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URBAN FORESTRY IN TRAVERSE CITY, MICHIGAN:
STREET TREE INVENTORY RESULTS
AND MANAGEMENT RECOMMENDATIONS

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James Kielbaso
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URBAN FORESTRY IN TRAVERSE CITY, MICHIGAN:
STREET TREE INVENTORY RESULTS
AND MANAGEMENT RECOMMENDATIONS

By

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ABSTRACT

URBAN FORESTRY IN TRAVERSE CITY, MICHIGAN:
STREET TREE INVENTORY RESULTS
AND MANAGEMENT RECOMMENDATIONS

By

John P. Giedraitis

A 100% city street tree inventory was conducted in Traverse City, Michigan. The purpose of this study was threefold: first, to identify the present overall condition of the street tree population; second, to identify current management requirements of the urban forest; and third, to develop a management action plan.

During the inventory, 7,514 street trees were individually examined, identified, measured, and recorded. Information including location, species, size, condition, and management requirements was collected.

The study provides background on the local setting, climate, and soils of the city. Based on the inventory, an analysis of the existing street tree population is presented including species composition, size and age relationships, and a profile of species condition. Management requirements are analyzed, recommendations for planting, maintenance, and removal are provided, and a five-year action plan to establish management priorities, schedule work, and prepare budgets is outlined. The report concludes with a postscript reviewing the impact of this report on urban forestry operations between 1983 and 1990.

To Cynthia and Daniel

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The survey and the preparation of this thesis would not have been possible without the support and assistance of many people. The author first wishes to express his appreciation to Dr. J. James Kielbaso for his continued guidance and assistance during this project and throughout the entire Master's program. This study was instigated by Mr. Dale Majerczyk, Traverse City Director of Public Services. His comments and suggestions contributed significantly to the study. Mr. Robert A. Anderson, the City Manager; Doc Aeschliman, retired Director of Parks; and the members of the City Commission gave initial and continuing support. Details concerning the past city forestry program were provided by Mr. Martin Melkild, retired City Forester. Current operations information was provided by Mr. John Fraser, present City Forester.

Invaluable assistance was provided by successive survey assistants: Bruce Tamulis, Dallas Burrell, and Thomas Giedraitis. Special recognition is also given to Anders Johanson, Manager of Michigan State University Computer Application Programming, for his personal support and staff commitment in the data processing. Thanks is also given to Jean Terrell, who patiently typed the manuscript.

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CHAPTER 1

INTRODUCTION

The City of Traverse City engaged the services of the author to conduct a 100% city street tree inventory during the summer of 1982. The purpose of this study was three-fold: first, to identify the present overall composition and condition of the street tree population; second, to identify current management requirements of the urban forest; and third, to develop a plan of action for the future.

During the inventory, 7,514 street trees were individually examined, identified, measured, and recorded. Information including location, species, size, condition, and management requirements was collected. In addition, information was gathered on environmentally-related problems such as dieback, sidewalk heaving, and injury. A sample survey form is included in Appendix A.

Trees were assigned to districts which were created based on the approximate age of the development within an area. Figure 1 outlines the city by district. The collected information was then keypunched and processed at Michigan State University. What follows in this thesis is an analysis of these data.

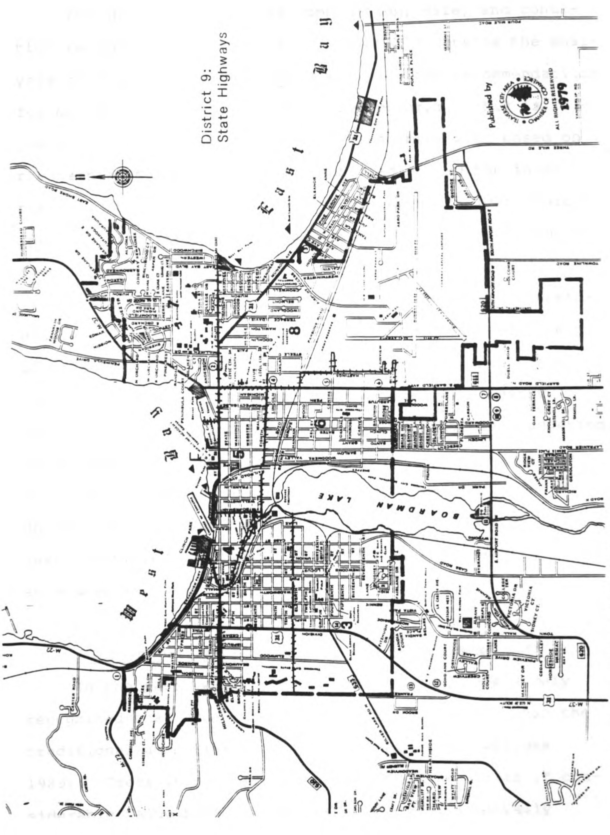

Figure 1. Survey Area and Districts.

The analysis of species composition, size, and condition is presented in Chapter 2. Chapter 3 details the analysis of management requirements and provides recommendations for building a more sound urban tree program. This is followed in Chapter 4 by a five-year management plan based on the maintenance requirements identified during the inventory. Lastly, the Postscript in Chapter 5 provides insight into how the report's recommendations were incorporated into forestry operations between 1983 and 1990.

The urban forest of Traverse City represents a considerable investment by the city. A well-planned tree care program based on the results and recommendations in this thesis can increase the cost effectiveness of forestry activities by allowing priorities, scheduling, and budgeting to be based on documented fact. Longer term cost savings will result from increases in tree vigor and survival, decreasing liability by reducing hazardous conditions, and less interference between trees and adjacent facilities such as sidewalks.

The Importance of Public Trees in Traverse City

In the past twenty years, it has become more widely recognized that urban trees provide more benefits than the traditional amenities of aesthetics and shade (Willeke 1989). Trees in cities are now recognized as being of considerable value both aesthetically and environmentally (Ebenreck 1989). By controlling wind and water erosion, they help stabilize the soil. Noise can be reduced to more tolerable levels through the placement of trees and other plants in the vicinity of objectionable sounds (Miller 1988).

Trees cleanse the atmosphere by precipitating and filtering out impurities and by adding oxygen to the air. It has been shown, for example, that the volume of carbon dioxide removed from the air by an eighty foot tall beech tree is equivalent to that produced daily by two single-family dwellings. Reduction of particulate pollutants of 7,000 or more dust particles per liter of air is possible along tree-lined streets (Bernatzky 1978).

Trees play an important role architecturally by enhancing buildings and other structures by defining or creating functional areas or other spaces by reinforcing structural designs. For instance, a passage from *The History of the Central Neighborhood*, Traverse City, Michigan, (Hale 1976) tells of some of the impact of street-side trees:

> . . . you sense yourself in a formal residential park, sheltered by overhead branches. Whether on a street, sidewalk or front lawn, the mature maple trees planted in the curbgrass shelter your passage with an overhead canopy and enhance your views.

In addition to their aesthetic values, trees can add monetary value to real property. For example, homes and building sites with trees usually sell more quickly and at higher prices than properties with no trees. Realty authorities have attributed an increased valuation per home by as much as twenty percent, with average increases of five to ten percent (Payne 1975, Martin 1986).

During the inventory, many citizens would interrupt and express a high level of concern for our actions relating to "their" tree. While information on attitudes was not actively collected by the author, most of the homeowners that were asked believed that city forestry activities were "good" for both themselves and the community as a whole.

A more scientific study of statewide public opinion was conducted in 1975 by the Department of Resource Development and the Cooperative Extension Service of Michigan State University (Kimball, et al., 1977). While not dealing directly with attitudes towards street trees, related issues were addressed. It was found that the level of resident satisfaction in the northwest region of Michigan was higher than it was statewide. In fact, the percentage of citizens who said they would be reluctant to leave or would never consider leaving their community was markedly higher in the region (eighty-four percent) than it was in the state as a whole (sixty-two percent).

In this public opinion survey, residents of Grand Traverse County were asked the most important factors in choosing a community in which to live. Of a list of twenty-one community characteristics, residents were asked if each was not important, slightly important, of moderate importance, or of great importance in choosing a community. The top ten most important characteristics attained from the survey are listed in Table 1.

From this citizen opinion survey, quality of air and water, natural scenery, and community physical appearance can be seen as important community issues. Street trees can provide an important factor in the attractiveness of Traverse City to present and potential residents and businesses. When seen in this light, public trees become an important goal when planning for community improvement.

Local Setting

Traverse City is located in the northwest portion of the lower peninsula of Michigan. It is situated at the base of the west bay of Grand Traverse Bay on Lake Michigan. The first white settlers to the region were missionaries who arrived in 1839. In the 1840s, lumbering operations began in what is now Traverse City. Vast stands of pine and hardwoods combined with the sheltered port of Grand Traverse Bay ensured a thriving lumber business for about the next sixty years. In 1893, at the height of the era, an estimated 250 million feet of lumber was processed annually by fourteen mills operating in the country. Early pictures of the area that is now the city show the trees had been stripped off by the 1860s.

After the turn of the century, as lumber activities declined, it was discovered that the soils and climate of the region were particularly suited for fruit production,

Table 1. Community Characteristics of Great Importance to Residents of Grand Traverse County.*

	Community Characteristic	% Who Indicated It Was of Great Importance in Grand Traverse County	% in State as a whole
1)	Less crime or danger there	75	78
2)	Quality of air and water	74	68
3)	Good place to raise children	63	64
4)	Natural scenery	60	41
5)	Quality of medical facilities	57	56
6)	Community physical appearance	50	50
7)	Quality of schools	50	54
8)	Size of population	50	29
9)	Friendliness of community	49	46
10)	Lower cost of living	45	52

*Adapted from Kimbal, et al., 1977.

and by 1905, cherries were an important crop. Currently, there are some two million tart cherry trees and 700,000 sweet cherry trees in the region. In normal years, the Traverse area produces about half of the national tart cherry crop. In 1923, the "Blessing of the Blossoms" ceremony took place. This was the forerunner of the week-long National Cherry Festival, an event that attracts some 300,000 people to Traverse City each July and ranks among the nation's largest yearly festivals. Tourism has also developed as an important industry to Traverse City and the region, and now summer visitors are the second most important industry to the region.

Traverse City was originally settled in 1847, incorporated as a village in 1881, and as a city in 1895. Often called the cherry capitol of the world, it is the regional center for government in the northwest Lower Peninsula. It covers 7.9 miles, has about seventy miles of streets, and has a population of approximately 18,000.

Climate of Traverse City

The climate of Traverse City is quasi marine or modified continental. Because of the city's proximity to Lake Michigan and because the prevailing westerly winds pass over the lake before reaching the city, the climate is quasi marine when the wind is westerly. However, if the wind shifts to the south or southeast, it passes over a large land mass before reaching Traverse City, and the climate changes to continental. But because of the prevailing westerly winds and the lake influence, winter is milder and summer is cooler than at the same latitude in Wisconsin or Minnesota.

With the lake moderating extremes, in the spring the cool lake water cools the warm air that reaches the area, and growth of plants is held back until frost is no longer likely. In the fall, the lake water, having been warmed by the summer sun, warms the cold air moving into the area and delays the first frost, thereby giving plants more time to mature.

The moderating lake effect diminishes with distance from the water. At Fife Lake, seventeen miles southeast of Traverse City, the average growing season is only eighty-seven days, while at Traverse City, the average growing season is about sixty-one percent longer at 142 days.

Precipitation during the growing season is favorable for tree growth. In the six-month period from April to September, the average rainfall is about seventeen inches and is well distributed. The rates of evaporation and transpiration are relatively low because the air is cool, the humidity high, and many days are cloudy or partly cloudy. As a result, soil moisture is usually adequate for tree growth on all but very sandy soils. Average snowfall is between seventy and eighty inches a year (USDA 1966).

Traverse City lies in Zone 5 of the plant hardiness zone map developed by Arnold Arboretum of Harvard

University. This corresponds to Zone 6 on the USDA plant hardiness zone map which has a defined limit of between -10° and -5°F for average annual minimum temperature (USDA 1972). Since the average annual lowest temperature in Traverse City is -10°F, only trees classified as capable of surviving those temperatures should be planted.

Surface Geology and Soils of Traverse City

The last sheet of the Wisconsin Ice Age formed the surface features of Traverse City and the surrounding area. When the last ice sheet melted and receded about 6,000 years ago, it left deposits known as the Manistee Moraine. This moraine partly surrounds Traverse City and extends northward into Leelanau County and eastward from Acme. The physiographic features of Traverse City are glacial lake plain throughout most of the city and moraines in the northeast section on the Old Mission Peninsula.

There are three major soil types found over the city (USDA 1966). These soils are described below.

(1) East Lake - Mancelona loamy sands, 0 to 2% slope (EmA). Found over most of the city west of Boardman Lake and River. These soils consist of well-drained sand and loamy sand that are underlain by calcareous sand and gravel at a depth of 10-42 inches. This deep, well-drained soil has rapid or very rapid internal drainage. The moisture-supplying capacity is fair to poor, and the soils may be droughty during dry periods. Aeration

is rapid, and natural fertility is moderate or moderately high. The surface is medium acid to neutral. The potential productivity is high for trees grown on these soils. Sugar maple has a high potential growth rate on these soils.

(2) Rubicon sand, 0-2% slopes (RwA). Found over most of the city east of the lake and south of Washington Street and Munson Avenue. This type is a well-drained soil that has a sand surface, subsurface, and subsoil. The soil reaction is slightly to medium acid. Aeration is rapid, natural fertility is low, and the moisture-supplying capacity is poor to very poor. The potential productivity for hardwood tree species is low.

(3) Lake Beach and Eastport sand, 0 to 6% slopes (LeB). Found in a strip running through the city adjacent to the west arm of Grand Traverse Bay. It includes all of the central business district, much of the Boardman neighborhood, and other areas along the lake shore. Because of the past, periodic soil movement that has occurred as a result of lake action, no strong soil profile has developed. This soil consists of well-drained, coarse-textured material deposited by water along the lake shore. The potential productivity for hardwood trees is very low.

The impact of soils on street tree growth and management will be considered throughout this thesis.

CHAPTER 2

ANALYSIS OF EXISTING STREET TREES - SURVEY RESULTS

During the inventory, information of species types, size, and condition was recorded for each street tree. What follows in this chapter is an analysis of this information for the total street tree population.

Species Composition

A total of 7,595 trees and shrubs were surveyed during the 100% inventory of street trees in Traverse City. Table 2 summarizes total species composition by common name, number, and percent of the total population. Trees representing thirty-eight genera and a total of sixty-one different species were identified. The five most common genera — maple, oak, pine, elm, and ash — represent about eighty-nine percent of all public street trees. Figure 2 provides a summary for the most common genera and the species contained in each.

Other species not in these five genera but also included in the upper twenty species include: black locust (87 trees or 1.1%), basswood or native linden (84, 1.1%), crabapple (79, 1.0%), honey locust (66, 0.9%), white cedar (43, 0.6%), blue spruce (46, 0.6%), and birches (44, 0.6%).

Table 2. Total Species Composition (Traverse City Inventory, 1982).

