Tree Inventory Management Plan

Town of Wake Forest, North Carolina

April, 2004

DAVEY RESOURCE GROUP
A Division of The Davey Tree Expert Company

Tree Inventory Management Plan

Town of Wake Forest, North Carolina

April, 2004

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Notice of Disclaimer

Inventory data provided by Davey Resource Group are based on visual recording at the time of inspection. Visual records do not include individual testing or analysis and do not include aerial or subterranean inspection. Davey Resource Group is not responsible for discovery or identification of hidden or otherwise non-observable hazards. Records may not remain accurate after inspection due to variable deterioration of inventoried material. Davey Resource Group provides no warranty with respect to the fitness of the urban forest for any use or purpose whatsoever.

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Executive Summary

The Town of Wake Forest, North Carolina combines rich history with beautiful neighborhoods, parks, and recreation facilities to create an attractive community and a great place to live, work, and play. The economic health of Wake Forest, as with many communities, is closely related to the ability of the municipal government to supply its citizens with efficient services, safe public spaces, and properly maintained infrastructure. Trees are an integral component of this urban environment. Their shade and beauty contribute to the community's quality of life and soften the hard appearance of concrete structures and streets. They help stabilize the soil by controlling wind and water erosion. Trees also help reduce noise and provide habitat for wildlife.

Trees also provide significant economic benefits, including increased real estate values and more attractive settings in which to locate commercial businesses. Trees provide shade and act as windbreaks. This, in turn, helps to reduce residential energy consumption. Unlike other components of the Town's infrastructure, the tree population, with proper care, will actually continue to increase in value with each passing year. When properly maintained, trees return overall benefits and value to the community far in excess of the time and money invested in them for planting, pruning, protection, and removal.

A successful urban forestry program requires a combination of organized leadership, comprehensive information about the tree population, dedicated personnel, and effective public relations.

Managing natural resources in urban areas is challenging in the very least. For many communities, finding suitable space for trees among streets, buildings, sewers, and utility lines is difficult. Frequently, a greater concern is providing adequate maintenance within budget constraints. A successful urban forestry program requires a combination of organized leadership, comprehensive information about the tree population, dedicated personnel, and effective public relations.

The Town of Wake Forest, North Carolina has commissioned a study of its public urban forest to inventory and evaluate the current condition of its street trees and to establish an effective planning and management program for this valuable resource. This document will explore some of the future management options while reviewing current conditions.

The Town of Wake Forest is located in Wake County, North Carolina and, according to data from the 2000 US Census, has approximately 12,550 residents. The Town of Wake Forest, North Carolina, a small but rapidly growing suburb of Raleigh provides a large number of business opportunities as well as a pleasant place to live and raise a family. Located a few miles from Falls Lake National Recreation Area, the town is centered around the Southeastern Baptist Theological Seminary College. Other points of interest include the Durant Nature Park and the Wake Forest College Birthplace Society Museum. One of the many interactions between the local government and the citizens of Wake Forest is the Tree Committee, which assists in the establishment and maintenance of a healthy urban forest environment.

Trees are an integral component of this urban environment. Their shade and beauty contribute to the community's quality of life and soften the hard appearance of concrete structures and streets. They help stabilize the soil by controlling wind and water erosion. Trees also help reduce noise levels, cleanse pollutants from the air, produce oxygen and absorb carbon dioxide, and provide habitat for wildlife.

Photo 1. Wake Forest birthplace home.

Trees also provide significant economic benefits, including increased real estate values and more attractive settings in which to locate commercial businesses. Trees provide shade and act as windbreaks, helping to decrease residential energy consumption. Unlike other components of the Town's infrastructure, the tree population, with proper care, will actually continue to increase in value with each passing year. When properly maintained, trees return overall benefits and value to the community far in excess of the time and money invested in them for planting, pruning, protection, and removal.

The Wake Forest Street Tree Population

Davey Resource Group performed an inventory of 4,426 trees, planting sites, and stumps in Wake Forest. Data on the trees were collected and analyzed, providing information on the species composition, relative age, health, and maintenance recommendations for the urban forest. The major findings of the *Wake Forest Tree Inventory and Management Plan* include the following:

- Davey Resource Group inventoried 4,426 total sites. Of these, 3,963 (89.5%) are street trees, 404 (9.1%) are planting sites, and 59 (1.3%) are stumps.
- The total value of Wake Forest's street tree population is estimated to be $3,058,872.52. The average value per tree is $771.86. These numbers are based on the tree valuation formula found in the Council of Tree and Landscape Appraisers' publication, *Guide for Plant Appraisal (Ninth Edition).*
- 52 genera and 81 species are represented in the inventoried trees.

- *Acer* spp. (maple) comprises 25.8% of the inventoried tree population, with *Quercus* spp. (oak) contributing 11.1%, *Prunus* spp. (cherry) 10.8%, *Cornus* spp. (dogwood) 8.2%, *Lagerstroemia* spp. (crapemyrtle) 6.6%, *Pinus* spp. (pine) 3.7%, *Cercis* spp. (redbud) 3.5%, *Pyrus* spp. (pear) 3.4%, *Ulmus* spp. (elm) 2.6%, and *Liquidambar* spp. (sweetgum) contributing 2.3%.
- The inventoried tree population has high percentages, 73.9% and 22.4% respectively, of small- and medium-sized trees. Small trees, which are six inches and less in diameter, represent 73.9% of the street tree population, 22.4% of the street trees are medium-sized (seven to 24 inches in diameter). Finally, 3.7% of the street trees are large-sized (25 inches and greater in diameter).
- There are three trees (0.08%) rated in Excellent condition, one (0.03%) in Very Good condition, 1,330 (33.6%) in Good condition, 2,193 (55.3%) in Fair condition, 385 (9.7%) in Poor condition, and 25 (0.6%) in Critical condition. 26 trees (0.7%) are rated as Dead.
- There is 257 trees (6.4%) recommended for removal in the total street tree population. Of these, 40 (0.1%) are recommended for Priority 1 Removal, 108 (2.7%) are recommended for Priority 2 Removal, and 109 (2.7%) are recommended for Priority 3 Removal. A total of 59 (1.5%) stumps are in need of grinding.
- There are 96 (2.4%) trees recommended for Priority 1 Prune and 119 (3.0%) recommended for Priority 2 Prune. Large Routine Prune is recommended for 860 (21.4%) trees, Small Routine Prune is recommended for 630 (15.7%) trees, and Training Prune is recommended for 2,001 (49.8%) trees.

Urban Forestry Management Recommendations

Based on the results of this study, Davey Resource Group makes the following recommendations for planning and managing the inventoried trees in Wake Forest's urban forest:

A *Five-Year Urban Forest Management Program* is explained and outlined in Chapter Three and includes estimated budgets for each activity. Specific tree management recommendations are detailed and include:

- Perform all recommended tree removals and Priority 1 Prunes as soon as possible beginning in 2004.
- Implement a continual routine maintenance cycle for the tree population to ensure pruning of all trees every five years.
- Beginning in Year 3, implement a Training Pruning Program for the large number of younger trees.
- Implement an expanded public relations campaign to gain increased citizen interest and Town support for the urban forestry program.

Introduction

Importance of the Urban Forest

Trees are a significant component of Wake Forest's urban environment. The street and park trees are an integral part of the Town's infrastructure, no less so than its streets, utilities, buildings, and sidewalks. As mentioned previously, the actual current legal value of Wake Forest's urban forest is approximately $3.0 million. Unlike other infrastructure components, the tree population, when properly cared for, will actually increase in value as the trees mature over time.

Photo 2. Deodar cedar (*Cedrus deodara*) in island median on Front street.

Trees return overall benefits and value to the community far in excess of the time and money invested in them for planting, pruning, protection, and removal. Their shade and beauty contribute to the community's quality of life and soften the hard appearance of concrete structures and streets, moderating harsh urban conditions. They help stabilize the soil by controlling wind and water erosion. Trees also help reduce noise levels, cleanse air of pollutants, produce oxygen, and absorb carbon dioxide, which is believed to contribute to the 'greenhouse effect'. Additionally, they provide significant economic value, including increased real estate values and improved settings for business activities.

Residents and officials of Wake Forest have recognized these benefits and realize the need to protect this investment with a comprehensive, urban forest management program for their public trees. Such a program begins with an inventory of the public trees and their present condition. This inventory will provide important information concerning the public trees.

Statement of Purpose

The purpose of this *Tree Inventory Management Plan* is to provide a five-year plan of action for the inventoried tree population of Wake Forest. The Town commissioned a study of its public tree population to inventory and evaluate the current condition of its trees. The inventory draws attention to immediate problems and provides the basis for designing a long-term management plan. The management plan, in turn, provides guidelines for the future, allows for more effective use of tree care funds, and allows for more accurate budget projections.

Scope

This document provides a comprehensive action plan for the inventoried street tree population in Wake Forest's as defined in the 2004 Tree Inventory. The management plan includes an analysis of the current tree population and maintenance recommendations, as well as long-range management recommendations.

It discusses the findings of the complete tree inventory performed by Davey Resource Group. The scope of this discussion includes:

- A summary and analysis of the tree inventory.
- A description of the species composition.
- A discussion of the general condition of the inventoried trees.
- Recommendations for specific maintenance recommendations for each tree; this concerns pruning or removal recommendations to reduce potential safety hazards, as well as developing cyclical pruning programs.
- A five-year budget for the street tree management program.

Goals

The Town of Wake Forest Tree Management Program discussed in this plan is intended to achieve the following goals:

- To gain an overall understanding of the inventoried tree population in terms of genus and species composition.
- To identify and recommend remedial action for trees with structural (or other) defects that could cause them to be (or become) potential safety risks to citizens, vehicles, and property.
- To analyze the individual and overall conditions of the inventoried tree population.
- To establish a tree safety pruning and removal program that will alleviate all identified potentially hazardous conditions by 2005.
- To establish a five-year cyclical tree pruning program beginning in 2006.
- To establish a new Training Prune Program for all immature and newly planted trees.

Evaluating and Updating This Plan

This plan is initially intended to provide urban forestry guidelines for the next five years. In order to measure the effectiveness of the implementation of the program in achieving the stated goals, a method for evaluation should be established. Specific accomplishments can be measured in comparison to the plan's goals and recommendations. These include:

- The near completion of all identified priority tree removals and priority pruning in Year 1 and Year 2 of the program.
- In Year 3 of the program, evaluate the number of trees pruned annually in the Routine Pruning Program.
- Annually compare the number of trees planted to the desired number of plantings and the number of removals per year.
- Beginning in Year 3, establish a Training Pruning Program and evaluate the number of trees pruned annually to match the goal of a five-year program.
- At the end of each year, compare the Town's annual urban forestry budget to that projected in this plan.

Photo 3. Wake Forest is steeped in history. The Town should maintain its urban forest to reflect a positive image towards its local surroundings (Southeastern Baptist Theological Seminary College).

Chapter One: Methodology

Summary

This chapter provides a description of the procedures used by Davey Resource Group in conducting the Wake Forest tree inventory. Definitions and methodology of data collection are provided to give the reader a total understanding of the inventory process.

Definition

A 'tree' is defined as a woody perennial plant, generally with one main trunk, having the potential to exceed 20 feet in height. A 'street tree' is further defined as a tree growing within the public right of way and, when applicable, the Town's eight-foot tree easement in newly developed areas. Right of way limits were determined through the use of the municipal tax maps; measurements were made using the map scale and correlated when possible with ground indicators.

Potential Planting Sites

Potential planting sites are located by street and address as part of the complete inventory. The sites are defined as areas suitable for tree planting within the existing right-of-way as defined above. The size of the site is designated as small (4-5 feet), medium (6-8 feet), or large (9 feet and greater), depending primarily on the growing space available and the presence of overhead wires. Planting sites are determined based on standard specifications as set forth in accepted technical journals, by the arboricultural industry, and by specific community requirements. The overall landscape and existing planting scheme was also taken into consideration for the spacing and sizes of recommended planting sites. Where any kinds of overhead wires exist, the planting site is recorded as small, regardless of the available growing space (Appendix F).

Data Collection

During the inventory of Wake Forest, street trees were individually examined, identified, measured, and recorded. Data were entered on hand-held Husky® FS/2™ data collection units and transferred to a computer for processing. Data were recorded for the following street tree variables, which are described in further detail below:

- Tree Location
- Tree Genus and Species Identification
- Tree Diameter
- Tree Trunks
- Tree Condition
- Tree Maintenance Requirements
- Further Inspection Required
- Utilities
- Tree Location Type
- Clearance Requirements
- Observations
- Hardscape Damage
- Growing Space Type/Size
- Additional Comments (Field Notes)

Tree Location

The inventory was conducted using a Husky® FS/2™ hand-held computer along with a 12-channel Trimble® Pathfinder™ Pro XR differential global positioning system (GPS). The system has sub-meter accuracy when used in conjunction with GPS data collected from a base station. The field-collected GPS information was differentially corrected using a desktop computer equipped with Trimble's Pathfinder® Office™ software and GPS data collected from an appropriate base station. The corrected GPS latitude-longitude positions were exported into a compatible coordinate system as an ArcView® shape file (*.shp) and incorporated into Geographic Information System (GIS) software. Using this hardware and software, each tree location was plotted on a digital map post-inventory.

Street Tree Location Methodology

To allow for maximum use of data, individual trees are inventoried by *street* name and *address* number and by *site* number. Each tree site location is also assigned *lot side* and *block side* information. In order to be consistent in the assignment of tree location information, we have developed a method for determining addresses, site numbers, and block side definitions. This method is designed so that the urban forester, contractors, or maintenance personnel will be able to identify the correct tree using Davey Resource Group's location information.

Each **address** includes a *street name* and *address number*. Addresses are determined from the actual address number posted on buildings. In instances where (A) there is no posted street number on a building; (B) trees are located on vacant lots; or (C) trees are located at the rear of a lot which borders two parallel streets, addressing is matched as closely as possible to opposite or adjacent addresses. An '**X**' is entered in the address number *assigned* field for these fictitious addresses.

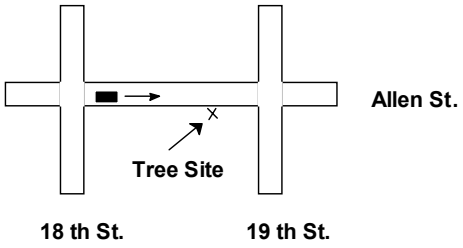
Each tree site at an address is assigned a **side code** depending on whether it is on the front (F), side (S), or rear (R) of the addressed lot. Median or Island tree sites (M) are also identified and assigned a fictitious address closest to an address on an opposite side of the street. Each median segment is collected and numbered with a fictitious (X) address that is interpolated from addresses facing the median/island. The tree sites on the median are collected in the direction of vehicular traffic flow. If there are multiple median areas between two cross streets, each segment is given its own fictitious (X) address.

Multiple tree sites at the same address are distinguished from one another by assigning each tree a separate **site number**. The basis of our location methodology is that the tree sites are collected and assigned site numbers in the direction of vehicular traffic flow. (This is only false in the case of one-way streets; one-way streets are collected and assigned site numbers as if they were two-way streets.) At each address, a separate number sequence is used for each side (front, side, rear, and median/island). This means that the trees at the front may be numbered 1 through 999 and, if trees are located on the side, rear, or median/island of that same address, each side is also numbered consecutively, again beginning with the number 1 and always in the direction of vehicular traffic flow.

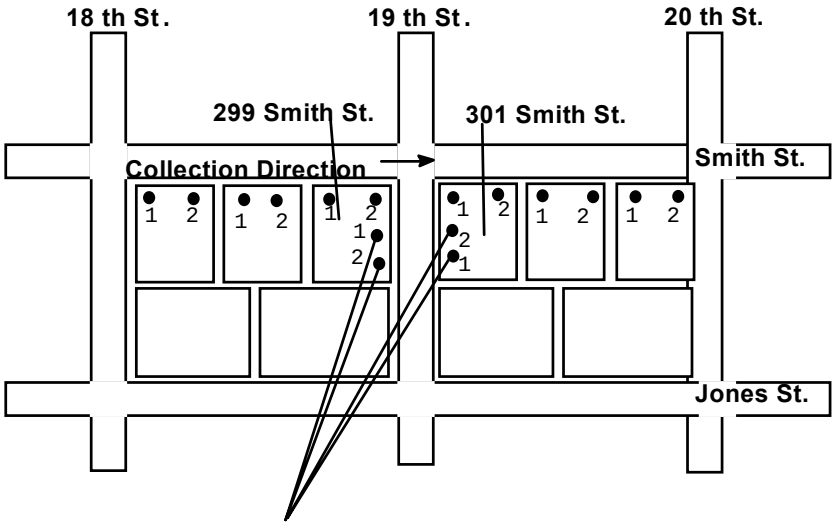
The block side information is composed of an **on** street, a **from** street, and a **to** street:

- The *on* street is the street that the tree site is actually located on. Be aware that some tree sites (e.g., those located on a side street) will be located on a street that is different from the actual addressed street. This means that the *on* street will not necessarily match the address street (Appendix G).
- The *from* street is the cross street the data collector is moving away from when moving in the direction of traffic flow (opposite of traffic flow when moving up the left side of one-way streets).
- The *to* street is the cross street the data collector is moving toward when moving in the direction of traffic flow (opposite of traffic flow when moving up the left side of one-way streets).

The *on* street may not be the same as the address street. For example, a corner house may have trees along the side and those trees may actually be on a side street. The *from* street is the first cross street in the direction from which you would approach the tree site (in order to be on the same side of the street as the tree site). The *to* street is the first cross street that you would cross when leaving the tree site. For example, the trimming crew in the truck shown below would find the tree site *on* Allen St. *from* 18th St. *to* 19th St.



The following diagram gives you a little more detail on how tree site numbering progresses as you move along a street:



These four tree sites are on 19th St., but have Smith St. addresses.

The corner lots have location information similar to the following:

Address:	299		Address:	299	
Street:	Smith St.		Street:	Smith St.	
Side:	F		Side:	F	
Site:	1		Site:	2	
Block:	On:	Smith St.	Block:	On:	Smith St.
	From:	18th St.		From:	18th St.
	To:	19th St.		To:	19th St.
Address:	299		Address:	299	
Street:	Smith St.		Street:	Smith St.	
Side:	S		Side:	S	
Site:	1		Site:	2	
Block:	On:	19th St.	Block:	On:	19th St.
	From:	Smith St.		From:	Smith St.
	To:	Jones St.		To:	Jones St.
Address:	301		Address:	301	
Street:	Smith St.		Street:	Smith St.	
Side:	S		Side:	S	
Site:	1		Site:	2	
Block:	On:	19th St.	Block:	On:	19th St.
	From:	Jones St.		From:	Jones St.
	To:	Smith St.		To:	Smith St.
Address:	301		Address:	301	
Street:	Smith St.		Street:	Smith St.	
Side:	F		Side:	F	
Site:	1		Site:	2	
Block:	On:	Smith St.	Block:	On:	Smith St.
	From:	19th St.		From:	19th St.
	To:	20th St.		To:	20th St.

Tree Genus and Species Identification

The Town's trees are identified by genus and species and by cultivars where appropriate (cultivar names are recorded in the Field Notes section of each tree record, when applicable). However, both botanical and common names are included in this document. The management plan format uses common names, but reports with the currently acceptable binomial nomenclature (botanical names) are included in Appendix A. The identification of trees by botanical names ensures the correct scientific identification of each tree species, while the use of common names can provide a readable format for all who may utilize this management plan.

Tree Diameter

Diameter at breast height (DBH) is a standard forestry measurement generally taken at 4.5 feet above the ground. Each tree and stump diameter was measured to the nearest inch with a 25-inch reach Biltmore® Cruiser™ stick.

Tree Trunks

During the inventory, each tree was evaluated for the total number of trunks present. For trees with multiple trunks, the largest trunk DBH was measured and recorded.

Tree Condition

Condition indicates the current state of a tree's health, structural soundness, overall shape, and growth rate (Appendix B). Symptoms of poor condition include discoloration, decay, dieback, decreased internodal length, and/or disfigured or necrotic stems or roots. To some extent, condition class is also a reflection of the life expectancy of the tree. Crown development, trunk condition, major branch structure, twig growth rate, insects/diseases, and root condition are all considered. In general, the condition of each tree is recorded as one of the following categories adapted from the rating system established by the International Society of Arboriculture® (ISA):

Excellent
100% - 90% condition class. The tree is nearly perfect in condition, vigor, and form. This rarely used category is generally applicable to small diameter trees that have been recently transplanted and are well established.

Very Good
89% - 80% condition class. Overall, the tree is healthy and satisfactory in condition, vigor, and form. The tree has no major structural problems, no mechanical damage, and may only have insignificant aesthetic, insect, disease, or structure problems.

Good
79% - 61% condition class. The tree has no major structural problems; no significant damage due to diseases or pests; no significant mechanical damage; a full balanced crown; and normal twig condition and vigor for its species.

Fair
60% - 41% condition class. The tree may exhibit the following characteristics: minor structural problems and/or mechanical damage; significant damage from non-fatal or disfiguring diseases; minor crown imbalance or thin crown; minor structural imbalance; or stunted growth compared to adjacent trees.

Poor
40% - 21% condition class. The tree appears unhealthy and may have structural defects. Trees in this category may also have severe mechanical damage, decay, and severe crown dieback or poor vigor/failure to thrive.

Critical
20% - 1% condition class. The tree has a major structural problem that presents an unacceptable risk, has very little vigor, and/or has a disease or insect problem that is ultimately fatal and, if not corrected, may threaten other nearby trees.

Dead
0% condition class. This category refers to dead trees only.

Tree Maintenance Requirements

Maintenance requirement information is collected to provide a basis for determining and prioritizing the primary maintenance recommendations of the inventoried tree population in Wake Forest. This information is useful for preparing accurate budgets and for developing maintenance schedules, whether the work is performed by in-house crews or contracted out to local tree care companies.

Tree Removal Requirements

Removals are categorized based on the urgency of the need for removal. The categories are *Priority 1 Removal, Priority 2 Removal,* and *Priority 3 Removal.* Each is briefly described below:

Priority 1 Removal

Trees designated as Priority 1 Removal are dead or have serious structural defects that cannot be effectively or practically remedied and present a potential hazard to the public. Such defects include, but are not limited to, extensive trunk decay and severely decayed or weakened V-crotches where the potential for failure is high. Trees in this category present an immediate, yet unpredictable, potential risk of damage to people or property. These trees should be removed as soon as possible.

Priority 2 Removal

Trees designated as Priority 2 Removal are dead or have one or more defects that cannot be cost-effectively or practically remedied, but because of the size or the location of the tree, there is diminished hazard to the public as compared to Priority 1 Removal trees. Representative defects include, but are not limited to, extensive trunk decay and severely decayed or weakened V-crotches or where the removal of limbs for safety concerns would drastically impact the tree form or its visual usefulness. These trees should be removed after trees in the Priority 1 Removal category have been removed.

Priority 3 Removal

Trees designated as Priority 3 Removal are small, dead, or poorly formed trees that need to be removed, but pose no hazard to the public. Healthy trees of undesirable species, such as Tree-of-Heaven (*Ailanthus altissima)*, may also be included in this category. These trees should be removed only after all Priority 1 and Priority 2 Removals have been completed.

Tree Pruning Requirements

Pruning recommendations are categorized based on the reason pruning is recommended or needed. The categories are *Priority 1 Prune, Priority 2 Prune, Large Routine Prune, Small Routine Prune,* and *Training Prune.*

Pruning categories in this report can be separated into *Safety Pruning Recommendations* and *Cyclical Pruning Recommendations.*

Safety Pruning Recommendations

These recommendations are categorized based on the presence of potentially hazardous conditions in the tree canopy that can be remedied through pruning. Trees in these two safety categories require pruning to remove deadwood and/or broken branches that pose a potential risk and may result in personal injury or property damage. Two classifications of this category address the priority of the work based on the size of the tree limbs needing pruning. These categories are *Priority 1 Prune* and *Priority 2 Prune*. Each is briefly described below:

Priority 1 Prune
Trees in this category require pruning to remove deadwood and/or broken branches that pose a potential risk that could result in personal injury or property damage. This category is used for any tree(s) with broken, hanging, dead, or otherwise potentially dangerous limbs greater than four inches in diameter which are in danger of failing or trees with a significant number of dead branches (which can be less than four inches in diameter) that require removal.

Priority 2 Prune
Trees in this category require pruning to remove deadwood and/or broken branches that pose a potential risk that could result in personal injury or property damage. This category is used for any tree(s) with broken, hanging, dead, or otherwise potentially dangerous limbs greater than two inches, but less than four inches, in diameter which are in danger of failing or those trees with a significant number of dead branches (which can be less than two inches in diameter) that require removal.

Cyclical Pruning Recommendations

These recommendations provide a guide to trees that currently have no potentially hazardous conditions that need to be remedied through one of the safety pruning recommendations above. Instead, the following three pruning categories are designed to include those trees that would benefit from a regular cyclical pruning program wherein they would be periodically inspected and pruned on a recurring basis. These categories are *Large Routine Prune*, *Small Routine Prune*, and *Training Prune*.

Large Routine Prune
Trees receiving this designation include those that would benefit from regular maintenance to limit the development of future problems or trees that have problems that may become future risks if not corrected. This category is for large growth habit trees that have minor amounts of deadwood less than two inches in diameter and/or with correctable structural problems. Large growth habit trees that will eventually obstruct or interfere with pedestrian or vehicular traffic clearance, traffic control devices, lines of sight, or overhead traffic lines are also included in this category.

Small Routine Prune
Trees receiving this designation include mature small growth habit trees that can be evaluated and pruned from the ground. This includes all trees, such as crabapples, that will not likely attain a height greater than 30 feet when mature. Trees with this classification will require routine horticultural pruning to correct structural problems or growth patterns that would eventually obstruct vehicular or pedestrian traffic or interfere with buildings or utility wires.

Training Prune
This includes newly planted trees, immature trees, and some mature trees less than 20 feet in height that need structural pruning in order to reduce the development of future problems. These trees have correctable structural problems or minor amounts of deadwood that pose little or no threat to personal injury or property damage.

Further Inspection Required

A tree inventory by its very nature involves only cursory, visual observations of each tree in order to gather basic information. **No trees received detailed examinations or inspections during the tree inventory.** Davey Resource Group's ISA® Certified Urban Foresters recorded certain trees as having pruning, removal, or other maintenance recommendations on the basis of this cursory observation.

Some trees will require further detailed examinations to determine what measures, if any, are needed to abate or mitigate potential risk of personal injury or property damage. These trees are listed in the *Trees Recommended for Further Inspection* section of the *Tree Inventory Workbook.*

The majority of trees in this category are rated in poor condition. Specifically, this category includes trees that exhibit structural damage or conditions (large cavities, severe lean, etc.) or the beginning stages of disease or decline that could create the potential for personal injury or property damage within the next five years.

Utilities

The presence of high and low voltage and cable and telephone overhead utility lines is noted during the inventory. This information is important in planning for pruning projects and for future tree plantings. For the purposes of this inventory, the presence of utility lines is indicated as *Yes* or *No* (Appendix F).

Tree Location Type

The physical location of trees in relation to the public right of way and/or public space is recorded. Location types include: *Borderline*, *Off ROW*, *Park or Public Space*, *Street*, and *Unknown*.

Clearance Requirements

The need for pruning to meet clearance standards over streets, parking lots, and sidewalks is noted where tree branches are considered to be interfering with the movement of *Vehicles* or *Pedestrians* or where they are obstructing *Buildings*, *Signs*, *Lights*, or *Traffic Signals*. This allows conflicts to be identified and addressed for treatment (Appendix E).

Observations

General observations concerning tree health, structure, and location have been recorded for each tree in the inventory, when applicable. Observation types include *Cavity/Decay*, *Grate/Guard*, *Mechanical Damage*, *Memorial Tree*, *Nutrient Deficiency*, *Pest Problem*, *Poor Location*, *Poor Root System*, *Poor Structure*, *Remove Hardware*, and *Serious Decline*. *None* means no observation types were recorded.

Hardscape Damage

Tree and stump roots that caused cracking, heaving, or lifting of Town sidewalk pavement one inch or more have been indicated by *Yes* or *No* entries (Appendix E).

Growing Space Type

The type of space available for tree growth is noted (Appendix E). The common site types include: *Island*, *Median*, *Open/Unrestricted* (areas such as yards or parks), *Raised Planter*, *Tree Lawn* (the area between a curb and a sidewalk), and *Well/Pit*.

Growing Space Size

The shortest dimension (width in feet) of each growing space type is noted (Appendix E).

Additional Comments (Field Notes)

Any additional comments regarding maintenance, cultivars, condition, disease, location, etc. are included for each tree, when applicable.

Chapter Two: The Town of Wake Forest's Tree Population

Summary

The urban forest in Wake Forest is a complex system of trees, site conditions, and maintenance recommendations. Understanding this system is important for proper decision-making regarding species selection and tree care practices. The *Tree Population Characteristics* section of this report provides insight into the current composition and condition of Wake Forest's inventoried tree population. This information comes from an analysis of the data collected during the tree inventory phase of the project. Specific information detailed in this chapter includes:

- Species Composition and Diversity
- Size Class Distribution
- General Health and Condition
- Tree Maintenance Recommendations
- Other Data Fields
- Tree Inventory Concerns

By accumulating and using this information, urban forest managers can forecast trends, anticipate maintenance needs, facilitate budgeting for tree-related expenditures, and develop a basis for long-range planning. This is necessary to ensure a stable and diverse tree population for the coming years and to plan for future tree planting operations.

Tree Population Characteristics

The characteristics of the urban forest include species, diameter, condition, and other tree and site factors. By identifying the species, diameter, and condition of trees in the urban forest, one can learn much about the forest's composition, relative age, and health. It is important to know the kinds of trees as well as the number of trees present in the Town. Species composition data are essential because tree species vary considerably in life expectancy and maintenance requirements. The types of trees present in a community greatly affect tree maintenance, activities, and budgets. Similarly, tree diameter and size class data help to define the general age and size distribution of the total tree population.

Species Composition and Diversity

Table 1. Significant Species Composition of Wake Forest

Scientific Name	Common Name	Number	Percentage
Acer rubrum	Red Maple	930	23.47
Prunus spp.	Cherry, spp.	468	11.81
Quercus phellos	Willow Oak	399	10.07
Cornus florida	Flowering Dogwood	361	9.11
Lagerstroemia spp.	Crapemytle, spp.	188	4.74
Acer saccharum	Sugar Maple	173	4.37
Cercis canadensis	Eastern Redbud	154	3.89
Pyrus calleryana	Callery Pear	149	3.76
Pinus taeda	Loblolly Pine	133	3.36
Liquidambar styraciflua	American Sweetgum	100	2.52
Totals		**3,055**	**77.10**

As can be seen in Appendix A, the inventoried street tree population is comprised of 4,022 trees and stumps distributed among 52 genera and 81 species. Table 1 illustrates that ten species account for 77.10% of the street tree population.

Generally, in the field of urban forestry, it is recommended that no one species should account for more than 10% of the total population. Furthermore, no single genus (a genus is a group of closely related species) should comprise more than 20% of the total population. Table 1 shows that *Acer rubrum* (Red Maple) comprises approximately 23.5% of the inventoried street tree population in Wake Forest. Furthermore, Figure 1 shows that the genus *Acer* (Maple) accounts for approximately 29% of the Town's total tree population.

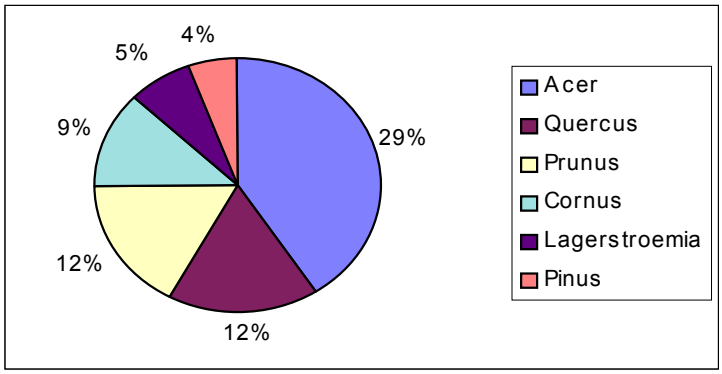


Figure 1. Wake Forest's Distribution of Trees by Genus

The inventory shows that the tree planting efforts in Wake Forest have resulted in an unbalanced species distribution pattern. Davey Resource Group recommends that the Town of Wake Forest plant a wider range of species by including both native and non-native, urban-tolerant species. Planting a large number of trees of the same species (monoculture) can lead to catastrophic results. A good example of this situation was the dominance of American elm (*Ulmus americana*) in American cities in the 20th century. When Dutch elm disease arrived in the United States in the 1930s, the resulting tree losses were devastating. Similar scenarios are now foreseeable for the Asian long-horned beetle and emerald ash borer.

Size Class Distribution

Tree species have different life spans and mature at different diameters, heights, and crown spreads. This means that actual tree ages cannot be assumed from the diameters of the trees. However, general classifications of size such as small, medium, and large can be used to describe the general characteristics of the urban forest. This does not substitute for age classes, which can give the actual age and maturity of the trees, but it can provide a general idea of the variability in the tree population. The actual breakdown by size can be found in Appendix C.

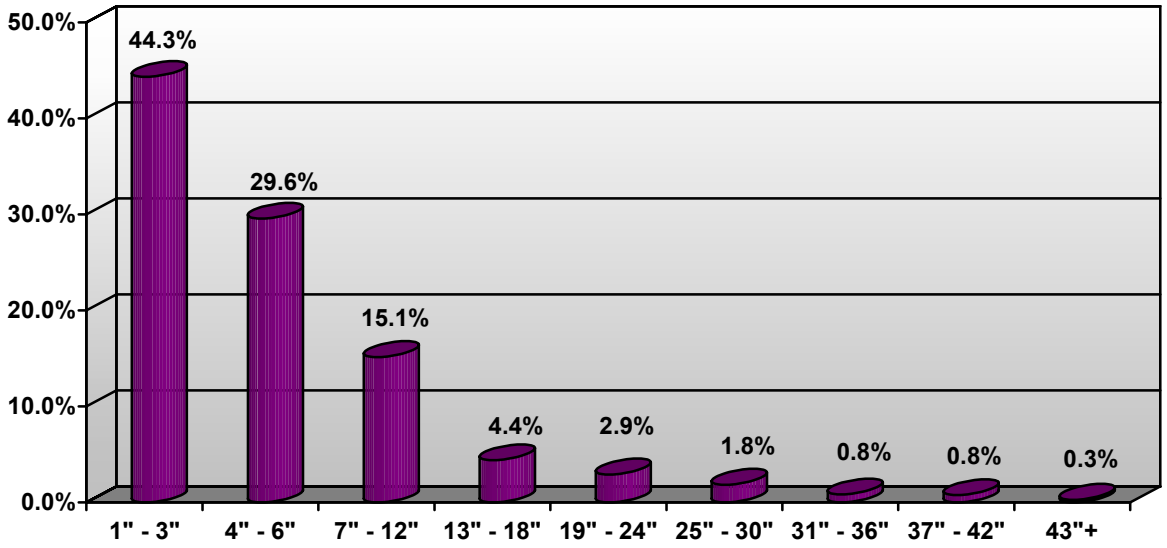


Figure 2. Diameter Size Class Distribution of Wake Forest's Inventoried Tree Population

As illustrated in Figure 2, small trees, which are six inches or less in diameter, represent approximately 74% of the total tree population inventoried in Wake Forest. Maples, Oaks, and Cherries account for the majority of these trees. It must be understood that 'small trees' does not mean that all trees in this class are of small growth habit. For example, the oaks that are in this group are simply young, recently planted trees. These trees, under normal conditions, will mature to medium- or large-sized trees from 50 to 90 feet in height. The redbuds have growth habits in which they mature at heights from 20 to 30 feet and diameters of 8 to 13 inches. These trees have a relatively short life span in the urban environment compared to larger maturing oaks and maples.

Species diversity alone is not sufficient to maintain a stable urban forest. The extent to which each species is adapted to the conditions in Wake Forest and the local climate will also determine the general health and longevity of the tree population. The many species currently being used in Wake Forest represent a fair group for street tree usage.

It should be noted that young, deciduous trees must be properly trimmed to encourage good growth habit and to minimize future maintenance requirements as the trees mature. Though the maintenance requirements are more intensive in young trees, this care can be performed efficiently by ground crews and without costly equipment.

Roughly 22% of the inventoried urban forest falls under the medium-sized classification with a diameter range of 7 to 24 inches. The crabapples and pears in this size class are considered mature in that they have or will have attained their maximum height.

Large trees, which are 25 inches and greater in diameter, represent approximately 4% of the inventoried tree population. Oaks, maples, and pines dominate this category.

Keeping the factors above in mind, it becomes clear that planning for tree planting in Wake Forest requires careful consideration of species selection. The small size class should be composed of both long-lived species and smaller, shorter-lived species, addressing the need for future requirements and the desire for such characteristics as spring flowers and fall color. Tree maintenance should be carried out to ensure the health and longevity of the trees, especially those with good maturity potential. This includes fertilizing, watering, mulching, and training pruning when young.

Normal recommendations in urban forest management call for achieving, over time, an appropriate age mixture by removing and replanting a certain percentage of trees each year. A good 'rule-of-thumb' for Town tree populations is a 20:60:20 mix of small, medium, and large trees, reflecting the percentage of trees in each size group and representing a uniform spread of tree ages from young to mature to overmature. Using this approach, a community can maintain the existing stocking level of its tree resource. By comparison, Wake Forest's current population is a 74:22:4 mix of small, medium, and large trees, respectively. This skew in the tree size groups is largely due to the recent plantings in the new residential development areas of the town.

General Health and Condition

The condition of a tree is evaluated by considering several factors including, but not limited to, the root characteristics, trunk, branch structure, canopy, foliage, and presence of pests, among others. Based on these factors, each tree is given a rating.

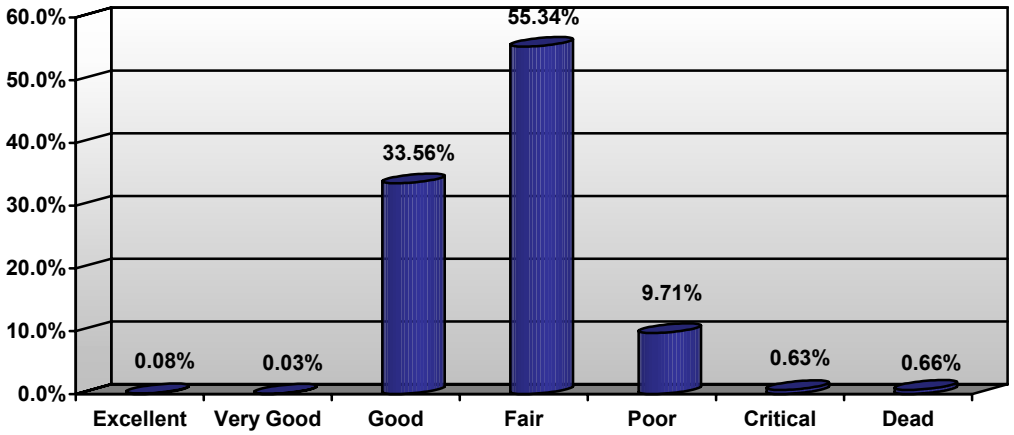


Figure 3. Wake Forest's Tree Conditions

As can be seen in Figure 3, a significant proportion of Wake Forest's tree population is in good health. Dead trees and trees in poor and critical condition only comprise approximately 11% of the total inventoried population. Flowering dogwood, red maple, and willow oak have the highest amount of trees listed in poor, critical, or dead condition classes.

The poor and critical condition ratings given to mature trees are generally due to visible signs of decline and stress including, but not limited to, decay, dead limbs, sparse branching, or poor structure. Where physical damage has occurred, these trees may also become more susceptible to diseases and other problems.

These kinds of stresses can also make trees more prone to pest problems by providing access to internal wood tissue. In fact, there are certain insect pests specifically drawn to wounded trees. If a tree is already stressed, the additional injury can substantially reduce the tree's ability to sustain defense mechanisms and maintain growth. When trees are in good health, most have the ability to withstand pest or disease problems but, with the onset of stress and/or decline, they are less able to produce sufficient energy for growth and survival and can succumb rapidly.

The poor condition rating given to young or newly planted trees is often due to severe physical damage or to a failure to thrive after planting. Young trees can be seriously impacted by physical damage from vehicles, lawnmowers, and poor pruning and are often vandalized because of their small size, which makes them an easy target for destruction.

When maintaining public trees, it must be realized that the potential for loss is an important factor in prioritizing treatments and making effective use of available funds. Monitoring the condition of significant trees and making efforts to maintain their health is essential. The loss of trees over time is an inevitable natural process. However, to control the decline, removal, and replacement of trees in a timely and cost-effective manner is the goal of the management process.

Photo 4. A vehicle clearance problem resulting from the lack of a proper training prune.

Photo 5. Extensive possibilities exist for right of way planting in the outside development area of Wake Forest.

Tree Maintenance Recommendations

One objective of the tree inventory was to determine the current appropriate maintenance recommendations for the tree population. The highest priority maintenance recommendations identified pertain to protecting public safety first and foremost. The requirements for specific pruning maintenance types or removals were decided upon by the inventory arborists based on the existence of potential safety hazards to the citizens of Wake Forest or their property. The maintenance activities associated with reducing the risk of injury or property damage include:

- **Priority 1 Removal and Priority 2 Removal**
- **Priority 1 Prune and Priority 2 Prune**

The other maintenance activities discussed here are:

- **Large Routine Prune**
- **Small Routine Prune**
- **Training Prune**
- **Stump Removal**

The latter four categories are not high priority safety pruning activities, but rather practices directed at improving the overall health, longevity, and aesthetics of the urban forest. It should be noted here that many other maintenance activities could be identified such as insect or disease treatments or fertilization. This information was not collected as part of the inventory because these types of maintenance activities are rarely included in a municipal tree management budget. Davey Resource Group has identified those maintenance activities that are of greatest importance to the overall management of the total tree population.

The current urban forest maintenance requirements have been determined from observations of the trunk, scaffold branches, and canopy of each tree, as well as the tree's location relative to streets, sidewalks, wires, signs, buildings, and traffic control devices.

This section analyzes the removal and pruning requirements noted during the inventory. Recommendations for future maintenance are included as part of the discussion of each category. The maintenance requirements are identified on a per tree basis by address in the Tree Inventory Workbook. Additionally, the next chapter discusses, in detail, the specific prioritization of maintenance work and provides a detailed five-year estimated budget for the maintenance of the street tree population.

Maintenance data should be used as a basis for prioritizing activity needs. This information will allow Wake Forest to develop cost-effective strategies by assisting all relevant Town officials with an accurate evaluation of current and future tree-related expenditures.

Table 2. Wake Forest's Tree Maintenance Requirements

Maintenance Required	Number of Trees	Percentage of Trees
Priority 1 Removal	40	0.99
Priority 2 Removal	108	2.69
Priority 3 Removal	109	2.71
Priority 1 Prune	96	2.39
Priority 2 Prune	119	2.96
Large Routine Prune	860	21.38
Small Routine Prune	630	15.66
Training Prune	2001	49.75
Stump	59	1.47
Totals	**4,022**	**100**

It is clear in Table 2 that a majority of the urban forest maintenance work needed in Wake Forest is 'non-hazardous' pruning activities. Approximately 87% of the total tree population require either routine or training pruning work. However, since a municipality's first priority is public safety, removal and pruning activities considered a high priority will be discussed next.

Tree Removals

Trees fail from natural causes such as disease, insects, and weather conditions and from physical injury due to vehicles, vandalism, poisoning, and root disturbance, among others. There are three main reasons why hazardous public trees should be removed: (1) to reduce risks to persons and property; (2) to eliminate breeding sites for insects and diseases; and (3) for aesthetic reasons. As stated above, trees recommended for removal in this inventory are those that may be potential safety risks or are in such poor condition that they are likely to die within the next few years.

Of the street trees inventoried, 40 (1%) are recommended for Priority 1 Removal and 107 (2.7%) are recommended for Priority 2 Removal (Table 2). A great majority are oaks and maples. The prompt removal of these trees will reduce municipal liability through the decreased likelihood of tree failure. Locations of the street trees to be removed are listed alphabetically by street name in the Tree Inventory Workbook.

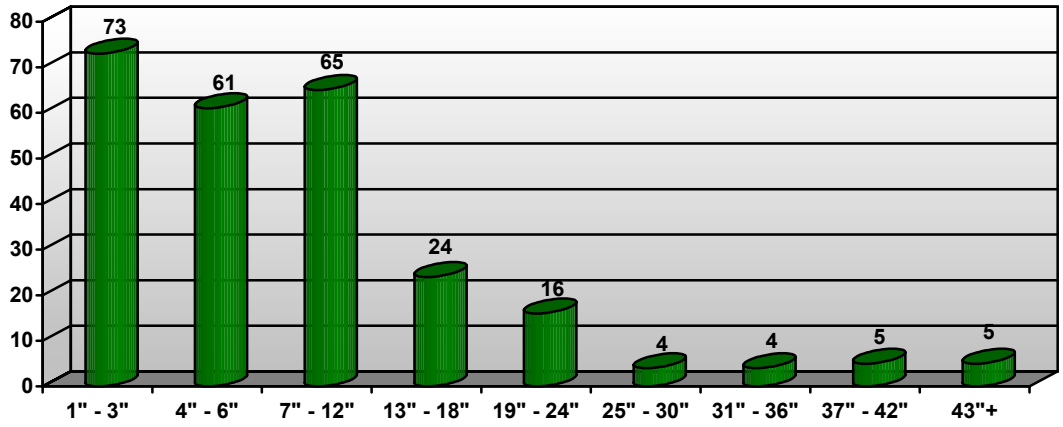


Figure 4. Number of Tree Removals by Diameter Size Class

Priority Pruning

Priority 1 Prune is the removal of dead, diseased, or obviously weak, heavy, or hazardous branches which are four inches in diameter or greater. As can be seen in Table 2, 96 (2.4%) inventoried trees in Wake Forest are in need of Priority 1 Prune work to reduce potential hazards and liability. A great majority are maples, oaks, and pines.

Photo 6. Willow oak (Quercus phello) in the right of way with end-loaded limbs and decay. Noted with hanger (Spring Street.).

Priority 2 Prune is the removal of dead, diseased, or obviously weak, heavy, or hazardous branches that are between two inches and four inches in diameter. 119 (3.0%) trees require this type of maintenance. A great majority are maples, oaks, and pecans.

All trees in these two pruning categories should be examined closely during trimming operations for severe internal decay or dieback. If, upon closer inspection, these trees are found to be severely decayed, they should be removed. The trees requiring trimming for risk conditions should be attended to as quickly as possible, starting with the greatest risk trees first. The Tree Inventory Workbook includes a listing of priority prunes by address.

Routine Pruning

Routine Pruning consists of the removal of dead, dying, diseased, interfering, objectionable, and weak branches on the main trunks, as well as those within the canopy area, of trees. All told, 1,490 (37.6%) of the inventoried trees in Wake Forest are current candidates for a Routine Prune. A systematic Routine Pruning cycle of all Town trees should be implemented to decrease the occurrence of potentially dangerous broken branches and large deadwood.

Large Routine Prune includes large growth habit trees requiring routine horticultural pruning to correct growth patterns that would eventually obstruct vehicular or pedestrian traffic or interfere with utility wires or buildings. Trees in this category are large enough to require bucket truck access or manual climbing. 860 (21.7%) of the trees in Wake Forest require this type of maintenance.

Small Routine Prune includes small growth habit trees requiring routine horticultural pruning to correct growth patterns that would eventually obstruct vehicular and pedestrian traffic or interfere with utility wires or buildings. Trees in this category may be mature trees, but are small enough that they can be pruned from the ground. 630 (15.9%) of the trees in Wake Forest require this type of maintenance.

The trees requiring Routine Pruning are not generally regarded as presenting an immediate risk of hazard. This will allow Wake Forest to budget and schedule most of its maintenance recommendations in a cost-efficient and timely manner. Although many of these recommendations are presently low priority, they can become high priority liabilities if neglected for an extended period of time. Pruning guidelines can be found in Appendix J. Refer to the next chapter for a discussion of the Routine Pruning Program.

Given the modest numbers of coniferous trees on the streets, such as loblolly pine, etc., mention must be given to the unique maintenance requirements of these species. Generally, these species do not require cyclical pruning, as do deciduous trees. Nor do these trees usually require training pruning when young (except in the case of multi-stemmed trees or those with codominant leaders).

Training Pruning

Training, or pruning to shape, consists of the removal of dead, dying, diseased, interfering, conflicting, and/or weak branches, as well as selective trimming to direct future branch growth and lessen wind resistance. This maintenance category applies to all trees less than 20 feet in height and are usually young and newly planted. Trees in this group are of such a size that they can be pruned from the ground with a pole pruner. In all, 2001 (50.5%) of the inventoried trees are designated as *Training Prune*. A great majority are redbuds, plums, and maples.

