

**DEVELOPMENT OF JACK PINE
MASS SELECTION SEED
ORCHARDS IN
NORTHERN MANITOBA**

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ABSTRACT

This report is a collation of information on the establishment of two mass selection orchard/test sites with a seed source from 32 stands of jack pine within the seed zone.

Open pollinated seed was collected from 32 stands (each stand represented by 10 best trees) distributed throughout two seed zones in northern Manitoba. Cone acquisition and seed handling procedures are documented. Rearing procedure and cultural practice are presented in Appendixes. Seedling handling and orchard establishment tasks are documented.

Thirty-three thousand seedlings were reared by stand identity in 175 cm³ containers for a period of 20 weeks, February - June, 1986. Orchard/test sites were located in areas representative of regional climate and suitable soil profiles in 1985. Sites were cleared in March, 1986 and soil prepared with disc implement in May, 1986. During July, 1986 both orchard sites were established (design, spacing layout and planting). Each orchard consists of six replicates with 32 source stands of 48 seedlings of each source, a total of 18,432 seedlings. Information on origin of source stands, rearing schedule, access, layout design and soil profile description and analysis is presented in Appendixes.

ACKNOWLEDGEMENTS

This report acknowledges the development of one pair of seed orchards for the northern region of Manitoba, within the Jack Pine Seed Orchard Program funded by the Canada-Manitoba Forest Renewal Development Agreement. Development reports for seed orchards in the Interlake and Eastern regions funded by the above program are reported separately.

I appreciate the effort of all participants, Manitoba Forestry Branch (MFB) and Forestry Canada (ForCan) who contributed towards program development. A special thanks to Pineland Provincial Forest Nursery staff who provided assistance with a co-operative spirit; and to Mr. Will Holland, Pedologist (ForCan) for providing guidance during the soil survey reconnaissance while examining and selecting potential sites.

I thank C. Brown for his dedication during orchard development, performing endless arduous field tasks and data collection towards this report. My personal appreciation to the Manitoba District Office staff who expeditiously made special efforts to accommodate me during the delivery of this demanding program. Also my sincere appreciation to John McQueen and Jake Dyck for teaching and helping me apply Wordperfect skills for this report.

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NOTE

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1. INTRODUCTION

In 1985, Manitoba Forestry Branch expressed a need for a cooperative program with Forestry Canada to improve jack pine (*Pinus banksiana* Lamb) yield and stem quality in areas where planting was about one million trees/year. A Jack Pine Seed Orchard Development Program was initiated within the Canada-Manitoba Forest Renewal Agreement to address that need in two areas of the province. This report outlines the purpose and describes the development of two seed zones in the northern region of Manitoba (Figure.1).

In view of the projected annual planting of one million trees for the region, a mass selection program was aimed to meet that need at appropriate cost in minimum time. Seed was collected from major stands throughout the area and two mass selection orchard/tests were established in 1986 with two objectives: (1) to identify superior stands in the area, if they exist, and (2) to assess visible genetic variation within source stands in the mass selection orchard/tests during the juvenile growth period over approximately 10 years. The first objective is the evaluation of genetic variation among stands to identify the best performance stands as seed collection areas. The second objective is to determine genetic variation by assessing phenotypic expressions for growth, stem quality and branching habit among closely spaced trees, within each stand, by progressive mass selection at year 4, 7 and 10. Recurrent mass selection over a 10- year period is intended to identify desirable performers. These best performers within all the stands will be control-pollinated to produce superior seed. In 1996, the mass selection orchards are expected to yield approximately one million open-pollinated seed with a modest gain of 5-10%.

Seedlings from 32 stands are tested on two sites in a uniform environment representative of the renewable forest in the region, using a mass selection criteria, to determine which genotypes are most adaptable for best growth volume, stem quality and branching habits. This report includes a calendar of major tasks, **Figure 2**. All methods and procedures from seed acquisition through to planting, including orchard site preparation, design and layout is described. Information on seed origin, crop rearing schedule, landscape description, soil profile description, chemical and physical analysis is presented in Appendixes. Orchard site preparation methods are described and design and spacing layout are explained and illustrated. Planting procedure is described. Orchard protection provisions are listed.

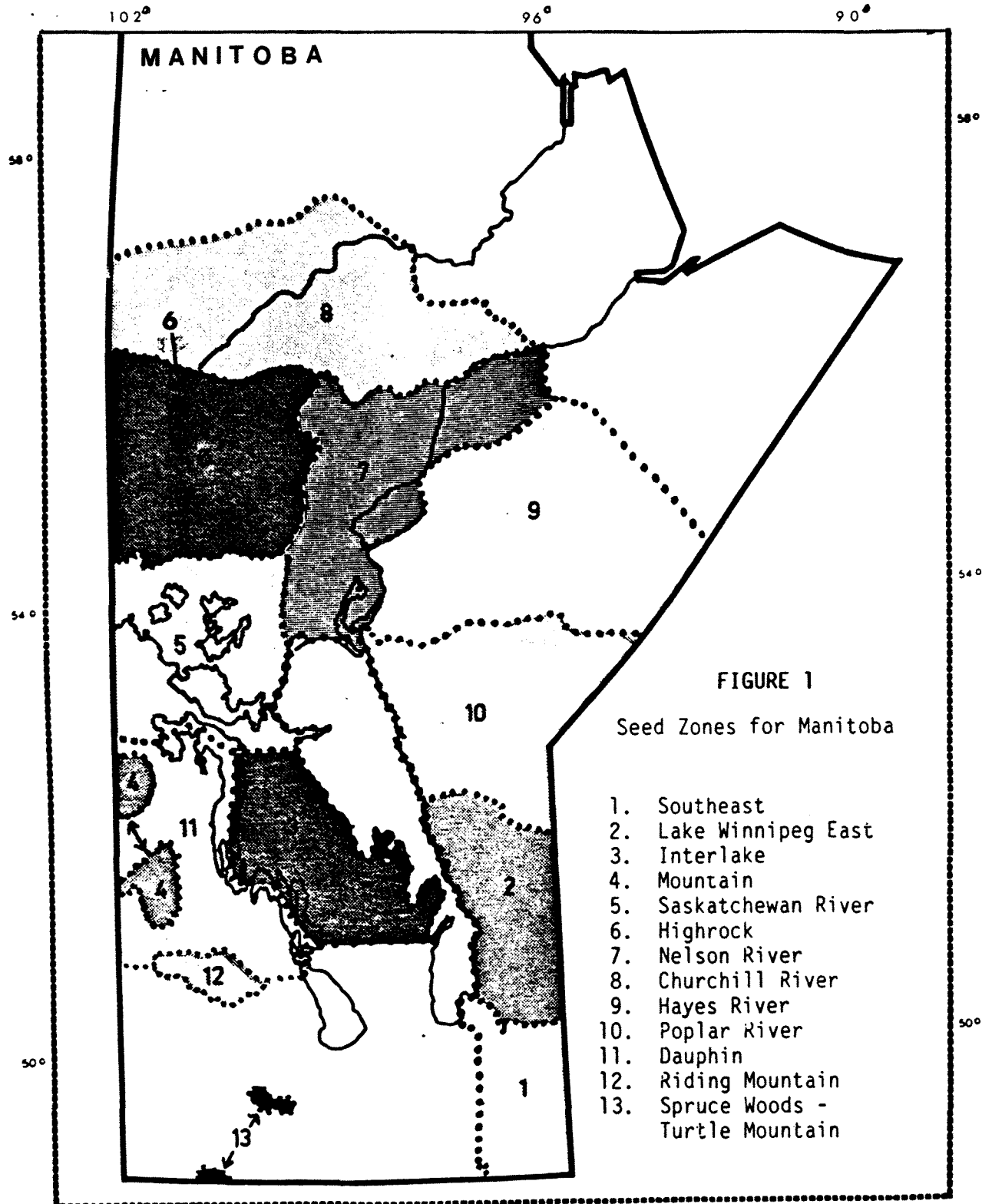


Figure 1. Seed source for orchard/test in the area of seed zones (5 and 6¹).

¹Revised Seed Zones for Manitoba, 1990

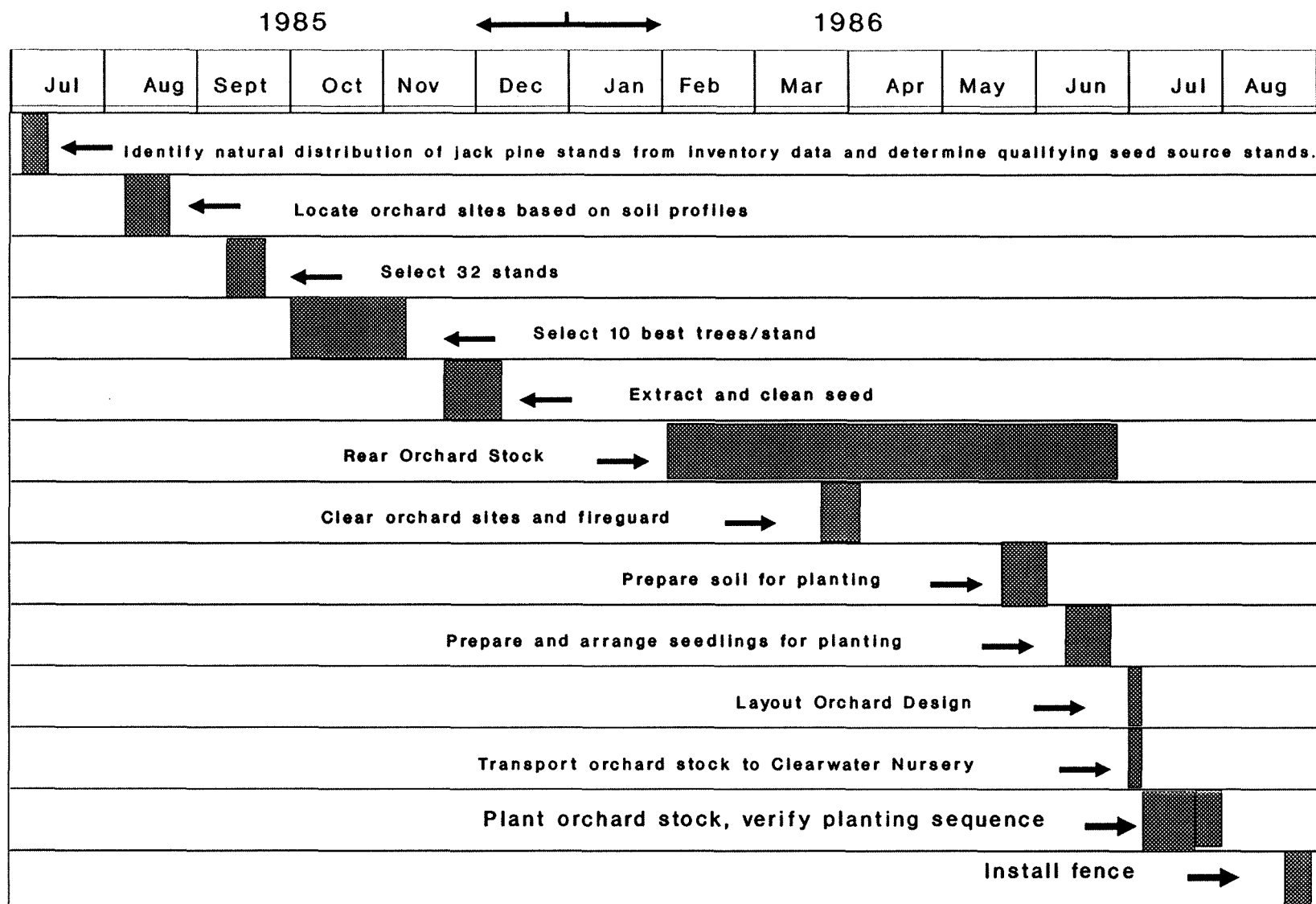


Figure 2. Calendar of major tasks during orchard development .