SPECIES	# of Trees	% of Total	SPECIES	# of Trees	% of Total
Apple	5	0.1	Maple, Norway	902	11.9
Ash, Green	118	1.6	Maple, Norway 'Crimson King'	67	0.9
Ash, White	48	0.6	Maple, Red	402	5.3
Aspen/Poplar	29	0.4	Maple, Silver	216	2.8
Beech, American	6	0.1	Maple, Sugar	3,633	47.8
Birch	44	0.6	Mountain Ash, European	15	0.2
Boxelder	70	0.9	Mulberry	5	0.1
Bush/Hedge	81	1.0	Oak, Pin	24	0.3
Catalpa	34	0.4	Oak, Red	417	5.5
Cedar, White	43	0.6	Oak, White	324	4.3
Cherry	5	0.1	Olive, Russian	1	0.01
Cherry, Black	6	0.1	Pear	3	0.04
Cherry, Fine	5	0.1	Pine, Austrian	1	0.01
Crabapple	79	1.0	Pine, Jack	1	0.01
Elm, American	8	0.1	Pine, Mugo	2	0.03
Elm, Siberian	169	2.2	Pine, Red	82	1.1
Fir, Balsam	9	0.1	Pine, Scotch	4	0.1
Fir, Douglas	4	0.1	Pine, White	249	3.3
Fir, White	4	0.1	Plum, 'Myrobalun'	14	0.2
Ginkgo	2	0.03	Spruce, Blue	46	0.6
Hackberry	3	0.04	Spruce, Englemann	4	0.1
Hawthorn	2	0.03	Spruce, Norway	30	0.4
Hemlock	17	0.2	Spruce, White	9	0.1
Honeylocust	66	0.9	Sycamore, American	4	0.1
Hornbeam, American	9	0.1	Tree of Heaven	3	0.04
Horsechestnut	10	0.1	Tulip Tree	1	0.01
Juniper	3	0.04	Vibernum	1	0.01
Lilac	10	0.1	Walnut, Black	25	0.3
Linden, Basswood	84	1.1	Walnut, English	1	0.01
Linden, Little Leaf	18	0.2	Willow	6	0.1
Locust, Black	87	1.1	Miscellaneous	25	0.3
			TOTAL	**7,595**	**100***

*All species included, percentages rounded off

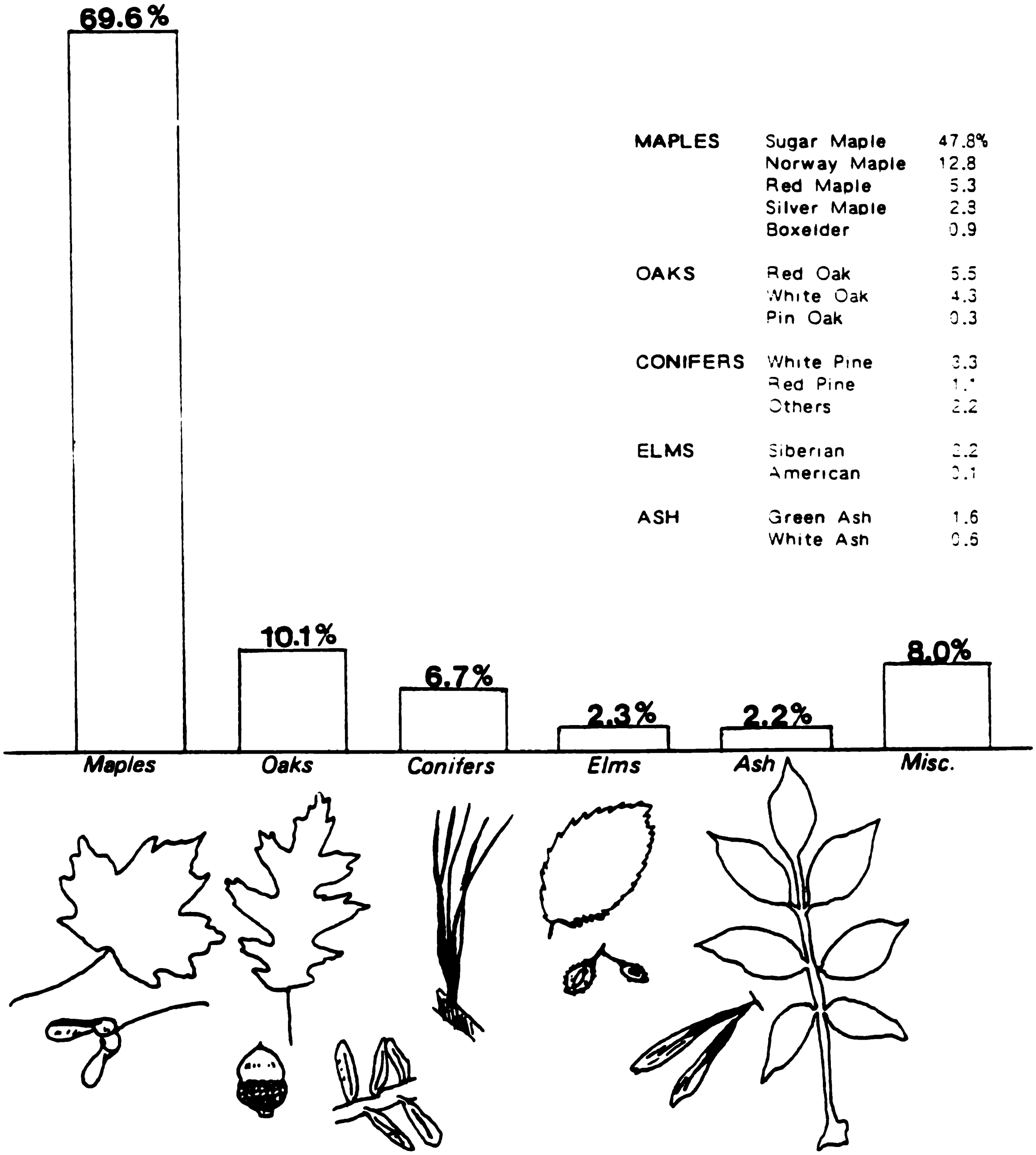

Figure 2. Species Composition by Genera (Traverse City Inventory, 1982).

Along with the species contained in the five most common genera, these species comprise about ninety-five percent of all trees inventoried. Each of the remaining forty-one species makes up less than 0.5% of the total population. Appendix B further details total species composition by district.

Size and Age of Street Trees

The size of each tree was recorded during the inventory. Tree size is given by its diameter in inches at breast height (dbh), or 4.5 feet above ground level. The percentage of street trees in each four-inch size classification is found in Figure 3.

This figure shows that tree size is rather evenly distributed throughout the diameter classes. This indicates an approximately all-aged urban forest. It can be assumed that as the trees in each diameter class grow, they will move into the next larger diameter class. As the trees in the twenty- to twenty-four-inch class move into the twenty-five-inch or greater size classes, higher mortality can be anticipated, as these trees will be nearing the end of their natural life span. Many of the trees of twenty-inch or greater diameter are probably the original street tree plantings from the turn of the century and before. While estimates relating size to lifespan are tenuous, it is believed many of the trees in this segment of the population will require replacement within the next decade or two.

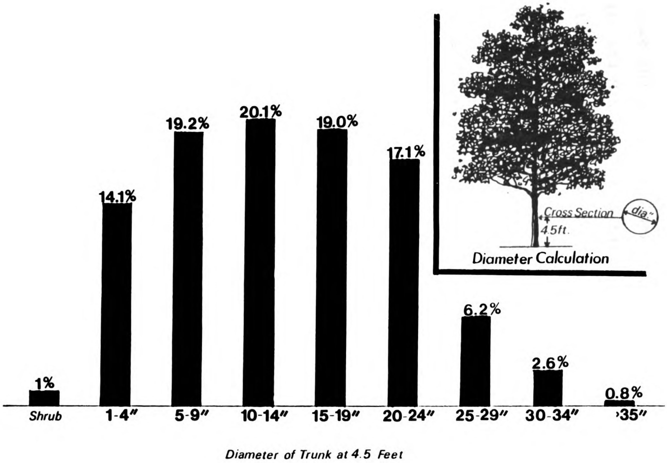

Figure 3. Percentage of Street Trees in Each Size Classification (Traverse City Inventory, 1982).

Higher mortality could possibly occur sooner if a particularly stressful situation occurs, such as drought or insect or disease outbreaks, further weakening these mature trees.

While there is not always a direct relationship between tree size and biological age, Richards (1978), Giedraitis (1984), and Mahoney (1989) have suggested that a functional age/size relationship can be established. Trees from one to nine inches in diameter may be considered functionally young; trees ten to fourteen inches as developing or functionally intermediate; and trees fifteen to twenty-four inches as functionally mature, that is, they are at their optimal functional size for a street tree. Trees over twenty-five inches in diameter can be considered functionally old or veterans. Whether these trees are biologically old depends on species and growing conditions. While these large trees may be magnificent specimens, they are no longer at their optimal size. They are generally older, may be too large for the scale of the street and the limited growing space, may be causing problems for adjacent facilities (for example, sidewalks), and when they eventually die, their large size will make them more difficult and expensive to remove.

The relative percentages of trees found in each functional age group are presented in Figure 4. Both this figure and Figure 3 point out the excellent size/age distribution of the street tree population. These figures reflect Traverse City's long-standing commitment to the planting and

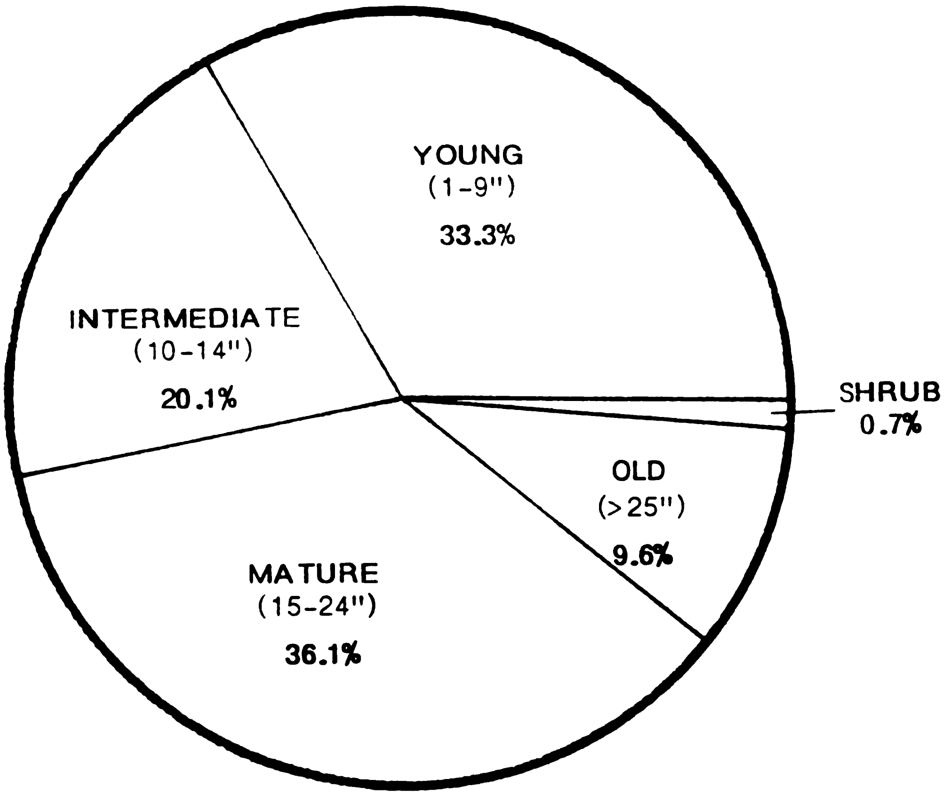

Figure 4. Percentage of Street Trees in Each Functional Age Class (Traverse City Inventory, 1982).

replanting of street trees. At present, this nearly all-aged urban forest is composed of the following functional age groups: thirty-three percent young, twenty percent developing/intermediate, thirty-six percent mature, and 9.6% old. However, the distribution of age groups by district reveals a slightly different picture. These district differences in the relative proportion of trees in each functional age group can be seen in Table 3.

In general, this table shows that the districts with the oldest developments have a higher proportion of older trees. Districts One, Two, and Three have a greater percentage (over 50%) of their trees in the mature and old age groups. In fact, District Two has over sixty-seven percent of its trees greater than fifteen inches in diameter. This contrasts with the new developments in Districts Four, Six, Seven, and Eight. In these latter areas, the proportion of functionally-young and intermediately-aged trees is considerably higher.

Profile of Species Condition

During the inventory, the condition of each tree was identified. For each tree, six factors were considered: trunk and root condition, growth rate, structure, insects and disease, crown development, and life expectancy. Based on a summary of these factors, a condition class ranging from 0 to 100% was assigned to the tree, and the tree was

Table 3. Functional Age of Street Trees Based on Diameter Size by District (Traverse City Inventory, 1982).

District	Total Trees	Mean dbh	% Street Trees by Diameter* Young 1-9"	Inter-mediate 10-14"	Mature 15-24"	Old >25"	Shrub %
All City	7,595	14.5	33.3	20.1	36.1	9.6	0.7
One	886	15.5	30.7	15.7	38.4	14.7	0.2
Two	2,067	17.5	17.2	14.9	51.3	15.9	0.3
Three	1,141	13.6	35.7	23.0	32.8	8.0	0.4
Four	413	11.3	52.3	11.9	27.6	8.2	0
Five	818	13.6	34.6	20.1	36.9	9.4	0.4
Six	689	14.3	41.8	24.7	25.8	4.1	3.2
Seven	710	13.1	33.8	33.1	28.0	4.0	0.8
Eight	700	11.7	52.6	21.1	22.1	2.8	1.1
Nine	171	9.6	57.9	34.5	7.6	0	0

*Diameter measured at 4.5 feet above ground level placed in one of the following five condition classes:

Excellent	90 to 100%
Good	70 to 89%
Fair	60 to 69%
Poor	50 to 59%
Very Poor	<49%

Figure 5 depicts the number and percent of all street trees by condition class. About sixty-six percent of the trees inventoried were in good to excellent condition. In addition, about nineteen percent were rated fair, about eight percent poor, and approximately seven percent were rated very poor. The 14.9% rated poor or very poor may be expected to live less than ten years.

A picture of how street trees perform as they grow emerges when functional ages are compared with condition classes. Condition versus age group is charted in Figure 6. This figure shows that as trees grow older, the percentage of trees in excellent condition drops, the percentage in good condition remains about the same, and the percentage of trees in the fair and poor condition classes rises. The percentage of trees rated very poor would probably also show a steady increase with advancing functional age; however, since these trees are probably removed as their conditions deteriorate, this increase is not reflected on the chart. The tables included in Appendix C further outline condition versus functional age for some of the more commonly occurring street trees.

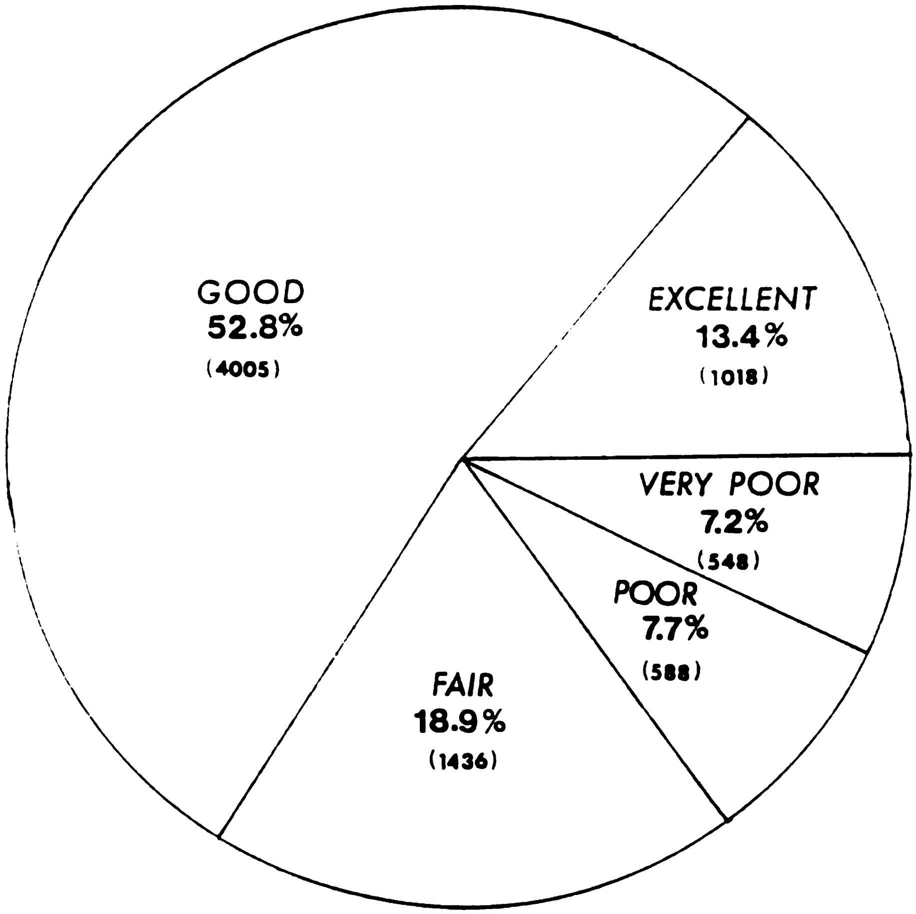

Figure 5. Percent and Number of All Street Trees by Condition Class (Traverse City Inventory, 1982).