Other Data Fields

Further Inspection Required

There are 123 (3.1%) trees within the Town's right of way recommended for *Further Inspection*. Many of these trees are listed as being in poor condition and have been noted as having decay to an undetermined extent. Other instances in which a tree would be recommended for Further Inspection include major structural defects and/or the need to re-evaluate risk factors. A Certified Arborist should perform these inspections on an annual basis. A listing of all trees with this designation can be found in the Tree Inventory.

Utilities

Of the 4,022 trees and stumps that were collected in the inventory, 1,063 sites (26.4%) are identified as having utilities above or immediately adjacent to them. Noting the presence of utility lines is necessary when planning pruning activities and can be used to identify which sites are more suitable for small growth habit tree species that will not interfere with utility lines when they mature.

Tree Location Type

Of the 4,426 trees, vacant sites and stumps inventoried in Wake Forest, 4,410 (99.6%) are designated as *Street* trees, 16 (0.4%) are designated as *Borderline* trees.

Tree Trunks

Of the 3,963 trees inventoried, 3,381 (85.3%) had one main trunk and 582 (14.7%) had multiple trunks. Trees with multiple trunks, such as large growth habit trees or weak-wooded species, can be a hazard to the general public. Trunks can fail due to decay, included bark, ice, wind, snow, etc. Large trees with multiple trunks should be monitored and excess trunks should be removed, if necessary.

Clearance Requirements

Of the 3,963 trees inventoried, 379 (9.6%) are identified as requiring clearance for *Vehicles*, 138 (3.5%) require a *Pedestrian* clearance, 9 (0.2%) require a *Sign* or *Signal* clearance, 6 (0.2%) require a *Light* clearance, and 4 (0.1%) require a *Traffic* sign clearance.

Observations

Of the 3,963 trees included in the inventory, 230 (5.8%) have a *Cavity/Decay* designation, 163 (4.1%) have *Mechanical Damage*, 121 (3.1%) have a *Remove Hardware* designation, 80 (2.0%) have *Poor Structure*, 34 (0.9%) are growing in a *Poor Location*, 25 (0.6%) are in *Serious Decline*, 21 (0.5%) have a *Poor Root System*, and 2 (0.05%) have a *Pest Problem*.

Hardscape Damage

Of the 4,022 trees and stumps inventoried, 30 (0.8%) are recorded as contributing to sidewalk and/or curb damage.

Growing Space Type

Of the 4,022 trees and stumps included in the inventory, 3,199 (80.7%) are located in *Open/Unrestricted* growing spaces, 672 (17.0%) are located in *Tree Lawns*, 51 (1.3%) are located on *Medians*, 20 (0.5%) are located in a *Well/Pit*, 18 (0.5%) are located on *Islands*, and 3 (0.08%) are located in a *Raised Planter*.

Vacant Planting Sites

Within the inventory, 404 potential planting sites are identified. The space available for a tree to be planted and thrive is a major factor that dictates the type of species best suited for a given location. Of the available sites, 127 are designated as Large, meaning that they are suitable for large growth habit trees (nine feet wide and greater grow space size). There are 168 Medium sites (six- to eight-foot-wide grow space sizes), and 109 Small sites (four- to five-foot-wide grow space sizes). In the event that voltage conducting, overhead utility wires are present, only Small planting sites are recommended.

The potential tree population of the Town's inventoried areas is 4,426 sites (3,963 existing trees plus 404 vacant planting sites and 59 stumps). This means that the Town of Wake Forest's urban forest is 89.5% stocked. Stocking is a traditional forestry term measuring the density and distribution of trees. For Wake Forest, this means of the total number of sites in the public right of way that are suitable for trees, only 89.5% currently have a tree present. Davey Resource Group generally recommends that the urban forest should be 90–100% stocked so that no more than 10% of the planting sites are vacant. The Town should make every effort to budget for tree planting in the near future so that it may reach the recommended stocking goal. Additionally, the 257 trees recommended for removal represent a future positive change in site status for potential planting sites. A list of all planting sites by street address is included in the Tree Inventory Workbook and can also be queried for in the TreeKeeper™ 7.4 software.

A systematic program of maintenance, specifically designed for newly planted trees, is necessary to provide them with the greatest chance of survival. Proper tree planting is crucial since inadequately dug planting holes, improperly placed support wires, etc. can lead to additional stress in and even death of young trees. Refer to Appendix J for tree planting and pruning specifications.

Photo 7. This willow oak (*Quercus phellos*) has damaged the a retaining wall and sidewalk as a result of its maturation. Large growth habit trees should be planted in sites with at least nine feet of grow space to prevent hardscape damage from occurring (W. North Ave.).

The Town must determine which tree species will be planted in each vacant site. The suggested species list considers maintenance recommendations, adaptability to specific planting site variables, mature size, and suitability to the restrictive conditions of the urban environment, among others. Careful planning is necessary to introduce a level of variety into the street tree population. Because a sizeable percentage (64.7%) of the vacant sites are identified for planting with large growth habit trees, it is of paramount importance to consider the recommended species in Appendix H.

Tree Inventory Concerns

During the inventory and subsequent data analysis, inventory personnel made specific observations that the Town should be aware of:

Trunk/Root/Crown Decay: Of the 3,963 trees inventoried in Wake Forest, 259 (6.5%) did have external indicators of root, crown, and trunk decay. The fruiting bodies of fungi are signs of internal damage. Careful monitoring of these trees is recommended and tree protection measures should be implemented in the future to prevent this type of damage. Other trees that displayed decay fungi or obvious signs of wood decay were those that had been previously affected by trunk or root damage from construction activities or other types of mechanical damage. Throughout the inventory, 123 (3.1%) were noted as requiring 'further inspection', mostly because of the presence of decay. In many of these cases, the extent of decay could not be determined visually or the extent of decay does not yet warrant priority maintenance. Trees recommended for further inspection should be examined annually.

Photo 8. Willow oak (*Quercus phellos*) in the right of way with extensive trunk decay and the street as a target.

***Development of a Training Pruning Program*:** Currently 2001 trees (50.5%) have been designated as Training Prune in Wake Forest. Therefore, the Town would benefit greatly from the utilization of a small-tree trimming operation. Training pruning is a relatively inexpensive operation since the trees can be pruned from the ground. Training Pruning will ensure that newly planted and young trees have a strong, central leader and good form as they mature. Since 74 % of the Town's tree population is composed of young trees six inches and less in diameter, this is an activity that would be extremely beneficial for the overall health and quality of the Town's urban forest.

Pest Problems: 19 (0.5%) of Wake Forest's street trees were recorded as having a pest problem. Currently, one major pest is attacking the Town's trees:

Mistletoe (Phoradendron spp.*)*: Mistletoe is a parasitic evergreen species that establishes itself in the crown of evergreen as well as deciduous trees, and is responsible for damaging thousands of trees every year. There are many different species of mistletoe most, of which are host specific. Mistletoe reproduces by producing small, sticky, whitish seed that often attract birds. After digesting the berries the seeds are deposited on healthy branches where they germinate and roots burrow into the vascular system of the host tree. Once the root systems has established the parasite takes water and nutrients from the host. This can cause branch dieback and can result in the death of the host tree. Mechanical removal of mistletoe does have some success, however, normally the entire branch must be removed at least a foot from the infestation to ensure that the entire root system is removed. Improving the vitality of infested trees by fertilizing, mulching, and watering may prove beneficial. Chemical controls can also be implemented; however, they are only a temporary solution and must be reapplied to be effective. Some tree species appear resistant to broadleaf mistletoe. Bradford pear, Chinese pistache, crapemyrtle, eucalyptus, ginkgo, goldenraintree, liquidambar, sycamore, and conifers, such as cedar, are rarely infested. These or other resistant species should be considered when planting in infested areas or when replacing infested trees (Appendix P).

Photo 9. Mistletoe (Phoradendron* spp.*) infestation.

Chapter Three: Five-Year Urban Forest Management Program

Summary

This chapter details the activities that will constitute the Five-Year Urban Forest Management Program for Wake Forest. Headings in this chapter include:

- Priority Tree Maintenance Recommendations
- Routine Pruning Program
- Training Pruning Program
- Public Relations and Education
- Five-Year Urban Forestry Program and Budget
- Sources of Funding
- Tree Ordinance Recommendations
- Management Recommendations for Updating Inventory

In this chapter, a Five-Year Urban Forest Management Program is described including estimated budgets for each activity across the five-year period. Specific tree management recommendations that are detailed include:

Management Recommendations for Street Trees

- Perform all Priority maintenance recommendations. This includes all removals and all priority pruning identified in the inventory. This program is designed to alleviate all potential hazards identified in the tree inventory by 2006.
- Beginning in Year 3, implement a continual Routine Pruning maintenance cycle for the entire street tree population to ensure their pruning every five years. This will involve the pruning of approximately 299 (greater than 20 feet in height) street trees annually (Table 4).
- Beginning in Year 3, implement a three-year cyclical Training Pruning Program for the younger street trees. This will involve the pruning of approximately 667 trees (less than 20 feet in height) annually (Table 5).
- A plan for after-care of new tree plantings should be implemented in order to maximize the survival rate. This includes pruning, mulching, and watering.
- Implement a Public Relations Program designed to educate the citizens of Wake Forest and to generate greater support for the urban forestry program.

A five-year budget for each of the above activities has been developed and presented in this chapter (Table 8). Additional sources of funding and recommendations for budgeting the urban forestry program are presented at the end of the chapter.

Priority Tree Maintenance Recommendations

The following tree maintenance recommendations are based on the analysis of the inventoried portion of Wake Forest's urban tree population in Chapter Two. These recommendations should be followed and used in the development of appropriate and realistic management goals. Implementation of these recommendations will allow Wake Forest to first address the highest priority maintenance recommendations related to public safety.

Initially, Wake Forest should concentrate on reducing the potential risks identified in the inventory. This means removing all trees identified as requiring Priority 1 and Priority 2 Removal and pruning all trees identified as requiring Priority 1 and Priority 2 Prune. A complete list of the maintenance requirements for each tree is located in the Tree Inventory Workbook.

Useful Life

The useful life of a public tree is ended when the cost of maintenance is greater than the value added by the tree to the community. This can be due to either the decline of the tree's condition and increasing maintenance activities or to the costs of repairing damage caused by the tree's presence.

Decline generally starts when the tree has reached a point where it cannot withstand the stresses imposed by its environment. Restrictive growing space, disease, insects, mechanical injury, pollution, and vandalism, among others, can cause stress. Although some species are more resistant to these urban stresses, all trees in urban settings will eventually decline, whether due to overmaturity, stress, or senescence.

The pattern of decline generally begins with persistent limiting site factors that place the tree in a state of chronic stress. This weakens the tree's natural defenses, leaving it more susceptible to injury from pests or unusual weather, such as a single insect induced defoliation or a late frost. Because the tree is now stressed, it has difficulty withstanding or combating the circumstance or recovering from such stress. As a result, the tree can become even more vulnerable to insects and disease that continue to reduce its vigor. Often, the first signs of a problem appear at this point.

The age at which a tree reaches the end of its useful life differs by species and also for certain individual trees within a genus. Slow-growing trees, such as *Carya* (pecan), are most valuable when they attain maturity. Fast-growing species, such as *Fraxinus* (ash), are most valuable as juvenile trees because they provide benefits quickly and become expensive to maintain as they reach maturity.

The end of the tree's useful life can also be reached while the tree is still healthy if it is growing in a limited site. Useful life, in this instance, is the point at which the cost of related maintenance, such as the repair of hardscape damage, exceeds the value added by the tree. For example, a large, fast-growing tree used in a smaller tree lawn will cause hardscape damage at an early age and periodically throughout its lifetime. The useful life of this tree will be reached before it begins to decline. A smaller tree, on the other hand, would probably not exceed grow space dimensions at any point in its life. The end of its useful life would probably be reached only when it started to decline due to senescence. A smaller tree, as a result, would make better use of this example tree site.

Priority Tree Maintenance Summary

The following priority tree maintenance recommendations are based on the tree inventory data collected in the first phase of this project. Where numerous priority removal and/or pruning treatment recommendations exist in the same area of the Town, the work should be performed at the same time in order to reduce travel time and costs.

The Town should also establish procedures for keeping the tree inventory information current. Keeping accurate records of work completed on specific trees and tracking tree condition will help do this. Wake Forest's tree inventory will prove to be a valuable tool in organizing, scheduling, and routing the needed work to be accomplished.

As mentioned earlier, the overall maintenance priorities are:

- Removals – Priority 1 and Priority 2
- Pruning – Priority 1 and Priority 2

Although large, short-term expenditures are required for trees with these maintenance recommendations, they should be performed within the first two years of the plan's implementation.

Following completion of these tasks, the Priority 3 Removal and Large/Small Routine Prune work should be addressed, including all Stump removals. A complete list of trees recommended for removal and priority pruning has been included in the Tree Inventory Workbook to expedite their location in the field. The data shape files can also be used in a GIS to find any desired trees. Based on the tree inventory's results, Table 4 provides a summary of Priority Maintenance Recommendations for Wake Forest's street trees.

Davey Resource Group strongly encourages the Town to schedule these activities to occur in as timely a manner as possible in order to advance the reduction of potential safety risks. By doing so, the Town will greatly lessen the potential of injury to citizens, damage to property, and possible liability litigation. Although it would be almost impossible to expect the Town to perform all needed maintenance activities immediately, an organized and systematic program will achieve the needed results in a timely manner and will demonstrate the Town's sincere attempt to keep all of its streets safe for the general public.

Table 3. Priority Tree Maintenance Requirements by Type and Size Class

Tree Diameter Size Class (Inches)	Priority 1 Removal	Priority 2 Removal	Priority 1 Prune	Priority 2 Prune
1 – 3	0	0	0	0
4 – 6	1	26	0	9
7 – 12	14	48	4	25
13 – 18	9	15	10	25
19 – 24	6	10	19	23
25 – 30	2	2	27	19
31 – 36	3	1	18	8
37 – 42	2	3	15	7
43+	3	2	3	3
Totals	**40**	**107**	**96**	**119**

To reduce the hazards in Wake Forest, the work in Tables 3 should be accomplished during 2004 and 2005. In addition to these immediate concerns, a natural mortality rate of 1% of the total tree population per year is usually expected (national averages show an annual mortality rate of about 1% for street and public space tree populations in cities). The mortality rate for Wake Forest's street trees would represent approximately 40 trees per year. It is important to keep in mind that as the current tree population ages and becomes overmature in the next 25 years or so, the Town should anticipate a gradual increase in this annual death rate. These anticipated tree removal costs are not factored into the budget projection for the Five-Year Management Program; however, the Town should allocate funds in anticipation of these removals.

Routine Pruning Program

Routine pruning is an activity that should take place on a cyclical basis for the entire tree population once all priority maintenance removal and pruning activities have been completed. Since the priority maintenance recommendations described above may be accomplished in the first two years, it is recommended that the *Routine Pruning Program* described here be implemented beginning in the same years, if funds exist for the work. If funds do not exist, the Routine Pruning Program can begin after the priority tasks have been completed. This activity is extremely beneficial for the overall health and longevity of street trees. Through routine pruning, potentially serious problems can be avoided because the trees can be closely inspected during these pruning cycles. Proper decisions can be made on declining trees and any trees that are becoming potential hazards can be managed appropriately before any serious incidents occur. Trees included in this program will not include young and newly planted trees. These trees will be included in the *Training Pruning Program* explained later. As young trees in this group grow larger, they will eventually become part of the Routine Pruning Program.

Small trees constitute a considerable portion (73.9%) of Wake Forest's street tree population. The Town's forestry personnel must recognize that as these small trees reach maturity, more work will be required to maintain a five-year pruning cycle. Wake Forest should concern itself with developing an organized, documented approach to cyclical tree maintenance that can be easily managed by Town staff and even properly trained volunteers, if budgetary issues are a concern.

Small Growth Habit Trees

Small Routine Pruning is recommended for mature, small growth habit trees such as the callery pears, redbuds, and plums in the Town of Wake Forest. These species are genetically small trees and usually attain a maximum height of no greater than 25-30 feet, but like all urban trees, require periodic pruning throughout their life span. The primary reason for periodic pruning of these small growth habit species is to maintain overall health and vigor through the removal of dead, dying, or diseased branches, as well as branches that may be interfering with the growth of other major branches. By maintaining these trees through periodic Small Routine Pruning, the potential for decay can be minimized and their vigor can be improved by retaining only strong, healthy branches.

Since 73.9% of the Town's tree population is composed of young trees six inches and less in diameter, and a total of 630 (15.9%) trees are recommended for Small Routine Pruning, this is an activity that would be extremely beneficial for the overall health and quality of Wake Forest's urban forest.

Small Routine Pruning can normally be accomplished from the ground with relatively inexpensive equipment. For this reason, the Town's crews will be able to easily perform this work with existing equipment. These crews would be responsible for the cyclical trimming of all mature, small trees, as well as the training pruning of young and recently planted trees. Additionally, they can perform clearance-trimming work. This is crown raising (the elevating of tree limbs) to allow vehicles to safely pass on a street or pedestrians to walk on a sidewalk. Furthermore, the clearing of limbs away from signs and traffic signals can be accomplished.

There are also many young redcedars and pines in Wake Forest. These trees normally require little in the way of training pruning, but inspections should be made to ensure that each tree does not have more than one leader or trunk. Occasionally pines will develop co-dominant leaders that, if not pruned to one leader, result in a tree with poor structure. Other problems may include the likelihood of creating traffic clearance problems and increased susceptibility to storm damage.

The five-year budget in this chapter provides average yearly estimates for this pruning program based on diameter classes and the number of trees in each diameter class. Table 5 details the average numbers of trees in each diameter class that would be pruned annually during the five-year Routine Pruning Program for street trees (note that trees with Priority type maintenance designations are not included in this table).

Five-Year Cycle

Results from the tree inventory indicate that about 1,490 (37.1%) street trees would be included in a cyclical pruning operation. An additional 215 (5.4%) street trees were recommended for some type of Priority Pruning. Once the priority pruning requirements of these trees are met, they too will fall into the maintenance category of Routine Pruning. This will increase the total of mature trees requiring Routine Pruning to 1,705 (42.4%).

It is suggested that a five-year cycle be implemented so that approximately 299 street trees per year are routinely pruned. As happens all too often in many cities, tree pruning consists of trimming by resident request or only if a hazardous situation exists. This management plan provides the Town with exact numbers concerning Routine Pruning and it serves as a guideline for accomplishing such a program.

Routine Pruning includes those trees requiring pruning on a cyclical basis to maintain tree form and health. Centralized pruning should be carried out, meaning that all trees in a Town block are trimmed. A certain number of Town streets (and blocks along those streets) should be designated for each year's work in order to meet the annual routine pruning goal.

Table 4. Routine Pruning Program for Street Trees by Size Class

Diameter Size Class (Inches)	Large/Small Routine Prune (Total Trees)	Large/Small Routine Prune (Approximate Trees/Year)
1 – 3	273	55
4 – 6	574	115
7 – 12	442	88
13 – 18	115	23
19 – 24	57	11
25 – 30	23	5
31 – 36	3	1
37 – 42	3	1
43+	0	0
Totals	**1,490**	**299**

Training Pruning Program

As described previously, training pruning consists of the removal of dead, dying, diseased, interfering, conflicting, and/or weak branches, as well as selective trimming to direct future branch growth on trees less than 20 feet in height. Although this type of trimming is called *Training Pruning*, the word 'training' truly pertains to young or recently planted trees. For these trees, Training Pruning is used to develop a strong structural architecture of branches so that future growth will lead to a healthy, structurally sound tree. Many young trees may have branch structure that can lead to potential problems as the tree grows, such as double leaders, many limbs attaching at the same point on the trunk, or crossing/interfering limbs. When trees are small, these problems can be remedied easily and inexpensively. Pruning can be accomplished from the ground with a minimum amount of equipment. If these problems are not corrected while trees are young, they can lead to instances where branches are poorly attached and where decay can develop at the crossing points of interfering limbs. Trees with poor branching become safety hazards, as they grow larger and could create potential liability for Wake Forest in the near future.

All newly planted trees should receive their first training prune three years following planting. No training pruning should be done when a tree is planted because it is already under stress from transplanting and needs as much of its leaf canopy as possible in order to manufacture food and increase root growth for proper establishment in its new site. Only dead or broken branches should be removed at the time of planting.

Three-Year Cycle

As with a Routine Pruning Program, the Training Pruning Program would also be accomplished on a cyclical basis, but the work would be scheduled during a three-year cycle rather than the five-year cycle for the routine pruning of larger trees. As mentioned above, newly planted trees should receive their first Training Pruning three years after planting. This work can be accomplished throughout the year. Particularly, since no bucket truck is required, Town employees can perform this work at any time. This type of work is also highly suitable for properly trained summer interns, part-time employees, and/or volunteers.

Work Estimates

A three-year pruning cycle would require the Training Pruning of approximately 667 street trees per year. Table 5 provides an annual average breakdown by diameter class. It has been Davey Resource Group's experience that, based on the generally small size of the trees in this category, a crew of two properly trained forestry personnel would be capable of accomplishing the work.

Table 5. Training Pruning Program: Street Trees by Size Class

Size Class (Inches)	Training Prune (Total Trees)	Training Prune (Approximate Trees/Year)
1 – 3	1410	470
4 – 6	527	176
7 – 12	64	21
Totals	**2001**	**667**

Training of Personnel

Proper training in young tree structural pruning would be required for all tree crew personnel. Additionally, these workers would require an understanding of the growth habits of the various species being planted, as well as an understanding of tree anatomy and physiology. This training can be received through the North Carolina Conservation Commission, local urban forestry consultants, and/or International Society of Arboriculture Certified Arborists. The tremendous aesthetic and financial benefits to be gained in the years to come from proper structural pruning of young trees are a strong incentive for educating tree crew personnel concerning proper pruning techniques. Additionally, the added knowledge gained by the individuals could prove to be an incentive in raising the sense of professionalism in their jobs.

Developing an Effective Tree Planting Program

Tree species and planting location designations are significant components of a municipal tree care program because of the long-term impact of these decisions. It is important to develop an overall planting strategy, initially concentrating on streets and blocks with the greatest need for improvement. Support from local business owners in funding plantings can be one method of achieving a full stocking of trees along main thoroughfares.

The success of a continuing tree planting program will be judged by the health of the trees post-planting and the amount of money spent on planting and maintaining the new trees. With a small amount of planning, healthy trees with greater life expectancies can be established with minimal up-front investment and minor maintenance costs.

The key elements for a successful tree-planting program are covered in this section and are primarily based on the exceptional reference *Principles and Practice of Planting Trees and Shrubs* (Watson and Himelick, 1997).

Tree Species Diversity

Tree plantings in newer developments add greatly to the aesthetic appeal of the neighborhood. However, species diversity in new plantings should be of major importance. As stated previously, maples (*Acer* spp.) account for 28.8% of Wake Forest's total tree population. The dangers (disease, insects, etc.) of planting monocultures have proven to be devastating throughout the Eastern and Midwestern United States. The goal here should be to increase species diversity throughout the Town such that no more than one species represents 10% and that no one genus comprises more than 20% of the total population. Consideration should be given to large trees that provide shade and are aesthetically pleasing.

Tree Species Selection

Wake Forest occurs in Zone 7 of the USDA Hardiness Zone Map, which identifies the climatic region where the average annual *minimum* temperature is between 0º and 10º F. Tree species selected for planting in the Town should be appropriate for this zone. A total of 404 potential planting sites were identified in the inventory. The sites are areas suitable for tree planting within the existing public right of way and tree easement as defined by the Town.

In addition to considering site characteristics such as availability of space, soil pH, and irrigation, species-specific features must also be scrutinized. A major consideration for street trees is the amount of litter dropped by mature trees. Species such as willow (*Salix* spp.) have weak wood and typically drop many small branches during a growing season. Others, such as American sweetgum (*Liquidambar styraciflua*), drop high volumes of syncarps (fruits). In certain species, such as ginkgo (*Ginkgo biloba*) and osage-orange (*Maclura pomifera*), female trees produce offensive/large fruit; male trees, however, produce no fruit. Furthermore, a few species of trees, including black locust (*Robinia pseudoacacia*), hawthorn (*Crataegus* spp.), and honeylocust (*Gleditsia triacanthos*) may have substantial thorns. These species should be avoided in high traffic areas.

Seasonal color should also be considered when planning tree plantings. Flowering varieties are particularly welcome in the spring and deciduous trees that display bright colors in autumn can add a great deal of interest to surrounding landscapes.

Above all, tree species should be selected for their durability and low maintenance characteristics. These attributes are highly dependent on site characteristics as well as species characteristics. Matching a species to its favored climatic and soil conditions is the most important task when planning for a low maintenance landscape. Plants that are well matched to their environmental and site conditions are much more likely to resist pathogens and insect pests and will, therefore, require less maintenance overall. Refer to Appendix H for additional tree species and cultivars suitable for planting in Wake Forest.

Full Stocking Potential

Full tree stocking is an elusive goal, since mortality of the young and old trees continues to make planting sites available. Nevertheless, it is worth the effort because the goal of working toward full stocking can help make other less glamorous aspects of urban forestry more palatable, especially removals.

The Town should consider a plan to grow from its current 89.5% stocking level (see the *Vacant Planting Sites* section in Chapter Two). This would entail a planned program of annual tree plantings aimed at filling the amount of vacant street tree planting sites. This program would involve plantings beyond those requested by homeowners. Annual planting programs should be planned throughout Wake Forest. Full stocking will require more resources than are currently available to purchase and plant trees.

With a total of 404 vacant sites, the Town would need to plant approximately 101 trees per year for ten years in order to reach its full stocking potential (the Town should decide its desired stocking rate and level of planting and removal in order to set a specific goal). This annual planting goal assumes that no trees are removed, no new streets are added, and all of the new plantings survive. A more accurate formula for determining the planting rate for such a goal comes from the textbook *Urban Forestry: Planning and Managing Urban Greenspaces* (Miller, 1997) and is written as:

$$N = \frac{R + (V/G)}{S}$$

Where:

N = number of trees to be planted annually
R = number of trees to be removed annually
V = existing vacant sites
G = years remaining to achieve full stocking potential goal
S = expected planting survival rate

Applying the formula above: Wake Forest's 404 available planting sites scattered throughout the Town. If it is known that 40 trees per year will be removed based on the natural mortality rate (see *Priority Tree Maintenance Summary* in Chapter Three), the Town needs full stocking in ten years, and the planting survival rate over that period is 80%, the result is:

$$N = \frac{40 + (404/10)}{0.80} = 100.5 = 101 \text{ trees/year}$$

The Tree Planting Process

As trees are purchased through local nurseries, the most important consideration should be species selection. This will aid in increasing species diversity throughout Wake Forest. Davey Resource Group has indicated 404 vacant planting sites along the Town streets that are suitable for new trees. Planting sites have been specifically identified by street, address, and site number in the Tree Inventory Workbook and can also be queried for in the TreeKeeper 7.4™ software. By setting a goal of filling all of these sites, the Town will be headed toward full stocking of its street tree population. Table 6 represents the costs associated with a planting program designed to fill all current vacant sites, in addition to future vacant sites that become available as trees are removed, over a course of ten years. The many benefits associated with the trees in Wake Forest can then begin to be maximized (as previously discussed in the section *Importance of the Urban Forest* in Chapter One).

Once the appropriate trees have been selected for planting, the most important detail to ensure success is the preparation of the planting sites. Appendix I explains the proper method of excavating a planting hole. In general, the tree-planting holes should be relatively shallow (typically slightly less deep than the height of the root ball) and quite wide (three times the diameter of the root ball). Care should be taken so that the root collars of the new trees are at the same level or slightly higher than the surrounding soil grade. In most situations, it is not recommended to add soil amendments to the planting holes as this can lead to severe differences between texture and structure of soils inside the planting holes and the surrounding soil. Such differences can lead to either water being wicked away from or accumulating in the planting holes.

Tree staking hardware should only be installed when necessary to keep trees from leaning (windy sites) or to prevent damage from pedestrians and/or vandals. Stakes should only be attached to trees with a loose, flexible material, and all staking material must be removed within one growing season (Appendix I)**.**

Photo 10. This young tree has been improperly planted. It is crucial that the tree is planted at the proper depth and all twine, nylon strings, plastic liners, and other synthetic materials are removed prior to planting. All burlap should be pulled back from the top of the root ball. Rot-resistant burlap and wire baskets should be removed (N. Franklin St.).

Tree Mulching

Mulch should be applied to the surface of the soil around each newly planted tree. Mulch should never be piled up around the root collar (so-called mulch 'volcanoes'), but rather should be pulled away from the root collar. Mulch that buries the root collar provides shelter for insects, fungi, and mammals that could damage the tree. Mulch should be applied to an area three times the diameter of the root ball to a depth of two to four inches. Mulch not only suppresses competition from grass and weeds, but also provides a zone where turf maintenance is not needed, thereby keeping lawn mowers and string trimmers safely away and thus preventing mechanical damage. Mulch also helps to hold moisture in the surface of the soil where most of the feeder roots are to be established.

Tree Fertilization

Any fertilization process should not be thought of as 'feeding' or 'energizing' the trees; instead, arboricultural fertilizers should be understood as essentially replacing soil elements or minerals that are lacking or in short supply for a variety of reasons. Nutrients may be in adequate supply but be unavailable for uptake by the trees because of extreme pH conditions. Application of fertilizer may not improve the situation until measures are taken to alter pH levels or to replace the trees with a species better suited for the existing soil conditions.

Fertilization may not be necessary for the first growing season unless specific nutrient deficiencies exist. At the beginning of the second growing season, fertilizers can be applied to the root zone. Nitrogen is usually the limiting nutrient for plant growth. Soil analysis, particularly when combined with a foliar analysis, can determine when other elements are in short supply. Slow-release fertilizers applied in autumn will help root growth and will still be available the following spring.

Tree Pruning

Assuming that the proper trees have been selected for each site, pruning young trees to improve branch structure is the most effective method of reducing maintenance costs as trees mature. At the time of planting, the only pruning that should be done is the removal of broken or dead branches. In the second growing season, minor pruning can be performed to remove branches with poor attachments. In subsequent years, selective pruning should be performed to achieve the proper spacing of branches. See Appendix J for more information on proper pruning techniques.

Table 6. Ten-Year Tree Planting Program

Year	Tree Cost	Planting Cost	Number of Trees	Total Cost
1	$110	$110	101	$22,220
2	$110	$110	101	$22,220
3	$110	$110	101	$22,220
4	$110	$110	101	$22,220
5	$110	$110	101	$22,220
6	$110	$110	101	$22,220
7	$110	$110	101	$22,220
8	$110	$110	101	$22,220
9	$110	$110	101	$22,220
10	$110	$110	101	$22,220
Totals	**$1,100**	**$1,100**	**1,010**	$222,200

Tree Purchases

Tree prices, of course, vary based on the species selected, but many nurseries offer trees of 1.5 to 2.5 inch caliper for $100 to $150. As the Town works at planting more trees annually, obtaining a good price for quality trees will become more important. Saving money on the cost per tree will allow a greater number of trees to be purchased.

Davey Resource Group believes that a good working relationship with a local nursery is very beneficial, but it is equally important that good prices and wide species availability is considered. It is recommended that Wake Forest continue to explore local and regional sources for trees and discuss pricing with the current nursery source. Due to the requirement to work towards species diversity, it may be necessary to use several nurseries as sources for trees.

Tree Planting Designs

Prior to conducting tree inventories, most cities determined available planting sites primarily through resident requests. With the data in the Tree Inventory Workbook and the TreeKeeper™ 7.4 software, Town officials now know the exact location of every available planting site in Wake Forest. A prioritization scheme can be developed to begin tree plantings throughout the Town. Often, the downtown business district is selected as the highest priority in order to increase the beauty and attractiveness of the area. Tree selection for business and shopping areas must take into consideration the need for shoppers to view storefronts, as well as the need to provide enough shade for shoppers. Tree canopies should be open, as in thornless honeylocusts (*Gleditsia triacanthos inermis*), and the branching habit must be high enough to allow pedestrians to walk comfortably beneath the trees. Other options are tall, narrow growing (fastigiate) species, such as Fastigiate European Hornbeam (*Carpinus betulus* 'Fastigiata') and many others. These trees can provide beauty, a look of uniformity, and a formal appearance to the shopping district.

Tree plantings in residential areas can be selected to match the existing types of trees growing on each street (such as large growth-habit trees or flowering tree species) or can be selected to begin to develop a uniform look for a given street. To create unity, balance, and beauty on a street, it is advantageous to plant the same species or species of similar form and size on both sides of the street, if possible. Keep species diversity in mind when developing any type of tree planting design. Often, in older neighborhoods, one side of the street has utility lines, which precludes the use of large trees. The primary aesthetic role that street tree plantings can play in a residential neighborhood is to visually link individual homes into a unified scene. It is this unified quality that makes older neighborhoods with large mature trees so attractive in many communities. Either formal or informal planting schemes are appropriate for neighborhood streets. In most instances, medium or large trees, spaced so that their canopies overlap, are desirable. As always, a street tree-planting program must have the objective of species diversity in mind at all times.

Tree Planting Program Assistance

The new objective of the planting program should be directed at filling the identified sites in addition to fulfilling resident requests for trees. This, of course, will increase the costs for tree purchases by the Town unless creative means are found in which to solicit contributions and help from the community-at-large. In any tree planting program, funding and participation can often be achieved by soliciting certain sectors of the community. Businesses, institutions, and corporations in the Town are often willing to donate funds for tree plantings in exchange for recognition in some way (either through the media or during Arbor Day ceremonies).

It is fully understood that a Townwide program will require maximum effort in the form of public relations to gain the support of the community. Wake Forest can become more involved in its urban forestry program through the use of solid public relations techniques. A select group of citizens can be responsible for organizing and implementing a campaign of public relations, education, and community financial support. Additionally, they can recruit volunteer groups to aid in tree planting activities on a designated weekend in the spring or fall. Volunteer organizations, such as a garden club, service organization, or Boy/Girl Scout troop, can be recruited to do the actual planting and after-care watering and maintenance activities.

Public Relations and Education

Through years of experience and research, Davey Resource Group has found that public education is the true key to reaching the goals of an urban forestry program in a community. By educating its citizens, Town officials, developers, and all contractors working within the Town, Wake Forest will be able to achieve urban forest preservation and protection goals. Ordinances and guidelines alone will not guarantee success since builders, contractors, and others often have their own priorities and trees and ordinances often are no more than a nuisance to them.

In working with communities to help implement and enforce a new tree preservation ordinance for new developments, Davey Resource Group personnel have consistently found resistance from builders and developers who implemented many ingenious means to circumvent ordinances. Only when a tree preservation educational seminar was developed (with attendance required by all contractors working within Town limits) did communities begin to see greater cooperation from contractors.

By requiring various community 'stakeholders' to attend educational sessions to learn about the community's urban forest, urban forest preservation, and the importance of it all to the future of the community, Wake Forest will begin to see much greater cooperation from all concerned parties.

It is recommended that various public outreach campaigns, aimed at educating the residents of Wake Forest and gaining their support for the urban forestry program, be implemented. Based on public relations efforts by urban foresters in other communities, the following types of activities are suggested for the Town to undertake:

- Hold a seminar or public meeting to discuss the tree inventory project, its results, and its importance for the Town.
- Develop monthly evening or weekend seminars directed at residents related to tree care and landscaping; bring in guest experts from various disciplines in the green industry.
- Host monthly 'Tree Talks'.
- Write a monthly 'Tree Talk' article for local newspapers.
- Send letters to residents in areas of the Town where Routine Pruning will be conducted each year; describe the pruning program and its goals.
- Develop a 'Tree Care' door hanger brochure to go to each residence where new trees are planted; this could help eliminate trunk damage and improper mulching and pruning of new trees by educating residents about proper tree care.
- Expand the annual Arbor Day celebration. Short programs on planting and pruning trees are some good ideas for increasing public interest in the Town's tree programs. Additionally, the Town could invite contractors to conduct demonstrations on tree planting, trimming, landscaping, species selection, etc. Organizers could also set up booths with tree information as helpful supplements for the general public. Refer to the National Arbor Day Foundation (visit http://www.arborday.org or call 402-474-5655) for publications that provide great Arbor Day ideas to assist in planning of this event.

Five-Year Urban Forestry Program and Budget

According to municipal code, the Town Forester is responsible for variety of administrative and advisory duties, including guiding the Town's tree planting and maintenance programs. The following section consists of a five-year program projection for all pertinent urban forestry activities and is intended to provide an example of the relative costs that could be incurred by the recommended activities. In presenting this budget, Davey Resource Group's consultants are aware that the portion of Wake Forest's budget allocated to street tree related functions might be stretched beyond its limits. However, Wake Forest must understand that the budgeting recommendations below are only estimates and are based on the application of sound urban forest management principles to Town forestry operations.

The five-year program is designed to address the highest priority removal and maintenance recommendations first. This is intended to reduce potential hazards to the public and all associated liabilities. The Town may find it in its best interest to begin this work in Year 1 of the management program or change the recommended pruning cycle to distribute the annual budget funds more evenly. **As stated previously, Davey Resource Group strongly encourages the Town to schedule these activities to occur in as timely a manner as possible in order to address the reduction of all potential safety risks.** By doing so, the Town will greatly lessen the potential of injury to citizens, damage to property, and possible liability litigation.

Tree pruning and removal costs for trees in this management plan are based on quotes from a large number of reputable North American tree care companies and are averages extracted from bids received by communities in the Eastern United States during the past few years. The figures are equivalent to average costs for the same activities by municipal in-house crews. These costs are an average and are used to base the Priority Maintenance Recommendations, Routine Pruning Program, and Training/Small Tree Pruning Program budget projections in this plan. Table 7 lists the estimated costs for tree removals, pruning, stump removals, fertilization, and mulching.

Table 7. Cost Estimates for Removals, Pruning, Stump Removals, Fertilization, and Mulching

Diameter Size Class (Inches)	Estimated Removal Cost/Tree	Estimated Pruning Cost/Tree	Estimated Stump Removal Cost/Stump	Estimated Fertilization Cost/Tree	Estimated Mulching Cost/Tree
1 – 3	$20	$15	$20	$4	$9
4 – 6	$85	$25	$20	$12	$9
7 – 12	$180	$60	$20	$15	$12
13 – 18	$290	$100	$30	$25	$12
19 – 24	$430	$140	$50	$40	$17
25 – 30	$690	$185	$70	$50	$17
31 – 36	$930	$250	$90	$75	$23
37 – 42	$1,200	$310	$110	$100	$23
43+	$1,500	$480	$130	$120	$23

Table 8 has been provided as an estimated budget for a five-year urban forest management program for the Town. These tables should be used as a general guideline for implementation of the five-year program, planning future tree care operations, and reviewing on-going Town forestry operations. Specific accomplishments should be measured in comparison to the plan's goals and recommendations. In short, the management program discussed in this plan aims to alleviate all identified potentially hazardous conditions within two years, establish a Training Pruning Program for all young and newly planted trees, and establish a five-year Routine Pruning Program.

Table 8. Estimated Costs For Wake Forest's Five-Year Urban Forestry Management Program: Street Trees

Estimated Costs for Each Activity			2004		2005		2006		2007		2008		Five Year Cost
Activity	Diameter Class	Cost/Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
Priority 1 Removal	1-3"	$20	0	$0									$0
	4-6"	$85	1	$85									$85
	7-12"	$180	14	$2,520									$2,520
	13-18"	$290	9	$2,610									$2,610
	19-24"	$430	6	$2,580									$2,580
	25-30"	$690	2	$1,380									$1,380
	31-36"	$930	3	$2,790									$2,790
	37-42"	$1,200	2	$2,400									$2,400
	43"+	$1,500	3	$4,500									$4,500
Activity Total(s)			**40**	**$18,865**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$18,865**
Priority 2 Removal	1-3"	$20	0	$0	0	$0							$0
	4-6"	$85	0	$0	26	$2,210							$2,210
	7-12"	$180	0	$0	48	$8,640							$8,640
	13-18"	$290	0	$0	15	$4,350							$4,350
	19-24"	$430	10	$4,300	0	$0							$4,300
	25-30"	$690	2	$1,380	0	$0							$1,380
	31-36"	$930	1	$930	0	$0							$930
	37-42"	$1,200	3	$3,600	0	$0							$3,600
	43"+	$1,500	2	$3,000	0	$0							$3,000
Activity Total(s)			**18**	**$13,210**	**89**	**$15,200**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$13,210**
Priority 3 Removal	1-3"	$20			73	$1,460							$1,460
	4-6"	$85			34	$2,890							$2,890
	7-12"	$180			3	$540							$540
	13-18"	$290			0	$0							$0
	19-24"	$430			0	$0							$0
	25-30"	$690			0	$0							$0
	31-36"	$930			0	$0							$0
	37-42"	$1,200			0	$0							$0
	43"+	$1,500			0	$0							$0
Activity Total(s)			**0**	**$0**	**110**	**$4,890**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$4,890**
Priority 1 Prune	1-3"	$15	0	$0									$0
	4-6"	$25	0	$0									$0
	7-12"	$60	4	$240									$240
	13-18"	$100	10	$1,000									$1,000
	19-24"	$140	19	$2,660									$2,660
	25-30"	$185	27	$4,995									$4,995
	31-36"	$250	18	$4,500									$4,500
	37-42"	$310	15	$4,650									$4,650
	43"+	$480	3	$1,440									$1,440
Activity Total(s)			**96**	**$19,485**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$19,485**
Priority 2 Prune	1-3"	$15	0	$0	0	$0							$0
	4-6"	$25	0	$0	9	$225							$225
	7-12"	$60	0	$0	25	$1,500							$1,500
	13-18"	$100	0	$0	25	$2,500							$2,500
	19-24"	$140	0	$0	23	$3,220							$3,220
	25-30"	$185	19	$3,515	0	$0							$3,515
	31-36"	$250	8	$2,000	0	$0							$2,000
	37-42"	$310	7	$2,170	0	$0							$2,170
	43"+	$480	3	$1,440	0	$0							$1,440
Activity Total(s)			**37**	**$9,125**	**82**	**$7,445**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$16,570**
Stump Removal	1-3"	$20					2	$40					$40
	4-6"	$20					7	$140					$140
	7-12"	$20					18	$360					$360
	13-18"	$30					18	$540					$540
	19-24"	$50					4	$200					$200
	25-30"	$70					2	$140					$140
	31-36"	$90					5	$450					$450
	37-42"	$110					3	$330					$330
	43"+	$130					0	$0					$0
Activity Total(s)			**0**	**$0**	**0**	**$0**	**59**	**$2,200**	**0**	**$0**	**0**	**$0**	**$2,200**
Routine Pruning Program	1-3"	$15					55	$825	55	$825	55	$825	$2,475
	4-6"	$25					115	$2,875	115	$2,875	115	$2,875	$8,625
	7-12"	$60					88	$5,280	88	$5,280	88	$5,280	$15,840
	13-18"	$100					23	$2,300	23	$2,300	23	$2,300	$6,900
	19-24"	$140					11	$1,540	11	$1,540	11	$1,540	$4,620
	25-30"	$185					5	$925	5	$925	5	$925	$2,775
	31-36"	$250					1	$250	1	$250	1	$250	$750
	37-42"	$310					1	$310	1	$310	1	$310	$930
	43"+	$480					0	$0	0	$0	0	$0	$0
Activity Total(s)			**0**	**$0**	**0**	**$0**	**299**	**$14,305**	**299**	**$14,305**	**299**	**$14,305**	**$42,915**
Training Pruning Program	1-3"	$15					470	$7,050	470	$7,050	470	$7,050	$7,050
	4-6"	$25					176	$4,400	176	$4,400	176	$4,400	$4,400
	7-12"	$60					21	$1,260	21	$1,260	21	$1,260	$1,260
Activity Total(s)			**0**	**$0**	**0**	**$0**	**667**	**$12,710**	**667**	**$12,710**	**667**	**$12,710**	**$38,130**
Tree Planting	Tree Purchasing	$110	0	$0	101	$11,110	101	$11,110	101	$11,110	101	$11,110	$44,440
	Tree Planting	$110	0	$0	101	$11,110	101	$11,110	101	$11,110	101	$11,110	$44,440
Activity Total(s)			**0**	**$0**	**101**	**$22,220**	**101**	**$22,220**	**101**	**$22,220**	**101**	**$22,220**	**$88,880**
Activity Grand Total			**191**		**293**		**1,126**		**1,067**		**1,067**		**3,744**
Cost Grand Total				**$60,685**		**$49,755**		**$51,435**		**$49,235**		**$49,235**	**$245,145**

Table 9. Arboricultural Planning Chart for Tree Management

ACTIVITY/ TREATMENT	YEAR*	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
REMOVALS													
Priority One (Inventory)	1	X	X	X							X	X	X
Priority Two (Inventory)	2	X	X	X							X	X	X
Removals (Anticipated)	4A	X	X	X							X	X	X
Stump Removal	3A	X	X	X							X	X	X
PRUNING													
Priority One	1	X	X	X							X	X	X
Priority Two	2	X	X	X							X	X	X
Routine Pruning (Five-Year Rotation)	3	X	X	X							X	X	X
Training Pruning (Three-Year Rotation)	1A	X	X	X							X	X	X
FERTILIZATION													
Macronutrient (N-P-K; Fair and Poor Condition Trees)	1A			X	X						X	X	
Macronutrient (N-P-K; Excellent and Good Condition Trees)	2			X	X						X	X	
Micronutrient (Fe/Mn Trunk Injection)	N					X	X	X	X				
Micronutrient (Fe/Mn Soil Treatment)	N												
PEST MANAGEMENT													
Scouting	1A				X	X	X	X	X	X			
Pesticide Treatments	N				X	X	X	X	X	X			
Pest Pruning	N												
TREE PLANTING													
Site Assessment	1A												
Ball & Burlap Container	1A			X	X	X				X	X	X	
Bare Root	1A			X	X	X							
Watering (New Trees)	1A			X	X	X	X	X	X	X	X	X	
Cabling and Bracing	4N	X	X	X								X	X
Mulching	1A												
Weed Control	1A			X	X	X							
Watering (Older Trees)	1A							X	X	X	X		
INVENTORY													
Update Field Inventory	3	X	X								X	X	X
Update Computer Database	1A												

Notes:
Shaded areas indicate months where tasks can be completed operationally
*** = Year task is recommended to be initiated/completed**
A = Continue on an annual basis after task is initiated
N = Implement on an as-needed basis
X = Optimal biological time (or for cost-efficiency)

Table 9 has been provided in order to help the Town of Wake Forest better organize the tree maintenance program that has been described in this chapter. The success of most tree maintenance tasks, such as planting, pruning, or fertilizing, is dependent upon seasonal temperature and weather conditions. The maintenance tasks described in this plan should be scheduled for and performed during optimal biological periods to sustain vigorous health and to ensure the best chance for survival of the Town's street trees.

Sources of Funding

Funding sources for tree care range from the Town's general funds to joint programs with local companies. Davey Resource Group encourages Wake Forest to explore the following sources of support for tree care operations:

Federal Government grants: Federal programs, such as *America the Beautiful* (www.america-the-beautiful.org), appropriate funds for tree planting and maintenance programs in cities throughout the United States. Another federal program, the *Intermodal Surface Transportation Efficiency Act of 1991* (ISTEA), established funding for transportation enhancement activities, including roadside beautification.

State Government grants: State programs, such as the Urban and Community Forestry Grant program offered by the State's Division of Forestry, will support a variety of urban forestry program development projects, including training and education.

The National Tree Trust (NTT) has two active grant programs: Seeds and Root (Branch program is to come) Program for Community Action and Organizational Support.

All grant requests are on a one-to-one basis with in-kind support, matching contribution, and/or volunteer support and are distributed to 501(c)(3) nonprofit urban and community forestry programs. Tree planting and maintenance and/or urban and community forestry education must be reflected in organizational documents, which include mission statements and by-laws. Municipalities can participate if they attach themselves to an eligible nonprofit organization. Awards have a minimum of $5,000 to a maximum of $25,000. Grant applications are due by October 1 of each year.

Seeds Program For Organizational Support (items that will be funded):

- Technology: computers, software, wiring, and networking
- General office equipment and supplies
- Rent for office space
- Salaries and wages
- General printing and postage
- Professional contracted services

Roots Program Funded Projects (all funded projects must include two or more of the following categories):

- Education: training, educational materials
- Involvement of under-served communities
- Tree planting and maintenance

- Community partnerships

- Community nursery

- Service learning: teaching strategy linking student community service to classroom instruction.

