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Issued July, 1913

YALE UNIVERSITY  
YALE FOREST SCHOOL—Bulletin 3

A WORKING PLAN FOR THE  
WOODLANDS OF THE NEW HAVEN  
WATER COMPANY

PREPARED AFTER FIVE YEARS OF FOREST PRACTICE  
1908 TO 1912

By  
RALPH C. HAWLEY  
*Assistant Professor of Forestry*



New Haven  
Yale University Press  
1913

Monograph



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# A WORKING PLAN FOR THE WOODLANDS OF THE NEW HAVEN WATER COMPANY

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PREPARED AFTER FIVE YEARS OF FOREST PRACTICE  
1908 TO 1912

BY RALPH C. HAWLEY

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## INTRODUCTION

Soon after the establishment of the Yale Forest School in 1900, the necessity developed for finding forest lands near the city of New Haven upon which to conduct field work. It was found that many of the most accessible and best timbered tracts were owned by the New Haven Water Company. In 1901 arrangements were made whereby the wooded lands on a single tract owned by this Company of about 250 acres near the Maltby Lakes, were placed under the management of the Yale Forest School. In the autumn of 1907 the New Haven Water Company, largely through the interest of Hon. Eli Whitney and Mr. David Daggett, officers of the Company and both prominent Yale graduates, decided to practice forestry on their entire holdings of over 8,000 acres and appointed the writer as Forester.

This arrangement, which is still in force, has proved of mutual advantage to the Company and the School. The condition of the woodlands has improved, open areas are being planted, expenditures have been more than offset by receipts, while eventually a large annual income will be received. The School utilizes these lands for purposes of field instruction. As the tract develops under proper treatment, its value for purposes of instruction will steadily increase.

Since the lands of the Company are used by the School for purposes of instruction, a written working plan is desirable.

The plan is divided into two parts: the first, descriptive of present conditions and past accomplishments; the second, treating of the policy to be pursued.

# PART I. DESCRIPTION OF THE PROPERTY

## LOCATION AND SIZE

The lands comprised in the holdings of the Company are adjacent to New Haven in New Haven County, Connecticut. They are not in one contiguous body, but (as shown on the map facing page 16) in many parcels, east, north and west of the city. It is evident that, while many isolated parcels\* occur, in the main the lands lie in a number of large blocks. The tracts nearest the city limits, namely, Wintergreen and Maltby, and a portion of Whitney, are less than five miles from the center of the city, while the Prospect tract, farthest away, is between thirteen and fourteen miles distant. All the lands are within a fourteen mile radius of the city, and about half are within a six mile radius.

The Company was organized in 1849 but has been most active in the purchase of lands in recent years. With rare exceptions the lands are on the watersheds of streams draining into storage reservoirs. In a country where the land is held in relatively small lots and usually is divided into farms, the acquisition of an unbroken tract is possible only as the result of much time and patient effort.

Eventually the consolidation of many of the scattered parcels with some of the larger blocks seems probable, since the holdings are being enlarged as favorable opportunities for purchase occur. Occasionally lands are sold because of their undesirable location with respect to reservoirs.

The exact total area owned is unknown, since the making of detailed maps has not kept up with the purchase of land. It is estimated, however, that the total area (exclusive of water surfaces) is between 8,500 and 9,000 acres. The area for which maps are available and which throughout this report will be referred to as the "total area" is 7,756 acres, divided between the different tracts as follows:

| TRACT†                     | AREA IN ACRES |
|----------------------------|---------------|
| East Wallingford . . . . . | 684.5         |
| Maltby . . . . .           | 1,099.5       |
| Saltonstall . . . . .      | 1,311.0       |
| Prospect . . . . .         | 293.5         |
| Whitney . . . . .          | 491.5         |
| West River . . . . .       | 3,421.5       |
| Wintergreen . . . . .      | 454.5         |
| Total . . . . .            | 7,756.0       |

\*Many of the smaller lots are not shown on this map.

†The names of these tracts are taken either from the name of the reservoirs which they protect, or from the name of the town in which they are located.



The working plan, while it relates particularly to these areas, can in its general provisions be applied equally well to the unmapped lands.

## PHYSIOGRAPHIC FEATURES

*Climate.* The average annual precipitation at New Haven for the last forty years has been 46.65 inches, with maximum and minimum of 60.26 and 34.83 inches, respectively. While the rainfall is ample for tree growth, droughts are likely to occur during the growing season and, while not protracted enough to seriously affect established forests, often cause considerable loss to reproduction and are especially disastrous to young plantations. During the past ten years, on the average, the latest killing frost in the spring has occurred on April 21 and the earliest in the autumn on October 13; hence a growing season of at least six months may be relied on.

*Topography.* The range in elevation above sea level is from about 20 feet to approximately 700 feet, although the greater part of the land lies between 100 and 500 feet, and on any given tract the range in relative elevation is small.

Underlying the region and influencing its topography are three general types of rock, namely, sandstone, granites and schists, and trap.

The sandstone, being the softest, has worn away most rapidly, and presents a rolling topography which makes logging easy. Only a relatively small portion of the tract is of this character. Granites and schists which underlie the greater portion of the area are responsible for considerable minor irregularities, such as small knolls, ridges or ledges rising abruptly to a height of from ten to fifty feet above the hollows. Such topography, although not rough enough to interfere seriously with logging, often makes it difficult to get wood down from the higher elevations. Trap occurs here in the form of intrusive dykes, sometimes rising over 200 feet above the surrounding country and frequently precipitous on the north and west sides. Such ridges form the most striking topographic features of the tract and offer the greatest difficulties to the removal of timber. There is less trap than either of the other two rock types.

*Drainage.* The general slope of the region is toward Long Island Sound. The lands are located on the watersheds of streams which, with one exception,\* drain southward into the Sound. Most of the streams converge as they approach the coast so as to pass

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\*Drainage from the Prospect tract goes northward.

either through the City of New Haven or nearby to the east or west. Thus the easy and natural outlet for forest products from most of the lands is toward New Haven.

*Soils.* The soils as well as the topography have an intimate relation with the underlying rock. Judged by their ability to produce crops of trees, a wide range of soils occurs, varying from those in swamps too wet to permit tree growth to others on rocky ledges too dry and shallow to produce anything but scattered, stunted trees. There is a wide range of more productive sites between these extremes. Practically no infertile, sandy lands occur, since all of the soils, regardless of the underlying rock, are fertile enough for tree growth. The poorest soils are on the trap ridges, but where of sufficient depth the trap soils are of excellent quality. The sandstone soils are the least stony. Most of the swamp land has granitic rock beneath it. In classifying lands according to their soil quality a separation into four classes was deemed sufficient, namely, into qualities I, II, III and swamp soils; quality I being the most, and quality III the least, productive of upland soils, while swamp includes all soils with an excessive amount of moisture.

