Forest Growth Organization of Western Canada

Regenerated Lodgepole Pine Trial

FIELD MANUAL

for

GROWTH PHASE MEASUREMENTS AND MAINTENANCE

Version 7.3

plus

Measurement Schedule 2022 - 2026

February 20, 2023

FOREST GROWTH
ORGANIZATION OF WESTERN CANADA

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1 Introduction

This document is intended for use by contractors engaged in periodic re-measurement of the Regenerated Lodgepole Pine (RLP) trial. The data required for ongoing monitoring of stand development differ from those used previously to model regeneration and juvenile stand dynamics during the first 20 years of the trial. Re-measurement standards and procedures have been revised accordingly.

The new standards and procedures for the most part comply with those of the Provincial Growth and Yield Initiative (PGYI).[1] A significant exception is the continued measurement of top height. Top height has been, and is likely to continue to be, important in analysis and modelling of the RLP trial data. The measurement of top height, as distinct from tree height, is not required under the PGYI standard applicable to new plots, where all trees are measured for height. Sub-sampling of tree height is permitted in the RLP trial (because of the high tree densities encountered); but measurement of all top height trees is required for all species. The procedure described in this manual for top height assessment accommodates both of these requirements, with minimal departure from PGYI standards.

The trial consists of 102 installations, each consisting of 4 treatment plots. General installation and plot information, that has already been recorded during trial establishment and the regeneration phase, does not need to be re-entered by contractors undertaking maintenance and measurements.

2 Plot layout

Figure 1 shows the standard layout of an installation. (Some installations depart from the standard in order to fit into small sites, by re-alignment or separation of the treatment plots.) The revised layout is superimposed on the original design, and requires only minor changes to accommodate the new tree plot, which occupies the top or northern half of the original measurement plot.

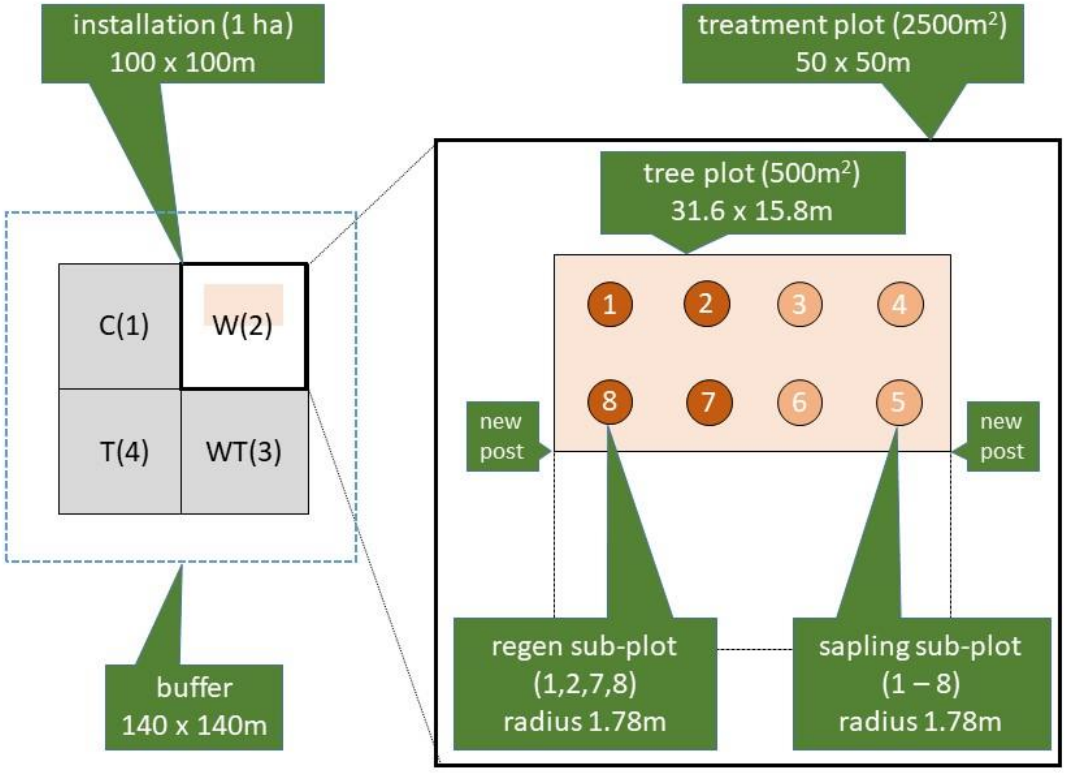
Installations are surrounded by a buffer area, approximately 20m wide, demarcated in blue. The installation, treatment, and original measurement plots are demarcated by centre and corner posts, as installed and maintained since establishment. Note however, that for ongoing measurements, the new tree plot is only 500m^2. This requires a new post to be placed mid-way (15.8m) between the original corner posts on either side of the original square 1000m^2 measurement plot, in order to demarcate corners of the new rectangular tree plot.