- The National Tree Trust Monetary Grant Program
  1120 G Street NW, Suite 770
  Washington, DC 20005
  1-800-846-8733
  www.nationaltreetrust.org

The Conservation Fund provides grants to non-profit organizations and public agencies. Monetary allocations range from $500-$2,500 through the *American Greenways DuPont Awards Program* sponsored by *The Conservation Fund*, *The DuPont Corporation,* and *The National Geographic Society*. Grant applications are due by December 31 of each year:

- The Conservation Fund
  1800 North Kent Street, Suite 1120
  Arlington, VA 22209
  703-525-6300
  www.conservationfund.org

Global ReLeaf dollars should be used to help cover the expenses associated with conservation- or restoration-oriented tree plantings. There is no specific guideline for grant amounts. Project proposals need to reach your *Global ReLeaf Forest Technical Committee* representative:

- National Association of State Foresters
  Global ReLeaf
  444 North Capitol Street NW, Suite 540
  Washington, D.C. 20001
  202-624-5415

This U.S. EPA grant program provides financial assistance to eligible community groups that are working on or plan to carry out projects to address environmental justice issues. Funds can be used to develop a new activity or substantially improve the quality of existing programs:

- United States Environmental Protection Agency
  Office of Environmental Justice (3103)
  401 M Street SW
  Washington, DC 20460
  1-800-962-6215

The National Recreational Trails Funding Act Program: NRTFA provides assistance in land acquisition and/or development of trails, stream and river access sites, bridges, boardwalks, fjords and crossings, signage, equestrian facilities, sanitary facilities, and other support facilities. The NRTFA is intended to provide benefits to all kinds of trail users. The U.S. Department of Transportation manages the program through the Federal Highway Administration and in conjunction with the Department of the Interior. The NRTFA program will provide 50% matching reimbursing assistance for eligible projects. Project applications are available after June 1 and are due by October 12 of each year.

For the NUCFAC grant program, all funds must be matched at least equally (dollar for dollar) with non-federal source funds. This match may include in-kind donations, volunteer assistance, and private and public (non-Federal) monetary contributions. All matching funds must be specifically related to the proposed projects:

- National Urban and Community Forestry Advisory Council
  Suzanne M. del Villar
  USDA Forest Service
  P.O. Box 1003
  Sugarloaf, CA 92386
  909-585-9268
  sdelvillar@fs.fed.us

ATW is a cost-share program between qualifying non-profit organizations and the *National Tree Trust*, requiring a commitment from all involved parties to plant trees along transportation corridors:

- America's Treeways Program Director
  National Tree Trust
  1120 G Street NW Suite 770
  Washington, D.C. 20005

The following U.S. EPA competitive grant program encourages community groups, businesses, and government agencies to work together on sustainable development efforts that protect the local environment and conserve natural resources while supporting a healthy economy and an improved quality of life. Proposals must be able to demonstrate sustainability, community commitment and contribution, and measurable results:

- U.S. EPA Sustainable Development Challenge Grants
  401 M Street SW
  Washington, DC 20460
  202-260-6812
  www.epa.gov/ecocommunity

Foundation grants: Many companies and estates operate foundation programs that contribute funds to worthy programs. Comprehensive listings of foundations in the United States are available at many public libraries. *The Foundation Directory, National Data Book of Foundations,* and the *Foundation Grants Index,* all published by the *Foundation Center*, are good references.

Private donations: Area corporations and organizations may donate funds to special tree planting and maintenance programs. Urban foresters can generate public support of tree care through programs involving 'memorial trees' or special tree improvement projects.

Volunteer groups: Urban foresters can encourage community organizations to donate funds or organize fund-raising activities or other support for community tree planting and maintenance programs.

Cooperative tree planting programs: In such programs, homeowners are offered a selected choice of street trees at a reduced price. In effect, a cooperative tree-planting program allows the homeowner to assume some of the cost of street tree planting while the Town can limit the species choices. Again, the key to the success of such a program is a detailed plan for implementing and publicizing the project.

Automobile tree damage reimbursement: The Town should be reimbursed for any tree damage caused by any given automobile accident, if the provision is in the Town's tree ordinance(s).

Establish a tree donation or memorial tree program: Use Arbor Day as a focal point for promoting citizen interest in contributing to the community. For example, first establish where and when memorial trees will be planted. Decide the form of memorial, such as a plaque at the tree or a listing in a community register. Set a donation price per tree that includes the cost of purchasing and planting the tree, as well as any recognition given to the donor. Determine how donations will be collected and set a time frame for the project. Take the same steps for publicizing the project: determine how, when and where it should be announced, and how application forms will be distributed. Consider a kick-off ceremony, brochures, public service announcements, press releases, and other avenues of communication with the general public.

Tree Ordinance Recommendations

The Town of Wake Forest's tree ordinance serves as a good starting point for addressing the concerns and issues of a public tree management program (Appendix L). Only through a strong, properly enforced ordinance will the Town achieve its stated objectives. Davey Resource Group recommends that Wake Forest regularly review its Town ordinances pertaining to street, park, and private property trees. This includes a review of permitted pruning, removal, and planting practices. As it was not in the scope of services, Davey Resource Group did not review Wake Forest's tree ordinance at this time.

A comprehensive list of recommended tree species (both native and exotic) has been developed by the urban forestry staff at North Carolina State University. Stringent enforcement mechanisms should be included in order to ensure that only acceptable species be planted in accordance with the long-term goal of the urban forestry program in Wake Forest. Furthermore, penalties/fines, such as the full reimbursement of a mature tree's appraised value, can be levied upon offenders who illegally prune or remove trees located in the public right-of-way without permission from the Town.

Summary and Conclusions

Wake Forest has a diverse public tree population in relatively good condition that adds to the beauty and livability of the Town. Although the urban forest is in relatively good condition at present, this is not a situation that should be taken for granted. As trees get older, they become increasingly inefficient in withstanding the inherent stresses of an urban environment and are subject to decline without professional and regular management.

Generally stated, Wake Forest's significant issues include:

1. **Potentially Hazardous Trees and Tree Parts**. A hazardous tree is defined through the presence of three factors: (1) There must exist a defective tree, or tree part, that poses a high risk of failure or fracture; (2) there must be a target that would be struck by the tree, such as people or property; and (3) a potential hazard exists when the environment increases the likelihood of tree failure. Such environmental factors could include severe storm events, strong winds, shallow or wet soil conditions, or growing spaces that restrict tree root or crown development.

   Situations where injury or property damage has occurred from falling trees are not isolated and are well documented in the media on a regular basis. Along with the potential for personal injury or property damage comes the probability of the responsible parties being held liable for any injuries or damages. Such lawsuits can and have resulted in costly judgments against the defendants.

   One of the primary concerns in Wake Forest must be public safety. Tree removals and pruning are a vital part of hazard mitigation. The street tree population is mostly in good to fair condition; however, there are large trees with varying degrees of decay existing in the scaffold limbs, trunks, and roots. The five-year plan discussed previously is designed to address the greatest safety risk conditions first. Consideration must always be made of area usage and the threat of falling limbs or trees to persons and property when putting a pruning and removal plan into action. This inventory has provided a prioritization scheme for hazard abatement, and it is strongly recommended that the five-year plan be followed accordingly.

2. **Mulching and Preventing Mechanical Damage**. Mechanical damage to the street trees will have long-term impacts. Basal injury can open trees to decay organisms and, over time, the original damage can become a substantial stability hazard or can contribute to the decline of the trees. A mulching or herbicide-spraying scheme should be considered in order to eliminate further mechanical damage to the roots and trunks of trees. When establishing or maintaining mulch rings around the trees, the use of post-emergent herbicides to control weeds or grass encroachment must be carefully applied, especially near thin-barked trees and tree root systems.

3. **Annual Inspection of Trees**. Significant trees greater than 18 inches DBH in high traffic areas should be inspected annually for possible deadwood removal.

4. **Expanded Tree Planting Efforts**. An expanded planting program should be initiated to replace any tree losses in the future and maintain a healthy, mature forest in the Town. It is recommended that more trees be planted on residential streets where the public can benefit from their beauty and environmental benefits. Also, more canopy trees should be planted in parks, interstate rights-of-way, Town-owned vacant land, etc. to increase Wake Forest's total tree canopy cover.
5. **Training and Routine Pruning**. Wake Forest should begin and continue Training and Routine Pruning Programs. These programs will allow the Town to take care of all the young and established trees in its urban forest. Training young trees and routinely pruning established trees will decrease the occurrence of structural problems and potential hazards in the Town's total tree population.

The management of trees in a municipality is challenging, to say the least. Balancing the recommendations of experts, the wishes of council members and other elected officials, the needs of citizens, the pressures of economics, the concerns for liability issues, the physical requirements of trees, and the desires for all of these factors to be met simultaneously is quite a daunting task. The staff responsible for Wake Forest's urban forestry program must carefully consider each specific issue and balance these pressures with a knowledgeable understanding of trees and their needs. If balance is achieved, the Town's beauty and the health and safety of the trees will be maintained.

Appendix A
Genus and Species Composition Frequency Reports

DAVEY

Wake Forest, NC

Quantity Report: Botanical

Botanical	Total	Percentage of Entire Population
Acer rubrum	930	23.47%
Prunus spp.	468	11.81%
Quercus phellos	399	10.07%
Cornus florida	361	9.11%
Lagerstroemia Sp.	188	4.74%
Acer saccharum	173	4.37%
Cercis canadensis	154	3.89%
Pyrus calleryana	149	3.76%
Pinus taeda	133	3.36%
Liquidambar styraciflua	100	2.52%
Juniperus virginiana	88	2.22%
Fraxinus pennsylvanica	75	1.89%
Malus spp.	69	1.74%
Ulmus parvifolia	64	1.61%
Thuja occidentalis	60	1.51%
Pistacia chinensis	57	1.44%
Ulmus alata	31	0.78%
Quercus rubra	28	0.71%
Quercus alba	27	0.68%
Ilex spp.	27	0.68%
Carya illinoensis	27	0.68%
Liriodendron tulipifera	23	0.58%
Magnolia grandiflora	22	0.56%
Acer palmatum	22	0.56%
Zelkova serrata	15	0.38%
Pinus strobus	15	0.38%
Quercus nigra	14	0.35%
Ulmus pumila	13	0.33%
Morus spp.	13	0.33%
Acer saccharinum	11	0.28%
Prunus serotina	10	0.25%
Quercus falcata	9	0.23%
Pinus echinata	9	0.23%
Unknown	8	0.20%
Betula nigra	8	0.20%

Botanical	Total	Percentage of Entire Population
Magnolia spp.	7	0.18%
Ginkgo biloba	7	0.18%
Cryptomeria japonica	7	0.18%
Ligustrum spp.	6	0.15%
Carya spp.	6	0.15%
Albizia julibrissin	6	0.15%
Ulmus americana	5	0.13%
Shrub	5	0.13%
Salix spp.	5	0.13%
Quercus palustris	5	0.13%
Ilex opaca	5	0.13%
Fagus grandifolia	5	0.13%
Betula papyrifera	5	0.13%
Taxodium distichum	4	0.10%
Melia azedarach	4	0.10%
Cedrus deodara	4	0.10%
Ulmus spp.	3	0.08%
Robinia pseudoacacia	3	0.08%
Quercus coccinea	3	0.08%
Quercus bicolor	3	0.08%
Platanus x acerifolia	3	0.08%
Pinus palustris	3	0.08%
Photinia spp.	3	0.08%
Nyssa sylvatica	3	0.08%
Koelreuteria paniculata	3	0.08%
Cornus kousa	3	0.08%
Betula spp.	3	0.08%
Acer platanoides	3	0.08%
Acer ginnala	3	0.08%
Rhododendron spp.	2	0.05%
Quercus virginiana	2	0.05%
Populus balsamifera	2	0.05%
Picea pungens	2	0.05%
Myrica cerifera	2	0.05%
Juniperus spp.	2	0.05%
Gleditsia triacanthos	2	0.05%
Torreya taxifolia	1	0.03%
Syringa vulgaris	1	0.03%

Botanical	Total	Percentage of Entire Population
Styrax japonicus	1	0.03%
Salix discolor	1	0.03%
Quercus marilandica	1	0.03%
Populus spp.	1	0.03%
Populus deltoides	1	0.03%
Populus alba	1	0.03%
Pinus sylvestris	1	0.03%
Pinus spp.	1	0.03%
Pinus resinosa	1	0.03%
Picea spp.	1	0.03%
Paulownia tomentosa	1	0.03%
Oxydendrum arboreum	1	0.03%
Juglans nigra	1	0.03%
Hibiscus syriacus	1	0.03%
Gleditsia triacanthos var	1	0.03%
Fraxinus spp.	1	0.03%
Fraxinus americana	1	0.03%
Catalpa speciosa	1	0.03%
Castanea mollissima	1	0.03%
Carpinus caroliniana	1	0.03%
Amelanchier spp.	1	0.03%
Acer campestre	1	0.03%
Grand Total	*3963*	*100%*

DAVEY

Wake Forest, NC

Species/Diameter Frequency Matrix

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
Arborvitae, Eastern		27	27	5	1						60
Ash, Green		67	2	2			2	1		1	75
Ash, spp.					1						1
Ash, White		1									1
Baldcypress, Common		1		3							4
Beech, American		2	1	2							5
Birch, Paper		3	2								5
Birch, River		3	2	3							8
Birch, spp.		1	1	1							3
Catalpa, Northern							1				1
Cedar, Deodar		3				1					4
Cherry, Black			4	5	1						10
Cherry, spp.		275	162	31							468
Chestnut, Chinese			1								1
Chinaberry			1	3							4
Chinese Pistache		14	33	10							57
Cottonwood, Eastern					1						1
Crabapple, Flowering		64	3	2							69
Crapemyrtle spp.		111	60	16	1						188
Cryptomeria, Japanese		4	2	1							7

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
Dogwood, Flowering		113	124	118	6						361
Dogwood, Kousa		1	2								3
Elm, American			2		2		1				5
Elm, Lacebark		49	15								64
Elm, Siberian		4	1	3	2	2	1				13
Elm, spp.					3						3
Elm, Winged		12	6	8	4	1					31
Ginkgo		7									7
Goldenraintree		3									3
Hickory, spp.		1	4	1							6
Holly, American		2	1	2							5
Holly, spp.		16	6	5							27
Honeylocust			1	1							2
Honeylocust, Thornless		1									1
Hornbeam, American				1							1
Juniper, spp.		2									2
Ligustrum spp.		5	1								6
Lilac, Common		1									1
Locust, Black		2		1							3
Magnolia, Southern		9	2		5	5	1				22
Magnolia, spp.		6	1								7
Maple, Amur			3								3

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
Maple, Hedge				1							1
Maple, Japanese		16	6								22
Maple, Norway		1		1	1						3
Maple, Red		390	361	160	8	10		1			930
Maple, Silver		2	6	2	1						11
Maple, Sugar		62	56	14	24	8	8	1			173
Mimosa		2		4							6
Mulberry, spp.		3	5	1	2	2					13
Oak, Blackjack					1						1
Oak, Live		2									2
Oak, Northern Red		23	1	2		1				1	28
Oak, Pin		3	1	1							5
Oak, Scarlet		3									3
Oak, Southern Red		2	2	1	1	1		1	1		9
Oak, Swamp White						1	1	1			3
Oak, Water		6		2	3	2		1			14
Oak, White		1	1	4	2	4	5	3	5	2	27
Oak, Willow		185	50	23	28	26	35	22	23	7	399
Pear, Callery		37	80	32							149
Pecan		3	4	6	7	2	4	1			27
Photinia spp.		1		2							3
Pine, Eastern White			2	1	4	5	3				15

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
Pine, Loblolly		13	12	28	43	32	5				133
Pine, Longleaf			1	1		1					3
Pine, Red			1								1
Pine, Scotch					1						1
Pine, Shortleaf				3	1	2	3				9
Pine, spp.			1								1
Planetree, London				3							3
Poplar, Balsam		1		1							2
Poplar, spp.			1								1
Poplar, White				1							1
Redbud, Eastern		79	50	24	1						154
Redcedar, Eastern		17	28	30	9	4					88
Rhododendron, spp.		2									2
Rose of sharon		1									1
Royal Paulownia					1						1
Serviceberry, spp.		1									1
Shrub		3	2								5
Snowbell, Japanese		1									1
Sourwood			1								1
Spruce, Colorado			1	1							2
Spruce, spp.		1									1
Stump		2	7	18	18	4	2	5	3		59

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
Sweetgum, American		69	9	12	4	2	2	1	1		100
Torreya, Florida				1							1
Tuliptree		2	6	9	3	2	1				23
Tupelo, Black		1			1	1					3
Unknown		7		1							8
Vacant Site, Large	127										127
Vacant Site, Medium	168										168
Vacant Site, Small	109										109
Walnut, Black			1								1
Wax-myrtle		1	1								2
Willow, Pussy			1								1
Willow, spp.		3	1		1						5
Zelkova, Japanese		2	9	4							15
Grand Total	*404*	*1758*	*1178*	*618*	*192*	*119*	*75*	*38*	*33*	*11*	*4426*

DAVEY

Wake Forest, NC

Species/Condition Frequency Matrix

Common Name	Very Good	Dead	Critical	Poor	Fair	Good	Excellent	N/A	TOTAL
Arborvitae, Eastern					41	19			60
Ash, Green				4	58	13			75
Ash, spp.						1			1
Ash, White					1				1
Baldcypress, Common						4			4
Beech, American				1	4				5
Birch, Paper					3	2			5
Birch, River					4	4			8
Birch, spp.					1	2			3
Catalpa, Northern					1				1
Cedar, Deodar					1	3			4
Cherry, Black				1	9				10
Cherry, spp.		5	4	32	202	225			468
Chestnut, Chinese					1				1
Chinaberry					4				4
Chinese Pistache					50	7			57
Cottonwood, Eastern						1			1
Crabapple, Flowering				2	48	19			69
Crapemyrtle spp.				24	161	3			188
Cryptomeria, Japanese					3	4			7
Dogwood, Flowering		4	7	79	209	62			361
Dogwood, Kousa				2	1				3

Common Name	Very Good	Dead	Critical	Poor	Fair	Good	Excellent	N/A	TOTAL
Elm, American				1	4				5
Elm, Lacebark				2	40	22			64
Elm, Siberian			3		8	2			13
Elm, spp.				2	1				3
Elm, Winged				3	16	12			31
Ginkgo					1	3	3		7
Goldenraintree				1	2				3
Hickory, spp.				1	5				6
Holly, American					1	4			5
Holly, spp.					12	15			27
Honeylocust					2				2
Honeylocust, Thornless						1			1
Hornbeam, American				1					1
Juniper, spp.						2			2
Ligustrum spp.					4	2			6
Lilac, Common					1				1
Locust, Black					3				3
Magnolia, Southern					12	10			22
Magnolia, spp.					3	4			7
Maple, Amur				1	2				3
Maple, Hedge					1				1
Maple, Japanese					9	13			22
Maple, Norway					3				3
Maple, Red		5	4	76	485	360			930
Maple, Silver				2	9				11

Common Name	Very Good	Dead	Critical	Poor	Fair	Good	Excellent	N/A	TOTAL
Maple, Sugar			1	23	118	31			173
Mimosa					5	1			6
Mulberry, spp.				1	12				13
Oak, Blackjack					1				1
Oak, Live					2				2
Oak, Northern Red				1	4	23			28
Oak, Pin					2	3			5
Oak, Scarlet						3			3
Oak, Southern Red				1	8				9
Oak, Swamp White					3				3
Oak, Water				5	8	1			14
Oak, White				4	21	2			27
Oak, Willow			3	56	138	202			399
Pear, Callery			1	17	79	52			149
Pecan				5	18	4			27
Photinia spp.					1	2			3
Pine, Eastern White					13	2			15
Pine, Loblolly		2		10	78	43			133
Pine, Longleaf				1	2				3
Pine, Red						1			1
Pine, Scotch					1				1
Pine, Shortleaf				1	5	3			9
Pine, spp.		1							1
Planetree, London					1	2			3
Poplar, Balsam					1	1			2

Common Name	Very Good	Dead	Critical	Poor	Fair	Good	Excellent	N/A	TOTAL
Poplar, spp.					1				1
Poplar, White					1				1
Redbud, Eastern		2	2	16	99	35			154
Redcedar, Eastern				2	39	47			88
Rhododendron, spp.						2			2
Rose of sharon					1				1
Royal Paulownia					1				1
Serviceberry, spp.						1			1
Shrub					4	1			5
Snowbell, Japanese						1			1
Sourwood					1				1
Spruce, Colorado						2			2
Spruce, spp.						1			1
Stump								59	59
Sweetgum, American	1			5	62	32			100
Torreya, Florida					1				1
Tuliptree				1	13	9			23
Tupelo, Black				1	1	1			3
Unknown		7			1				8
Vacant Site, Large								127	127
Vacant Site, Medium								168	168
Vacant Site, Small								109	109
Walnut, Black					1				1
Wax-myrtle					1	1			2
Willow, Pussy					1				1

Common Name	Very Good	Dead	Critical	Poor	Fair	Good	Excellent	N/A	TOTAL
Willow, spp.					3	2			5
Zelkova, Japanese					15				15
Grand Total:	1	26	25	385	2193	1330	3	463	4426

DAVEY

Wake Forest, NC

Quantity Report: Genus

Genus	Total	Percentage of Entire Population
Acer	1143	28.84%
Albizia	6	0.15%
Amelanchier	1	0.03%
Betula	16	0.40%
Carpinus	1	0.03%
Carya	33	0.83%
Castanea	1	0.03%
Catalpa	1	0.03%
Cedrus	4	0.10%
Cercis	154	3.89%
Cornus	364	9.18%
Cryptomeria	7	0.18%
Fagus	5	0.13%
Fraxinus	77	1.94%
Ginkgo	7	0.18%
Gleditsia	3	0.08%
Hibiscus	1	0.03%
Ilex	32	0.81%
Juglans	1	0.03%
Juniperus	90	2.27%
Koelreuteria	3	0.08%
Lagerstroemia	188	4.74%
Ligustrum	6	0.15%
Liquidambar	100	2.52%
Liriodendron	23	0.58%
Magnolia	29	0.73%
Malus	69	1.74%
Melia	4	0.10%
Morus	13	0.33%
Myrica	2	0.05%
Nyssa	3	0.08%
Oxydendrum	1	0.03%
Paulownia	1	0.03%
Photinia	3	0.08%
Picea	3	0.08%

Genus	Total	Percentage of Entire Population
Pinus	163	4.11%
Pistacia	57	1.44%
Platanus	3	0.08%
Populus	5	0.13%
Prunus	478	12.06%
Pyrus	149	3.76%
Quercus	491	12.39%
Rhododendron	2	0.05%
Robinia	3	0.08%
Salix	6	0.15%
Shrub	5	0.13%
Styrax	1	0.03%
Syringa	1	0.03%
Taxodium	4	0.10%
Thuja	60	1.51%
Torreya	1	0.03%
Ulmus	116	2.93%
Unknown	8	0.20%
Zelkova	15	0.38%
Grand Total	*3963*	*100%*

DAVEY

Wake Forest, NC

Quantity Report: Genus

Genus	Total	Percentage of Entire Population
Acer	1143	28.84%
Quercus	491	12.39%
Prunus	478	12.06%
Cornus	364	9.18%
Lagerstroemia	188	4.74%
Pinus	163	4.11%
Cercis	154	3.89%
Pyrus	149	3.76%
Ulmus	116	2.93%
Liquidambar	100	2.52%
Juniperus	90	2.27%
Fraxinus	77	1.94%
Malus	69	1.74%
Thuja	60	1.51%
Pistacia	57	1.44%
Carya	33	0.83%
Ilex	32	0.81%
Magnolia	29	0.73%
Liriodendron	23	0.58%
Betula	16	0.40%
Zelkova	15	0.38%
Morus	13	0.33%
Unknown	8	0.20%
Ginkgo	7	0.18%
Cryptomeria	7	0.18%
Salix	6	0.15%
Ligustrum	6	0.15%
Albizia	6	0.15%
Shrub	5	0.13%
Populus	5	0.13%
Fagus	5	0.13%
Taxodium	4	0.10%
Melia	4	0.10%
Cedrus	4	0.10%
Robinia	3	0.08%

Genus	Total	Percentage of Entire Population
Platanus	3	0.08%
Picea	3	0.08%
Photinia	3	0.08%
Nyssa	3	0.08%
Koelreuteria	3	0.08%
Gleditsia	3	0.08%
Rhododendron	2	0.05%
Myrica	2	0.05%
Torreya	1	0.03%
Syringa	1	0.03%
Styrax	1	0.03%
Paulownia	1	0.03%
Oxydendrum	1	0.03%
Juglans	1	0.03%
Hibiscus	1	0.03%
Catalpa	1	0.03%
Castanea	1	0.03%
Carpinus	1	0.03%
Amelanchier	1	0.03%
Grand Total	*3963*	*100%*

DAVEY

Wake Forest, NC

Quantity Report: Common

Common	Total	Percentage of Entire Population
Arborvitae, Eastern	60	1.51%
Ash, Green	75	1.89%
Ash, spp.	1	0.03%
Ash, White	1	0.03%
Baldcypress, Common	4	0.10%
Beech, American	5	0.13%
Birch, Paper	5	0.13%
Birch, River	8	0.20%
Birch, spp.	3	0.08%
Catalpa, Northern	1	0.03%
Cedar, Deodar	4	0.10%
Cherry, Black	10	0.25%
Cherry, spp.	468	11.81%
Chestnut, Chinese	1	0.03%
Chinaberry	4	0.10%
Chinese Pistache	57	1.44%
Cottonwood, Eastern	1	0.03%
Crabapple, Flowering	69	1.74%
Crapemyrtle spp.	188	4.74%
Cryptomeria, Japanese	7	0.18%
Dogwood, Flowering	361	9.11%
Dogwood, Kousa	3	0.08%
Elm, American	5	0.13%
Elm, Lacebark	64	1.61%
Elm, Siberian	13	0.33%
Elm, spp.	3	0.08%
Elm, Winged	31	0.78%
Ginkgo	7	0.18%
Goldenraintree	3	0.08%
Hickory, spp.	6	0.15%
Holly, American	5	0.13%
Holly, spp.	27	0.68%
Honeylocust	2	0.05%
Honeylocust, Thornless	1	0.03%
Hornbeam, American	1	0.03%

Common	Total	Percentage of Entire Population
Juniper, spp.	2	0.05%
Ligustrum spp.	6	0.15%
Lilac, Common	1	0.03%
Locust, Black	3	0.08%
Magnolia, Southern	22	0.56%
Magnolia, spp.	7	0.18%
Maple, Amur	3	0.08%
Maple, Hedge	1	0.03%
Maple, Japanese	22	0.56%
Maple, Norway	3	0.08%
Maple, Red	930	23.47%
Maple, Silver	11	0.28%
Maple, Sugar	173	4.37%
Mimosa	6	0.15%
Mulberry, spp.	13	0.33%
Oak, Blackjack	1	0.03%
Oak, Live	2	0.05%
Oak, Northern Red	28	0.71%
Oak, Pin	5	0.13%
Oak, Scarlet	3	0.08%
Oak, Southern Red	9	0.23%
Oak, Swamp White	3	0.08%
Oak, Water	14	0.35%
Oak, White	27	0.68%
Oak, Willow	399	10.07%
Pear, Callery	149	3.76%
Pecan	27	0.68%
Photinia spp.	3	0.08%
Pine, Eastern White	15	0.38%
Pine, Loblolly	133	3.36%
Pine, Longleaf	3	0.08%
Pine, Red	1	0.03%
Pine, Scotch	1	0.03%
Pine, Shortleaf	9	0.23%
Pine, spp.	1	0.03%
Planetree, London	3	0.08%
Poplar, Balsam	2	0.05%
Poplar, spp.	1	0.03%

Common	Total	Percentage of Entire Population
Poplar, White	1	0.03%
Redbud, Eastern	154	3.89%
Redcedar, Eastern	88	2.22%
Rhododendron, spp.	2	0.05%
Rose of sharon	1	0.03%
Royal Paulownia	1	0.03%
Serviceberry, spp.	1	0.03%
Shrub	5	0.13%
Snowbell, Japanese	1	0.03%
Sourwood	1	0.03%
Spruce, Colorado	2	0.05%
Spruce, spp.	1	0.03%
Sweetgum, American	100	2.52%
Torreya, Florida	1	0.03%
Tuliptree	23	0.58%
Tupelo, Black	3	0.08%
Unknown	8	0.20%
Walnut, Black	1	0.03%
Wax-myrtle	2	0.05%
Willow, Pussy	1	0.03%
Willow, spp.	5	0.13%
Zelkova, Japanese	15	0.38%
Grand Total	*3963*	*100%*

DAVEY

Wake Forest, NC

Quantity Report: Common

Common	Total	Percentage of Entire Population
Maple, Red	930	23.47%
Cherry, spp.	468	11.81%
Oak, Willow	399	10.07%
Dogwood, Flowering	361	9.11%
Crapemyrtle spp.	188	4.74%
Maple, Sugar	173	4.37%
Redbud, Eastern	154	3.89%
Pear, Callery	149	3.76%
Pine, Loblolly	133	3.36%
Sweetgum, American	100	2.52%
Redcedar, Eastern	88	2.22%
Ash, Green	75	1.89%
Crabapple, Flowering	69	1.74%
Elm, Lacebark	64	1.61%
Arborvitae, Eastern	60	1.51%
Chinese Pistache	57	1.44%
Elm, Winged	31	0.78%
Oak, Northern Red	28	0.71%
Pecan	27	0.68%
Oak, White	27	0.68%
Holly, spp.	27	0.68%
Tuliptree	23	0.58%
Maple, Japanese	22	0.56%
Magnolia, Southern	22	0.56%
Zelkova, Japanese	15	0.38%
Pine, Eastern White	15	0.38%
Oak, Water	14	0.35%
Mulberry, spp.	13	0.33%
Elm, Siberian	13	0.33%
Maple, Silver	11	0.28%
Cherry, Black	10	0.25%
Pine, Shortleaf	9	0.23%
Oak, Southern Red	9	0.23%
Unknown	8	0.20%
Birch, River	8	0.20%

Common	Total	Percentage of Entire Population
Magnolia, spp.	7	0.18%
Ginkgo	7	0.18%
Cryptomeria, Japanese	7	0.18%
Mimosa	6	0.15%
Ligustrum spp.	6	0.15%
Hickory, spp.	6	0.15%
Willow, spp.	5	0.13%
Shrub	5	0.13%
Oak, Pin	5	0.13%
Holly, American	5	0.13%
Elm, American	5	0.13%
Birch, Paper	5	0.13%
Beech, American	5	0.13%
Chinaberry	4	0.10%
Cedar, Deodar	4	0.10%
Baldcypress, Common	4	0.10%
Tupelo, Black	3	0.08%
Planetree, London	3	0.08%
Pine, Longleaf	3	0.08%
Photinia spp.	3	0.08%
Oak, Swamp White	3	0.08%
Oak, Scarlet	3	0.08%
Maple, Norway	3	0.08%
Maple, Amur	3	0.08%
Locust, Black	3	0.08%
Goldenraintree	3	0.08%
Elm, spp.	3	0.08%
Dogwood, Kousa	3	0.08%
Birch, spp.	3	0.08%
Wax-myrtle	2	0.05%
Spruce, Colorado	2	0.05%
Rhododendron, spp.	2	0.05%
Poplar, Balsam	2	0.05%
Oak, Live	2	0.05%
Juniper, spp.	2	0.05%
Honeylocust	2	0.05%
Willow, Pussy	1	0.03%
Walnut, Black	1	0.03%

Common	Total	Percentage of Entire Population
Torreya, Florida	1	0.03%
Spruce, spp.	1	0.03%
Sourwood	1	0.03%
Snowbell, Japanese	1	0.03%
Serviceberry, spp.	1	0.03%
Royal Paulownia	1	0.03%
Rose of sharon	1	0.03%
Poplar, White	1	0.03%
Poplar, spp.	1	0.03%
Pine, spp.	1	0.03%
Pine, Scotch	1	0.03%
Pine, Red	1	0.03%
Oak, Blackjack	1	0.03%
Maple, Hedge	1	0.03%
Lilac, Common	1	0.03%
Hornbeam, American	1	0.03%
Honeylocust, Thornless	1	0.03%
Cottonwood, Eastern	1	0.03%
Chestnut, Chinese	1	0.03%
Catalpa, Northern	1	0.03%
Ash, White	1	0.03%
Ash, spp.	1	0.03%
Grand Total	*3963*	*100%*

Botanical	Total	Percentage of Entire Population
Acer campestre	1	0.03%
Acer ginnala	3	0.08%
Acer palmatum	22	0.56%
Acer platanoides	3	0.08%
Acer rubrum	930	23.47%
Acer saccharinum	11	0.28%
Acer saccharum	173	4.37%
Albizia julibrissin	6	0.15%
Amelanchier spp.	1	0.03%
Betula nigra	8	0.20%
Betula papyrifera	5	0.13%
Betula spp.	3	0.08%
Carpinus caroliniana	1	0.03%
Carya illinoensis	27	0.68%
Carya spp.	6	0.15%
Castanea mollissima	1	0.03%
Catalpa speciosa	1	0.03%
Cedrus deodara	4	0.10%
Cercis canadensis	154	3.89%
Cornus florida	361	9.11%
Cornus kousa	3	0.08%
Cryptomeria japonica	7	0.18%
Fagus grandifolia	5	0.13%
Fraxinus americana	1	0.03%
Fraxinus pennsylvanica	75	1.89%
Fraxinus spp.	1	0.03%
Ginkgo biloba	7	0.18%
Gleditsia triacanthos	2	0.05%
Gleditsia triacanthos var	1	0.03%
Hibiscus syriacus	1	0.03%
Ilex opaca	5	0.13%
Ilex spp.	27	0.68%
Juglans nigra	1	0.03%
Juniperus spp.	2	0.05%
Juniperus virginiana	88	2.22%

Botanical	Total	Percentage of Entire Population
Koelreuteria paniculata	3	0.08%
Lagerstroemia Sp.	188	4.74%
Ligustrum spp.	6	0.15%
Liquidambar styraciflua	100	2.52%
Liriodendron tulipifera	23	0.58%
Magnolia grandiflora	22	0.56%
Magnolia spp.	7	0.18%
Malus spp.	69	1.74%
Melia azedarach	4	0.10%
Morus spp.	13	0.33%
Myrica cerifera	2	0.05%
Nyssa sylvatica	3	0.08%
Oxydendrum arboreum	1	0.03%
Paulownia tomentosa	1	0.03%
Photinia spp.	3	0.08%
Picea pungens	2	0.05%
Picea spp.	1	0.03%
Pinus echinata	9	0.23%
Pinus palustris	3	0.08%
Pinus resinosa	1	0.03%
Pinus spp.	1	0.03%
Pinus strobus	15	0.38%
Pinus sylvestris	1	0.03%
Pinus taeda	133	3.36%
Pistacia chinensis	57	1.44%
Platanus x acerifolia	3	0.08%
Populus alba	1	0.03%
Populus balsamifera	2	0.05%
Populus deltoides	1	0.03%
Populus spp.	1	0.03%
Prunus serotina	10	0.25%
Prunus spp.	468	11.81%
Pyrus calleryana	149	3.76%
Quercus alba	27	0.68%
Quercus bicolor	3	0.08%
Quercus coccinea	3	0.08%
Quercus falcata	9	0.23%
Quercus marilandica	1	0.03%

Botanical	Total	Percentage of Entire Population
Quercus nigra	14	0.35%
Quercus palustris	5	0.13%
Quercus phellos	399	10.07%
Quercus rubra	28	0.71%
Quercus virginiana	2	0.05%
Rhododendron spp.	2	0.05%
Robinia pseudoacacia	3	0.08%
Salix discolor	1	0.03%
Salix spp.	5	0.13%
Shrub	5	0.13%
Styrax japonicus	1	0.03%
Syringa vulgaris	1	0.03%
Taxodium distichum	4	0.10%
Thuja occidentalis	60	1.51%
Torreya taxifolia	1	0.03%
Ulmus alata	31	0.78%
Ulmus americana	5	0.13%
Ulmus parvifolia	64	1.61%
Ulmus pumila	13	0.33%
Ulmus spp.	3	0.08%
Unknown	8	0.20%
Zelkova serrata	15	0.38%
Grand Total	*3963*	*100%*

DAVEY

Wake Forest, NC

Species/Maintenance Frequency Matrix

Common Name	Plant	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Routine Prune	Small Routine Prune	Training Prune	Stump	TOTAL
Arborvitae, Eastern						1	59				60
Ash, Green		2	2	1			5		65		75
Ash, spp.							1				1
Ash, White									1		1
Baldcypress, Common							3		1		4
Beech, American			1			2			2		5
Birch, Paper							4		1		5
Birch, River							4		4		8
Birch, spp.							2		1		3
Catalpa, Northern							1				1
Cedar, Deodar							4				4
Cherry, Black			1	1			7		1		10
Cherry, spp.			2	13			2	167	284		468
Chestnut, Chinese									1		1

Common Name	Plant	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Routine Prune	Small Routine Prune	Training Prune	Stump	TOTAL
Chinaberry							4				4
Chinese Pistache						1	27	1	28		57
Cottonwood, Eastern							1				1
Crabapple, Flowering				2				10	57		69
Crapemyrtle spp.			6	11		4		140	27		188
Cryptomeria, Japanese							7				7
Dogwood, Flowering		6	34	18		12		161	130		361
Dogwood, Kousa									3		3
Elm, American			1			1	3				5
Elm, Lacebark				1				13	50		64
Elm, Siberian			1	2	2	1	3		4		13
Elm, spp.			1				2				3
Elm, Winged		1			1		11		18		31
Ginkgo									7		7
Goldenraintree				1			1		1		3
Hickory, spp.			2	1			2		1		6

Common Name	Plant	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Routine Prune	Small Routine Prune	Training Prune	Stump	TOTAL
Holly, American								2	3		5
Holly, spp.							2	14	11		27
Honeylocust				1			1				2
Honeylocust, Thornless									1		1
Hornbeam, American							1				1
Juniper, spp.							2				2
Ligustrum spp.								2	4		6
Lilac, Common									1		1
Locust, Black				1			1		1		3
Magnolia, Southern						2	10		10		22
Magnolia, spp.									7		7
Maple, Amur									3		3
Maple, Hedge								1			1
Maple, Japanese								11	11		22
Maple, Norway							2		1		3
Maple, Red		7	11	24	3	12	253		620		930

Common Name	Plant	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Routine Prune	Small Routine Prune	Training Prune	Stump	TOTAL
Maple, Silver			1				5		5		11
Maple, Sugar		3	5	2	8	12	44		99		173
Mimosa								6			6
Mulberry, spp.		1			1		1	4	6		13
Oak, Blackjack							1				1
Oak, Live									2		2
Oak, Northern Red			1			1	2		24		28
Oak, Pin							3		2		5
Oak, Scarlet									3		3
Oak, Southern Red			1	2	2	1	3				9
Oak, Swamp White					1	2					3
Oak, Water		1	1			3	3		6		14
Oak, White		1	2		6	9	8		1		27
Oak, Willow		10	14	5	59	34	71	1	205		399
Pear, Callery		2	6					58	83		149
Pecan				2	3	4	14		4		27

Common Name	Plant	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Routine Prune	Small Routine Prune	Training Prune	Stump	TOTAL
Photinia spp.								3			3
Pine, Eastern White					2	1	12				15
Pine, Loblolly		2	7	1	4	9	110				133
Pine, Longleaf							3				3
Pine, Red							1				1
Pine, Scotch							1				1
Pine, Shortleaf		1			1		7				9
Pine, spp.				1							1
Planetree, London							3				3
Poplar, Balsam							1		1		2
Poplar, spp.							1				1
Poplar, White							1				1
Redbud, Eastern		1	6	11	2			21	113		154
Redcedar, Eastern					1	1	85		1		88
Rhododendron, spp.								1	1		2
Rose of sharon									1		1

Common Name	Plant	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Routine Prune	Small Routine Prune	Training Prune	Stump	TOTAL
Royal Paulownia							1				1
Serviceberry, spp.									1		1
Shrub				1				3	1		5
Snowbell, Japanese									1		1
Sourwood									1		1
Spruce, Colorado							2				2
Spruce, spp.							1				1
Stump										59	59
Sweetgum, American				1		5	34		60		100
Torreya, Florida							1				1
Tuliptree			1	1		1	14		6		23
Tupelo, Black		1					1		1		3
Unknown		1		6					1		8
Vacant Site, Large	127										127
Vacant Site, Medium	168										168
Vacant Site, Small	109										109

Common Name	Plant	Priority 1 Removal	Priority 2 Removal	Priority 3 Removal	Priority 1 Prune	Priority 2 Prune	Large Routine Prune	Small Routine Prune	Training Prune	Stump	TOTAL
Walnut, Black							1				1
Wax-myrtle									2		2
Willow, Pussy									1		1
Willow, spp.								2	3		5
Zelkova, Japanese								9	6		15
Grand Total	404	40	107	110	96	119	860	630	2001	59	4426

Appendix B
Tree Condition Frequency Reports

DAVEY

Wake Forest, NC

Quantity Report: Condition

Condition	*Total*	*Percentage of Entire Population*
Fair	2193	55.34%
Good	1330	33.56%
Poor	385	9.71%
Dead	26	0.66%
Critical	25	0.63%
Excellent	3	0.08%
Very Good	1	0.03%
Grand Total	*3963*	*100%*

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Critical			
Cornus	7	28.00%	0.17%
Acer	5	20.00%	0.12%
Prunus	4	16.00%	0.10%
Ulmus	3	12.00%	0.07%
Quercus	3	12.00%	0.07%
Cercis	2	8.00%	0.05%
Pyrus	1	4.00%	0.02%
Summary for Critical (7 items)			
Sum	*25*	*100%*	*0.62%*
Dead			
Unknown	7	26.92%	0.17%
Prunus	5	19.23%	0.12%
Acer	5	19.23%	0.12%
Cornus	4	15.38%	0.10%
Pinus	3	11.54%	0.07%
Cercis	2	7.69%	0.05%
Summary for Dead (6 items)			
Sum	*26*	*100%*	*0.65%*
Excellent			
Ginkgo	3	100.00%	0.07%
Summary for Excellent (1 item)			
Sum	*3*	*100%*	*0.07%*
Fair			
Acer	627	28.59%	15.59%
Prunus	211	9.62%	5.25%
Cornus	210	9.58%	5.22%
Quercus	187	8.53%	4.65%
Lagerstroemia	161	7.34%	4.00%
Pinus	99	4.51%	2.46%
Cercis	99	4.51%	2.46%
Pyrus	79	3.60%	1.96%
Ulmus	69	3.15%	1.72%
Liquidambar	62	2.83%	1.54%

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Fraxinus	59	2.69%	1.47%
Pistacia	50	2.28%	1.24%
Malus	48	2.19%	1.19%
Thuja	41	1.87%	1.02%
Juniperus	39	1.78%	0.97%
Carya	23	1.05%	0.57%
Zelkova	15	0.68%	0.37%
Magnolia	15	0.68%	0.37%
Liriodendron	13	0.59%	0.32%
Ilex	13	0.59%	0.32%
Morus	12	0.55%	0.30%
Betula	8	0.36%	0.20%
Albizia	5	0.23%	0.12%
Shrub	4	0.18%	0.10%
Salix	4	0.18%	0.10%
Melia	4	0.18%	0.10%
Ligustrum	4	0.18%	0.10%
Fagus	4	0.18%	0.10%
Robinia	3	0.14%	0.07%
Populus	3	0.14%	0.07%
Cryptomeria	3	0.14%	0.07%
Koelreuteria	2	0.09%	0.05%
Gleditsia	2	0.09%	0.05%
Unknown	1	0.05%	0.02%
Torreya	1	0.05%	0.02%
Syringa	1	0.05%	0.02%
Platanus	1	0.05%	0.02%
Photinia	1	0.05%	0.02%
Paulownia	1	0.05%	0.02%
Oxydendrum	1	0.05%	0.02%
Nyssa	1	0.05%	0.02%
Myrica	1	0.05%	0.02%
Juglans	1	0.05%	0.02%
Hibiscus	1	0.05%	0.02%
Ginkgo	1	0.05%	0.02%
Cedrus	1	0.05%	0.02%
Catalpa	1	0.05%	0.02%
Castanea	1	0.05%	0.02%

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Summary for Fair (48 items)			
Sum	*2193*	*100%*	*54.53%*
Good			
Acer	404	30.38%	10.04%
Quercus	234	17.59%	5.82%
Prunus	225	16.92%	5.59%
Cornus	62	4.66%	1.54%
Pyrus	52	3.91%	1.29%
Pinus	49	3.68%	1.22%
Juniperus	49	3.68%	1.22%
Ulmus	36	2.71%	0.90%
Cercis	35	2.63%	0.87%
Liquidambar	32	2.41%	0.80%
Thuja	19	1.43%	0.47%
Malus	19	1.43%	0.47%
Ilex	19	1.43%	0.47%
Magnolia	14	1.05%	0.35%
Fraxinus	14	1.05%	0.35%
Liriodendron	9	0.68%	0.22%
Betula	8	0.60%	0.20%
Pistacia	7	0.53%	0.17%
Taxodium	4	0.30%	0.10%
Cryptomeria	4	0.30%	0.10%
Carya	4	0.30%	0.10%
Picea	3	0.23%	0.07%
Lagerstroemia	3	0.23%	0.07%
Ginkgo	3	0.23%	0.07%
Cedrus	3	0.23%	0.07%
Salix	2	0.15%	0.05%
Rhododendron	2	0.15%	0.05%
Populus	2	0.15%	0.05%
Platanus	2	0.15%	0.05%
Photinia	2	0.15%	0.05%
Ligustrum	2	0.15%	0.05%
Styrax	1	0.08%	0.02%
Shrub	1	0.08%	0.02%
Nyssa	1	0.08%	0.02%
Myrica	1	0.08%	0.02%

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Gleditsia	1	0.08%	0.02%
Amelanchier	1	0.08%	0.02%
Albizia	1	0.08%	0.02%
Summary for Good (38 items)			
Sum	*1330*	*100%*	*33.07%*
N/A			
Stump	59	100.00%	1.47%
Summary for N/A (1 item)			
Sum	*59*	*100%*	*1.47%*
Poor			
Acer	102	26.49%	2.54%
Cornus	81	21.04%	2.01%
Quercus	67	17.40%	1.67%
Prunus	33	8.57%	0.82%
Lagerstroemia	24	6.23%	0.60%
Pyrus	17	4.42%	0.42%
Cercis	16	4.16%	0.40%
Pinus	12	3.12%	0.30%
Ulmus	8	2.08%	0.20%
Carya	6	1.56%	0.15%
Liquidambar	5	1.30%	0.12%
Fraxinus	4	1.04%	0.10%
Malus	2	0.52%	0.05%
Juniperus	2	0.52%	0.05%
Nyssa	1	0.26%	0.02%
Morus	1	0.26%	0.02%
Liriodendron	1	0.26%	0.02%
Koelreuteria	1	0.26%	0.02%
Fagus	1	0.26%	0.02%
Carpinus	1	0.26%	0.02%
Summary for Poor (20 items)			
Sum	*385*	*100%*	*9.57%*
Very Good			
Liquidambar	1	100.00%	0.02%
Summary for Very Good (1 item)			
Sum	*1*	*100%*	*0.02%*
Grand Total	*4022*		

Diameter Class	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Critical			
1 - 3	7	28.00%	0.18%
7 - 12	6	24.00%	0.15%
4 - 6	6	24.00%	0.15%
19 - 24	2	8.00%	0.05%
43 +	1	4.00%	0.03%
37 - 42	1	4.00%	0.03%
31 - 36	1	4.00%	0.03%
13 - 18	1	4.00%	0.03%
Summary for Critical (8 items)			
Sum	*25*	*100%*	*0.63%*
Dead			
1 - 3	17	65.38%	0.43%
4 - 6	6	23.08%	0.15%
7 - 12	3	11.54%	0.08%
Summary for Dead (3 items)			
Sum	*26*	*100%*	*0.66%*
Excellent			
1 - 3	3	100.00%	0.08%
Summary for Excellent (1 item)			
Sum	*3*	*100%*	*0.08%*
Fair			
1 - 3	851	38.81%	21.47%
4 - 6	697	31.78%	17.59%
7 - 12	353	16.10%	8.91%
13 - 18	115	5.24%	2.90%
19 - 24	72	3.28%	1.82%
25 - 30	53	2.42%	1.34%
31 - 36	26	1.19%	0.66%
37 - 42	21	0.96%	0.53%
43 +	5	0.23%	0.13%
Summary for Fair (9 items)			
Sum	*2193*	*100%*	*55.34%*

Diameter Class	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Good			
1 - 3	806	60.60%	20.34%
4 - 6	357	26.84%	9.01%
7 - 12	126	9.47%	3.18%
13 - 18	24	1.80%	0.61%
19 - 24	15	1.13%	0.38%
25 - 30	2	0.15%	0.05%
Summary for Good (6 items)			
Sum	*1330*	*100%*	*33.56%*
Poor			
7 - 12	112	29.09%	2.83%
4 - 6	105	27.27%	2.65%
1 - 3	72	18.70%	1.82%
13 - 18	34	8.83%	0.86%
19 - 24	25	6.49%	0.63%
25 - 30	18	4.68%	0.45%
37 - 42	8	2.08%	0.20%
31 - 36	6	1.56%	0.15%
43 +	5	1.30%	0.13%
Summary for Poor (9 items)			
Sum	*385*	*100%*	*9.71%*
Very Good			
19 - 24	1	100.00%	0.03%
Summary for Very Good (1 item)			
Sum	*1*	*100%*	*0.03%*
Grand Total	*3963*		