## THE SOCIAL AND INDUSTRIAL SITUATION

One of the fundamental conditions for profitable forestry is a good local market. This condition is well met in the case of the Company's lands, for the region near New Haven is one of the most thickly settled in the United States. The city of New Haven has a population of over 133,000, while fully 300,000 people live within nine miles of some part of the holdings. Manufacturing is the principal industry, there being 500 manufacturing plants of various kinds in New Haven and the surrounding region. Even outside of New Haven the population is centered in towns and there are portions of the country very scantily populated.

Only a small proportion of the total population is engaged in agriculture, chiefly represented by market gardening, dairying and orcharding.

## CLASSIFICATION OF LANDS

According to the best available figures,\* 46 per cent of the area of New Haven County is forested. The balance, roughly 215,000 acres, is agricultural, or included in towns and cities,

\*Forest Survey of Litchfield and New Haven Counties, Conn.; Connecticut Agricultural Experiment Station, 1909.

water surfaces or salt marshes. Thus the Company's woodlands, though the largest single holding in the county, represent but a small part of the total forest in the region about New Haven.

An important step preliminary to the making of the working plan was the classification of the lands into various types. The accurate maps made by the Company's engineers, usually on the scale of 400 feet to the inch and divided into sheets of convenient size, were of great assistance in this work. In exceptional cases less accurate maps on a smaller scale had to be utilized. On these the types and age classes were shown.\* From these maps the areas were determined by means of the planimeter.

Seven types were recognized as shown in Table 1, the first three being wooded, the last three unwooded, and the old field partly wooded and partly open. Following the table are brief descriptions defining each. Fuller descriptions of the wooded and old field types will be found under "Forest Types."

TABLE 1.—AREAS BY TYPES.

| Type.               | Area in acres. |
|---------------------|----------------|
| Hardwood.....       | 3703.0         |
| Hemlock .....       | 132.0          |
| Pine.....           | 416.5          |
| Old field.....      | 2737.0         |
| Agricultural.....   | 712.0          |
| Administrative..... | 34.0           |
| Barren .....        | 21.5           |
| Total.....          | 7756.0         |

*Hardwood.* Comprises land occupied by hardwoods other than gray birch.

*Hemlock.* All stands containing 80 per cent or more (judged by the crown space occupied) of hemlock are included.

*Pine.* Includes all stands containing 80 per cent or more of pine.

*Old field.* This type contains both wooded and open land. The forest cover is usually broken and principally composed of red cedar and gray birch. Where open land is included it is of poorer quality than that classed as agricultural, and more suitable for growing forest crops. All formerly cultivated fields which are now lying idle and slowly reverting to forest are included. With

\*In securing data for the type and age class maps each stand was visited and a separate description made covering the following points: Type; Age; Area; Total volume; Forest; Soil; Annual growth; Past treatment; Recommended treatment.

These descriptions are recorded on 5 x 8 inch cards printed with the proper headings. Each card carries the description of a single stand or subcompartment. (See page 21.) The cards are placed in a filing case and serve as a card catalogue of the tract. Used in connection with the maps detailed information can be secured and work planned in the office for any portion.

the exception of a few isolated seedlings many of these fields are treeless.

*Agricultural.* Land suitable for cultivation or grazing is classified under this head. It is difficult to draw the line between agricultural land and open old fields, as the former, if neglected a few years, may become old field, while, on the other hand, certain old fields, if cared for, may develop an agricultural value. The distinction is based more on the present condition and probable use for the next few years than on the actual value of each site for producing farm or forest crops.

*Administrative.* Certain open areas, chiefly near the lakes, are included in this class, because of use in connection with the administration of the tract.

*Barren.* This includes a small amount of land useless for growing tree crops.

### FOREST TYPES

In general, the forest may be classed as young hardwoods composed of many evenaged stands. Of 4,251.5 acres completely forested, the hardwood type comprises 3,703 acres. The pine and hemlock types cover relatively small areas, 132 and 416.5 acres, respectively, and contain from 10 to 20 per cent of hardwoods. A large part of the stand occurring in the old field type is composed of gray birch and red cedar.

Table 2 shows the area in each age class and type and brings out clearly the fact that the forest is young. The range of age is from one year to over eighty years. The classification of the

TABLE 2.—AREA OF THE FOREST TYPES ACCORDING TO AGE CLASSES OR TO DENSITY OF STOCKING.

| Age in years.        | Hardwood acres. | Hemlock acres. | Pine acres. | Old Field acres. | Total acres. |
|----------------------|-----------------|----------------|-------------|------------------|--------------|
| 1-10                 | 1037.0          | —              | 382.5       | —                | 1419.5       |
| 11-20                | 757.5           | —              | —           | —                | 757.5        |
| 21-30                | 519.0           | —              | —           | —                | 519.0        |
| 31-40                | 563.0           | —              | —           | —                | 563.0        |
| 41-50                | 348.0           | —              | —           | —                | 348.0        |
| 51-60                | 303.5           | 1.0            | —           | —                | 304.5        |
| 61-70                | 113.5           | 122.5          | —           | —                | 236.0        |
| 71-80                | 29.0            | 6.5            | —           | —                | 35.5         |
| 81-up                | 32.5            | 2.0            | 34.0        | —                | 68.5         |
| Density of stocking. |                 |                |             |                  |              |
| .0 to .3             | —               | —              | —           | 1709.0           | 1709.0       |
| .4 to .6             | —               | —              | —           | 511.5            | 511.5        |
| .7 to 1.0            | —               | —              | —           | 516.5            | 516.5        |
| Total                | 3703.0          | 132.0          | 416.5       | 2737.0           | 6988.5       |

forest into age classes is a simple matter on account of the even-aged character of the stands. This results from the system of clear cutting which has prevailed in the past and is still followed. In the old field type trees of all ages may occur in the same stand and hence it was impossible to classify this type by age classes. A division into three classes was made, based on the extent to which the old field was stocked with trees.\*

The principal commercial species are chestnut and white, red, black and chestnut oaks. Further information regarding the composition and condition of the forest is presented separately for each type.

*Hardwood.* While the hardwood type is distinguished from the other types by being composed almost wholly of hardwoods, yet there are found great variations in its composition depending on the quality of the site. In the swamps, soft maple is the chief species, with elm, ash, whitewood and swamp white oak as its most frequent associates. Pure stands of soft maple are not uncommon. The condition of the stands on swamp land depends quite largely on the amount of moisture contained in the soil. Some of the swamps are so wet as to restrict the tree growth to scattered, stunted individuals, while in other less moist situations conditions are nearly as favorable for growth as on quality I sites.

On quality I sites chestnut predominates, with red oak second. Other oaks, hickory, ash, whitewood, black birch, soft maple, beech and hemlock are usually present. Ordinarily at least 60 per cent of the stand is chestnut, and frequently pure stands occur. On quality II sites chestnut is still an important species, but the oaks,—red, white, black and scarlet,—taken together, are fully as important. Very rarely is a pure chestnut stand found and often the percentage of chestnut is less than twenty-five. Five oaks, namely, chestnut, scarlet, black, red and white, occur, and with hickory form nearly the entire forest on quality III sites. Thus the forest on the three upland sites is composed principally of chestnut and oak, ranging through a great variation of mixtures to pure stands of either. On the poorest third quality sites stands from fifty to eighty years old are barely of merchantable size even for cordwood.