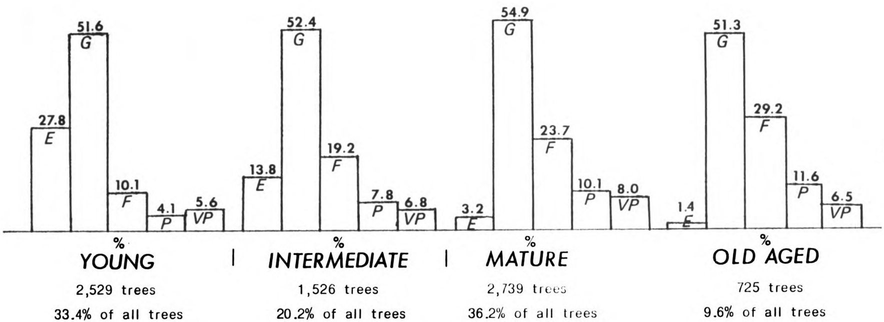

Figure 6. Condition Classes of Street Trees by Functional Age Groups (Traverse City Inventory, 1982).

Dieback in Street Trees

Symptoms

Dieback or decline is the common name given to a tree condition that has become more noticeable in recent years. Tree decline is characterized by the following symptoms. Usually, an abnormal leaf condition, such as leaf scorch, indicates that a moisture deficiency problem is involved. Often, starting in July or August, there may be a premature autumn coloration. As decline or dieback continues, there may be death of twigs and branches of increasing size in the upper crown region; this will be noticeable as many of the branches fail to leaf out in the spring. Reduced terminal growth of twigs causes development of foliage in tufts near the twig ends. Sometimes there may be abnormally large seed crops. In addition, there may be evidence of injuries, trunk and root rot, and other specific diseases (Manion 1981, Sinclair 1988).

Causes

A tree exhibiting dieback may be experiencing an insect or disease infestation, adverse environmental conditions, old age, or any combination of these conditions. Moisture stress will be present almost every summer for street-side trees, and this stress can be greatly increased during periods of drought. Low soil fertility, compacted soil, and restrictive rooting space can also be contributing factors in decline. Harmful concentrations of salt compounds building up in the soil near trees can produce decline symptoms. Cutting of roots for the construction of pipelines, side-walks, and roads will cause additional stresses. This may be followed by root rot, and over a period of time, decline will be initiated in the tree (Manion 1981). During the inventory, no attempt was made to diagnose dieback causes, since this usually involves knowledge of the history of the growing site and often entails microscopic analysis in a laboratory.

Survey Results

While surveying trees, dieback was recorded if there were significant numbers of dead or dying branches in the crown. In all, 729 trees, or about ten percent of all trees, displaying dieback symptoms were surveyed. Table 4 shows the relationship between tree size and incidence of dieback. In general, this table demonstrates that dieback is present in all sizes of street trees and generally increases with increasing tree size. Although dieback is considered to be a natural response to stress, the incidence in Traverse City appears high. Maples are known to be sensitive to the urban conditions that cause stress. In fact, about eighty-eight percent of recorded diebacks were for maples. Table 5 outlines dieback for some of the more frequent species.

This table shows that sugar maple has the highest number of diebacks overall (541) and that it has the highest

Table 4. Size and Dieback in Street Trees (Traverse City Inventory, 1982).

Size (dbh)	No. of Trees with Dieback	% of Size Class with Dieback	% of all Dieback
1- 4"	83	7.7	11.4
5- 9"	88	6.0	12.1
10-14"	132	8.7	18.1
15-19"	151	10.5	20.7
20-24"	168	12.9	23.0
> 25"	107	14.8	14.7
Totals	724		**100 %**

Table 5. Dieback Recorded for Selected Species (Traverse City Inventory, 1982).

Species	No. of Species with Dieback	% of Species with Dieback	% of all Dieback
Sugar Maple	541	14.9	74.2
Red Maple	43	10.7	5.9
Silver Maple	12	5.6	1.6
Norway Maple	44	4.9	1.9
White Oak	13	4.0	1.9
Red Oak	12	2.9	1.6
Others	64		8.8
Totals	**729**		**100 %**

Table 6. Size and Dieback in Sugar Maples (Traverse City Inventory, 1982).

Size (dbh)	No. of Trees with Dieback	% of Size Class with Dieback	% of all Sugar Maple Dieback
1- 4"	68	11.0	12.6
5- 9"	61	10.9	11.3
10-14:	79	14.1	14.6
15-19:	110	16.7	20.3
20-24"	137	17.3	25.3
>25"	86	19.7	16.0
Totals	**541**		**100%**

percentage of diebacks for any species (14.9%). This rate is three times higher than the percentage of all Norway maples experiencing dieback (4.9%).

Because about fifteen percent of all sugar maples are experiencing dieback, a closer look will be taken to see the relationship between size and incidence of dieback in this species. Table 6 outlines this relationship and shows that the incidence of dieback is high in all size classes and increases with increasing size. That dieback occurs in all diameter classes at these high levels is somewhat unusual. However, it points out the fact that this tree is rather intolerant of extreme urban conditions. It also points to a lack of systematic maintenance given to trees over their lifetime. A regular program of pruning, fertilization, and injury repair could lower the overall incidence of dieback by maintaining trees in high vigor. High vigor trees can more easily overcome occasional stresses; with low vigor trees, condition deteriorates with each additional stress. This need for systematic tree care will be addressed more completely in the following chapter.

CHAPTER 3

MANAGEMENT REQUIREMENTS: SURVEY RESULTS AND RECOMMENDATIONS

The City of Traverse City is committed by ordinance, policy, and tradition to the full responsibility for management of street-side trees. Each city tree, or collectively the urban forest, has three fundamental management requirements: planting, maintenance, and removal. What follows is a description, summary, and analysis of the management requirements for street trees noted during the inventory. Recommendations for future action are included under each management requirement. In addition, program recommendations concerning standards, records and record keeping, and public relations are also provided.

Planting

Perhaps the most publicly acceptable and most visible management requirement of the urban forest in Traverse City is planting. Continuous planting and replanting over the years have established the all-aged urban forest that exists today (see Figure 3). Since planting records were established in the late 1950s, over four thousand trees and shrubs have been planted street-side and in public parks.

The two principle species that have been used for streetside plantings by the city are sugar maple and Norway maple. Little leaf lindens, varieties of thornless honey locusts, green ash, and elms have also been used to a lesser extent. Over the years, this continuous planting effort has done an excellent job of planting Grandview Parkway, new subdivisions, and commercial areas. Also, continuous replanting of lost trees has not allowed large gaps to appear.

During the inventory, 3,064 planting sites and their locations were noted. A planting site is considered as a space in a sufficiently wide treelawn* about fifty feet away from the nearest street tree with no interference from private trees. The location of each of these sites has been provided to the City. The number of planting sites by district is included in Appendix B. Districts with high percentages of planting sites include Districts Six and Nine.**

The high number of planting sites in District Six is probably due to the abundance of gravel roads and lack of curbing, and hence the lack of clearly defined treelawns for planting. Also, over portions of this district, much of the original tree cover was preserved in development, which may lessen the need for formal city tree plantings. District Nine includes the state highways. Noticeable for the relatively large numbers of planting sites in this district is Division Street.

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*Treelawn is defined as the space between the street edge and a property line.

**See District Map on page 2.

It is recommended that priorities for future planting be established. Highest priority should be given to locations most exposed to the public. These would include entranceways and main thoroughfares. Grandview Parkway is an excellent example of this principle at work. Plantings in these areas lead to favorable public reaction to the tree program and help to give visitors to the area a favorable impression of the city. The next priority should be replanting after tree removal. Prompt replanting efforts will generate public support for city forestry activities. Remaining priorities should deal mostly with filling the remaining planting spaces in residential areas. These should be established by the city forester after determining the needs and desires of the citizens.

After planting priorities have been established, it is recommended that the site be visited, its restrictions analyzed, and an appropriate species or variety selected. "The right tree in the right place" should be the general rule. A suggested master tree selection list for Traverse City is provided in Appendix D. This list could possibly be used in conjunction with the master street tree planting plan developed by Mr. Martin Melkild, retired City Forester.

When selecting species for planting, the city forester should also consider the diversity, or species mix, that exists now and in the future. The recent Dutch elm disease catastrophe left Traverse City relatively untouched but serves to point out the problem associated with low species diversity. Although there is currently no comparable infestation with maples, it is recommended that a wider variety of species be planted for a greater population diversity in the future. The particular mix to be obtained is a matter of planting policy to be determined by the city forester.

The ultimate size of street tree plantings is also a policy whose review is recommended. Many cities are now moving to the use of smaller trees for street-side planting. Lower growing trees generally require more skill and expense to obtain and maintain, but they also tend to have less disruptive habits and usually have lower removal costs. The city forester should study this concept, in light of citizen preferences and future maintenance considerations, to determine future tree size policy.

Once priorities have been established and a species for planting selected, the tree(s) must be procured. The city is fortunate in this respect in that it owns a nursery. When the planting plan is in place, plants can be obtained at a much smaller size several years in advance of street-side planting. Superior cultivars can therefore be obtained at less cost, planting times can be more easily scheduled, and trees can be specially pruned for several years before planting.

In many of the older sections of the city, trees are planted on fifteen-foot spacings. This makes replanting of a young shade tree difficult at best. Sugar maple is rather unique in its ability to grow very slowly while under shade conditions and then quickly when light is finally obtained. However, it is now realized that fifteen feet is too close for very large trees and that fifty feet is a much more appropriate distance. It is recommended that when a tree is removed from one of these mature rows, where appropriate, underplantings should be made with shade tolerant trees with a small to moderate ultimate size. Species to consider would be serviceberry and dogwood. Both have showy spring flowers, distinctive fall color, and moderate ultimate height. Eventually, as all the maples are removed, sugar maple or another appropriate species could be planted among the smaller trees. The homeowner disappointment over losing a tree followed by dissatisfaction over not having another sugar maple replanted would be buffered. These smaller, shade tolerant trees would then serve as an intermediate stage between no trees (or small, scattered, thin-crowned maples that had been underplanted beneath a complete canopy) and the thirty or forty years that it will take to establish a new stand of functionally mature trees.

Maintenance of Existing Trees

The trees that line the streets of Traverse City lack many of the biological advantages enjoyed by forest trees. Trees growing in an unnatural, stress-filled environment require intensive culture and systematic maintenance. In addition to planting, trees must be given supportive services to prolong and intensify their usefulness. From a management perspective, urban forest maintenance in Traverse City may be defined as the carrying out of practices necessary for reasonable health, vigor, and compatibility with the urban environment. Maintenance involves all practices between planting and removal. These activities may be divided into three categories: (1) growth control, (2) damage control, and (3) insect and disease control. A copy of the location of each tree requiring each of these maintenance activities has been provided to the City for budgeting and scheduling purposes. Examples of these work/assignment printouts are included in Appendix E.

Growth Control

There are two major types of growth control practices done to city trees. One is pruning to retard or direct growth, and the other is fertilization to enhance growth.

Pruning

Pruning is one of the most important management practices in the urban forest. Pruning requirements were identified for each tree during the inventory. Each tree was evaluated, and a pruning recommendation was recorded if the tree required one or more of the following pruning practices:

- removal of broken or hanging branches
- deadwood removal
- pruning for clearance (lifting)
- crown training
- crown thinning

If the tree needed any of these practices, the individual practice was then classified as either higher or lower priority. A description of the general guidelines used for pruning recommendations are as follows:

(1) **Removal of Broken or Hanging Branches.** Branches, either living or dead, that are broken at some point. Hangers interfere with other branches, obstruct visibility, and create a safety hazard.

Lower Priority - only one or two branches broken or hanging that are not very large, generally no more than four inches in diameter.

Higher Priority - three or more broken or hanging branches; also a large hanging branch four inches or more in diameter.

(2) **Deadwood Removal.** Dead branches within crown.

Lower Priority - small branches one or two inches in diameter and not more than 10% or 20% of the crown.

Higher Priority - larger branches over three or four inches in diameter that could cause damage or injury. Also, if more than 20% or 30% of the crown is dead.

(3) **Pruning for Clearance.** Also known as crown lifting. Removal of branches and suckers from the trunk and all low-hanging limbs to allow for seven- to eight-foot clearance over sidewalks and about fourteen feet over the road for vehicular traffic. Raise limbs for visibility on corners and for signs.

Lower Priority - if low limbs or suckers will grow to more serious problems.

Higher Priority - low hanging branches or suckers obstructing views or creating clearance hazard.

(4) **Crown Training.** Training is done on small trees to establish good form. It is the structuring and shaping of the crown while the tree is young. This is done to prevent later developmental problems such as poor branching structure.

Lower Priority - a few branches need pruning.

Higher Priority - presence of V crotches, crossing branches, low branches, and general poor form.

(5) **Crown Thinning.** Thinning is a cultural practice to reduce the number of branches. This includes removal of crossing and rubbing branches. Thinning lightens the crown to reduce the possibility of wind or ice breakage. Thinning also improves sunlight and air circulation which allows better crown development and reduces insect and disease problems. Thinning may also be conducted on older trees to rejuvenate them by

establishing a better crown-to-root ratio; especially useful when roots have been cut or damaged.

Lower Priority - a few or smaller branches need pruning.

Higher Priority - judgment call; many or larger branches need removal.

Table 7 describes the overall management recommendations for the various pruning practices. Management recommendations for pruning practices by district are included in Appendix B. Table 7 shows that there is a large amount of pruning to be done. The largest number of trees in need of pruning are in the thinning, deadwood, and training categories, respectively. It is recommended that the city not attempt to conduct all this pruning at once but rather establish priorities for the pruning practices. It is suggested that the most important pruning recommendations to be carried out are those that lead to a reduction of hazards to life and property. These would include the removal of hangers, deadwood removal, and pruning for clearance. Within each one of these recommended pruning practices, attention should first be given to the higher priority. For instance, removal of a higher priority hanger should take precedence over a lower priority hanger, and so on.

The next most important pruning priority is pruning to ensure the development of structural strength, shape, and form. This would include training and thinning practices.

Table 7. Street Tree Management Recommendations - Pruning (Traverse City Inventory, 1982).

Pruning Recommendation	Total Trees	Lower Priority		Higher Priority	
		%	No.	%	No.
Remove Hangers		2.3	172	0.7	51
Remove Deadwood		23.9	1,817	24.7	1,877
Trim for Clearance		7.2	550	2.4	186
Train Crown		10.8	882	11.5	870
Thin Crown		34.4	2,616	24.1	1,831
	7,595				

Pruning of young trees, or training, can prevent later, more expensive pruning, reduce breakage in severe storms, and provide a more pleasing street tree form. The survey found that about seventy-three percent of all trees in the one- to four-inch size category were in need of training. It was also found that about forty-six percent of all trees in the five- to nine-inch size category were in need of some training. It is recommended that the city start a systematic program of training now to avoid increasing developmental problems in the future. Thinning of the crown is recommended as the last pruning priority. Once pruning priorities have been established and the numbers of trees to be pruned estimated, it is recommended that pruning work be spread over a series of years. Management requirements, including pruning, are outlined for some of the more common street tree species in Appendix F.