2. SELECTED POPULATION

2.1 Seed Acquisition

A total of 32 stands were located throughout the jack pine population to acquire a representative sample for the region. Geographic location of two orchard/test sites and 32 seed stand used therein are presented in **Figure 3**. Seed source stands selected for the orchard/test met the following criteria: stand area of at least 40 ha, natural stand origin, minimum age 50 and even aged, fully stocked, and above average vigour. Ten trees were selected from each stand by ocular assessment using subjective judgement to select for desirable traits in the following order of importance: above average height and diameter, straight stem with minimum taper, self pruning, horizontal branching, single leader, dominant crown, least resistance to attack by insects and diseases, and a cone crop with a minimum of 50 cones (200 viable seed). Cones were collected in October, 1985, and seed from each tree was assigned a number and kept separate. Stand locations, elevations and physical characteristics of each stand are recorded in **Appendix 7.1**.

2.2 Cone and Seed Handling

Seed extraction and processing was done at Pineland Provincial Forest Nursery. Cones were dipped in 38°C water to break resin bond and placed in a walk-in drier at 45°C for 16 hours. Opened cones were tumbled in an Octagon Tumbler, 50 cm wide x 80 cm long. Seed-wings were parted from seed by placing seed between two 9" sieves, #12 and #18, immersed in tapped water for one to two minutes to wet seed. The sieves were rotated for three to four minutes over a stream of heated air provided by an aspirator (400 CFM). After the seed-wings parted the seed, the contents were sifted through a series of sieves (#8 top to #18 bottom).

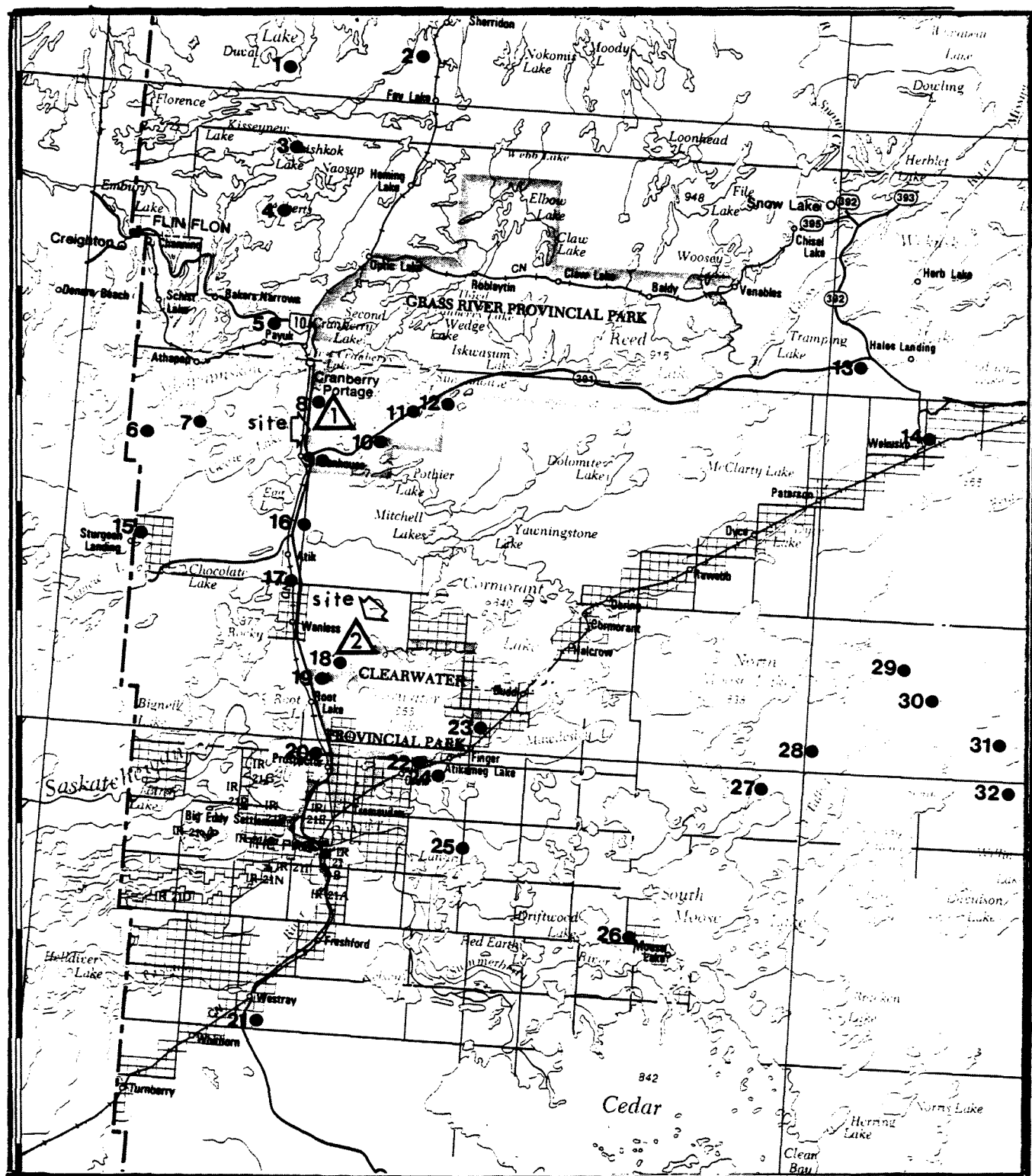


Figure 3. Geographic location of two orchard/test sites and 32 seed stands used therein.

In the final stage, removal of fine particles and empty seed was accomplished with a Columnar Air Aspirator with the control of air flow through a variable air damper until all empty seed was removed. On final check, only full seed was present.

Germination tests confirmed 99% viability. Cleaned seed was bagged in light- gauge paper bags and allowed to air dry for 10 to 14 days before being bottled in screw cap bottles and stored at 0°C for three weeks. In preparation for seeding, two hundred seeds from each of the 10 trees representing a stand were bulked to formulate 32 seedlots. Surplus seed was stored at -10°C as reserve.

2.3 Rearing of Planting Stock

Because the Tree Improvement greenhouse facility in Manitoba was still under construction during January, 1986, the orchard crop was reared in greenhouses at Northern Forestry Centre (NoFC), Edmonton, Alberta. To accommodate the crop in available space, container size was reduced from the desired 350 cm³ to a modified 175 cm³. Stock was reared from February 1, 1986 to May 14, 1986 in "Hillsons" Roottrainers. A book of "Hillsons", when folded formed four cells, each cell, 175 cm³ in volume. Two sides of the cells are corrugated (grooved) to prevent spiralling of roots. These containers are tapered at the bottom to 20 by 10 mm openings. Eight folded books fit into a tray, forming a unit of 32 cells. To encourage jack pine seedlings to grow additional lateral roots, these containers were modified with a radial arm saw by cutting a horizontal opening 3 mm wide x 30 mm long on both sides, approximately 35 mm from the bottom of the containers.

Peat was tested for acidity several days prior to loading to determine amount of horticultural grade lime required to bring the pH level to 5.0. Trays were filled with moist sphagnum peat (Sunshine brand) using a tray-filling machine. Since a mechanical mixer was not on site, two bales of peat were dumped into a large metal bin and large lumps were

broken down manually by stirring. After most peat lumps were crushed, 350 g of lime was added per bale of peat by sprinkling while stirring. After a few minutes of stirring, 6 L of water/bale of peat was sprinkled and stirred to bring the moisture up to the desired level to facilitate uniform loading density. Peat bales that were moist or wet were given proportionate amount of water. Mechanical loading of trays was accomplished by shovelling peat into the vibrating hopper of a tray filler (Spencer-Lemaire model) where trays were conveyed in a continuous line. Continuous manual trim topping and brushing was performed during tray-filling to achieve uniform peat density and level with top of container.

Peat density was monitored after totally saturating filled trays with a water spray boom. Trays filled to correct density usually settled approximately 1 cm below top of container. When peat settled more than 1 cm after saturation, filling density was considered inadequate. By pressing lightly on the saturated peat, the level would remain the same. If the saturated peat remained at the same level after pressing firmly, the density was considered to be too firm. After the water saturation test, the trays were seeded manually January 27 to January 31. Two seeds per cell were sown. The seeded trays were covered with #2 granite grit, placed in greenhouses on wood lathe benches and covered with 2 ml polyethylene.

Greenhouse temperature was set for 25°C during the day (0600-2000) and 20°C during the night (2200-0600). High Pressure Sodium (HPS) lighting was set for 0600-2000 h to provide uniform heat to facilitate germination. Germination occurred on the 6th and 7th day after seeding. Polyethylene was removed on the 6th day after seeding. Germination was complete by the 7th day when the radical rose 1 to 2 cm above grit. After the polyethylene was removed, the crop was misted daily with tapped water for 6 days, twice a day, at 1000 hours and 1300 hours. An establishment nutrient solution (N-P-K 115-15-77 ppm) was applied the 2nd week after germination. From the 3rd to the 10th week, application of growth development nutrient (N-P-K 229-29-154 + 5.5 ppm of Fe), (Carlson 1983), was applied weekly at the rate of 1 L per 10 cells. Commercial soluble fertilizer, Plant Product, 28-14-14 and 20-0-25 was prescribed and applied. Electrical conductivity (Ec) and pH was

monitored on a weekly basis, regularly on the 5th day after application of nutrient. From the 11th week to 20th week the nutrient was changed to hardening regime (N-P-K 45-99-165 + 5.5 ppm Fe) at the rate of 1 L per 10 cells. The crop was watered beyond the saturation point weekly, usually on Mondays, from the 3rd to the 20th week. The crop rearing schedule is presented in **Appendix 7.2**. As scheduled, on May 15th, the crop was transported via reefer-truck from Edmonton to the Tree Improvement Facility/Greenhouse for the final stage of rearing, (14-20 weeks).

2.5 Pre-Planting Treatment of Seedlings

During the last week of June the entire crop was reduced from 32,768 to 22,400 seedlings were separated into two groups: orchard seedlings and surplus seedlings. Nearly all the seedlings were of excellent planting quality in all 32 seedlot sources (**Figure 4**). During the separation and grading process, cell-media, including roots, were vertically cleaved to about 50 mm up from the bottom while the container books were in open position. This procedure was undertaken to (1) encourage a natural root growth and morphology after planting, (2) prevent common root deformity of container reared jack pine seedling planted in heavy clay soils and (3) facilitate planting without compromising growth response (**Figure 5**).

To facilitate planting of the orchard equal number of seedlings per tray were arranged to accommodate the field design. Two trays of 25 seedlings of each seedlot source were arranged to fill a block of 48 planting positions, leaving two seedlings for discard. Seedling arrangement from rearing stage to planting stage is presented in **Table 1**.