Of the stands in the hardwood type, 28 per cent are less than ten years of age, while only about 13 per cent are over fifty years old. Stands younger than fifty years rarely yield enough merchantable timber to be considered mature. The site must be quality I and the stand contain a large percentage of chestnut to be merchantable before the fiftieth year.

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\*That this division is virtually an age division is explained on page 13.

The areas in each age class are given in Table 2. In the majority of cases the stands are fully stocked. Injury by forest fires has resulted in opening up some stands and the effects of grazing can be seen in others. The severest injury has come from the chestnut blight. It is probable that not a single stand containing chestnut is free from the disease. In places the chestnut trees of all ages are dead or dying. The final result of the present attack can not be definitely foretold, but unless it is checked all the chestnut will likely be killed within a very few years. This will leave the stands which now contain chestnut in very poor condition. Should the sprouts from the stumps of the diseased trees also be infected, as now appears likely, the disappearance of chestnut as a commercial tree will result. Further consideration of this question will be found under "Methods of Cutting and Reproduction, Hardwood Type."

*Hemlock.* An area of only 132 acres, located mostly on steep northerly or easterly slopes or in sheltered ravines, is included in this type, of which 121 acres are on the Saltonstall tract. Hemlock forms over 80 per cent of the stand, the remainder being chestnut, chestnut oak and red oak. While the entire area is classified as over fifty years of age, still there is a great deal of reproduction, mainly young hemlock, wherever openings exist. The type as it occurs here is evenaged. All the stands in the type are fully stocked and of merchantable size. The trees, except the chestnut which is diseased, show very little injury of any sort.

*Pine.* Of the 416.5 acres in the type, 382.5 acres are plantations less than ten years of age and the remaining 34 acres are natural growth over eighty years old. With a few exceptions, white pine is the chief tree in all stands. Some Scotch pine and a little red pine have been planted.\* A few acres of European larch and Norway spruce plantations have been classified under the pine type to avoid making other types.

The natural growth of white pine occurs on the Salstonstall tract and is an open, irregular, merchantable stand with some hemlock and with an undergrowth of inferior hardwoods. Soil conditions are poor because of fires.

The plantations are not fully stocked. Approximately 200 acres which were planted in 1912 suffered a loss of about 50 per cent. All gaps will be filled and brought to a density of over 0.7. Scattered through the plantations are small groups of young hardwoods under which pines were not planted, so that the stands contain a small mixture of hardwoods.

*Old field.* All of the lands in this type were formerly cleared

\*See page 19 for a record of the plantations.

and used either for cultivation or pasture. When abandoned, the fields soon began to reseed with trees. Ordinarily the natural transformation of an open field into a fully stocked forest requires from 50 to 100 years. In exceptional cases it has been accomplished in less than ten years.

The first trees to start on an open field are usually red cedar and gray birch, but aspen, soft maple and black birch also appear. The seeds of these trees are readily disseminated over open fields by birds or the wind. Several years later the heavy seeded species, such as chestnut, oak and hickories, come in and as they are more tolerant of shade than the cedar, gray birch and aspen, they finally get possession of the ground and change the stand over to the hardwood type. In other words, the old field type is only temporary. Land in all stages of transition, from absolutely bare fields to fully stocked stands of cedar, gray birch, etc., with an understory of chestnut, oak and hickory is included in the old field type.

Since the seeding up of an old field ordinarily requires a long period of years the resulting stand is unevenaged in character.\* Hence this type can not be classified directly into stands of different ages. But since the density of stocking indicates in a general way the time since the field was abandoned this may be taken as a rough indication of the age of the stand.† Old fields have been separated into three classes based on the proportion of the area covered with trees. A stocking of 0 to 0.3 means that the field has less than one-third of its area covered with trees; 0.4 to 0.6, between one-third and two-thirds covered; and 0.7 to 1.0, between two-thirds and completely covered.

Old field stands are generally in healthy condition; but even the oldest contain little merchantable timber. Cedar fence posts are the most valuable product.

## PRESENT VOLUME

In connection with the mapping and classifying of the lands into types, an estimate was made of the wood and timber standing on the Company's land. This is expressed in cords since the greater part of the material is merchantable only for fuelwood. The figures are only approximate, because they were secured by ocular estimates of each stand, but they are sufficiently accurate for the purposes of the working plan and the management of the tract. The total volume is 34,140 cords.

\*Occasionally evenaged stands of birch or aspen result.

†What is wanted in this type is not so much the exact age of the trees in the stand as the extent to which the process of natural reseeding has progressed.

TABLE 3.—CONTENTS IN CORDS BY TYPES AND AGE CLASSES FOR EACH TRACT.

| Type.          | Age Class. | East Wallingford. | Maltby. | Prospect. | Saltonstall. | Whitney. | West River. | Wintergreen. | Total. | Total  |
|----------------|------------|-------------------|---------|-----------|--------------|----------|-------------|--------------|--------|--|
|                | Years.     | Cords.            | Cords.  | Cords.    | Cords.       | Cords.   | Cords.      | Cords.       | Cords. | Cords.   |
| Hardwood.....  | 1-10       | —                 | —       | —         | —            | —        | 30          | —            | 30     | 30<br>2360<br>3940<br>7760<br>5345<br>5325<br>2125<br>805<br>1005<br>28695 |
|                | 11-20      | 35                | 30      | 490       | 275          | 20       | 1380        | 130          | 30     |  |
|                | 21-30      | 70                | 590     | 840       | 610          | 130      | 1050        | 640          | 640    |  |
|                | 31-40      | 75                | 180     | 145       | 2960         | 180      | 3425        | 800          | 800    |  |
|                | 41-50      | —                 | 1345    | 190       | 555          | 535      | 2720        | —            | —      |  |
|                | 51-60      | 320               | 210     | 30        | 2050         | 140      | 2580        | —            | —      |  |
|                | 61-70      | 365               | 1430    | —         | 15           | 50       | 265         | —            | —      |  |
|                | 71-80      | 265               | 160     | —         | —            | —        | 350         | 30           | —      |  |
|                | 81-up      | 120               | 45      | —         | 300          | 40       | 500         | —            | —      |  |
| Hemlock.....   | 51-60      | —                 | —       | —         | —            | 20       | 5           | —            | 25     | 25<br>2130<br>240<br>95<br>2490  |
|                | 61-70      | —                 | —       | —         | 2070         | —        | 60          | —            | 60     |  |
|                | 71-80      | —                 | 60      | —         | —            | —        | 180         | —            | 180    |  |
|                | 81-up      | —                 | —       | —         | —            | 40       | 55          | —            | 95     |  |
| Pine.....      | 1-10       | —                 | —       | —         | 45           | —        | —           | —            | 45     | 45<br>550<br>595   |
|                | 81-up      | —                 | —       | —         | 550          | —        | —           | —            | 550    |  |
| Old field..... | 0 to 0.3   | —                 | —       | —         | 25           | —        | 75          | —            | 100    | 100<br>415<br>1845<br>2360   |
|                | 0.4 to 0.6 | —                 | 5       | 80        | 50           | —        | 280         | —            | 415    |  |
|                | 0.7 to 1.0 | —                 | 130     | 80        | 75           | 15       | 1545        | —            | 1845   |  |
| Total.....     |            | 1250              | 4185    | 1855      | 9580         | 1170     | 14500       | 1600         | —      | 34140  |



In Table 3 the contents in cords for the principal tracts are given by types and age classes.