Fertilization

Enhancing growth by fertilization is a necessary management practice to maintain tree health and vigor. The need for this activity was realized a few years ago, and a successful program of cooperation between citizens and the forestry unit was carried out in the Central Neighborhood Area (in District Two). Under this program, homeowners were canvassed, and each contributed five dollars to help defray costs. Trees were deep fertilized with a high nitrogen, water soluble fertilizer by city crews. Observations by Mr. Melkild have determined that as a result of this program the mortality rate of the older sugar maples in this area has been reduced.

During the inventory, 1,265 trees were found with signs of nutrient deficiency or lower than expected condition classes. These trees would benefit from fertilization. Due to the sandy nature of the soils and their mostly moderate fertility, it is recommended that systematic fertilization of trees become a standard activity for the tree care unit. In particular, as the growth of older trees slows, fertilization can help them remain in a healthy state, more able to overcome the increasing stresses brought on by old age. Young trees also benefit from application activities. In fact, about eighty-five percent of all the trees recommended for fertilization were nineteen inches or less in diameter. These trees may need extra help until their root systems are developed enough to obtain adequate water during dry periods.

When homeowners water and fertilize their lawns, they are indirectly aiding the street trees. These practices are widespread throughout the city and should not be discouraged. A very high percent of a sugar maple's absorptive roots are in the top three to five inches of soil. The prevailing sandy soils with their low ability to retain water combined with a cover of turf competing for available moisture and nutrients can severely stress trees during dry periods. The importance of homeowner watering and fertilization can be critical to keeping tree vigor high. Any future increase in the water rates should consider the higher long-term tree mortality and the associated costs for more frequent removal and planting.

Damage Control

The second major category of management practices is damage control. Control of tree damage involves both damage prevention and damage repair. Damage prevention practices include removing restrictive girdling roots and cabling or bracing weak crotches or damaged trees. Damage repair activities include the treatment of cavities and wounds. The objectives of repair practices are to prevent decay and to put wounds in the best condition for wound closure. Table 8 summarizes damage control maintenance requirements recorded during the survey.

Table 8. Summary of Damage Control Maintenance Requirements (Traverse City Inventory, 1982).

Recommendation	Total Trees	Need Control %	Need Control No.
Girdling Root Removal		6.3	480
Brace/Cable		6.7	508
Repair Injury		4.8	364
	7,595		

Damage Prevention

Preventive maintenance is an important aspect of urban tree care. It includes removal of girdling roots and cabling and bracing operations. A girdling root is one that has grown closely oppressed to the main trunk, overlapping other roots. As these roots increase in thickness, they may strangle other roots and gradually restrict water and nutrient transport in the trees. If girdling roots are removed early enough, the tree may recover. A total of 480 trees were found to have girdling roots. Maple was the most common genus experiencing this problem, with 447 or ninety-three percent of all girdling roots recorded. Norway maple had the highest species incidence, with 116 or thirteen percent of all Norway maple trees having this problem. There were 197 or about eight percent of all sugar maples with girdling roots. These two species compose about eighty-six percent of all recorded girdling root removals. It is recommended that the city forester inspect the trees with girdling roots and determine if treatment is appropriate.

Cabling and bracing practices can lower the incidence of personal injury or property damage during severe weather. Bracing is used to support or strengthen tree structure by using bolts to join weak or split limb crotches, brace limb and trunk splits, and support trunk or crotch cavities. Cabling is used to support or strengthen tree structure by using cables connecting two or more limbs within the same tree. Cabling is used to limit excessive limb motion or relieve pressure on weak, decayed, or split limbs or crotches. About seven percent (508) of all trees were found to require cabling or bracing practices. Most of the trees in need of these preventive maintenance activities are older, larger diameter trees that have crotching patterns that were not corrected while the tree was young. It is recommended that the city forester inspect trees identified as having cabling/bracing needs and determine which trees require immediate treatment.

Damage Repair

Cavities and trunk and butt wounds in need of repair were recorded during the inventory. A total of 364 or about five percent of all trees were found to need some sort of damage repair. Most often, this requirement was noted for mechanical injury done to the base or trunk of the tree. Mechanical injury results from damage by cars, vandals, utilities, root cuts, and frequently from lawn mowers damaging the thin bark of young trees. In fact, many trees were noted in treelawns by public buildings and along Grandview Parkway that had been damaged by city-operated lawn mowers. It is recommended that efforts be made to lessen this problem by removal of grass or mulching near these trees and/or training personnel to avoid creating such injuries.

Young trees, with their thin barks, are especially susceptible to injury. About seventy-three percent of all repair requirements are for trees less than nineteen inches in diameter. The highest incidence of damage was recorded on red maple, with about nine percent of all red maples requiring injury repair. This suggests that in the future, use of this thin-barked species should be confined to low use areas. It is recommended that the city forester inspect trees with damage repair requirements recorded to determine priorities for repair.

Insect and Disease Control

To keep city trees healthy and attractive, special management practices are sometimes necessary to protect them against two of the more important causes of plant decline and failure — insects and diseases. During the inventory, 179 trees were found with noticeable insect infestations. The most prominent insect pests are aphids and sugar maple leaf rollers. Other important insect problems identified were scales on ash and leaf miners and borers on birch.

Disease problems were also recorded during the inventory. A total of 108 trees were found to be infected.

Almost one-half of the diseases recorded occurred on the elms surveyed. Common fungal disease problems encountered with elms include leaf spot and wetwood. On maples, Phyllosticta spot fungus was the most frequently counted fungal problem.

Overall, the incidence of insect and disease found in Traverse City is low, and problems are mostly localized. It is recommended that regular monitoring of pest problems be continued. Regular control by chemicals and nonchemical means should also be continued so that pest populations are not allowed to build up to epidemic levels. It is also recommended that when trees in very poor condition are found during regular tree inspections, these locations should be noted and the trees removed at the earliest possible opportunity. Trees in low vigor are readily attacked by insects and diseases. As the number of these pests build up, they may spread onto the nearby healthy trees.

Street Tree Removals

The causes of street tree failure include natural causes such as disease, insects, and weather conditions and man-induced causes from physical injury due to vehicles, vandalism, poisoning, and root cutting for sidewalks. There are three main reasons why street trees should be removed when they fail: first, for hazard reduction to persons and property; second, to eliminate breeding sites for insects and disease; and third, dead trees detract from the visual quality of a street.

A total of 476 trees in need of removal were identified during the survey. This is about six percent of all trees surveyed. A separate computer printout has been provided to the city showing the location of each of these removals for scheduling purposes. City trees were recommended for removal when it was obvious that their condition class had deteriorated to the point where they were no longer functional and were, in fact, an increasing liability. Several removals were noted of stumps that had resprouted. Also, forty shrubs were recommended for removal. These shrubs were planted by homeowners and are not in accordance with city clearance requirements.

Table 9 outlines the number of removals recommended by diameter class. This table shows that old age may not be the primary cause of mortality of street trees in Traverse City. City conditions are frequently unnatural and stressful for street trees. One would expect that mortality would be initially high as young trees are becoming established, lower during their intermediate years, and higher as they get older. This is not reflected on the table. In fact, recommended removals rise rather steadily through each size class.

One of the reasons for this could be the lack of systematic care given to the street trees throughout their lives. A systematic maintenance program of growth control

Table 9. Recommended Removals by Diameter Class*
(Traverse City Inventory, 1982).

Diameter Size Class	Number	% of Size Class
1- 4"	50	4.7
5- 8"	70	4.8
9-14"	103	6.7
15-19"	108	7.5
20-24"	102	7.9
25-29"	31	6.6
30-34"	7	3.6
35-39"	1	2.8
40-49"	4	16.0
Shrubs	40	53.3
Total	**516**	
% of All Trees		**6.3%**

*Diameter measured at 4.5 feet above ground.

and damage control practices could lower the overall removal rate of these younger trees. This could lead to less frequent removal and replanting and would ensure that street trees would have an increased life span, thereby providing increasingly higher values over a longer period of time.

Table 10 provides removal recommendation figures for the more frequently occurring street tree species. Comparing the percentage of each species needing removal, red maple is highest with 8.9%, and sugar maple is second with 8.2%. Of all trees over ten inches in diameter, the percent recommended for removal is greatest for sugar maple. This comparison gives some indication of how individual species are performing in their streetside locations. Sugar maples are dying about three times as fast as Norway maples. Sugar maples are widely known to be more susceptible to the stresses of streetside planting locations than are Norway maples. It should also be noted here that the sugar maples are generally slower growing and longer lived than Norways. This could account for some of the mortality differences between the species.

It can be expected that once the slight backlog of removals is completed, the rate of removals city-wide will increase over the next twenty years. This predicts the need for an increasing tree removal program with even greater possible increases after any future period of dry years. This is especially true of the older sugar maple population.

Table 10. Percentage of Removals by Size Classes for Selected Species (Traverse City Inventory, 1982).

Species	Total Removals	% Needing Removal	Diameter*			
			1-9"	10-14"	15-24"	25"
Sugar Maple	298	8.2	3.9	11.3	10.7	7.8
Norway Maple	25	2.8	1.4	2.2	4.7	4.2
Red Maple**	35	8.9	8.8	7.3	3.9	0
Silver Maple	11	5.1	5.9	3.9	5.9	4.3
Red Oak+	12	2.9	4.7	2.2	2.3	1.4
White Oak	10	3.1	0	4.3	3.8	2.4

*Diameter measured at 4.5 feet above ground.

**Three trees are sprouts from stumps to be removed.

+One tree stump needing sprout removal.

If a program of systematic maintenance practices was implemented, removal rates for trees under twenty-five inches in diameter would probably decrease. As the older trees move towards the end of their life span, their mortality rates could also possibly be lowered somewhat by increasing maintenance activities. However, except where present hazards can be readily corrected as an alternative to removal, the benefits from maintenance of already declining trees are likely to be short lived and thus marginal. It is recommended that future efforts be concentrated on systematic care of younger trees in an attempt to lower the overall removal rate.

Trees and Sidewalks

As trees grow, they may cause problems for adjacent facilities, such as above- and below-ground utilities and sidewalks. Of particular concern in Traverse City is the problem of sidewalk heaving caused by the increase in girth of the roots of the adjacent tree. The city has a responsibility to its citizens to reduce this hazard. Replacement of heaved sections is expensive both in terms of materials and manpower and often in terms of tree health.

The purpose of identifying sidewalk problems during the inventory was threefold. First was to determine the magnitude of this problem and record the species, size, and location of this problem. A copy of this information was provided to the city so that locations of repairs could be more easily identified. Second was to determine the relationships between size and species causing sidewalk heaving. From this information, recommendations on future plantings to avoid this problem could be made. Lastly, by noting the location of each new sidewalk section, species, size, and condition could be determined for trees injured by sidewalk repair. These data lead to recommendations for future sidewalk repair.

Size and Species Causing Heaving

The survey identified 806 instances of tree roots heaving adjacent sidewalk sections. Sidewalk heaving was noted as either a vertical displacement less than one-half inch (432 trees) or greater than one-half inch (374 trees). In all, about one out of ten street trees were causing heaving. In general, districts having older trees had a higher incidence of sidewalk heaving. District Five* had the highest percentage of trees causing this problem, with one out of five trees heaving sidewalks.

It was found that there is a direct relationship between the size (age) of trees and the incidence of heaving. Table 11 shows that as trees grow, sidewalks are more frequently lifted. In fact, the rate of heaving is over sixteen percent when the tree is mature, and this increases

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*See District Map, page 2.

to over twenty percent when the tree is functionally old. When relating species to sidewalk heaving, it is seen that certain species are more prone to this condition. Table 12 outlines this by relating species to incidence of sidewalk heaving.

In all, sugar maples accounted for over sixty-two percent of all recorded instances of heaving. About fourteen percent of all sugar maples are heaving sidewalks. Basswood and black locust were species found to have the highest percentage of sidewalk heaving. This is probably because most of the trees in each of these species populations are older. The oaks had the lowest incidence of heaving recorded. This is in spite of the fact that both these species populations are made up mostly of older trees, indicating a difference in rooting patterns.* Maples characteristically have shallow, spreading root systems, and as these roots thicken, sidewalk displacement frequently occurs. Oaks, on the other hand, are generally more deeply rooted and hence interfere less frequently with sidewalks.

To determine why such a high incidence of heaving has occurred, it is necessary to consider past planting practices. Planting shallow-rooted species such as maples will eventually cause some sidewalk problems, but the frequency of heaving can be significantly reduced by planting farther away from the sidewalk. Treelawn widths through most of the

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*Age distributions for some common species are given in Appendix C.

Table 11. Sidewalk Heaving by Functional Age Class of Trees (Traverse City Inventory, 1982).

Functional Age Class		No. of Heaves	% of Age Class	% of All Heaves
Young*	(1-9")	48	1.9	6.0
Intermediate	(9-14")	168	10.7	20.2
Mature	(15-24")	445	16.2	55.2
Old	(>25")	150	20.7	18.6
	Totals	**806**		**100 %**

*Young trees have probably not caused heaving but are most likely replacements of the tree that caused heaving. Sidewalks should have been repaired when the first tree was removed.

Table 12. Sidewalk Heaving by Tree Species (Traverse City Inventory, 1982).

Species		No. of Heaves	% of Species	% of All Heaves
Basswood		15	17.8	1.9
Black Locust		15	16.9	1.9
Boxelder		11	15.7	1.4
Sugar Maple		501	13.8	62.2
Silver Maple		29	13.5	3.6
Red Maple		53	13.2	6.6
Norway Maple		102	11.3	12.7
White Oak		19	5.9	2.4
Red Oak		24	5.7	3.0
	Totals	**796**		**95.7%**

city are six feet or greater. In fact, eighty-six percent of all trees inventoried were on a treelawn wider than six feet. However, most trees in the city are planted within three feet of the sidewalk, and more recent plantings are made at about thirty inches from sidewalk to tree.

The area where roots grow away from the trunk is known as the root crown. This root crown has a greater radius than the trunk at breast height (dbh). For example, a twenty-six-inch dbh tree that was planted thirty inches from the sidewalk is now seventeen inches away from the sidewalk (30 - 13-inch tree radius dbh = 17 inches). If the radius of the root crown of this tree is eight or ten inches greater than at dbh, this places the root crown within one foot of the sidewalk. If several major roots are growing out from the root crown, seeking the less restrictive growing space of the front lawn, a high incidence of sidewalk heaving can be expected as these roots increase in girth. This example reflects a common condition in the city.

Effects of Sidewalk Repair on Street Trees

When city crews repair displaced sidewalks, a fairly standard procedure is followed. The heaved section is broken up and removed; the underlying material is dug up and roots cut to a minimum depth of fifteen inches. The underlying soil is replaced, and the new section poured. During the inventory, 474 new sidewalk sections adjacent to trees were recorded. This amounts to about six percent of all trees. In all, about ninety-two percent of all identified new sidewalk sections noted were adjacent to maples. As seen in Table 13, it was found that sections had been replaced more frequently next to older trees.

To more clearly demonstrate the effect of root cutting for new sidewalks, an analysis of size versus condition class was made. By comparing the condition classes for those trees that had new sections and those that did not in each diameter class, it was found that trees next to new sidewalk sections generally had lower overall condition classes. From this analysis and observations made by the city sidewalk crew, homeowners, and Mr. Melkild, it can be said that root cuts made for sidewalks reduce tree vigor. As an example, Table 14 shows the relationship between condition class and sidewalk replacement for sugar maple. This table demonstrates that the overall condition classes are lower for sugar maple with new sidewalks than those without new sidewalks.

Recommendations for Sidewalk Repair

As demonstrated by the previous section, the repair of sidewalk heaving will continue to be a major maintenance task for the city. To help prevent this problem in the future, it is recommended that shallow-rooted species, such as maples, be planted only on treelawns six feet or wider and be planted in the middle of the treelawn or a minimum of

Table 13. New Sidewalk Sections as Related to Functional Tree Age (Traverse City Inventory, 1982).

