ensures that there are no edge tie issues between existing VRI’s.

Integrating RESULTS Information

The integration of the RESULTS spatial files and tree attribute data will be completed at the delineation and attribution stages of the project. The Contractor is required to incorporate RESULTS data provided by FAIB. For free growing openings, photo interpreters may re-delineate and/or re-attribute the polygons if they do not agree with the RESULTS information. However, if the free growing survey information is recent, the data is typically accepted as is.

A PGDB file for the RESULTS openings found within the project area (Table 5) and the associated tree attributes will be provided to the contractors.

Table 5. Summary of RESULTS database openings for the Lillooet TSA project area.

RESULTS Data	Area (ha)	# of Openings
RESULTS Free Growing (# of Openings)	56,902	2,110
RESULTS Depletion/Regen (# of Openings)	27,594	1,024
Total	***84,496***	***3,134***

Free growing updates and depletion/regeneration updates for the project area newer than the last updates are under a current contract using the 2017-2018 SPOT imagery. A data cut of the production database for these updates will be provided to the Phase 1contractor in VRIMS format (as well as a shapefile with spatial and attribute information, and a point file with attribute information). Some openings found on the air photos won't be found in the RESULTS data cut. Attribution of harvested areas that are not identified in the RESULTS spatial files will be completed in accordance with the Photo Interpretation Guidelines for Integrating RESULTS Information.

New Data Sources

The fieldwork program calls for the establishment of air and ground calls to provide photo interpreters with actual ground data to use as calibration points. The current standard for distribution of calibration points is a minimum of 10 ground calls and 20 air calls per FME.

The ground call types will be a combination of 1-point and 3-point calls. The type of ground call established in each polygon is based on the species complexity as described in the *VRI Photo Interpretation Field Calibration Procedures*.

Due to the impact of Mountain Pine Beetle (MPB) and fires on the Lillooet landbase, the current stand projection models used by FAIB have had a significant increase in uncertainty for inventory projections. To improve upon the Variable Density Yield Projection (VDYP 7) for impacted stands, there is a desire to improve and develop an understory layer (natural regeneration or Y layer) module for VDYP 7 performance and improve the AAC decision making related to disturbed stand projections. See Appendix C of Schedule A for further information.

To capture new understory regeneration information, new sampling procedures are being piloted for stands that have been impacted by MPB or fires and have the dead stand characteristics as determined in the VRI photo interpretation manuals.

An additional tool that will be utilized is ground *observations*. For these, the field crew collects a subset of the full suite of ground call attributes in a quick "observation" without establishing a formal plot (typically in transit between ground calls). Minimum data collection for an observation includes species composition, age, and UTM coordinates. On average, there should be 10 ground observations per FME (in addition to the 20 air and 10 ground calls).

The exact ratios of air calls to ground calls, and 1-point to 3-point ground call types will be determined before the project starts. This determination will be based on recommendations from other recent VRI Phase 1 projects and by reviewing the new aerial images.

Prior to the initiation of a field calibration program, a Field Calibration Plan is to be submitted to the Ministry Project Manager for approval. Documentation within this sampling plan must include a map of the project area indicating the general location and distribution of the calibration points.

As part of the deliverables, the Ministry requires a complete set of any new data sources be provided in a digital format determined by the Ministry, including the geographical locations (UTM coordinates) of these data sources as well as the complete set of field attribute data collected.

Attribute Estimation

This project will be undertaken in softcopy (digital photogrammetric) format. Photogrammetric tree heights will be taken where suitable at the discretion of the photo interpreter.

The MPB infestation and wildfire history has caused significant change to the forested landscape in the Lillooet TSA. The focus for the attribute estimation will be on getting accurate descriptions of the live component of the forest. This includes the residual component remaining in the overstory and, where visible, the understory. Note that understory can typically only be interpreted when crown closure of the overstory is very low and the understory trees are large enough to be resolved on the photos.

All polygon descriptions will be carried out to the standards of the most current version of the *VRI Photo Interpretation Procedures*. This now includes the capture of attributes on the "dead" ("D") layer for any polygons with more than 100 dead stems per ha.

Mapping

The Ministry has developed a format and database standards for the submission and storage of spatial and attribute data for VRI photo interpretation. All new projects must be completed to this standard and submitted to the Ministry Project Manager as per the delivery schedule.

The Contractor will adhere to the most current version of the *VRIMS Personal Geodatabase Structure and Use* and the *VRIMS Vegetation Cover Polygon Validation Rules* published by the Forest Analysis and Inventory Branch.

Section 3 - Project Implementation

Project Pre-Work Meeting

A project pre-work meeting is mandatory. The purpose of this meeting is to bring together the Ministry Project Manager, VRI Contractor, and Quality Assurance personnel prior to project start-up. This meeting will ensure that an efficient communication network is established, identify individuals responsible for all aspects of the project, allow discussion of any issues before project work commences, and establish timelines for deliverables and data flow. Minor changes to the contract to complete the project activities may be identified at this meeting.