In every measurement plot there are 8 circular sub-plots (radius 1.78m) marked with green plot centre stakes. These sub-plots retain the original reference numbers. They are laid out on a 7.90 m square grid. All 8 are used for sampling saplings; numbers 1, 2, 7 and 8 are used for sampling coniferous regeneration. These regeneration sub-plots were selected because they are arranged in

[1] Alberta Agriculture and Forestry. 2015. *Minimum standards and suggested protocol and priorities for establishing and measuring permanent sample plots in Alberta*. Technical Report Pub. No.: T/605.

a square. This is preferable to a linear arrangement (i.e. sub-plots 1 to 4) in which sampling is more likely to be influenced by linear patterns of site preparation, slash, and planting.

Figure 1. Installation diagram



3 General and historical plot information

Contractors undertaking maintenance and measurements do not need to enter general installation and plot data shown in Table 1 (with the exception of installation and plot identity codes); but may need to refer to them. Values of variables are included in Table 1 where they apply to all plots in the trial (e.g. plot sizes and tagging limits).

Each treatment plot is uniquely referenced by a sequence of codes representing the nominal eco-class (1 - 5), replicate (1 - 5), target density (Table 2), and experimental vegetation management treatment (Table 3). The nominal eco-classes were assigned for initial project planning; but have been replaced for analytical purposes. They are retained in the plot name for reference only. Original agency codes used in the trial, plus current and equivalent PGYI codes, are shown in Table 4. Table 5 lists PGYI codes for plot treatments that were applied before or during the regeneration phase of the trial, in sequence of occurrence.

Table 1. General plot information

Variable	Format	Examples and notes
General plot information		
Agency/company	A4	Table 4
Plot number	A15	E.g. 2_2_1600_T
Stand type	I1	Always 2 (1st rotation post-harvest)
Stand origin	A1	P=planted, S=naturally seeded
UTM zone	A5	UTM11, UTM12
Datum	A7	NAD83, NAD87
GPS – easting (x-coordinate)	F14.5	GPS of original plot centre
GPS – northing (y-coordinate)	F14.5	GPS of original plot centre
GPS – latitude	F15.10	GPS of original plot centre
GPS – longitude	F15.10	GPS of original plot centre
Topographic position	I1	E.g. 1=Hollow or depression, 7=Hilltop or crest, etc.
Slope	I3	Average percent (%) slope of the plot
Aspect	A2	E.g., N=north, NW=northwest, NA=no aspect (0 slope)
Elevation	I4	Height above seas level
Ecological classification		
Natural sub-region	A3	10=Upper Foothills, 11=Lower Foothills,
Ecosite guide	A2	WC=west-central[2], SW=southwestern[3]
Nutrient regime	A1	A, B, C, D, E; e.g. C=medium, (not a PGYI code)
Moisture regime	I1	1 to 9; e.g. 5=mesic, (not a PGYI code)
Plot sizes and tagging limits		Apply to all plots
Tree plot size	F7.1	500.0 m^2
Tree plot shape	A1	Rectangular
Minimum tree tagging limit	F3.1	5.1 cm
Sapling sub-plot size	F5.1	10.0 m^2
Sapling sub-plot shape	A1	Circular
Sapling tagging limit – DBH	F3.1	0.1 cm
Sapling tagging limit – height	F4.2	1.30 m
Number of sapling sub-plots	I5	8
Regeneration sub-plot size	F5.1	10.0 m^2
Regeneration sub-plot shape	A1	Circular
Regeneration tagging limit	F4.2	0.30 m
Number of regeneration sub-plots	I5	4
Plot treatments		
Treatment type (PGYI)	A2	Table 5
Treatment year	I4	Year a treatment occurred
Treatment month	I2	Month a treatment occurred
Treatment day	I2	Day a treatment occurred
Plot disturbances		
Plot disturbance	I2	Historic (see Table 7 for codes)
Disturbance year	I4	E.g. 2006
Disturbance month	I2	Included if known
Disturbance day	I2	Included if known