Functional Age (dbh)		No.	% of All New Sections
Young	(1-9")	16	3.4
Intermediate	(10-14")	61	12.9
Mature	(15-24")	298	62.9
Old	(>25")	99	20.8
	Totals	**474**	**100 %**

Table 14. Relationship Between Condition Class and New Sidewalks for Sugar Maple (Traverse City Inventory, 1982).

Condition Class	% With New Sidewalk	% Without New Sidewalk
Excellent	3.0	18.2
Good	50.8	49.1
Fair	24.3	16.6
Poor	11.5	8.1
Very Poor	10.4	8.0

four feet from the sidewalk. This recommendation is the only long-term measure to control sidewalk heaving. Once the city has determined that a section is in need of replacement, it is recommended that it follow the sequence outlined below (Elias and Wittaker 1975):

(1) Repair the sidewalk section as soon as heaving is noticeable thereby using less labor and inflicting less damage to tree roots, or instead of immediate replacement, use asphalt between the heaving and adjacent sections forming a sort of small ramp. Replacement of the section could then be delayed until the tree dies and must be removed.

(2) Remove section.

(3) Remove soil to expose the roots causing heaving.

(4) Prune roots as little as possible to restore sidewalk grade. Paint all pruning wounds with tree wound dressing.

(5) Adjust sidewalk grade with sand.

(6) Repour sidewalk or reset section. If root crown is near, leave a semi-circle or square out of the new section to allow for lateral growth.

(7) Prune the adjacent tree. Root pruning the adjacent tree disturbs the balance between roots and crown, and for this reason there should be a proportionate amount of foliage removed to restore the balance. This pruning should be done by a qualified crew as soon as possible after the root cuts are made.

Even following these recommendations, some tree mortality will occur. This is especially true since most root cuts will involve older trees that are naturally in lower vigor. However, these recommendations offer the greatest hope for insuring higher survival rates after root cuts for sidewalk repair.

Development of Standards and Specifications

It is recommended that the city forester of Traverse City prepare tree work standards and specifications for work to be done on street trees. These specifications should be referenced in the city ordinance and, upon their completion, be approved by the City Commission. Good standards and specifications are the basis for consistent and high quality tree management. Clear requirements for tree work are important for providing performance standards for city tree crews or for developing contracts for private contractors. To aid in the development of standards and specifications, examples of standards and specifications from the National Arborists Association and from the International Society of Arboriculture should be consulted.

Records and Record Keeping

The importance of keeping accurate records when managing street trees cannot be overemphasized. The street tree inventory that was conducted in 1982 provides a solid base of information for future management. It demonstrates that accurate information on street tree conditions, locations, and management requirements serves a useful purpose in directing scarce resources to highest priority street tree needs.

It is recommended that as forestry activities are performed, records be kept on planting, maintenance, and removals. Eventually, these records will indicate tree species which have been most successful as street trees and will show how maintenance activities affect long-term tree performance. Also, records help show how public funds have been spent and help to direct management toward the most efficient future use of these funds.

It is further recommended that as these activity records are received this information be processed onto the current data file obtained from the inventory. A unique aspect of the inventory system used is that it produces data accessible through an interactive system so that information can be periodically updated. With this system, work performed on individual trees is recorded throughout the year, and summaries can be obtained showing work accomplished and future management requirements. The use of computerized record keeping can be an invaluable tool in the more efficient management of public trees in Traverse City.

The Public and Public Trees

That citizens are concerned about the public trees of Traverse City is evidenced by the commission of this study and by the great interest expressed by homeowners during the survey. The survey crew spent a fair portion of its time confronted by mostly interested, but sometimes irate, residents. Once they were assured that no one was harming "their tree," they often asked why the study was being conducted followed by more specific questions on tree species, age, and condition. In general, most residents realized the value that the tree(s) contributed to the appearance and value of their neighborhood and property. However, some complained about sidewalk heaving, city care of the tree, too much shade, excessive litter drop, and other problems.

The comment made by Mr. Majerczyk that "No matter what else we do, they never forget what we did or didn't do to the tree in front of their house" demonstrates the personal interest that many homeowners have in their trees. After all, the homeowner sees the tree each day, and its care plays a role in his general perception of the city government and the services it provides.

Good public relations is critical in a tree care program (Schroeder 1985). Citizens should be given a role in determining management practices that directly affect "their" trees and the public trees of the community in general. For instance, a leaflet or flyer given to a homeowner when a tree is planted will let the citizens know how the city is spending their taxes. It will also encourage the homeowner to care for the tree - perhaps watering it during dry periods or periodically replenishing the mulch around its base.

Responding quickly to resident complaints and requests will improve the credibility of the tree care unit. An improved relationship between residents and the tree care unit will result in a more positive attitude towards the tree program in general and will generate more support, both verbal and monetary.

It is recommended that publicity and promotion of forestry activities be a regular function of the forestry unit. Special events, such as dedications and memorial plantings and Arbor Day, are highly visible and serve to promote general forestry activities. It is also recommended that the city apply to the State Urban Forester for an application to become a "Tree City — USA" as Traverse City fulfills all of the requirements of this National Arbor Day Foundation project.

CHAPTER 4

A FIVE-YEAR PLAN FOR THE SYSTEMATIC MANAGEMENT OF STREET TREES

The 7,514 trees lining the streets of Traverse City represent a substantial value to the city. Their value has been conservatively estimated to be about nine million dollars (Ruth, et al., 1982; see Appendix G). In addition to this value, the city spends about seventy-five thousand dollars a year to maintain these trees. The annual tree care budget is about ten dollars per tree per year and an annual per capita expenditure of about four dollars.

It should be noted, especially in these times of budget restrictions and dollar-stretching efforts, that while many city expenditures involve capital investment in projects that decline in value, investment in tree planting and maintenance is an investment in a commodity that increases in value. The five-year management plan that follows is based on the results of the 1982, 100% street tree inventory of Traverse City. It is recommended that the city use these figures as a basis for future city forestry activities. In this way, the City of Traverse City will continue to protect past investments and ensure a higher future value of the urban forest.

The information collected in the inventory and presented earlier in this report indicates that the overall street tree situation is presently good. Although species diversity is fairly low, the forest is all aged, and most trees are in good to excellent condition. In addition, the maintenance requirements for most trees are neither abnormally high nor unexpected.

This plan is intended to serve as a guide. It attempts to establish tree management priorities, scheduling, and budget estimates based on the inventory results. The numbers of trees are an approximation. Costs are based on previous studies and reports from other Michigan cities and are intended strictly as reasonable guidelines.

Based on the survey, the following recommended amount of work should be conducted over the next five years:

(1)	<u>Removals</u>:	250 per year for first two years 150 per year for remaining three years
(2)	<u>Planting</u>:	250 per year for first two years 300 per year for remaining three years
(3)	<u>Pruning</u>:	
	Hangers:	51 for first year 20 per year for remaining four years
	Deadwood Removal:	(prune only higher priority recommendations) 1,877 total or 375 per year
	Crown Thinning:	(prune only higher priority recommendations) 1,831 total or 366 per year

Crown Lifting:	100 first two years
	50 per year for remaining years
Training:	(all trees in need of training)
	1,692 total or 338 per year

(4) Fertilization: 1,265 total or 253 per year

(5) Damage Control:

Damage Prevention:	repair girdling roots, 25 per year
	cable/brace, 100 per year
Damage Repair:	repair injury
	50 per year

(6) Insect and Disease Control — chemical and nonchemical controls

50 per year

The cost of this work is outlined in Table 15, which shows a maintenance activity and budget worksheet for 1983 to 1988.

Table 15. Municipal Tree Care - Traverse City.
Maintenance Activity and Budget Worksheet for 1983-1988.

	Activity	Unit Cost	1983 $ (No.)	1984 $ (No.)	1985 $ (No.)	1986 $ (No.)	1987 $ (No.)
(1)	**Removals**	90.00	22,500 (250)	22,500 (250)	13,500 (150)	13,500 (150)	13,500 (150)
(2)	**Planting**	60.00	15,000 (250)	15,000 (250)	18,000 (300)	18,000 (300)	18,000 (300)
(3)	**Pruning**						
	Remove Hangers	6.50	322 (51)	130 (20)	130 (20)	130 (20)	130 (20)
	Remove Deadwood	55.00	20,625 (375)	20,625 (375)	20,625 (375)	20,625 (375)	20,625 (375)
	Crown Thinning	13.70	5,014 (366)	5,014 (366)	5,014 (366)	5,014 (366)	5,014 (366)
	Crown Lifting	15.00	1,500 (100)	1,500 (100)	750 (50)	750 (50)	750 (50)
	Crown Training	6.00	2,328 (388)	2,328 (388)	2,328 (388)	2,328 (388)	2,328 (388)
(4)	**Fertilization**	15.00	3,795 (253)	3,795 (253)	3,795 (253)	3,795 (253)	3,795 (253)
(5)	**Damage Control**						
	Remove Girdling Roots	40.00	1,000 (25)	1,000 (25)	1,000 (25)	1,000 (25)	1,000 (25)
	Cable/Brace	39.00	3,900 (100)	3,900 (100)	3,900 (100)	3,900 (100)	3,900 (100)
(6)	**Insect and Disease Control**	5.00	1,000 (200)	1,000 (200)	1,000 (200)	1,000 (200)	1,000 (200)
	ESTIMATED TOTAL MAINTENANCE EXPENSE		$77,000	$76,800	$70,000	$70,000	$70,000

CHAPTER 5

SUMMARY, CONCLUSION, AND POSTSCRIPT

Summary of Findings

The 100% city street tree inventory of Traverse City was conducted to identify present overall composition and condition of the street tree population, to identify current management requirements of the urban forest, and lastly, to develop a plan of action for the future.

A total of 7,595 trees and shrubs were individually inventoried. Trees representing thirty-eight genera and sixty-one species were identified. Almost ninety percent of all street trees were in five genera: maple, oak, pine, elm, and ash. In all, nearly seventy percent of all street trees were maples, with sugar maple making up about forty-eight percent of the total population. Analysis of size distribution showed a fairly all-aged population, with good representation in each size class.

The condition of the street tree population is at present mostly good to excellent (66%). However, the incidence of dieback at ten percent of all trees is high. Dieback was especially noticeable in sugar maple, with almost fifteen percent exhibiting dieback symptoms.

During the inventory, management requirements for planting, maintenance, and removal were noted. In general, Traverse City has had a fairly continuous history of planting and replanting. This has led to the fairly all-aged street tree population that currently exists. Recommendations on planting, priorities, species selection and diversity, and replanting schemes were suggested to insure that the tradition of tree-lined streets is continued.

The maintenance requirements for the street tree population is not excessively high. However, recommendations were made to establish priorities for maintenance work so that the hazard to persons and properties is reduced. Also, recommendations were made to aid the city in directing resources towards insuring a more aesthetic, healthy, and longer-lived street tree population.

About six percent of the tree population is in need of removal. The percentage of removals rises rather steadily as trees increase in size. The high percentage of removals at smaller sizes points to the need for a program of systematic maintenance for streetside trees. Analysis of removal recommendations also suggests that sugar maples are more intolerant to urban stresses than other species planted streetside. An overall increase in removals can be expected within the next twenty years as the older segment of the population, especially sugar maples, die.

The conflict between trees and sidewalk repair was also noted. In all, about one in ten trees were found adjacent to heaved sidewalk sections. Analysis shows that when root cuts are made for sidewalk repair, the condition of the adjacent tree is usually lowered. Recommendations were made to, first, lower the incidence of sidewalk heaving in the future, and second, to minimize the damage to existing trees when sidewalks are repaired.

Lastly, a five-year plan for the systematic management of street trees was presented. Based on the 100% inventory of city street trees, a plan was outlined attempting to establish tree management priorities, scheduling, and budget estimates.

Conclusion

The street tree resource of Traverse City is currently in good condition. Recommendations provided in the study were mostly directed towards the establishment of an integrated or systematic tree care program. This program could insure healthy, aesthetic street trees far into the future by providing care over the life of the tree.

However, the city should pay particular attention to the older segment of the street tree population. It was suggested that the city prepare a master street tree planting plan based on recommendations provided so that orderly replacement will take place. It was also recommended that more attention be provided to the younger segment of the population. Many of these trees currently have nutrient problems and training requirements that, if left unchecked, may considerably lower their future utility and value.

Lastly, the city may want to consider new or alternative sources of revenue production for urban forestry activities. One possible method could be a cost-sharing arrangement for new tree establishment. Under this program, the homeowner could pay some percentage of the cost of tree planting, i.e., a 50:50 cost sharing with the city. Another revenue producing alternative for which Traverse City is uniquely suited is maple syrup production.

Traverse City has almost 2,500 sugar maples over ten inches in diameter. When tree size and number of taps per tree is considered, the city has a 6,000 tap potential. Assuming three taps per gallon of finished syrup, the potential production could equal about 2,000 gallons of syrup. At twenty dollars a gallon, a gross return of about $40,000 could be anticipated. Annual expenses can be assumed to be between thirty to forty percent of the gross, yielding an average net annual return of between $24,000 and $28,000 per year after a two- to three-year pay back period for initial equipment investment (Giedraitis 1983).

The city may not wish to start up an operation of this size. It was found that large concentrations of older sugar maples are concentrated in certain areas of the city such as the Central Neighborhood. It is suggested that community leaders, such as those within the Central Neighborhood Association, set up a nonprofit organization chartered to devote profits from syrup production to perpetuating the tradition of street tree planting and care in the city. Volunteer labor would hold down annual expenses and provide for service and citizens' groups and individuals contributing to city beautification efforts.

It is recommended that the city further explore the possibility of sugar bush potential by contacting Athens Youth Council in Athens, Michigan; the Rotary Club in Union City, Michigan; and the Shepard Sugar Bush Corporation in Shepard, Michigan.

Postscript: 1990

The preceding thesis on Traverse City's urban forest is based on the street tree inventory conducted in 1982. The inventory results and management recommendations report written from the data obtained during the survey were presented to the City of Traverse City in early 1983. This report formed the basis for this thesis.

As a postscript to this thesis, a follow-up interview was conducted with Mr. John Fraser, current City Forester for Traverse City. Mr. Fraser was asked a series of questions based on the survey results and recommendations made both in the report to the city and in this thesis. As he has had the benefit of being with the City Forestry Unit for over fourteen years, Mr. Fraser has a good perspective on operations before the 1983 report was presented and what subsequent changes have been made.

The questions were asked in an attempt to determine what recommendations had been implemented and the overall value and utility of this street tree plan. Mr. Fraser was asked about the status of recommendations made for the following tree management areas: planting, maintenance, trees and sidewalks, standards and specifications, record keeping, public relations, and the five-year plan. His responses are outlined below and show that much of what was recommended in 1983 has since been implemented.

Planting

The Forestry Unit is planting between 80 to 100 trees each fall. Budget constraints limit planting below the recommended 300 trees per year. The Forestry Unit is using the inventory printout to locate planting spaces only after replanting the sites of previous removals and citizen planting requests have been satisfied. While the master tree selection list is used somewhat to match the correct tree species to the site available, the current nursery space limits the numbers of species available. It is hoped that in the near future, a larger nursery will be developed closer to town, possibly near the airport.

While the goal is to plant a more diverse urban forest by using such species as Norway maples, lindens, and honey locust, large shade trees still make up the bulk of street tree plantings. Smaller trees are used when overhead lines are a consideration. The distance between new trees is at least forty feet wherever possible, rather than the previous practice of planting trees at fifteen- to twenty-foot spacings.

Maintenance

The report given to the city and presented in this thesis gave several recommendations on maintenance. One was the use of the survey printout to schedule trimming. Mr. Fraser noted that although they had attempted to trim according to the printout, he found operations to be more efficient when block priorities were established. Entire blocks were trimmed instead of just trees with high ratings from the survey. To date, all districts have been trimmed based on the printout of block priorities.

Traverse City is now on a seven-year trim cycle, trimming almost 1,000 trees each year. About 60% to 70% of trimming follows a schedule during the fall, winter, and early spring, while the rest is on call and occurring mostly in the summer months. Priority for tree pruning is training first, followed by deadwood removal, homeowner request, and district block priorities.