Included in this estimate of 34,140 cords is considerable material of suitable size and quality for lumber. There is fully 4,250,000 board feet of such timber divided as follows:

|                     |           |             |
|---------------------|-----------|-------------|
| Hemlock . . . . .   | 1,000,000 | board feet. |
| Pine . . . . .      | 250,000   | “ “         |
| Hardwoods . . . . . | 3,000,000 | “ “         |

### GROWTH

A detailed study of the present rate of growth has not been made, but during the past few years figures have been secured on numerous cuttings which show the mean annual growth per acre under various conditions. The data obtained in this way have been verified by comparison with the yield tables in Bulletin 96 of the United States Forest Service, entitled "Sprout Hardwoods in Connecticut."

Table 4 gives the annual growth for the four forest types. The areas in each type are classified according to soil quality and the rate of growth in cords per area of each type and quality has been estimated.

TABLE 4.—MEAN ANNUAL GROWTH ACCORDING TO SOIL QUALITIES.

| Type.          | Quality. | Area.  | Annual growth per acre. | Total. |
|----------------|----------|--------|-------------------------|--------|
|                |          | Acres  | Cords.                  | Cords. |
| Hardwood.....  | I        | 660.0  | 1.0                     | 660    |
| " .....        | II       | 2587.0 | 0.6                     | 1552   |
| " .....        | III      | 400.0  | 0.3                     | 120    |
| " .....        | swamp    | 56.0   | 0.5                     | 28     |
| Old field..... | I        | 227.0  | 0.8                     | } 500* |
| " .....        | II       | 2487.0 | 0.5                     |        |
| " .....        | III      | 14.0   | 0.25                    |        |
| " .....        | swamp    | 9.0    | 0.4                     |        |
| Hemlock.....   | I        | 21.0   | 0.8                     | 17     |
| " .....        | II       | 46.0   | 0.5                     | 23     |
| " .....        | III      | 65.0   | 0.25                    | 16     |
| Pine.....      | I        | 137.0  | 1.00                    | 137    |
| " .....        | II       | 219.0  | 0.7                     | 153    |
| " .....        | III      | 60.5   | 0.4                     | 24     |
| Total.....     |          | 6988.5 |                         | 3230   |

The annual increment of 3,230 cords does not indicate the actual amount of wood available for cutting, since it is calculated for young as well as merchantable stands. As a rela-

\*Reduced due to incomplete stocking.

tively large part of the forest is under twenty years of age, most of the increment is on unmerchantable stands.

Decrease in the annual growth due to injury by the chestnut blight has not been considered in this estimate since the final effect of the disease is not known. Should the young chestnut sprouts be killed back repeatedly the annual growth may fall as low as 1,500 cords per annum.

### UTILIZATION

Forest products of all kinds find a ready market in New Haven and the surrounding country. The principal products sold at the present time are lumber, ties, poles and cordwood. The railroads and street railways afford a large and steady demand for ties, taking chestnut and all the oaks. Chestnut poles for trolley, telephone and telegraph lines ordinarily find a ready market. Thousands of cords of wood are burned annually at the brickyards in the Quinnipiac Valley and by the brass mills of the Naugatuck Valley. New Haven and the many smaller cities and towns nearby consume large quantities of fuelwood. Thus cordwood usually finds ready sale. The principal species sawn into lumber are chestnut, oak, hickory, whitewood and ash. The lumber is used locally by the numerous manufactories.

The timber is sawn mainly by portable mills cutting less than 10,000 board feet per day, although there are in the region a few stationary mills run by water power or steam. These portable mills can be easily moved into the relatively small patches of forest in which the merchantable timber ordinarily occurs. The work of cutting and hauling logs to the mills may proceed throughout the year. Much of the woods labor is recruited from farmers and men otherwise employed during the summer time. For this reason most of the logging is concentrated in the fall and winter months. After being sawn at the mills the lumber may be stacked near by for several months. No portions of the property are more than ten miles from railroads, while the average haul is under five. Owing to the good system of state and other public roads, timber is usually hauled by teams directly to the purchaser, instead of being shipped to them by rail.

Ties are either hewn in the woods or sawn at the mills and then delivered alongside railroad sidings or trolley lines. Poles are cut to order, peeled and hauled to pole yards in the cities or delivered at the holes in which they are to be set. Cordwood is cut into 5-foot lengths, piled and left in the woods for about a year to season. It is hauled directly to the brickyards, brass mills, city wood yards, etc.