A project pre-work checklist, signed off by all parties attending, will organize and guide the meeting.

Scheduling

The Phase 1 project will progress over just more than two fiscal years commencing spring of 2019. 2019/20 fiscal will be delineation of 25 FME's starting in the North of the project area. Work will proceed from North to South (due to limited access), with ~18 FMEs being completed in 2019/2020, and the remaining FMEs being completed by mid-August 2021. The complete new inventory will be available in 2022. This schedule may change in order to meet the Ministry's needs. Field calibration is to coincide with subsequent attribution of associated blocks.

Table 6. Proposed project schedule for the Lillooet TSA Inventory project.

FISCAL YEAR	PRIME ACTIVITY
2018/2019	VPIP PLANNING and CONTRACT DEVELOPMENT AND AWARD
2019/2020	Delineation Field Calibration Attribution
2020/2021	Delineation Field Calibration Attribution
2021/2022	Attribution Contract Evaluation

A delivery schedule outlining progressive delivery of products will be set by the Ministry for each fiscal. The format of the delivery schedule will be agreed to at the project pre-work meeting.

Project Manager

The Ministry Project Manager for the Lillooet TSA VRI will be determined at the start of the project(s). Responsibilities include the following: coordinating the project; monitoring and communicating project progress with the local stakeholders; ensuring all contractors are qualified and certified; overseeing photo-interpretation activities; ensuring quality assurance is complete and delivered at each stage; and assisting in coordinating technical expertise where required.

Personnel

All VRI photo interpretation work must be completed by or directly supervised by a VRI Certified Photo Interpreter (as per list maintained by Forest Analysis and Inventory Branch). At least one third of the photo interpreters working on the project must be certified for VRI photo interpretation or have demonstrated to the Ministry that interpreters have "equivalent" training and certification similar to the BC VRI Photo Interpretation Certification. All uncertified photo interpreters are to be directly supervised by a Certified Photo Interpreter working on that project. There is a limit of 6 photo interpreters approved to work on the project at any one time; this would help maintain consistency across the project.

Quality Assurance

An independent third-party quality assurance (QA) will be completed on all stages of the project (historical data source transfer, delineation, calibration fieldwork, and attribution) in accordance with the *VRI Photo Interpretation Quality Assurance Procedures and Standards*.

QA for digital map production will be conducted by the Ministry. Contractors will utilize "VEGCAP for Contractors" validation software to perform QA on data files.

All QA findings and re-work instructions are communicated to the VRI Contractor by the Ministry Project Manager.

Deliverables

The VRI Phase 1 project deliverables for each stage of the Phase 1 project are outlined in the *VRI Photo Interpretation Procedures* and the *VRI Field Calibration Procedures for Photo Interpretation*.

The deliverables schedule will be determined by the Ministry at the start of the project. Deliverables are required to be spread out evenly across the entire term of the contract. Deliverables required in a particular fiscal year must be submitted by the end of February to provide sufficient time for completion of independent third-party QA and Ministry in-house GIS QA.

Submission of all final deliverables will be signed-off by a qualified ABCFP registered Forest Professional.

Roles & Responsibilities

MFLNRORD

The Ministry Project Manager is the point of contact for the Ministry and provides overall communication of project activities with contractors and District staff and stakeholders.

VRI Contractor

The VRI Contractor works with the Ministry Project Manager to ensure the planning, coordination and execution of project activities are consistent with the VPIP and contract requirements.

VRI QA Contractor

The VRI QA Contractor works with the VRI Contractor and Ministry Project Manager to ensure that Quality Assurance reporting meets the VRI prescribed standards.

References for Inventory Standards and Procedures

All work will be carried out in accordance with the following British Columbia Government specifications, current at the time of contract signing.

- *Vegetation Resources Inventory Photo Interpretation Procedures*
- *Vegetation Resources Inventory Photo Interpretation Quality Assurance Procedures and Standards*
- *Vegetation Resources Inventory Field Calibration Procedures for Photo Interpretation*
- *Photo Interpretation Guidelines for Integrating RESULTS Information* (contained within the *VRI Photo Interpretation Procedures, Appendix A*)
- *Vegetation Resources Inventory – The B.C. Land Cover Classification Scheme and addendum*
- *VRIMS Personal Geodatabase Structure and Use*
- *VRIMS Vegetation Cover Polygon Validation Rules*

Project Sign-Off Sheet

Lillooet Timber Supply Area Vegetation Resources Inventory
Project Implementation Plan for Re-Inventory

I have reviewed and approved the Lillooet Timber Supply Area Vegetation Resources Inventory Project Implementation Plan for Re-Inventory.

Tim Salkeld Date March 3, 2020
Manager, Forest Inventory Section
Forest Analysis and Inventory Branch
Ministry of Forests, Lands, Natural Resource Operations and Rural Development