Maintenance	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Critical			
Priority 3 Removal	11	44.00%	0.28%
Priority 2 Removal	7	28.00%	0.18%
Priority 1 Removal	7	28.00%	0.18%
Summary for Critical (3 items)			
Sum	*25*	*100%*	*0.63%*
Dead			
Priority 3 Removal	23	88.46%	0.58%
Priority 1 Removal	3	11.54%	0.08%
Summary for Dead (2 items)			
Sum	*26*	*100%*	*0.66%*
Excellent			
Training Prune	3	100.00%	0.08%
Summary for Excellent (1 item)			
Sum	*3*	*100%*	*0.08%*
Fair			
Training Prune	969	44.19%	24.45%
Large Routine Prune	552	25.17%	13.93%
Small Routine Prune	481	21.93%	12.14%
Priority 2 Prune	91	4.15%	2.30%
Priority 1 Prune	71	3.24%	1.79%
Priority 3 Removal	23	1.05%	0.58%
Priority 2 Removal	4	0.18%	0.10%
Priority 1 Removal	2	0.09%	0.05%
Summary for Fair (8 items)			
Sum	*2193*	*100%*	*55.34%*
Good			
Training Prune	979	73.61%	24.70%
Large Routine Prune	267	20.08%	6.74%
Small Routine Prune	79	5.94%	1.99%
Priority 2 Prune	3	0.23%	0.08%
Priority 3 Removal	2	0.15%	0.05%

Maintenance	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Summary for Good (5 items)			
Sum	*1330*	*100%*	*33.56%*
Poor			
Priority 2 Removal	96	24.94%	2.42%
Small Routine Prune	70	18.18%	1.77%
Priority 3 Removal	51	13.25%	1.29%
Training Prune	50	12.99%	1.26%
Large Routine Prune	41	10.65%	1.03%
Priority 1 Removal	28	7.27%	0.71%
Priority 1 Prune	25	6.49%	0.63%
Priority 2 Prune	24	6.23%	0.61%
Summary for Poor (8 items)			
Sum	*385*	*100%*	*9.71%*
Very Good			
Priority 2 Prune	1	100.00%	0.03%
Summary for Very Good (1 item)			
Sum	*1*	*100%*	*0.03%*
Grand Total	*3963*		

Appendix C
Tree Diameter Frequency Reports

DAVEY

Wake Forest, NC

Quantity Report: Diameter

Diameter	*Total*	*Percentage of Entire Population*
3	895	22.58%
2	612	15.44%
4	544	13.73%
5	331	8.35%
6	296	7.47%
1	249	6.28%
7	205	5.17%
8	128	3.23%
9	95	2.40%
10	74	1.87%
11	59	1.49%
13	40	1.01%
12	39	0.98%
16	35	0.88%
21	29	0.73%
19	29	0.73%
15	28	0.71%
14	28	0.71%
25	23	0.58%
18	22	0.56%
17	21	0.53%
23	18	0.45%
22	15	0.38%
20	15	0.38%
27	12	0.30%
33	11	0.28%
29	11	0.28%
26	10	0.25%
35	9	0.23%
28	9	0.23%
24	9	0.23%
30	8	0.20%
37	7	0.18%
42	6	0.15%
41	6	0.15%

Diameter	*Total*	*Percentage of Entire Population*
38	6	0.15%
31	6	0.15%
43	4	0.10%
36	4	0.10%
40	3	0.08%
46	2	0.05%
39	2	0.05%
34	2	0.05%
58	1	0.03%
55	1	0.03%
49	1	0.03%
48	1	0.03%
45	1	0.03%
32	1	0.03%
Grand Total	*3963*	*100%*

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
1 - 3			
Acer	471	26.82%	11.88%
Prunus	275	15.66%	6.94%
Quercus	225	12.81%	5.68%
Cornus	114	6.49%	2.88%
Lagerstroemia	111	6.32%	2.80%
Cercis	79	4.50%	1.99%
Liquidambar	69	3.93%	1.74%
Fraxinus	68	3.87%	1.72%
Ulmus	65	3.70%	1.64%
Malus	64	3.64%	1.61%
Pyrus	37	2.11%	0.93%
Thuja	27	1.54%	0.68%
Juniperus	19	1.08%	0.48%
Ilex	18	1.03%	0.45%
Magnolia	15	0.85%	0.38%
Pistacia	14	0.80%	0.35%
Pinus	13	0.74%	0.33%
Unknown	7	0.40%	0.18%
Ginkgo	7	0.40%	0.18%
Betula	7	0.40%	0.18%
Ligustrum	5	0.28%	0.13%
Cryptomeria	4	0.23%	0.10%
Carya	4	0.23%	0.10%
Shrub	3	0.17%	0.08%
Salix	3	0.17%	0.08%
Morus	3	0.17%	0.08%
Koelreuteria	3	0.17%	0.08%
Cedrus	3	0.17%	0.08%
Zelkova	2	0.11%	0.05%
Robinia	2	0.11%	0.05%
Rhododendron	2	0.11%	0.05%
Liriodendron	2	0.11%	0.05%
Fagus	2	0.11%	0.05%
Albizia	2	0.11%	0.05%

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Taxodium	1	0.06%	0.03%
Syringa	1	0.06%	0.03%
Styrax	1	0.06%	0.03%
Populus	1	0.06%	0.03%
Picea	1	0.06%	0.03%
Photinia	1	0.06%	0.03%
Nyssa	1	0.06%	0.03%
Myrica	1	0.06%	0.03%
Hibiscus	1	0.06%	0.03%
Gleditsia	1	0.06%	0.03%
Amelanchier	1	0.06%	0.03%
Summary for 1 - 3 (45 items)			
Sum	*1756*	*100%*	*44.31%*
13 - 18			
Pinus	49	28.16%	1.24%
Quercus	35	20.11%	0.88%
Acer	34	19.54%	0.86%
Ulmus	11	6.32%	0.28%
Juniperus	9	5.17%	0.23%
Carya	7	4.02%	0.18%
Cornus	6	3.45%	0.15%
Magnolia	5	2.87%	0.13%
Liquidambar	4	2.30%	0.10%
Liriodendron	3	1.72%	0.08%
Morus	2	1.15%	0.05%
Thuja	1	0.57%	0.03%
Salix	1	0.57%	0.03%
Prunus	1	0.57%	0.03%
Populus	1	0.57%	0.03%
Paulownia	1	0.57%	0.03%
Nyssa	1	0.57%	0.03%
Lagerstroemia	1	0.57%	0.03%
Fraxinus	1	0.57%	0.03%
Cercis	1	0.57%	0.03%
Summary for 13 - 18 (20 items)			
Sum	*174*	*100%*	*4.39%*
19 - 24			
Pinus	40	34.78%	1.01%

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Quercus	35	30.43%	0.88%
Acer	18	15.65%	0.45%
Magnolia	5	4.35%	0.13%
Juniperus	4	3.48%	0.10%
Ulmus	3	2.61%	0.08%
Morus	2	1.74%	0.05%
Liriodendron	2	1.74%	0.05%
Liquidambar	2	1.74%	0.05%
Carya	2	1.74%	0.05%
Nyssa	1	0.87%	0.03%
Cedrus	1	0.87%	0.03%
Summary for 19 - 24 (12 items)			
Sum	*115*	*100%*	*2.90%*
25 - 30			
Quercus	41	56.16%	1.03%
Pinus	11	15.07%	0.28%
Acer	8	10.96%	0.20%
Carya	4	5.48%	0.10%
Ulmus	2	2.74%	0.05%
Liquidambar	2	2.74%	0.05%
Fraxinus	2	2.74%	0.05%
Magnolia	1	1.37%	0.03%
Liriodendron	1	1.37%	0.03%
Catalpa	1	1.37%	0.03%
Summary for 25 - 30 (10 items)			
Sum	*73*	*100%*	*1.84%*
31 - 36			
Quercus	28	84.85%	0.71%
Acer	2	6.06%	0.05%
Liquidambar	1	3.03%	0.03%
Fraxinus	1	3.03%	0.03%
Carya	1	3.03%	0.03%
Summary for 31 - 36 (5 items)			
Sum	*33*	*100%*	*0.83%*
37 - 42			
Quercus	29	96.67%	0.73%
Liquidambar	1	3.33%	0.03%

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Summary for 37 - 42 (2 items)			
Sum	*30*	*100%*	*0.76%*
4 - 6			
Acer	432	36.89%	10.90%
Prunus	166	14.18%	4.19%
Cornus	126	10.76%	3.18%
Pyrus	80	6.83%	2.02%
Lagerstroemia	60	5.12%	1.51%
Quercus	55	4.70%	1.39%
Cercis	50	4.27%	1.26%
Pistacia	33	2.82%	0.83%
Juniperus	28	2.39%	0.71%
Thuja	27	2.31%	0.68%
Ulmus	24	2.05%	0.61%
Pinus	17	1.45%	0.43%
Zelkova	9	0.77%	0.23%
Liquidambar	9	0.77%	0.23%
Carya	8	0.68%	0.20%
Ilex	7	0.60%	0.18%
Liriodendron	6	0.51%	0.15%
Morus	5	0.43%	0.13%
Betula	5	0.43%	0.13%
Malus	3	0.26%	0.08%
Magnolia	3	0.26%	0.08%
Shrub	2	0.17%	0.05%
Salix	2	0.17%	0.05%
Fraxinus	2	0.17%	0.05%
Cryptomeria	2	0.17%	0.05%
Populus	1	0.09%	0.03%
Picea	1	0.09%	0.03%
Oxydendrum	1	0.09%	0.03%
Myrica	1	0.09%	0.03%
Melia	1	0.09%	0.03%
Ligustrum	1	0.09%	0.03%
Juglans	1	0.09%	0.03%
Gleditsia	1	0.09%	0.03%
Fagus	1	0.09%	0.03%
Castanea	1	0.09%	0.03%

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Summary for 4 - 6 (35 items)			
Sum	*1171*	*100%*	*29.55%*
43 +			
Quercus	10	90.91%	0.25%
Fraxinus	1	9.09%	0.03%
Summary for 43 + (2 items)			
Sum	*11*	*100%*	*0.28%*
7 - 12			
Acer	178	29.67%	4.49%
Cornus	118	19.67%	2.98%
Prunus	36	6.00%	0.91%
Quercus	33	5.50%	0.83%
Pinus	33	5.50%	0.83%
Pyrus	32	5.33%	0.81%
Juniperus	30	5.00%	0.76%
Cercis	24	4.00%	0.61%
Lagerstroemia	16	2.67%	0.40%
Liquidambar	12	2.00%	0.30%
Ulmus	11	1.83%	0.28%
Pistacia	10	1.67%	0.25%
Liriodendron	9	1.50%	0.23%
Ilex	7	1.17%	0.18%
Carya	7	1.17%	0.18%
Thuja	5	0.83%	0.13%
Zelkova	4	0.67%	0.10%
Betula	4	0.67%	0.10%
Albizia	4	0.67%	0.10%
Taxodium	3	0.50%	0.08%
Platanus	3	0.50%	0.08%
Melia	3	0.50%	0.08%
Populus	2	0.33%	0.05%
Photinia	2	0.33%	0.05%
Malus	2	0.33%	0.05%
Fraxinus	2	0.33%	0.05%
Fagus	2	0.33%	0.05%
Unknown	1	0.17%	0.03%
Torreya	1	0.17%	0.03%
Robinia	1	0.17%	0.03%

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Picea	1	0.17%	0.03%
Morus	1	0.17%	0.03%
Gleditsia	1	0.17%	0.03%
Cryptomeria	1	0.17%	0.03%
Carpinus	1	0.17%	0.03%
Summary for 7 - 12 (35 items)			
Sum	*600*	*100%*	*15.14%*
Grand Total	*3963*		

Condition	Total	Percentage of Sub-Category Population	Percentage of Entire Population
1 - 3			
Fair	851	48.46%	21.47%
Good	806	45.90%	20.34%
Poor	72	4.10%	1.82%
Dead	17	0.97%	0.43%
Critical	7	0.40%	0.18%
Excellent	3	0.17%	0.08%
Summary for 1 - 3 (6 items)			
Sum	*1756*	*100%*	*44.31%*
13 - 18			
Fair	115	66.09%	2.90%
Poor	34	19.54%	0.86%
Good	24	13.79%	0.61%
Critical	1	0.57%	0.03%
Summary for 13 - 18 (4 items)			
Sum	*174*	*100%*	*4.39%*
19 - 24			
Fair	72	62.61%	1.82%
Poor	25	21.74%	0.63%
Good	15	13.04%	0.38%
Critical	2	1.74%	0.05%
Very Good	1	0.87%	0.03%
Summary for 19 - 24 (5 items)			
Sum	*115*	*100%*	*2.90%*
25 - 30			
Fair	53	72.60%	1.34%
Poor	18	24.66%	0.45%
Good	2	2.74%	0.05%
Summary for 25 - 30 (3 items)			
Sum	*73*	*100%*	*1.84%*
31 - 36			
Fair	26	78.79%	0.66%
Poor	6	18.18%	0.15%

Condition	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Critical	1	3.03%	0.03%
Summary for 31 - 36 (3 items)			
Sum	*33*	*100%*	*0.83%*
37 - 42			
Fair	21	70.00%	0.53%
Poor	8	26.67%	0.20%
Critical	1	3.33%	0.03%
Summary for 37 - 42 (3 items)			
Sum	*30*	*100%*	*0.76%*
4 - 6			
Fair	697	59.52%	17.59%
Good	357	30.49%	9.01%
Poor	105	8.97%	2.65%
Dead	6	0.51%	0.15%
Critical	6	0.51%	0.15%
Summary for 4 - 6 (5 items)			
Sum	*1171*	*100%*	*29.55%*
43 +			
Poor	5	45.45%	0.13%
Fair	5	45.45%	0.13%
Critical	1	9.09%	0.03%
Summary for 43 + (3 items)			
Sum	*11*	*100%*	*0.28%*
7 - 12			
Fair	353	58.83%	8.91%
Good	126	21.00%	3.18%
Poor	112	18.67%	2.83%
Critical	6	1.00%	0.15%
Dead	3	0.50%	0.08%
Summary for 7 - 12 (5 items)			
Sum	*600*	*100%*	*15.14%*
Grand Total	*3963*		

DAVEY

Wake Forest, NC

Quantity Report: Diameter Class

Diameter Class	*Total*	*Percentage of Entire Population*
1 - 3	1756	44.31%
4 - 6	1171	29.55%
7 - 12	600	15.14%
13 - 18	174	4.39%
19 - 24	115	2.90%
25 - 30	73	1.84%
31 - 36	33	0.83%
37 - 42	30	0.76%
43 +	11	0.28%
Grand Total	*3963*	*100%*

Maintenance	Total	Percentage of Sub-Category Population	Percentage of Entire Population
1 - 3			
Training Prune	1410	80.20%	35.06%
Small Routine Prune	160	9.10%	3.98%
Large Routine Prune	113	6.43%	2.81%
Priority 3 Removal	73	4.15%	1.82%
Stump	2	0.11%	0.05%
Summary for 1 - 3 (5 items)			
Sum	*1758*	*100%*	*43.71%*
13 - 18			
Large Routine Prune	110	57.29%	2.73%
Priority 2 Prune	25	13.02%	0.62%
Stump	18	9.38%	0.45%
Priority 2 Removal	15	7.81%	0.37%
Priority 1 Prune	10	5.21%	0.25%
Priority 1 Removal	9	4.69%	0.22%
Small Routine Prune	5	2.60%	0.12%
Summary for 13 - 18 (7 items)			
Sum	*192*	*100%*	*4.77%*
19 - 24			
Large Routine Prune	56	47.06%	1.39%
Priority 2 Prune	23	19.33%	0.57%
Priority 1 Prune	19	15.97%	0.47%
Priority 2 Removal	10	8.40%	0.25%
Priority 1 Removal	6	5.04%	0.15%
Stump	4	3.36%	0.10%
Small Routine Prune	1	0.84%	0.02%
Summary for 19 - 24 (7 items)			
Sum	*119*	*100%*	*2.96%*
25 - 30			
Priority 1 Prune	27	36.00%	0.67%
Large Routine Prune	23	30.67%	0.57%
Priority 2 Prune	19	25.33%	0.47%
Stump	2	2.67%	0.05%
Priority 2 Removal	2	2.67%	0.05%

Maintenance	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Priority 1 Removal	2	2.67%	0.05%
Summary for 25 - 30 (6 items)			
Sum	*75*	*100%*	*1.86%*
31 - 36			
Priority 1 Prune	18	47.37%	0.45%
Priority 2 Prune	8	21.05%	0.20%
Stump	5	13.16%	0.12%
Priority 1 Removal	3	7.89%	0.07%
Large Routine Prune	3	7.89%	0.07%
Priority 2 Removal	1	2.63%	0.02%
Summary for 31 - 36 (6 items)			
Sum	*38*	*100%*	*0.94%*
37 - 42			
Priority 1 Prune	15	45.45%	0.37%
Priority 2 Prune	7	21.21%	0.17%
Stump	3	9.09%	0.07%
Priority 2 Removal	3	9.09%	0.07%
Large Routine Prune	3	9.09%	0.07%
Priority 1 Removal	2	6.06%	0.05%
Summary for 37 - 42 (6 items)			
Sum	*33*	*100%*	*0.82%*
4 - 6			
Training Prune	527	44.74%	13.10%
Small Routine Prune	296	25.13%	7.36%
Large Routine Prune	278	23.60%	6.91%
Priority 3 Removal	34	2.89%	0.85%
Priority 2 Removal	26	2.21%	0.65%
Priority 2 Prune	9	0.76%	0.22%
Stump	7	0.59%	0.17%
Priority 1 Removal	1	0.08%	0.02%
Summary for 4 - 6 (8 items)			
Sum	*1178*	*100%*	*29.29%*
43 +			
Priority 2 Prune	3	27.27%	0.07%
Priority 1 Removal	3	27.27%	0.07%
Priority 1 Prune	3	27.27%	0.07%
Priority 2 Removal	2	18.18%	0.05%

Maintenance	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Summary for 43 + (4 items)			
Sum	*11*	*100%*	*0.27%*
7 - 12			
Large Routine Prune	274	44.34%	6.81%
Small Routine Prune	168	27.18%	4.18%
Training Prune	64	10.36%	1.59%
Priority 2 Removal	48	7.77%	1.19%
Priority 2 Prune	25	4.05%	0.62%
Stump	18	2.91%	0.45%
Priority 1 Removal	14	2.27%	0.35%
Priority 1 Prune	4	0.65%	0.10%
Priority 3 Removal	3	0.49%	0.07%
Summary for 7 - 12 (9 items)			
Sum	*618*	*100%*	*15.37%*
Grand Total	*4022*		

Appendix D
Tree Maintenance Frequency Reports

DAVEY

Wake Forest, NC

Maintenance/DBH Class Frequency Matrix

Maintenance	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
Large Routine Prune		113	278	274	110	56	23	3	3		860
Plant	404										404
Priority 1 Prune				4	10	19	27	18	15	3	96
Priority 1 Removal			1	14	9	6	2	3	2	3	40
Priority 2 Prune			9	25	25	23	19	8	7	3	119
Priority 2 Removal			26	48	15	10	2	1	3	2	107
Priority 3 Removal		73	34	3							110
Small Routine Prune		160	296	168	5	1					630
Stump		2	7	18	18	4	2	5	3		59
Training Prune		1410	527	64							2001
Grand Total	*404*	*1758*	*1178*	*618*	*192*	*119*	*75*	*38*	*33*	*11*	*4426*

Diameter Class	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Large Routine Prune			
4 - 6	278	32.33%	7.01%
7 - 12	274	31.86%	6.91%
1 - 3	113	13.14%	2.85%
13 - 18	110	12.79%	2.78%
19 - 24	56	6.51%	1.41%
25 - 30	23	2.67%	0.58%
37 - 42	3	0.35%	0.08%
31 - 36	3	0.35%	0.08%
Summary for Large Routine Prune (8 items)			
Sum	*860*	*100%*	*21.70%*
Priority 1 Prune			
25 - 30	27	28.13%	0.68%
19 - 24	19	19.79%	0.48%
31 - 36	18	18.75%	0.45%
37 - 42	15	15.63%	0.38%
13 - 18	10	10.42%	0.25%
7 - 12	4	4.17%	0.10%
43 +	3	3.13%	0.08%
Summary for Priority 1 Prune (7 items)			
Sum	*96*	*100%*	*2.42%*
Priority 1 Removal			
7 - 12	14	35.00%	0.35%
13 - 18	9	22.50%	0.23%
19 - 24	6	15.00%	0.15%
43 +	3	7.50%	0.08%
31 - 36	3	7.50%	0.08%
37 - 42	2	5.00%	0.05%
25 - 30	2	5.00%	0.05%
4 - 6	1	2.50%	0.03%
Summary for Priority 1 Removal (8 items)			
Sum	*40*	*100%*	*1.01%*
Priority 2 Prune			
7 - 12	25	21.01%	0.63%

Diameter Class	Total	Percentage of Sub-Category Population	Percentage of Entire Population
13 - 18	25	21.01%	0.63%
19 - 24	23	19.33%	0.58%
25 - 30	19	15.97%	0.48%
4 - 6	9	7.56%	0.23%
31 - 36	8	6.72%	0.20%
37 - 42	7	5.88%	0.18%
43 +	3	2.52%	0.08%
Summary for Priority 2 Prune (8 items)			
Sum	*119*	*100%*	*3.00%*
Priority 2 Removal			
7 - 12	48	44.86%	1.21%
4 - 6	26	24.30%	0.66%
13 - 18	15	14.02%	0.38%
19 - 24	10	9.35%	0.25%
37 - 42	3	2.80%	0.08%
43 +	2	1.87%	0.05%
25 - 30	2	1.87%	0.05%
31 - 36	1	0.93%	0.03%
Summary for Priority 2 Removal (8 items)			
Sum	*107*	*100%*	*2.70%*
Priority 3 Removal			
1 - 3	73	66.36%	1.84%
4 - 6	34	30.91%	0.86%
7 - 12	3	2.73%	0.08%
Summary for Priority 3 Removal (3 items)			
Sum	*110*	*100%*	*2.78%*
Small Routine Prune			
4 - 6	296	46.98%	7.47%
7 - 12	168	26.67%	4.24%
1 - 3	160	25.40%	4.04%
13 - 18	5	0.79%	0.13%
19 - 24	1	0.16%	0.03%
Summary for Small Routine Prune (5 items)			
Sum	*630*	*100%*	*15.90%*
Training Prune			
1 - 3	1410	70.46%	35.58%
4 - 6	527	26.34%	13.30%

Diameter Class	Total	Percentage of Sub-Category Population	Percentage of Entire Population
7 - 12	64	3.20%	1.61%
Summary for Training Prune (3 items)			
Sum	*2001*	*100%*	*50.49%*
Grand Total	*3963*		

Condition	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Large Routine Prune			
Fair	552	64.19%	13.72%
Good	267	31.05%	6.64%
Poor	41	4.77%	1.02%
Summary for Large Routine Prune (3 items)			
Sum	*860*	*100%*	*21.38%*
Priority 1 Prune			
Fair	71	73.96%	1.77%
Poor	25	26.04%	0.62%
Summary for Priority 1 Prune (2 items)			
Sum	*96*	*100%*	*2.39%*
Priority 1 Removal			
Poor	28	70.00%	0.70%
Critical	7	17.50%	0.17%
Dead	3	7.50%	0.07%
Fair	2	5.00%	0.05%
Summary for Priority 1 Removal (4 items)			
Sum	*40*	*100%*	*0.99%*
Priority 2 Prune			
Fair	91	76.47%	2.26%
Poor	24	20.17%	0.60%
Good	3	2.52%	0.07%
Very Good	1	0.84%	0.02%
Summary for Priority 2 Prune (4 items)			
Sum	*119*	*100%*	*2.96%*
Priority 2 Removal			
Poor	96	89.72%	2.39%
Critical	7	6.54%	0.17%
Fair	4	3.74%	0.10%
Summary for Priority 2 Removal (3 items)			
Sum	*107*	*100%*	*2.66%*
Priority 3 Removal			
Poor	51	46.36%	1.27%

Condition	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Fair	23	20.91%	0.57%
Dead	23	20.91%	0.57%
Critical	11	10.00%	0.27%
Good	2	1.82%	0.05%
Summary for Priority 3 Removal (5 items)			
Sum	*110*	*100%*	*2.73%*
Small Routine Prune			
Fair	481	76.35%	11.96%
Good	79	12.54%	1.96%
Poor	70	11.11%	1.74%
Summary for Small Routine Prune (3 items)			
Sum	*630*	*100%*	*15.66%*
Stump			
N/A	59	100.00%	1.47%
Summary for Stump (1 item)			
Sum	*59*	*100%*	*1.47%*
Training Prune			
Good	979	48.93%	24.34%
Fair	969	48.43%	24.09%
Poor	50	2.50%	1.24%
Excellent	3	0.15%	0.07%
Summary for Training Prune (4 items)			
Sum	*2001*	*100%*	*49.75%*
Grand Total	*4022*		

DAVEY

Wake Forest, NC

Quantity Report: Maintenance

Maintenance	*Total*	*Percentage of Entire Population*
Training Prune	2001	49.75%
Large Routine Prune	860	21.38%
Small Routine Prune	630	15.66%
Priority 2 Prune	119	2.96%
Priority 3 Removal	110	2.73%
Priority 2 Removal	107	2.66%
Priority 1 Prune	96	2.39%
Stump	59	1.47%
Priority 1 Removal	40	0.99%
Grand Total	*4022*	*100%*

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Large Routine Prune			
Acer	304	35.35%	7.67%
Pinus	134	15.58%	3.38%
Quercus	91	10.58%	2.30%
Juniperus	87	10.12%	2.20%
Thuja	59	6.86%	1.49%
Liquidambar	34	3.95%	0.86%
Pistacia	27	3.14%	0.68%
Ulmus	19	2.21%	0.48%
Carya	16	1.86%	0.40%
Liriodendron	14	1.63%	0.35%
Magnolia	10	1.16%	0.25%
Betula	10	1.16%	0.25%
Prunus	9	1.05%	0.23%
Cryptomeria	7	0.81%	0.18%
Fraxinus	6	0.70%	0.15%
Populus	4	0.47%	0.10%
Melia	4	0.47%	0.10%
Cedrus	4	0.47%	0.10%
Taxodium	3	0.35%	0.08%
Platanus	3	0.35%	0.08%
Picea	3	0.35%	0.08%
Ilex	2	0.23%	0.05%
Torreya	1	0.12%	0.03%
Robinia	1	0.12%	0.03%
Paulownia	1	0.12%	0.03%
Nyssa	1	0.12%	0.03%
Morus	1	0.12%	0.03%
Koelreuteria	1	0.12%	0.03%
Juglans	1	0.12%	0.03%
Gleditsia	1	0.12%	0.03%
Catalpa	1	0.12%	0.03%
Carpinus	1	0.12%	0.03%
Summary for Large Routine Prune (32 items)			
Sum	*860*	*100%*	*21.70%*

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Priority 1 Prune			
Quercus	68	70.83%	1.72%
Acer	11	11.46%	0.28%
Pinus	7	7.29%	0.18%
Ulmus	3	3.13%	0.08%
Carya	3	3.13%	0.08%
Cercis	2	2.08%	0.05%
Morus	1	1.04%	0.03%
Juniperus	1	1.04%	0.03%
Summary for Priority 1 Prune (8 items)			
Sum	*96*	*100%*	*2.42%*
Priority 1 Removal			
Quercus	12	30.00%	0.30%
Acer	10	25.00%	0.25%
Cornus	6	15.00%	0.15%
Pinus	3	7.50%	0.08%
Pyrus	2	5.00%	0.05%
Fraxinus	2	5.00%	0.05%
Unknown	1	2.50%	0.03%
Ulmus	1	2.50%	0.03%
Nyssa	1	2.50%	0.03%
Morus	1	2.50%	0.03%
Cercis	1	2.50%	0.03%
Summary for Priority 1 Removal (11 items)			
Sum	*40*	*100%*	*1.01%*
Priority 2 Prune			
Quercus	50	42.02%	1.26%
Acer	24	20.17%	0.61%
Cornus	12	10.08%	0.30%
Pinus	10	8.40%	0.25%
Liquidambar	5	4.20%	0.13%
Lagerstroemia	4	3.36%	0.10%
Carya	4	3.36%	0.10%
Ulmus	2	1.68%	0.05%
Magnolia	2	1.68%	0.05%
Fagus	2	1.68%	0.05%
Thuja	1	0.84%	0.03%

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Pistacia	1	0.84%	0.03%
Liriodendron	1	0.84%	0.03%
Juniperus	1	0.84%	0.03%
Summary for Priority 2 Prune (14 items)			
Sum	*119*	*100%*	*3.00%*
Priority 2 Removal			
Cornus	34	31.78%	0.86%
Quercus	19	17.76%	0.48%
Acer	17	15.89%	0.43%
Pinus	7	6.54%	0.18%
Pyrus	6	5.61%	0.15%
Lagerstroemia	6	5.61%	0.15%
Cercis	6	5.61%	0.15%
Ulmus	3	2.80%	0.08%
Prunus	3	2.80%	0.08%
Fraxinus	2	1.87%	0.05%
Carya	2	1.87%	0.05%
Liriodendron	1	0.93%	0.03%
Fagus	1	0.93%	0.03%
Summary for Priority 2 Removal (13 items)			
Sum	*107*	*100%*	*2.70%*
Priority 3 Removal			
Acer	26	23.64%	0.66%
Cornus	18	16.36%	0.45%
Prunus	14	12.73%	0.35%
Lagerstroemia	11	10.00%	0.28%
Cercis	11	10.00%	0.28%
Quercus	7	6.36%	0.18%
Unknown	6	5.45%	0.15%
Ulmus	3	2.73%	0.08%
Carya	3	2.73%	0.08%
Pinus	2	1.82%	0.05%
Malus	2	1.82%	0.05%
Shrub	1	0.91%	0.03%
Robinia	1	0.91%	0.03%
Liriodendron	1	0.91%	0.03%
Liquidambar	1	0.91%	0.03%
Koelreuteria	1	0.91%	0.03%

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Gleditsia	1	0.91%	0.03%
Fraxinus	1	0.91%	0.03%
Summary for Priority 3 Removal (18 items)			
Sum	*110*	*100%*	*2.78%*
Small Routine Prune			
Prunus	167	26.51%	4.21%
Cornus	161	25.56%	4.06%
Lagerstroemia	140	22.22%	3.53%
Pyrus	58	9.21%	1.46%
Cercis	21	3.33%	0.53%
Ilex	16	2.54%	0.40%
Ulmus	13	2.06%	0.33%
Acer	12	1.90%	0.30%
Malus	10	1.59%	0.25%
Zelkova	9	1.43%	0.23%
Albizia	6	0.95%	0.15%
Morus	4	0.63%	0.10%
Shrub	3	0.48%	0.08%
Photinia	3	0.48%	0.08%
Salix	2	0.32%	0.05%
Ligustrum	2	0.32%	0.05%
Rhododendron	1	0.16%	0.03%
Quercus	1	0.16%	0.03%
Pistacia	1	0.16%	0.03%
Summary for Small Routine Prune (19 items)			
Sum	*630*	*100%*	*15.90%*
Training Prune			
Acer	739	36.93%	18.65%
Prunus	285	14.24%	7.19%
Quercus	243	12.14%	6.13%
Cornus	133	6.65%	3.36%
Cercis	113	5.65%	2.85%
Pyrus	83	4.15%	2.09%
Ulmus	72	3.60%	1.82%
Fraxinus	66	3.30%	1.67%
Liquidambar	60	3.00%	1.51%
Malus	57	2.85%	1.44%
Pistacia	28	1.40%	0.71%

Genus	Total	Percentage of Sub-Category Population	Percentage of Entire Population
Lagerstroemia	27	1.35%	0.68%
Magnolia	17	0.85%	0.43%
Ilex	14	0.70%	0.35%
Ginkgo	7	0.35%	0.18%
Zelkova	6	0.30%	0.15%
Morus	6	0.30%	0.15%
Liriodendron	6	0.30%	0.15%
Betula	6	0.30%	0.15%
Carya	5	0.25%	0.13%
Salix	4	0.20%	0.10%
Ligustrum	4	0.20%	0.10%
Myrica	2	0.10%	0.05%
Fagus	2	0.10%	0.05%
Unknown	1	0.05%	0.03%
Taxodium	1	0.05%	0.03%
Syringa	1	0.05%	0.03%
Styrax	1	0.05%	0.03%
Shrub	1	0.05%	0.03%
Robinia	1	0.05%	0.03%
Rhododendron	1	0.05%	0.03%
Populus	1	0.05%	0.03%
Oxydendrum	1	0.05%	0.03%
Nyssa	1	0.05%	0.03%
Koelreuteria	1	0.05%	0.03%
Juniperus	1	0.05%	0.03%
Hibiscus	1	0.05%	0.03%
Gleditsia	1	0.05%	0.03%
Castanea	1	0.05%	0.03%
Amelanchier	1	0.05%	0.03%
Summary for Training Prune (40 items)			
Sum	*2001*	*100%*	*50.49%*
Grand Total	*3963*		

Appendix E
Clearance, Further Inspection, and Growing Space Size/Type Frequency Reports

DAVEY

Wake Forest, NC

Quantity Report: Space Size

Space Size	*Total*	*Percentage of Entire Population*
99	3534	79.85%
5	278	6.28%
4	229	5.17%
8	84	1.90%
10	63	1.42%
6	60	1.36%
20	54	1.22%
3	47	1.06%
2	35	0.79%
7	24	0.54%
9	17	0.38%
25	1	0.02%
Grand Total	*4426*	*100%*

DAVEY

Wake Forest, NC

Quantity Report: Location Type

Location Type	*Total*	*Percentage of Entire Population*
Street	4410	99.64%
Borderline	16	0.36%
Grand Total	*4426*	*100%*

DAVEY

Wake Forest, NC

Quantity Report: Grow Space

Grow Space	*Total*	*Percentage of Entire Population*
Open/Unrestricted	3534	79.85%
Treelawn	797	18.01%
Median	54	1.22%
Well/Pit	20	0.45%
Island	18	0.41%
Planter	3	0.07%
Grand Total	*4426*	*100%*

DAVEY

Wake Forest, NC

Quantity Report: Further Inspection

Further Inspection	*Total*	*Percentage of Entire Population*
No	3840	96.90%
Yes	123	3.10%
Grand Total	*3963*	*100%*

DAVEY

Wake Forest, NC

Quantity Report: Clearance

Clearance	*Total*	*Percentage of Entire Population*
None	3427	86.47%
Vehicle	379	9.56%
Pedestrian	138	3.48%
Sign	9	0.23%
Light	6	0.15%
Traffic Signal	4	0.10%
Grand Total	*3963*	*100%*

Appendix F
Hardscape Damage and Utilities Frequency Reports

DAVEY

Wake Forest, NC

Quantity Report: Hardscape Damage

Hardscape Damage	*Total*	*Percentage of Entire Population*
None	3933	99.24%
Hscape Present	30	0.76%
Grand Total	*3963*	*100%*

DAVEY

Wake Forest, NC

Quantity Report: Utilities

Utilities	*Total*	*Percentage of Entire Population*
No	3363	75.98%
Yes	1063	24.02%
Grand Total	*4426*	*100%*

Appendix G
Miscellaneous Reports

DAVEY

Wake Forest, NC

Quantity Report: Observations

Observations	*Total*	*Percentage of Entire Population*
No Observations	3710	83.82%
Cavity/Decay	253	5.72%
Mechanical Damage	163	3.68%
Remove Hardware	121	2.73%
Poor Structure	80	1.81%
Poor Location	34	0.77%
Serious Decline	25	0.56%
Poor Root System	21	0.47%
Pest Problem	19	0.43%
Grand Total	*4426*	*100%*

Street	Total	Percentage of Entire Population
N MAIN ST	233	5.26%
S MAIN ST	212	4.79%
S ALLEN RD	102	2.30%
HIGHGATE CIR	89	2.01%
DURHAM RD	89	2.01%
TILLAMOOK DR	85	1.92%
N WINGATE ST	66	1.49%
E HOLDING AVE	65	1.47%
DEACON RIDGE ST	65	1.47%
S WHITE ST	64	1.45%
N COLLEGE ST	61	1.38%
SIENA DR	60	1.36%
STEEPLE RUN DR	58	1.31%
FLAHERTY AVE	55	1.24%
WALLRIDGE DR	53	1.20%
LAKEVIEW AVE	52	1.17%
BARNFORD MILL RD	51	1.15%
MOULTONBORO DR	50	1.13%
ROCKVILLE RD	47	1.06%
W SYCAMORE AVE	45	1.02%
N TAYLOR ST	45	1.02%
CORAM FIELDS RD	44	0.99%
BROOKS ST	44	0.99%
WAIT AVE	43	0.97%
AMARYLLIS WY	43	0.97%
STONE MONUMENT DR	41	0.93%
ROSE PETAL RUN	41	0.93%
LEDGEROCK RD	38	0.86%
GROVETON TRL	38	0.86%
AMHERST CREEK DR	38	0.86%
ROOKWOOD CT	37	0.84%
E JUNIPER AVE	37	0.84%
W NORTH AVE	35	0.79%
SPRING VALLEY RD	35	0.79%
S WINGATE ST	35	0.79%

Street	Total	Percentage of Entire Population
S FRANKLIN ST	35	0.79%
MIDDLE BRIDGE RD	35	0.79%
LONGBOURN DR	34	0.77%
FINDHORN LN	34	0.77%
E WALNUT AVE	34	0.77%
CIMARRON PKWY	34	0.77%
WHITE CARRIAGE DR	33	0.75%
W PINE AVE	33	0.75%
SELSEY DR	32	0.72%
HIGHLAND DR	32	0.72%
FORESTVILLE RD	31	0.70%
E PINE AVE	31	0.70%
YELLOW POPLAR AVE	30	0.68%
N ALLEN RD	30	0.68%
ALBERBURY COMMONS CT	30	0.68%
SUGAR MAPLE AVE	29	0.66%
E JONES AVE	29	0.66%
WINDSOR DR	28	0.63%
ST CATHERINES DR	28	0.63%
WOODLAND DR	27	0.61%
E NELSON AVE	27	0.61%
WATCH HILL LN	26	0.59%
HARRIS POINT WY	24	0.54%
WHEDDONCROSS WY	23	0.52%
WATCHET PL	23	0.52%
W HOLDING AVE	23	0.52%
TORRY HILL CT	23	0.52%
KINVARA CT	23	0.52%
NAXOS DR	22	0.50%
ELM AVE	22	0.50%
ELIZABETH AVE	22	0.50%
CARROLL ST	22	0.50%
BRICK ST	22	0.50%
SPRING PARK RD	21	0.47%
SPRING AVE	21	0.47%
RAYBURN AVE	21	0.47%
JUBILEE CT	21	0.47%
BREWERS GLYNN CT	21	0.47%

Street	Total	Percentage of Entire Population
BREWER AVE	21	0.47%
SHIRETOWN LN	20	0.45%
LILLIPUT LN	20	0.45%
WHISTLING SWAN DR	19	0.43%
FAITHFUL PL	19	0.43%
E CEDAR AVE	19	0.43%
CALADIUM DR	19	0.43%
W JUNIPER AVE	18	0.41%
VENTURA WOODS CT	18	0.41%
SILVER LINDEN LN	18	0.41%
ROBINSON DR	18	0.41%
FRIENDSHIP CHAPEL RD	18	0.41%
CEDAR BRANCH CT	18	0.41%
ABERCROMBIE RD	18	0.41%
FARM RIDGE RD	17	0.38%
BAKEWELL CT	17	0.38%
MIRACLE DR	16	0.36%
MELKSHAM RD	16	0.36%
BORAGE DR	16	0.36%
AMERSHAM LN	16	0.36%
W CHESTNUT AVE	15	0.34%
W AVE	15	0.34%
SHAPINSAY AVE	15	0.34%
HILLSWICK PL	15	0.34%
DUNN CREEK CRSG	15	0.34%
RODNEY BAY CRSG	14	0.32%
E VERNON AVE	14	0.32%
E PERRY AVE	14	0.32%
WAKE DR	13	0.29%
W CEDAR AVE	13	0.29%
SINEWELL DR	13	0.29%
SEVENTH ST	13	0.29%
PEARCE AVE	13	0.29%
OLD MAGNOLIA LN	13	0.29%
N FRANKLIN ST	13	0.29%
LIGON MILL RD	13	0.29%
JAFFILEY CT	13	0.29%
SARRATT RIDGE CT	12	0.27%

Street	Total	Percentage of Entire Population
PINE RIDGE CT	12	0.27%
NEWQUAY LN	12	0.27%
MONTVILLE CT	12	0.27%
BREWER CIR	12	0.27%
W VERNON AVE	11	0.25%
LEDYARD CT	11	0.25%
FARM RD	11	0.25%
BERINGER FOREST CT	11	0.25%
STABLE POINT CIR	10	0.23%
PINEVIEW DR	10	0.23%
MONDAVI WOODS CT	10	0.23%
MOCKINGBIRD LN	10	0.23%
MARJORAM CT	10	0.23%
EDGEFORD PARK LN	10	0.23%
ECOLA VALLEY CT	10	0.23%
AGNEW CT	10	0.23%
WINTER BLOOM CT	9	0.20%
OLD ASH CT	9	0.20%
LOTUS LN	9	0.20%
FOREST RD	9	0.20%
E OWEN AVE	9	0.20%
BUGGY RUN CIR	9	0.20%
VAIL SPRINGS CT	8	0.18%
TENBURY WOODS CT	8	0.18%
N WHITE ST	8	0.18%
MIRAMIR WOODS CT	8	0.18%
JULIE ANN CT	8	0.18%
FINCHURCH CIR	8	0.18%
CARMEL WOODS CT	8	0.18%
CAMERON DR	8	0.18%
BACARDI CT	8	0.18%
STADIUM DR	7	0.16%
SOLUNAR CT	7	0.16%
LITTLEHAMPTON CT	7	0.16%
LAMBTON AVE	7	0.16%
E SOUTH AVE	7	0.16%
DURKYN PL	7	0.16%
DEER HOLLOW CT	7	0.16%

Street	Total	Percentage of Entire Population
DAGMAR LN	7	0.16%
CROOKHAM CT	7	0.16%
BELMELLEN CT	7	0.16%
WOODS MILL CIR	6	0.14%
W OWEN AVE	6	0.14%
VENTURA SPRINGS CT	6	0.14%
S COLLEGE ST	6	0.14%
PURISIMA CT	6	0.14%
OXWICH CT	6	0.14%
LOCKMABEN ST	6	0.14%
HAVISHAM CT	6	0.14%
E SYCAMORE AVE	6	0.14%
E OAK AVE	6	0.14%
ANGEL STAR LN	6	0.14%
W OAK AVE	5	0.11%
TULIP GROVE LN	5	0.11%
SOVEREIGN WY	5	0.11%
REMINGTON WOODS DR	5	0.11%
PINE AVE	5	0.11%
HYSOP LN	5	0.11%
EVESHAM CT	5	0.11%
E ROOSEVELT AVE	5	0.11%
CROWDER AVE	5	0.11%
TYLER RUN DR	4	0.09%
TILGATE CT	4	0.09%
ROBIN AVE	4	0.09%
OLD BAILEY CT	4	0.09%
E CHESTNUT AVE	4	0.09%
DUGWAY CT	4	0.09%
CATRUSH WY	4	0.09%
CARRIAGE MEADOWS DR	4	0.09%
CARDINAL CREST LN	4	0.09%
BUGGY WHIP CT	4	0.09%
TESSIER CT	3	0.07%
SIXTH ST	3	0.07%
SHROPSHIRE CT	3	0.07%
NUTHATCH CT	3	0.07%
MILL ST	3	0.07%

Street	Total	Percentage of Entire Population
JOYNER CT	3	0.07%
GRACECHURCH ST	3	0.07%
FOXBRIDGE CT	3	0.07%
E NORTH AVE	3	0.07%
CUL-DE-SAC	3	0.07%
BLACK SWAN WY	3	0.07%
ANGEL FALLS RD	3	0.07%
TACY PL	2	0.05%
STONINGHAM PL	2	0.05%
STIRRUP CT	2	0.05%
ROWSBY CT	2	0.05%
GUINNESS PL	2	0.05%
FLICKER CT	2	0.05%
FAIRBURN CT	2	0.05%
DEACONS BEND CT	2	0.05%
COMPHREY CT	2	0.05%
ANDREW CT	2	0.05%
WATER AVE	1	0.02%
WAHLBRINK DR	1	0.02%
W WALNUT AVE	1	0.02%
W DURNESS CT	1	0.02%
SHANNONFORD CT	1	0.02%
QUAIL AVE	1	0.02%
HILL ST	1	0.02%
HAYWICKE PL	1	0.02%
FRONT ST	1	0.02%
E DURNESS CT	1	0.02%
E DUNPATRICK PL	1	0.02%
DANIEL CT	1	0.02%
Grand Total	*4426*	*100%*

On_Street	Total	Percentage of Entire Population
N MAIN ST	212	4.79%
S MAIN ST	113	2.55%
CIMARRON PKWY	104	2.35%
S ALLEN RD	103	2.33%
DURHAM RD	88	1.99%
E HOLDING AVE	84	1.90%
TILLAMOOK DR	79	1.78%
BARNFORD MILL RD	79	1.78%
HIGHGATE CIR	76	1.72%
SIENA DR	73	1.65%
DEACON RIDGE ST	73	1.65%
N COLLEGE ST	72	1.63%
S WHITE ST	70	1.58%
N TAYLOR ST	61	1.38%
STEEPLE RUN DR	59	1.33%
WALLRIDGE DR	54	1.22%
N WINGATE ST	52	1.17%
W SYCAMORE AVE	50	1.13%
ROCKVILLE RD	47	1.06%
MOULTONBORO DR	47	1.06%
S WINGATE ST	46	1.04%
LEDGEROCK RD	46	1.04%
LAKEVIEW AVE	46	1.04%
FLAHERTY AVE	45	1.02%
BROOKS ST	45	1.02%
AMARYLLIS WY	42	0.95%
LONGBOURN DR	41	0.93%
N FRANKLIN ST	40	0.90%
AMHERST CREEK DR	40	0.90%
W PINE AVE	39	0.88%
SPRING VALLEY RD	38	0.86%
SELSEY DR	38	0.86%
S FRANKLIN ST	38	0.86%
CORAM FIELDS RD	38	0.86%
WAIT AVE	37	0.84%

On_Street	Total	Percentage of Entire Population
E JUNIPER AVE	37	0.84%
ROSE PETAL RUN	36	0.81%
CARROLL ST	36	0.81%
WINDSOR DR	35	0.79%
E JONES AVE	35	0.79%
FORESTVILLE RD	33	0.75%
WHITE CARRIAGE DR	32	0.72%
W CEDAR AVE	32	0.72%
SPRING PARK RD	32	0.72%
W NORTH AVE	31	0.70%
STONE MONUMENT DR	31	0.70%
E WALNUT AVE	31	0.70%
E PINE AVE	31	0.70%
HIGHLAND DR	30	0.68%
W HOLDING AVE	29	0.66%
MIDDLE BRIDGE RD	29	0.66%
MELKSHAM RD	29	0.66%
WOODLAND DR	28	0.63%
FINDHORN LN	28	0.63%
WHISTLING SWAN DR	27	0.61%
ROOKWOOD CT	27	0.61%
FAITHFUL PL	27	0.61%
YELLOW POPLAR AVE	26	0.59%
ST CATHERINES DR	26	0.59%
GROVETON TRL	26	0.59%
ALBERBURY COMMONS CT	25	0.56%
N ALLEN RD	24	0.54%
LILLIPUT LN	24	0.54%
HARRIS POINT WY	24	0.54%
PEARCE AVE	23	0.52%
KINVARA CT	23	0.52%
SILVER LINDEN LN	22	0.50%
FRIENDSHIP CHAPEL RD	22	0.50%
WHEDDONCROSS WY	21	0.47%
NAXOS DR	21	0.47%
SUGAR MAPLE AVE	20	0.45%
JUBILEE CT	20	0.45%
E PERRY AVE	20	0.45%

On_Street	Total	Percentage of Entire Population
WATCHET PL	19	0.43%
W VERNON AVE	19	0.43%
W JUNIPER AVE	19	0.43%
CALADIUM DR	19	0.43%
BREWER AVE	19	0.43%
ROBINSON DR	18	0.41%
FARM RD	18	0.41%
E NELSON AVE	18	0.41%
E CEDAR AVE	18	0.41%
BORAGE DR	18	0.41%
SPRING AVE	17	0.38%
SEVENTH ST	17	0.38%
RAYBURN AVE	17	0.38%
E VERNON AVE	17	0.38%
TORRY HILL CT	16	0.36%
SINEWELL DR	16	0.36%
ELM AVE	16	0.36%
CEDAR BRANCH CT	16	0.36%
BRICK ST	16	0.36%
BAKEWELL CT	16	0.36%
ABERCROMBIE RD	16	0.36%
WATCH HILL LN	15	0.34%
W AVE	15	0.34%
MIRACLE DR	15	0.34%
LOTUS LN	15	0.34%
FOREST RD	15	0.34%
E OAK AVE	14	0.32%
DUNN CREEK CRSG	14	0.32%
BREWER CIR	14	0.32%
WAKE DR	13	0.29%
W CHESTNUT AVE	13	0.29%
PINE RIDGE CT	13	0.29%
OLD MAGNOLIA LN	13	0.29%
SHIRETOWN LN	12	0.27%
SHAPINSAY AVE	12	0.27%
FARM RIDGE RD	12	0.27%
ELIZABETH AVE	12	0.27%
AMERSHAM LN	12	0.27%

On_Street	Total	Percentage of Entire Population
S COLLEGE ST	11	0.25%
RODNEY BAY CRSG	11	0.25%
E SYCAMORE AVE	11	0.25%
STABLE POINT CIR	10	0.23%
PINE AVE	10	0.23%
NEWQUAY LN	10	0.23%
MONTVILLE CT	10	0.23%
BREWERS GLYNN CT	10	0.23%
AGNEW CT	10	0.23%
TACY PL	9	0.20%
MOCKINGBIRD LN	9	0.20%
LEDYARD CT	9	0.20%
JAFFILEY CT	9	0.20%
DAGMAR LN	9	0.20%
BUGGY RUN CIR	9	0.20%
WOODS MILL CIR	8	0.18%
WINTER BLOOM CT	8	0.18%
VENTURA WOODS CT	8	0.18%
TULIP GROVE LN	8	0.18%
OLD ASH CT	8	0.18%
MIRAMIR WOODS CT	8	0.18%
MARJORAM CT	8	0.18%
HYSOP LN	8	0.18%
FINCHURCH CIR	8	0.18%
E OWEN AVE	8	0.18%
CROOKHAM CT	8	0.18%
CAMERON DR	8	0.18%
BERINGER FOREST CT	8	0.18%
W OWEN AVE	7	0.16%
W OAK AVE	7	0.16%
SIXTH ST	7	0.16%
EDGEFORD PARK LN	7	0.16%
DEER HOLLOW CT	7	0.16%
CROWDER AVE	7	0.16%
CARDINAL DR	7	0.16%
W WALNUT AVE	6	0.14%
SARRATT RIDGE CT	6	0.14%
PURISIMA CT	6	0.14%

On_Street	Total	Percentage of Entire Population
MONDAVI WOODS CT	6	0.14%
MILL ST	6	0.14%
LAMBTON AVE	6	0.14%
HAVISHAM CT	6	0.14%
FOREST LYNKS DR	6	0.14%
ECOLA VALLEY CT	6	0.14%
E CHESTNUT AVE	6	0.14%
TENBURY WOODS CT	5	0.11%
SOLUNAR CT	5	0.11%
REMINGTON WOODS DR	5	0.11%
PINEVIEW DR	5	0.11%
N BROOKS ST	5	0.11%
LOCKMABEN ST	5	0.11%
HILLSWICK PL	5	0.11%
HILL ST	5	0.11%
FLICKER CT	5	0.11%
EVESHAM CT	5	0.11%
DURKYN PL	5	0.11%
DUGWAY CT	5	0.11%
CATRUSH WY	5	0.11%
BRIMFIELD SPRINGS LN	5	0.11%
ANGEL STAR LN	5	0.11%
VENTURA SPRINGS CT	4	0.09%
TESSIER CT	4	0.09%
TEMPLERIDGE RD	4	0.09%
OXWICH CT	4	0.09%
LITTLEHAMPTON CT	4	0.09%
LIGON MILL RD	4	0.09%
JULIE ANN CT	4	0.09%
E SOUTH AVE	4	0.09%
E ROOSEVELT AVE	4	0.09%
CARRIAGE MEADOWS DR	4	0.09%
CARDINAL CREST LN	4	0.09%
BUGGY WHIP CT	4	0.09%
BACARDI CT	4	0.09%
ANDREW CT	4	0.09%
VAIL SPRINGS CT	3	0.07%
TILGATE CT	3	0.07%

On_Street	Total	Percentage of Entire Population
STONINGHAM PL	3	0.07%
ROBIN AVE	3	0.07%
NUTHATCH CT	3	0.07%
JOYNER CT	3	0.07%
COMPHREY CT	3	0.07%
BELMELLEN CT	3	0.07%
ANGEL FALLS RD	3	0.07%
WATER AVE	2	0.05%
WAHLBRINK DR	2	0.05%
TYLER RUN DR	2	0.05%
STIRRUP CT	2	0.05%
SOVEREIGN WY	2	0.05%
SHROPSHIRE CT	2	0.05%
N WHITE ST	2	0.05%
HAYWICKE PL	2	0.05%
GUINNESS PL	2	0.05%
GRACECHURCH ST	2	0.05%
FRONT ST	2	0.05%
FOXBRIDGE CT	2	0.05%
FAIRBURN CT	2	0.05%
E DUNPATRICK PL	2	0.05%
DUNN AVE	2	0.05%
BLACK SWAN WY	2	0.05%
W DURNESS CT	1	0.02%
VENFLOR CT	1	0.02%
SPARROW DR	1	0.02%
SHANNONFORD CT	1	0.02%
ROWSBY CT	1	0.02%
QUAIL AVE	1	0.02%
OLD BAILEY CT	1	0.02%
LIBERTY ST	1	0.02%
LEE ST	1	0.02%
KULLANA LN	1	0.02%
E DURNESS CT	1	0.02%
DEACONS BEND CT	1	0.02%
DANIEL CT	1	0.02%
CARMEL WOODS CT	1	0.02%
Grand Total	*4426*	*100%*

DAVEY

Wake Forest, NC

Quantity Report: Trunks

Trunks	*Total*	*Percentage of Entire Population*
1	3381	85.31%
2	211	5.32%
3	144	3.63%
4	66	1.67%
9	59	1.49%
5	41	1.03%
6	29	0.73%
7	20	0.50%
8	11	0.28%
12	1	0.03%
Grand Total	*3963*	*100%*

Appendix H
Suggested Tree Species

Suggested Tree Species

Proper landscaping and tree planting are critical components of the atmosphere, livability, and ecological quality of a community's urban forest. The tree species listed below have been evaluated for factors such as size, disease and pest resistance, seed or fruit set, and availability. The following list is offered to assist all relevant community personnel in selecting appropriate tree species. These trees have been selected because of their aesthetic and functional characteristics and their ability to thrive in the majority of soil and climate conditions found throughout the Eastern United States.