WATERBURY

NAUGATUCK

BEACON FALLS

SEYMOUR

ANSONIA

DERBY

MALTBY

PROSPECT

CHESHIRE

WEST RIVER

MT. CARMEL

WINTERGREEN

NEW HAVEN

MAP  
SHOWING LOCATION  
OF  
LANDS OWNED  
BY THE  
NEW HAVEN WATER CO

COMPANY LANDS      TOWN AND CITIES



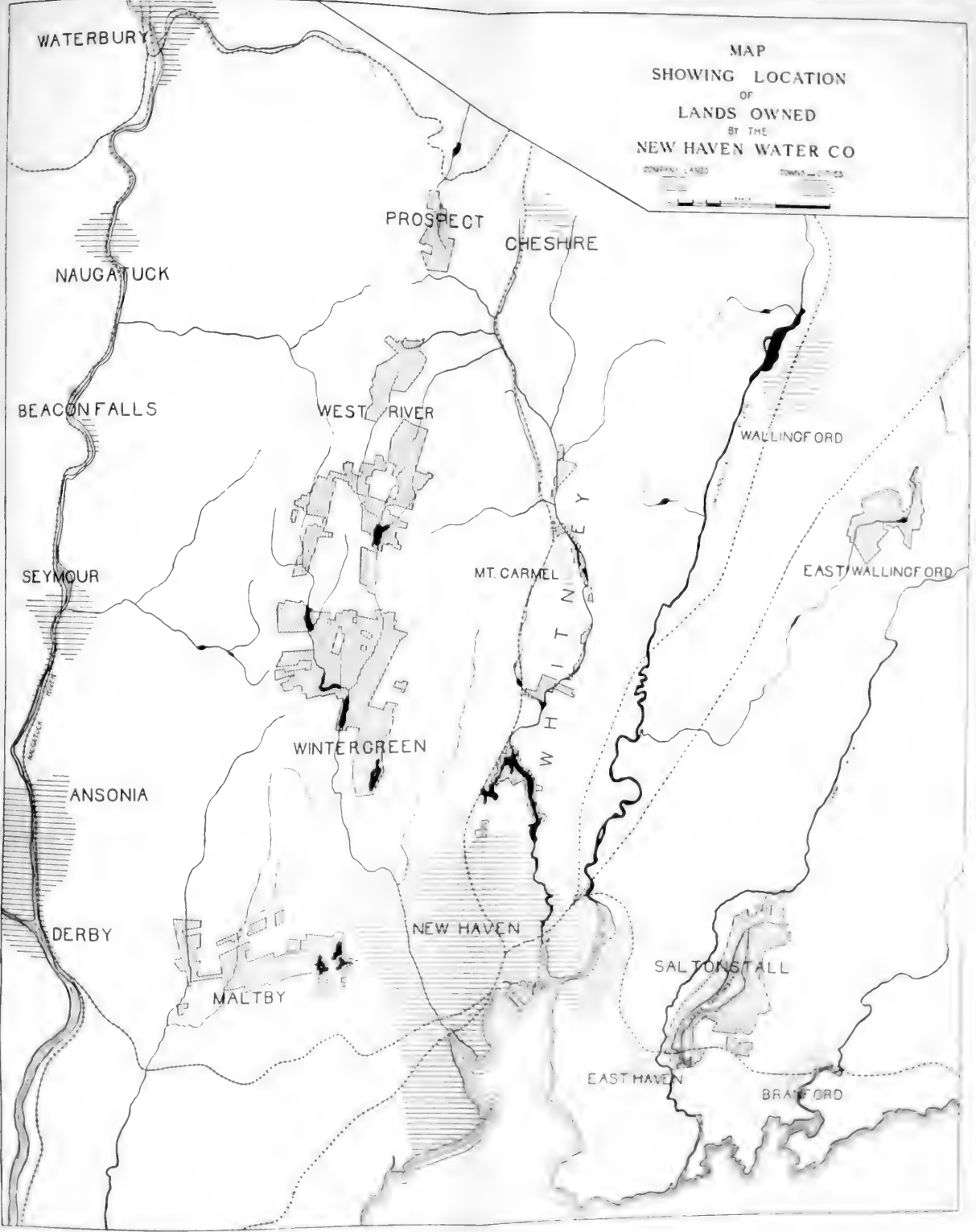
WALLINGFORD

EAST WALLINGFORD

SALTONSTALL

EAST HAVEN

BRADFORD





While all parts of the Company's lands are relatively near to market, yet the accessibility and hence the value of the wood on different portions varies widely. Local topography, by rendering it easy or difficult to bring the forest products out to the nearest road, may influence values fully as much as actual distance from market. Since standing wood and timber in this region is rarely sold by the unit, average stumpage prices are not readily obtained. In most cases a woodlot is sold for a lump sum, and often the owner has no accurate idea of what he received per unit of product. However, based on past sales from the Company's lands, the following figures are submitted which are as high as can be secured unless the owner does his own cutting and selling.

TABLE 5.—PRICES FOR WOOD AND TIMBER.

|  | Stumpage<br>Well<br>located. | Stumpage<br>Poorly<br>located. | Value delivered,<br>wholesale. |
|--|------------------------------|--------------------------------|--------------------------------|
| Cordwood.....  | \$ 1.50 per cord             | \$0.30 per cord                | \$3.75-\$5 per cord            |
| Ties:  |                              |                                |                                |
| No. 1.....   | \$ .45 apiece                | \$ .30 apiece                  | \$ .70 apiece                  |
| " 2.....   | .35 "                        | .20 "                          | .55 "                          |
| " 3.....   | .12 "                        | .00 "                          | .35 "                          |
| Poles (30- and 35-foot lengths<br>are most in demand): |                              |                                |                                |
| 30-foot.....   | \$ 1.75 apiece               | \$1.00 apiece                  | \$3.00 apiece                  |
| 35- ".....   | 2.25 "                       | 1.30 "                         | 4.00 "                         |
| Lumber:  |                              |                                |                                |
| Chestnut.....  | \$ 8.00 per M.               | \$5.00 per M.                  | \$20-25 per M.                 |
| Oak.....   | 10.00 " "                    | 5.00 " "                       | 20-35 " "                      |
| Hemlock.....   | 5.00 " "                     | 3.00 " "                       | 18 " "                         |
| Other species.....                                     | 6.00 " "                     | 4.00 " "                       | 18-25 " "                      |

## PAST OPERATIONS

*Cuttings.* Five kinds of cuttings have been made since the woodlands were placed under management, namely, cleanings, liberation cuttings, thinnings, damage cuttings and reproduction cuttings. Most of the cutting has been done in the hardwood type in which thinnings, damage cuttings and reproduction cuttings have been made. Approximately 150 acres have been thinned, 250 acres have received damage cuttings and 75 acres reproduction cuttings.

Thinnings are moderately heavy "C" grade and remove merchantable dead, suppressed,\* intermediate and a few co-dominant trees. This removes between 30 and 35 per cent of the total vol-

\*Frequently suppressed trees of tolerant species like beech and maple have been left as an understorey to improve soil conditions.

ume or from six to twelve cords of wood per acre. The product of the thinnings is suitable only for cordwood, except occasional chestnut fence posts. So far, thinnings have been made in stands thirty-five or more years old. In two or three instances a second thinning has been made from five to seven years after the first. The second thinning, "C" grade, removes from four to six cords per acre, or about 20 per cent of the total volume.

The wood removed in thinnings has been mainly cut at a stated price per cord, the rate varying from 90 cents for chestnut to \$1.25 for hickory; average \$1.00 per cord. It is doubtful whether these prices are any higher than if the stand were cut clear instead of being thinned.

Owing both to past mistreatment of certain stands and to injury wrought by the chestnut blight, damage cuttings have been and still are required. Fire-injured and stagheaded trees and all the diseased chestnut are taken out in the cuttings. Much of the material is suitable for ties, poles and lumber and is cut into these products instead of into posts and cordwood. A yield of from ten to fifteen cords per acre is usual, leaving from 30 to 60 per cent of the stand. The damage cuttings resemble first cuttings of the shelterwood system. Ordinarily oak predominates among the trees left standing.

Relatively few stands have received reproduction cuttings. There are, however, a few examples of first cuttings under the polewood sprout system where in stands from fifty to sixty years of age about 40 per cent of the volume has been removed in the form of a heavy thinning for the purpose of encouraging seedling reproduction of heavy-seeded hardwoods. Insufficient time has elapsed since the cuttings to determine the success of the method. More frequently mature stands have been cut clear and left to reproduce by sprouts. Since these stands ranged in age from 70 to 100 years, the sprout reproduction has been incomplete.

In the pine type only a little cutting has been done. A mature stand on the Saltonstall tract received a damage cutting in 1910, unhealthy and dying trees and merchantable dead trees being cut.