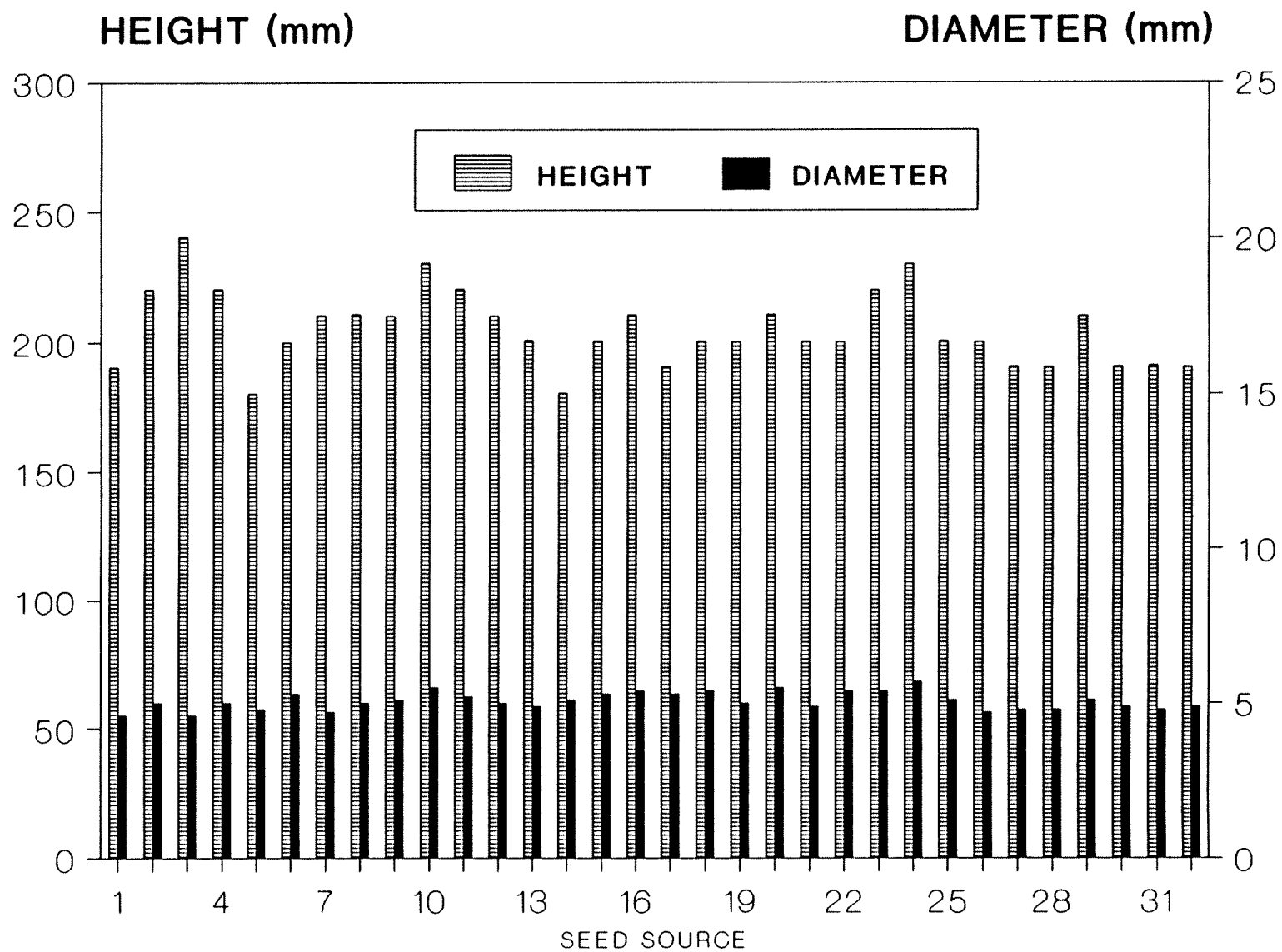


Figure 4. Average seedling height and diameter at planting (20 weeks).

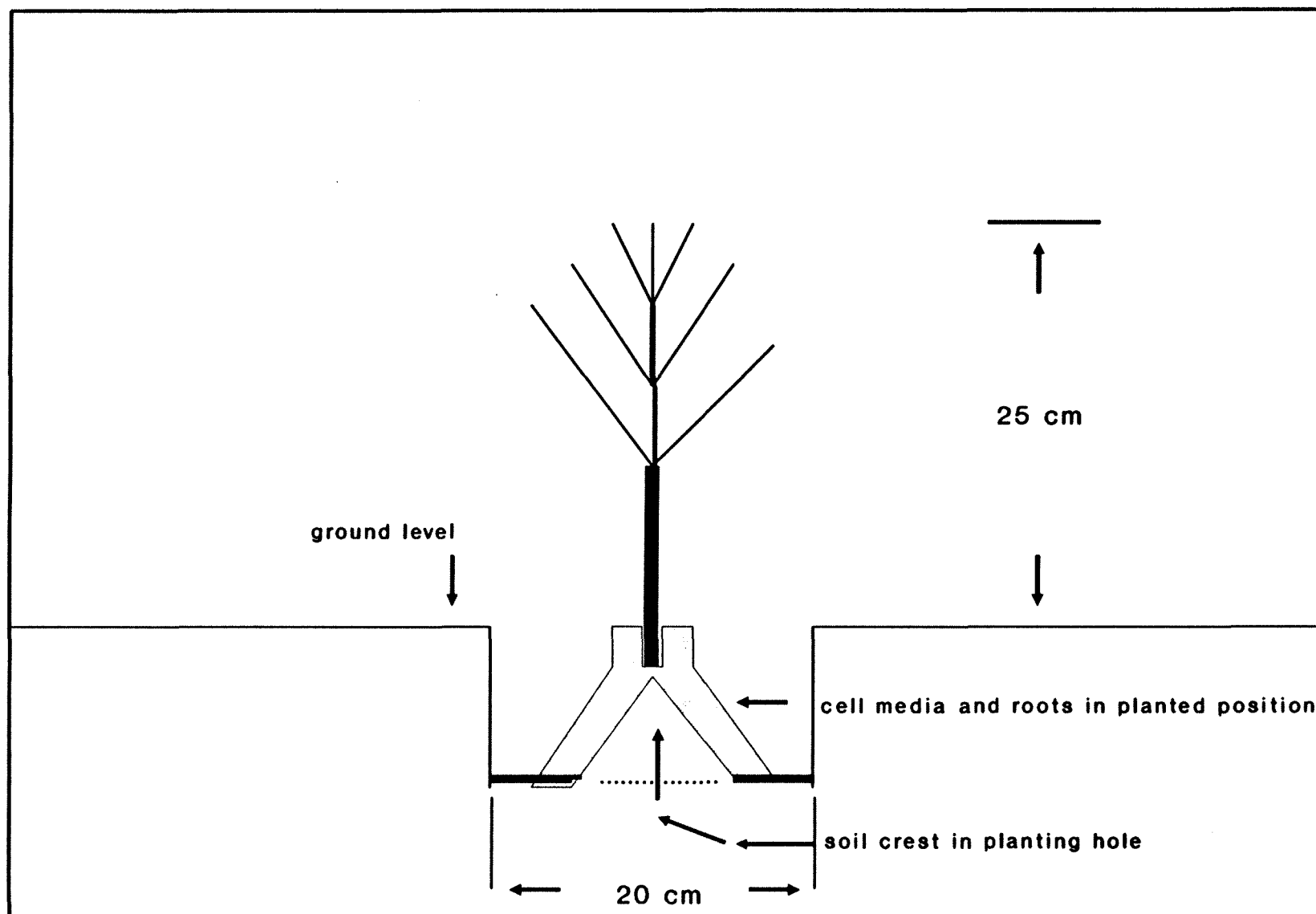


Figure 5. Profile of planted seedling with splayed roots and cell media.

Table 1 - Seedling arrangement: Rearing to design arrangement for planting

Seedling Log Book	Total Reps. in design	Seedlings/ Block	Seedlings/ Seed Source	Orchard Blocks (Seed Sources)	Seedling Totals
Seeded cells	N/A	N/A	1,024	32	32,768
Selected seedlings for planting (including spares) at 20 week	12	58.3	700	32	22,400
Surplus seedlings at nursery	N/A	50	324	32	10,368
Seedlings shipped to planting site	12	50	600	32	19,200
Spare seedlings retained on site	12	2	24	32	760
Seedlings planted	12	8	576	32	18,432

3. PHYSICAL ENVIRONMENT

3.1 Location

Prior to locating orchard/test sites, guidelines were established in January, 1985 by the Tree Improvement Specialist for the program. Topography, soil, management factors, environmental conflicts, pollen isolation and life hazards were considered during location of orchard/test sites. The following factors served as guidelines: (a) areas where topography was preferably level with adjacent slope for air drainage or slightly sloping; (b) soils representative of the region and suitable for the purpose; (c) areas where a "Land Use Reserve " could be secured from the Provincial Lands Branch by Manitoba Forestry Branch and accessible by an all-weather road or within 0.5 km of a current roadway; (d) minimal risk with better than average protection from forest fires and the availability of water within 0.5 km for fire suppression; (e) areas that are at least 2 km from existing transmission lines or other developments and at least 0.5 km from major highways; and (f) minimal contamination from foreign pollen. Data on geographical aspects is referenced for both sites **Table 2.**

3.2 Climate

Because climate is one of the natural factors that has the most significant impacts on tree performance (growth and flowering), utmost care was taken to avoid locations with climatic anomalies to get an accurate response from the population tested. Climate in the region from which the seedlot sources originated is probably relatively uniform with the exceptions of slight modification in localized areas in proximity to large lakes like Cormorant Lake (**Figure 3**). Orchard/test sites were established in areas which have good air drainage, average exposure to wind and sunlight and are at least 2 km from large lakes to avoid climatic anomalies. Climatic data for local weather stations is presented **Table 3.**

Table 2 - Physiographic Divisions² and Geographical aspects of orchard sites

	Site 1	Site 2
MODE	CRANBERRY PORTAGE	ROOT LAKE
Major Physiographic Divisions (regions).	Precambrian Shield 2 (c) Southern limit of drift plain.	Manitoba Lowland 3 (a)Saskatchewan Delta (b) Northern part of Westlake Plain.
Local Landscape:	Glacial ridge	Glacial ridges
Local Relief Feature:	60 m.	60 m.
Nearest Climate Stn.:	25 km N.W.	22 km S.E.
Nearest Settlement:	Cranberry	Wanless
North Latitude:	54° 32'	54° 08'
West Longitude:	101° 22'	101° 18'
Elevation:	327 m	344 m
Section-township- range-meridian:	NW 17-64-26-W	NW 28-59-26-W
Map sheet:	63k	63k
Name 1:250,000:	Cormorant Lake	Cormorant Lake

²Economic Atlas of Manitoba

TABLE 3 - Climatic data for local weather station³

Climate Normals	Baker Narrows Airport (25 km N E of site 1)	The Pas Airport (22 km S E of site 2)
Mean frost-free days	115	115
Mean January temperature	-22.7 ⁰ C	-23.6 ⁰ C
Mean July temperature	17.8 ⁰ C	17.7 ⁰ C
Mean July maximum temperature	23.0 ⁰ C	23.8 ⁰ C
Average annual precipitation	445 mm	453 mm
Average May - Sept precipitation	287 mm	285 mmm

³Canadian Climate Normals:Environment Canada

3.3 Soils

During July, 1985, the Tree Improvement Specialist conducted a reconnaissance survey with the assistance of a pedologist to locate and examine potential test sites. The only information available on soil types in the region was a Soils Map of Cormorant Lake Sheet 63 K⁴ which provided some guidelines on the extent of dominant textures and profile types. Through the systematic use of vegetation, mature stands and evaluation of indicator plants in conjunction with soil profile investigations by digging frequent pits in the desirable areas (corridor), finally led to the location of site 1.

Soils in the test region are predominantly of the Brunisolic Order and to a lesser extent of the Luvisolic Order. An extensive portion of both soil Orders are mainly coarse to fine textured in the upper horizons and fine textured in the lower horizons. These soils are rapidly-to-well drained and are moderately productive and support good growth of native jack pine. Because the orchard/tests are to serve a dual purpose, i.e., assessment of genotype performance and seed production, well-drained soils and medium- textured upper horizons were chosen as the best option.

The following guidelines were established as basic soil requirements for orchard/test sites: (a) a soil profile type which represents population to be tested and equally suitable for an intensive forest renewal program; (b) well-drained loam to clay loam with moderate fertility; (c) stoneless or least stoney as possible; and (d), a pH range 5 to 7.5 representative of tested population, slightly to moderately calcareous.

