Effects of Pruning on Improved Radiata Breeds – Trial Establishment Report

I.P. McInnes

Report No. 6A February 1998

FOREST & FARM PLANTATION MANAGEMENT COOPERATIVE

EXECUTIVE SUMMARY

EFFECTS OF PRUNING ON IMPROVED RADIATA PINE BREEDS - TRIAL ESTABLISHMENT REPORT

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Report No. 6a **February 1998**

Four trials were planted in the period 1994-97, to evaluate the response to pruning of the latest genetically improved cuttings of the Growth and Form and Long Internode breeds of radiata pine. These breeds represent the extremes of radiata pine branch habit.

The trials were planted on the following sites:

FR 226	Kaingaroa Forest, cutover site	planted 1994
FR 228	Ohaaki (Taupo), farm site	planted 1994
FR 256	Te Matai (Te Puke), farm site	planted 1995
FR 336	Santoft Forest (Wanganui), cutover site	planted 1997

The experimental design used is a split plot factorial design with plots of each of the two breeds being adjacent to one another and receiving the same silvicultural treatment. A variety of silvicultural treatments will be applied, involving three final crop stockings (and thus pruned stockings) of 200, 300 and 400 stems/ha, and three pruning severities of 2.5, 4.0 and 5.5m of green crown remaining after each pruning lift. An unpruned control is included on two sites. The initial stocking is twice that of the final crop stocking.

Note: This report replaces Report No. 6 which only contained information on the establishment of FR 226 and FR 228.

EFFECTS OF PRUNING ON IMPROVED RADIATA PINE BREEDS — TRIAL ESTABLISHMENT REPORT

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INTRODUCTION

With the development of genetically improved breeds of radiata pine, it is important to quantify the differences between new breeds and unimproved seedlots. Field trials exist but these concentrate on aspects such as thinning and final crop stocking (West 1994). An area where trials are lacking is in pruning. The only existing trial of this sort is at Tumunui, just south of Rotorua which has three pruning severity levels, but only one stocking treatment (Knowles 1984).

To overcome this, a new series of trials have been planted to specifically investigate the effect of pruning on the Growth & Form and Long Internode breeds of radiata pine. These breeds comprise multi-nodal and long-internode tree types which represent the extremes of branch morphology.

This trial series focuses on traits, in this case branching, rather than specific breeds as these are continually changing. The establishment of this trial series will help achieve one of the recommendations made by the Cooperative's Silvicultural Trials Working Group (West et al 1996). In future, if there is a difference in the response to pruning, then the silviculture can be altered to suit the trait, with GF factor being of lesser importance.

Four trials have been planted on the following sites:

FR 226,	Kaingaroa Forest, cutover site,	planted 1994,
FR 228,	Ohaaki (Taupo), farm site,	planted 1994,
FR 256,	Te Matai (Te Puke), farm site,	planted 1995,
FR 336,	Santoft Forest (Wanganui), cutover site,	planted 1997.

EXPERIMENTAL DESIGN

A split plot factorial experimental design was used with the Growth & Form plots being located adjacent to Long Internode plots, and receiving the same silvicultural treatment. The paired plots were allocated randomly within blocks, with two replications installed at each site.

The breeds comprised a range of specific crosses intermixed at time of planting within the two breeds of Growth & Form and Long Internode. The rating for each breed is as follows:

Growth and Form	GF 28
Long Internode	LI 25 (GF 18)

It is felt that there would be limited use from having a control seedlot in these trials (eg genetically unimproved seedlot). The objective of the trial is to compare the two types of crown architecture and how they respond to pruning over a range of pruning severities and stockings. We are not trying to quantify any growth difference of these breeds over others, more to ascertain if there is a difference in the response to pruning between the traits of multi-nodal versus uni-nodal branch habit. With the continuing genetic improvement of these breeds, trials will always be following behind developments, hence the importance of concentrating on traits, representing the contrasting branch habit, rather than specific crosses. Within any one breed, there will be a range of branching and internode characteristics. By choosing highly multi-nodal and uni-nodal breeds, this range will be maximised. In this regard, the analysis of individual trees, in which growth will be modelled as a function of internode length (regardless of breed) and crown length, may ultimately be of most interest.

Treatments will consist of three pruning severities and three final crop stockings. The pruning severity is of primary interest so will consist of a severe treatment (2.5 m green crown length remaining), a medium treatment (4.0 m green crown length remaining) and a mild treatment (5.5 m green crown length remaining). All treatments will have a minimum pruned height of 6.0 m and will be 'variable lift' pruned in 3-4 lifts.

For a given stocking, the variation in pruning severity only results in a small amount of variation of total crown per hectare. For increased utility in modelling, a much wider range of crown/ha is necessary, so three stockings have been included. This will allow any trends in the basal area increment to crown/ha relationship to be

determined. The final crop stockings are equal to the final pruned stocking and will cover the range commonly implemented by industry. The number of trees pruned (and final crop stocking) will be 200, 300 and 400 stems/ha. All treatments were planted with an initial stocking ratio of twice the final crop stocking so there is no confounding effect from varying selection ratios.

Treatments are summarised in the following table.

Table 1 — Treatments contained in the improved breeds pruning trials

	Green Crown Remaining			
Final Stocking	2.5 m	4.0 m	5.5 m	Unpruned
200 stems/ha	✓	✓	✓	
300 stems/ha	✓	✓	✓	✓*
400 stems/ha	✓	✓	✓	

* This treatment is only present at Te Matai, FR 256 (2 replications) and Santoft, FR 336 (3 replications). All other treatments have two replications on each site.