[2]Beckingham, J. D., Corns, I. G., & Archibald, J. H. (1996). *Field guide to ecosites of west-central Alberta*. Special Report 9. Canadian Forest Service, Northwest Region, Northern Forestry Centre, Edmonton, Alberta.

[3] Archibald, J. H., Klappstein, G. D., & Corns, I. G. (1996). *Field guide to ecosites of southwestern Alberta.* Special Report 8, Canadian Forest Service, Northwest Region, Northern Forestry Centre, Edmonton, Alberta.

Table 2. Target planting (and thinning) densities

Code	Spacing (m^2)	Target density (stems/ha)	Target trees per treatment plot (0.25 ha)
0 or 9	(1.5)	0 (4444)	0 (1111)
816	3.5	816	204
1111	3.0	1111	278
1600	2.5	1600	400
2500	2.0	2500	625
4444	1.5	4444	1111

Table 3. Experimental treatments

Code	Plot #	Treatment name	Treatment description
C	1	Control	No vegetation management treatments
W	2	Weeding	Competing vegetation removed
WT	3	Weeding & thinning	Both treatments 2 & 4
T	4	Thinning	Thinned to target density

Table 4. Agencies

RLP Code	PGYI Code	Agency name
ANC	ANC	ANC Timber Ltd.
BRL	BLUE	Blue Ridge Lumber Inc.
CFPGP	CFPL	Canadian Forest Products Ltd. (Grande Prairie)
MWFP	MWWC	Millar Western Forest Products Ltd.
SDA	SUND	Sundance Forest Products (West Fraser Edson)
SLS	SPRA	Spray Lakes Sawmills
SPI	SFPI	Sundre Forest Products
WEYDV	WYGP	Weyerhaeuser Drayton Valley
WEYED	WYPT	Weyerhaeuser Edson
WEYGP	WYPT	Weyerhaeuser Grande Prairie
WWC	WFML	West Fraser Hinton

Table 5. PGYI treatment types

Code	Sequence	Description
NT		No treatment
M	1	Mechanical site preparation
P	2	Planting
FI	3	Fill-in planting
TH	4	Tending, chemical (using herbicide)
TW	4	Tending, manual (using manual / mechanical means)
PC	5	Pre-commercial thinning

In addition to the above plot-level data, field crews will be provided with the following tree-level data from the last regeneration phase measurement of each plot, to assist in identifying previously measured trees:

- Tree number;
- Regeneration plot number;
- Species;
- Origin (P = planted, N = natural);
- Vigour (AL = alive; AU = alive, unlikely to survive; DE = dead; MD = missing, assumed dead; MI = missing; MT = thinned);
- DBH.

These data include all those trees tagged in regeneration plots 1 to 8, plus all trees within the old measurement plot that were tagged outside regeneration plots. Note that the latter may include trees which are outside the revised tree measurement plot, and should be ignored.

Note that condition codes, ages, and heights from the last regeneration phase measurement are NOT included. This is to avoid unnecessary complexity and confusion. The condition codes now adopted under the provincial standard are completely different from those used during the RLP regeneration phase. The sampling of age during the regeneration phase was based on the RSA top height / age sampling method, which does not necessarily apply to the trees now requiring assessment. Because of the newly introduced height sub-sampling protocol, including heights from previous measurements again could cause confusion, possibly resulting in crews measuring too many or the wrong trees.

4 Measurements

Plot and tree variables to be included in re-measurements of the trial are summarized in Table 6, along with reporting formats, maximum allowable errors, examples and notes.