⁴Manitoba Soil Survey (unpublished map)

By extensive probing, and by digging a series of soil pits in areas with suitable physical aspects, site 2 was located. The soil profile is slightly less desirable, consisting of a medium-textured material in the upper horizon followed by finer-textured material in lower horizons. Soil drainage is not as good as in site 1. At least two soil pits were dug on each site as final confirmation.

The most representative soil profile of each orchard site is described by recording: horizon; depth; moist and dry colour; texture; mottles, if present; structure type; consistency; roots; ores; clay films; stones; horizon boundary; thickness range and reaction. Colour and consistency of dry horizons were recorded prior to crushing samples for analysis. Physical and chemical analysis of each soil horizon sample were performed by NoFC, Soil Service Laboratory. Site description, soil profile classification and description, including results of physical and chemical analysis, are presented in **Appendix 7.4.**

4. ORCHARD/TEST ESTABLISHMENT

4.1 Configuration

Both orchard/tests are relatively equal in area and number of seedlings planted, although they are of different configuration. Site # 1 is 230 m² and site # 2 is 180 m x 305 m. To minimize soil variation in orchards/tests, layout pattern was adjusted accordingly to minimize its effect on tree growth. The orchards have provisions for access around test blocks, a buffer zone between the fence and the fireguard right of way.

4.2 Clearing and Preparation

Initial site preparation began the latter part of March 1986, with snow partially receded, but while the ground was frozen. Tree diameters ranged from 5 to 60 cm in a semi- to fully-stocked stand of mixed wood *Populous tremuloides michx* (trembling aspen) and *Picea glauca* (white spruce). For best results and efficient use of equipment, standing trees were uprooted perpendicular to the desired direction of debris removal. For example, for rectangular sites, trees were uprooted along the long axis and the debris was removed perpendicular to the long axis.

The first step involved uprooting the standing trees with a bulldozer (D8) without turning up subsoil or breaking trees at the base. Good results were achieved by setting the blade approximately 90 cm above ground and maintaining the dozer blade at that level for most trees. The blade was gradually raised to approximately 100 cm above ground level when larger (over 25 cm) trees were encountered to facilitate up-rooting success. Nearly 99% of the trees were uprooted without breaking at the base and without turning up subsoil. Tree roots that occasionally split at the base, leaving major roots in the ground, were flagged and removed with a ripper tooth.

The second step involved removing all trees and debris off the site with a brush piler (D8) without removing any organic material off the site. This was accomplished by starting at the centerline and pushing all debris (uprooted trees and deadfalls) in a perpendicular direction to the first step. This process removed 95% of the debris; a final pass with an angled dozer resulted in a clean site.

During May 1986, a 4 wheel drive tractor (200 HP) with dual rubber tires was used to pull a 7 m wide, romex hinge offset agricultural disc implement to prepare the site by chopping the organic layer and any remaining roots. At least six passes were required to chop and break up the organic layer and roots to a depth of 15 cm. Roots, stumps, and stones were removed every two passes. The first three passes of discing were at a right angle to previous passes and the last three were at an angle of 45° to previous passes. This procedure, in conjunction with depth control, resulted in good mixing of organic material within the upper 15 cm of soil. This procedure prevented the valuable upper soil horizon from mixing with the heavy clay in the lower horizon. Final step of site preparation involved dragging a pad (of four logs each .3 x 7 m long) at 30° to direction of travel to crush some outstanding lumps (15-20 cm) and to level the site.

4.3 Layout

Prior to planting, an orchard/test layout was undertaken on each site to position six replicates, border tree space, fence zone and a fireguard right-of-way. The layout consists of two adjacent columns of 3 replicates, surrounded by a 6 m wide space for two rows of border trees (black spruce), which are spaced at 2 m intervals and a 4 m wide fence zone. In addition, this layout includes a 25 m wide right-of-way for a fireguard surrounding the fenceline (**Figures 6 and 10**). Permanent wire-looped pins (1000 mm long x 4 mm diameter) were inserted in the ground to mark all block corners. All other planting positions within the blocks were temporarily marked with colour-coded wire pins (300 mm long x 3 mm diameter, with looped tops) at one-metre square intervals. A numbered aluminum tag (6 mm in diameter) bearing replicate and block number was

mounted on the lower left corner of each block to identify the planting position of each seedlot source in each respective replicate (**Figures 8 and 12**).

4.4 Design

The design chosen for the orchard/test represents a compromise between short-term and long-term screening trials. Both orchard/test installations are designed to consist of six replicates on each site, with each replicate consisting of 32 blocks. In every replicate each block (6 x 8 tree seedlings) represents a seedlot from one of the 32 source stands with a minimum of a 4 m buffer space around each block. The 32 block design per replicate is organized on a permuted neighbourhood concept - where the positioning of stand population in the, test environment is never repeated or positioned closer than 3 block positions of each other anywhere within and among replicates (**Figures 7 and 11**). Also the stand arrangement in the replicate and among replicates is positioned at least 3 blocks from adjacent stands occurring on the geographic scene (**Figure 3**). This design is intended to distribute the test population uniformly throughout each of the two test sites in order to reduce the sampling error of the environmental interaction X genotype performance of the entire population in the test. Practical considerations were included in the design to accommodate such operational aspects as progressive thinning, operational breeding, maintenance and seed production.

4.5 Spacing

Tree spacing in the orchard/test, consists of one metre square among trees within a block (6 x 8) trees and 4 m between blocks, (**Figures 8 and 12**). A block represents a group of trees from one seedlot (stand). One metre square spacing among trees in the block will allow trees to grow for four years without competition. This spacing will allow each block of 48 trees to be divided into 12 plots of 4 trees each, to accommodate three culling phases. The first culling phase is 4 years after planting, just prior to crown

closure. The second culling phase is about 7 years after planting and a final culling phase takes place in 10 years after planting, which will leave 2 or 3 best trees remaining of an original 48 tree block.

4.6 Planting

After all the layout work was completed on both sites, all the seedlings were transported in an enclosed trailer, during the first week of July ,1986, to Clearwater Provincial Forest Nursery which is located within 22 km from Site 1. Planting stock was setout in a standard shade frame under direct sunlight for ease of watering and last application of fertilizer with a mechanical boom.

The final stage of marking all planting positions and spacing commenced with the assistance of an eight two-person crews who positioned marker pins as described previously in section 4.5. In preparation for planting, pre-numbered trays with seedlings were distributed with a trike and trailer, to appropriate positions, according to orchard design by matching a pre-numbered pair of trays to a numbered tag at each block. Each two-person crew was assigned a column of blocks to plant.

All planting crews were given a protocol to follow. Each assigned block of 48 seedlings was planted before the next block was assigned. One person dug holes while the second person planted 48 seedlings in random order from a pair of trays which contained 50 graded seedlings. When no accidents were encountered, two seedlings remained in the paired trays as spares. Planting holes (approximately 20 cm square x 15 cm deep) were dug with a square faced shovel, 20 cm wide. An elongated lump of soil was placed down the middle of the hole to form a crest on which the cleaved root cell was straddled (**Figure 5**). Site 1 was planted during July 9 through 17 and Site 2 was planted July 21 through 30. Average daytime temperature ranged 19° to 26°C.

4.7 Protection

Orchard site protection consists of fireguard, chain link fence, a body of water and an access road. The fireguard is a 25 m wide right-of-way perimeter which was cleared of trees and vegetation and scrubbed to mineral soil during site clearing. All debris from site clearing was disposed of by burning. A 180 cm-high chain link fence (5 cm x 5 cm mesh) consisting of 11 gauge wire mounted on metal post T rail, was installed during establishment. An access road is available to the sites and a source of slough/pit water is available within 300 m of the orchard sites for fire suppression.

5. DATA ACQUISITION AND APPLICATION

Prior to planting, seedling height and diameter were measured at random to establish baseline data, i. e., average height and diameter at planting (**Figure 2**). Performance data, such as height, diameter and possibly stem quality are scheduled to be collected in September, 1991. Culling format and data collection procedure will be prepared prior to field measurement. Subsequent data collection is scheduled for approximately 1993 and 1996. The scheduled data collection dates are based on projected growth rates for respective sites.

Random assessment of tree survival and growth after 4 seasons, during 1990, indicates survival remains unchanged at 99% and total height growth ranging between 1.4 and 2.0 m in both orchards. Stem growth trend appears normal. Approximately 1-2 % of terminals show evidence of terminal weevil attack.

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APPENDIX 7.1 - INFORMATION ON SEED ORIGIN BY STAND

Geographic Coordinates, Elevations and Physical Characteristics of the Northern Mass Tree Selection

Stand #	Latitude 00°00'	Longitude 00°00'	Elevation m	Twp.	Rge.	F.M.U.* #	Physical Characteristics
1	55 02	101 29	336	70	27	63	Fully stocked stand, average differential between selected trees and average stand quality.
2	55 06	101 09	336	70	25	63	Fully stocked and good quality stand. Above average differential among selected trees. Some evidence of self-pruning branches.
3	54 55	101 28	322	68	27	62	Fully stocked stand. Above average stand quality. Below average differential among selected trees. Some self-pruning characteristics.
4	54 49	101 29	348	67	27	62	Fully stocked stand. Average stand quality. Average differential among trees. Average branching angle.
5	54 39	101 30	305	65	27	62	Fully stocked stand. Wide range in stem qualities. Average to above average stem quality.
6	54 28	101 51	305	63	29	56	Moderate stocked stand. Wide range of stem qualities. Branching angle 90° to 60° range. Some cones have lodgepole pine features (barbed cones without any curvature).
7	54 29	101 40	305	63	28	56	Moderate to fully stocked stand. Excellent stem quality and good branching angle 90°. Self-pruning. Stems, needles, cones and some branches have appearance of lodgepole pine.
8	54 30	101 20	305	64	26	60	Moderate stocking open-grown stand. Wide range of stem qualities. Average to above average qualities.
9	54 26	101 21	305	63	26	60	Fully stocked stand. Excellent stand. Average differential range in stem, quality, and branching habit.
10	54 27	101 10	305	63	25	60	Fully stocked stand. Excellent quality stand. Above average stem quality. Good self-pruning characteristics displayed.
11	54 31	101 05	305	64	24	60	Fully stocked stand. Average stand quality and differential among trees.
12	54 32	101 00	305	64	24	60	Fully stocked and average stand quality. Wide range of stem qualities and branching habits.

* Forest Management Unit

APPENDIX 7.1 cont'd

Stand #	Latitude 00° 00'	Longitude 00° 00'	Elevation m	Twp.	Rge.	F.M.U.* #	Physical Characteristics
13	54 37	99 98	275	65	17	61	<p>Average stand quality. Wide range of stem and branching qualities. Some trees bearing cones with features of lodgepole pine. Branching angles of 90° were displayed on trees # 121-126.</p> <p>Trees # 127-130. Moderate stocking, below average stand. Many fine branches. Wide differential between branch angles and stems quality.</p>
14	54 31	99 44	275	64	16	54	Moderate to open-grown stand. Average stand quality. Wide differential in branch angle and stem quality.
15	54 17	101 49	275	61	29	56	<p>Trees # 141-156. Moderate stocked stand. Average to above average stems with fine branching. Some lodgepole-like cones.</p> <p>Trees # 147-150. Open grown stand. Wide differential range in stem quality and branching habit.</p>
16	54 19	101 24	305	61	27	56	Fully stocked stand. Excellent stand quality. Small differential among stem qualities. Average to above average height and diameter differences.
17	54 14	101 25	275	61	27	56	Fully stocked stand. Excellent quality stand. Very good to average stem quality. Wide range of branching habits displayed.
18	54 11	101 16	305	60	26	57	Below average stand. Wide differential range in stems and branching habits.
19	54 09	101 19	305	59	26	57	Moderate stocking. Average stand quality. Wide differential among stem and branching habits.
20	53 58	101 19	305	58	26	56	Open to moderate stocking. Average to above average quality stand. Some excellent quality stems and self-pruning branches.
21	53 33	101 23	305	53	27	52	Open to moderate stocking. Stem quality ranging from below to above average. Wide range of branching habit. High degree of budworm damage.
22	53 58	101 00	259	58	24	57	Fully stocked stand. Good differential between selected trees and average trees.