Although there are only two replications of each treatment, the analysis will gain additional strength for the following reasons:

1. This is a series of trials replicated across four sites. The most important analysis will be a combined analysis of all four trials for which there is ample replication.
2. The trials are factorial in design which increases the effective replication of the pruning severity treatments. There are actually six plots of each pruning severity (across three stockings) for each seedlot, at each trial.
3. Although there will be a standard analysis on plot means comparing treatments using ANOVA and response surface methods, there will also be an analysis of individual trees. In this analysis, growth will be modelled as a function of internode length and crown length. There will be more than ample replication for this analysis.

The ANOVA table is included below.

Table 2 — Analysis of Variance

Source	Degrees of Freedom
Block	1
Stocking	2
Pruning Severity	2
Stocking x Pruning	4
Main Plot Error	8
Breed	1
Breed x Stocking	2
Breed x Pruning	2
Breed x Stocking x Pruning	4
Sub-plot Error	9
Total	35

INDIVIDUAL TRIALS

The trials are explained individually on the following pages, with background information on each trial, as well as compartment and trial maps.

FUTURE MANAGEMENT

The trials will be thinned in two stages and pruned in 3-4 lifts to at least 6.0 m.

Plots will be installed and measured in the winter prior to the expected first pruning lift. The pruning can then be scheduled using EARLY.

Trials will be measured annually in winter for DBH, height, and crown height. They will also be measured at the time of pruning for DBH, height, pruned height, DOS, DOS height, maximum branch and internode diameter at the base of the green crown. Data will be stored on the NZ FRI Permanent Sample Plot database.

Trees that are removed at thinning may be used for ancillary work such as destructively sampling for foliage biomass and assessing resin pocket incidence.

The trials will receive weed control treatments the same as the rest of the compartment they are in.

ACKNOWLEDGEMENTS

The following organisations are gratefully acknowledged for provision of trial sites and labour:

Fletcher Challenge Forests Ltd,
Te Toke Trust,
Blakely Pacific Ltd,
Ernslaw One Ltd.

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REFERENCES

Knowles, R.L., 1984. Establishment of Field Tests for Evaluating Response to Pruning of *Pinus radiata* '870' and '268' Progeny. FRI Workplan 429.

West, G.G., 1994. Review of Silvicultural Trials. Forest and Farm Plantation Management Cooperative Report No 3.

West, G.G., Elliot, D., Kater, M., McLarin, M., Smale, P., Sutton, W., Taylor, P., 1996. A strategic plan for new and existing silvicultural trials. Forest and Farm Plantation Management Cooperative Report No 35.

1. KAINGAROA FOREST, FR 226

This trial is located in compartment 1235, Kaingaroa Forest (Fletcher Challenge Forests Ltd). It is located on second rotation radiata pine cutover.

The trial is located on a south-east facing slope of 0-5°. The lower part of the trial is on flat land adjacent to Totara Rd (see Figure 1), while the remainder of the trial is on a gentle slope. Site preparation consisted of oversowing in spring of 1993 with maku lotus and yorkshire fog. In April 1994, the area was sprayed with Escort. The site had a covering of logging slash and dead blackberry with some grasses present at the time of planting. The compartment was spot sprayed in September after planting with a mixture of Gardoprim and Gallant.

The trial was planted by a contract planting crew with NZ FRI supervision on 22/23 August 1994.

Plots are 0.3025 ha (55 x 55 m) and will each incorporate a 0.1000 ha measurement plot. The 400 stems/ha final stocking has a plot size of 0.1512 ha, with two plots per 55 x 55 m square. The measurement plot will be 0.0500 ha.

The trial location and layout are shown in Figures 1 and 2. The trial was divided into two blocks based on slope with block 1 (plots 1-18) on the lower, flatter part and block 2 (plots 19-36) on the sloping part.

Initial tree spacings for each stocking were chosen so that trees would be on a nominal square spacing following final thinning. Target planting spacings for each of the three initial stockings were:

400 stems/ha	7.0 x 3.5m
600 stems/ha	5.8 x 2.9m
800 stems/ha	5.0 x 2.5m

Actual planting dimensions are included in Appendix I.
Planting rows are orientated approximately northwest/southeast.

Figure 1 — Location of FR 226 within compartment 1235.