Table 6. Measurement variables

Variable	Format	Maximum error	Examples and notes
1. Identity and timing			
Plot number	A15	None	E.g. 2_2_1600_T
Measurement number	I2	None	Sequentially assigned by project manager
Year of measurement	I4	None	E.g. 2022
Month of measurement	I2	None	0 to 12
Day of measurement	I2	None	0 to 31
Contractor	A50	None	Name of field contractor
Crew member 1 – 2	A25	None	First initial plus the last name
2. Condition / disturbance			
Plot condition/disturbance	A3	None	Since previous measurement (Table 12)
Plot disturbance year	I4	None if known	E.g. 2022
3. Surface vegetation			
Sub-plot number	I1	None	1,2.7.8
% – shrubs	I3	±20%	Percent ground cover by shrubs
% – herbs/forbs	I3	±20%	Percent ground cover by herbs / forbs
% – grass	I3	±20%	Percent ground cover by grass
% – moss/lichen	I3	±20%	Percent ground cover by moss / lichen
4. Tree measurement			
Tree number	I7	None	E.g., 1, 2, 3, etc.
Tree label	A15	None	Historic tag label if it differs from tree number
Species	A2	None	Table 8
DBH	F5.1	+0.2 cm or +3%	E.g. 12.8 cm
Height of DBH	F4.2	+0.05 m or +5%	E.g. 1.37 m
Tree location	I1	None	Sub-plot 1 to 8; 0 if outside subplots
Tree origin	I2	None	Table 9
Tree height	F5.2	+0.05 m or 5%	E.g. 8.15 m
Height to live crown	F5.2	+0.05 m or 10%	Height to the base of continuous live crown
Crown class	A1	+1 class	Table 10
Tree condition 1 – 3	I2		Table 11
Tree condition cause	I2		Table 11
Tree condition severity	I1		Table 11
Comment	A250		For unusual or unique information
5. Regeneration density			
Sub-plot number	I1	None	1, 2, 7, 8
Regeneration species	A2	None	Table 8 (coniferous only)
Density count	I4	±10%	0 to 9999
6. Tree age and top height			
Total age	I3	+2 years or +5%	Total age (years), from the point of germination
Top height	F5.2	+0.05 m or +5%	E.g. 5.84 m

Where maximum errors are indicated as "none", no errors are permissible. Where they are defined in both absolute and relative units (e.g. ±0.05 m or 5%), whichever is greater will be

allowed. The adequacy of tree condition assessments (for which no maximum error is shown in Table 6) will be subject to judgement by the field auditor.

Further explanations are provided below, under each of the headings listed in Table 6.

4.1 **Identity and timing**

- Each measurement of a plot is uniquely identified by the plot number and a measurement number. The latter is assigned sequentially by the project manager.
- Conduct measurements between July 15 and October 15.
- Record timing of measurements by year, month and day. If the measurement is not completed in one day, record the last day.
- Assessments of vegetation and coniferous regeneration must be completed under snow-free conditions.

4.2 **Plot condition and disturbance**

- See table 7.
- Record conditions in the treatment plot which have changed or not been previously noted, and disturbances which have occurred since the previous measurement.
- Record year of disturbance if known.
- Notify the project manager immediately of any observed damage that might affect the integrity and utility of the plot.

Table 7. Plot condition and disturbances

1	Active and no obvious damage	10	Inactive, closed or abandoned
2	Natural damage (severe wind)	11	Destroyed (anthropogenic)
3	Natural damage (flood and water)	12	Destroyed (fire)
4	Natural damage (defoliation)	13	Destroyed (climate/weather)
5	Man-made damage (road, seismic, pipeline)	14	Plot closed and reopened
6	Man-made damage (un-planned treatment)	15	Burned
7	Natural and man-made damage (cause unknown)	16	Missing or lost
8	Harvested or cut down	17	Mistletoe
9	Partially harvested	18	Mountain pine beetle

4.3 **Surface vegetation**

Record to $\pm$ 5% the percent of the ground, on each of the 4 regeneration sub-plots, that is covered by shrubs, herbs / forbs, grass, and moss / lichens respectively. For shrubs, base this on crown closure of all shrubs (including tall, low and ground level), regardless of whether their stems are inside or outside the sub-plot. Include sedge species with grasses. Do not include moss coverage on logs or debris elevated above the ground. The maximum value for each of the 4 life-forms is 100 percent.