On the Maltby tract a few acres of young plantation were cleaned of the hardwood sprouts and seedlings which overtopped the pine. On about two acres of the same tract large hardwoods shading young pines have also been cut.

*Method of handling cuttings.* Where cordwood and posts only are secured in a cutting, the work has usually been done by the Company and the cordwood sold wholesale, piled in the woods. On the Maltby tract, where a small engine and cutoff saw are installed, the wood is sawn into short lengths and retailed to the



Company's employees. The Company uses all the chestnut posts in putting up boundary fences.

Where ties, poles or lumber are cut, the standing timber is sold either by the lot or at a unit price. Only rarely has lumber been sold at a unit price, since local lumbermen are unfamiliar with this method of sale. Ties frequently, and poles nearly always, are sold at a unit price.

In a few cases cordwood and timber have been sold to reliable purchasers on a basis of 60 per cent of the difference between the total expenses of manufacture and the total receipts from sales. By this arrangement the Company receives 60 per cent of the difference and the purchaser, who finances and attends to the entire operation, 40 per cent. The results so far have been fully as good financially as could have been secured through selling by any other method.

The total annual cut of all products, including lumber, ties, etc., figured entirely in cords for purposes of comparison, is as follows:

|      |   |   |   |   |   |       |        |
|------|---|---|---|---|---|-------|--------|
| 1908 | . | . | . | . | . | 1,300 | cords. |
| 1909 | . | . | . | . | . | 1,600 | "      |
| 1910 | . | . | . | . | . | 1,000 | "      |
| 1911 | . | . | . | . | . | 2,500 | "      |
| 1912 | . | . | . | . | . | 2,200 | "      |

*Planting.* Experimental plantings were made by the School on the Maltby tract from 1901 to 1905 and approximately forty acres were planted. The species used were white pine and Norway spruce, with a few European larch, red pine, Scotch pine, arborvitæ and hemlock. From 1909 to 1912 small plantations of white, red and Scotch pine were also made on the Whitney tract. From 1906 to 1908, inclusive, no planting was done.

In the spring of 1909 the Company planted 35,000 white pine transplants and five bushels of red oak acorns and in the spring of 1910, 40,000 white pine transplants. In 1911, about 9,000 red oak seedlings were planted on the slopes above Lake Dawson. In 1912, 233,000 transplants, mainly white pine with a few Scotch pine and Norway spruce, were planted on the Saltonstall, Maltby and Whitney tracts. The area of the plantations is given in the "1-10 year" age class of the pine type. (See Table 2, page 10.)

The last few seasons have been unfavorable for plantations and losses have been heavy. In the 1912 plantations the loss at the end of the first year was about 50 per cent, or approximately the average for the entire state.

A nursery was established on the Maltby tract in the spring of 1909 for producing the stock needed to plant the Company's open

lands. This nursery now has an area of one-half acre and is mainly used for growing seedlings to the age of two years, when they are transplanted and most of them placed in another nursery on the Whitney tract. The transplants are planted in the fields when three years old, though in some cases four-year-old plants have been used. The nurseries are now fully developed to the output desired, namely, a minimum of 240,000 transplants a year or enough to plant 200 acres.

Inventories under date of December 31, 1912, show the following number of plants on hand:

TABLE 6.—AMOUNT OF NURSERY STOCK ON HAND DECEMBER 31, 1912.

| Species.               | Seedlings. |         | Transplants. |        |
|------------------------|------------|---------|--------------|--------|
|                        | 1 year.    | 2 year  | 3 year       | 4 year |
| White Pine.....        | 360,000    | —       | 192,000      | —      |
| Red Pine.....          | 450,000    | 300,000 | —            | —      |
| Scotch Pine.....       | —          | 12,000  | 63,500       | —      |
| Western Yellow Pine... | —          | 6,500   | —            | —      |
| Norway Spruce.....     | —          | 3,000   | —            | 12,000 |
| European Larch.....    | —          | 9,500   | —            | —      |
| Totals.....            | 810,000    | 331,000 | 255,500      | 12,000 |

The transplants set out in 1912 were the first grown from seed in the Company's nurseries. The total cost was \$3.80 per thousand or \$4.60 per acre of plantation. Setting out the trees, 6 x 6 feet apart, or 1,210 plants per acre, cost \$7.20 per acre, thus making the total cost of the plantation \$11.80 per acre.

*Protection.* The main reliance in guarding against forest fires is patrol. No special men are employed for this purpose, since regular employees are assigned to each tract to keep the reservoirs and streams in proper condition and act as watchmen against trespassers and fires. Men are often detailed on Sundays and holidays during the dry season to watch particularly dangerous places. Their efficiency in extinguishing and guarding against fires is improving each year.

Chemical extinguishers with extra charges are distributed in convenient places on the various tracts. As yet, however, the supply is not as large as desirable.

Fire lines are used around some of the pine plantations, and also on the Wintergreen tract where there is great danger of fires being started by careless people. In the latter case several cleared lines which are burned over each year divide the tract into

sections within a single one of which a fire may be confined. Both burned and plowed lines are used around the plantations. With but few exceptions the forest is already well protected against grazing.

*Administration.* The Forester acts in an advisory capacity, recommending both the general policy and most details of the work. Actual operations in the field are in charge of the Company's superintendent, who accomplishes the work largely with the Company's regular employees, assigned temporarily as needed to forestry work. All the planting work and protection of the tract is thus handled. Most of the cordwood is cut by the Company, but a large share of the cuttings for products more valuable than cordwood is done by lumbermen who purchase the timber, and whose work is inspected by the Company.

*Receipts and expenditures.* The financial result of the work so far has been satisfactory, considering the condition of the tract, namely, that the forest is largely made up of young stands and that, therefore, the areas on which cuttings can now be made are small compared to the total size of the tract. A small surplus has resulted each year as shown in Table 7. Expressed as annual net returns per acre these figures are very low and indicate the present unsatisfactory condition of the forest.

TABLE 7.—RECEIPTS, EXPENDITURES AND SURPLUS, 1908 TO 1912.

|  | Receipts.  | Expenditures. | Surplus.   |
|--|------------|---------------|------------|
| 1908   | \$1,581.93 | \$1,490.24    | \$ 91.69   |
| 1909   | 5,406.56   | 2,355.22      | 3,051.34   |
| 1910   | 3,797.80   | 2,783.76      | 1,014.04   |
| 1911   | 2,335.62   | 1,965.74      | 369.88     |
| 1912   | 5,290.78   | 3,662.88      | 1,627.90   |
| Average annual surplus.....  |            |               | \$1,230.97 |
| Average annual net return per acre based on an estimated total area (excluding agricultural lands) of 8,000 acres..... |            |               | 0.155      |

*Management units.* For purposes of systematizing the management it is advisable to divide and subdivide the total area. The lands naturally group into several main tracts, each protecting the watershed of a given set of reservoirs. Seven such groups serving as main divisions are recognized, as follows: East Wallingford, Maltby, Prospect, Saltonstall, Whitney, West River and Wintergreen. Each tract is for convenience divided into smaller portions called compartments and each compartment into sub-

compartments. Boundaries of compartments are usually ridges, streams or public roads and are easily recognizable. Compartment divisions are permanent. A compartment may contain a number of different forest types and age classes. There are in all fifty-one compartments, ranging in size from less than 50 to over 400 acres.