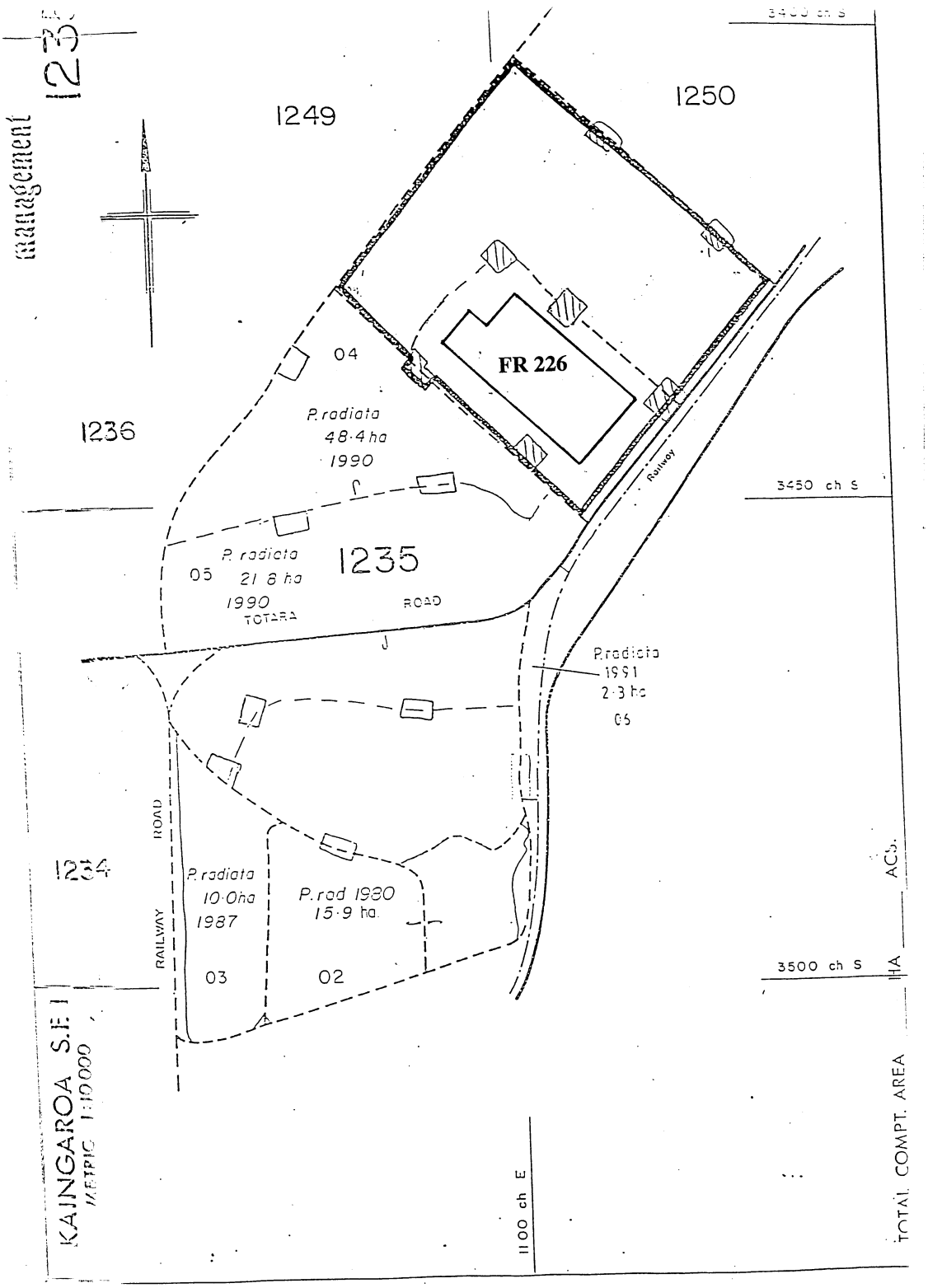
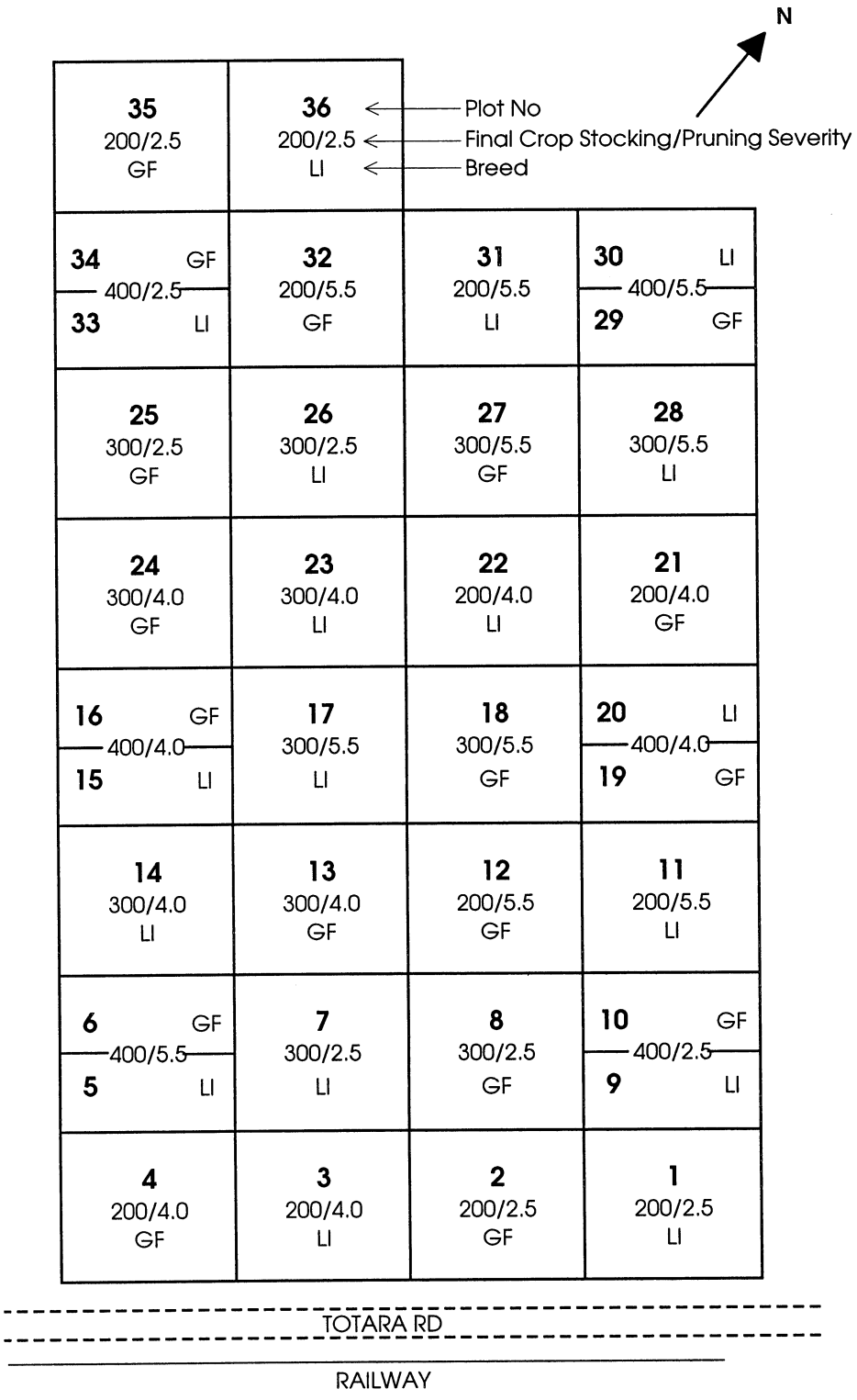