4.4 **Tree measurement**

Tree number

- If the tree is already tagged, use the existing tree number.
- Where previously untagged trees are now tagged, assign a new tree number, taking care not to duplicate existing numbers on the same tree plot. This will normally be best achieved by creating a new series of one thousand numbers e.g. if the highest number previously tagged in the plot is 4900, number new trees commencing at 5001.

Tree species

- Tree species are coded using the two-digit characters defined in Table 8.

Table 8. Alberta tree species occurring in the RLP trial

Species group	Species	Scientific name	Code
Deciduous	Aspen	*Populus tremuloides* Michx.	Aw
	Balsam poplar	*Populus balsamifera* L.	Pb
	White birch	*Betula papyrifera* Marsh.	Bw
Pine	Lodgepole pine	*Pinus contorta* var. *latifolia* Engelm.	Pl
	Jack pine	*Pinus banksiana* Lamb.	Pj
Spruce	White spruce	*Picea glauca* (Moench) Voss	Sw
	Engelmann spruce	*Picea engelmannii* Parry ex Engelm.	Se
	Black spruce	*Picea mariana* (Mill.) B.S.P.	Sb
Fir	Balsam fir	*Abies balsamea* (L.) Mill.	Fb
	Subalpine fir	*Abies lasiocarpa* (Hook.) Nutt.	Fa
Larch	Tamarack larch	*Larix laricina* (Du Roi) K. Koch	Lt
Other	Dead deciduous		Dd
	Dead coniferous		Du
	No tree		No

DBH (diameter breast-height)

- DBH is required for all tagged trees ($\geq$ 5.1 cm DBH) within the tree plot, and all tagged saplings ($\geq$ 1.30 m) in height within sapling sub-plots 1 to 8.
- Refers to tree diameter (cm), normally taken 1.30 m above the point of germination (see *height of DBH* below).
- Measure along the bole (not from vertical because of the possible changes in the amount of lean over time).
- Measure for all numbered stems in the tree plot and sapling sub-plots.
- Record to the nearest ±0.1 cm.

Height of DBH

- Refers to the height (to ±0.01 m) along the bole at which the DBH is measured.
- Wherever DBH is measured, the height at which the DBH is measured must also be recorded.
- Height of DBH may differ from 1.30 m only where measurement at 1.30 m is precluded (e.g. by swelling, forking).

Tree location

- Record the sub-plot number (1 to 8) for all trees (≥ 5.1 cm DBH) within the tree plot, or as 0 if the tree is outside the sub-plots. Also record the sub-plot number for all saplings (≥ 1.3 m) within the 8 sapling plots, and regeneration (≥ 30 cm) sampled for height (see below) within the 4 regeneration sub-plots.

Tree origin

- See Table 9.
- Planted trees are identifiable from their tree numbers by reference to tree lists extracted from trial establishment and regeneration phase data.

Table 9. Tree origins applicable to the RLP trial

Code	Description
0	Unknown
1	Naturally seeded
2	Sucker (from the roots or base of a tree) or coppice (from downed logs, stumps/snags)
3	Layering (from the rooting of un-detached branches)
6	Planted, regular stock
9	Advanced (originated prior to the date of harvest)

Tree height

- Heights are required for a minimum of 1/4 (25%) of the live trees (≥ 5.1 cm DBH) in the tree plot, and live saplings (≥ 1.30 m in height) in the sapling sub-plots.
- A minimum of 5 heights per species (trees and saplings combined) is required for each plot, if sufficient stems are present.
- Start by measuring every 4th live tree or sapling tagged within the 8 sub-plots, and every 4th live tree tagged outside the sub-plots; then measure additional stems if required to meet the minimum of 5 per species.
- The data collection application provided to field crews contains a "sample tree" field which defaults to "no". Switch this to "yes" for trees selected for height measurements.
- Measure height for up to 10 coniferous regeneration trees (≥ 30 cm and less than 1.30 m in height) per species in each regeneration sub-plot.
- Height refers to the total tree height (m), taken from the ground to the tip of the tree, regardless if the tip is alive or dead. Dead trees previously tagged as dead do not need to be re-measured.
- Measure to the nearest 1 cm if a tree is shorter than 2 m; taller trees can be measured to the nearest 10 cm.