APPENDIX 7.1 - cont'd

Stand #	Latitude 00° 00'	Longitude 00° 00'	Elevation m	Twp.	Rge.	F.M.U.* #	Physical Characteristics
23	54 03	100 51	275	58	23	57	Moderate to fully stocked stand. Excellent tree stem quality. Self-pruning flat branches. Average stand differential.
24	53 57	100 58	259	57	24	55	Moderate stocked stand. Average stand differential. Flat branches.
25	53 51	100 53	259	56	24	55	Fully stocked stand. Average stand quality. Very small stand differential between selected trees and general stand quality.
26	53 43	100 26	259	54	21	53	Fully stocked stand. Average stand quality. Very small stand differential among trees.
627	54 00	100 03	270	58	18	53	Fully stocked stand. Very good stand quality. Very distinguishable differential between selected trees and general stand quality.
28	54 03	99 59	282	58	17	53	Fully stocked stand. Average stand quality with good stand differential between selected trees and average trees within stand.
29	54 12	99 47	305	60	16	53	Fully stocked stand. Excellent tree quality and large differential among trees in size and stem quality.
30	54 09	99 40	275	59	15	53	Fully stocked stand. Excellent stem quality, self-pruning branches. Large differential among trees in stem quality and size.
31	54 06	99 30	275	59	14	53	Moderate stocking. Average to very good stem quality. Large differential among trees in stem quality and size.
32	54 00	99 32	275	57	14	53	Fully stocked stand. Average stand quality. Very small differential among trees. Distorted tree tops (multiple upper crowns and disk shaped crowns).

APPENDIX 7.2 - SEEDLING REARING SCHEDULE FOR NORTHERN MASS SELECTION ORCHARD: GERMINATION TO PLANTING

Date 1986	Time (wks)	Temp. Day/Night	Light (HPS)hrs.	Growing media tests		Feed Schedule fert./irrig.	Cultural Practice
				Ec(ms/cm)	pH		
Jan 22-24					5.0	- saturate filled cavities with H ₂ O	- fill containers with peat (adjust pH to 5.0 with hort. grade lime - seed source lots 1-32, cover containers with polyethylene
27-30							
Feb 03-07	0	25°C	(0200-2000)				- remove polyethylene when radicle touch. Mist with H ₂ O @ 10,13,1500 hrs.
Feb 10-14	1	25°C	(0200-2000)			- thin crop to one seedling/cavity. - Fertilize	- establishment nutrient (115-15-77 ppm N-P-K) @ 1L/10 cavities (175cm ³). - growth development nutrient (229-29-154 ppm N-P-K + 5.5 ppm Fe) @ 1L/10 cavities (175 cm ³) total 3000 L.
17-21	2	25°C/20°C				- Weekly: ----->	
24-28	3					- Irrig - Mon	
						- Fert - Fri	
Mar 03-07	4						- manicure: remove needles 7cm up. - rotate crop on 10th weeks exponential root deve./shoot hardening nutrient - (45-99-165 ppm N-P-K + 5.5 ppm Fe) @ 3000 L/crop - apply benlate @ 1.2g/L H ₂ O - (81 application) - rotate crop on 14th week.
10-14	5			.280	5.0		
17-21	6				5.0		
24-28	7				5.1		
Apr 01-04	8			.290	5.1		
07-11	9	23°C/18°C		.330	5.1	- Weekly: ----->	
14-18	10				5.2	Irrig - Mon	
21-25	11			.360	5.2	Fert - Fri	
May 28-02	12				5.2		
05-09	13			.490	5.3		
12-16	14	20°C/5°C	Natural		5.3		
19-23	15		Daylight	.510	5.3		
25-30	16				5.4		
Jun 02-06	17	18°C/2-5°C		.600	5.4		- grade/cull crop from 34,868 to 22,400 and clear root cavity
09-13	18				5.4		
16-20	19			.560	5.5		
23-27	20				5.5		
Jul 03-05	22						- ship crop (in containers) to planting site

APPENDIX 7.3 - LANDSCAPE AND SOIL PROFILE DESCRIPTION

LANDSCAPE DESCRIPTION: SITE 1 - CRANBERRY PORTAGE

Date:	1985-9-20
Described by:	A.M. Nanka
Location:	Cranberry Portage
Vegetation:	Fully stocked stand: <i>Populus tremuloides</i> (aspen) 80%; <i>Picea glauca</i> (white spruce) 15%; <i>Picea mariana</i> (black spruce) 4%; <i>Betula papyrifera</i> (paper birch) 1%; <i>Alnus crispa</i> (green alder) moderate and <i>Salix</i> spp. (willow) sparse.
Elevation:	327 m
Parent Material:	Moderately calcareous, sandy loam to heavy clay (till)
Landform:	Morainal plain
Surface expression:	Very gently undulating
Estimated drainage:	Moderately well drained
Classification ⁵ :	Brunisolic Grey Luvisol
Association ⁶ :	Egg Lake series

⁵The System of Soil Classification for Canada (1974)

⁶Soil Map for Cormorant Lake sheet 63 K (unpublished)

SITE 1 - cont'd**SOIL PROFILE DESCRIPTION: SITE 1 - CRANBERRY PORTAGE**

L-H	12-0 cm; Black (10 YR 2/1,m), very dark grey (2.5 Y 3/0,d); semi-decomposed organic matter; abundant, fine to coarse roots; clear wavy boundary, 7-12 cm thick.
Bm	0-8 cm; brown (10 YR 5/3,m), pale brown (10 YR 6/3,d); sandy loam; single grain sand and gravel; structureless; very friable when moist:very soft when dry; abundant, fine to coarse roots; gradual boundary, 8-12 cm thick.
llAe	8-30 cm; dark greyish brown (10 YR 4/2,m) greyish brown (10 YR 5/2,d); clay; weak coarse and fine subangular blocky; plastic when moist, hard when dry; friable; common, fine roots; abrupt irregular boundary, 8-24 cm thick.
llBt	30-40 cm; dark greyish brown (10 YR 4/2,m) brown (10 YR 5/3,d); clay; strong, fine to moderate subangular blocky; numerous and continuous clay skins; sticky when moist, firm when dry; common, fine roots; irregular boundary, 10-15 cm thick.
BC	40-64 cm; dark greyish brown (10 YR 4/2,m) greyish brown (10 YR 5/2,d); clay loam; & massive; friable when moist, hard when dry; few fine roots; discontinuous boundary, 20-25 cm thick.
llCK1	64-80 cm; dark greyish brown (2.5 Y 4/2,m) greyish brown (2.5 Y 5/2,d); clay; fine massive; firm plastic and sticky when moist, very hard when dry; few fine roots; clear wavy boundary; occasional stone.
llCK	80-120 cm; greyish brown (2.5 Y 5/2,m) clay loam; medium platy; stratified horizontal cleavage lines; firm when moist, hard when dry; occasional root in upper part of horizon; calcareous.

Colour : m = moist, d = dry

APPENDIX 7.3 - LANDSCAPE AND SOIL PROFILE DESCRIPTION

LANDSCAPE DESCRIPTION: - SITE 2 - ROOT LAKE

Date:	1985-89
Described by:	A.M. Nanka
Location:	Root Lake East
Vegetation:	Fully stocked stand: <i>Populus tremuloides michx</i> (aspen) 35%; <i>Pinus banksiana lamb</i> (jack pine) 25%; <i>Picea glauca moench</i> (white spruce) 20%; <i>Picea mariana (Mill.)</i> (black spruce) 20%; <i>Salix amygdaloides Anderss</i> (willow) sparse; and <i>Alnus rugosa (Du Roi)</i> (grey alder) very sparse.
Elevation:	344 m
Parent Material:	Calcareous, loamy till
Landform:	Morainal plain
Surface expression:	Very gently undulating: site nearly level
Estimated drainage:	Moderately well drained
Classification ⁵ :	Degraded Eutric Brunisolic
Association ⁶ :	Atikameg Series

⁵The System of Soil Classification for Canada (1974)

⁶Soil Map for Cormorant Lake sheet K 63 (unpublished information)

SITE 2 - cont'd**Soil Profile Description : SITE 2 - ROOT LAKE**

- L-H 8-0 cm; Black (2.5 Y 2/0,m), very dark grey (2.5 Y 3/0,d); semi-decomposed organic; abundant, fine and medium roots; clear, wavy boundary, 5-12 cm thick.
- Ae 0-15 cm; Greyish brown (2.5 Y 5/2,m), light brownish grey (2.5 Y 6/2,d); sandy loam; medium subangular blocky; very friable when moist, friable when dry; plentiful fine roots; common; wavy boundary, 10-15 cm thick.
- Bt1 15-25 cm; greyish brown (2.5 Y 5/2,m), light brownish grey (2.5 Y 6/2,d); clay; weak, fine subangular blocky; friable when moist, hard when dry; fine and medium roots; common; wavy boundary, 10-14 cm thick.
- Bt2 25-36 cm; dark greyish brown (2.5 Y 4/2,m), greyish brown (2.5 Y 5/2,d); clay; strong medium subangular blocky; friable when moist, hard when dry; few, fine roots; wavy boundary, 5-18 cm thick.
- CK1 36-70 cm; greyish brown (2.5 Y 5/2,m), light brownish grey (2.5 Y 6/2,d); clay; weak fine subangular blocky; friable when moist, hard when dry; fragments of dolomite; very few fine roots between 36 and 50 cm; smooth boundary, 12-16 cm thick.
- CKII 70-102 cm; light brownish grey (2.5 Y 6.2,m & d); clay; fine massive; friable when moist, very hard when dry; few pores many fragments of dolomite reacts very slowly with acid.