Deciduous Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer rubrum	Red Maple	Red Sunset®
Acer saccharum	Sugar Maple	'Legacy'
*Aesculus flava**	Yellow Buckeye	
Betula nigra	River Birch	Heritage®
Carpinus betulus	European Hornbeam	'Franz Fontaine'
*Castanea mollissima**	Chinese Chestnut	
Celtis occidentalis	Common Hackberry	'Prairie Pride'
Cercidiphyllum japonicum	Katsuratree	'Aureum'
*Diospyros virginiana**	Common Persimmon	
*Fagus grandifolia**	American Beech	
Fagus sylvatica	European Beech	(Numerous exist)
Fraxinus americana	White Ash	Autumn Purple®
Fraxinus pennsylvanica	Green Ash	Cimmaron®
*Fraxinus quadrangulata**	Blue Ash	'True Blue'
Ginkgo biloba	Ginkgo	(Choose male trees only)
Gleditsia triacanthos inermis	Thornless Honeylocust	'Shademaster'
Gymnocladus dioicus	Kentucky Coffeetree	Prairie Titan®
*Juglans regia**	English Walnut	'Hansen'
*Larix decidua**	European Larch	
Liquidambar styraciflua	American Sweetgum	Cherokee™
Liriodendron tulipifera	Tulip Tree	'Fastigiatum'
*Magnolia acuminata**	Cucumbertree Magnolia	(Numerous exist)
*Magnolia macrophylla**	Bigleaf Magnolia	
Metasequoia glyptostroboides	Dawn Redwood	'Emerald Feathers'
Nyssa sylvatica	Black Tupelo	
Platanus x *acerifolia*	London Planetree	'Yarwood'
*Platanus occidentalis**	American Sycamore	
Quercus alba	White Oak	
Quercus bicolor	Swamp White Oak	
Quercus coccinea	Scarlet Oak	

Large Trees: Greater than 45 Feet in Height at Maturity (Continued)

Scientific Name	Common Name	Cultivar
Quercus ellipsoidalis	Northern Pin Oak	
Quercus frainetto	Hungarian Oak	
Quercus imbricaria	Shingle Oak	
Quercus lyrata	Overcup Oak	
Quercus macrocarpa	Bur Oak	
Quercus muehlenbergii	Chinkapin Oak	
Quercus phellos	Willow Oak	
Quercus prinus	Chestnut Oak	
Quercus robur	English Oak	Heritage®
Quercus rubra	Northern Red Oak	'Splendens'
Quercus shumardii	Shumard Oak	
Styphnolobium japonicum	Japanese Pagodatree	'Regent'
Taxodium distichum	Common Baldcypress	'Shawnee Brave'
Tilia americana	American Linden	'Redmond'
Tilia cordata	Littleleaf Linden	'Greenspire'
Tilia tomentosa	Silver Linden	'Sterling'
Ulmus parvifolia	Lacebark Elm	Allée®
Zelkova serrata	Japanese Zelkova	'Green Vase'

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Aesculus x *carnea*	Red Horsechestnut	
*Alnus glutinosa**	Common Alder	'Pyramidalis'
Cladrastis lutea	American Yellowwood	'Rosea'
Eucommia ulmoides	Hardy Rubber Tree	
Koelreuteria paniculata	Goldenraintree	
Ostrya virginiana	American Hophornbeam	
Parrotia persica	Persian Parrotia	'Vanessa'
Phellodendron amurense	Amur Corktree	'Macho'
Prunus maackii	Amur Chokecherry	'Amber Beauty'
Prunus sargentii	Sargent Cherry	
Pyrus calleryana	Callery Pear	'Earlyred'
Quercus acutissima	Sawtooth Oak	
Quercus cerris	Turkey Oak	
Sorbus alnifolia	Korean Mountainash	'Redbird'

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer buergerianum	Trident Maple	Streetwise®
Acer campestre	Hedge Maple	Queen Elizabeth™
Acer cappadocicum	Coliseum Maple	'Aureum'
Acer ginnala	Amur Maple	Red Rhapsody™
Acer griseum	Paperbark Maple	
Acer nigrum	Black Maple	
*Acer pensylvanicum**	Striped Maple	
*Aesculus pavia**	Red Buckeye	
Amelanchier arborea	Downy Serviceberry	(Numerous exist)
Amelanchier laevis	Allegheny Serviceberry	
Carpinus caroliniana	American Hornbeam	
Cercis canadensis	Eastern Redbud	'Forest Pansy'
Chionanthus virginicus	White Fringetree	
Cornus kousa	Kousa Dogwood	(Numerous exist)
Cornus mas	Corneliancherry Dogwood	'Spring Sun'
Corylus avellana	European Filbert	'Contorta'
*Cotinus coggygria**	Common Smoketree	'Flame'
*Cotinus obovata**	American Smoketree	
Crataegus phaenopyrum	Washington Hawthorn	Princeton Sentry™
Crataegus viridis	Green Hawthorn	'Winter King'
*Franklinia alatamaha**	Franklinia	
Halesia tetraptera	Carolina Silverbell	'Arnold Pink'
Magnolia x *soulangiana**	Saucer Magnolia	'Alexandrina'
*Magnolia stellata**	Star Magnolia	'Centennial'
*Magnolia tripetala**	Umbrella Magnolia	
*Magnolia virginiana**	Sweetbay Magnolia	Moonglow®
Malus spp.	Flowering Crabapple	(Disease resistant only)
Oxydendrum arboreum	Sourwood	'Mt. Charm'
Prunus subhirtella pendula	Weeping Higan Cherry	
Prunus virginiana	Common Chokecherry	'Schubert'
Styrax japonicus	Japanese Snowbell	'Emerald Pagoda'
Syringa reticulata	Japanese Tree Lilac	'Ivory Silk'

Note: * denotes species not recommended for use as street trees.

Coniferous and Evergreen Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Abies balsamea	Balsam Fir	
Abies concolor	White Fir	'Violacea'
Chamaecyparis nootkatensis	Nootka Falsecypress	'Pendula'
Cryptomeria japonica	Japanese Cryptomeria	'Sekkan-sugi'
*Ilex opaca**	American Holly	
Picea omorika	Serbian Spruce	
Picea orientalis	Oriental Spruce	
Pinus densiflora	Japanese Red Pine	
Pinus strobus	Eastern White Pine	
Pinus sylvestris	Scotch Pine	
Psedotsuga menziesii	Douglasfir	
Thuja plicata	Western Arborvitae	(Numerous exist)
Tsuga canadensis	Eastern Hemlock	

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Chamaecyparis thyoides	Atlantic Whitecedar	(Numerous exist)
Juniperus virginiana	Eastern Redcedar	
Pinus bungeana	Lacebark Pine	
Pinus flexilis	Limber Pine	
Thuja occidentalis	Eastern Arborvitae	(Numerous exist)

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Ilex x *attenuata**	Foster's Holly	
Pinus aristata	Bristlecone Pine	
Pinus mugo mugo	Mugo Pine	

Note: * denotes species recommended for use as street trees.

This suggested species list was compiled through the use of the excellent references *Dirr's Hardy Trees and Shrubs* (Dirr, 2003) and *Manual of Woody Landscape Plants (5th Edition)* (Dirr, 1998). Cultivar selections are only recommendations and are based on Davey Resource Group's experience and tree availability in the nursery trade.

Appendix I
Davey® Planting Guidelines

Planting Guidelines

The following guidelines to tree planting will help reduce transplanting shock and ensure that trees adapt to the new site. Keep in mind that spring and fall are the best times of the year to plant trees, but some trees do better when transplanted in spring rather than fall, and vice versa. Check with your nursery when planning tree-planting operations.

Site Conditions

A frequent cause of new tree failure is poor acclimation to site conditions. This includes not only the planting site, but also the climate conditions at the nursery and the similarity in the new tree location. For example, a tree raised in a nursery farther south than the planting site may have more difficulty in adapting than a tree grown in more similar climate conditions. Furthermore, the soil conditions of the site (pH, moisture, oxygen and nutrient availability) should be sufficient to meet the specific requirements of the tree. It is more cost-effective to choose the right tree for a site than to modify the site after the tree has been planted or to have high maintenance costs because a poorly established tree is unhealthy.

Tree Selection

In addition to selecting trees that are tolerant of existing site conditions, select trees that show normal growth and are free of serious insect and disease problems. The trees should exhibit good vitality, appearing undamaged with a healthy root mass. Trees should have good leaf color, annual twig growth and bud appearance. Careful nursery selection is essential.

Single-stemmed trees should not have the appearance of clumped foliage arising from the same point on the stem. Such a condition, while providing an initial tree form, will ultimately cause branching problems such as weak crotches and should be avoided. Trees with good potential for lower maintenance when mature will have a scaffold or ladder appearance with branch angles greater than forty-five degrees. Some trees have this form naturally while others need to be pruned when young to encourage such form.

Stock Type

Trees are delivered from the nursery in one of three states of preparation: balled-and-burlapped trees, with soil surrounding the root system; bare-root trees, without soil; and containerized trees, generally grown in the container in which they are delivered.

Bare-root is the least expensive and allows roots to be in contact with the native soil. However, care must be taken to keep the roots protected and moist before planting, as the fine roots can dry rapidly.

Balled-and-burlapped tree roots are slower to dry out than bare-root trees, as the roots are inside a soil ball. However, the burlap may cover dead or poorly pruned roots and should be inspected before planting. The type of soil surrounding the roots should not be too different from the soil on the site or the tree roots may not extend sufficiently into the surrounding soil from the root ball. In such a case, the backfill soil should be amended to provide a transition between the two types of soil.

Container-grown trees have an undisturbed root system and can be planted with the intact root system. If the tree has been in the container for too long, however, the tree may be pot-bound with the roots encircling the inside perimeter of the pot. The roots should be sliced or partially separated in order to improve the ability of the tree to extend the roots into the surrounding soil.

Tree Planting

The tree should be planted to the same depth or slightly higher than it was growing at the nursery. A high mound should be avoided as the soil can dry out quickly in the summer and freeze in the winter.

The hole should be dug shallow and wide. It should not be any deeper than the root ball but should be a wide hole, allowing for amendments, if necessary, or for loosening heavy clay soil to allow for improved oxygen availability and root penetration.

The backfill soil should be added gradually and watered carefully to settle the soil but not to saturate it. Balled-and-burlapped trees should have any untreated burlap pulled away from the top of the root ball and cut away—not buried—so that none of the burlap is exposed at the soil surface. Otherwise, the burlap can wick moisture away from the roots of the freshly planted tree.

Tree Staking

Stakes should only be used to support trees on windy sites or for smaller trees with weak trunks. The stakes should be placed before the backfill is added to avoid damaging any large roots. A stake is meant to provide a temporary support and should be removed within a year to allow the tree to develop trunk strength and to limit the potential for physical damage from the stakes and the support ties.

Wooden stakes, metal pipe, fence stakes and metal reinforcing bars may all be used for support. Anything used for a tie should have a flat, smooth surface and be somewhat elastic to allow for slight movement for the tree. Suitable materials include rubber strips or webbing and belting. Wire covered with hose or tubing **should not** be used.

Tree Irrigation

Because a newly transplanted tree may have lost much of its root system, watering is critical for successful establishment. Initial watering at planting should be followed with weekly watering, particularly during dry periods. A newly planted tree will benefit from at least an inch of water a week.

Mulching

Newly planted trees respond well to mulch placed around the tree. This reduces initial root competition with turf and limits the possibility of physical damage by mowers. These factors contribute to the health of the trees and increase the likelihood of survival.

The mulch should **not** be piled (mulch 'volcanoes') around the tree and should not actually touch the tree trunk. No more than a 2-3 inch depth of mulch should be added, with it being no more than ½ inch deep closest to the tree.

Pruning

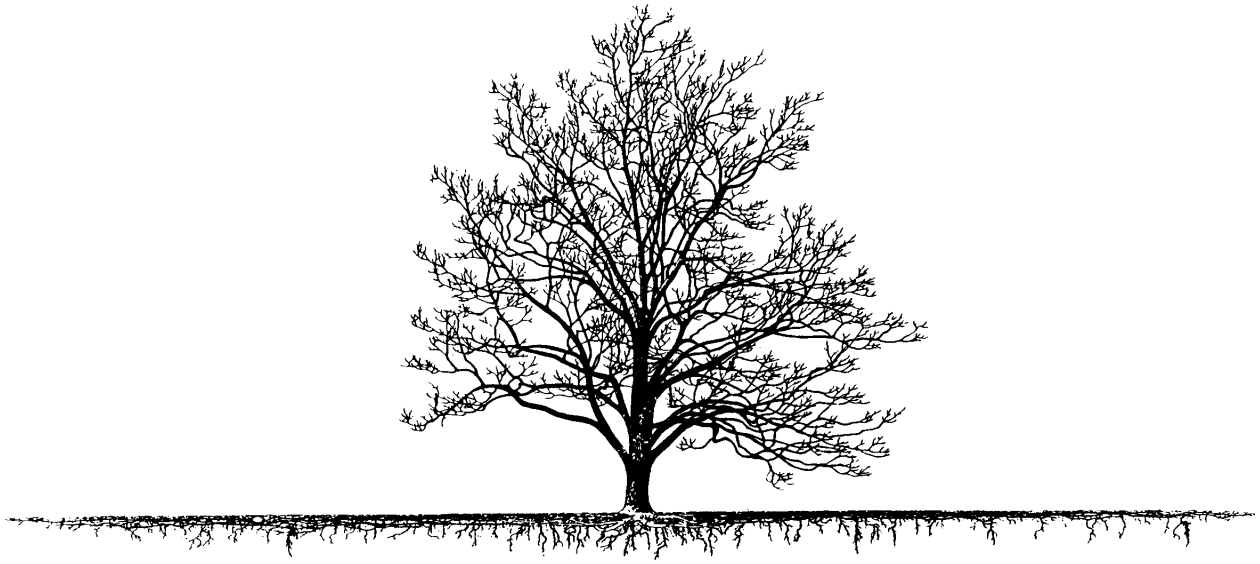
When planting a tree, only dead or broken branches should be removed. All living branches should be left on the tree to help promote tree establishment. Once the tree has been established on the site, training pruning can be done to promote good branching patterns, but no more than 1/4 of the branches should be removed at any one time.

Fertilizing

Fertilizer is not generally necessary at the time of planting and, indeed, if placed improperly in the planting hole can injure roots. The addition of nitrogen, in a slow-release form, however, can benefit a newly planted tree and it may be efficient to apply at the time of planting.

Appendix J
Davey® Pruning Guidelines

Tree Pruning Guidelines



DAVEY®

Introduction

Pruning consists of *selectively* removing branches (living and dead) from woody plants, ranging from pinching off a bud at the end of a twig to removing large limbs.

Proper pruning benefits trees, shrubs, and vines, and the associates of woody plants (including humans). Pruning branches can be one of the most beneficial or the most damaging practices arborists do to trees.

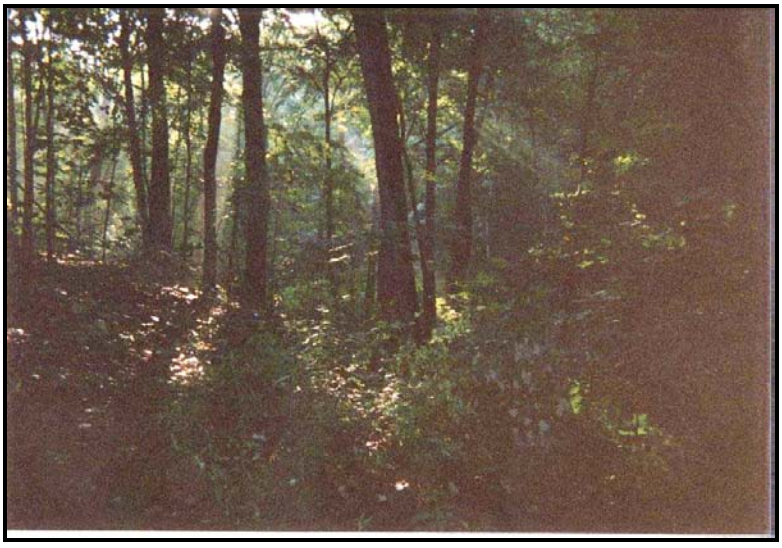
A basic principle of pruning is that the removal of any live stems, branches, twigs, and buds affects growth of the plant. Proper pruning prevents and corrects defective form that could result in branch or stem failure. Thus, knowledge of plant biology is essential for the correct methods of Davey pruning.

Most tree species evolved in competitive forest communities. Consequently, trees developed efficient branching systems to capture the energy of available light for photosynthesis.

Woody plants also evolved the ability to get rid of inefficient energy resources by *shedding* shaded branches (cladaptosis). A branch is naturally shed from its base. As natural shedding occurs, the wood tissue around the branch core within the stem protects against decay. Davey's limb removal cuts imitate natural branch shedding (natural target pruning).

Many people equate woody plant pruning to amputation, but there should be no fear of wise and careful use of pruning equipment. A properly pruned tree, shrub, or vine is a combination of art, science, and skill.

Davey Tree surgeons adhere to Davey and industry pruning standards. In the arboriculture industry, the current standard approved by the ISA and the NAA is *The American National Standards Institute* (ANSI) A300 issued in 1995. Davey Residential Operations adheres to the National Arborist Association (NAA) *Pruning Standards for Shade Trees* (revised 1988) where four classes of pruning are defined. The NAA classes appear in a condensed version on the back of the Davey Plant Health Care quote/work order forms printed before 1996.



Reasons for Pruning

The first rule in pruning is **do not cut without a reason**. Too often arborists tend to over prune to meet client expectations. Proper pruning is an effort to *direct* new growth rather than 'control' growth.

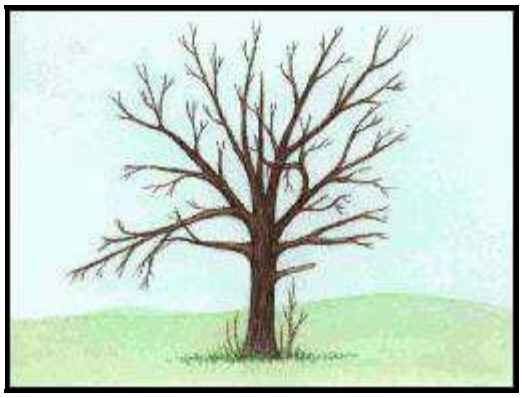
Most pruning cuts are of a *preventive* or a *corrective* nature to be beneficial to woody plant health.

Health

- *Sanitation* by removing dead, broken, decayed, diseased or insect-infested wood (crown cleaning).
- *Thinning* to improve penetration of light and air, and to reduce wind resistance and potential storm damage.
- Reduction of the number of poorly attached *epicormic branches.*
- *Girdling root* removal.
- Correct and/or redirect *structural growth* that may cause future problems (weak crotches, branches growing out of proportion, etc.).

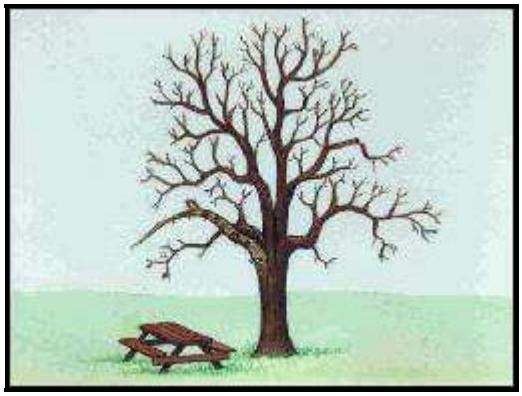
Appearance

- Shape for aesthetic purpose, natural forms, growth habit (training).
- Influence flowering, fruiting, promotion of shoots, canes, bark color.
- Direct new growth and/or correct improper prior pruning (crown restoration).



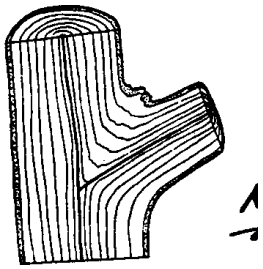
Convenience or Safety of Property and People

- Correct or modify storm-damaged, neglected, or poorly pruned woody plants.
- Identify and remove potential hazard limbs, stems and deadwood (hazard reduction pruning).
- Line clearance (directional pruning).
- Raise or lower obstructive canopies over or near roads, sidewalks, playgrounds, buildings, pools, satellite dishes, etc. by removing interfering limbs (crown reduction and/or crown raising).
- Provide access to more light for understory plants and turf (crown thinning).
- Vista pruning (alter crowns to allow views of something beyond tree screens).



Pruning Methods and Techniques

Branch Attachment to Stems



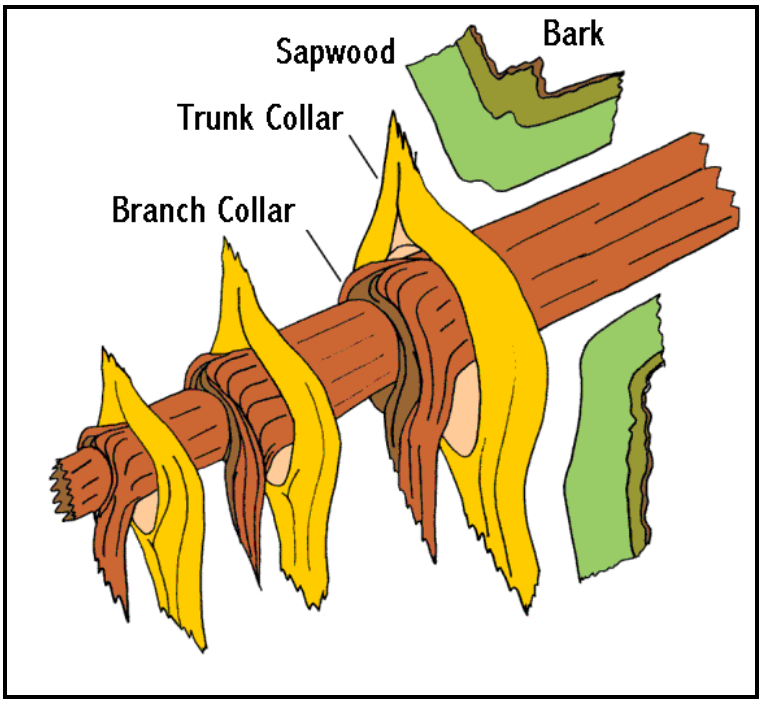
New branch tissues generated by the vascular cambium usually start growth before trunk tissues. As current-year branch tissue develops from branch ends toward the trunk, it turns abruptly downward at the branch base to form a *collar*.

Trunk branch tissues grow later and form a trunk collar over the branch collar (trunk collars and branch collars are collectively called the *branch collar*).

The collar is where wood and bark of the branch and the trunk come together, like an overlapping tissue 'switching zone'. All true branches on woody plants have branch collars.

The *branch bark ridge* (BBR) is raised bark developing in the branch crotch and shows the angle of the branch core in the tree.

If a branch dies or is removed, the trunk collar continues to grow over the thin belt of branch tissue below the collar junction. The wood core of the branch is walled off (compartmentalized) in the trunk.



Proper Pruning Cuts (Natural Target Pruning)

Location of *branch bark ridges* and *branch collars* determines the location of a pruning cut. Cuts must be made *outside* of the branch bark ridge, angling away from the trunk outward as close as possible to the collar.

- There is no set or standard angle for a proper collar cut.
- The proper angle depends on the shape of the collar.
- Conifers often have flat collars where a straight cut close to the collar is correct.
- Sometimes the angle of the cut will necessitate an *upstroke* cut with a handsaw or chainsaw.

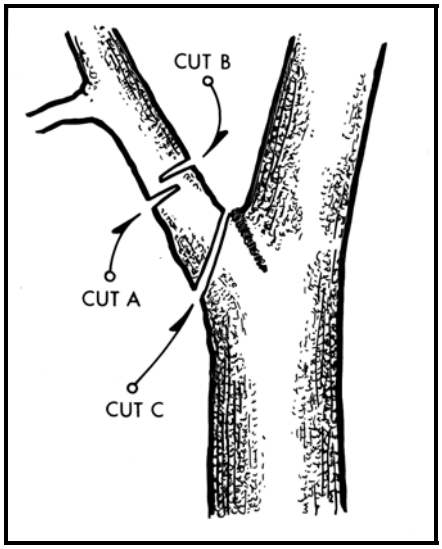
Do not cut into the collar to stimulate callus production and rapid closure. Although closure is desirable for appearance, such a cut promotes decay and future hazards. Never put a pruning tool behind the branch bark ridge.

Whether a branch collar is obvious or not, the position of the final or finish cut should:

- Minimize the branch stub that is an entryway for decay fungi.
- Retain the natural decay protection present in the branch core. The intact branch collar is the first line of defense in preventing decay within the trunk.
- Minimize the overall size of the pruning wound and direct damage to the stem.

Always **stub cut** the branch first. Limbs that cannot be controlled must be removed using at least **three** cuts. Roping of limbs may be necessary to prevent damage to other parts of the tree if they cannot be controlled by hand.

1. The first cut (Cut A) **undercuts** the limb one or two feet out from the parent branch or trunk. A properly made undercut will eliminate the chance of the branch 'peeling' or tearing bark as it is removed.
2. The second cut (Cut B) is the **top cut** which is usually made slightly further out on the limb than the undercut. This allows the limb to drop smoothly when the weight is released.
3. The third cut (Cut C) or **finish cut** is to remove the stub.



Each finish cut should be made carefully, outside of the branch bark ridge and the evident collar, leaving a smooth surface with no jagged edges or torn bark.

There are some situations where the cambium dies back beneath a branch collar after a correct cut:

- The trunk collar did not join the branch collar directly below the branch. Sunken spots under branches are a sign of this condition.
- Winter cuts may result in undercollar dieback.
- Problem tends to increase with size of branches removed.

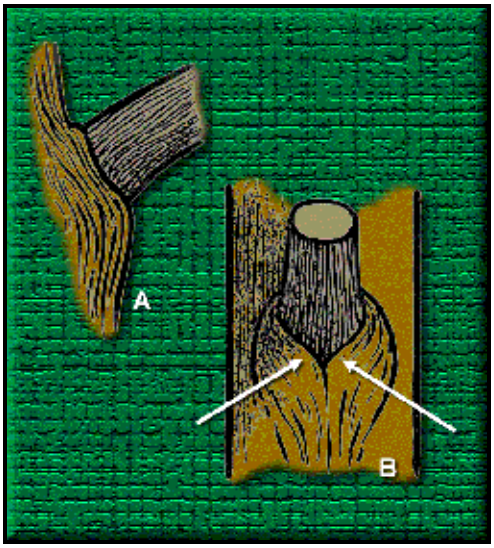
Callus and Woundwood

Callus is undifferentiated meristematic tissue that forms at wound margins from the cambium.

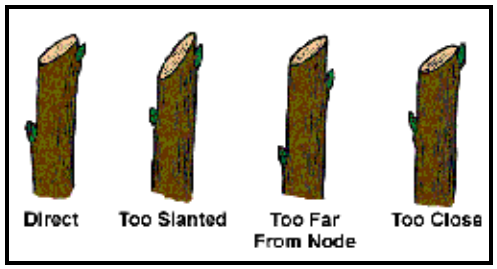
Callus differentiates into *woundwood* over time. Woundwood is 'new wood' and has the different cell components of periderm, cambium, phloem, and xylem.

A *complete* ring of callus and subsequent woundwood will develop around and eventually over proper cuts. Woundwood forms only to the sides of improper cuts (flush cuts), which means the collar and branch protection zone is damaged and the trunk is wounded.

A proper pruning cut results in a smaller wound area, and more rapid callus and woundwood movement over the wound. Cuts on dead limbs that have trunk collars moving up the dead branch wood must also be made just outside of the evident collar.



- Appropriate only for small woody plants or one to two-year old branches (twigs, branchlets) on trees.
- Cut back to a bud (lateral bud) or lateral branchlet, slanting at a 45° angle above the bud *node* on alternately arranged branches and stems.
- Two or more buds at a node (opposite, whorled) require a *transverse* cut just above the bud tips or a 45° angle cut removing one of the buds and leaving the other(s) to elongate in a desired direction.
- Cut 1/8" higher above the bud tips when pruning in cold weather to prevent winter injury to the bud (tissue around a winter cut is more vulnerable to desiccation).



- Leaving a majority of *inward* facing buds produces growth towards center.

- Leaving a majority of *outward* facing buds results in more open growth.

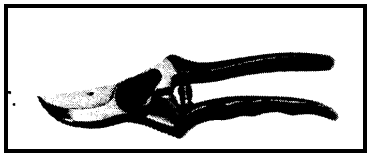
Pruning Tools

Use **well-sharpened** tools for both your safety and to help reduce tearing of wood and cambial tissues. Wear specified protective equipment .

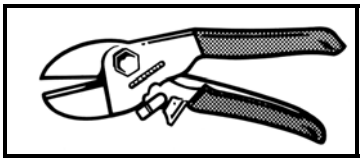
Pruning Shears

Hand shears, secateurs, hand pruners, one-hand shears:

- Remove branches, stems up to 1/2" diameter.
- By-pass (hook and blade, scissors, drop-forge, curve blade): make closer cuts than anvil-type.



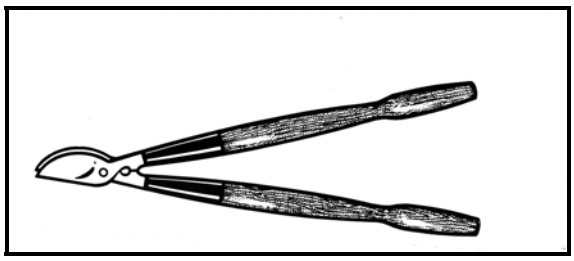
- Anvil (straight-blade): good for only soft-tissued wood, will crush harder wood (inappropriate per A300 standards).



Lopping shears

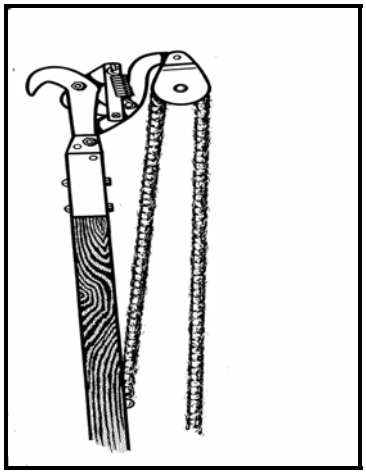
Two-hand shears:

- Remove branches, stems up to 1-3/4" diameter.
- Most useful in rejuvenation.
- By-pass, hook and blade, etc.
- Anvil, straight-blade.
- Ratcheting.



Pole Pruners

- Wood and insulated poles (round and squared).
- Cut like by-pass shears.
- Important to keep blade side in toward the cut.



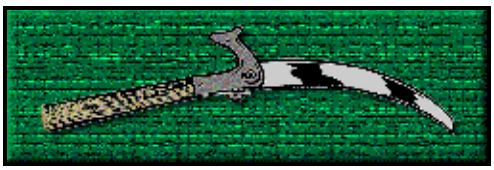
Cut at the outer side of the branch bark ridge at a slightly outward angle so as not to injure or remove the branch collar. Hook the pruner head around the limb to be cut with the blade side against the lateral branch or stem to remain. The arborist must be in a safe working position and the pruner handle positioned so the blade will not jam in the wood. You should not cut off a limb directly above yourself if there is any chance that it could fall and hit you.

Change your working position before completing the cut; place the hook so you have a straight pull on the rope and the lever arm can move far enough to complete the cut. An experienced tree surgeon can give a limb a flip with the side of the pruner head, just as the cut is completed, so that the limb will fall in the desired direction.

Saws

Pole saws:

- Hook cast onto pole-head.
- Wood poles (round and squared).
- Insulated poles (foam core).
- Difficult to make clean, accurate cuts.



Fine-tooth saw blades (more points per inch):

- On folding, rigid, and grip handles.
- *Needlepoint* teeth.
- Razor-tooth, Japanese, or *tri-edge* style teeth (*Fanno*™ 1311, *Felco*™*, Corona*™); narrow, curved blades facilitate getting into tight spots.

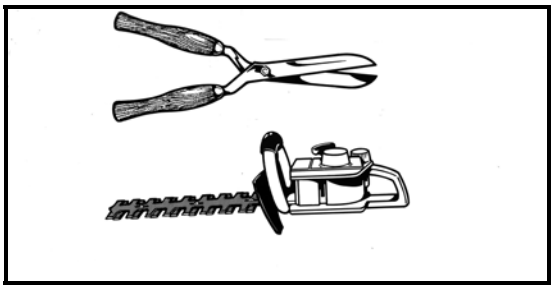
Arborist saws cut on the *pull* stroke:

- Davey-issue speed saw.
- Raker and gullet saws.
- Needle-tooth saws Fanno™ series.
- Scabbards, blade lengths.
- Pole saw blades now available with tri-edge teeth.

Hedge Shears

Clippers/trimmers:

- Manual (sometimes called 'pruning' shears)



- Powered (electric, gasoline)
- Cut off growth ‘in line’ with no regard for node locations or branch bark ridges.
- Provide time and labor savings at expense of overall plant health.
- Dull blades compound problems and make you work harder!

Crown Thinning and Cleaning

A proper thinning cut removes a branch at its point of attachment, or back to a lateral branch large enough to assume a terminal role.

Learn to foresee the need for removing live branches while they are small. Avoid large cuts. Direction can be influenced by removal of short portions of growth or even by removal of individual buds.

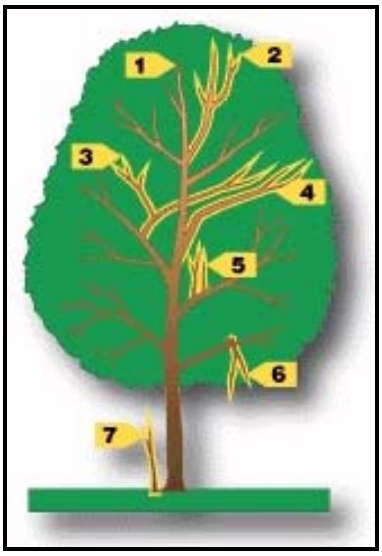
Thinning of lower branches can ‘raise’ a limb. If, after crown raising, the remaining leaf material is insufficient for limb size, consider complete removal. The client's opinion is important.

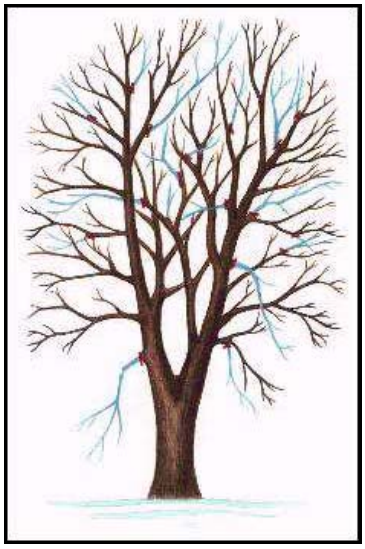
Never perform excessive thinning, which is stressful, especially on thin-barked or young trees prone to sunscald.

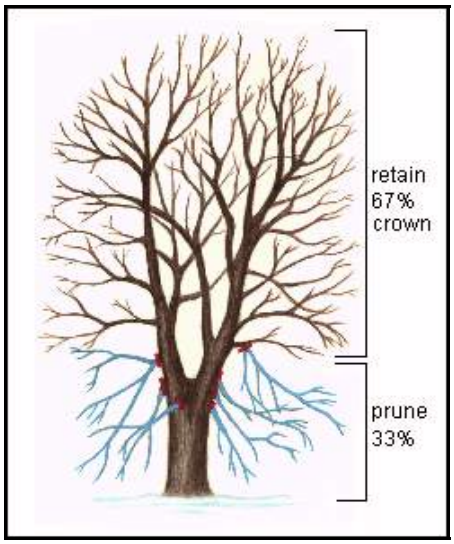
Avoid removing more than 1/4 of the live branches on a tree. Older or overmature trees should have an absolute minimum of living branches removed.

Always avoid ‘skinning’ or ‘hollowing' out the center of a tree's canopy. The majority of thinning cuts should be made along the outer crown. Proper thinning requires a good deal of limb-walking and deft use of a pole-pruner when and where aerial lifts are not used.

When thinning laterals from a limb, maintain well-spaced inner branches to achieve more distribution of foliage along the branch.







Caution must be taken to avoid creating an effect known as *lion-tailing*:

- Caused by removing all of the inner laterals and foliage.
- Displaces foliar weight to the ends of the branches.
- May result in sunburned bark tissue, renewed and excessive epicormic branches, weakened branch structure and breakage.
- Wind whippage.

Lion-tailing

Removal of Diseased or Insect-Infested Branches

Sanitation or 'eradicative' pruning (crown cleaning):

- Cut out diseased limbs back to collars, appropriate lateral branches, or a scaffold branch at least one foot below infected portion.
- Disinfect tools *during or after* pruning diseased branches with bleach solution (1 part bleach to 10 parts water) or Lysol.
- Do not use any form of alcohol to sterilize pruning tools *during* the work. Use alcohol to disinfect auger-bits, injection tees or pruning tools *after* the job, especially plants with wetwood or fireblight bacterial infections.

Removal of Weak, Rubbing, or Competing Stems

Remove, if possible, but avoid large holes in the canopy.

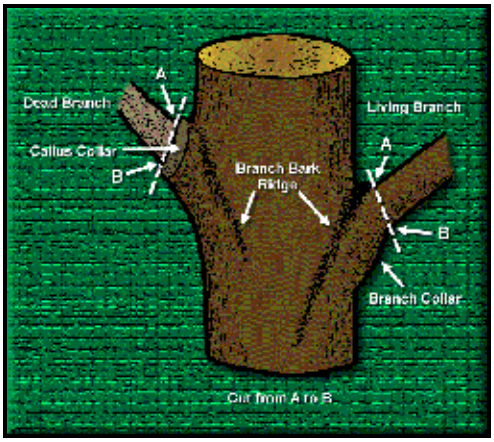
The life of large limbs, weakened by decay or cracks, can often be extended by "shortening" or weight removal using highly selective thinning cuts. Cabling and/or rigid bracing may be required to secure limbs or codominant stems if removal is not possible.

Deadwood Removal

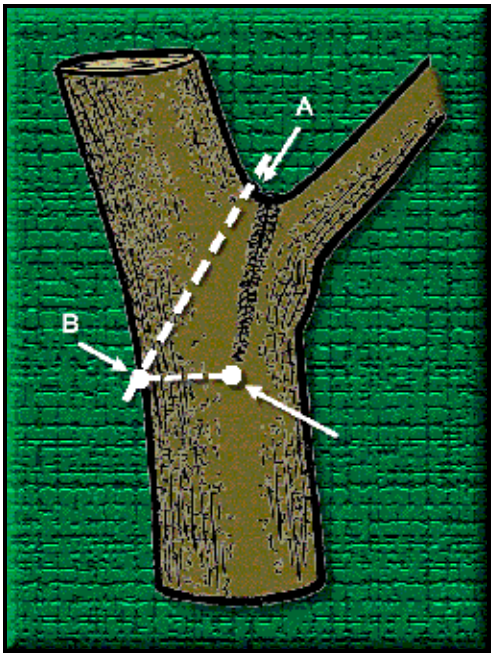
Sanitation and hazard reduction pruning:

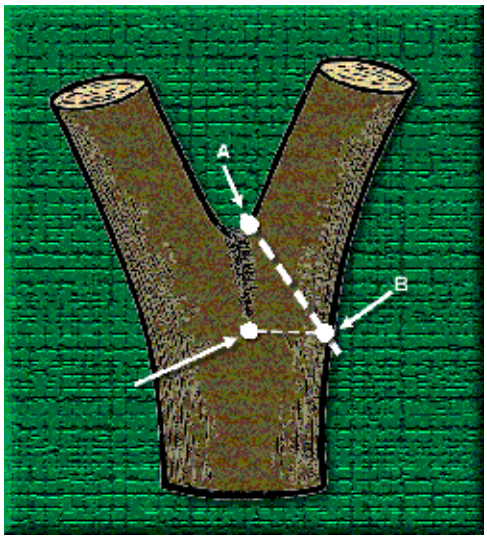
- Dead branches and stubs are an energy source (cellulose, glucose).
- Decay fungi.
- Boring insects.

Again, do not remove the branch collar around dead branches. Cut as close as possible to the collar of good wood surrounding the branch base.



Locate Target Points





Codominant Stem or Branch Removal

Always *stub cut* the stem to be removed, and then make the *finish* cut with care.

Some defect (discoloration) will develop in the remnant stem 'core' in the main stem:

- Usually not attached like a true branch with protective collar.
- Barrier zone should develop and confine defect if correct cut is performed.

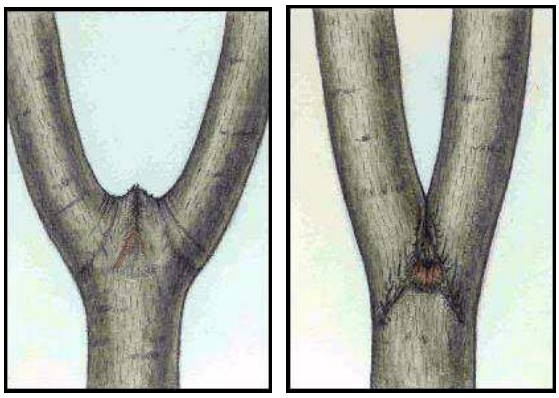
Never remove both stems!

When the bark plates on the stem bark ridge turn upward, the union of the stems is usually *strong.*

When the bark between the stems turns inward the union of the stems is *weak.*

It is the *union* of the stems or upright branches more than the *angle* that determines whether attachment is weak or strong.

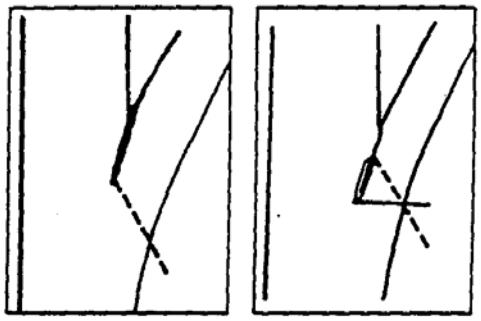
The stems have *included bark* squeezed or embedded *between* them.