Figure 2 — Layout of FR 226.

FR 226 IMPROVED BREEDS PRUNING TRIAL

COMPARTMENT 1235, KAINGAROA



Note: Plot size: 55 x 55 m
All plots are planted at twice final crop stocking.

2. OHAAKI, FR 228

This trial is located on Te Toke Trust land which is being planted in trees over the next three years. Fletcher Challenge Forests Ltd is establishing and managing the forests for the Trust. The site is an ex-farm site adjacent to the Waikato River, just south of the Ohaaki geothermal power station.

The trial is located on flat land, although the surrounding area gradually slopes towards the Waikato River. A small stream and marshy area is to the west of the trial. The Waikato River is located approximately 200 m to the east. (See Fig. 3 for details).

Site preparation consisted of rotary-hoed strips at 4 m intervals which were then ripped and mounded. Deer fences were not removed until after rotary hoeing and ripper-mounding, hence there are gaps in the rip lines where the fences were previously located. The area had been grazed until the day of planting.

The trial was established by labourers (provided by the Trust) who had limited planting experience. Planting was supervised by NZ FRI staff and was carried out on 20/21 September, 1994.

Plots are 0.3136 ha (56 x 56 m) with a 0.1000 ha measurement plot within. The highest stocking (400 stems/ha final stocking) has two plots per 56 x 56m plot with each measurement plot being 0.0500 ha.

The trial location and layout are shown in Figures 3 and 4. The trial was divided into two blocks with block 1 (plots 1-18) near the stream and block 2 (plots 19-36) further from the marshy area. The site is uniform other than this.

As the area had already been ripped into rows 4m apart, these had to be used as the between row spacing. The plots are 56m wide which allows 14 rows per plot. This was constant for all stockings. Nominal planting spacings were:

400 stems/ha	4.0 x 6.0m
600 stems/ha	4.0 x 4.5m
800 stems/ha	4.0 x 3.0m

Actual planting dimensions are included in Appendix I.
Planting rows run approximately east to west.

Figure 3 — Location of FR 228 within Trust land.