Starting four years ago, the Forestry Unit began fertilizing all trees using in-ground injections with water-soluble fertilizers. Fertilization is now done on a four-year cycle for approximately 200 trees each year.

Information on girdling roots has proved to be useful only when there is an apparent decline in the top of the tree. The list of trees for cabling/bracing operations proved to be more useful information, and, after reinspection, some 15 to 20 trees are completed each year. When asked if the trees indicated as removals had been taken down, Mr. Fraser said that all the dead trees had been removed soon after they had received the survey. The exceptions were ones that, in the City Forester's opinion, were worth corrective treatments. These were trimmed and preserved.

Trees and Sidewalks

As was reported to the city and in this thesis, there was a considerable conflict between trees and sidewalks, especially when the latter were repaired. Mr. Fraser reports that this situation is much improved. Based on the suggestions made in the report, the Forestry Unit is working with the Street Department to ensure the new sidewalk repair program now being contracted out is well coordinated to ensure minimum tree root damage. This includes minimum digging, clean root cuts, and painting of root wounds.

Standards and Specifications

An Urban Forestry Committee of the Traverse City Commission was established three to four years ago. This committee reviewed the entire 1983 street tree plan and developed a proposed Urban Forestry Management Plan for Traverse City, which included standards and specifications for tree care. The status of this plan is now pending before the Commission. Mr. Fraser also indicated there is some concern now for protecting larger trees, but there is some reluctance to regulate actions on private property.

Record Keeping

Mr. Fraser indicated the inventory is now on an IBM personal computer, programmed at his request by Michigan State University. It is now possible to use the inventory and computer program for scheduling work and recording work histories. It can also be used to obtain summary reports, although Mr. Fraser said these reports are still being modified.

Public Relations

In the report and thesis, several recommendations on public relations were made. One involved a flier that could be handed out to the adjacent homeowner when a tree is planted. This has been developed and includes asking the homeowner to water the tree in the summer, since this operation is no longer conducted by the city. The city has also applied for and received the status of "Tree City, USA" from the National Arbor Day Foundation. An Arbor Day ceremony is now held every year on the third Friday in April. This event highlights the importance of trees in Traverse City and demonstrates public support to public officials.

Traverse City has also been recycling Christmas Trees for the past five years. Citizens are asked to bring their trees to any of 10 drop-off sites during the five weeks after Christmas. Trees are chipped by the city and used in city operations. Since the number of trees brought in last year (3,000) exceeded the number of households in the city, Mr. Fraser feels this program is very successful.

Five-Year Plan

Mr. Fraser was asked if the 1983 proposed Five-Year Management Plan had been used, as recommended, as a guide to establishing management priorities, scheduling, and estimating budgets. He stated it had not been used much, since once operations priorities have been established they must fit into available funding and political realities. Maple syrup production as a funding mechanism was also suggested in the Plan. Mr. Fraser stated they are currently not encouraging this activity on street trees, since they feel it may have the potential for injuring the tress.

Postscript Conclusion

The Street Tree Plan for Traverse City, Michigan, is now one of the oldest computerized tree survey and management plans in the United States. Mr. Fraser indicated he thought the inventory and plan were "fantastic" and very useful. Traverse City has implemented many of the suggested management recommendations and has used this pioneering inventory as a strong base for an urban forestry program that has grown from a $70,000 budget in 1982 to $195,000 in 1990.

The City Forester, City Commission, and citizens of Traverse City are rightfully proud of their city trees. Their continuing tradition of maintaining and improving their street tree resources will help ensure their urban forest will continue to provide its many benefits far into the future.

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APPENDICES

APPENDIX A

SAMPLE SURVEY FORM

LAND USE
1-Single 3-Multi 5-Industry 7-Church
2-Double 4-Business 6-Vacant 8-Govt.
Plus Ht. (stories) 1-one 2-two 3-more

Surface: 1) concrete 2) asphalt 3) gravel
Drainage: 1 Ditch; 2 Curb; 3 None

SIDE
N S E W ODD EVE BLV
1 2 3 4 5 6 7 Street ____________ ____ of ____ Sheets
From ____________ to ____________

Street Tree Survey ________
Date ________
Crew ________
Dist. ________

	ADDRESS	Corner Lot on this street but address on other st. Enter other street name	Land use	Building Height	Sidewalk (1)=yes	Treelawn width	1=existing tree 2=planting site 3=unplantable-site 4=unplantable-space	Distance from Lot Line (lower) NSEW	SPECIES	D B H	Height	% Crown dead	Condition class	RECOMMENDATIONS – TRIMMING: Lift 2 1	Train 3 2	Thin 3 2	Deadwood 4 2	Hanger 2 1	M Trim Rating	Remove	Girdling Root	Brace	Repair	Fertilize	Spray etc.	Sidewalk	COMMENTS or other Recommendations
1																											
2																											
3																											
4																											
5																											
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Figure A. Sample Inventory Form Used in 1982 Street Tree Inventory, Traverse City, Michigan.

APPENDIX B

SUMMARY OF SURVEY RESULTS BY CITY DISTRICT

Table B.1. Species Distribution of the Most Frequently Occurring Trees by District (Traverse City Inventory, 1982)

Species	Total Trees	All City	Percent of District Trees Represented by Each Species								
			1	2	3	4	5	6	7	8	9
Sugar Maple	3,633	47.8	67.3	65.7	50.6	44.8	59.4	12.9	27.5	17.1	15.8
Norway Maple	902	11.9	9.6	13.9	16.1	10.2	14.7	3.8	13.1	4.6	18.7
Red Oak	417	5.5	0	0	1.5	2.2	4.0	23.8	7.6	19.6	1.2
Red Maple	402	5.3	1.1	5.8	5.3	5.3	7.2	8.4	3.7	6.7	0
White Oak	324	4.3	0.1	1.3	4.0	1.2	2.3	20.5	2.7	9.3	1.2
White Pine	249	3.3	0.2	0.2	0.8	0	0.2	3.5	13.2	15.7	2.3
Silver Maple	216	2.8	2.5	3.4	6.8	1.2	3.3	1.2	0.6	0.1	0
Siberian Elm	169	2.2	2.0	0.7	3.4	0.7	1.8	5.1	2.7	2.9	2.9
Green Ash	118	1.6	1.5	0.4	0.4	19.6	0.7	0.6	0	0.1	0
Black Locust	87	1.1	0.9	0.4	1.1	2.4	0.9	3.0	1.5	1.4	0
Basswood	84	1.1	3.4	1.7	0.3	1.0	0.7	0.1	0.4	0.1	0
Red Pine	82	1.1	0	0.8	0.4	0	0	3.3	2.4	2.4	2.3
Crabapple	79	1.0	1.0	0.1	0.4	3.6	0.4	0.1	0.6	1.3	18.7
Boxelder	70	0.9	1.0	0.5	1.9	0	1.2	2.5	0.1	0	0
Norway Maple 'Crimson King'	67	0.9	0.6	0.4	1.0	0	0	0.3	2.8	2.6	1.2
Honeylocust	65	0.9	1.0	0.1	1.2	3.9	0.1	0	0.3	0	12.3
White Ash	48	0.6	0.3	0.6	0.9	0.2	0.1	0.3	1.1	1.3	0.6
Blue Spruce	46	0.6	0.2	0	0.4	0.7	0	0.9	1.7	1.6	3.5
Birches	44	0.6	0.2	0.04	0.3	1.2	0.4	0.6	0.8	2.0	3.5
White Cedar	43	0.6	0.7	0	0.6	0.2	0	0.4	2.1	1.4	0
Others	450	5.9	4.1	3.1	2.3	1.2	1.2	8.7	15.1	9.7	4.1
Total	7,595										

Table B.2. Diameter Classes for Street Trees, All City and by District. (Traverse City Inventory, 1982).

District	Total Trees	Mean Diameter (inches)	Percent of District Trees in Each Diameter Class								
			1-4"	5-9"	10-14"	15-19"	20-24"	25-29"	30-34"	>35"	Shrub
All City	7,595	14.5	14.1	19.2	20.1	19.0	17.1	6.2	2.6	0.8	0.7
One	886	15.5	12.4	18.3	15.7	18.1	20.3	9.1	3.5	2.1	0.2
Two	2,067	17.5	11.6	5.6	14.9	22.6	28.7	9.9	5.1	0.9	0.3
Three	1,141	13.6	13.8	21.4	23.0	18.1	14.7	5.8	1.5	0.7	0.4
Four	413	11.3	31.0	21.3	11.9	14.3	13.3	6.1	1.9	0.2	0
Five	818	13.6	15.3	19.3	20.2	22.0	14.9	5.3	1.8	0.3	0.4
Six	689	14.3	14.8	27.0	24.7	18.1	7.7	2.8	1.2	0.1	3.2
Seven	710	13.1	10.1	23.7	33.1	20.8	7.2	2.0	0.8	1.2	0.8
Eight	700	11.7	15.7	36.9	21.1	12.1	10.0	2.3	0.1	0.4	1.1
Nine	171	9.6	17.0	40.9	29.2	5.3	3.5	2.3	1.8	0	0

*Diameter measured at 4.5 feet above ground level.

Table B.3. Condition Classes for Trees, All City and by District (Traverse City Inventory, 1982)

District	Total Trees	Percent of District Trees in Condition Class					
		Excellent	Good		Fair	Poor	Very Poor
		90-100%	80-89%	70-79%	60-69%	50-59%	49%
All City	7,595	13.4	23.2	29.6	18.9	7.7	7.2
One	886	14.7	24.6	28.3	19.0	6.9	6.5
Two	2,067	6.0	19.2	33.8	23.2	10.4	7.5
Three	1,141	14.8	27.1	28.3	16.7	7.2	5.9
Four	413	14.8	37.3	30.8	8.5	3.1	5.6
Five	818	17.0	23.3	27.0	15.4	8.1	9.2
Six	689	8.1	19.6	29.9	23.5	11.0	9.6
Seven	710	30.1	19.2	20.7	15.4	5.1	9.6
Eight	700	16.9	24.3	30.1	19.9	3.6	5.3
Nine	171	4.7	29.2	35.7	15.8	8.8	5.8

Table B.4. Number of Planting Sites Recorded by District (Traverse City Inventory, 1982).

District	Planting Sites	District	Planting Sites
All City	3,064	Five	228
One	238	Six	882
Two	315	Seven	256
Three	498	Eight	393
Four	64	Nine	190

Table B.5. Pruning Recommendations Recorded for Street Trees (Traverse City Inventory, 1982).

District	Total Trees	Percent of District Trees with Pruning Recommendations by Priority									
		Lift		Thin		Train		Deadwood		Hanger	
		Low	High	Low	High	Low	High	Low	High	Low	High
All City	7,595	7.2	2.4	34.4	24.1	10.8	11.5	23.9	24.7	2.3	0.7
One	886	9.6	1.1	33.6	30.1	10.4	18.8	21.3	33.6	3.4	0.6
Two	2,067	3.6	1.1	42.0	28.2	5.6	6.8	27.7	36.8	2.4	1.2
Three	1,141	8.2	3.2	37.0	32.3	12.2	15.2	23.7	21.4	3.1	0.4
Four	413	20.1	4.8	22.5	54.0	4.6	28.1	30.5	24.9	5.3	1.0
Five	818	7.2	1.3	40.7	20.4	13.2	13.0	25.3	23.1	2.8	0.6
Six	689	8.1	7.4	27.4	10.2	12.0	11.6	24.2	15.7	0.6	0.7
Seven	710	6.2	2.7	65.4	9.0	17.7	3.7	16.8	9.6	0.3	0.1
Eight	700	7.3	1.9	27.6	8.1	16.1	7.9	22.0	13.4	0.9	0.4
Nine	171	2.9	1.8	21.6	18.1	15.2	3.5	7.6	7.0	0.6	0

Table B.6. Management Recommendations Other Than Pruning for Street Trees (Traverse City Inventory, 1982).

District	Total Trees	Percent of District Trees by Recommendations								
		Remove	Girdling Roots	Cable/ Brace	Repair	Fertilize	Insects	Disease	Sidewalk Heave $< \frac{1}{2}''$	Sidewalk Heave $> \frac{1}{2}''$
All City	7,595	6.5	6.3	6.7	4.8	16.7	2.4	1.4	5.7	4.9
One	886	6.2	7.4	3.3	2.0	8.9	3.4	1.6	6.8	8.2
Two	2,067	7.2	9.1	7.2	2.9	13.3	0.6	0.5	5.7	5.5
Three	1,141	5.7	7.9	9.4	5.9	28.8	3.8	1.3	7.5	4.4
Four	413	8.5	6.3	4.1	0.2	38.0	4.4	0	14.8	10.9
Five	818	8.7	9.4	8.7	6.5	28.6	1.5	0.7	11.2	9.4
Six	689	8.3	0.6	9.6	10.6	8.9	2.0	3.9	1.5	1.6
Seven	710	5.2	1.1	6.2	5.9	5.8	2.4	2.4	0.4	0
Eight	700	2.6	1.4	3.4	4.7	7.7	3.6	2.4	0.3	0.7
Nine	171	4.1	6.4	0.6	10.5	20.5	4.1	0.6	0	0

Table B.7. Problems Encountered with Street Trees (Traverse City Inventory, 1982).

District	Total Trees	Percent of District Trees by Problem				
		Dieback	Injury	Rot	Sidewalk Cut	Frost Crack
All City	7,595	9.6	4.2	1.5	6.3	1.1
One	886	11.3	1.2	0.1	5.8	0.1
Two	2,067	10.1	1.0	0.4	10.3	0.2
Three	1,141	10.1	3.3	2.1	7.2	1.1
Four	413	24.5	1.5	0	10.2	0
Five	818	14.7	3.8	5.0	11.9	0.2
Six	689	4.2	8.7	4.8	0.4	2.8
Seven	710	2.4	.56	0.3	0.1	2.8
Eight	700	1.7	7.6	1.0	0.4	1.6
Nine	171	18.7	34.5	0.6	0	7.6

APPENDIX C

CITY-WIDE EVALUATION OF SIZE AND CONDITION FOR SELECTED STREET TREE SPECIES

Table C.1. Evaluation of Size and Condition: Sugar Maple (Traverse City Inventory, 1982).

Functional Age of Tree	Tree Diameter Class (Inches)	Trees in Diameter Class		Percent of Trees in Diameter Class by Condition Class				
		Total Number	% of Total	Excellent (100-90%)	Good (89-70%)	Fair (69-60%)	Poor (59-50%)	Very Poor (49%)
Young	1-4	617	17.0	32.3	51.5	6.6	3.2	6.3
	5-9	558	15.4	43.4	43.4	6.5	2.2	4.7
Intermediate	10-14	559	15.4	21.5	44.9	15.6	8.2	9.8
Mature	15-19	659	18.2	6.1	52.5	19.4	10.8	11.2
	20-24	793	21.9	1.3	52.8	25.6	11.6	8.7
Old	25-29	300	8.3	1.3	48.7	29.3	13.0	7.7
	30-34	115	3.2	0	47.0	31.3	15.6	6.1
	35-39	16	0.4	0	43.8	18.8	31.1	6.3
	>40	5	0.1	0	20.0	40.0	20.0	20.0
Total		**3,623**	**100**	**16.9**	**49.2**	**17.2**	**8.4**	**8.2**
% for All Street Trees				**13.4**	**52.8**	**18.9**	**7.7**	**7.2**

*Diameter measured at 4.5 feet above ground level.

Table C.2. Evaluation of Size and Condition: Norway Maple (Traverse City Inventory, 1982).