Remedies:

To *remove*, stub cut the stem first and then cut where the dotted line is with care; avoid cutting into the remaining stem.

If the saw cannot complete this cut, tap a small wedge into the kerf and cut the remainder of the wood with a flat chisel and mallet.



To *strengthen* stem on older trees, a cable can be attached; place at a point approximately two-thirds of the distance from the crotch to the ends of the stems.

When a cable is used to strengthen stems, the cable and hardware must be checked regularly. When the risk of stem fracture becomes high, the weaker stem should be removed.

Davey Residential Operations employs four general classes of pruning. Classes 1, 2, and 3 are classified as maintenance pruning, which is recommended when the primary objective is to maintain or improve tree health and structure, including hazard reduction pruning:

- Class #1 - *Fine Pruning*: consists of the removal of dead, dying, diseased, interfering, objectionable, and weak branches (crown cleaning), as well as selective thinning to lessen wind resistance. Some deadwood up to ½ inch in diameter may remain within the main leaf area where it is not practical to remove such. Girdling roots will be monitored and removed where possible.

- Class #2 - *Medium Pruning*: consists of the removal of dead, dying, diseased, interfering, objectionable and weak branches (crown cleaning). Some deadwood up to one inch in diameter may remain within the leaf canopy
- Class #3 - *Hazard reduction*: pruning is recommended when the primary objective is to reduce the danger to a specific target, caused by visibly defined hazards in a tree, by removing dead, diseased or obviously weak branches two inches in diameter greater.
- Class #4 - *Crown Reduction Pruning*: consists of reducing canopy tops, sides, under branches, or individual limbs at appropriate lateral limbs and stems for purposes of clearance of storm damage repair. Some crown reduction pruning incorporates hazard reduction pruning.

Epicormic Branches

Epicormic branches may be needed to fill in the canopy where trees have been excessively thinned or storm damage has occurred (crown restoration).

Epicormic branches (shoots, watersprouts, suckers) arise from two types of "buds":

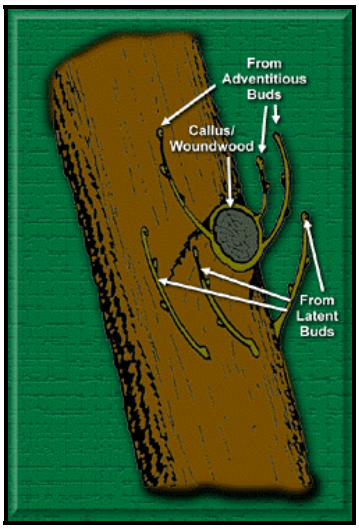
- Adventitious buds.
- Latent (dormant) buds or meristematic points.

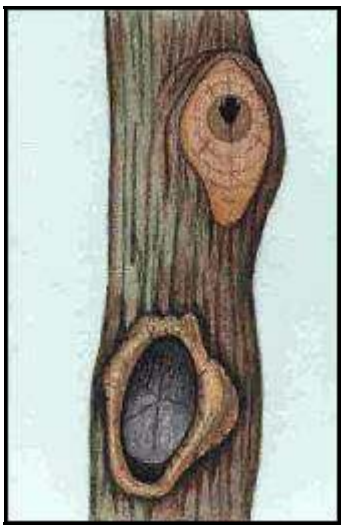
Adventitious epicormics come from meristematic tissue generated anew by the cambium. Most adventitious buds develop from callus tissues moving over a wound, or from root tissue.

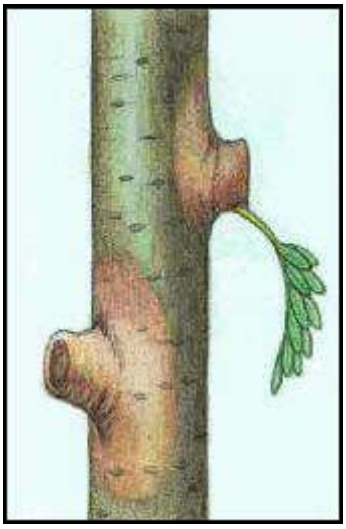
Latent (dormant) buds or *meristematic points* are formed at an earlier time in the life of a woody plant but do not 'release' or grow. Latent buds are 'carried along' in rays in the cambial zone year after year, as the tree increases girth, and are usually released upon injury or stress. Epicormic sprouts from latent meristematic points are often found in the vicinity of pruning cuts, usually below the wound.

Epicormic branches are *stimulated* on a much larger scale by winter or early spring pruning rather than by late spring-summer pruning (desirable in shrub renewal or rejuvenation).

A *watersprout* is an epicormic branch growing from branch and stem parts, or above a graft union.







A *sucker* is an epicormic branch growing from root tissue or <u>below</u> a graft union.

Apical Dominance and Control

Woody plant natural shapes, forms, or habits are governed by species' inherent (genetic) determination of:

- Leaf and flower bud locations.
- Bud-break patterns along stems.
- Branching angles.
- How buds and branches elongate.

Apical dominance = terminal bud(s) suppress lateral buds along an elongating shoot

Excurrent and *decurrent* branching patterns:

- Decurrent woody plants have overall weak apical control, but strong apical dominance while shoots are elongating.
- Random-branching excurrent plants have weak apical dominance and overall strong apical control
- Whorl-branching excurrent trees have both strong apical dominance and control.

Decurrent

Excurrent

Plant growth regulators are substances that enhance or alter the growth and development process of a plant. In most cases these chemicals either increase or decrease normal growth, flowering and/or fruiting of plants.

Selective growth control and/or branch release by natural growth regulators:

- Auxins
- Abscisic acid (ABA)
- Cytokinins
- Gibberellins (gibberellic acid = GA)
- Ethylene

Branch terminals – auxin source
Roots – cytokinin source

Low auxin = axillary bud release,
High cytokinin energy storage drain

High auxin = bud suppression,
Low cytokinin initiate new roots

Plant growth regulators are substances that enhance or alter the growth and development process of a plant. In most cases these chemicals either increase or decrease normal growth, flowering and/or fruiting of plants.

Utility arborists use synthetic growth regulators to *control* the growth of trees and other vegetation beneath utility lines. Growth *inhibitors* can be:

- Sprayed on the foliage.
- Painted on pruning wounds.
- Banded on the bark.
- Soil applied.
- Injected into trees.

Antigibberellins are growth regulators that counter the effects of naturally occurring *cell-elongation* hormones (gibberellin). Ideal formulations are being sought that would minimize phytotoxicity while reducing utilities' pruning expenses.

Another use of growth inhibitors is to suppress epicormic branch production on trees:

- Not yet widely used by arborists.
- Must be applied annually.
- Client concern over the use of chemicals.
- Applicator safety concerns.
- Epicormic branch growth can be minimized with proper cuts.
- Retarded woundwood development.

Painting of Cuts

Proper cuts negate the "need" for wound dressings. Wound dressings will not *prevent* decay; wound dressings have been evaluated to often *promote* wood decay or cause cambium damage.

Cuts or wounds in certain species during the growing season may attract insects that carry diseases or allow fungus invasion. Native oaks or elms and European elms should be pruned during dormant periods in regions where wilt disease conditions are known to exist.

If pruned in summer, pruning wounds on wilt-susceptible oaks and elms should be treated with the current wound dressing recommended by The Davey Institute.

Pruning Phenology

The ideal or optimal times to prune most woody plants are:

- Late in the dormant season.
- After leaves are fully formed and expanded.

Client concerns with excessive *sap flow* (birches, maples):

- Avoid pruning during height of sap flow (just before growing season) if possible.
- Sap flow may be unsightly but does not cause definite injury.
- Prune immediately after leaves are fully expanded if client cannot be convinced.

Avoid pruning birches after leaf expansion, as the wounds may be attractive to boring insects.

Dead, broken or weak limbs may be removed at any time with little effect, except in wilt-susceptible oaks and elms.

Pruning before the spring leaf bud-break period can enhance stimulated growth and rapid wound closure. Pruning during the period after leaf expansion will result in suppressed growth and maximum 'dwarfing'.

Avoid pruning those woody plants undergoing bud break and early leaf expansion, especially in the period where bark 'slips' (cambial development of unlignified wood).

Flowering can be reduced or enhanced by pruning at the appropriate time of the year. Woody plants that bloom on current season's growth ('summer-flowering' such as crapemyrtle or butterfly-bush) are best pruned to enhance flowering:

- During the dormant season.
- Just prior to or immediately after leaf expansion.
- In late summer (post-bloom).

Plants that bloom on last season's wood ('spring-flowering') should be pruned *just after bloom*.

- Fruit trees are often pruned during the dormant season to enhance structure and distribute fruiting wood, and after bloom to thin fruit-load.

Pruning Selection

Ideal pruning technique begins with planting the right tree in the right place (PHC selection).

Maintaining tree size or allowing for limited crown growth is possible with a regular pruning schedule begun early in the tree's life.

- Consider the extent of mature branches and crown.
- Select good stock with proper growth form.
- Imagine how form will continue to develop; there is no way to turn a large tree back into a small tree.
- Don't expect to improve form with future prunings.

Avoid obtaining saplings with included bark; the stem union becomes weaker rather than stronger as the plant grows. Failure of one or both stems of the fork frequently occurs when the tree is mature, especially during snow and ice storms (loading events).

Structural Pruning

Structural pruning principles are used when training young woody plants or working with a tree that has not been pruned in many years. Properly trained shrubs and young trees will develop into structurally strong plants that should require little corrective pruning as they mature.

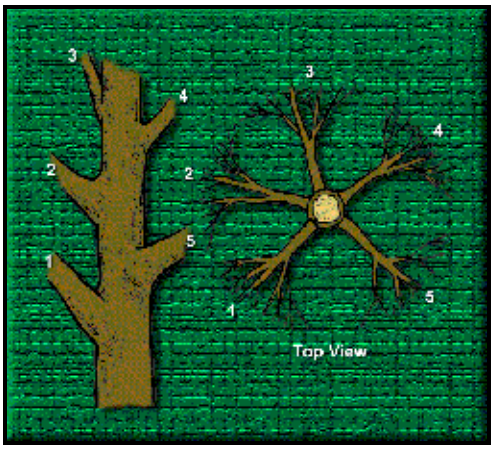
Trees that will be large at maturity should have a sturdy, tapered trunk, with well-spaced branches smaller in diameter than the trunk.

If two branches develop from apical buds at the tip of the same stem they will form *codominant* branches or, eventually, codominant stems. Each codominant branch is a direct extension of the stem. It is best if one is removed when the tree is young.

Branches with narrow angles of attachment and codominant branches may tend to break if there is *included bark* that gets enclosed inside the crotch as the two branches develop girth and length.

The relative *size* of a branch in relation to the trunk is usually more important for strength of branch attachment than is the *angle* of attachment. Scaffold branches' diameters should not be more than 1/2 the stem or trunk diameter.

Select main branches to give *radial distribution*. Discourage branches growing directly over another unless spaced well apart.



On large-growing trees, except whorl-branching conifers, branches that are more than 1/3 the diameter of the trunk in size should be well spaced along the trunk (at least 18 inches apart).

Maintain one-half the foliage on branches arising in the lower 2/3 of younger trees.

- Increases trunk taper.
- More uniformly distributes weight and wind stress along the trunk.

This rule of thumb also holds true for an individual limb:

- Leave lower and inside branches along the limb.
- Limb can develop taper and strength.
- Stress and weight can be evenly distributed along the length.

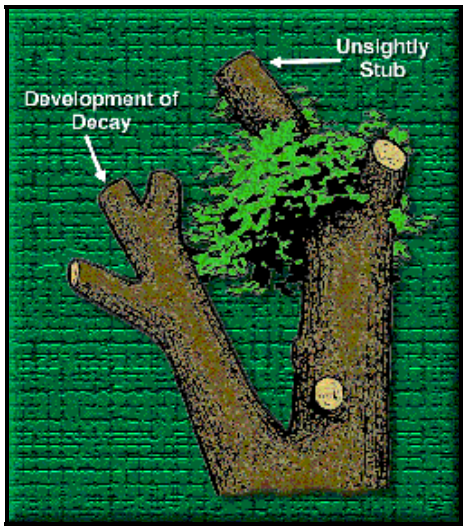
The height of the lowest scaffold branch will depend on the intended function of the tree: screen an unsightly view, provide a windbreak, shade a patio, installed as a walkway or street tree.

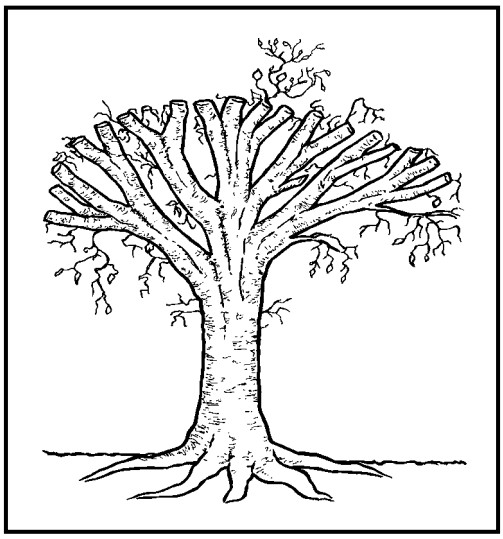
Pruning at Planting

For years, the conventional wisdom was that trees should be severely pruned at time of transplant to compensate for root loss and to "balance" the crown with the root system (especially bareroot trees). This practice has since been discovered to prolong *transplant shock.*

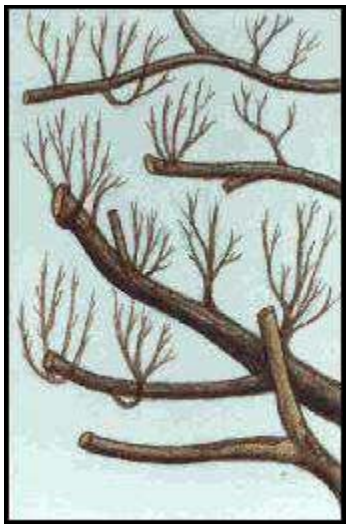
- Transplant pruning should be limited to removal of dead, broken, diseased, or interfering branches.
- Leave small shoots along the trunk for later removal.
- Protect the trunk from ‘sunburn’.
- Aid in development of proper trunk taper.
- Leave as many terminal buds as possible.
- Stimulate root-growth triggered by hormones in these buds.

Topping, Tipping, and Roundover

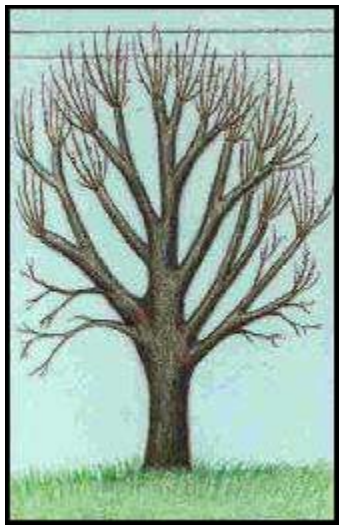




Topping: cutting vertical branches and stems back to inadequate nodes (heading) or to internodes (stubbing).



Tipping: heading side or horizontal branches to stubs or weak laterals.



Roundover: topping + tipping.

Many people have the misconception that cutting or heading the main branches of a tree back to stubs to 'reduce the height' is the proper way to prune.

Apparently, a short tree is thought to be safer and healthier than a tall tree regardless of how the result is attained. Heading back to stubs or inadequate laterals permanently disfigures and weakens a tree. Topping is one of the worst things humans do to trees.

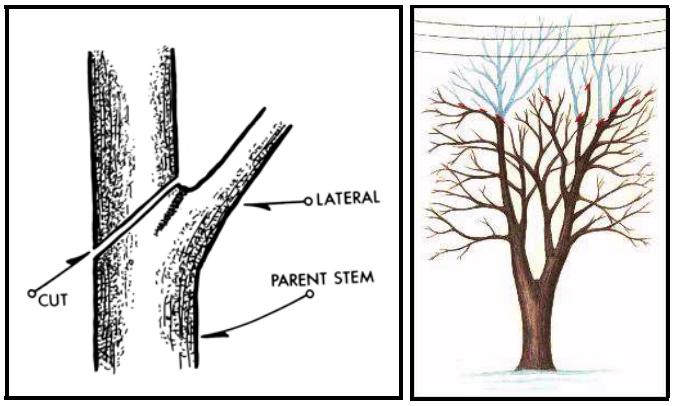
The International Society of Arboriculture (ISA) and the National Arborist Association (NAA) consider heading-back to stubs an unacceptable arboricultural practice. Modern pruning standards do not include heading-back as any sort of a recommended technique.

- Topping removes a major portion of a tree's leaves that are necessary for the production of carbohydrates.
- Stimulation of epicormic branches at or just below an internodal stub cut causes a topped tree to grow back to its original height faster and denser than a properly pruned tree. The sprouts are weakly attached and easily broken off in storms.
- Bark within the canopy can become scalded by sudden exposure to direct sunlight.
- Stubs attract wood-boring insects and sustain wood decay organisms.
- Topping, tipping, and roundover cuts permanently disfigure a tree.

Crown Reduction, Restoration, and Raising

If the height or width of a tree has to be reduced because of storm damage or interference with structures or utility lines, it is performed correctly by a method called *crown reduction* or *drop-crotch* pruning (NAA Class IV Crown Reduction). This procedure involves the removal of a main leader, scaffold or branch at its point of attachment with a lateral branch large enough to assume a terminal or leader role.

The final cut should begin or end somewhat *parallel* to the remaining lateral branch and offset slightly above the branch bark ridge (without cutting into the bark ridge). The remaining lateral branch must be at least one-half to one-third the diameter of the branch or leader that is being removed.



If a tree has been topped previously and now has epicormic sprouts, *crown restoration* can improve its structure and appearance. Decayed, rotting stubs and tipped branches are cut back to appropriate laterals or entirely removed. One to three sprouts on main branch stubs are retained to become permanent branches and reform a more natural appearing crown. Selected epicormic branches may need to be thinned to a lateral to control length and ensure adequate attachment for the size of the sprout. Restoration usually requires several prunings over a number of years.

Trees in urban and landscape settings may need to have lower limbs removed. *Crown raising* or elevating removes the lower branches of a tree in order to provide clearance for buildings, vehicles, pedestrians, and vistas. Excessive removal of lower limbs should be avoided so that the development of trunk taper is not affected and structural stability is maintained.

Definitions of Arboricultural Terms

Anvil-Type Pruning Tool – Pruning tool that has a straight sharp blade that cuts against a flat metal cutting surface (see *hook and blade-type pruning tool*).

Arborist – A professional who possesses the technical competence through experience and related training to provide for or supervise the management of trees and other woody plants in the residential, commercial, and public landscape.

Boundary Reaction Zone – A separating boundary between wood present at the time of wounding and wood that continues to form after wounding.

Branch – A secondary shoot or stem arising from one of the main axes (i.e. trunk or leader) of a tree or woody plant.

Branch Collar – Trunk tissue that forms around the base of a branch between the main stem and the branch or a branch and a lateral. As a branch decreases in vigor or begins to die, the branch collar becomes more pronounced.

Branch Bark Ridge – Raised area of bark in the branch crotch that marks where the branch wood and trunk wood meet.

Callus – Undifferentiated tissue formed by the cambium layer around a wound.

Cambium – Dividing layer of cells that forms sapwood (xylem) to the inside and bark (phloem) to the outside.

Climbing Spurs – Sharp, pointed devices affixed to the climber's leg used to assist in climbing trees (also known as *gaffs, hooks, spurs, spikes, climbers).*

Closure – The process of woundwood covering a cut or other tree injury.

Crotch – The angle formed at the attachment between a branch and another branch, leader, or trunk of a woody plant.

Crown – The leaves and branches of a tree or shrub; the upper portion of a tree from the lowest branch on the trunk to the top.

Crown Cleaning – The removal of dead, dying, diseased, crowded, weakly attached, low-vigor branches, and watersprouts from a tree's crown.

Crown Raising – The removal of the lower branches of a tree in order to provide clearance.

Crown Reduction – The reduction of the top, sides, or individual limbs by the means of removal of the leader or longest portion of a limb to a lateral no less than one-third of the total diameter of the original limb removing no more than one-quarter of the leaf surface.

Crown Thinning – The selective removal of branches to increase light penetration and air movement, and to reduce weight.

Cut – The exposed wood area resulting from the removal of a branch or portion thereof.

Decay – Degradation of woody tissue caused by biological organisms.

Espalier Pruning – A combination of cutting and training branches that are oriented in one plane, formally or informally arranged, and usually supported on a wall, fence, or trellis. The patterns can be simple or complex, but the cutting and training is precise. Ties should be replaced every few years to prevent girdling the branches at the attachment site.

Facility – Equipment or structure used to deliver or provide protection for the delivery of an essential service such as electricity.

Girdling Roots – Roots located above or below ground whose circular growth around the base of the trunk or over individual roots applies pressure to the bark area, ultimately restricting sap flow and trunk/root growth. Frequently results in reduced vitality or stability of the plant.

Heading – Cutting a currently growing or one-year-old shoot back to a bud, or cutting an older branch or stem back to a stub or lateral branch not sufficiently large enough to assume the terminal role. Heading should rarely be used on mature trees.

Heartwood – The inactive xylem (wood) toward the center of a stem or root that provides structural support.

Hook and Blade Pruning Tool – A hand pruner that has a curved, sharpened blade that overlaps a supporting hook (in contrast to *an anvil-type pruning tool*).

Horizontal Plane (palms) – An imaginary level line that begins at the base of live frond petioles.

Lateral – A branch or twig growing from a parent branch or stem.

Leader – A dominant upright stem, usually the main trunk. There can be several leaders in one tree.

Limb – Same as *Branch,* but larger and more prominent.

Lopping – See *Heading.*

Mycellum – Growth mass of fungus tissue found under bark or in rotted wood.

Obstructing – To hinder, block, close off, or be in the way of; to hinder or retard a desired effect or shape.

Parent Branch or Stem – The tree trunk or a large limb from which lateral branches grow.

Petiole – The stalk of a leaf.

Phloem – Inner bark tissue through which primarily carbohydrates and other organic compounds move from regions of high concentration to low.

Pollarding – Pollarding is a training system used on some large-growing deciduous trees that are severely headed annually or every few years to hold them to modest size or to give them and the landscape a formal appearance. Pollarding is not synonymous with topping, lopping, or stubbing. Pollarding is severely heading some and removing other vigorous water sprouts back to a definite head or knob of latent buds at the branch ends.

Precut or Precutting – The two-step process to remove a branch before the finished cut is made so as to prevent splitting or bark tearing into the parent stem. The branch is first undercut, and then cut from the top before the final cut.

Pruning – Removal of plant parts.

Qualified Line Clearance Tree Trimmer – A tree worker who, through related training and on-the-job experience, is familiar with the techniques in line clearance and has demonstrated his/her ability in the performance of the special techniques involved. This qualified person may or may not be currently employed by a line clearance contractor.

Qualified Line Clearance Tree Trimmer Trainee – Any worker undergoing line-clearance tree trimming training, who, in the course of such training, is familiar with the techniques in line clearance and has demonstrated his/her ability in the performance of the special techniques involved. Such trainees shall be under the direct supervision of qualified personnel.

Qualified Person or Personnel – Workers who, through related training or on-the-job experience, or both, are familiar with the techniques and hazards of arboriculture work including training, trimming, maintaining, repairing, or removing trees, and the equipment used in such operations.

Qualified Tree Worker, Person, or Personnel – A person who, through related training and on-the-job experience, is familiar with the hazards of pruning, trimming, repairing, maintaining, or removing trees and with the equipment used in such operations and has demonstrated ability in the performance of the special techniques involved.

Qualified Tree Worker Trainee – Any worker undergoing on-the-job training who, in the course of such training, is familiar with the hazards of pruning, trimming, repairing, maintaining, or removing trees, with the equipment used in such operations and has demonstrated ability in the performance of the special techniques involved. Such trainees shall be under the direct supervision of qualified personnel.

Remote/Rural – Areas associated with very little human activity, land improvement, or development.

Sapwood – The active xylem (wood) that stores water and carbohydrates, and transports water and nutrients; a wood layer of variable thickness found immediately inside the cambium, comprised of water-conducting vessels or tracheids and living plant cells.

Shall – As used in this standard, denotes a mandatory requirement.

Should – As used in this standard, denotes an advisory recommendation.

Stub – An undesirable short length of a branch remaining after a break or incorrect pruning cut is made.

Stubbing – See *Heading.*

Target – A person, structure, or object that could sustain damage from the failure of a tree or portion of a tree.

Terminal Role – Branch that assumes the dominant vertical position on the top of a tree.

Thinning – The removal of a lateral branch at its point of origin or the shortening of a branch or stem by cutting to a lateral large enough to assume the terminal role.

Throwline – A small, lightweight line with a weighted end used to position a climber's rope in a tree.

Topping – See *Heading.*

Tracing – Shaping a wound by removing loose bark from in and around a wound.

Urban/Residential – Locations normally associated with human activity such as populated areas including public and private property.

Utility – An entity that delivers a public service such as electricity or communication.

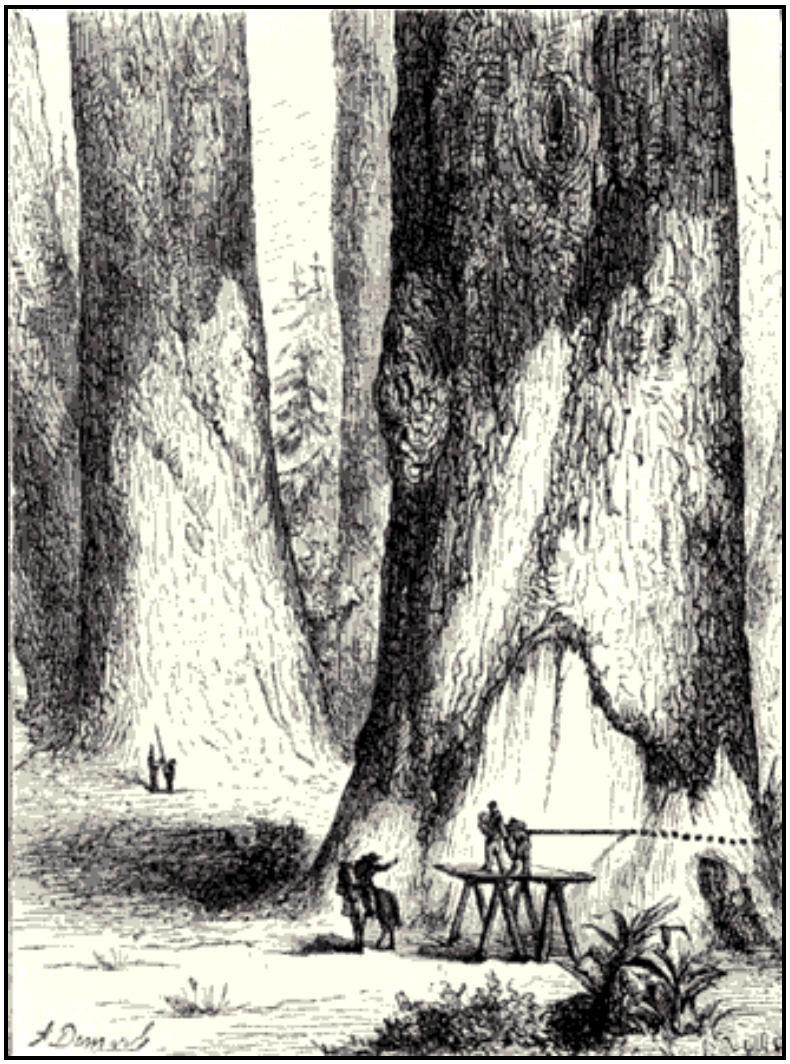
Utility Space – The physical area occupied by the utility's facilities and the additional space required ensuring its operation.

Wound – An opening that is created any time the tree's protective bark covering is penetrated, cut, or removed, injuring or destroying living tissue. Pruning a live branch creates a wound, even when the cut is properly made.

Woundwood – Differentiated woody tissue that forms after the initial callus has formed around the margins of a wound. Wounds are closed primarily by woundwood.

Xylem – Wood tissue; active xylem is called *sapwood* and inactive xylem is called *heartwood.*

Young Tree – A tree young in age or a newly installed tree.



Appendix K
Street Tree Fertilization, Planting, Pruning, and Removal Specifications

CITY-WIDE STREET TREE PLANTING SPECIFICATIONS
CITY OF _____, _____

I. Scope of Work

To provide all supervision, material, labor, equipment, service operations and expertise required to deliver, locate, plant and guarantee for one year, street trees in the City of _____ as specified herein. Contractor has responsibility to:

A) Furnish, transport and plant trees;

B) Reserve workspace along streets;

C) Excavate in-place soil, plant and backfill with topsoil approved by City Administrator;

D) Furnish and place mulch;

E) Remove excess material and clean up site;

F) Guarantee trees for one year and make appropriate replacement planting;

G) Keep work site safe at all times; and

H) Any work incidental to above.

II. Definitions

A) Reference is any other specifications or standards means the latest revision in effect on date of invitation to bid. This set of specifications governs when disagreement with a reference specification occurs.

B) Specified means specified in the invitation to bid and/or order or contract.

C) ANSI Z60.1-Standards are American Standard for Nursery Stock.

D) City Administrator is the city's representative that will administer the technical aspects of this tree planting contract. The City Administrator for this contract is: _____

E) Contractor is a company that earns the majority of its annual revenue from planting or maintaining trees and/or shrubbery. Contractor must possess an I.S.A. Certified Arborist License or Certified Landscapers License or Certificate.

III. Materials Specifications

Mention of any product name neither constitutes an endorsement of that product nor excludes the use of similar products meeting specifications.

A) Nursery Stock - All trees healthy, vigorous and well-grown, showing evidence of proper root and top pruning, single-trunked, high-branched specimens suitable for use along streets. All trees 1-3/4 inch caliper unless otherwise noted. All trees grown at least one year in a currently active nursery having same climatic conditions as the City of _____. All trees meet ANSI Z60.1-standards for top grade. Label attached to each tree at nursery indicating botanical name

and common name. City Administrator will mark trees in the nursery and has final approval of species or variety used and nursery from which trees are obtained.

B) Root balls and burlap - All trees balled and burlapped with ball shape and size conforming to ANSI Z60.1 standards. Root flare will be easily visible on root balls. Only rottable burlap and rottable rope permitted. Root balls adequately protected at all times from sun, heat, freezing and drying. City Administrator will reject any cracked or manufactured root balls.

C) Mulch - Year-old rough wood chips created by local tree service companies during brush chipping operations.

IV. Work Procedures

A) Source of supply - Contractor submits to City Administrator, within ten (10) days after receipt of notice of award of contract, complete and detailed information concerning the source of supply for each item of plant material specified in the planting list.

B) Tree location - All planting sites will be identified and marked by the City Administrator before planting begins. The appropriate utilities services will be notified of planting site locations by Contractor immediately after contract has been awarded. Contractor will also be responsible for notifying the appropriate utility authority prior to digging. Contractor will be responsible for any damage to utilities during the planting process. Sites will be marked by a white flag in the grass area and also with a white mark painted on the curb. All trees will be centered between curb and sidewalk, at least two feet from curb line unless otherwise specified by the City Administrator.

C) Delivery - Trees shall be transported and handled with adequate protection. Trees shall be covered with burlap or tarpaulin during transit or transported in closed truck to prevent drying out of the tree. Trees in leaf shall be sprayed before shipping with "Wiltpruf" or other anti-desiccant approved by the City Administrator.

D) Temporary storage - Root balls of trees not immediately planted after delivery must be adequately protected by mulch or heeling-in and watering until planting occurs. Contractor assumes all risk and expense of temporary storage.

E) Planting holes - Holes may be dug by hand, backhoe, tree spade or other approved equipment at specified location. An auger is not considered approved equipment. Walls of the planting hole shall be dug so that they are properly sloped and sufficiently loosened to remove the glazing effects of the digging. The planting hole shall be elliptical in shape with the top diameter two times that of the ball. The bottom of the hole shall be rough, flat and deep enough to have the plant at its original planting depth or slightly higher. Holes shall be ground only on day tree is planted. Contractor is responsible to ensure all holes are safe until planted and covered with mulch.

F) Precautions during digging - When underground utilities are encountered, Contractor immediately calls the controlling agency or company and the City of

_____. The Contractor, at his expense, restores to original condition all structures, facilities and other property damaged by his company's work.

G) Surplus excavation - Removed and disposed of by Contractor at his own expense.

H) Planting - Allowed only between the dates of _____ and _____. Planting is only allowed when the soil is not frozen. Balled and burlapped trees are set on tamped backfill, placing tree at same depth as in nursery or up to two (2) inches higher than that level. Planting height may be adjusted if unusual site situations are encountered after approval by City Administrator. Burlap should be pulled back one-third the depth of the root ball and rope or twine should be cut from trunk. Trees with forked top oriented with forked limbs shall be pointed parallel to street and not toward street. Planting is not allowed on days when temperatures fall below 30°F.

I) Root pruning - Ends of broken or damaged roots more than 1/4 inch in diameter should be pruned with a clean cut, removing only injured portion.

J) Backfilling - Planting holes shall be backfilled with approved topsoil. Mix soil amendments in mixture prior to filling the hole to prevent stratification. Incorporate a transplant inoculant that contains water absorbing material such as polymers, root stimulants, and endo- and ecto-mycorrhizal fungi into the backfill. Backfill sides of the tree hole halfway with soil mixture and tamp as the hole is being filled. Cut and remove all rope, twine, burlap and wires from the top half of the soil ball. Wire baskets should be cut and removed to a two-inch depth below the soil line. Burlap should be pulled back with half of the soil ball exposed after plants are properly placed in the planting hole. Shape backfill and mulch in a water ring to facilitate watering.

K) Top pruning and wound treatment - Pruning to make trees shapely and typical of species shall be done according to recognized horticultural standards and instructions of the City Administrator. Accidental damage during planting not great enough to warrant branch removal or tree replacement should be promptly traced according to recognized horticultural practices. Pruning paint is not necessary.

L) Mulching - Place rough wood chips loosely around trees within 24 hours after planting to uniform depth of no more than four (4) inches and to a diameter of three (3) feet where possible.

M) Extra holes - Excess or improperly located planting holes are to be immediately backfilled and seeded with Kentucky Bluegrass, and covered with two (2) inches of straw, at Contractor's expense.

N) Watering - Thoroughly water to settle backfill when half of backfill is in place and again after all backfill is placed. It is highly recommended that watering continue through the first growing season to increase chances of survival after planting.

O) Wrapping - Trees are not wrapped unless specified by the City Administrator. If wrapping is required, trunk and wrapping shall be treated with a 20 percent Lindane and water spray. Wrapping is crinkle-draft tree wrapping paper tied with rottable twine.

P) Productivity - Production schedule beginning and ending dates will be agreed upon in writing between the Contractor and the City Administrator.

Q) Supervision - Contractor is required to consult with the City Administrator concerning details and scheduling of all work. Contractor shall have a competent person in charge of work at all times to whom the City Administrator may issue directions and who is authorized to accept and act upon such directives. Supervisor calls the City Administrator before each day's work begins to provide work locations by street.

R) Public relations - An information sheet shall be supplied by the City Administrator to Contractor for distribution to property owner.

V. Substitutions

If a species or variety is used as a substitute with the approval of the City Administrator, the per tree price paid by the City is the lowest of:

A) The per tree price of the species or variety originally bid on; or

B) The lowest bid price for the substitute species or variety if it is specified elsewhere in this contract.

VI. Inspections

A) Nursery inspection - The City Administrator, at its discretion, will inspect and mark nursery stock purchased under this contract before digging.

B) Agency inspection - Federal, state and other authorities inspect all trees before removal from nursery, as required by local law. Required certificates declaring trees free of all diseases and insects shall accompany each order or shipment of trees.

C) Planting inspection - The City Administrator, at its discretion, inspects progress of planting or temporarily stored trees to review the progress of the work and condition of trees.

D) Guarantee period inspection - The City Administrator inspects planting work to verify completion and begin guarantee period. Contractor requests this inspection in writing at least ten (10) days before its scheduled date. After inspection, the City Administrator notifies Contractor in writing of date of beginning of guarantee period or of deficiencies to correct before guarantee period begins.

E) Correction inspection - Two months before end of guarantee period, the City Administrator inspects work and notifies Contractor of replacement and other corrections required to make work acceptable.

F) Final inspection - At end of guarantee period, City Administrator inspects trees to determine final acceptance. Contractor requests this inspection in writing at least ten (10) days before the scheduled date.

G) Stock inspections - The City Administrator reserves right to inspect trees before they are removed from delivery truck at work site. Delivery truck driver or other

agent or Contractor should call the City Administrator's office before leaving for work site each day to facilitate these on-truck inspections.

H) Other inspections - City Administrator reserves right to inspect on-site work at any time without notice. Contractor calls City Administrator on morning of each working day to provide work location.

VII. Guarantee

Contractor guarantees that all trees remain alive and healthy until the end of a one (1) year guarantee period. Contractor replaces, as specified, and at his expense, any dead trees and any trees, that in the opinion of the City Administrator, have become unhealthy or unsightly or have lost their natural shape due to dead branches, improper pruning or maintenance, or any other cause due to the Contractor's negligence, or weather conditions. Contractor straightens any leaning trees, bearing the entire cost.

VIII. Rejection

Contractor disposes of any tree rejected by the City Administrator at the Contractor's expense.

IX. Items

Each entry (Street name, estimated number of trees and species) within each section is considered a separate item. The City Administrator reserves the right to delete any item or items because of an inability to obtain specified trees or other reasonable cause.

*TREE REMOVAL AND PRUNING SPECIFICATIONS CITY OF*_____, _____

I. Scope of Work

To provide all labor, supervision, equipment, services and expertise necessary to perform urban forestry maintenance work in the City of _____ as specified herein. Since this work is of a potentially dangerous nature, and requires special expertise, it is to be performed by a contractor that derives a majority of its annual income from arboricultural work and whose employees are highly trained and skilled in all phases of tree service work. Contractors must have been in business for at least five years. The City will require proof of Contractor's involvement in tree service work. The contractor has the responsibility to:

A. Remove or prune designated trees.

B. Reserve work space along streets.

C. Grind out stump when tree is to be removed.

D. Remove excess material and clean up site.

E. Guarantee that specifications be met.

F. Keep work site safe at all times.

II. Definitions

A. **Reference:** Reference to any other specifications or standards means the latest revision in effect on date of invitation to bid. This set of specifications governs when disagreement with a reference specification occurs.

B. **Specified:** Means specified in the invitation to bid

C. **ANSI Z-133:** American Standard of Tree Worker Safety.

D. **ANSI A300:** Standard Practices for Trees, Shrubs and Other Woody Plant Maintenance

E. **City Administrator:** The City's representative that will administer the technical aspects of this tree pruning and removal contract. The City administrator for this contract is: _____

F. **Contractor:** A company that earns the majority of its annual revenue for pruning, removing or maintaining trees and/or shrubbery. Contractor must possess an I.S.A. Certified Arborist License.

III. Work Procedures

A. **Equipment:** All bidders must have in their possession or available to them by formal agreement at the time of bidding: trucks, devices, chippers, hand tools, aerial and other equipment and supplies which are necessary to perform the work as outlined in these specifications. The City may inspect such equipment or agreements prior to the awarding of a contract.

B. **Tree Location:** Work limited to trees located on all public rights-of-way and City-owned property. All work under this contract shall be assigned by supplying the Contractor with a list of trees that have been marked with blue paint for priority pruning or red paint if tree is to be removed. All other trees on list are to be pruned for vehicular and pedestrian traffic. The City reserves the right to change, add, or delete areas or quantities to be pruned or removed as it deems to be in its best interest. Pruning and removal operations will commence no later than thirty (30) days after the contract has been awarded and will be completed no later than 90 days after work has begun. The Contractor will be responsible for notifying the appropriate utility authority before removing trees growing in the utility wires. Contractor will be responsible for any damage to utilities during the removal or pruning process.

C. **Public Relations:** An information sheet will be sent by the City Administrator to the property owners.

D. **Supervision:** Contractor consults with the City concerning details of scheduling of all work. Contractor has a competent person in charge of his work at all times to whom the City may issue directives and who shall accept and act upon such directives, and who reads, speaks and writes English competently. Failure for the supervisor to act on said directives shall be sufficient cause to give notice that the Contractor is in default of contract unless such directives would create potential personal injury of safety hazards. The City requires a certified arborist on job site, and requires the arborist's certification number in this bid.

E. **Inspections:** The City is called at #_____ before 8:30 a.m. on mornings of each working day and told exact location of that day's work. The City inspects work at its discretion and is requested by letter, five days in advance of the completion of this contract, to provide a final inspection.

F. **Tree Damage:** Climbing irons, spurs or spikes are not used on trees to be pruned. Any tree damage caused by contractor is repaired immediately at no additional expense to the satisfaction of the City Administrator. Trees damaged beyond repair, as judged by the City Administrator, are removed at no expense to the City and replaced by a tree of size and species designated by the City Administrator at no additional expense to the City or the dollar value of such damaged trees, as determined by the City Administrator, is deducted from the monies owed the Contractor.

G: **Pruning Specifications:** Conforms to latest revision of standards of National Arborist Association, ANSI A300. All cuts shall be made as close as possible to the trunk or parent limb, without cutting into the branch collar or leaving a protruding stub. Bark at the edge of all pruning cuts should remain firmly

attached. All branches too large to support with one hand shall be precut to avoid splitting or tearing of the bark. Where necessary, ropes or other equipment should be used to lower large branches or stubs to the ground. Treatment of cuts and wounds with wound dressing or paints has not been shown to be effective in preventing or reducing decay, and is not generally recommended for this reason. Wound dressing over infected wood may stimulate the decay process. If wounds are painted for cosmetic or other reasons, then material non-toxic to the cambium layer of meristematic tissue must be used.

Care must be taken to apply a thin coating of material only to exposed wood.

Old injuries are to be inspected. Those not closing properly and where the callus growth is not already completely established should be bark traced if the bark appears loose or damaged. Such tracing shall not penetrate the xylem (sapwood), and margins shall be kept rounded.

Equipment that will damage the bark and cambium layer should not be used on or in the trees. For example, the use of climbing spurs (hooks or irons) is not an acceptable work practice for pruning operations on live trees. Sharp tools shall be used so that clean cuts will be made at all times.

All cut limbs shall be removed from the crown upon completion of the pruning. Cleanup of branches, logs or any other debris resulting from any tree pruning shall be promptly and properly accomplished. The work area shall be kept safe at all times until the cleanup operation is completed. Under no condition shall the accumulation of brush, branches, logs or other debris be allowed upon a public property in such a manner as to result in a public hazard.

Trees impeding vehicle or pedestrian traffic should be raised up a least 13 feet over streets and 8 feet over sidewalks. Trees obstructing control devices (stop signs, yield signs and traffic lights) should be trimmed to allow for adequate visibility.

H. **Removal Specifications:** Removals will include topping and other operations necessary to safely remove the assigned trees. No trees or trunks are felled onto pavement. Work includes removal of basal sprout and brush and weeds within three feet of the trunk. The tree stump will be ground out to a depth of six (6) inches below the normal surface level including all surface roots. Immediately after grinding each stump, the grindings must be removed from the work area. Adjacent sidewalks, lawns, streets and gutters will be cleaned. Backfill consisting of clean earthen soil should be used to fill the cavity, free of debris, to normal ground level and seeded with an approved seeding mix. Do not backfill with wood chips. All labor, supervision, equipment, materials and supplies necessary for the execution of this work must be provided for by the contractor at no additional cost to the city. All debris disposal must be provided by the contractor at no additional cost to the city. The chosen contractor will be required to follow the ANSI Z-133 Standards for tree worker safety. If a contractor is not aware of these standards, copies can be provided by the City of _____.

I. **Traffic Control:** Is total responsibility of Contractor and is coordinated with the proper department of the City of _____.

The contractor shall be solely responsible for pedestrian and vehicular safety and control within the work site and shall provide the necessary warning devices, barricades and personnel needed to give safety, protection, and warning to persons and vehicular traffic within the area.

Blocking of public streets shall not be permitted unless prior arrangements have been made with the City and is coordinated with the appropriate departments. Traffic control is the responsibility of the Contractor and shall be accomplished in conformance with State, County and Local highway construction codes.

J. **Utility Agencies:** Are contacted by Contractor any time assistance is needed to work safely around overhead or underground installations. The City provides a list of principal contacts and telephone numbers for public and private utility organizations.

Tree trimming and removal operations may be conducted in areas where overhead electric, telephone and cable television facilities exist. The Contractor shall protect all utilities from damage, shall immediately contact the appropriate utility if damage should occur, and shall be responsible for all claims for damage due to his operations.

The Contractor shall make arrangements with the utility for removal of all necessary limbs and branches that may conflict with or create a personal injury hazard in conducting the operations of this contract. If the Contractor has properly contacted the utility in sufficient time to arrange for the required work by the utility, delays encountered by the Contractor in waiting for the utility to complete its work will not be the responsibility of the Contractor.

K. **Safety:** Work conforms to the latest revision of American National Standards Institute Standard Z-133.1 (Safety Requirement for Pruning, Trimming, Repairing, Maintaining, Removing Trees and for Cutting Brush).

At the time a contract is entered into, the Contractor shall certify in writing to the City that all Contractor's employees working on this job are either ‘Qualified Line Clearance Tree Trimmers’ or ‘Qualified Line Clearance Tree Trimmer Trainees’, as defined in the above ANSI Z-133.1 Standards.

L. **Clean Up:** Clean up procedures are completed within two hours after debris have been placed around the site of each tree requiring pruning or removal. The work site is left equal to or cleaner than pre-work conditions. Tree parts dropped or lowered from trees are kept off private property.

It shall be the responsibility of the Contractor to remove and dispose in a proper and acceptable manner all logs, brush and debris resulting from the tree maintenance operations. Wood may be left for residents, but that not taken must be disposed of.

M. **Damages:** Done by the Contractor to any person or property, public or private, are the total responsibility of the Contractor and are repaired or compensated for

by the Contractor to the satisfaction of both injured party and the City at no cost to the City.

N. **Insurance:** Contractor shall be fully insured as specified and shall be completely covered by State Workers' Compensation during the life of this contract. The Contractor shall have liability insurance in the amount of $1,000,000.00 for each occurrence and shall name the City as an additional insured on its policy for the work being performed in the City of _____.

O. **Payments:** Partial billings are acceptable, but not more frequently than every two weeks. Payment is made according to actual number of stumps removed. Ten percent (10%) of each invoice is withheld until Contractor's work is completed to the satisfaction of the City. Billing for work along any street may not be made until Contractor completes all work on that street. At the discretion of the city, half of the ten percent (10%) retainer may be held until spring if enough snow is on the ground that a proper inspection of sites cannot be conducted. When an inspection is done and the Contractor, as directed by the City, corrects any problem that may occur, the remainder of the retainer will be paid.

P. **Working Hours:** The Contractor will schedule work between the hours of 7:00 a.m. and 6:00 p.m. Monday through Friday unless authorized by the City to do otherwise.

Q. **Subcontracts:** The Contractor will not be allowed to subcontract work under this contract unless written approval is granted by the City. The Subcontractor, as approved, shall be bound by the conditions of the contract between the City and the Contractor. The authorization of a Subcontractor is to perform in accordance with all terms of the contract and specifications. All directions given to the Subcontractor in the field shall bind the Contractors as if the notice had been given directly to the Contractor.

R. **Execution of Contract:** The successful Bidder shall, within five (5) calendar days of the mailing of written notice of selection as the successful bidder, enter in to contract with the City on forms included within the bidding documents for the performance of work awarded him and shall simultaneously provide the appropriate bonds, indemnities and insurance required hereunder.

The contract, when executed, shall be deemed to include the entire agreement between the parties; the Contractor shall not base any claim for modification of the contract upon any prior representation or promises made by representatives of the City, or other persons.

S. **Discontinuance of Work:** Any practice obviously hazardous as determined by the City shall be immediately discontinued by the Contractor upon receipt of either written or oral notice to discontinue such practice.

T. **Observance of Laws, Ordinances and Regulations:** The Contractor, at all times during the term of this contract, shall observe and abide by all Federal, State and Local laws which in any way affect the conduct of the work and shall comply with all decrees and orders of courts and competent jurisdiction. The Contractor shall comply fully and completely with any and all applicable State

and Federal Statutes, rules and regulations as they relate to hiring, wages and other applicable conditions of employment.

U. **Supervision:** This contract will be under the direct supervision of the City or its authorized representatives. Any alteration or modifications of the work performed under this contract shall be made only in written agreement between the Contractor and the City-authorized representative and shall be made prior to commencement of the altered or modified work. No claims for extra work or materials shall be allowed unless covered by written agreement.