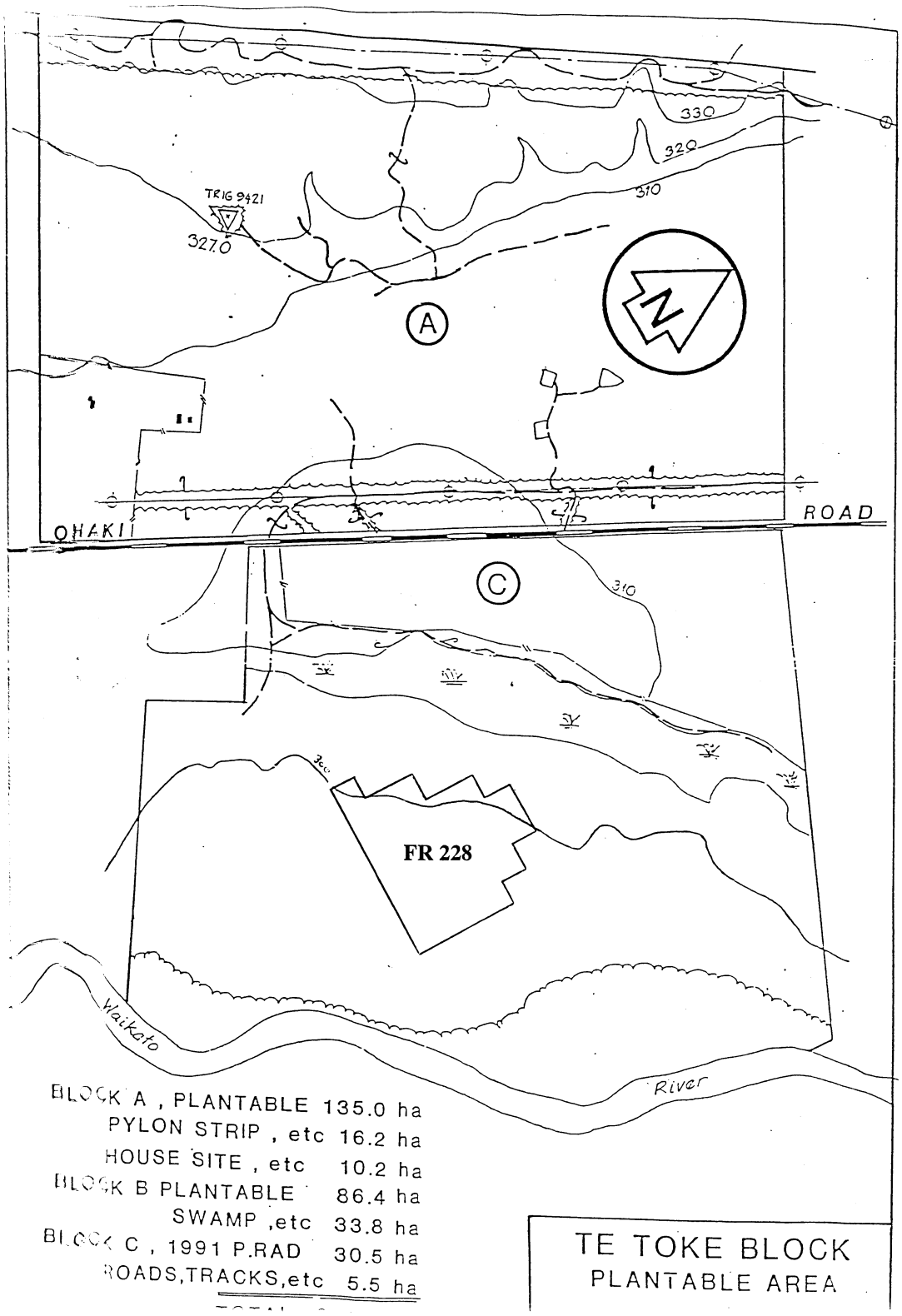
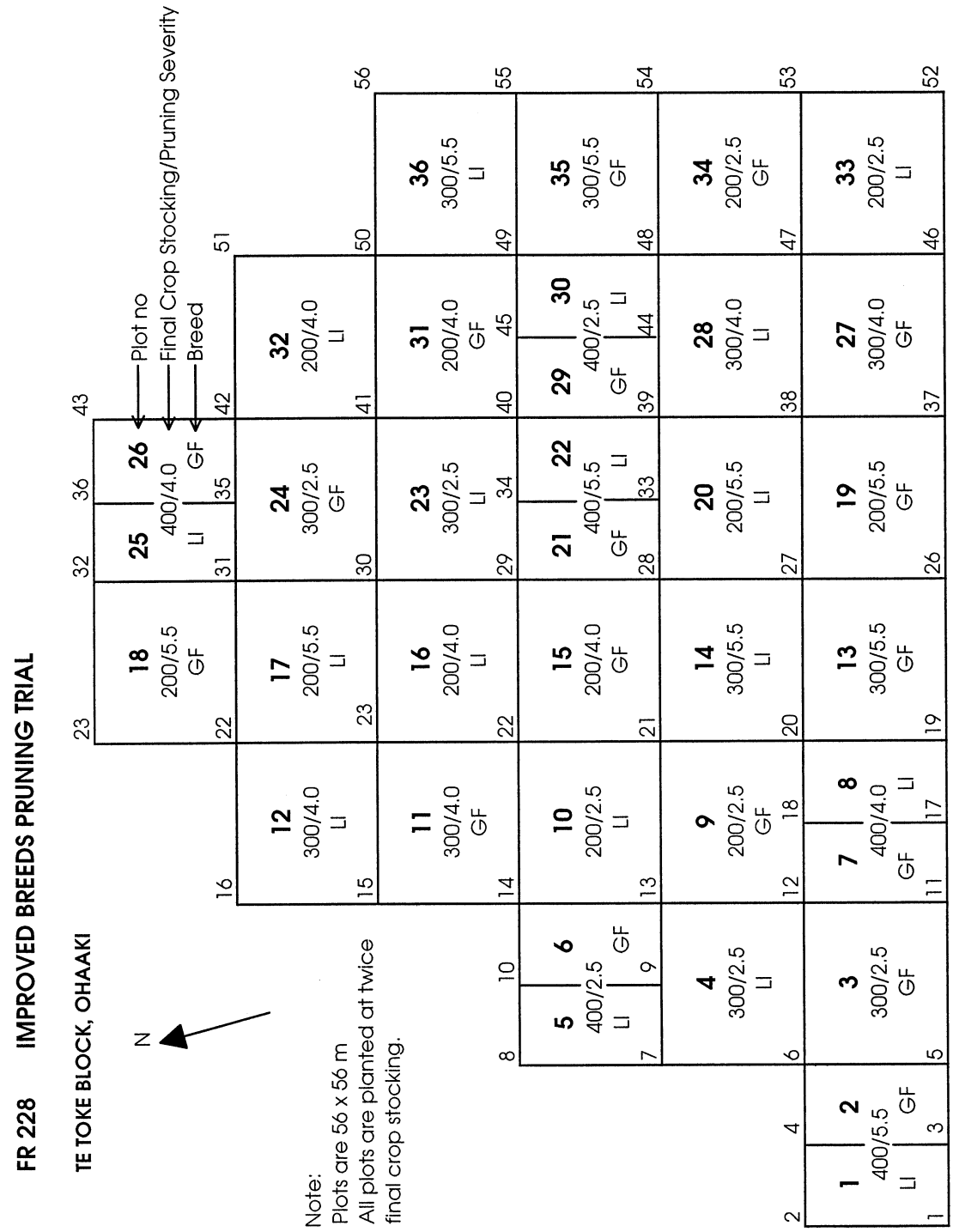


Figure 4 — Layout of FR 228.



3. TE MATAI RD, TE PUKE, FR 256

This trial is located on a highly fertile ex-farm site on Te Matai Rd which has been purchased and converted to forestry by Blakely Pacific Ltd.