Functional Age of Tree	Tree Diameter Class (Inches)	Trees in Diameter Class		Percent of Trees in Diameter Class by Condition Class				
		Total Number	% of Total	Excellent (100-90%)	Good (89-70%)	Fair (69-60%)	Poor (59-50%)	Very Poor (49%)
Young	1-4	59	6.6	25.4	64.4	5.1	0	5.1
	5-9	224	24.9	35.7	56.7	5.8	1.3	0.4
Intermediate	10-14	275	30.6	20.0	57.8	14.9	5.1	2.2
Mature	15-19	204	22.8	8.3	57.8	21.6	7.8	4.4
	20-24	112	12.5	1.8	64.3	17.9	11.6	4.5
Old	25-29	19	2.1	5.3	73.7	15.8	5.3	0
	30-34	3	0.3	0	100	0	0	0
	35-39	0	0	0	0	0	0	0
	>40	2	0.2	0	0	0	0	100
Total		**898**	**100**	**18.9**	**59.1**	**13.8**	**5.2**	**3.0**
% for All Street Trees				**13.4**	**52.8**	**18.9**	**7.7**	**7.2**

*Diameter measured at 4.5 feet above ground level.

Table C.3. Evaluation of Size and Condition: Red Maple (Traverse City Inventory, 1982).

Functional Age of Tree	Tree Diameter Class (Inches)	Trees in Diameter Class		Percent of Trees in Diameter Class by Condition Class				
		Total Number	% of Total	Excellent (100-90%)	Good (89-70%)	Fair (69-60%)	Poor (59-50%)	Very Poor (49%)
Young	1-4	21	5.3	14.3	66.7	14.3	0	4.5
	5-9	92	23.4	9.8	40.2	28.3	11.9	7.6
Intermediate	10-14	137	34.8	5.8	60.6	16.1	11.7	5.8
Mature	15-19	101	25.6	3.9	47.5	27.8	14.9	5.9
	20-24	33	8.4	0	54.5	27.3	3.0	15.2
Old	25-29	8	2.0	0	62.5	25	12.5	0
	30-34	2	0.5	0	50	0	0	50
	35-39	0	0	0	0	0	0	0
	>40	0	0	0	0	0	0	0
Total		**394**	**100**	**6.0**	**51.8**	**23.9**	**11.1**	**7.3**
% for All Street Trees				**13.4**	**52.8**	**18.9**	**7.7**	**7.2**

*Diameter measured at 4.5 feet above ground level.

Table C.4. Evaluation of Size and Condition: Silver Maple (Traverse City Inventory, 1982).

Functional Age of Tree	Tree Diameter Class (Inches)	Trees in Diameter Class		Percent of Trees in Diameter Class by Condition Class				
		Total Number	% of Total	Excellent (100-90%)	Good (89-70%)	Fair (69-60%)	Poor (59-50%)	Very Poor (49%)
Young	1-4	8	3.7	0	62.5	12.5	12.5	12.5
	5-9	9	4.2	0	55.5	33.3	11.1	0
Intermediate	10-14	51	23.6	0	66.7	23.5	7.8	2.0
Mature	15-19	54	25.0	0	54.5	21.8	14.5	9.2
	20-24	48	22.2	0	52.1	29.2	12.5	6.2
Old	25-29	22	10.2	0	45.5	31.8	18.2	4.5
	30-34	18	8.3	0	55.6	33.3	11.1	0
	35-39	5	2.3	0	60.0	40.0	0	0
	>40	1	0.5	0	100	0	0	0
Total		**216**	**100**	**0**	**56.0**	**26.4**	**12.0**	**5.5**
% for All Street Trees				**13.4**	**52.8**	**18.9**	**7.7**	**7.2**

*Diameter measured at 4.5 feet above ground level.

Table C.5. Evaluation of Size and Condition: Red Oak (Traverse City Inventory, 1982).

Functional Age of Tree	Tree Diameter Class (Inches)	Trees in Diameter Class		Percent of Trees in Diameter Class by Condition Class				
		Total Number	% of Total	Excellent (100-90%)	Good (89-70%)	Fair (69-60%)	Poor (59-50%)	Very Poor (49%)
Young	1-4	19	4.6	21.1	57.9	15.8	10.5	0
	5-9	45	10.5	8.9	62.2	26.7	6.7	8.9
Intermediate	10-14	89	21.4	2.4	52.8	30.3	10.1	4.5
Mature	15-19	117	28.1	3.4	56.4	23.9	11.9	4.3
	20-24	76	18.3	2.6	61.8	30.3	2.6	2.6
Old	25-29	40	9.6	0	55.0	32.5	10.0	2.5
	30-34	22	5.3	0	54.5	36.4	9.1	0
	35-39	5	1.2	0	80.0	20.0	0	0
	>40	3	0.7	33.3	33.3	0	0	33.3
Total		**416**	**100**	**2.9**	**57.2**	**27.6**	**8.7**	**3.6**
% for All Street Trees				**13.4**	**52.8**	**18.9**	**7.7**	**7.2**

*Diameter measured at 4.5 feet above ground level.

Table C.6. Evaluation of Size and Condition: White Oak (Traverse City Inventory, 1982).

Functional Age of Tree	Tree Diameter Class (Inches)	Trees in Diameter Class		Percent of Trees in Diameter Class by Condition Class				
		Total Number	% of Total	Excellent (100-90%)	Good (89-70%)	Fair (69-60%)	Poor (59-50%)	Very Poor (49%)
Young	1-4	13	4.0	15.4	69.2	15.4	0	0
	5-9	46	14.2	0	58.7	30.4	10.9	0
Intermediate	10-14	93	28.8	1.1	62.4	25.8	6.5	4.3
Mature	15-19	69	21.4	0	78.3	4.3	10.1	7.2
	20-24	61	18.9	1.6	62.3	26.2	4.9	4.9
Old	25-29	26	8.0	3.8	50.0	38.5	3.8	3.8
	30-34	9	2.8	0	88.9	11.1	0	0
	35-39	3	0.9	0	66.7	33.3	0	0
	>40	3	17.6	0	100	0	0	0
Total		**323**	**100**	**1.5**	**61.6**	**25.1**	**6.8**	**4.0**
% for All Street Trees				**13.4**	52.8	**18.9**	7.7	7.2

*Diameter measured at 4.5 feet above ground level.

APPENDIX D

MASTER TREE SELECTION LIST FOR TRAVERSE CITY

TRAVERSE CITY TREE SELECTION GUIDE

Situation: Residential area
Treelawn 3-6 feet
Overhead wires at 25 feet

Recommended Selections

Acer campestre	- Hedge Maple
Acer ginnala	- Amur Maple
Carpinus betulus	- European Hornbeam
Carpinus caroliniana	- American Hornbeam
Crataegus spp.	- Hawthorn
Koelreuteria paniculata	- Golden Rain Tree
Malus spp.	- Crabapple
Pyrus calleryana 'Bradford'	- Bradford Pear

Situation: Residential area
Treelawn 3-6 feet
No overhead wires

Recommended Selections

Acer rubrum 'Scanlon'	- Scanlon Red Maple
Acer saccharum 'Monumentale'	- Newton Sentry Sugar Maple
Acer saccharum 'Goldspire'	- Goldspire Sugar Maple
Cladrastis lutea	- Yellow Wood
Fraxinus pennsylvania var. *lanceolata*	- Marshall's Seedless Ash
Fraxinus velutina	- Modesto Ash
Gleditsia triacanthos inermis	- Thornless Honey Locust
Ginkgo biloba	- Ginkgo
Ostrya virginiana	- Hop Hornbeam
Phellodendron amurense	- Amur Corktree
Pyrus calleryana 'Bradford'	- Bradford Pear
Quercus palustris	- Pin Oak
Sophora japonica	- Japanese Pagoda Tree
Tilia cordata	- Littleleaf Linden
Ulmus parvifolia	- Chinese Elm
Zelkova serrata	- Japanese Zelkova

Situation: Residentail area
Treelawn greater than 6 feet
Overhead wires at 25 feet

Recommended Selections

Acer campestre - Hedge Maple
Acer ginnala - Amur Maple
Carpinus betulus - European Hornbeam
Carpinus caroliniana - American Hornbeam
Crataegus phaenopyrum - Washington Hawthorn
Koelreuteria paniculata - Golden Rain Tree
Malus spp. - Crabapple

Situation: Residential area
Treelawn greater than 6 feet
No overhead wires

Recommended Selections

Acer platanoides - Norway Maple
Acer rubrum - Red Maple
Acer saccharum - Sugar Maple
Cercidiphyllum japonicum - Katsura Tree
Cladrastis lutea - Yellow Wood
Fraxinus spp. - Ash
Ginkgo biloba - Ginkgo
Gleditsia triacanthos inermis - Thornless Honey Locust
Ostrya virginiana - Hop Hornbeam
Phellodendron amurense - Amur Cork Tree
Platanus acerifolia - London Plane Tree
Pyrus calleryana 'Bradford' - Bradford Pear
Quercus palustris - Pin Oak
Sophora japonica - Japanese Pagoda Tree
Tilia cordata - Little Leaf Linden
Ulmus parvifolia - Chinese Elm
Zelkova serrata - Japanese Zelkova

Situation: Commercial area
Pollution present
Restricted planting site
Utility wires overhead

Recommended Selections

Carpinus betulus	- European Hornbeam
Crataegus phaenopyrum	- Washington Hawthorn
Malus spp.	- Crabapple
Cercidiphyllum japonicum	- Katsura Tree

Situation: Commercial area
Pollution present
Restricted planting site
No overhead utility wires

Recommended Selections

Acer platanoides	- Norway Maple
Celtis occidentalis	- Common Hackberry
Phellodenron amurense	- Amur Cork Tree
Ginkgo biloba	- Ginkgo
Gleditsia triacanthos inermis	- Thornless Honey Locust
Tilia spp.	- Linden
Ulmus 'Urban Elm'	- Urban Elm
Sophora japonica	- Japanese Pagoda Tree

Situation: Narrow space for tree

Recommended Narrow Upright Selections

Acer platanoides 'Columnare'	- Columnar Norway Maple
Acer rubrum 'Columnare'	- Columnar Red Maple
Crataegus monogyna 'Stricta'	- Columnar English Hawthorn
Ginkgo biloba 'Fastigiata'	- Sentry Ginkgo
Koelreuteria panicularia 'Fastigiata'	- Golden Rain Tree
Malus 'Lilet'	- Lilet Crabapple
Sophora japonica 'Fastigiata'	- Fastigate Japanese Pagoda
Tilia platyphyllos 'Fastigiata'	- Fastigate Big Leaf Linden

Situation:

Compacted soil
Reflected heat
Air pollution
Salt spray

Recommended Tolerant Selections

Acer platanoides	- Norway Maple
Acer rubrum	- Red Maple
Ailanthus altissima	- Tree of Heaven
Celtis occidentalis	- Hackberry
Crataegus spp.	- Hawthorn
Fraxinus spp.	- Ash
Ginkgo biloba	- Ginkgo
Gleditsia triacanthos inermis	- Honey Locust
Malus spp.	- Crabapple
Platanus acerifolia	- London Plane Tree
Pyrus calleryana	- Bradford Pear
Sophora japonica	- Japanese Pagoda Tree
Tilia spp.	- Linden
Ulmus 'Urban Elm'	- Urban Elm
Zelkova serrata	- Japanese Zelkova