Height to live crown

- Measure on trees and saplings selected for height or top height measurement.
- Record to the nearest ±10 cm (or ±1 cm if tree height is <2 m).
- Assess from the lowest-reaching point of the lowest branch considered to be part of the continuous live crown.

Crown class

- See Table 10.
- Assess on trees and saplings selected for height or top height measurement.
- Refers to the relative position of the tree crown within the entire canopy of a stand; and is defined by the height of the tree crown in relation to its neighbours or competitors.

Table 10. Crown classes

Code	Description
D	Dominant, crown extends above the general canopy level
C	Co-dominant, crown forms the general canopy level
I	Intermediate, crown below but extends into the bottom of the general canopy level
S	Suppressed, crown entirely below the general canopy level
N	No crown class (e.g., tree with severe lean, broken top, broken stem, dead, standing dead)

Tree condition

- See Table 11.
- Assess tree condition for:
    - All trees (5.1 cm DBH) in the tree plot;
    - All saplings (> 1.3 m) in the 8 sapling sub-plots;
    - Coniferous regeneration trees (≥ 30 cm and less than 1.30 m in height) selected for height measurement in the 4 regeneration sub-plots.
- Three sets of tree condition codes are used to denote up to three observed (most obvious) tree conditions and their associated causes and severities.
- When multiple causes are suspected for a single condition, record the most obvious cause for the observed condition, or (if the condition is deemed important), record the same condition more than once, at the expense of less important conditions if necessary.
- Assign severity levels based according to expected impacts on the long-term survival, growth or form of the tree, as follows:
    1. Minor: unlikely to have an adverse impact;
    2. Moderate: obvious and could potentially have an adverse impact (e.g. western gall rust with gall encircling <50% of the bole);
    3. Severe: prominent and is almost certain to have a significant adverse impact (e.g. western gall rust with gall encircling ≥50% of the bole).
- Contractors measuring the RLP trial should be trained and accredited in the assessment of tree health and damage by insects and diseases.

Table 11. Tree condition codes

Condition	Cause	Severity
0 Live and healthy	1 Spruce budworm	1 Minor
1 Dead but standing	2 Defoliator	2 Moderate
2 Dead and down	3 Mountain pine beetle	3 Severe
3 Broken or dead top	4 Root collar weevil	4 Unknown or not applicable
4 Bole damage	5 Terminal weevil	
5 Crown damage	6 *Armillaria* root disease	
6 Root damage	7 Shepherd's crook	
7 Crook	8 Dwarf mistletoe	
8 Sweep	9 Stem disease	
9 Fork (above DBH)	10 Western gall rust (WGR)	
10 Lean	11 Animal	
11 Poor form	12 Wind	
12 Same stump (fork below DBH)	13 Snow/ice/frost/cracks	
13 Harvested or cut down	14 Hail	
14 Missing	15 Fire	
15 Disqualified	16 Mechanical	
16 Newly qualified	17 Improper planting	
17 Re-numbered	18 Poor ground conditions	
	19 Competition	
	20 Insect (other)	
	21 Disease (other)	
	22 Climate/weather/flood	
	23 Anthropogenic	
	99 Unknown or not applicable	

4.5 Coniferous natural regeneration density count

- Count by species the total number of live, naturally regenerated coniferous seedlings, ≥0.30 and <1.30 m in height, on each of the 4 regeneration sub-plots. Counts should exclude planted trees and include any ingress already subsampled.
- See Table 8 for species codes.
- Enter "No" in the regeneration species field if none are present on the regeneration sub-plot.
- Note that no sampling is required for deciduous regeneration <1.30 m in height.

4.6 Tree age and top height

- Tree age and top height are required for the 5 largest-DBH eligible live trees or saplings (i.e. stems ≥ 1.3m in height) of each species having 5 or more trees or saplings present on the tree plot.
- Engelmann spruce may be grouped with white spruce, subalpine fir with balsam fir, and jack pine with lodgepole pine. Other species listed in Table 8 should be assessed separately if 5 or more eligible trees or saplings per species are present on the plot.
- Trees that originated prior to harvest (origin code 9), and trees with either of the following conditions, are not eligible:
    - Lost or broken top that has not yet been replaced by a new leader;