Colour : m = moist, d = dry

APPENDIX 7.4 - PHYSICAL AND CHEMICAL ANALYSIS OF SOIL HORIZON SAMPLES

Depth		distribution, %			Texture	CaCo ₃	pH	Organic Matter	Ca	K	P
Hor.	cm.	Sand	Silt	Clay	Class	%		%	ppm	ppm	ppm
Site 1 - Brunisolic Grey Luvisol											
L-H	12-0					0	6.4	42.3	4320	595	67
Bm	0-8	78	10	12	SL	0	6.4	0.8	820	66	2
IIAe	8-30	18	14	68	HC	0	5.8	1.3	4240	232	1
IIBt	30-40	16	8	76	HC	0	6.0	0.9	4440	222	4
BC	40-64	44	20	36	CL	0	6.2	0.4	2100	91	1
IICK1	64-80	16	20	64	HC	0	7.2	0.7	4280	175	0
Site 2 - Orthic Grey Luvisol											
L-H	8-0					0	5.1	53.8	5420	510	18
Ae	0-15	52	28	20	SL	0	5.9	1.3	785	106	3
Bt1	15-25	16	22	62	HC	0	6.3	1.1	7640	265	5
Bt2	25-36	14	22	64	HC	0	6.8	0.9	4120	307	3
CK1	36-70	6	22	72	HC	L	7.8	0.7	4320	222	2
CKII	70-102	4	22	74	HC	L	8.2	0.3	5880	202	1

Legend:

L: Low
SL: Sandy loam
CL: Clay loam
HC: Heavy clay

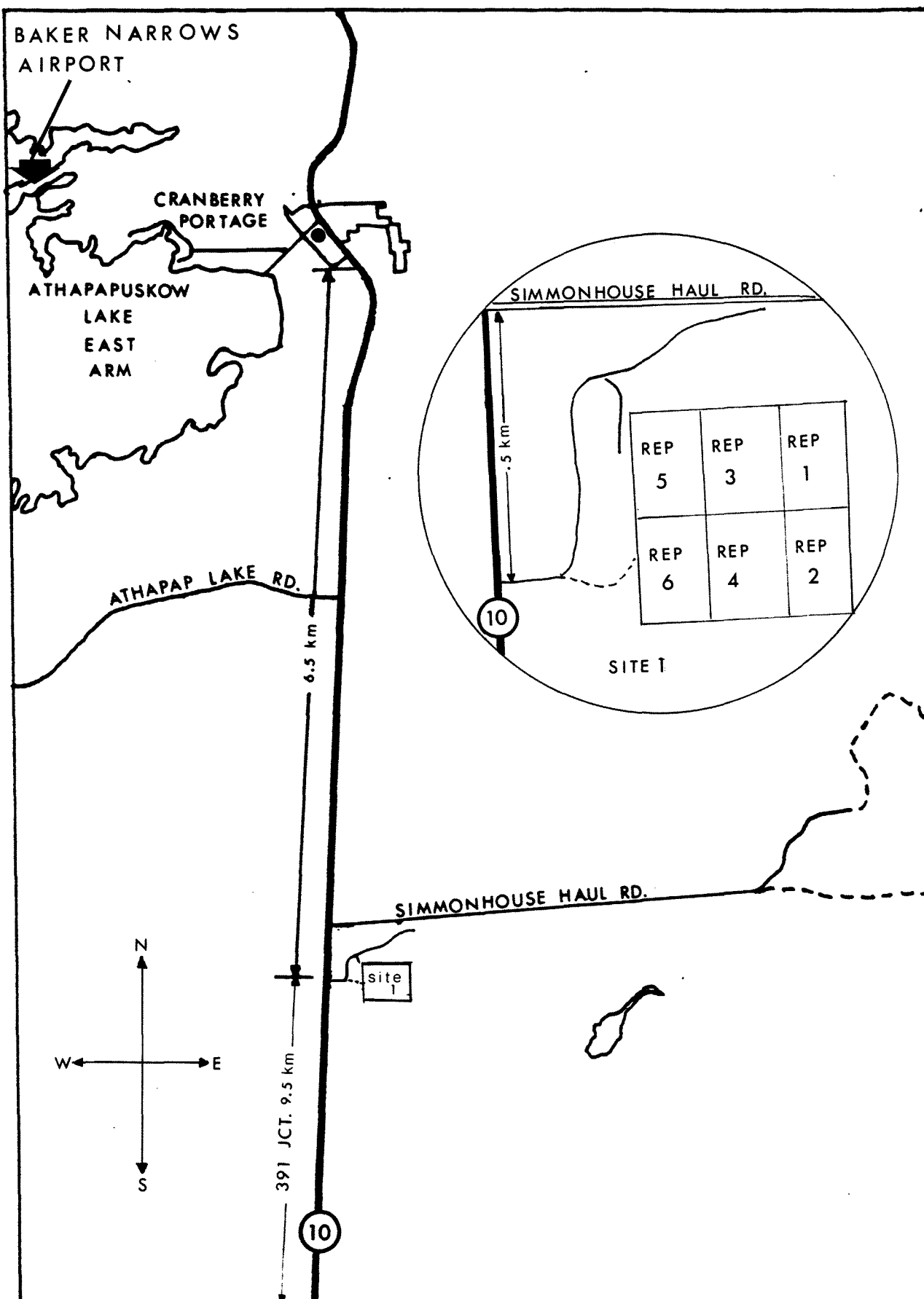


Figure 6. Road map to Cranberry Portage orchard/test, site 1.

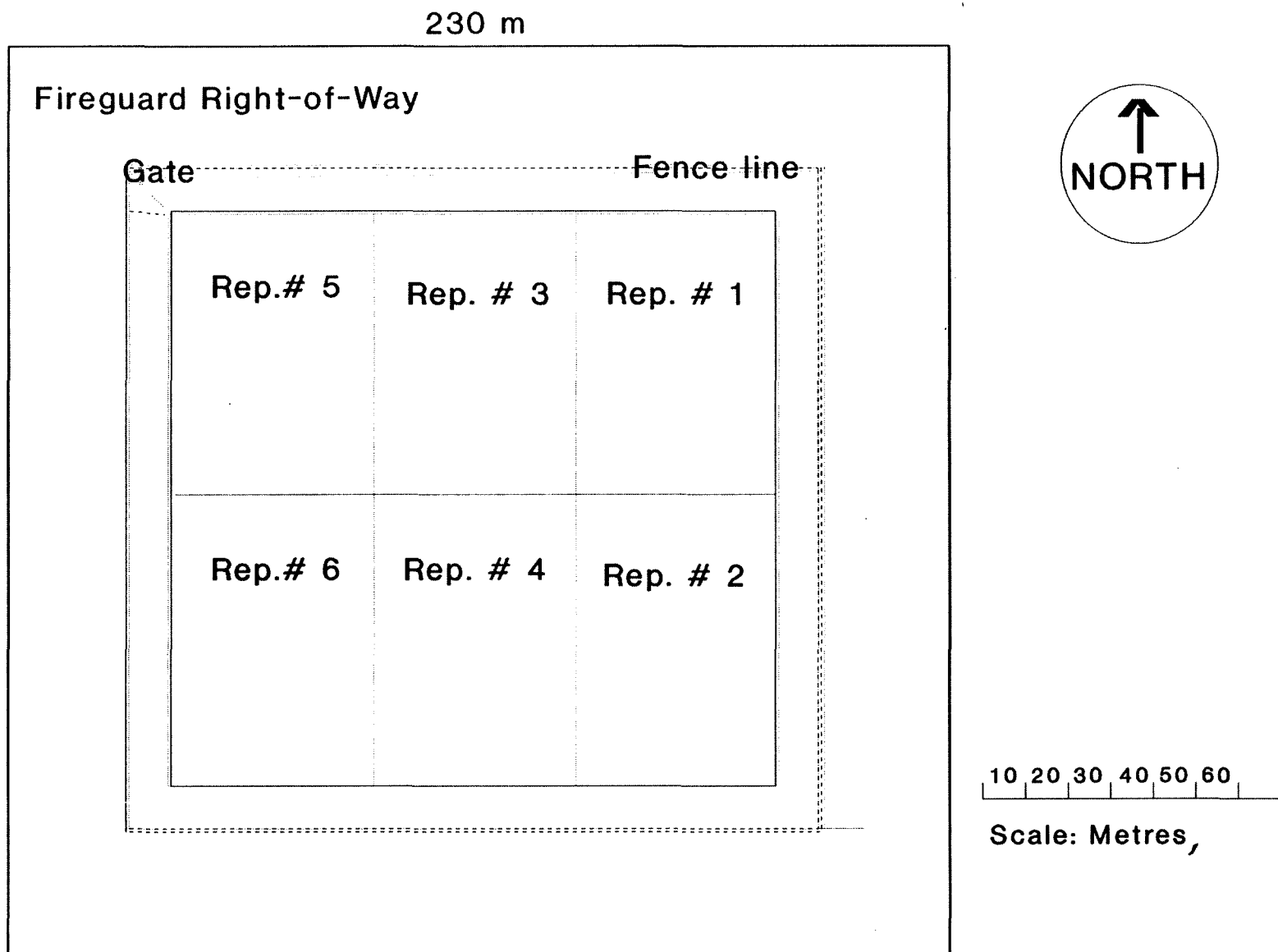
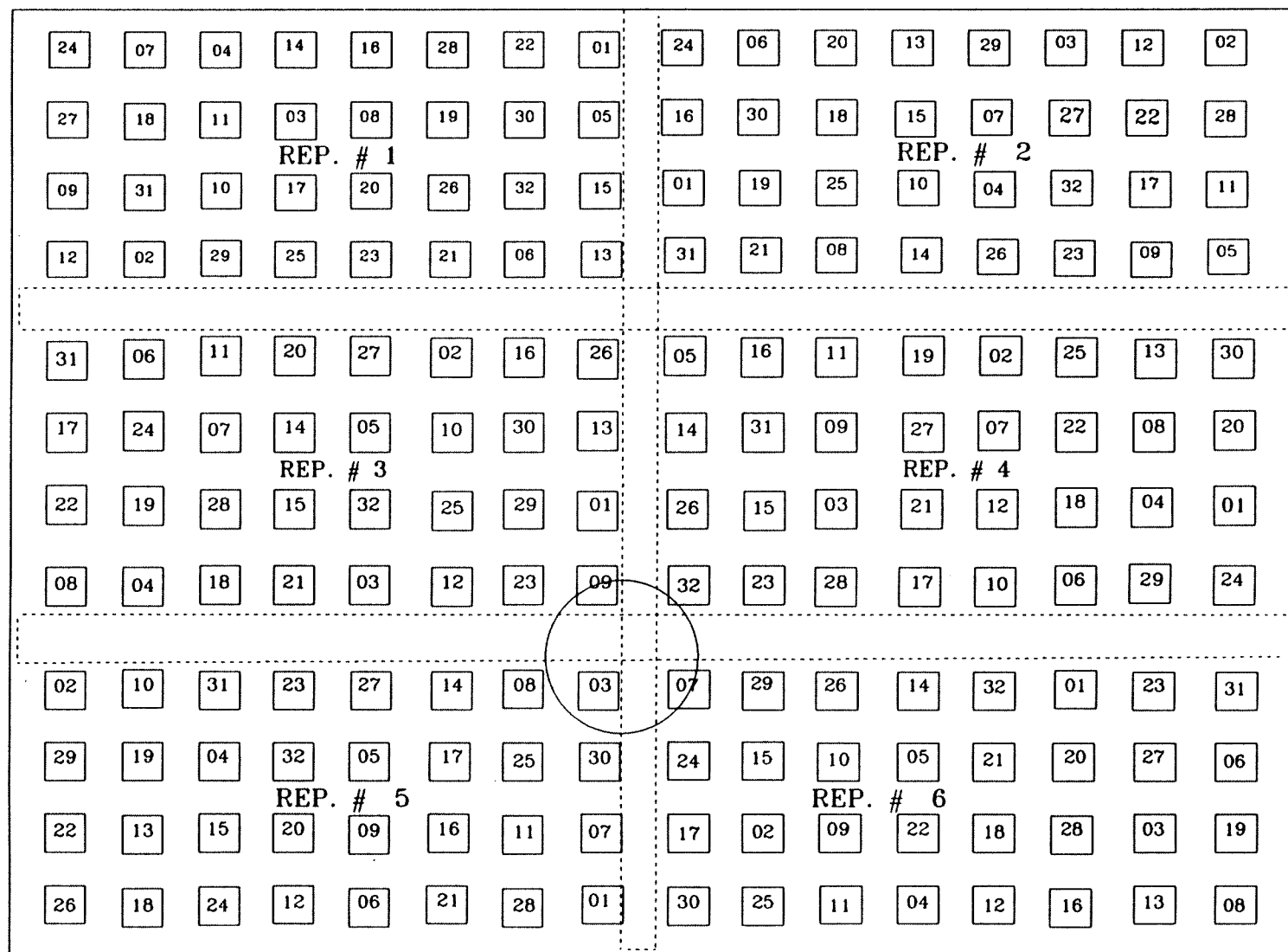


Figure 7. Replicate order 1-6, Cranberry Portage orchard/test, site 1.



SEE ENLARGED INSERT IN FIGURE 9 (next page)

← NORTH

Figure 8. Design and block sequence for replicate 1-6, Cranberry Portage orchard, site 1.