APPENDIX E

SAMPLES OF WORK/ASSIGNMENT PRINTOUTS

M A I N T A I N A N C E   DISTRICT   1 TRAVERSE CITY

TREE KEY PRM	ADDRS	DIST ANCE	COR NER	D S T	CROSSST LOW	CROSSST HGH	ST WID TH	S U R	D R N	S O S	L U	H	BLDG SET BCK	S D W	TL WD	E X	P L	U N	INTERFRNC WI LG C 3 PRE NT R W	SPE CIE S	D B H	TR HT	PT CR DD	CD CL S	TRIM L F	TRIM T H	TRIM S P	TRIM D W	TRIM H G	RA TI NG	R M V	C R R	B R C	R P R	F R Y	S P R	S D W	
034	00008	0195		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0200		1	083	184	000	2	3	1	6	1	000	0	15	1	0			036	08	25	20	60	0	3	0	2	0	05	0	0	0	0	0	0	0	
034	00008	0222		1	074	182	000	2	3		6	1	000	0	12	1	0			021	24	35	10	70	0	3	0	0	2	05	0	0	0	0	0	1	0	1
034	00008	0230		1	139	180	000	2	3	2	6	1	000	0	20	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0245		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0248		1	083	184	000	2	3	1	6	1	000	0	15	1	0			031	08	20	10	80	0	3	0	0	0	03	0	0	0	0	0	0	0	2
034	00008	0278		1	083	184	000	2	3	1	6	1	000	0	15	1	0			031	08	15	10	70	0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0288		1	074	182	000	2	3		6	1	000	0	12	1	0			088	13	35	10	70	0	3	0	0	0	03	0	0	0	0	0	0	0	
034	00008	0295		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0308		1	139	180	000	2	3	2	6	1	000	0	20	1	0			031	08	20		80	0	2	3	0	0	05	0	0	0	0	0	0	0	
034	00008	0328		1	139	180	000	2	3	2	6	1	000	0	20	1	0			031	10	20		90	0	3	3	0	0	05	0	0	0	0	0	0	0	
034	00008	0345		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0358		1	083	184	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0378		1	139	180	000	2	3	2	6	1	000	0	20	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0395		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0425		1	139	180	000	2	3	2	6	1	000	0	20	1	0			031	05	15		70	0	2	0	0	0	02	0	0	0	0	0	0	0	
034	00008	0445		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0495		1	074	182	000	2	3		6	1	000	0	12	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0545		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0595		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0645		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0695		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0745		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0795		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0845		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0895		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0948		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0995		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
034	00008	0998		1	083	180	000	2	3	1	6	1	000	0	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00000	0021		1	034	184	000	2	3	3	7	1	000	1	15	1	0			080	40	40	10	70	1	0	0	0	0	01	0	0	1	0	0	0	0	
084	00117	0040		1	001	002	000	2	3	4	1	1	000	0	10	1	0			010	20	65	20	70	0	2	0	2	0	04	0	0	0	0	0	0	0	
084	00119	0035		1	001	002	000	2	3	4	2	1	000	0	10	1	0			010	27	65	40	50	0	0	0	4	0	04	0	0	0	0	0	0	1	
084	00123	0015		1	001	002	000	2	3	4	1	1	000	0	10	1	0			010	18	55	20	70	0	3	0	4	0	07	0	0	0	0	0	0	0	
084	00123	0040		1	001	002	000	2	3	4	1	1	000	0	10	1	0			012	18	50	20	70	0	2	0	4	0	06	0	0	0	0	1	0	0	
084	00128	0040		1	001	002	000	2	3	4	1	1	000	0	10	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00201	0050	100	1	001	002	000	2	3	4	7	1	000	0	10	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00203	0045		1	001	002	000	2	3	4	1	1	000	0	10	1	0			012	18	50	10	90	0	2	0	2	0	04	0	0	0	0	1	0	0	
084	00211	0015		1	001	002	000	2	3	4	1	1	000	0	10	1	0			010	22	80	20	60	0	2	0	2	0	04	0	0	0	0	0	0	0	
084	00215	0010		1	001	002	000	2	3	4	1	1	000	0	10	1	0			014	24	50	10	80	1	3	0	2	0	06	0	0	0	0	0	0	0	
084	00215	0035		1	001	002	000	2	3	4	1	1	000	0	10	1	0			014	18	50	30	50	0	2	0	4	0	06	0	0	0	0	1	0	0	
084	00301	0015		1	001	182	000	2	3	4	1	1	000	1	15	1	0			010	14	65	20	60	0	2	0	1	0	06	0	0	0	1	0	0	0	
084	00301	0030		1	001	182	000	2	3	4	1	1	000	1	15	1	0			010	13	55	10	70	0	2	0	2	0	04	0	0	0	0	0	0	0	
084	00307	0030		1	001	182	000	2	3	4	1	1	000	1	15	1	0			010	24	70	10	60	0	2	0	2	0	04	0	0	0	0	0	0	0	
084	00309	0010		1	001	182	000	2	3	4	1	1	000	1	15	1	0			010	18	80	20	70	0	2	0	2	0	04	0	0	0	0	0	0	0	
084	00313	0060		1	001	182	000	2	3	4	1	1	000	1	15	1	0			010	28	70	30	80	1	2	0	4	0	07	0	0	0	0	1	0	0	
084	00318	0030		1	001	182	000	2	3	3	1	1	000	0	18	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00407	0015		1	182	184	000	2	3	4	2	1	000	1	10	1	0			021	18	35	50	40	0	0	0	4	0	04	0	0	0	0	0	1	0	
084	00407	0040		1	182	184	000	2	3	4	2	1	000	1	10	1	0			021	22	65	30	60	0	0	0	4	0	04	0	0	0	1	0	1	0	
084	00415	0020		1	182	184	000	2	3	4	1	1	000	1	10	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00419	0015		1	182	184	000	2	3	4	1	1	000	1	10	1	0			010	20	65	20	70	0	3	3	4	0	10	0	0	0	0	0	0	0	
084	00427	0030		1	182	184	000	2	3	4	1	1	000	1	10	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00431	0020		1	182	184	000	2	3	4	1	1	000	1	10	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00437	0020		1	182	184	000	2	3	4	1	1	000	1	10	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00503	0030		1	034	184	000	2	3	4	1	1	000	1	03	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00505	0030		1	034	184	000	2	3	4	1	1	000	1	03	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00508	0060		1	034	184	000	2	3	3	1	1	000	1	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00508	0150		1	034	184	000	2	3	3	1	1	000	1	15	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00509	0000		1	034	184	000	2	3	4	1	1	000	1	03	1	0			028	24	40	10	68	0	0	0	2	0	02	0	0	0	0	0	0	0	
084	00509	0050		1	034	184	000	2	3	4	1	1	000	1	03	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00720	0038	001	1	001	182	000	2	3	3	1	1	000	0	18	1	0			010	21	65	10	70	0	3	0	0	0	03	0	0	0	0	0	0	0	
084	00720	0153	001	1	001	182	000	2	3	3	1	1	000	0	18	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00801	0035	182	1	001	182	000	2	3	4	1	1	000	1	15	1	0			010	22	70	20	60	0	2	0	2	0	04	0	0	0	0	0	0	0	
084	00801	0080	182	1	001	182	000	2	3	4	1	1	000	1	15	1	0			010	18	55	30	50	0	0	0	4	0	04	0	0	0	0	1	0	0	
084	00801	0140	182	1	001	182	000	2	3	4	1	1	000	1	15	1	0			010	04	20	10	70	0	0	3	0	0	02	0	0	0	0	1	0	0	
084	00802	0000	081	1	002	081	000	2	3	4	4	1	000	0	00	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00802	0055	182	1	182	184	000	2	3	4	1	1	000	1	10	1	0			012	10	45	20	50	0	2	2	2	0	06	0	0	0	0	0	0	0	
084	00802	0080	182	1	182	184	000	2	3	4	1	1	000	1	10	1	0			012	12	50	10	60	0	2	0	2	0	04	0	0	0	0	0	0	0	
084	00881	0021		1	072	184	000	2	3	3	8	1	000	1	04	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00881	0080		1	072	184	000	2	3	3	8	1	000	1	04	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00881	0114		1	072	184	000	2	3	3	8	1	000	1	04	0	1			0					0	0	0	0	0	00	0	0	0	0	0	0	0	
084	00880	0000		1	001	117	000	2	3	3		1	000	0	00	0	1	1		0					0	0	0	0	0	00	0	0	0	0	0	0	0	
088	00701	0005		1	180	203	000	2	3	4	1	1	000	0	20	1	0			010	08	30		90	0	0	2	0	0	02	0	0	0	0	0	0	0	
088	00701	0050		1	180	203	000	2	3	4	1	1	000	0	20	1	0			010	10	40		90	0	3	2	0	0	05	0	0	0	0	0	0	0	
088	00705	0030		1	180	203	000	2	3	4	1	1	000	0	20	1	0			010	12	40	00	90	0	2	2	0	0	04	0	0	0	0	0	0	0	
088	00708	0012		1	180	203	000	2	3	3	1	1	000	0	20	1	0			010	09	25	10	90	0	3	0	0	0	03	0	0	0	0	0	0	0	
088	00708	0054		1	180	203	000	2	3	3	1	1	000	0	20	1	0			010	05	20	10	80	0	0	2	0	0	02	0	0	0	0	0	0	0	
088	00709	0033		1	180	203	000	2	3	4	1	1	000	0	20	1	0			010	10	40	10	90	0	3	3	0	0	05	0	0	0	0	0	0	0	
088	00709	0070		1	180	203	000	2	3	4	1	1	000	0	20	1	0			010	12	40	00	90	0	3	3	0	0	06	0	0	0	0	0	0	0	
088	00712	0057		1	180	203	000	2	3	3	1	1	000	0	20	1	0			010	03	18	00	90	0	0	3	0	0	03	0	0	0	0	0	0	0	
088	00713	0050		1	180	203	000	2	3	4	1	1	000	0	20	1	0			010	12	35	00	90	0	3	3	0	0	06	0	0	0	0	0	0	0	
088	00713	0085		1	180	203	000	2	3	4	1	1	000	0	20	1	0			010	10	40	00	90	0	0	2	0	0	02	0	0	0	0	0	0	0	
088	00718	0030		1	180	203	000	2	3	3	1	1	000	0	20	1	0			010	03	15	10	90	0	0	3	0	0	03	0	0	0	0	0	0	0	
088	00718	0072		1	180	203	000	2	3	3	1	1	000	0	20	1	0			010	03	18	00	80	0	0	0	0	0	00	0	0	0	0	0	0	0	
088	00720	0029		1	180	203	000	2	3	3	1	1	000	0	20	1	0			010	03	18	00	90	0	0	2	0	0	02	0	0	0	0	0	0	0	
088	00720	0068		1	180	203	000	2	3	3	1	1	000	0	20	1	0			010	03	18	10	80	0	0	3	0	0	03	0	0	0	0	0	0	0	
088	00721	0015		1	180	203	000	2	3	4	1	1	000	0	20	1	0			010	08	25	10	90	0	3	2	0	0	08	0	0	0	0	0	0	0	
088	00721	0050		1	180	203	000	2	3	4	1	1	000	0	20	1	0			010	08	30		90	0	2	2	0	0	04	0	0	0	0	0	0	0	
088	00721	0100		1	180	203	000	2	3	4	1	1	000	0	20	1	0			010	08	30	10	80	0	3	3	0	0	08	0	0	0	0	0	0	0	
088	00724	0027		1	180	203	000	2	3	3	1	1	000	0	20	1	0			024	02	12	00	90	0	2	2	0	0	04	0	0	0	0	0	0	0	
088	00724	0062		1	180	203	000	2	3	3	1	1	000	0	20	1	0			010	04	18	00	80	0	0	3	0	0	03	0	0	0	1	0	2	0	

DISTRICT 1 AVG TRIM RATING(NOT COUNTING PLANTING SITES OR REMOVALS

BLOCK	N	AVG	LIFT	THIN	TRAIN	DEAD	HNGR	REM	GRR	BRC	RPR	FERT	SPRY	SDW	DIE	INJ	ROT	NEW	FC
001054177	3	4.3	0	3	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0
001074054	3	4.7	0	1	0	3	0	2	0	0	0	1	0	0	0	0	0	0	0
001074189	1	5.0	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0
001131074	16	3.4	1	7	7	7	1	1	2	1	1	5	1	7	1	0	0	1	0
001144131	31	4.5	6	25	10	18	0	3	2	1	0	7	0	6	2	0	0	3	0
001177083	4	6.0	1	4	1	2	1	0	0	0	0	0	1	0	1	0	0	0	0
001189054	4	3.3	0	0	3	1	0	0	0	0	0	0	0	0	1	0	0	0	0
001211144	1	5.0	0	1	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0
002054177	3	4.0	0	1	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0
002074054	3	4.7	2	1	0	2	0	4	2	0	0	0	0	3	6	0	0	0	0
002131074	14	4.8	0	7	4	10	0	2	0	0	0	4	2	2	6	0	0	2	0
002144131	17	4.7	6	13	5	10	0	0	0	1	0	4	0	4	3	0	0	1	0
002177083	5	5.0	0	5	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0
034054177	1	3.0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0
034074191	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
034074194	1	0.0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
034083160	1	3.0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
034139160	4	4.0	0	4	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0
034144162	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
034162074	6	2.5	2	3	1	0	1	0	0	1	0	0	1	1	2	0	0	0	0
034177083	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
034191054	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
034194083	7	2.9	0	5	2	1	0	0	0	0	0	0	0	0	0	2	0	0	0
054001162	9	4.3	1	7	1	7	0	0	0	0	1	3	0	0	0	0	0	0	0
054002001	8	5.1	1	7	0	8	0	0	0	0	0	3	0	1	0	0	0	0	0
054072194	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
054091002	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
054091117	0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

DISTRICT-1	WORK/INSPECTION ASSIGNMENT	1 SIDEWALK PROBLEMS	11/01/82
136004190048	48 FEET FROM 419	SUGAR MAPLE	24 INCHES
136004200075	75 FEET FROM 420	SUGAR MAPLE	20 INCHES
136004210024	24 FEET FROM 421	SUGAR MAPLE	20 INCHES
136004210045	45 FEET FROM 421	SUGAR MAPLE	22 INCHES
136004270045	45 FEET FROM 427	SUGAR MAPLE	24 INCHES
136004290024	24 FEET FROM 429	SUGAR MAPLE	26 INCHES
136004300000	0 FEET FROM 430	SUGAR MAPLE	23 INCHES
136004390015	15 FEET FROM 439	SUGAR MAPLE	20 INCHES
136004430072	72 FEET FROM 443	BASSWOOD	16 INCHES
136004430108	108 FEET FROM 443	BASSWOOD	24 INCHES
MONROE	FROM HILL	TO WILLOW	
136006110090	90 FEET FROM 611	SUGAR MAPLE	30 INCHES
OAK	FROM 3RD	TO FRONT	
144001190006	6 FEET FROM 119	SUGAR MAPLE	18 INCHES
144001190036	36 FEET FROM 119	SUGAR MAPLE	17 INCHES
OAK	FROM 2ND	TO 3RD	
144002010015	15 FEET FROM 201	SUGAR MAPLE	28 INCHES
144002010048	48 FEET FROM 201	SUGAR MAPLE	28 INCHES

DISTRICT-1	WORK/INSPECTION ASSIGNMENT	DISTRICT 1 REMOVALS	11/01/82
177004250027	27 FEET FROM 425	SIBERIAN ELM	10 INCHES
177004260025	25 FEET FROM 426	SUGAR MAPLE	12 INCHES
177004260032	32 FEET FROM 426	SUGAR MAPLE	20 INCHES
177004270009	9 FEET FROM 427	BOXELDER	03 INCHES
177008240055162	55 FEET FROM 824 RANDOLPH	SIBERIAN ELM	28 INCHES
SPRUCE	FROM 2ND	TO RANDOLPH	
177009010006162	6 FEET FROM 901 RANDOLPH	SUGAR MAPLE	15 INCHES
VINE	FROM 2ND	TO RANDOLPH	
189003180018	18 FEET FROM 318	SUGAR MAPLE	16 INCHES
189003180036	36 FEET FROM 318	SUGAR MAPLE	14 INCHES
189003180054	54 FEET FROM 318	SUGAR MAPLE	16 INCHES
WAYNE	FROM MADISON	TO CITY LIMITS	
194004510045125	45 FEET FROM 451 MADISON	SUGAR MAPLE	15 INCHES
194004510060125	60 FEET FROM 451 MADISON	SUGAR MAPLE	20 INCHES
WAYNE	FROM ELMWOOD AVE	TO SPRUCE	
194009110012	12 FEET FROM 911	SUGAR MAPLE	17 INCHES
WAYNE	FROM MADISON	TO MONROE	
194011270033	33 FEET FROM 1127	BUSH/HEDGE	01 INCHES

APPENDIX F

MANAGEMENT REQUIREMENTS FOR SOME OF THE MORE COMMON SPECIES OF TRAVERSE CITY STREET TREES

Table F.1. Pruning Requirements Recorded for Some Common Street Tree Species (Traverse City Inventory, 1982).

Species Name	Total Number	% of Species with Pruning Requirements				
		Remove Hangers	Remove Deadwood	Trim for Clearance	Train Crown	Thin Crown
Sugar Maple	**3,633**	**3.4**	48.5	8.5	30.5	62.7
Norway Maple	**902**	**3.5**	45.9	14.0	21.6	80.0
Red Maple	**402**	**3.2**	51.7	5.4	9.4	65.0
Silver Maple	**216**	**2.3**	64.8	12.0	10.2	76.0
Red Oak	**417**	**2.9**	76.5	2.9	4.1	45.1
White Oak	**324**	**1.5**	66.7	9.2	2.5	51.2
Green Ash	**118**	**1.7**	22.1	29.7	62.7	82.2
White Ash	**48**	**4.2**	58.3	8.3	25.0	45.9
Siberian Elm	**169**	**2.4**	59.1	20.2	17.7	56.8
Black Locust	**87**	**1.1**	65.5	10.3	8.0	52.9
Basswood	**84**	**8.4**	77.3	17.7	4.8	82.2
Total for All Street Trees	**7,595**	**2.9**	**48.7**	**9.7**	**22.3**	**58.6**

Table F.2. Management Requirements Recorded Other Than Pruning for Some Common Street Tree Species (Traverse City Inventory, 1982).

Species Name	Total Number	% of Species with Requirement						
		Remove	Repair Injury	Brace/ Cable	Repair Girdling Root	Fertilize	Insect Problem	Disease Problem
Sugar Maple	3,633	8.2	4.3	7.3	8.2	21.8	2.6	0.5
Norway Maple	902	2.8	6.0	7.5	12.9	15.0	0.7	0.4
Red Maple	402	8.7	8.7	9.2	5.0	17.2	0.5	2.0
Silver Maple	216	5.1	7.4	10.2	5.1	11.6	1.4	1.9
Red Oak	417	2.9	6.2	5.8	1.4	6.2	0.5	0.5
White Oak	324	3.1	5.2	8.3	0.9	9.0	1.9	1.0
Green Ash	188	5.1	0	0	1.7	73.7	2.3	0
White Ash	48	6.3	8.3	6.5	2.1	4.2	2.1	0
Siberian Elm	169	10.7	4.1	10.7	2.4	6.5	2.4	29.6
Black Locust	87	1.1	4.6	14.9	1.1	6.5	9.2	1.1
Basswood	84	2.4	3.6	11.9	3.6	1.2	4.8	0
Total for All Street Trees	**7,595**	**6.3**	**4.8**	**6.7**	**6.3**	**16.7**	**2.4**	**1.4**

APPENDIX G

COMPUTATION OF THE VALUE OF THE STREET TREE POPULATION

APPENDIX G

COMPUTATION OF THE VALUE OF THE STREET TREE POPULATION

Computation on Average Street Tree Value:*

Diameter	14.517 inches			
Basic Value	$2,979.00			multiplied by
Species Value	75%	=	$2,234	multiplied by
Condition Value	68.25%	=	$1,525	multiplied by
Location Value	80%	=	$1,220	

Value of the Average Street Tree	**$1,220**
Total Number of Trees	**x 7,514**
	$9,166,332

Description of Values:

Mean Diameter Given from 100% street tree inventory

Basic Value Diameter times .7854d² yields basal area in square inches. This is multiplied by a basic value of $18 per sq. inch.

Species Value This is determined by tree character and habit of growth; length of life and durability; immunity from diseases and insects; and usefulness, cleanliness, and hardiness. An average species value of 75% has been assigned.

Condition Value This value is based on the mean condition class recorded from the 100% street tree inventory

Location Value Street trees are assigned an 80% location value.

*Calculations based on 100% street tree inventory and on values given in the Michigan Forestry and Parks Association and Michigan State University, Forestry Department, "Michigan Shade Tree Evaluation Guide, 1982."