The trial is located on a plateau in the middle of the property with a slight slope (< 5°) rising towards the north-east. The area was grazed until shortly before planting. Spot spraying was carried out soon after planting with a mixture of Gardoprim and Gallant.

The trial was planted by local planting contractors with FRI supervision on 8 and 10 August, 1995.

The trial layout is shown in Figure 5. The trial was divided into two blocks, mainly separated by a farm access track. Block 1 is plots 1-18 and plots 22-23. Block 2 is plots 19-21 and 24-40.

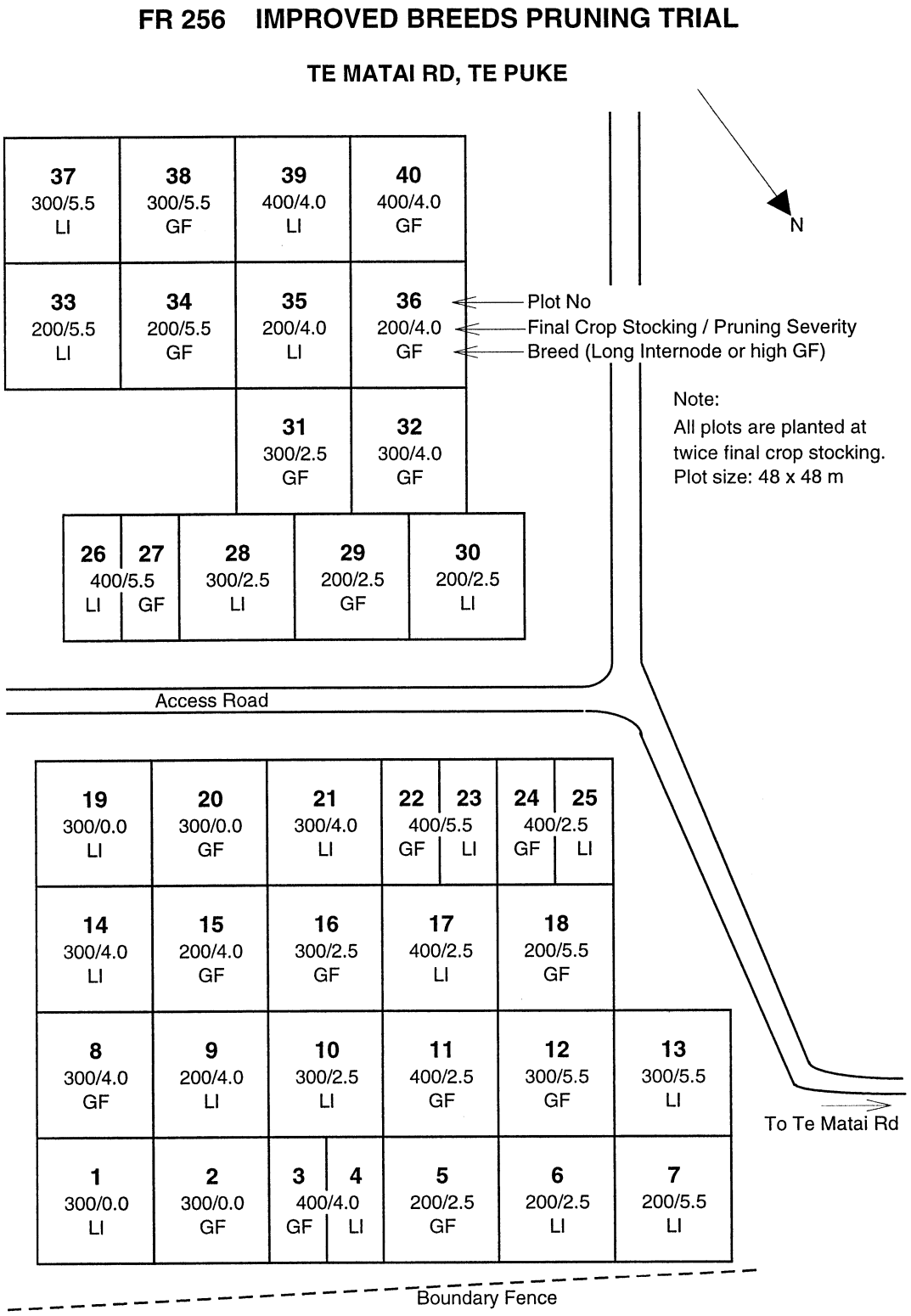
Plots are 0.2304 ha (48 x 48 m) with 0.1000 ha measurement plots within this. Some of the highest stocked plots have two plots within this and have 0.0500 ha measurement plots.

Nominal planting spacings are as follows:

400 stems/ha	4.0 x 6.0 m
600 stems/ha	4.0 x 4.0 m
800 stems/ha	4.0 x 3.0 m

Actual planting dimensions are included in Appendix I.
Planting rows are oriented approximately northwest-southeast.

Figure 5 — Layout of FR 256.



4. SANTOFT FOREST, FR 336

This trial is located in compartment 69, Santoft Forest (Ernslaw One Ltd), 20 km from Bulls. It is located on second rotation radiata pine cutover. This is a low fertility sand site with Site Index of approximately 23.5 m.

The trial is on a reasonably uniform site which gently slopes up towards the northern side (< 5°). Site preparation consisted of line raking at 90° to the prevailing northwest wind direction at approximately 16 m intervals. The site received a pre-plant spray and was oversown with Maku lotus and red clover. At the time of planting, a 1080 poisoning programme was underway in the forest so browsing by rabbits should be minimal.