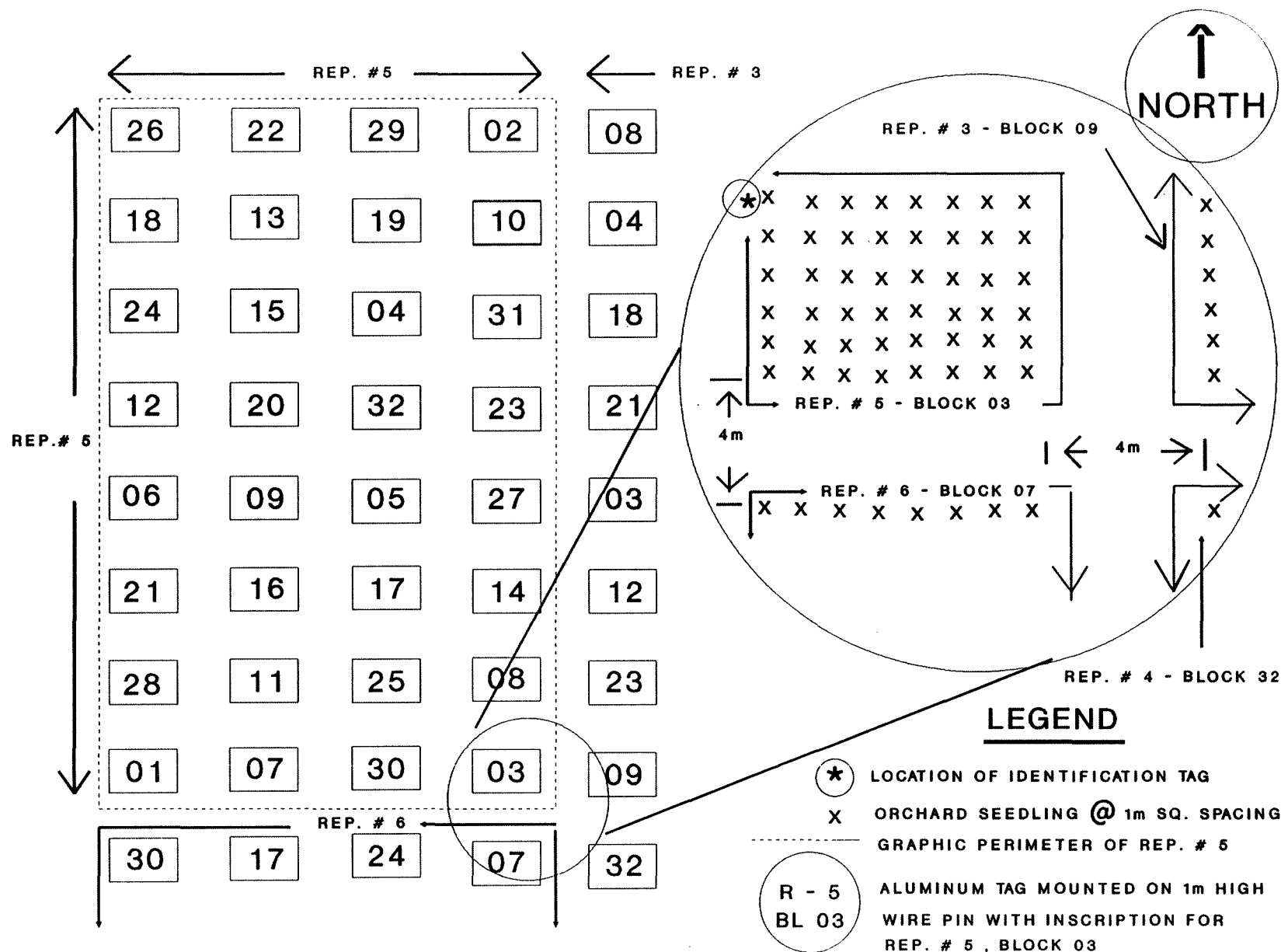


Figure 9. Block layout and tree spacing, replicate 1 - 6, Cranberry Portage orchard/test, site 1.

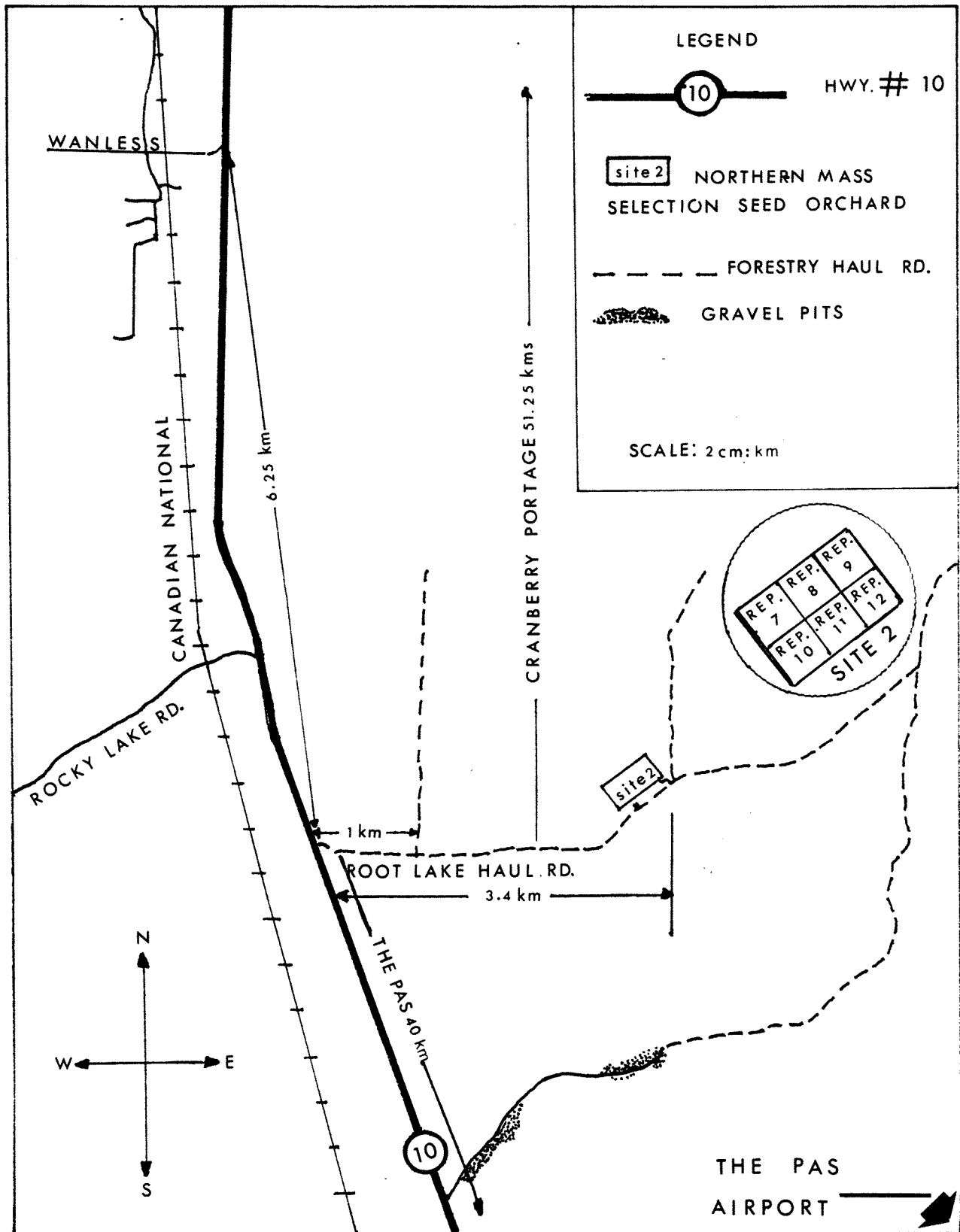


Figure 10. Road map to Root Lake orchard/test, site 2.

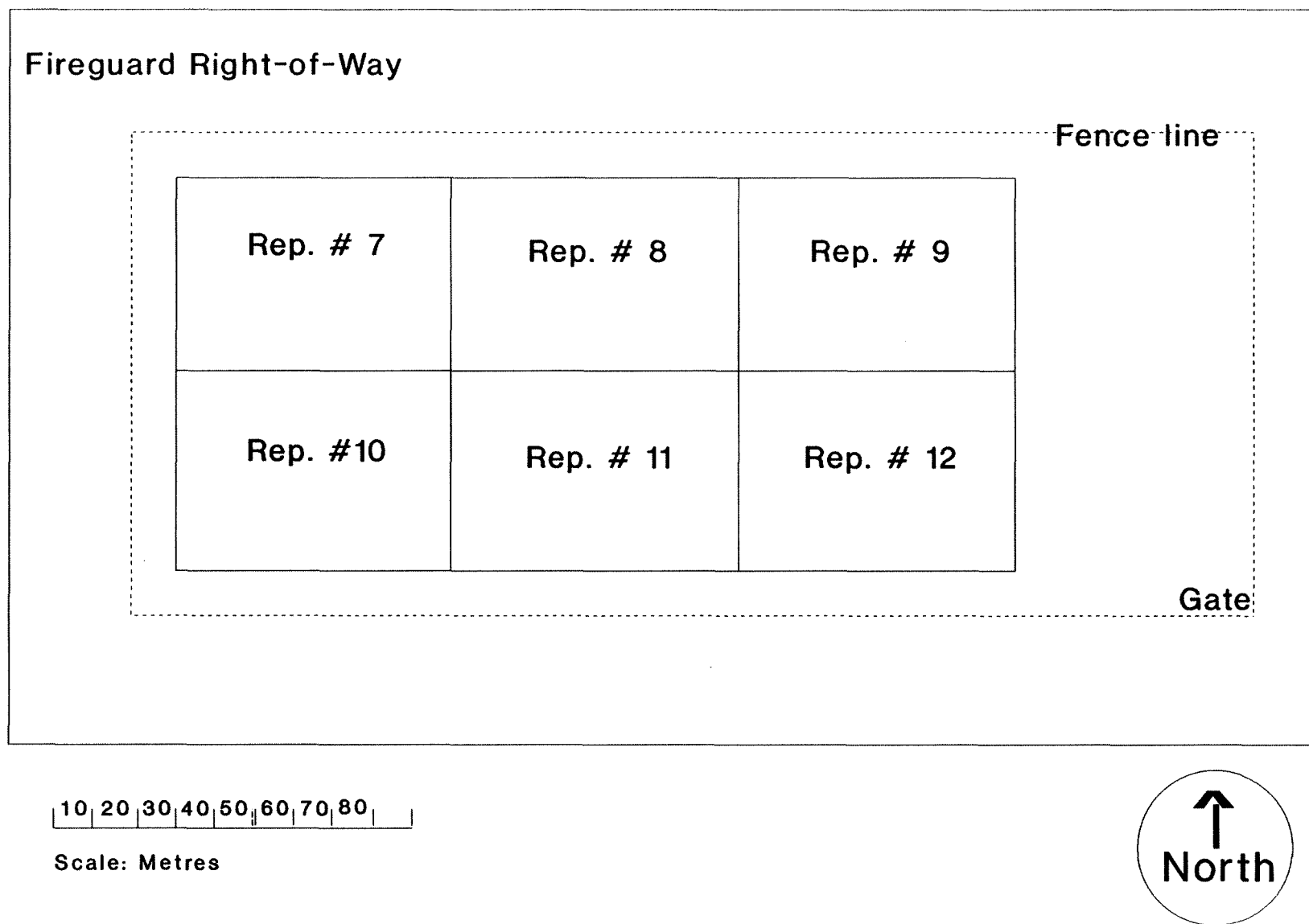
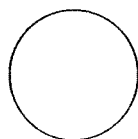
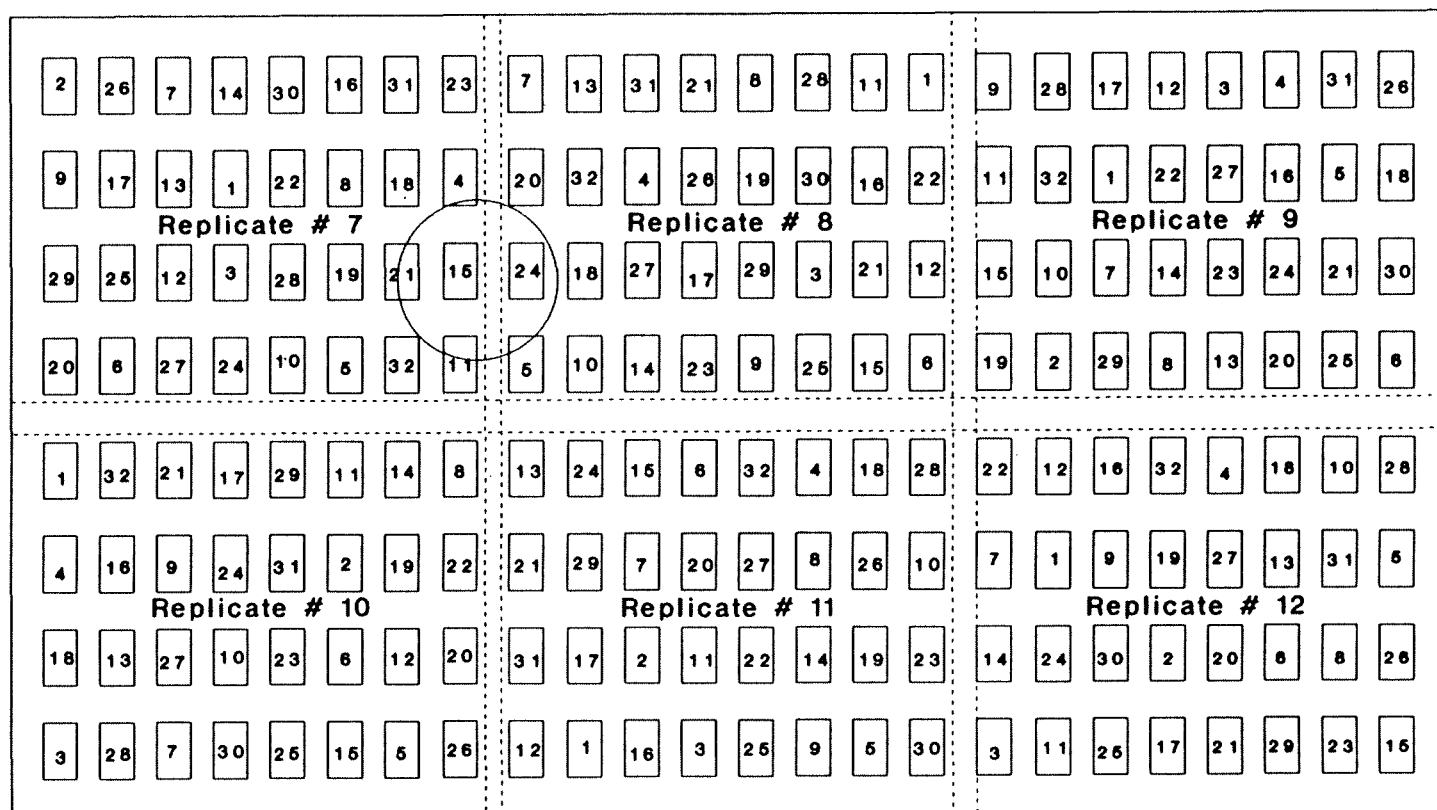