Each compartment is divided into as many sub-compartments as it has individual stands, that is, portions of the forest differing in age or type. A single sub-compartment contains only one type and only one age class, and serves as the smallest unit considered. There are few sub-compartments of less than an acre, while the largest contain about 100 acres. Sub-compartment boundaries are often not marked on the ground, being distinguishable as lines of difference between types and age classes. These boundaries are subject to change with each revision of the maps. There are more than 700 sub-compartments.

## PART II. MANAGEMENT OF THE PROPERTY

### OBJECT OF MANAGEMENT

The chief interest of the Company is water, with forestry as a secondary consideration. Water companies depending upon the flow of streams are in a favorable position to practice forestry. It is necessary for them to own more or less land around their reservoirs and along the main streams. A forest cover on a watershed assists in keeping the water free from impurities. Much of the land, either from its topography or quality of soil, is incapable of producing farm crops, and forestry affords the only means whereby it can be made productive. The remainder, although fertile enough to be of agricultural value, is, for the most part, so located with respect to streams and reservoirs that it is inadvisable to farm on account of the danger of contaminating the water. Cultivation may be practiced provided no manure is used, but inasmuch as the fields deteriorate rapidly unless fertilized, it amounts to the same thing as forbidding cultivation.

A water company having an indeterminate existence is in a better position than a private owner to afford the present investment needed to protect and develop the forest until finally it becomes the source of an annual net income. The New Haven Water Company realizes that its lands can be made to grow tree crops without interfering with its main work. It desires to make this profitable financially and at the same time afford the maximum protection to the watersheds. This is the main purpose of the forest management.

While striving for the best financial results, effort is directed to developing the appearance of the forest from the æsthetic standpoint.

### SILVICULTURAL SYSTEMS

#### METHODS OF CUTTING AND REPRODUCTION

*Hardwood type.* Where this type is to be managed permanently for the production of hardwoods, the so-called "polewood sprout" method of reproduction is advised. Under this method

a heavy cutting, removing from 40 to 60 per cent of the stand, should be made from eight to fifteen years before the end of the rotation, to encourage seedling reproduction of species which do not sprout prolifically. At the end of the rotation the remainder of the stand is cut and the seedlings which started after the first cutting, together with sprouts, form the new stand. The "pole-wood sprout" method can be applied only to stands which do not need to be harvested for approximately ten years. Overmature stands which must be utilized at once are cut clear and reproduced by sprouts. This does not give a fully stocked stand, as many of the stumps fail to sprout. The open places should be planted.

Eventually it may be advisable to change the entire hardwood type into a pine forest. Whether this should be done will depend largely upon whether means are found for controlling the chestnut blight. Chestnut is now an abundant tree on the tract and is a rapid grower, hence if it becomes possible to grow it with a reasonable degree of safety, the hardwood type should be managed for chestnut. A final decision on this point should be postponed. With the chestnut eliminated from the hardwood forest, there are no species left which can approach the white and red pines in rate of growth and yield per acre. The oaks would be the principal trees left were the chestnut removed, and they are particularly susceptible to the attack of the gipsy moth. There is a possibility that this insect may spread throughout Connecticut and in that event it would be imperative to replace the hardwoods, especially the oak, with pine.

For the next few years cuttings in the hardwood type will be almost entirely of three classes: (1) Clear cutting of overmature stands; (2) damage cuttings to remove blight-injured chestnut; (3) thinnings in stands from thirty to fifty years of age, removing 25 to 40 per cent of the volume, for the purpose of increasing the rate of growth and utilizing trees which would otherwise be overtopped and killed.

*Hemlock type.* A large share of the hemlock forest grows on steep, rocky, thin-soiled slopes and ridges where it is essential that a forest cover be preserved. On such situations it is often difficult to re-establish the forest if once removed, since hemlock does not sprout. For these reasons stands of hemlock on slopes and ridges should never be cut clear, but only single individuals and groups of the larger trees removed at any one time. This will maintain an unevenaged stand and furnish the best possible protection to exposed sites.

In a few cases the hemlock type occurs on level or gentle sloping land. Here the mature stands, which are nearly evenaged, should

be cut clear and the area planted to pine. Hemlock is too slow-growing to be encouraged anywhere but on steep slopes, where its thick crown and habit of retaining live branches well down to the ground make it admirable as a protection forest.

*Pine type.* All stands but one in this type are ten years of age or younger. For this reason it is hardly necessary to decide on the method of reproduction to be used in the type as a whole. The one mature stand is open in character, but with such a thick undergrowth of shrubs and hardwoods that it will be difficult to secure natural reproduction. The stand should be left untouched for the next ten years to the end that reproduction may start beneath the hardwood undergrowth.

The young plantations, except those made in open fields, will require improvement cuttings to remove undesirable trees and shrubs that are overtopping and injuring the pine.

*Old field type.* The forest on old fields is too open and is composed either of such slow-growing trees as cedar, or such worthless trees as gray birch, that conversion into pine is desirable. On the old fields having a density of stocking of 0.6 or less the conversion can be accomplished by planting the openings. At the present time it is not advisable to plant old fields that have grown up thickly. These should be left until the stand becomes old enough to be cut for cordwood. A clear cutting can then be made and the area planted.

#### ROTATION AND EXPECTED YIELD

*Hardwood type.* A rotation of from sixty to eighty years with the average nearer the latter, will be needed in order to secure trees large enough for lumber. No reliable yield tables exist for mixed hardwood stands, but from the cut of numerous mature stands, it is believed that at eighty years not more than 20,000 board feet will be secured and ordinarily the yield will be much less.

*Hemlock type.* A rotation of from 80 to 100 years is advisable. Owing to the poor sites and to the fact that the type is managed as a protection forest, the yield will be low. No definite data are available to determine the amount.

*Pine type.* Yield tables for white pine are available and show that a rotation of about fifty years is at present the most profitable. In the yield table constructed by the New Hampshire Forestry Commission and published in their report for 1905-06, the following yields in board feet per acre are given for pine stands at fifty years of age:

|             |   |   |   |        |             |
|-------------|---|---|---|--------|-------------|
| Quality I   | . | . | . | 47,450 | board feet. |
| Quality II  | . | . | . | 37,800 | “ “         |
| Quality III | . | . | . | 27,650 | “ “         |

These figures are too high for use here since the climate is less favorable for white pine, but yields of 40,000, 30,000 and 20,000 board feet, on soil qualities I, II and III, respectively, are possible at fifty years.