The trial was planted by a local planting contractor with FRI supervision on 26 and 27 August 1997.

All measurement plots will be 0.1000 ha within a 50 x 50 m square (total area 0.2500 ha).

There is known to be a height increase with increasing distance from the coast. For this reason, the trial has been blocked with block 1 closer to the coast (plots 1 to 20) and block 2 further away (plots 21 to 42). The trial location and layout are shown in Figures 6 and 7. There are two replicates of each treatment, and three of the unpruned control as this is only present at one stocking (300 stems/ha). The trial is approximately 700 m from the sea at the closest point.

Two of the previous trials had been planted at a between row spacing of 4 m for all treatments and a varying within row spacing to give the three stockings. This was maintained to keep a similar configuration for consistency among trials.

Nominal planting spacings for each are:

400 stems/ha	4.1 x 6.0 m
600 stems/ha	4.1 x 4.0 m
800 stems/ha	4.1 x 3.0 m

Actual planting dimensions are included in Appendix I.
Planting rows run approximately north-south.

Figure 6 — Location of FR 336 within compartment 69.

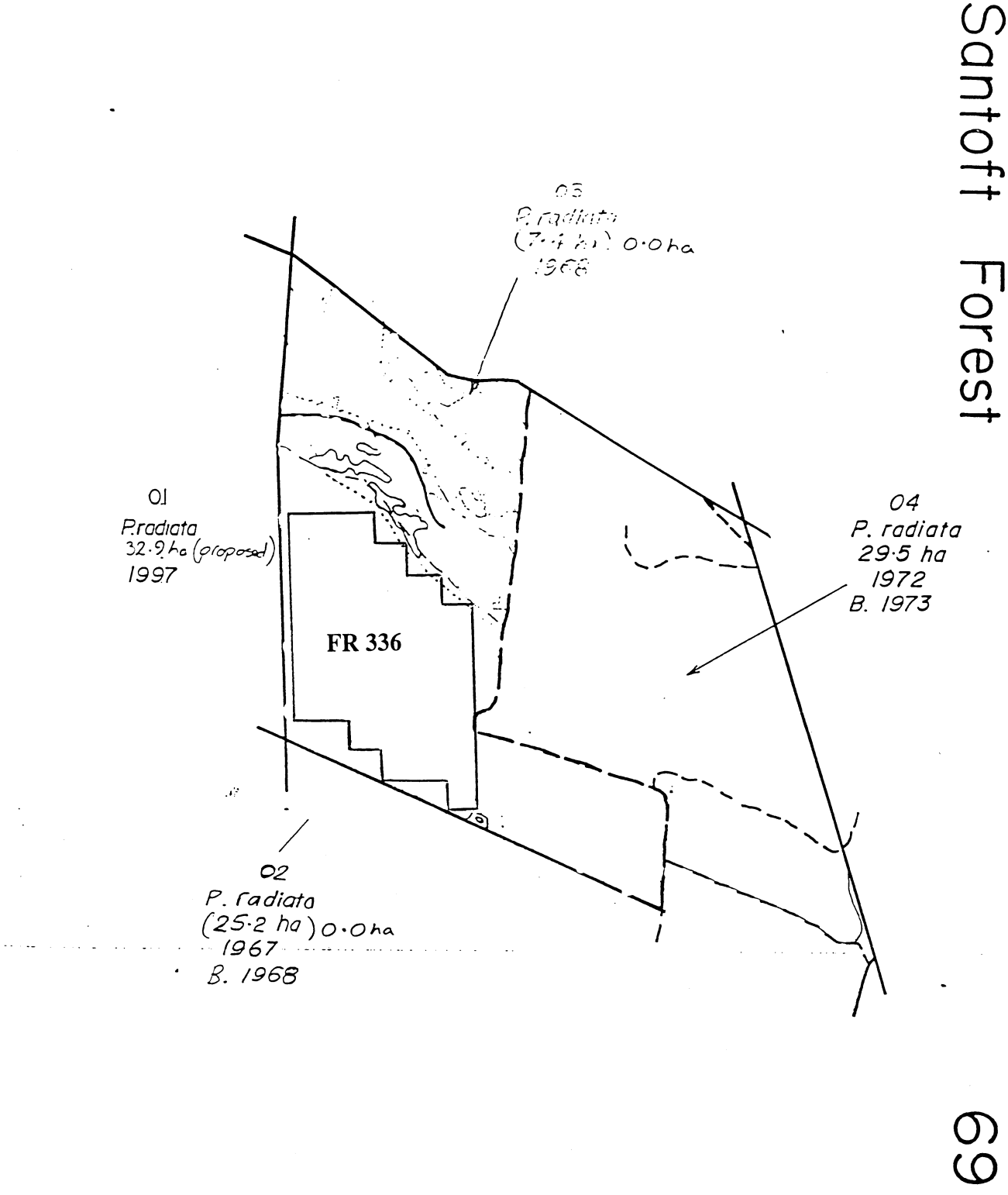
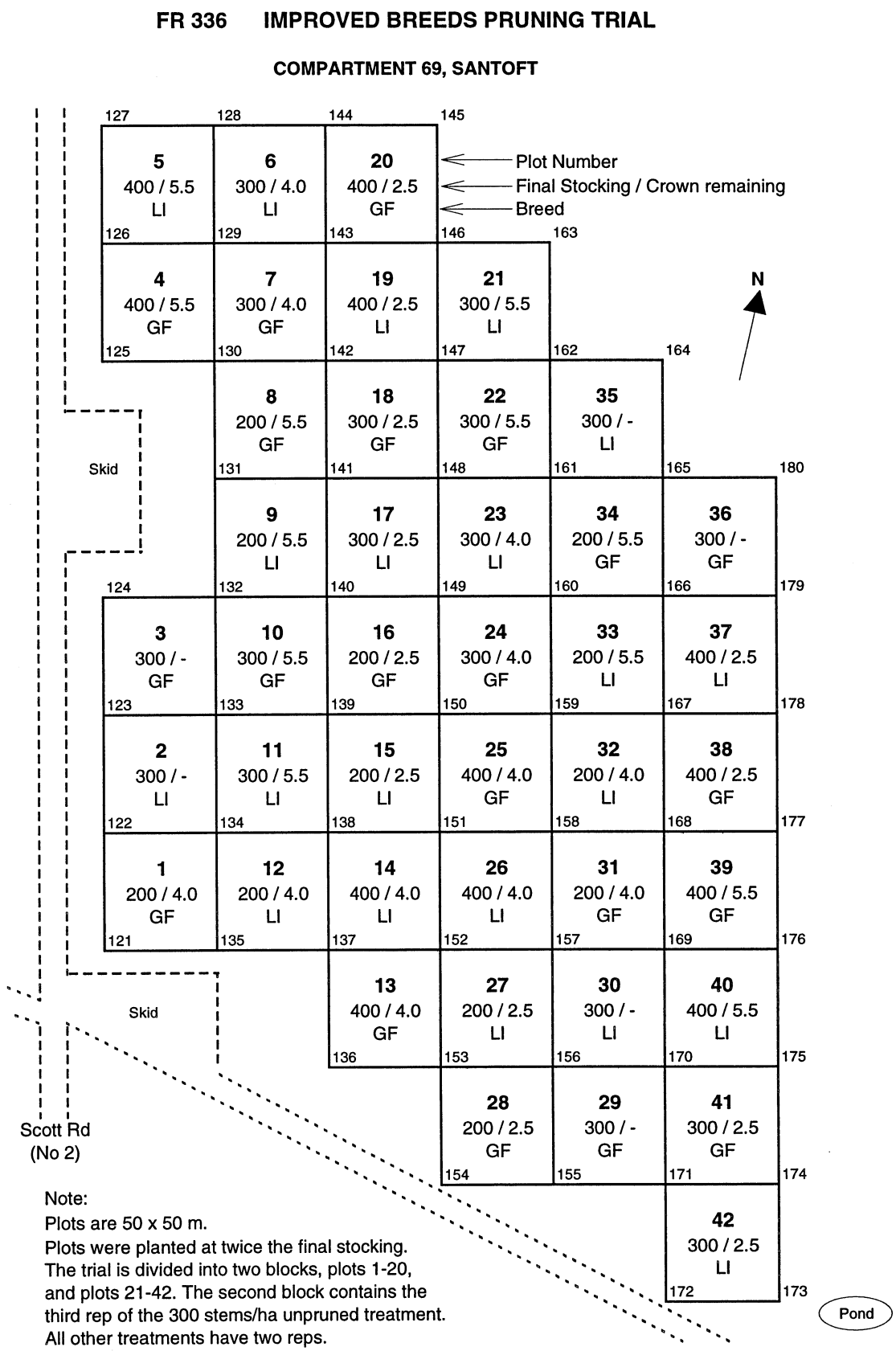