V. **Bidding Specification and Contractual Terms:** Tree maintenance work done under the direction of this contract shall be bid on forms as provided by the City.

W. **References:** Municipal tree pruning and removal experience is required. The bidder will provide a list of municipal governments that it has serviced in the past five years with a contact person listed.

X. **Award:** For a bid to be considered, prices must be quoted for the entire pruning and removal project.

Y. **Contract Termination:** The City shall have the right to terminate a contract or a part thereof before the work is completed in the event:

i. Previous unknown circumstances arise making it desirable in the public interest to void the contract;

ii. The Contractor is not adequately complying with the specifications;

iii. Proper arboricultural techniques are not being followed after warning notification by the City or its authorized representatives;

iv. The Contractor refuses, neglects or fails to supply properly trained or skilled supervisory personnel and/or workers or proper equipment of the specified quality and quantity;

v. The Contractor in the judgment of the City is unnecessarily or willfully delaying the performance and completion of the work;

vi. The Contractor refuses to proceed with work when as directed by the City; or

vii. The Contractor abandons the work.

Z. **Indemnification:** I, the Contractor, agree to indemnify, hold harmless, and defend the City from and against any and all loss, damage, or expense which the City may suffer or for which the City may be liable by reason of any injury (including death) or damage to any property arising out of negligence on the part of the Contractor in the execution of the work to be performed hereunder.

This indemnity provision shall not apply in cases where the Contractor has not been provided with timely notice, nor shall the Contractor be liable to the City for any settlement of any complaint affected without the prior written consent of the Contractor. This indemnity provision also specifically does not apply to loss, damage or expense arising out of contact with the City's trees by persons (other than employees of the Contractor engaged in the work contemplated by this agreement) who are around such trees.

STUMP REMOVAL SPECIFICATIONS FOR DEPARTMENT OF PUBLIC SERVICE CITY OF _____, _____

I. Scope of Work

To provide all labor, supervision, equipment, services and expertise necessary for grinding of stumps, disposal of grindings and debris and backfilling of stump holes in the City of _____ as specified herein. Since the work is potentially dangerous, and requires special expertise, it is to be performed by a Contractor that derives a majority of its annual income from arboricultural work and whose employees are highly trained and skilled in all phases of tree service work. Contractors must have been in business for at least five years. The City may require proof of the Contractor's involvement in tree service work.

The Contractor has the responsibility to:

A. Reserve work space along streets;

B. Grind out designated stumps;

C. Remove excess material and clean up the work site;

D. Guarantee the specifications will be met; and

E. Keep work site safe at all times.

All bidders must have in their possession or available to them by formal agreement at the time of bidding: trucks, stump grinders, hand tools, and other equipment and supplies that are necessary to perform the work as outlined in these specifications.

II. Location

Work is limited to stumps located on all public rights-of-way and City-owned property. All work under this contract shall be assigned by supplying the Contractor with a list of stumps that have been marked with the diameter of the stump.

The City reserves the right to change, add, or delete areas or quantities of stumps to be removed as it deems necessary. Stumping operations will commence no later than five (5) days after the contract has been awarded and will be completed no later than _____.

III. Supervision

Contractor consults with the City concerning details of scheduling of all work. Contractor has a competent person in charge of his work at all times to whom the City may issue directives and who shall accept and act upon such directives, and who reads, speaks and writes English competently.

Failure for the supervisor to act on said directives shall be sufficient cause to give notice that the Contractor is in default of contract unless such directives would create potential

personal injury of safety hazards. The City requires a certified arborist on the job site, and requires the arborist's certification number in this bid.

IV. Inspections

The City is called at #_____ before 8:30 a.m. on mornings of each working day and told exact location of that day's work. The City inspects work at its discretion and is requested by letter, five days in advance of the completion of this contract, to provide a final inspection.

V. Stump Grinding

The tree stumps will be ground out to a depth of six (6) inches below the normal surface level including all surface roots. Immediately after grinding each stump, the grindings must be removed from the work area. Adjacent sidewalks, lawns, streets and gutters will be cleaned. Holes are not to be left open overnight. Backfill consisting of clean earthen soil should be used to fill in the cavity, free of debris, to four (4) inches above the existing lawn grade surrounding the stump site (to allow for settling) and seeded with an approved seeding mix. Do not backfill with wood chips.

All labor, supervision, equipment, material and supplies necessary for the execution of the work must be provided for by the Contractor at no additional cost to the City. All debris disposal must be provided by the Contractor at no additional cost to the City.

The chosen Contractor will be required to follow the ANSI Z-133 Standards for tree worker safety. If a Contractor is not aware of these standards, copies can be provided by the City of _____.

VI. Traffic Control

Is total responsibility of Contractor and is coordinated with the proper department of the City of _____.

The Contractor shall be solely responsible for pedestrian and vehicular safety and control within the work site and shall provide the necessary warning devices, barricades and personnel needed to give safety, protection, and warning to persons and vehicular traffic within the area.

Blocking of public streets shall not be permitted unless prior arrangements have been made with the City and is coordinated with the appropriate departments. Traffic control is the responsibility of the Contractor and shall be accomplished in conformance with State, County and Local highway construction codes.

VII. Utility Agencies

Are contacted by Contractor any time assistance is needed to work safely around overhead or underground installations. The City provides list of principal contacts and telephone numbers for public and private utility organizations.

The Contractor shall protect all utilities from damage, shall immediately contact the appropriate utility if damage should occur, and shall be responsible for all claims for damage due to his operations. It is left to the Contractor's discretion to notify the appropriate utility authority before stump removal begins. If the Contractor has properly contacted the utility in sufficient time to arrange for the required work by the utility, delays encountered by the Contractor in waiting for the utility to complete its work will not be the responsibility of the Contractor.

VIII. Damages

Done by the Contractor to any person or property, public or private, are the total responsibility of the Contractor and are repaired or compensated for by the Contractor to the satisfaction of both injured party and the City at no cost to the City.

IX. Insurance

Contractor shall be fully insured as specified and shall be completely covered by State Workers' Compensation during the life of this contract. The Contractor shall have liability insurance in the amount of $1,000,000.00 for each occurrence and shall name the City as an additional insured on its policy for the work being performed in the City of _____.

X. Payments

Partial billings are acceptable, not more frequently than every two weeks. Payment is made according to actual number of stumps removed. Ten percent (10%) of each invoice is withheld until Contractor's work is completed to the satisfaction of the City. Billing for work along any street may not be made until Contractor completes all work on that street. At the discretion of the city, half of the ten percent (10%) retainer may be held until spring if enough snow is on the ground that a proper inspection of sites cannot be conducted. When an inspection is done and the Contractor, as directed by the City, corrects any problem that may occur, the remainder of the retainer will be paid.

XI. Working Hours

The Contractor will schedule work between the hours of 7:00 a.m. and 6:00 p.m. Monday through Friday unless authorized by the City to do otherwise.

XII. Subcontracts

The Contractor will not be allowed to subcontract work under this contract unless written approval is granted by the City. The Subcontractor, as approved, shall be bound by the conditions of the contract between the City and the Contractor. The authorization of a Subcontractor is to perform in accordance with all terms of the contract and specifications. All directions given to the Subcontractor in the field shall bind the Contractors as if the notice had been given directly to the Contractor.

XIII. Execution of Contract

The successful Bidder shall, within five (5) calendar days of the mailing of written notice of selection as the successful bidder, enter into contract with the City on forms included

within the bidding documents for the performance of work awarded him and shall simultaneously provide the appropriate bonds, indemnities and insurance required hereunder. The contract, when executed, shall be deemed to include the entire agreement between the parties; the Contractor shall not base any claim for modification of the contract upon any prior representation or promises made by representatives of the City, or other persons.

XIV. Discontinuance of Work

Any practice obviously hazardous as determined by the City shall be immediately discontinued by the Contractor upon receipt of either written or oral notice to discontinue such practice.

XV. Observance of Laws, Ordinances and Regulations

The Contractor, at all times during the term of this contract, shall observe and abide by all Federal, State and Local laws which in any way affect the conduct of the work and shall comply with all decrees and orders of courts and competent jurisdiction. The Contractor shall comply fully and completely with any and all applicable State and Federal Statutes, rules and regulations as they relate to hiring, wages and other applicable conditions of employment.

XVI. Supervision

This contract will be under the direct supervision of the City or its authorized representatives. Any alteration or modifications of the work performed under this contract shall be made only in written agreement between the Contractor and the City-authorized representative and shall be made prior to commencement of the altered or modified work. No claims for extra work or materials shall be allowed unless covered by written agreement.

XVII. Bidding Specification and Contractual Terms

Stump work done under the direction of this contract shall be bid on forms as provided by the City.

XVIII. Award

For a bid to be considered, prices must be quoted for the entire stump removal project.

XIX. Contract Termination

The City shall have the right to terminate a contract or a part thereof before the work is completed in the event:

A. Previous unknown circumstances arise making it desirable in the public interest to void the contract;

B. The Contractor is not adequately complying with the specifications;

C. Proper arboricultural techniques are not being followed after warning notification by the City or its authorized representatives;

D. The Contractor refuses, neglects or fails to supply properly trained or skilled supervisory personnel and/or workers or proper equipment of the specified quality and quantity;

E. The Contractor in the judgment of the City is unnecessarily or willfully delaying the performance and completion of the work;

F. The Contractor refuses to proceed with work when as directed by the City; or

G. The Contractor abandons the work.

XX. Indemnification

I, the Contractor, agree to indemnify, hold harmless, and defend the City from and against any and all loss, damage, or expense which the City may suffer or for which the City may be liable by reason of any injury (including death) or damage to any property arising out of negligence on the part of the Contractor in the execution of the work to be performed hereunder.

This indemnity provision shall not apply in cases where the Contractor has not been provided with timely notice, nor shall the Contractor be liable to the City for any settlement of any complaint affected without the prior written consent of the Contractor. This indemnity provision also specifically does not apply to loss, damage or expense arising out of contact with the City's stumps by persons (other than employees of the Contractor engaged in the work contemplated by this agreement) who are around such stumps.

CITY WIDE STREET TREE FERTILIZATION SPECIFICATIONS

CITY OF _____, _____

I. Scope of Work

To provide all supervision, material, labor, equipment, service operations and expertise required to fertilize street trees in the City of _____ as specified herein. Contractor has responsibility to:

A) Furnish, transport and apply water soluble fertilizer;

B) Reserve work space along streets;

C) Use hydraulic sprayer and soil probe or lance at 100-200 PSI;

D) Remove excess material and clean up site;

E) Keep work site safe at all times; and

F) Any work incidental to above.

II. Material Specifications

Section A: Types of Fertilizer to be Used

1. Inorganic Fertilizer (Chemical) - Is that derived from chemical sources. These nutrients are readily available in the soil and are rapidly soluble, with a short residual period.
2. Soluble Fertilizer - Is mixed with water and applied in liquid form. Soluble fertilizers may be applied via the deep root feeding method. Soluble fertilizers are usually inorganic and readily available. Materials with a limited solubility that dissolve slowly are often listed on fertilizer labels as water-insoluble nitrogen (WIN).

Section B: Fertilizer Analysis

1. Established Plantings - use fertilizers with N-P-K ratios of 3-1-2 or 3-1-1 for best response. These formulations may have slight variations.
2. Inorganic (water-soluble) nitrogen should be supplemented with synthetic or organic nitrogen (WIN) for the slow availability characteristics of the insoluble form of the material.

Section C: Rates of Application

1. For optimum plant growth, apply 4 -6 lbs. of actual nitrogen per 1000 sq. ft. every two years.
2. Diameter at Breast Height (DBH) - Measure the trunk diameter at 4.5 feet above grade. Generally for optimum growth, apply 1/4 lb. actual nitrogen per inch DBH to trees under 6 inches in diameter. The rate can be increased to 1/2 lb. N per inch DBH for most trees over 6 inches DBH. The majority of the trees to be

3. fertilized in this project will be 2 - 4 inch DBH. Using a 3-inch DBH tree and fertilizing with 1/4 lb. actual N per inch DBH would require 4.2 lbs of an 18-5-11 complete fertilizer:

   3 inches (dia) x 0.25 lb/inch (rate) = 0.75 lb. (amount of N).

   0.75 lb. (amount of N) / 0.18 (%N in 18-5-11) = 4.166 lbs of 18-5-11.

4. Liquid application - Diluted fertilizer solutions should be applied at the rate recommended by the manufacturer according to operating pressure and flow rate of the equipment to be used. Apply sufficient liquid mixture to supply the required rate of fertilizer as determined by the surface area of DBH method. It is suggested that one apply 150 gallons to each 2000 sq. ft. of surface area. Inject approximately 1/2 gallon of fertilizer solution per injection at 2.5 ft. spacings.

Section D: Timing of Fertilizer Applications

Early spring before bud break is the recommended time for fertilizing. Fertilizing should not be done after leaves have fully expanded.

Section E: Method of Fertilizer Application

Liquid Injection - Injections using a soil probe or lance should be 2.5 feet apart, and 6 - 12 inches deep for trees. Begin lance injection 2 - 3 feet from the tree trunk and work out about 8 feet beyond the trunk or to the sidewalk or other hardscape obstacle, which ever is farthest. Use a hydraulic sprayer at 100-200 lbs pressure and soil lance designed for liquid fertilizer with a manual shut off valve and three or four horizontal discharge holes at 90 degrees in its point. Inject half a gallon of fertilizer solution into each hole. The addition of water to dry soil as occurs during the liquid injection process is an excellent side-benefit.

Section F: Additional Guidelines

1. Undesirable tree species that could be found on tree lawns or on public rights-of-way should not be fertilized. These are:

   silver maple, boxelder, alder, birch, catalpa, red bud, Russian-olive, osage-orange, apple, mulberry, poplar, cottonwood, cherry plum, black cherry, black locust, sassafras, willow, and elm.

2. Be aware that over-fertilizing small trees such as flowering crabapple can result in excessive succulent growth. Succulent growth is more prone to fireblight symptoms on susceptible plants such as pear, crabapple and mountain ash.

3. Fertilize in moist soils - Fertilizer should always be applied in moist soils to enhance fertilizer uptake and reduce fertilizer injury to plants and aid in soil injection treatment. If soils are not moist, irrigation should precede fertilization to moisten the plant root zone area. The liquid injection method of fertilizing trees will help moisten the soil in the root zone while applying desired nutrients.

4. Fertilizing Excessively Wet Soils - Avoid fertilizing trees growing in soil that is excessively wet. The roots in wet soil are often damaged from lack of oxygen caused by the accumulation of toxic gases. Adding fertilizer in any form may contribute to root injury.

5. Read the Label - Read the entire label of any fertilizer product before application and apply per label recommendations.

Appendix L
Sample Street Tree Ordinance

A PROPOSED STREET TREE ORDINANCE FOR

_____, _____

BE IT ORDAINED BY THE COUNCIL OF THE CITY OF _____, _____.

Section 1. Short Title

This ordinance shall be known and may be cited as the STREET TREE ORDINANCE OF THE CITY OF _____, _____.

Section 2. Definitions

For the purposes of this Ordinance the following terms, phrases, words and their derivations shall have the meaning herein given.

1. The word "shall" is always mandatory and not merely suggested.
2. The "City" means the City of _____.
3. When not inconsistent with the context, words of the masculine gender shall include the feminine and words of the feminine gender shall include the masculine; words used in the plural number shall include the singular number and words used in the singular number shall include the plural number; words used in the future tense shall include the present and words in the present tense shall include the future.
4. The term "Superintendent of Public Works" means the person authorized to exercise the powers granted to him by this Ordinance.
5. The word "person" means any person, firm, partnership, association, corporation, company, or organization of any kind.
6. The words "tree" or "street tree" include any tree or other plant in a public place or on private property as indicated by subsequent provisions of this Ordinance.
7. The words "public place" mean any public street, public highway, public park, and any property owned or held by the City of _____ within the boundaries of said City.
8. The words "arboriculture, "management" or "preservation" mean the treating, spraying, pruning and any other tree care work intended for the preservation of trees and the removal and prevention of tree pests, blights, and diseases of any and all kinds.

Section 3. The Street Tree Director

The Superintendent of Public Works shall by virtue of his office, be the Street Tree Director.

(Alternate) Section 3-A. Establishment of a Street Tree Committee

An administrative committee called the "Street Tree Committee" is hereby established. This five member committee shall consist of four citizen members and the Street Tree Director who shall serve as chairman and represent the City Board.

1. Term of Office

The four citizen members of the committee shall be appointed by the Mayor for a term as hereinafter provided or until their successors are appointed. The first two elector members shall be appointed for a term of one year and the second two elector members shall be appointed for a term of two years, respectively.

2. Authority of the Street Tree Committee

The committee shall have the authority to elect a secretary, establish subcommittees, adopt rules and regulations as may be necessary for the purpose of carrying out the intent of this Ordinance. Such regulations for the planting, care, pruning and removal of trees shall not only be aimed at the elimination of economic waste by reason of damage to public property and/or the property of others in the interest of public health, safety and welfare, but also for the aesthetic appearance of streets, avenues, highways, parks and other public areas in the city.

Section 4. Powers and Duties of the Street Tree Director

1. General Authority

The Street Tree Director is hereby given complete authority, control and supervision of all trees which now or which may hereafter exist upon any public place in this City and over all trees which exist upon any private property in this City when such trees are in such a hazardous condition as to affect adversely the public health, safety and welfare.

2. Specific Powers and Duties

A. Preservation and Removal of Trees on Public Property

The Street Tree Director shall have the right and duty to prune, preserve or remove any tree or other plant existing upon any public place when such tree, or part thereof, is so infected with any injury, fungus, insect or other plant disease or when such tree, or part thereof, constitutes an interference with travel. Said Director is further authorized to take such measures with regard to such trees or plants as he deems necessary to preserve the function and to preserve or enhance the beauty of such public place.

B. Order to Preserve or Remove Trees on Private Property

The Street Tree Director shall have the authority and it shall be his duty to order the pruning, preservation or removal of trees or plants upon private property when such trees constitute a public nuisance or when he shall find such action necessary to preserve the public health, safety and welfare.

i) Dead, Dangerous, or Diseased Tree

Any dead, dangerous, or diseased tree insofar as it affects the public health, comfort, safety and welfare is hereby declared a public nuisance dangerous to life and limb. For the purposes of this ordinance, a dead tree is any tree with respect thereto the Street Tree Director or his designated agent has determined that no part thereof is living; a dangerous tree is any tree, or part thereof, living or dead, which the said Street Tree Director or his designated agent shall find is in such a condition and is so located as to constitute a danger to persons or property on public space in the vicinity of the said tree; a

diseased tree shall be any tree on private property in such a condition of infection from a major pathogenic disease as to constitute, in the opinion of the said Street Tree Director or his designated agent, a threat to the health of any other tree.

ii) Specific Species as a Public Nuisance

Any trees, such as ailanthus, silver maple, poplar, boxelder, catalpa or willow whose roots penetrate through or under the surface of any public place in the City, is hereby declared to be an undesirable species of tree for street planting.

iii) Obstructions as a Public Nuisance

Any hedge, tree, shrub or other growth situated at the intersection of two or more streets, alleys or driveways in the City is hereby declared to be a public nuisance to the extent that such hedge, tree, shrub or other growth obstructs the view of the operator of any motor vehicle with regard to other vehicles or pedestrians approaching or crossing the said intersection.

C. Authority of Street Tree Director to Enter on Private Premises

The Street Tree Director or any designated member of his staff shall have the authority to enter upon private premises at any and all reasonable times to examine any tree or shrub located upon or over such premises and to carry out the provisions of this Ordinance.

D. Desirable and Undesirable Plant Lists

The Street Tree Director shall provide lists of trees undesirable for planting in public places in the City so as to ensure the public safety and welfare. These shall not be recommended for general planting, and their use, if any, shall be restricted to special locations where, because of certain characteristics of adaptability or landscape effect, they can be used to advantage. The Street Tree Director shall provide lists of trees desirable for planting in public spaces. Other species and varieties may be added or deleted as experience proves their value. These lists are from the Street Tree Inventory provided by Davey Resource Group, a division of The Davey Tree Expert Company.

E. Issuance of Permits for Trimming, Removal and Planting

The Street Tree Director is given full authority and control in connection with the issuance of permits hereinafter provided for.

F. Issuance of Conditional Permits

The Street Tree Director shall have the authority to affix reasonable conditions to the grant of a permit issued in accordance with Section 6 of this Ordinance.

G. Delegation of Duties and Authority

In the exercise of all or any of the powers herein granted, the Street Tree Director shall have the authority to delegate all or part of his powers and duties with respect to supervision and control to his subordinates and assistants in the employ of the City, as he may from time to time determine. Such subordinates or assistants may be

appointed by the Street Tree Director as he deems expedient. He may, at any time, remove them from office.

H. Supervision

The Street Tree Director or his appointed officer shall have the authority and it shall be his duty to supervise all work done under a permit issued in accordance with terms of this Ordinance.

Section 5. Street Tree Inventory Plan Adopted

This is hereby adopted for the City of _____, a Street Inventory Plan Public Document showing species of all trees existing or to be planted in the public right-of-way of all streets within the City. Said Street Tree Inventory Plan is attached to this Ordinance and is hereby incorporated by reference. No person shall hereafter plant, transplant or remove any public tree on or to any street of the City except on a location where it will be in conformation to the Street Tree Inventory Plan and the species and variety therein designated.

Section 6. Required Permit and Conditions for Granting Relief

1. General Requirements

No tree shall be planted or removed in or upon any public place without a written permit from the Street Tree Director. Such permit shall designate the type of tree and place where such tree is to be planted or removed. The Street Tree Director shall have the authority to designate the species and variety of tree to be planted and the required spacing and required minimum planting size.

2. Application Data

The application for a permit herein required shall state the number, species and variety of trees to be pruned, preserved, removed or planted, the kind of treatment to be administered and such other information as the Street Tree Director shall find reasonably necessary to a fair determination of whether a permit should issue hereunder.

3. Standards for Issuance

The Street Tree Director shall issue the permit provided for herein when he finds that the desired action or treatment is satisfactory and that the proposed method and workmanship are satisfactory.

4. Exemptions

No permit shall be required to cultivate or water public trees or shrubs. The Street Tree Director may authorize any tree expert company or other professional to do the work or act described in Subsection 1 of this section without a written permit for each tree whenever he determines that such work or act will not be detrimental to the public interest and will be in accord with the spirit and other requirements of this Ordinance.

Section 7. General Tree Regulations

1. Injury to Trees Prohibited

No person shall, without the written permission from the Street Tree Director in the case of a public tree, do or cause to be done to others, any of the following acts:

A. Secure, fasten or run any rope, wire, sign or other device or material to, around, or through a tree.

B. Break, injure, mutilate, deface, kill or destroy or permit any fire to burn where it will injure any tree.

C. Permit any toxic chemical, gas, smoke, brine, oil or other injurious substance to seep, drain or to be emptied upon or about any tree.

D. Excavate any ditch or trench in such a manner as to adversely affect the health of a tree or damage the root system.

E. Erect, alter, repair or raze any building or structure without placing suitable guards around all nearby trees which may be injured or defaced by or where said injury or defacement may arise out of, in connection with or by reason of such operation. Quality of said guard shall be determined by the Street Tree Director.

F. Knowingly permit any uninsulated electric transmission or distribution wires to come in prolonged contact with any public tree.

G. Remove any guard, stake or other device or material intended for the protection of any public tree or close or obstruct any open space about the base of a public tree designed to permit access of air, water and fertilizer.

2. Moving Trees

All moving of trees upon any public place in this City made necessary by the moving, construction or razing of a building or structure by any other private enterprise shall be done under the supervision of the Street Tree Director at the expense of the applicant. Such applicant, as one of the conditions of obtaining such permission, shall deposit with the City such sum in cash as the Street Tree Director may determine and specify to cover all the costs of moving and replacement thereof: provided, however, that in lieu of such cash deposit the Street Tree Director may, at his discretion, accept a good and sufficient bond in like amount conditioned upon the payment of all the costs of such moving and replacing.

Section 8. Procedure Upon Order to Preserve or Remove

When the Street Tree Director shall find it necessary to order the pruning, preservation or removal of trees or plants upon private property as authorized in Section 4, (2), (b) herein, he shall serve a written order to correct the dangerous condition upon the owner, occupant or other person responsible for its existence.

1. Method of Service

The order herein shall be served in one of the following ways:

A. By making personal delivery of the order to the person responsible.

B. By leaving the order with some person of suitable age and discretion upon the premises.

C. By affixing a copy of the order to the door at the entrance of the premises in violation.

D. By mailing a copy of the order to the last known address of the owner of the premises by registered mail.

E. By publishing a copy of the order in the local paper once a week for three consecutive weeks.

2. Time for Compliance

The order required herein shall set forth a time limit for compliance, dependent upon the hazard and danger created by the violation. In cases of extreme danger to person or public property, the Street Tree Director shall have the authority to require compliance immediately upon service of the order.

3. Appeal From Order

A person to whom an order hereunder is directed shall have the right, within 24 hours of service of such order, to appeal to the Mayor, who shall review such order within five working days and file his decision thereon. Unless the order is revoked or modified, it shall remain in full force and be obeyed by the person to whom directed. A person to whom such order is directed must comply with said order within 20 working days after an appeal shall have been determined. When a person to whom an order is directed fails to comply within the specified time period, the Street Tree Director may take such steps as he finds necessary to remedy the condition.

4. Special Assessment

If the cost of remedying a condition is not paid within 30 days after receipt of a statement therefore from the Street Tree Director, such cost shall be levied against the property upon which said hazard exists as a special assessment. The levying of such assessment shall not affect the liability of the person to whom the order is directed to fine and imprisonment as provided in Section 11. Such special assessment shall be collected with a forfeiture of 5% and interest for failure to pay at the time fixed by the assessing Ordinance.

5. (OPTIONAL) Assessment Ordinance

Those costs incurred by the City which constitute a special assessment as authorized by the Code of the City of _____, shall become a lien upon the property as of the date of the filing of the certificate of expenditure within the City Council. If such lien shall remain unpaid at the expiration of two years from the date of the filing of the certificate, the property may be sold for taxes in the same manner as property sold for general real estate taxes.

Section 9. Regulations Governing Residential and Apartment House Subdivisions

1. Street trees shall be planted by the property owner in all new residential and apartment house subdivisions including single family dwellings, stores, offices and industry within the City, including land abutting any street previously opened as well as those opened for the subdivision. Installation shall be made under the guidance of the Street Tree Director.

2. The number, size, species and location of the street trees planted at all new residences, offices, apartments, etc. shall be as specified by the Street Tree Director.

3. The Department of Licenses and Inspections shall not grant a building permit unless a street tree planting permit has been issued and a bond has been filed or cash deposited with the Street Tree Director to ensure compliance with this Ordinance and regulations adopted hereunder.

4. The bond or cash deposit shall equal the cost, as determined by the Street Tree Director, of purchasing and planting the required number of street trees.

5. The subdivider may comply with the street tree regulations or request the Street Tree Director to contract the work on public bid.

6. If a bond or cash deposit exceeds or is less than an accepted bid, the subdivider, in the case of the bond, may decrease or shall increase the bond and, in the case of a cash deposit, be reimbursed or increase the deposit in the amount of the difference.

7. Street trees shall be planted by the subdivider or contractor within two years from the issuance of a permit. Failure to plant the trees shall be a default and the bond or cash deposit shall be forfeited. Any funds derived from a default shall be expended by the Street Tree Director to plant the required trees.

Section 10. Regulations Pertaining to Persons Engaged in the Handling and Care of Street Trees

No person, firm or corporation shall advertise, solicit or contract as a tree expert to improve the condition of fruit, forest, shade or ornamental trees by feeding, fertilizing, trimming, bracing or other methods of improving or protecting trees without first obtaining a yearly permit from the Street Tree Director.

1. Anyone interested in obtaining such a permit shall make applications to the Street Tree Director. The Street Tree Director shall review the qualifications of the applicant and determine whether a permit will be issued.

2. Said permit shall be a prerequisite to the performance of any work connected with the planting, removing, spraying, pruning, bark tracing and root pruning or any other acts necessary to obtaining such work.

3. He shall obtain and maintain in full force and effect, covering the performance of the work covered by the permit issued under these Regulations, comprehensive property damage and public liability insurance. Said policy of insurance to have a minimum limit of $100,000 and $300,000 for injury to any person or persons and $50,000 for damages to any property. A certificate of said insurance policy with a 30-day cancellation notification shall be placed on file with the Street Tree Director. Additionally, they must provide workers' compensation insurance for all employees.

4. He shall perform the work described above in a professional manner and, in addition, shall comply with the specifications (written and drawn) furnished by the Street Tree Director. He shall further comply with regulations governing work to be done as directed upon the permit to cover such work.

5. A party who fails to obtain such as permit violates this section of the Ordinance and may be subject to a fine of not more than $100 per day. The imposition of this penalty shall not affect the liability of the person to fine and imprisonment as provided in Section 11 of this Ordinance.

Section 11. Penalty

Any person violating any of the provisions of this Ordinance shall be deemed and held guilty of a misdemeanor and upon conviction, shall be fined in any sum not to exceed $100 for each such offense and each day during which the violation shall continue, shall be held and deemed to be a separate offense.

Section 12. Constitutionality

If any of the provisions of this Ordinance shall be declared invalid or unconstitutional by any court of competent jurisdiction, such declaration shall not invalidate any other provisions of this Ordinance. The council of the City of _____ hereby declares that they would have adopted each and every portion of this Ordinance separately regardless of the possible invalidity of any part thereof.

Section 13. Adoption

This ordinance shall take effect from and after _____.

(Alternate) Section 13-A. Adoption

This Ordinance is hereby declared to be an emergency measure for the reason that its immediate passage is necessary for the preservation of the public peace, health and safety of the City of _____ and it shall take effect and be in force immediately from and after the date of its passage and approval.

Section 14. Repealer

Any Ordinance of part thereof heretofore adopted which in any manner conflicts with any provisions of this Ordinance is hereby repealed to the extent of such conflict.

Appendix M
Sample Tree Preservation Ordinance

SAMPLE TREE PRESERVATION ORDINANCE

1.0 Intent

The City of _____ finds that:

- _____ has an abundance of trees that have benefited its citizens for many years, providing protection, cool shade, food and rest;
- _____'s trees have played an important role in the quality of life and the economic value of homes and property in the City;
- _____'s trees have acted as purifying systems for the air, and with their roots have held the soil to minimize erosion and flooding;
- _____'s trees have been an invaluable physical and psychological counter-balance to the urban setting, making life more comfortable by providing shade and cooling the air, reducing noise level and glare, and providing an essential counter-point to man's impact on the land;
- As the population of the City has expanded, so have the needs for housing and services. To meet those needs, development has occurred, but sometimes those needs have been met at very great expense to the City's natural environment;
- The City's trees, which have been so invaluable, are easily damaged and destroyed during the activities associated with development, even when these trees are not in the direct way of said development;
- While homeowners commonly preserve, plant and replace their trees, the process of development itself has often resulted in the clearing or inadvertent damage to trees and shrubs on large tracts of land, that results in a net loss of trees to the City;
- The intent of this ordinance is to ensure the protection of the maximum number of City trees possible and to preserve and perpetuate these natural assets for future generations.

1.1 Purpose

City of _____ finds that the interests of the public health, safety and welfare of its citizens require the establishment of standards limiting the destruction of and ensuring the survival of as many trees as possible in the City and the replacement of trees sufficient to promote the value of property and the quality of life of its citizens; to safeguard the ecosystem necessary to insure the stabilization of soil by the prevention of erosion and sedimentation; to reduce storm water run-off and the costs associated therewith; to replenish groundwater supplies; to prevent the destruction of carbon dioxide and to replenish oxygen in the atmosphere; and to provide greenbelts and buffers to screen against noise pollution, artificial light and glare.

Toward those ends, and for the benefit of all of the citizens of _____, it is intended that this ordinance will prohibit the unnecessary clearing of trees and to provide for the reforestation of cleared land so as to achieve no net loss of trees and to preserve, as much as possible, the existing tree composition.

2.0 Definitions

1. Basal area (BA) is the cross-sectional area at breast height (4.5 -feet), usually expressed in square inches or square feet of all of the trees in the stand.
2. Diameter breast height (dbh) is the diameter of any tree, 4.5 feet above the natural ground line. Wherever the word diameter is used in this ordinance, it shall be taken to mean dbh, unless otherwise specified. The related term, circumference, is the diameter multiplied by 3.1416 (π), and is also a measurement around the tree at the 4.5 feet standard.
3. Dripline is the outside diameter of a tree crown.
4. Historic Tree is a tree which has been found by the City to be of notable historic interest to the City based on its age, species, size or historic association with the City.
5. Official Master Tree Protection Map is a map identifying tree protection areas, specimen trees and historic trees, and shall mean those official maps on file with the City.
6. Person is any public or private individual, group, company, firm, corporation, partnership, association, society or other combination of human beings whether legal or natural.
7. Protected Tree is any tree growing within tree protection areas.
8. Shrub - is any woody plant of low height with several stems.
9. Specimen Tree is a tree determined by the City to be of high value to the community because of its type, size, age or other significant tree characteristic.
10. Urban Forester(s) is the individual, or individuals, responsible for administering and enforcing this ordinance.
11. City Tree Board is the board responsible for overseeing this ordinance.
12. Tree is a woody plant having at least one well defined stem and a more or less definitely formed crown, usually attaining a height of at least eight feet.

13. Tree Destruction Permit is the permit which must be obtained before any tree may be removed, as specified in this ordinance.

14. Tree Protection Area is any undeveloped area which contains a significant number of trees, and which should have an on-site inspection by the Urban Forester before any tree destruction permit is issued for that area, notwithstanding any exemptions which otherwise apply. Such areas are identified on the Official Master Tree Protection Map.

3.0 Tree Destruction Permit

It shall be unlawful to cut or remove or otherwise cause the death of any tree having a dbh of over eight (8) inches, except as otherwise provided by the City Tree Board, pursuant to Section _____, in _____, as covered in this ordinance, without first having obtained a permit, except as otherwise herein provided. It shall be unlawful to remove any tree from a Tree Protection Area without having first obtained a Tree Destruction Permit. Certain trees, designated as specimen or historic trees, because of their size, age, rarity, historic or ecological value shall be protected from cutting or destruction regardless of their location within the City.

3.1 Exceptions

The requirement of a permit in the above section is modified in the following situations:

3.1.1 Homeowners shall not be required to obtain a permit to cut a tree from the parcel of land upon which they reside, unless that parcel exceeds 100,000 square feet or unless the tree is identified as a specimen or historic tree pursuant to the terms of this ordinance.

3.1.2 This ordinance is not intended to regulate commercial nurseries, Christmas tree farms, orchards, horticultural operations, or the destruction of dead trees or the destruction of a tree that has become, or threatens to become, an immediate danger to human life or property. This exception shall not be construed to include the harvesting of lumber.

3.1.3 Cutting down, killing or otherwise destroying trees by state or county agencies. public service companies and natural gas companies performing normal construction and maintenance pursuant to applicable state or federal safety construction laws and regulations do not fall within the purview of this ordinance.

4.0 Enforcement Authority

The City Forester shall have the responsibility to identify and designate tree protection areas, specimen and historic trees, issue tree destruction permits and supervise all work performed under any permit issued pursuant to this ordinance.

4.1 Any person residing in the City may request that the City Forester examine any tree to determine if that tree should be protected as a specimen or historic tree.

4.2 The City Forester shall survey the City for specimen, historic, and other important trees. Upon identifying a specimen or historic tree, the City Forester shall place a notice in the

land records of property upon which any such tree is located, stating that such tree is protected by the provisions of this ordinance. Such notice shall also be added to the City official Tree Protection Map. When a tree destruction permit application is received, the Forester shall make an on-site inspection, if necessary, to ascertain the presence or absence of such protected trees.

4.3 The City Forester shall consult with the applicant for a tree destruction permit so as to ensure the survival of any trees not removed from the site.

4.4 The City Forester may make reasonable entry upon any lands within the City for the purpose of making any investigation, survey, or study contemplated by this ordinance.

4.5 The City Forester shall make all approvals or denials of tree destruction permits and all designations of specimen or historic tree status in writing.

4.6 The City Forester shall prepare the Official Master Tree Protection Map.

4.7 The City Forester shall coordinate with the entities identified in 3.1.3 of this ordinance so as to meet the purposes of this ordinance.

5.0 City Tree Board

There is hereby created a City Tree Board, consisting of no less than five individuals to oversee the activities of this ordinance and to serve in an advisory role to the City Forester in setting policy guidelines for enforcement of this ordinance. They shall be residents of the City, no less than 18 years of age, and shall be individuals who are actively interested in the improvement of the natural environment of _____. Their terms shall be for ____ years, following usual procedures for new boards.

5.1 The City Tree Board shall have the authority to change the minimum size requirement for a tree destruction permit for some species of trees, when appropriate.

6.0 Application for Tree Destruction Permits

A tree destruction permit shall be obtained for the destruction of any tree protected by this ordinance by submitting a written application to the City Forester, together with such filing fee as shall be set by the Board of Trustees. The application shall be a sworn statement which shall include the applicant's name and address; the consent of the owner of the land upon which the trees are located; the location of the property upon which the trees to be removed are located; and tree size, age and species, if known, of the trees to be removed.

6.1 If the application for tree destruction involves more than three trees, or if the property whereon the trees are located has been the subject of three previous tree destructions during the year preceding the current application, or if the tree to be removed is in a tree protection area, the application shall additionally contain the following information: a diagram of the 100 foot radius surrounding each tree to be removed, or a diagram to the property line, whichever is closer, that indicates the location of trees to be removed; and the locations of surrounding trees within that radius, together with their diameter and a tree restoration plan that meets the requirements of Section 9.0.

6.2 In addition to the previous permit requirements, if the proposed destruction is pursuant to construction or on-site improvements such as roads or utilities, in order to provide the City Forester enough information to evaluate the applicant's proposed restoration plan, and to also allow the City Forester to make recommendations that would facilitate the preservation of on-site trees, the applicant must also provide: the location of all diseased or damaged trees; the location of any trees interfering with any roadway, pavement or utility line; any proposed grade changes; all trees to be removed identified on the site for the Forester's inspection; and a plan showing location of future buildings and improvements.

7.0 Approval of the Tree Destruction Permit

Upon receipt of an application for the destruction of more than three trees, or upon the receipt of an application for any tree destruction in a Tree Protection Area, the City Forester shall visit and inspect the site and shall approve the destruction permit for those trees that meet the following criteria: the destruction of the tree or trees is necessary to allow reasonable use of the property; the destruction of the trees will not adversely affect soil erosion, soil moisture retention, flow of surface waters and the destruction of the trees is not inconsistent with the master drainage plan of the City; the trees to be removed are not specimen or historic trees as defined in this ordinance; and the applicant's tree restoration plan is adequate, pursuant to the standards described in Section 9.0.

7.1 The City Forester shall review the application for tree destruction to confirm that all the trees that will be destroyed are, in fact, included in the plan.

7.2 For purposes of this ordinance, it shall be presumed that trees within fifteen (15) feet of buildings and improvements will be irreparably damaged.

7.3 No tree destruction permit shall be valid for a period longer than one (1) year.

8.0 Appeal Procedures

Any person may appeal in writing, within fourteen days, the City Forester's written decision approving or denying a tree destruction permit, or approving or denying specimen or historic tree status to the City Tree Board.

8.1 Any person may appeal any decision of the City Tree Board to the Board of Trustees in writing within fourteen days.

9.0 Tree Restoration Plan and Mitigation Standards

The restoration plan shall provide for the preservation or the restoration of a minimum of 75% of the original basal area of all of the trees in the stand, except as otherwise allowed in this ordinance's mitigation sections.

9.1 If the tree restoration plan calls for the replacement of trees, the trees should be replaced in kind, if feasible. If not, the replacement trees will be selected from an approved list of preferred trees prepared by the City Forester and posted in a prominent place in the City and also provided to the applicant at the time of original application.

9.2 The applicant may, as mitigation to the restoration plan requirements, deposit with the City Tree Board, a cash payment in lieu of the preservation of some or all of the trees on the site necessary to meet the basal area requirements. Such deposit shall be placed in a fund to be established by the City Tree Board. Such fund shall be used only for tree planting and maintenance projects within the City that have been approved by the City Tree Board. The City Tree Board shall determine the amount of the deposit based upon the value of the trees removed from the applicant's property, including replacement cost, using procedures established by the International Society of Arboriculture.

9.3 Any of the aforementioned alternatives may be utilized in combination as deemed appropriate by the City Tree Board.

10.0 Timeliness

Before a preliminary plat plan, application for a special use permit, grading permit or a building permit may be approved by the City, the site must be inspected by the City Forester to determine if a tree destruction permit is necessary and to determine if specimen and historic trees are present on the site.

11.0 Tree Protection During Development

During any building, renovating or razing operations on any site which has been the subject of an approved tree restoration plan, the builder must erect and maintain suitable protective barriers around all trees, so as to prevent damage to said trees and so as to prevent a change in grade within the dripline of the tree.

11.1 Protective posts of nominal two inches by four inches or larger, or equivalent, shall be implanted deep enough in the ground to be stable, with at least three feet of post visible above ground, and linked together by approved fencing or other approved material and shall be clearly flagged with bright plastic tape so as to be readily visible.

11.2 The protective barrier described in 11.1 shall be established at a distance from the trunk of the protected tree to be at least six inches for each one inch of trunk diameter at 4.5 feet above natural grade line, or at minimum of two-thirds (2/3) of the distance to the dripline, whichever is greater.

11.3 The City Forester or the Tree Board may from time to time provide further protective standards or instructions so as to increase the likelihood of protected tree survival after development.

12.0 Bonding Procedure and Re-inspection Process

The City Forester has the authority, subject to appeal in writing within fourteen days by the applicant to the township Board of Trustees, to require the applicant to post a bond sufficient to guarantee the survival of specimen and historic trees and the completion of the approved restoration plan. The bond shall not be discharged until the City Forester shall visit and inspect the site to determine compliance. The inspection shall take place one year after planting, thereby allowing the City Forester to confirm the survival of the trees.

13.0 Penalties

Any person who violates any of the provisions of this ordinance, or permits any such violation, or who fails to comply with any of the requirements hereof, or who uses any land in violation of any detailed statement or plan submitted by him and approved by the City Forester shall be subject to punishment as provided by law. Each tree unlawfully removed or otherwise destroyed shall be a separate violation. Each violation shall be punished by a five hundred dollar fine, in addition to the value of the tree. The value of such tree(s) shall be determined using procedures established by the International Society of Arboriculture and in accordance with section 9.0 of this ordinance.

13.1 Any violation of this ordinance shall also constitute a public nuisance that may be enjoined and abated as provided by law.

13.2 No building permit, plat plan, grading permit, or special use permit shall be issued for any parcel of land that has been cleared of trees without meeting the requirements of this ordinance for a period of six years after the offense.

14.0 Severability

This ordinance is not a substitute for landscaping requirements which may be imposed pursuant to other sections of the City ordinances, although other landscaping requirements may be used to satisfy the requirements of an applicant's restoration plan. Should any part or provision of this ordinance be declared invalid by a court of competent jurisdiction, the same shall not affect the validity of the ordinance as a whole, or any part thereof, other than the part declared to be invalid.

15.0 Effective Date

This ordinance is declared to be an emergency ordinance which is immediately necessary for the preservation of the public health, safety and general welfare, and is therefore made immediately effective.

Appendix N
Contracting Tree Work

Contracting Tree Work

Tree care companies can be utilized to perform work beyond the capabilities of municipal manpower and equipment. Some of the advantages of using contracted crews to do tree work are—

- Does not require an increase in municipality personnel or re-training of existing personnel.
- Does not require large capital expenditures on equipment.
- Allows for greater flexibility in scheduling tree care operations.
- Allows the amount of work performed on an annual basis to be adjusted based on available municipality budget, without laying off municipality personnel.

A municipality can most cost-effectively contract tree work by:

- Scheduling work in the winter months, since this is traditionally the slow season for tree care companies. Companies may offer reduced rates (10 to 20%) for off-season work to keep their employees on the payroll.
- Performing work on a project basis. In this way, the tree care company is guaranteed a certain dollar volume of work, and the municipality is guaranteed specific work rates. Tree companies may offer a reduced rate (5 to 15%) for fixed-volume business.

Contracting of Tree Care on a Project Basis

To secure the best possible prices, Davey Resource Group recommends contracting on a project-by-project basis. Projects can include work on an individual tree or work on a group of trees, based on either the type of maintenance to be performed or by location of work. In the first example, all of the removals can be identified as a project, and bids can be solicited for the performance of the removals alone within a specific time frame. Ideally, bids for work should be on a per tree basis by diameter class. In the second example, the maintenance for all trees on several streets can be identified as a single project and bids solicited for the entire project. There are many variations of this concept for contracting tree care, and the Municipality can select the method that best suits its requirements. Project planning should focus on the efficient use of workers and equipment by the selected contractor. This will aid the Municipality in obtaining the best pricing for tree care projects.

It is important to consider more than just pricing when selecting a tree care contractor. Contractors should be required to post performance bonds on projects over a certain dollar amount; should show proof of adequate general liability and workers' compensation insurance; should be able to demonstrate sufficient ability to perform the work as specified; should hold all necessary licenses, such as pesticide application certification; and should be able to provide references to past work that is similar to the work specified for the project. In addition, the Municipality should maintain awareness of any public relations problems involving the contractor's work procedures, equipment and personnel appearance. Such problems or potential problems should be remedied as soon as possible.

Recommendations for Contractor Crew Inspection

When inspecting contractor tree crew operations, the Municipality should make sure the crews follow the guidelines set forth in contract specifications for the work being performed. These specifications should be developed and approved by the Municipality to ensure quality performance by contractors. Following these guidelines should result in improved pruning procedures and safe work practices. The inspection process should ensure that the contractual procedures are followed. Examples include:

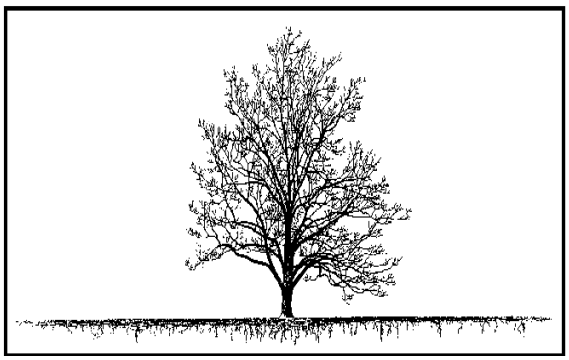
- Climbing crews do not use climbing spikes except for tree removals.
- All pruning cuts are made according to specifications. Pollarding, framing, or rounding over is not acceptable practice.
- Work operations are properly protected with traffic cones, pedestrian barriers and flaggers to prevent injury to crew personnel and the general public, and to prevent damage to adjacent property.

Appendix O
Construction Damage and Tree Preservation

Construction Damage and Tree Preservation

Trees are valuable assets. They clean the air, provide shade and wind protection, add aesthetic benefits, decrease cooling and heating costs, provide pollution control, provide stormwater management benefits, and increase property value.

Unfortunately, when expansion occurs in the name of progress, trees are often compromised in the process. Attempts to save trees during the construction process are often doomed unless protective measures are carefully implemented prior to and strictly enforced during construction.

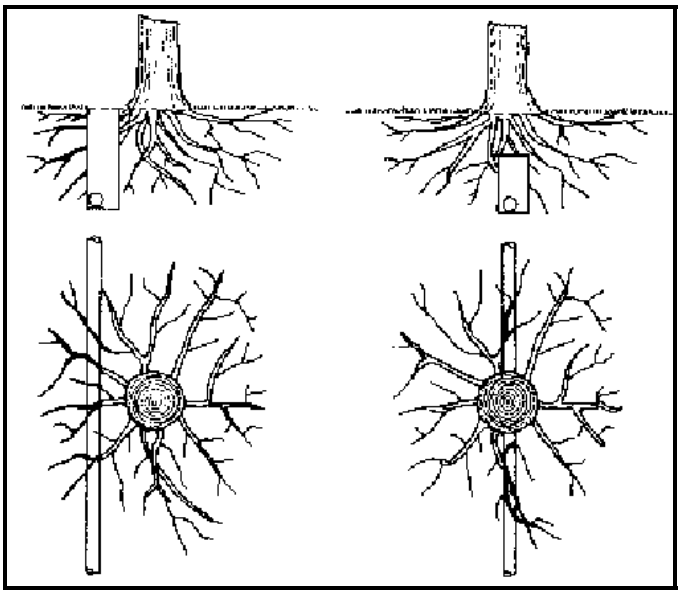


Scientists and arborists agree that the greatest percentage of tree roots are in the upper 12 to 18 inches of soil and extend well beyond the spread of the canopy. Trees are adversely affected both above and below ground by construction activities. To preserve trees during construction activities, every possible preservation technique must be implemented to minimize damage.

The following activities damage trees during construction:

1. **<u>Trenching</u>:** Construction equipment can injure a tree by tearing or breaking limbs and/or roots and by damaging the bark and wounding the trunk. Wounds created from these actions are permanent and can be fatal if extensive.