#### REGULATION OF THE YIELD

For purposes of regulating the yield, the entire tract may be considered a unit on which it is desirable to have an annual yield rather than cuttings at periodic intervals. The annual growth amounts to 3,230 cords, but owing to the fact that the older age classes are deficient, it will be impossible to continue cutting the full growth. If the tract is to be put into normal condition much less than the growth should be cut for some time and the forest capital, that is, the growing stock, allowed to accumulate. As stated in Part I under the heading "Growth," injury by the chestnut blight may reduce the annual increment to 1,500 cords a year.

Unfortunately, the present situation is such that the annual yield cannot be brought down to a low figure for several years without allowing much timber to go to waste. It is imperative that diseased and dying chestnut be cut before it becomes unfit for use. For the next few years the amount of the annual cut will be fixed quite largely by this requirement. Outside of cuttings to remove damaged chestnut, thinnings to improve the rate of growth should be practically the only cuttings made for the next ten years. Not over 500 cords per year should be removed in these thinnings. The cuttings to remove damaged chestnut probably will not exceed 2,500 cords in any one year.

#### CUTTING POLICY

Within the next ten years the following cuttings should be made:

- (a) All stands over seventy years of age cut clear.
- (b) Damage cuttings in stands containing merchantable chestnut, removing this species.
- (c) Thinnings in all well-stocked stands from thirty to sixty years old.

The stands silviculturally most in need of attention should be treated first.



Where the products secured are cordwood and chestnut fence posts, the work will be done by the Company with men working either by the day (in exceptional cases), or at a fixed price per unit. All chestnut posts can be used by the Company in its own fences.

Where ties, poles and lumber as well as cordwood are cut, sales should continue to be made to local lumbermen. These sales may include the entire stand and be for a lump sum or any one of the three mentioned products may be sold separately and at unit prices. Ordinarily more can be secured for a given stand if the timber is sold at unit prices. Owing to the fact, however, that lumbermen object to buying in this way and that it is often troublesome to keep close track of the cutting and check the timber removed, it may be best in many cases to sell for a lump sum. The arrangement already tried of permitting a lumberman to cut and sell timber and pay for it on the basis of 60 per cent of the difference between receipts from sales and expenses of operation should be continued in certain instances. Eventually the Company may find it advisable, instead of selling the stumpage, to sell the products in manufactured form. At present, however, the annual operations are not extensive enough to make this profitable.

Trees to be removed in thinnings and damage cuttings are blazed at a convenient height from the ground. As the chopping proceeds, frequent inspections by the Company's foremen will insure that only marked trees are cut. In clear cuttings the boundaries of the area should be designated.

Except in rare cases the brush and tops will be left as they lie after cutting. It is considered unnecessary to dispose of them as an aid in protection, because the chief fire danger comes from the hardwood leaves spread in a comparatively uniform layer over the ground. A fire will start and spread readily in leaves, and tops only add to the intensity of the fire. Hardwood tops inside of two years partially decay and absorb so much moisture that they burn with difficulty. The brush should be piled and burned on clear cut areas which are to be immediately planted.

### PLANTING

Planting is done primarily to bring the open areas in the old field type into forest. Natural reproduction on these areas is slow and usually brings in slow-growing and worthless species. The old field type consists of 2,737 acres, of which approximately 800 are open. The cost, judging by past experience, will average \$12 to \$15 per acre for a completed plantation. It is advised that

200 acres a year be planted, requiring nine years to cover the present old field area. Inasmuch as it will undoubtedly be necessary to fill fail places in a portion of the plantations, probably over ten years will be needed to finish.

White and red pine are the two species advised for planting and are chosen for their commercial value, rapidity of growth, high yield per acre and, in case of the red pine, immunity from insects or fungous enemies. With the exception of the chestnut, whitewood and white ash, all the native hardwoods are slower growing than these pines. The blight makes the planting of chestnut inadvisable. Whitewood and white ash, especially the former, thrive only on fairly moist, or bottom land sites, which are comparatively infrequent. As a cover for city watersheds, conifers are to be preferred to hardwoods on lands near streams and reservoirs, because hardwood leaves blow into the water and often have to be removed.

Either of the pines can be planted on all well-drained sites, but not on soil saturated with water for the greater part of the growing season. Swamps present the greatest problem from the planting standpoint, since few commercial species thrive on wet ground and it is difficult to get them started. American arborvitæ is probably the best conifer that can be planted in the wet land. For the present the question of planting the swampy ground will be held open, attention being devoted to planting the far larger areas of upland.

The question of changing the hardwood type into a nearly pure stand of pine, with a mixture of hardwoods, will also be kept in abeyance until the old field type is planted. The change could be accomplished by setting out on clear-cut hardwood lands from 100 to 200 pines per acre in the openings between clumps of sprouts. The resulting stand could finally, under treatment, be made nearly pure pine. On the open fields the plants should be spaced 6 x 6 feet.

Three-year-old once-transplanted stock should be used. The work of growing the plants is now being carried on successfully by the Company and should be continued. The planting has been done by its men. It should be done in the early spring and rushed through before the weather becomes warm and dry. Unfortunately the demands for laying new water pipe are urgent at this season and it is difficult to obtain the necessary labor to do the planting promptly. The length of time required to finish planting in the spring of 1912 indicates that possibly, having part, at least, of the field planting done by contract may be as satisfactory as having it all done by the Company's employees. Either this plan

should be given a trial or an extra force employed for a few weeks during the planting season.

Fail places in the plantations made the preceding year should be filled each year if the loss exceeds 25 per cent, or in case of a smaller loss if in the form of a few relatively large patches instead of being scattered uniformly.

### PROTECTION

The system of protection against fires which has been used for the last few years (see page 20) should be continued. The plantations ought to be watched with special care and protected by fire lines as well as by patrol. More fire fighting tools, such as chemical extinguishers and bucket pumps, are needed. Those now available are distributed at the most important places, but more should be purchased and placed at advantageous points in plantations and other dangerous situations. One extinguisher or pump to every fifty acres of plantation would be good economy.

Certain stands in the old field and hardwood types are suffering from the grazing of cattle. In nearly all of these cases the land is owned by the Company but subject to life use or use for a period of years by the former owner. As these rights expire, grazing should be stopped except on lands better suited for grazing purposes than for growing trees. The two cannot be successfully practiced on the same area.

### ADMINISTRATION

The system of administration now in use and described on page 21 should remain in force.

### EXPECTED FINANCIAL RETURNS

Forestry should prove a better proposition financially for water companies than for most other land owners. This is mainly because the investment in land with interest and taxes cannot be justly charged against the forestry account. The land is held for protection and water conservation, and taxes and interest must be figured regardless of whether forestry is practiced or not.

Being relieved of these charges, which accumulate during the half century or more required to grow a tree crop, the returns eventually should be relatively high. European forests in rare cases yield as high as \$15 net profit per acre per annum and annual net returns of \$5 per acre are frequent. In the course

of time results comparable with this latter figure are anticipated from the tract, but for the present nothing of the sort is possible. It is expected that during the next ten years, while extensive planting is in progress, the expenditures can be a little more than covered by the receipts.

#### REVISION OF THE WORKING PLAN

The plan should be revised at the end of ten years from date of present working plan.







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