Figure 7 — Layout of FR 336.



APPENDIX I — Planting Spacings

FR 226 Kaingaroa

Nominal Planting Density (stems/ha)	400	600	800
Rows	8	10	11
Distance between rows	7.0m	5.8m	5.0m
Dist. between outside rows and plot edge	3.0m	1.4m	2.5m
Seedlings per row	16	19	11
Dist. between seedlings	3.5m	2.9m	2.5m
Dist. between end seedlings and plot edge	1.25m	1.4m	1.25m
Seedlings per plot	128	190	121

FR 228 Te Toke, Ohaaki

Nominal Planting Density (stems/ha)	400	600	800
Rows	14	14	14
Distance between rows	4.0m	4.0m	4.0m
Dist. between outside rows and plot edge	2.0m	2.0m	2.0m
Seedlings per row	9	13	9
Dist. between seedlings	6.0m	4.5m	3.0m
Dist. between end seedlings and plot edge	1.25m	1.0m	0.5m
Seedlings per plot	126	182	126

FR 256 Te Matai Rd, Te Puke

Nominal Planting Density (stems/ha)	400	600	800
Rows	12	12	12
Distance between rows	4.0 m	4.0 m	4.0 m
Dist. between outside rows and plot edge	2.0 m	2.0 m	2.0 m
Seedlings per row	8	12	16
Dist. between seedlings	6.0 m	4.0 m	3.0 m
Dist. between end seedlings and plot edge	3.0 m	2.0 m	1.5 m
Seedlings per plot	96	144	192

FR 336 Santoft Forest

Nominal Planting Density (stems/ha)	400	600	800
Rows	12	12	12
Distance between rows	4.1 m	4.1 m	4.1 m
Dist. between outside rows and plot edge	2.5 m	2.5 m	2.5 m
Seedlings per row	9	13	17
Dist. between seedlings	6.0 m	4.0 m	3.0 m
Dist. between end seedlings and plot edge	1.0 m	1.0 m	1.0 m
Seedlings per plot	108	156	204

Note: Due to windrows on this site, approximately 6 trees per plot were not planted so the actual planting density should be very close to the prescribed stockings of 400, 600, or 800 stems/ha.