    - Severe western gall rust (≥50% of the bole encircled by gall).
- The data collection application provided to field crews contains a "top height tree" field which defaults to "no". Switch this to "yes" for trees selected for top height and age measurements.
- Measure the total tree height (m) of the selected eligible trees or saplings, from the ground to the tip of the tree.
- Estimate total age (number of years since germination or suckering) by:
    - Counting the number of branch whorls on coniferous trees or bud scars on deciduous trees from the current season's growth (i.e., terminal leader) down to the root collar node;
    - Adding one year to allow for germination to cotyledon;
    - For planted lodgepole pine, referring to the planting date provided for the plot.
- Note that, for at least the next 5 years, no coring of trees to obtain ring counts, and no measurements of breast-height age, are necessary or permitted. Thereafter, coring within buffers may be permitted if deemed essential for analytical purposes.

5 Maintenance and quality control

Before or during the first re-measurement conducted using this manual, it will be necessary to:

- Install 2 new corner posts for each tree plot (see Figure 1);
- Tag any trees not previously tagged, that now meet the tagging limits (see Table 1), and number them (see Section 4.1).

The maintenance requirements indicated in Table 12 must be checked at each plot measurement visit, and the listed requirements met.

Measurements must be accurate within the limits specified in Table 6. Maintenance must meet the requirements identified in Table 12. No errors or omissions are acceptable in plot maintenance.

Measurements and maintenance will both be subject to field audits. Contractors are encouraged to submit completed data to the project manager as soon as possible to allow for timely checking and auditing. The project manager will check the data to identify any abnormalities or discrepancies. Field audits will be conducted in consultation with the applicable company technical representative. Outages identified during the field audit will be regarded as potentially applying to all plots measured by the contractor within the measurement year. The project manager will discuss observed problems with the respective company technical representative, and notify the field contractor of any required remedial action. Corrected plots will be re-audited. The project manager will provide a recommendation for payment to member companies only when satisfied that all quality control issues have been addressed.

Table 12. Maintenance requirements

Item	Requirement
Access maps	• Accurate, and updated if access has changed
Installation tie-point	• Clearly visible • Marked with azimuth and distance to installation centre
Installation buffer	• Clearly visible around entire installation • Conduit poles secure in ground and blue paint refreshed as required • Blue ribbon tied to lateral branches
Installation centre post	• Legible tag with installation number e.g. ANC_2_2_1600 • Secure in ground • Orange paint clearly visible • Flagged with orange ribbon • Witness trees flagged on lateral branches
Treatment plot corner posts	• Secure in ground • Orange paint clearly visible • Witness trees flagged on lateral branches • 2 new posts added (see Figure 1)
Tree plot corner posts	• Secure in ground • Red paint clearly visible • Witness trees flagged on lateral branches
Treatment plot centre post	• Legible tag with the full plot number e.g. ANC_2_1600_T • Secure in ground • Red paint clearly visible
Sub-plot centre stakes	• Centre stakes for sub-plots 1 to 8 properly positioned • Secure in ground.

Tree tagging	• Number on tags legible and clearly displayed (e.g. off the ground)
	• Attached to tree either by:
	  ○ Placement of a big-loop-tag to the main stem (providing a minimum of 10 cm of diameter slack to allow for growth) or
	  ○ Tagging a lateral branch
	• Pigtails replaced as above unless tree not robust enough
	• If utilized, pigtails positioned 20 cm north of assigned tree

6 Measurement Scheduling

The intended re-measurement interval for the growth phase of the Trial is 5 years. Table 13 shows the current measurement schedule. This may be varied in future depending on analytical needs, project priorities, and availability of field staff.