Figure 11. Replicate order 7-12, Root Lake orchard/test, site 2.



SEE ENLARGED INSERT IN FIGURE 13 (next page)



Figure 12. Design and block sequence for replicate 7-12, Root Lake orchard/test, site 2.

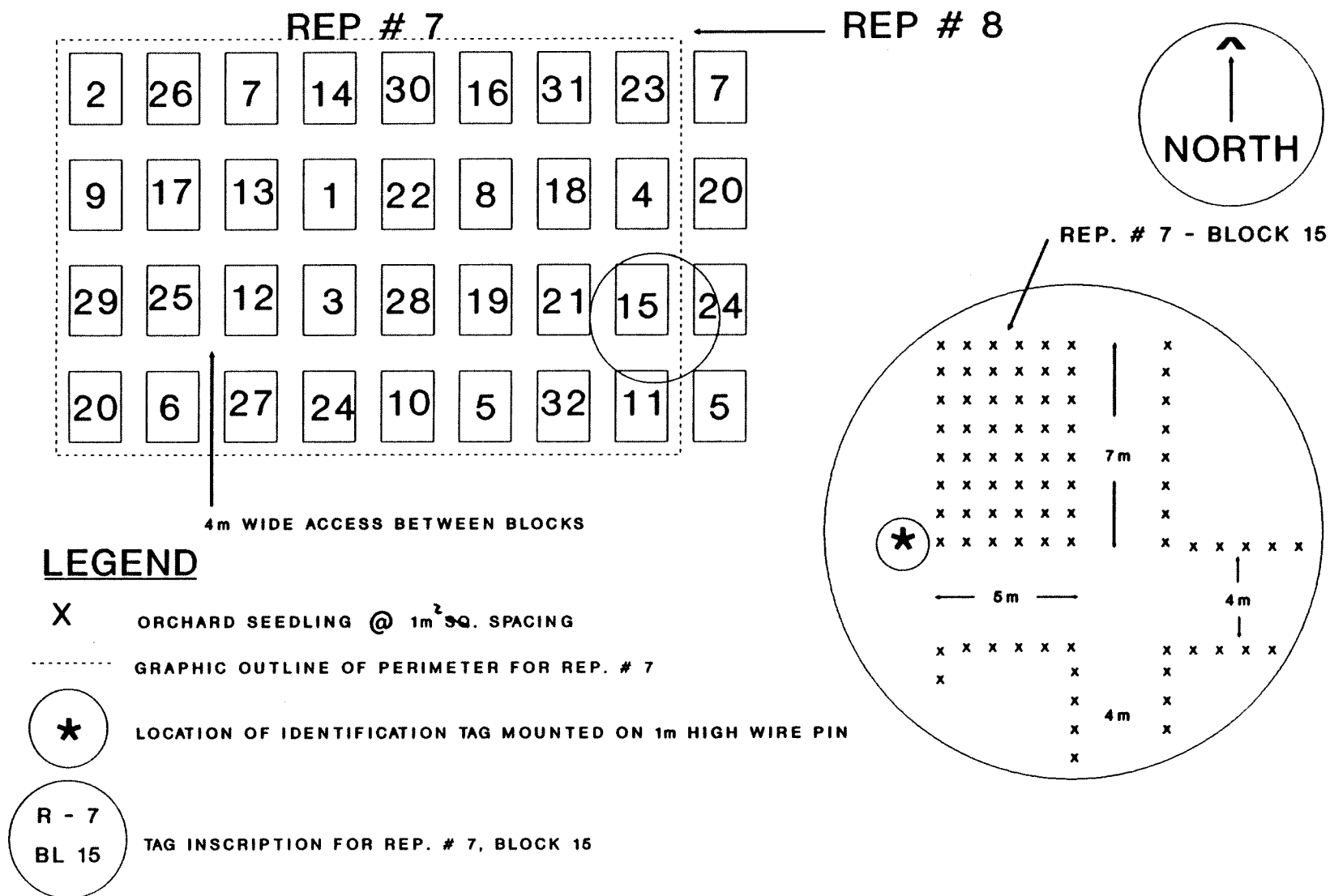


Figure 13. Block layout and tree spacing for replicate 7 - 12, Root Lake orchard/test, site 2.

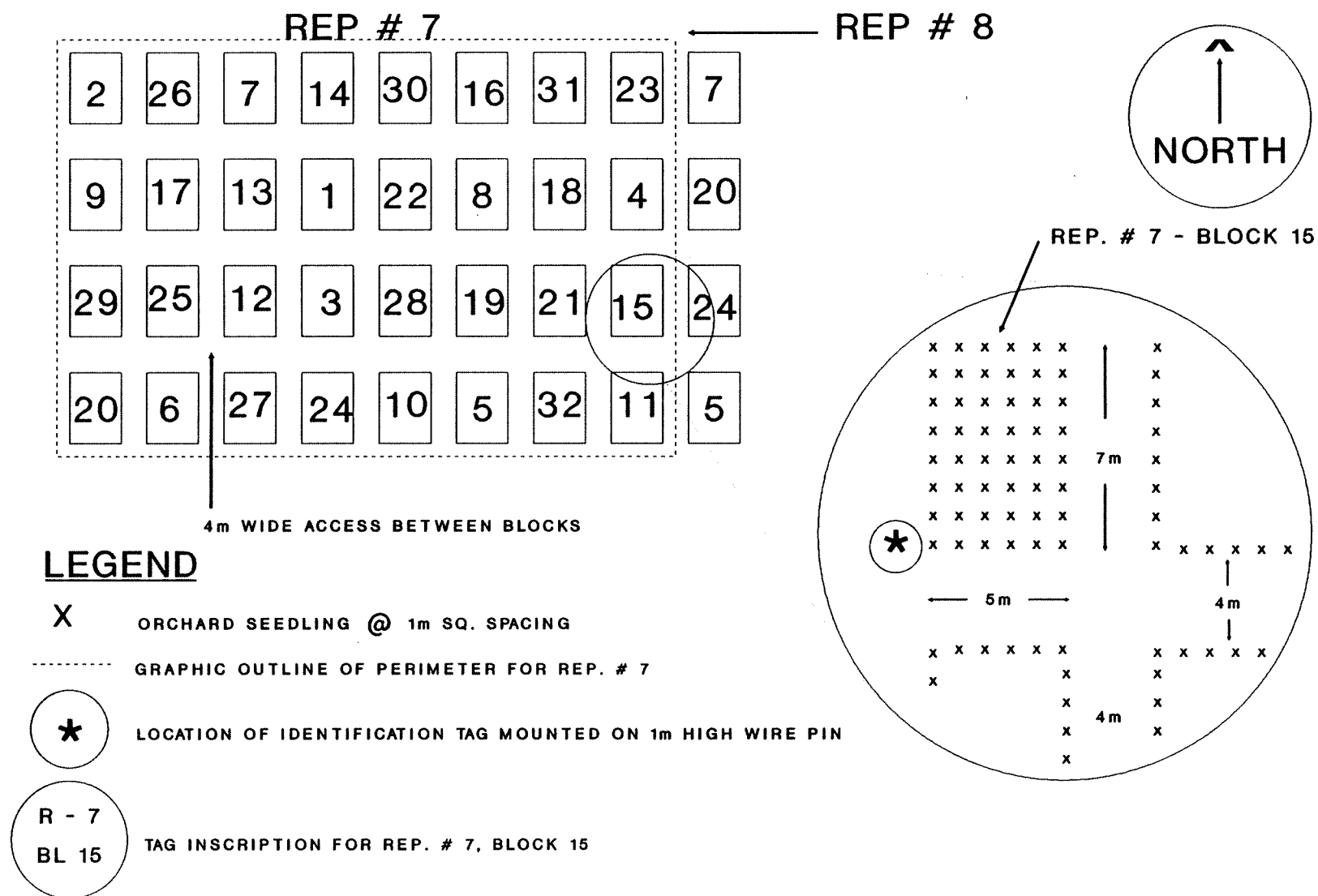


Figure 13. Block layout and tree spacing for replicate 7 - 12, Root Lake orchard/test, site 2.