Table 13. 5-year measurement schedule

Agency	Installation	2022	2023	2024	2025	2026	Total
ANC	ANC_2_2_0		4				4
	ANC_2_2_1111		4				4
	ANC_2_2_1600		4				4
	ANC_2_2_2500		4				4
	ANC_2_2_4444		4				4
	ANC_2_2_816		4				4
Sub-total	ANC		24				24
BRL	BRL_5_2_0	4					4
	BRL_5_2_1111	4					4
	BRL_5_2_1600	4					4
	BRL_5_2_2500	4					4
	BRL_5_2_4444	4					4
	BRL_5_2_816	4					4
Sub-total	BRL	24					24
CFPGP	CFPGP_4_3_0					4	4
	CFPGP_4_3_1111				4		4
	CFPGP_4_3_1600				4		4
	CFPGP_4_3_2500			4			4
	CFPGP_4_3_4444		4				4
	CFPGP_4_3_816	4					4
Sub-total		4	4	4	8	4	24
MWFP	MWFP_5_1_0			4			4
	MWFP_5_1_1111			4			4
	MWFP_5_1_1600			4			4
	MWFP_5_1_2500			4			4
	MWFP_5_1_4444			4			4
	MWFP_5_1_816			4			4
Sub-total	MWFP			24			24
SDA	SDA_3_3_0		4				4
	SDA_3_3_1111		4				4
	SDA_3_3_1600		4				4
	SDA_3_3_2500		4				4
	SDA_3_3_4444		4				4
	SDA_3_3_816		4				4
Sub-total	SDA		24				24

Agency	Installation	2022	2023	2024	2025	2026	Total
SLS	SLS_1_1_0	4					4
	SLS_1_1_1111		4				4
	SLS_1_1_1600			4			4
	SLS_1_1_2500			4			4
	SLS_1_1_4444	4					4
	SLS_1_1_816		4				4
Sub-total	SLS	8	8	8			24
SPI	SPI_1_3_0		4				4
	SPI_1_3_1111		4				4
	SPI_1_3_1600		4				4
	SPI_1_3_2500		4				4
	SPI_1_3_4444		4				4
	SPI_1_3_816			4			4
	SPI_3_2_1111			4			4
	SPI_3_2_1600			4			4
	SPI_3_2_2500			4			4
	SPI_3_2_4444			4			4
	SPI_3_2_816			4			4
	SPI_3_2_9			4			4
	SPI_5_3_1600			4			4
	SPI_5_3_816			4			4
Sub-total	SPI		20	36			56
WEYDV	WEYDV_3_4_0		4				4
	WEYDV_3_4_1111		4				4
	WEYDV_3_4_1600		4				4
	WEYDV_3_4_2500		4				4
	WEYDV_3_4_4444		4				4
	WEYDV_3_4_816		4				4
Sub-total	WEYDV		24				24
WEYED	WEYED_3_5_0				4		4
	WEYED_3_5_1111				4		4
	WEYED_3_5_1600				4		4
	WEYED_3_5_2500				4		4
	WEYED_3_5_4444				4		4
	WEYED_3_5_816				4		4
Sub-total	WEYED				24		24

Agency	Installation	2022	2023	2024	2025	2026	Total
WEYGP	WEYGP_1_2_0		4				4
	WEYGP_1_2_1111		4				4
	WEYGP_1_2_1600		4				4
	WEYGP_1_2_2500		4				4
	WEYGP_1_2_4444		4				4
	WEYGP_1_2_816		4				4
	WEYGP_2_3_0			4			4
	WEYGP_2_3_1111		4				4
	WEYGP_2_3_1600			4			4
	WEYGP_2_3_2500	4					4
	WEYGP_2_3_4444	4					4
	WEYGP_2_3_816	4					4
	WEYGP_3_1_0			4			4
	WEYGP_3_1_1111			4			4
	WEYGP_3_1_1600			4			4
	WEYGP_3_1_2500			4			4
	WEYGP_3_1_4444			4			4
	WEYGP_3_1_816			4			4
Sub-total	WEYGP	12	28	32			72
WWC	WWC_2_1_0				4		4
	WWC_2_1_1111				4		4
	WWC_2_1_1600				4		4
	WWC_2_1_2500				4		4
	WWC_2_1_4444				4		4
	WWC_2_1_816				4		4
	WWC_4_1_0				4		4
	WWC_4_1_1111				4		4
	WWC_4_1_1600				4		4
	WWC_4_1_2500					4	4
	WWC_4_1_4444					4	4
	WWC_4_1_816					4	4
	WWC_4_2_1111					4	4
	WWC_4_2_1600					4	4
	WWC_4_2_2500					4	4
	WWC_4_2_4444					4	4
	WWC_4_2_816					4	4
	WWC_5_3_0	4					4
	WWC_5_3_1111	4					4
	WWC_5_3_2500	4					4
	WWC_5_3_4444	4					4
Sub-total	WWC	16			36	32	84
Grand total		64	132	104	68	36	404