Whenever possible, trenching should be restricted to areas that will disturb the least amount of root systems. Where this cannot be achieved because of other site restrictions, tunneling or directional boring should be considered. These practices minimize tree damage by keeping root injury to a minimum.



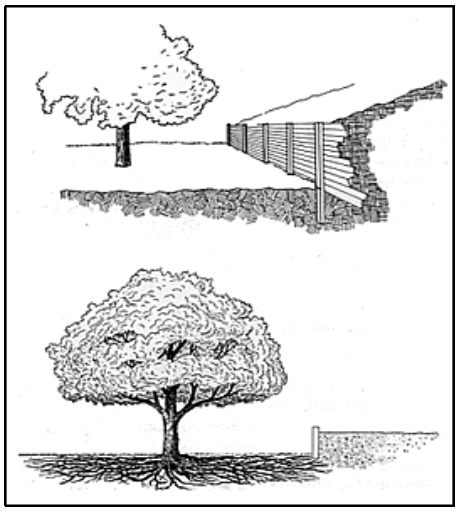
2. **<u>Soil Compaction</u>:** The most damaging effect of construction activity is soil compaction. Species tolerance to compaction varies, but most trees will suffer when the surrounding soil is compacted extensively.

Soil compaction during construction is usually due to equipment and vehicles continually driving over the root zone and from construction supplies and materials being stored for long periods of time near trees. Compaction happens very quickly and is difficult, if not impossible, to correct. Only seven passes of a small tractor over the same area is enough to change a porous soil consistency to one similar to concrete.

To remedy this, fencing and 'off-limits' areas should be established. If this cannot be accomplished, then a thick layer of unrefined (coarse) wood chips (12 to 18 inches deep) or sturdy geotextile materials can be temporarily laid over the driving area to reduce compaction.

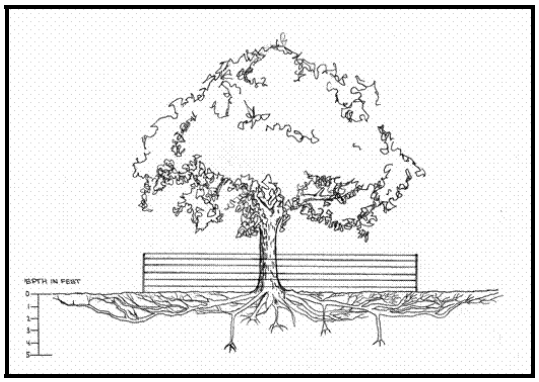
3. **<u>Soil Clearing and Grading</u>:**

Mechanical damage, soil compaction, and stripping of soil nutrients can all be avoided by preserving a tree's root zone. Restricting construction activity in and near the root zone by erecting metal, plastic, or wood fencing is the most effective means of avoiding damage to roots, trunks, and crowns.



Also, site design solutions are available to achieve required grade changes and to retain trees. The project architect and/or engineer, working in conjunction with a qualified arborist, can help develop innovative solutions to construction activities and tree preservation.

Branches directly interfering with construction work should be properly pruned back. If a tree is severely injured, it should be removed.



Ultimately, a *Tree Preservation Plan* should be developed specifically for all construction projects in the City that will affect trees. A preservation plan must note that protective tree fencing shall be installed prior to any site work and that it be placed at or outside of the dripline to ensure survivability of existing trees. It must also state that no site disturbing activities (cut, fill, parking, or material storage) shall take place inside the fenced area. It is also a very good idea to post signs on the fencing that display all pertinent information such as potential penalties, City forester's name and phone, etc.

Trees that are only slightly damaged may be restored to a healthy condition by pruning, watering, fertilizing, core aeration, and/or radial trenching.

While trees that have been disrupted by construction activities may not be showing signs of damage or stress now, they may show signs of decline in the near future. Trees in construction zones can be damaged or killed by root severance, soil compaction, soil grading, and/or construction materials (toxic leaks and spills).

Tables 1 and 2 list symptoms of construction damage and methods to minimize damage to trees. More information about construction damage and protecting trees during construction is included in Appendix O.

Table 1. Symptoms and Signs of Construction Activity Damage

TREE PART	SYMPTOMS AND SIGNS OF DAMAGE
Crown	Slow growth rate, staghorns, and/or dieback
Leaves	Wilted, scorched, sparse, undersized, distorted, chlorotic, browning margins, premature autumn color, and/or premature drop
Trunk	Wounds, absent bark, crown rot, absence of buttress (root) flares, adventitious sprouting, suckering, and/or severe insect damage and disease
Branches	Dieback, slow growth rate, wounds, adventitious sprouting, and/or suckering
Fruits and flowers	Abnormally large crop, absence of fruit, and/or flowering out of season

Table 2. Major Construction Impacts and Methods to Minimize Damage

IMPACT TO TREE	CONSTRUCTION ACTIVITY	METHODS/TREATMENTS TO MINIMIZE DAMAGE
Root Loss	Stripping site of organic surface soil during mass grading	Restrict stripping of topsoil around trees. Any woody vegetation (slated for removal and adjacent to preserved trees) should be cut at ground level and not pulled out by equipment. This will prevent tree root injury.
	Lowering grade; scarifying; preparing subgrade for fills and/or structures	Use retaining walls with discontinuous footings to maintain natural grade as far as possible from trees. Excavate to finish grade by hand and cut exposed roots with a saw to avoid root wrenching and shattering by equipment, or cut with root pruning equipment. Spoil beyond cut face can be removed by equipment sitting outside the dripline of the tree.
	Subgrade preparation for pavement	Use paving materials requiring a minimum amount of excavation (e.g., reinforced concrete instead of asphalt). Design traffic patterns to avoid heavy loads adjacent to trees (heavy load bearing pavement requires thicker base material and subgrade compaction). Specify minimum subgrade compaction under pavement within dripline (extra reinforcement in concrete or geotextile under asphalt may be needed).
	Excavation for footings, walls, and/or foundations	Design walls/structures with discontinuous footings/pier foundations. Excavate by hand. Avoid slab foundations/post and beam footings.
	Trenching for utilities and/or drainage	Coordinate utility trench locations with installation contractors. Consolidate utility trenches. Excavate trenches by hand in areas with roots larger than 2 in. in diameter. Tunnel under woody roots rather than cutting them.
Wounding Top of Tree	Injury from equipment	Fence trees to enclose low branches and protect trunk. Report all damage promptly so arborists can treat appropriately.
	Pruning for vertical clearance for buildings, traffic, and/or construction equipment	Prune to minimum height required prior to construction. Consider minimum height requirements of construction equipment and emergency vehicles over roads. An arborist, not construction personnel, should perform all pruning.
Unfavorable Conditions for Root Growth; Chronic Stress from Reduced Root Systems	Compacted soils	Fence-off trees to keep traffic and storage out of root area. In areas of engineered fills, specify minimum compaction (usually 85%) if fill will not support a structure. Provide a storage yard and traffic areas for construction activity well away from trees. Protect soil surface from traffic compaction with thick mulch. Following construction, vertical mulch compacted areas. Install aeration vents.

Table 2. Major Construction Impacts and Methods to Minimize Damage (Continued)

IMPACT TO TREE	CONSTRUCTION ACTIVITY	METHODS/TREATMENTS TO MINIMIZE DAMAGE
	Spills and/or waste disposal (e.g., paint, oil, fuel)	Post notices on fences prohibiting dumping and disposal of waste around trees. Require immediate cleanup of accidental spills.
	Soil sterilants (herbicides) applied under pavement	Use herbicides safe for use around existing vegetation and follow label directions.
	Impervious pavement over soil surface	Utilize pervious paving materials (e.g., interlocking blocks set on sand). Install aeration vents in impervious paving.
Inadequate Soil Moisture	Rechannelization of stream flow, redirecting runoff, lowering water table, and/or lowering grade	In some cases, it may be possible to design systems to allow low flows through normal stream alignments and provide bypass into storm drains for peak flow conditions. (Usually flood control and engineering specifications are not flexible where the possibility of flooding occurs). Provide supplemental irrigation in similar volumes and seasonal distribution as would normally occur.
Excess Soil Moisture	Underground flow backup; raising water table	Fills placed across drainage courses must have culverts placed at the bottom of the low flow so that water is not backed up before rising to the elevation of the culvert. Study the geotechnical report for groundwater characteristics to see that walls and fills will not intercept underground flow.
	Lack of surface drainage away from tree	Where surface grades are to be modified, make sure that water will flow away from the trunk; i.e., that the trunk is not at the lowest point. If the tree is placed in a well, drainage must be provided from the bottom of the well.
	Compacted soils; irrigation of exotic landscapes	Compacted soils have few macropores and many micropores. Core vent to improve drainage. Some species cannot tolerate frequent irrigation required to maintain lawns, flowers, and other shallow-rooted plants. Avoid landscaping under those trees, or utilize plants that do not require irrigation.
Increased Exposure	Thinning stands; removal of undergrowth	Preserve species that perform poorly in single stands as groups or clusters of trees. Maintain the natural undergrowth.
	Reflected heat from surrounding hard surfaces	Minimize use of hard surfaces around trees. Monitor soil moisture needs where water use is expected to increase.
	Pruning	Avoid severe pruning where previously shaded bark would be exposed to sun. Where pruning is unavoidable, provide protection to bark from sun.

Appendix P
Davey® Technical Bulletins

TECHNICAL BULLETIN
Prepared by The Davey Institute
DAVEY

ZIMMERMAN PINE MOTH

Dioryaria zimmermani

Figure 1. Examine the trunk and branch whorls for resin flow and white pitch accumulation caused by larvae tunneling inside the main trunk.

Figure 2. The larvae feeds under the pitch globs and severs the vascular tissues. The reddish frass specks in the pitch are diagnostic for this pest.

SYMPTOMS: White to cream-colored pitch masses (Figure 1) accumulate at the whorl area where the branches join the main trunk. The presence of pink-red sprinkles (frass) inside the pitching resin (Figure 2) distinguishes the Zimmerman pine moth larva's attack from other borers or disease symptoms. The part of the tree above the pitch masses (Figure 1) still receives water from the tree's roots so it continues to grow, but because of the larva's tunneling, nutrients taken in through the tree's canopy do not travel below the girdled attack site. Because it is not getting nourishment, the trunk below the attack site does not increase in diameter; therefore, the top becomes susceptible to wind throw and breakage after a few years.

CAUSE: All pines are attacked, but Austrian and Scotch are most susceptible. The larva is the immature stage of a moth that is 5/8-inch long and has gray wings with mottled reddish and gray markings. Adults emerge from the tree mid-June through mid-September (peak emergence occurs in mid-August) and deposit eggs on rough areas on the trunk. The larvae hatch and spend the winter in little silken covers under bark flakes or resin. In early April through early May, the larvae tunnel into the wood. There is one generation per year.

SOLUTIONS: There are two windows of control. The best results have been in early April before the overwintering larvae start tunneling. The second window is mid-June through early September, when the adults start flying. All branches and the entire trunk should be thoroughly treated.

Printed in the U.S.A. T15226-1/2000

TECHNICAL BULLETIN
Prepared by The Davey Institute
DAVEY

WINTER INJURY TO ORNAMENTAL PLANTS

The winter season can be particularly injurious to ornamental trees and shrubs, particularly those that have been stressed by poor growing conditions or planted north of their hardiness zone.

Boxwood, camellia, crape myrtle, forsythia, Southern magnolia, mahoma, American holly, pyracantha and rhododendron are especially susceptible to winter injury.

Figure 1. Winter drying is evident on this mahonia.

CAUSES OF WINTER INJURY: "Winter injury" is a catch-all term for various kinds of symptoms that show up in spring. Most so-called winter injury results from low temperatures, winter drying or sunscald.

Low temperatures*:* Damage caused by low temperatures is rarely preventable. Damage attributed to winter may actually occur in the fall before leaf drop or in spring soon after leaf buds open, as well as in winter - any time dormant or semi-dormant plant tissue is subjected to abnormally low temperatures or wide temperature fluctuations. It is important to recognize that injury symptoms may not appear until several weeks after spring leaf and twig growth or even later, when there is a water shortage and/or high temperatures.

Winter drying: Broad and narrowleaf evergreens lose moisture even during the winter. If the soil is frozen or very dry, this moisture cannot be replaced, and various parts of the tree or shrub, such as foliage, buds or twigs, will dry out. Symptoms of winter drying are bronzing or browning, occurring at the margins of broadleaf evergreens (Figure 1) and at the tips of narrowleaf evergreens.

Winter sunscald*:* Winter sunscald is damage to the trunk when underlying bark tissues are killed. High temperatures on a sunny, bright winter day, followed by low temperatures after sunset, can cause this injury. It is not simply the cold, but the rapid change in temperature, that destroys plant tissue. Winter sunscald is more often seen on thin-barked or recently transplanted trees and favors the south and west sides of trees.

SOLUTIONS: To improve the appearance and health of an injured plant and to increase its chances for survival, follow these practices:

1. Prune out dead and dying tissue after the plant's leaves emerge in the spring.
2. Help invigorate the plant through fertilization and proper watering and mulching.
3. Control insects and disease to help prevent further plant stress.
4. Consider bark beetle and borer treatments to protect these weakened plants.

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TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

Vascular Wilt Diseases

Verticillium Wilt / Oak Wilt

These diseases are caused by separate fungi that attack the water-conducting (vascular) system of trees. A tree responds by blocking its vascular system to contain the disease and, in so doing, cuts off the water supply to its leaves.

SYMPTOMS:

VERTICILLIUM WILT - The first symptoms of this disease are sudden wilting and dying of leaves on scattered individual branches during the summer. In some cases, large areas in the tree may wilt and die. Infected branches often show an olive-green discoloration in the new sapwood. This disease is most commonly found in maples, but it also affects several other plant species. Some trees will recover if the disease is managed properly.

OAK WILT - Leaves in the upper crown turn a dull green, bronze, or tan beginning at the leaf margin. Soon the leaves wilt and drop off the tree with various degrees of discoloration. Brown streaks develop in the new sapwood. Trees in the red oak group (red, black, pin, and scarlet) are not known to recover once infected. The white oak group (white, bur) varies in species resistance to oak wilt, but these trees usually die slowly over a period of several years.

CAUSE: Verticillium wilt is a soil-borne fungus that invades susceptible trees through the roots. It does not readily move from tree to tree.

Oak wilt can be spread by insects that carry the pathogen on their bodies from an infected tree to an uninfected tree. It also spreads via the vascular system of grafted roots of adjacent trees.

SOLUTION: For trees with only a few branches affected by Verticillium wilt, prune the affected parts and then fertilize. Trees with vigorous growth can "wall-off" or contain the disease within the old wood tissue, producing new wood which is not infected. During dry periods, water and mulch the tree to help improve recovery.

The major strategy with oak wilt is to prevent its spread to healthy oaks. This can be an extensive project involving the prompt removal of infected trees and the disruption of root grafts. Without these measures, the disease will almost assuredly spread and kill more trees. If there is a healthy oak within 40 feet of the diseased one, fumigation or trenching should be done to prevent root graft transmission of this fungus at least 10- 15 days prior to the removal of the diseased tree. Live oaks (only in Texas) infected with oak wilt can be injected with labeled fungicides to suppress the growth and spread of the disease-causing fungus.

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TECHNICAL BULLETIN
Prepared by The Davey Institute
DAVEY

TWO-SPOTTED SPIDER MITE

Tetranychus urticae

Figure 1. Stippling on this burning bush is the result of feeding by two-spotted spider mites.

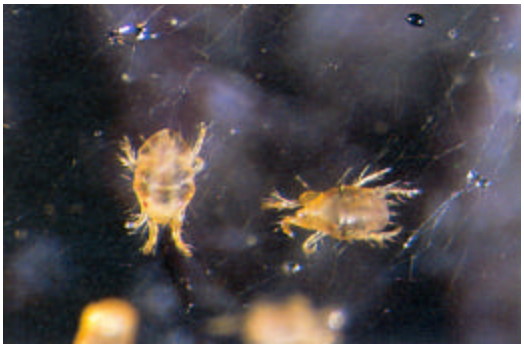

Figure 2. Perched on webbing, these tiny spider mites are easier to see than on your plants.

The two-spotted spider mite, neither a spider nor an insect, is a notorious pest that wreaks havoc on over 150 different plant species. The two-spotted spider mite is a warm-season mite. Though several other species of mites reach damaging levels on landscape plants, some, such as spruce and southern red spider mites, are more active in cooler weather. Plants commonly attacked by the two-spotted mite include `Compactus' winged euonymus (burning bush), azalea, forsythia and silver maple, plus many evergreens such as spruce and juniper. Even roses and annuals such as marigolds are susceptible.

SYMPTOMS: Mites feed on the undersides of leaves and suck the chlorophyll out of the leaf cells (Figure 1). This feeding causes a white-flecked, stippled appearance and can lead to premature leaf drop. Stressed plants suffer branch dieback and can become aesthetically challenged.

CAUSE: Spider mites are hard to combat because they are tiny (Figure 2) and easily overlooked until they are out of control. They reproduce at a record-breaking rates: under optimum conditions new adults develop every eight days, and each new adult female produces about 100 eggs!

SOLUTIONS: During hot, dry periods, the two-spotted spider mite is particularly difficult to control. Thorough coverage with the proper control product on both sides of the leaf is essential, and frequent inspections are necessary. The correct control product is essential to avoid harm to the spider mites' predators. Use of an inappropriate product such as Sevin, Dursban or Orthene, or general cover spraying, has resulted in spider mite outbreaks.

Two applications may be sufficient to manage the mites. However, there should be an option that would permit up to four applications when mites are in an outbreak situation. Because horticultural oil has no residual effect, multiple applications may be required. For severe mite outbreaks, longer-residual miticides and alternating miticide products will provide better results. Winter oil applications are not effective, as these pests do not overwinter on host plants.

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

TREE AND SHRUB FERTILIZATION

Why Fertilize Trees and Shrubs?

Forest trees usually thrive without the addition of fertilizer, which can give the erroneous impression that trees, in general, do not require fertilizer. Forest soils are rich in humus which is replenished by the decay of plant residues. In contrast, urban soils are usually very low in humus (organic matter) and nutrients. When leaves are removed (raked away), nature's recycling program for nutrients is interrupted. Because ornamental trees and shrubs are also subjected to harsh and unfavorable soil and environmental conditions, the need for fertilizer is even greater.

The addition of fertilizer not only improves the appearance! and condition of trees and shrubs, it also helps them to better withstand minor insect and disease problems, drought, and other stresses. Fertilization is not a cure-all but, after years of research, we have found that well-nourished trees do not have as many serious and costly problems.

Before fertilizing

What Is The Best Fertilizer To Use?

Davey's Arbor Greene 30-10-7 is a complete slow release fertilizer, containing nitrogen, phosphorous, and potassium. The nitrogen in Arbor Green is bound in organic molecules and then released in soil by microorganisms. This provides a prolonged availability and the plants will be more vigorous.

Fertilizers with high water soluble nitrogen release quickly and leach away, offering little nutrient carry-over from one season to the next. Due to the complex nature of the organic compounds found in Arbor Green®, the release rate is slow and consistent which results in a uniform growth response and healthier plants.

The salt index, which measures the salt concentration and, thus, the burn potential of fertilizer, is very low for Arbor Green*). This means that Arbor Green ® will not burn the roots of trees and shrubs with low salt tolerance, stressed or declining landscape plants, and newly planted trees and shrubs.

After fertilizing

How Should Trees and Shrubs Be Fertilized?

Our trained professional injects the proper amount of Arbor Green® and water under pressure directly into the soil of the root zone. This technique provides better distribution of the nutrients in the soil profile for more efficient contact and absorption by the roots. It also improves soil porosity and replenishes moisture within the root system. Our Davey fertilization technique will help plants develop a denser root system which will improve nutrient and water uptake.

The health and appearance of trees and shrubs will noticeably improve with fertilization. Because prevention is the goal, trees should be fertilized *before* problems occur for best results.

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TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

TOPPING vs. PROPER PRUNING

Many people have no idea that cutting large diameter main branches of a tree back to stubs in an effort to reduce the height is an unacceptable, and unskilled way to prune trees. This approach guarantees quick, visible results, but leaving stubs (also referred to as "hat-racking") permanently disfigures and essentially initiates the decline of that tree (see Figure I and 2).

Topping invites internal decay. When a branch is correctly pruned at its point of attachment (Figure 2) to the trunk just outside of the branch collar and the branch bark ridge, internal decay is usually stopped from progressing into the trunk by a barrier inside the collar. Also, a correct cut results in more rapid wound closure so that the bark quickly grows over the injury.

The trees on this beautiful lot have been topped. The beauty and the value of this property have been greatly decreased.

Branch stubs produced by topping harbor decay fungi which have an avenue to break through the protective barrier in the collar and then proceed into the main trunk. Whenever a cut is made in the main leader by topping, there is nothing to prevent decay from developing in the trunk. The tree may be structurally weakened and its useful life-span reduced. Other adverse effects of topping are:

1. Topping removes a major portion of a tree's leaves which are necessary for the production of carbohydrates.

2. Once-shaded bark in the canopy may be scalded by exposure to direct sunlight. This weakens the integrity of the protective bark and it is more prone to borers, diseases and decay fungi.

3. Stubbing stimulates the development of watersprouts just below the cut. These shoots grow rapidly, causing a topped tree to grow back to its original height faster and denser than a properly pruned tree. These watersprouts are weakly attached and are in danger of splitting out in a storm.

If the height of a tree has to be reduced because of storm damage or interference with electrical wires, it can be correctly done by a method called ***crown reduction or drop crotch pruning.*** This procedure involves the removal of a main leader or main branch at the point of attachment of a lateral branch (see Figure 2). The final cut should be parallel to the lateral branch and the branch bark ridge without cutting into the bark ridge. The lateral branch should be at least one-third the diameter of the branch or leader that is being removed.

The National Arborists Association considers "topping back to stubs" as an unacceptable arboricultural practice and advises against it. The NAA has developed pruning standards which define the type and degree of recommended pruning.

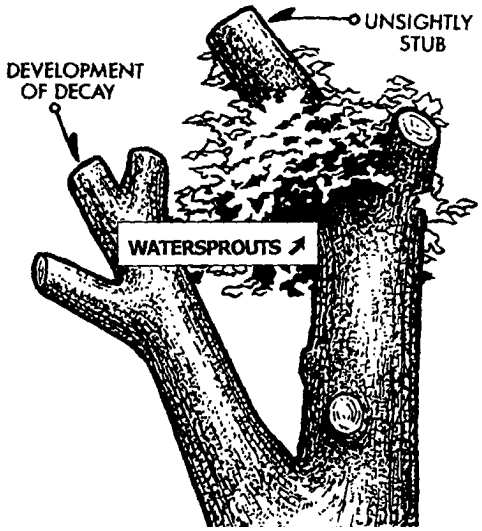

Figure 1. Incorrect Topping
Topping in this manner not only ruins the natural form of the tree but weakens the tree. The stubs are unsightly and invite the entrance of disease and decay. Weak watersprouts (new shoots) proliferate in a witches'-broom fashion.

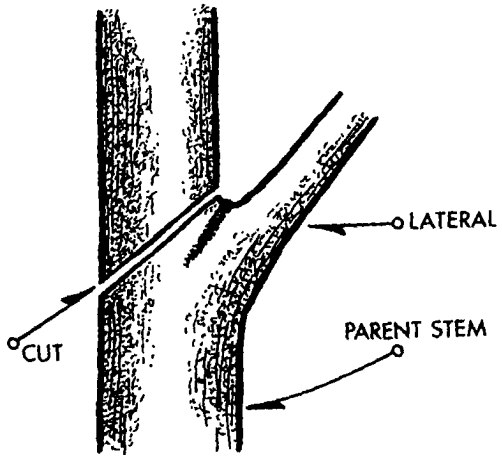

Figure 2. Crown Reduction Pruning
In reducing the crown of a tree, the main branch should be cut back to a lateral branch to reduce the possibility of decay and to encourage the growth of tissue over the wound.

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TECHNICAL BULLETIN DAVEY
Prepared by The Davey Institute

Tip Blight of Austrian, Red and Scotch Pine

(Diplodia pinea)
(Sphaeropsis sapinea)

This disease is most commonly seen on Austrian pine. It can also be seen on Mugo and Scotch pines, and on occasion is noted on some of the other two-and three-needle pines such as the red pine.

SYMPTOMS: The most evident symptom of tip blight is brown, stunted new shoots with short, brown needles. Needles on infected shoots often turn tan to dark brown. Close inspection of the bases of the dead needles may reveal the resin droplets and black specks of erupting fungal fruiting bodies.

Seed cones are susceptible to infection their second year but not their first. The damage to the cones is rarely severe, and black fruiting bodies can be seen by looking closely at the cone scales.

Short brown needles on new shoots stunted by Tip Blight.

When severe, the disease causes extensive dieback and weakening of the tree. When new candles have been killed several years in succession, a badly disfigured, possibly dead tree can result. Other problems may also cause similar symptoms, such as winter drying, drought, pine-shoot moth injury, and some needlecast fungi.

CAUSE: Spores of the fungus, *Diplodia pinea,* develop in the black fruiting bodies forming on the needles, fascicle sheaths, scales of second year cones and bark. They are spread about during periods of rainfall and high humidity. Although spores are produced from April through November, the pine needles are only susceptible to infection in the early spring. Furthermore, only current year needles are susceptible.

SOLUTIONS*:* Infection of new shoots can be reduced with fungicide applications. Attention must be given to protecting new growth of the trees from bud swell to 1/4 candle expansion stage. It is important to get the first application on the trees prior to bud break before candles emerge out of the sheath. Two to three applications of fungicide may be needed.

Since many spores are produced on cones, removal of previously blighted shoots probably doesn't decrease spore numbers appreciably, however, it does serve to make the tree look better and may increase its vitality. Trees should be kept in good health and regular maintenance, watering during droughts, and fertilizing.

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TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

THE RED IMPORTED FIRE ANT

Solenopsis wagneri

Figure 1. *Fire ant mounds may reach 14 inches in height and 12 to 16 inches wide. Lateral foraging tunnels may extend 15 to 30 underground.*

Figure 2. *Note the stinger on this fire ant (next to a thumbnail). Fire ants (workers) are only about 1/16 to 1/4 inch in length.*

The red imported fire ant is a member of fire ants found in the U.S., which include the black imported fire ant *(S. richteri),* southern fire ant (S. *xyloni)* and the fire ant (S. *geminata).* The red imported fire ant was originally introduced into this country from South America in the Mobile, Alabama area around 1932. Due to its aggressive nature, it has displaced most of the other ant species in infested areas, which range from southern North Carolina to central Texas.

SYMPTOMS: The red imported fire ant constructs mounds (Figure 1) in sunny areas in lawns, pastures, fields and roadsides. The colonies live underground in widely ranging tunnels, through which the workers forage. When the mound is disturbed, the workers rush to attack the offender. The ants quietly climb on to the enemy, clamp down with their jaws and then thrust with their stingers. The sting creates a burning sensation (hence the name fire ant) and a pustule may develop, which lasts for several days. Immediately rubbing the area of the sting gently will help aid in dispersing the venom and minimize pustule development. Persons who are allergic to bee and wasp venom may also be allergic to fire ant stings.

The red imported fire ant is a predator of insects and other arthropods and soil creatures. They perform a beneficial role in agricultural settings (sugarcane and cotton fields) by feeding on pest insects. However, they are a nuisance when they infest lawns, parks, playgrounds and other human-frequented areas.

CAUSES: Red imported fire ant colonies develop when winged adult males and females are produced in the parent colony. They then swarm, mate and the males die shortly afterwards. Swarming can take place any time

of the year, but peak activity is in the spring and fall. Females may fly several miles. Mated females find a suitable site, shed their wings and tunnel four inches into the ground. The female (queen) deposits several eggs and tends them as they mature into workers. Afterwards, the queen's sole function is to lay eggs (800/day) and the workers perform all the other tasks, such as tending the brood, constructing mounds, foraging and defending the colony. Colonies mature in three years and may contain as many as 500,000 workers. Queens may live up to eight years.

SOLUTION: Red imported fire ant colonies can be controlled in several ways.

1. Drench mounds found in flower beds or gravel areas with boiling water.

2. Chemical applications involve spreading the product OVER the mound then thoroughly watering. If not watered properly, the ants will relocate the colony to another area.

3. Baits contain insect growth regulators, which sterilize the queen and usually take longer to control the infestation. Baits MUST be applied **AROUND** the perimeter of the mound without disturbing it, in order to provide satisfactory control.

4. Avoid new invasions with yearly inspections and treatment as needed, especially in counties where red imported fire ant is established.
5. Before purchasing new landscape plants, **carefully inspect** for ant mounds or activity, to avoid bringing a colony home to your landscape.

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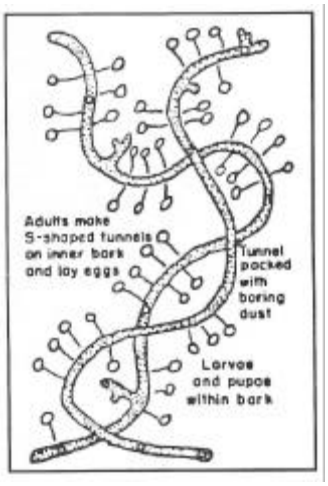
TECHNICAL BULLETIN DAVEY
Prepared by The Davey Institute

Southern Pine Beetle

Dendroctonus frontalis

Loblolly, shortleaf, and Virginia pines are preferred hosts of the southern pine beetle, but when populations become explosive, any pine may be attacked. Weakened trees are most susceptible to beetle attacks. Pines can be stressed or weakened in many ways, both by nature (drought, fire, freezing and thawing, floods, or lightning strikes) and by construction damage.



Larvae tunnels beneath the bark, forming S-shaped galleries.

SYMPTOMS: The first sign of beetle attack is a fading of the tree crown, progressively changing from green to dull green, then yellow and shortly to reddish-brown. Other indications are whitish pitch tubes which are produced when the beetles bore through resin canals.

CAUSE: The southern pine beetle is one of the most destructive insect enemies of pine in the South and Southeast. These 1/8" to 1/4" long, reddish-brown beetles can kill a giant pine if conditions are right.

Larvae tunnel beneath the bark, forming a network of S-shaped galleries that can girdle the tree. This vascular disruption, along with the growth of blue stain fungi introduced by the beetles, results in the death of the tree. In most areas, there are four or five generations a year, resulting in large populations unless control measures are taken.

White pitch tubes caused by the boring activity of southern pine beetle.

SOLUTIONS: The homeowner can reduce chances of attack and death of pines by having the trees fertilized with a slow-release fertilizer. Watering during dry periods is also essential.

Infested trees should be cut and removed as soon as possible to prevent spread. Do not leave the cut wood as firewood. Other pines on the property should be treated two to three times per year with products that effectively protect pines.

Pines that are kept vigorous and healthy (fertilize, mulch, and water) are less attractive to the beetles because they are able to thwart or repel the beetles with sticky pitch.

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TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

SCALE INSECTS

Figure 1. Gloomy scale, *Melanaspis tenebricosa*, is an armored scale that infests silver maple. Armored scales are typically flattened and blend into the bark.

Figure 2. The bumps on this live oak twig are a lecanium scale, *Parthenolecanium* species, an example of a soft Scale insect. These insects resemble miniature cowry shells.

SYMPTOMS: Look for undersized and sometimes, yellow-mottled leaves. A severe infestation will cause canopy thinning due to premature leaf drop and branch dieback. These insects can be found on bark, twigs, leaves or needles. Scale insects are a serious threat to plant health.

CAUSE: Scale insects are usually overlooked because they are small and blend into the bark or leaf tissue where they are feeding and they are not as mobile as larger insects. In fact, they are anchored into the plant's vascular tissue with their thread-like mouth parts, much like a button is sewn onto a shirt. There are two general groups of scale insects, the armored and soft scale insects.

Armored scales create a durable covering from wax pores on their body. This cover is like a lid which can be flipped off to reveal the vulnerable scale. This group of scales is flattened and smaller than soft scales, usually 1/8 to 1/4 inch in length. Armored scales may have multiple generations each growing season, however, they only produce 10 to 50 eggs per female. There are around 300 species of armored scales in the United States such as the gloomy scale (Figure 1), pine needle scale, euonymus scale and oystershell scale.

Soft scales are larger (1/4 to 1/2 inch long) and rounded in a profile with a flexible, waxy covering that is directly connected to the insect's body. Because these scales imbibe a large volume of sap, they excrete the excess as a sticky substance, politely referred to as "honeydew" or "ghost rain". People often complain that their trees are "weeping" or dripping, when it is actually the soft scale population in the tree that is dripping the honeydew. Due to the high sugar content of the honeydew, it is frequently colonized by the black growth of a fungus called a sooty mold. Females produce 1000 to 2000 eggs, another factor that makes them difficult

to control as it does not take long for a plant to become re-infested if just a few females survive the pesticide applications. Fortunately, there is usually only one generation per year. There are about 85 soft scale species in the United States, such as oak lecanium (Figure 2), cottony maple scale, pine tortoise scale and magnolia scale.

SOLUTION: Scale insects are difficult to control or "manage". Winter applications of "dormant" oil can be effective for some species, such as most of the soft scale group. However, the armored group, the euonymus, gloomy and obscure scales are in a susceptible stage at that time. But, in the winter, the pine needle scale and oystershell scale are in the egg stage and are not as vulnerable to "dormant" oil treatments. Management of some species requires pesticides that provide residual activity that will outlast the prolonged hatch periods of the crawlers (nymph that hatches from the egg) and the second instar stage. Reducing large populations of scales may take several applications per year and several years to achieve.

TECHNICAL BULLETIN
Prepared by The Davey Institute

PROPER PRUNING OF TREES

Proper pruning improves the health and appearance of trees and prolongs their useful life by removing undesirable branches which are dead, weakened, interfering, diseased, or insect-infested.

Before pruning

TYPES OF PRUNING: The Davey Tree Expert Company recognizes four general classes of pruning which define the type and degree of recommended pruning.

- **Aesthetic or Fine Pruning** is the thorough removal of undesirable branches over 1/2 inch in diameter. This includes selective thinning to lessen wind resistance (see photos).
- **Maintenance or Standard Pruning** is the removal of undesirable branches over I " in diameter.
- **Hazard Reduction Pruning** is the removal of undesirable branches over 2" in diameter. This class is recommended where safety considerations are paramount.
- **Crown Reduction Pruning,** also called natural or drop crotch pruning, is the proper reduction in the height or spread of the tree canopy.
- **Crown Raising** is the removal of lower branches in order to provide clearance.

After fine pruning

TOPPING vs. THINNING: Proper pruning is not to be confused with the disfiguring practice of "topping". Topping (heading, stubbing, hatrocking, etc.) is the indiscriminate removal of' a tree's main leader and branches resulting in stubs. The cut surfaces of the stubs do not close readily, and accelerated internal decay develops. The resulting flush of multiple epicormic branches (watersprouts) from the stubbed branches form terminals that are very weak. Topping leaves a tree highly susceptible to damage from strong winds, sunscald, winter injury, insects, and diseases.

Thinning is the correct method for removal of branches to their point of attachment to the trunk or another branch sufficient in size. This method eliminates unhealthy and unsightly stubs, resulting in an open, airy, natural appearance to trees. Thinning requires more skill and time to perform than does topping. Trees that are properly pruned and thinned will live longer and should not need to be pruned as often as trees that have been topped.

WHEN TO PRUNE: Maintenance pruning of most shade trees can be done anytime. Severe pruning, however, should be done in late winter or early spring before new growth begins. Pruning trees like birch and maple, which seep profusely from cut surfaces in the spring, is sometimes delayed until the fall, although the loss of sap is seldom injurious. Pruning of trees susceptible to certain vascular diseases, like American elm and certain oaks, should be avoided during the activity period of beetles which spread the diseases.

TECHNICAL BULLETIN
Prepared by The Davey Institute
DAVEY

Mistletoe

(Phoradendron spp.)

SYMPTOMS: Initial establishment of a mistletoe plant usually occurs on a small tree branch. Multiple clusters can develop on the same host tree after the initial mistletoe plant produces fruit. If multiple clusters of mistletoe develop, the host usually suffers loss of vigor, dieback of branch ends beyond the point of attachment, and often death.

Figure 1. A single mistletoe plant is shown attached to its host branch.

CAUSE: True mistletoe (the leafy kind found in the United States, of the genus Phoradendron) is a parasite that destroys thousands of trees every year. Mistletoe obtains its water, mineral nutrients and small amounts of organic compounds carried in sapwood from the stems of the woody host plants. True mistletoe species have simple leaves, oppositely arranged, either expanded or scalelike, depending on the species. The stem is woody near the base, and the nodes are closely spaced and somewhat swollen so that the plants sometimes appear jointed. The plants are evergreen and develop best in full sunlight high in the crowns of large trees.

SOLUTION: Treatment with Florel® while the host tree is dormant can provide reasonable management, but the mistletoe is not killed and will need to be retreated in three to four years. If cosmetically acceptable, remove the affected branches. Take care to remove at least one foot from the mistletoe to ensure that you get any part of the branch that has the mistletoe's spreading sinker roots, which are underneath the bark tissues. Mistletoe plants on large limbs or trunks may be cut or broken to help reduce the moisture stress that this parasitic plant places on the host tree. This process will have to be done repeatedly because new sprouts will develop.

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

Maple Decline

Maple decline affects primarily sugar maple, Norway maple, and red maple in the Northeast and Midwest. The problem is not a new one; stagheaded maples were described as early as 1917 in Massachusetts. At that time, dieback was attributed mainly to drought and poor conditions for tree growth afforded by the urban environment. These same conditions exist today, and reports of the incidence and severity of maple decline have increased markedly in recent years.

Maple decline affects upper portion of tree.

In urban sites, principle stress factors in maple decline include drought, de-icing salts, and/or road and sidewalk construction. These stresses also facilitate invasion by secondary organisms, including root rots, decays and twig blights, which greatly reduce chances of recovery from the original stress(es). When a healthy tree is stressed repeatedly, the stress alters the tree's internal chemistry to allow repeated attack by secondary organisms, and the tree declines and ultimately dies.

SYMPTOMS:

- **Reduced twig growth.** A general rule of thumb is that if the annual increase in twig length averages less than 5 cm., the tree may be in trouble.
- **Reduced foliage growth.** Sparse, light-green or scorched foliage signals that the tree may be declining.
- **Early fall coloration.** Maples normally begin showing fall color after the first frost or in mid to late September. When fall color develops earlier than normal, in late July or early August, the maple is definitely suffering from decline.
- **Dead branches in upper canopy.** Small dead branches seen in tree tops in late spring or early summer are indicative of decline. Over time, larger, more visible branches and limbs will die. The more numerous the dead twigs or branches are, the more severe the die-back decline conditions.
- **Poor root conditions.** If roots can be examined, look for reduced occurrence of small feeder rootlets; dead, brittle roots; and decaying buttress roots.

SOLUTIONS: The success of treatment to declining maples depends primarily on early detection of maple decline, the health of the tree prior to treatment, and its ability to respond to treatment.

(over)

Treatment for declining urban maples includes: watering, fertilizing, pruning dead branches, and reducing salt-laden spring water runoff over the roots.

Watering trees every week or two during dry weather is recommended. Trees should be watered slowly to soak the entire soil area under the tree canopy to a depth of 12 or more inches.

Fertilizing is best done with a slow-release fertilizer to minimize soil salts and safeguard the sensitive absorbing roots. Davey recommends Arbor Green injected into the root area to a depth of 12 inches. Proper fertilization will help stimulate new roots and improve the health and vigor of trees.

Dead branches should be pruned as well, to stimulate renewed vigorous shoot growth. Pruning, in addition to fertilization, helps revitalize declining trees and helps the tree ward off secondary organisms.

Road salt impact can be reduced by placing a barrier (curb, berm, ditch, etc.) to catch or divert the spring runoff water which often contains copious amounts of salt. If soil and foliar analyses have been run and high sodium or chloride concentrations were found, then leaching the soil with fresh water or applying gypsum to improve soil structure may be useful.

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TECHNICAL BULLETIN
Prepared by The Davey Institute

Lightning Protection For Trees

It takes years and years to grow a large, magnificent tree. It takes only seconds for lightning to strike one down.

A damaged strip of bark resulting from a lightning strike. A tree lightning protection system would have prevented this from occurring.

DAMAGE: More than half of the trees that are struck by lightning eventually die. For an unprotected tree, minimal damage may be evident on the trunk (cracking, peeling bark, etc.) while the roots have suffered considerable damage. Such a tree will probably soon wilt after being struck. For other trees, lightning may break off branches, trunks may split down the middle, or the entire tree may explode or burn. Even if lightning does not physically kill a tree, it will be much more valuable to destruction by boring insects and decay fungi.

CAUSE: Trees are attractive lightning targets because they provide a better conducting path than air for lightning to travel from a storm cloud to the earth. The tallest trees in a grove, trees in open areas, trees on the edge of a grove facing an approaching storm, trees on hilltops, and trees located close to buildings where wiring or plumbing might enhance ground conductivity are likely points of discharge for lightning bolts. Contrary to popular belief, lightning will often strike the same place more than once.

The tree species most often struck are: oak, elm, pine, tulip tree, cottonwood, ash, maple, sycamore, hemlock, and spruce.

SOLUTION: Although a tree lightning protection system does not prevent a tree from being struck by lightning, it is possible to equip a tree so that lightning will be conducted harmlessly into the soil.

A system of heavy, copper cables is installed from the highest point in the tree and from the ends of major branches, down the trunk, and into the soil beyond the tree's main root area.

(over)

Copper is a better conductor, making it more attractive to lightning than wood. If lightning were to strike the protected tree, it would actually strike only the copper and travel down the conductor cable into the ground where its energy would safely dissipate, thus saving the tree from being damaged or destroyed.

An added benefit of a tree lightning protection system is called the cone of protection. This refers to an area beneath and around a tree that is protected from lightning strikes. Lightning that would normally strike anywhere within this area will be attracted instead to the copper protection system of the tree. The cone of protection reduces the chance of injury or damage for people, buildings, or animals within the cone.

TECHNICAL BULLETIN
Prepared by The Davey Institute

IRON DEFICIENCY CHLOROSIS IN ST. AUGUSTINEGRASS

Chlorosis, caused by lack of iron, results in yellow blotchy areas in a

***SYMPTOMS**:* The entire leaf blade takes on pale green to bright yellow coloration. This usually occurs in blotchy, irregular areas throughout the lawn. The leaves have an interveinal yellowing, and, in severe cases, the newer leaves become yellow to almost white. The symptoms are common in the summer months, especially during periods of heavy rainfall. Because the lack of iron decreases the photosynthetic production of the grass plants, lawns may thin out, and weeds can gain a foothold if the situation is not treated.

CAUSE: Under alkaline conditions (pH greater than 7.5), iron is bound to the soil particles and is unavailable to the roots. Other factors that may exacerbate this condition include excessive irrigation, soil compaction, shaded sites, and high phosphorous and bicarbonate levels.

Before treating, rule out other problems that could cause similar symptoms, such as St. Augustinegrass decline (SAD), which is a virus-caused disease that occurs in Texas, Louisiana and Arkansas. Root-attacking nematodes will also cause an off-color appearance. Both SAD and nematodes will discolor the entire plant and not just the newer growth (leaves) as iron chlorosis does.

SOLUTION: The long-term solution is to correct soil alkalinity gradually with applications of sulfur. This will decrease the soil pH over a period of a few years. Repeated foliar applications of readily available iron such as iron sulfate or chelated iron will temporarily green-up the turf for a few weeks.

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TECHNICAL BULLETIN DAVEY
Prepared by The Davey Institute

INSECT PESTS OF BIRCH TREES

Birch Leafminer

Fenusa pusilla

Figure 1. *Brown, inflated blotches develop on leaves during mid to late spring.*

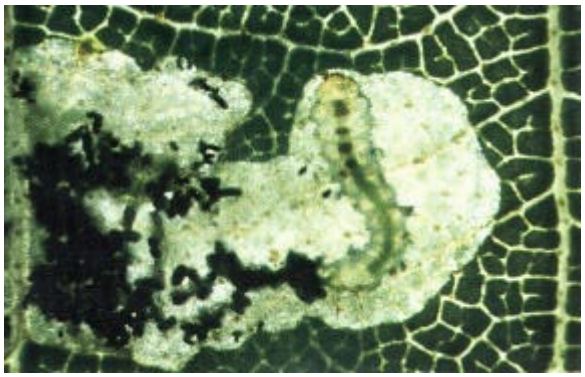

Figure *2. Leaves are "gutted" by small insect larvaefeeding inside the leaf.*

SYMPTOMS: Birch leaves develop brown, inflated blotches by mid to late spring (Figure 1). Leaves may be killed by small larvae inside the leaf, which devour green tissues between the upper and lower surfaces of the leaf (Figure 2). A severely infested tree canopy takes on a tan-brown appearance and defoliates prematurely. Repeated years of infestations can cause branch die-back and makes trees more vulnerable to borers and environmental stress.

CAUSE: The adult birch leafminer is a 1/8 inch-long, black, robust, gnat-like insect, referred to as a sawfly. The female deposits eggs into young leaves. Larvae hatch and begin feeding inside the leaves, causing damage. They mature within 10-15 days, drop to the ground to pupate, and emerge as sawflies. There are several generations per year, with a new batch of sawflies attacking each new flush of foliage.

SOLUTION*:* Foliar applications are effective when the birch leaves are about half-grown in the spring. A second application in about 3 to 4 weeks may be necessary to minimize damage by the second generation of birch leafminers.

A soil application for season-long results should be injected into the soil in August through October, the year prior to birch leafminer activity. This new product accumulates slowly in the tree and an early application is required for the product to be effective in the spring.

Before you plant, select a planting site where birch trees will prosper, such as in moist, well drained, sandy, or loamy soils. They will fall and be stressed even more by leafminer damage when they are planted in heavy, clay-type soils.

Fertilizing, mulching and watering also will help birch trees recover from birch leafminer damage.

(over)

INSECT PESTS OF BIRCH TREES

Bronze Birch Borer

Agrilus anxius

***SYMPTOMS**:* Look for off-colored and sparse foliage in the upper canopy of the birch tree. Branches in the upper crown die. Swollen ridges are observed on the trunk and branches (Figure 1). Small D-shaped holes in the bark are the exit points of the adult borer.

CAUSE: The bronze birch borer is a destructive beetle larva that feeds on birch trees weakened from drought, poor growing conditions or other insect infestations, such as birch leafminer. Borer larvae make long, winding tunnels under the bark, which cause the trunk or branch to die from lack of water and nutrients because the vascular tissues have been severed (Figure 2).

SOLUTION: Applications in early to mid-May can reduce further borer infestations. Applications need to be applied to rough areas of the bark on the main trunk and limbs, and especially at branch-trunk ridges. However, do not expect to control larvae that are already inside the tree.

A new treatment consists of using a soil-injected product applied in August through early October to prevent borer damage during the next season.

Prior to planting, select a well-drained sandy or loamy soil. Birches struggle in clay soils. Thereafter, keep the tree healthy by fertilizing, watering, mulching and controlling other insects and diseases. Fertilizing can increase a birch's tolerance to borer attack as well as help it overcome previous borer damage. European birch, *Betula pendula,* is highly prone to borer attack. Resistant species such as native paper bark species, *Betula papyrifera,* should be planted.

Figure 1. *Swollen ridges due to borer activity in the trunk and branches.*

Figure 2. *Borer larvae make long, winding tunnels under the bark.*

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TECHNICAL BULLETIN DAVEY
Prepared by The Davey Institute

Hypoxylon Canker of Oaks

Hypoxylon atropunctatum
Hypoxylon mediterraneum
Hypoxylon punctulatum

SYMPTOMS: Yellowing or wilting of oak leaves may signal the onset of Hypoxylon but these symptoms are typical of many stress factors, not necessarily caused by this disease.

Hypoxylon can be identified by the dark-colored, crusty fungus tissue on the dead cankered area. Large pieces of bark may slough off, exposing the fungus beneath. Bark may slough off in patches but, characteristically, in strips up to several meters long. Spore masses may vary in color from tan to bluish-gray to black. It is these spores, transported by wind, which cause new infections on wounded or stressed trees.

Willow and water oak appear to be most susceptible, followed by red oak and occasionally post and live oak. Although found throughout North America, this disease is primarily a problem in the Southern United States.

CAUSE: This fungus is noted for attacking trees which are already in a stressed or declining condition. Hypoxylon infected trees have been found where stress has resulted from construction damage, excessive fill, lawn mower damage, or storm damage. Drought conditions or excessively wet soils also predispose susceptible trees to the disease.

SOLUTION: Keep the trees as vigorous as possible by properly fertilizing. Prune out any branches showing early infection since this reduces the amount of spore inoculum. If grade changes or construction are anticipated, contact a qualified arborist for recommendations. Insect populations should be managed to reduce stresses resulting from insect feeding.

TECHNICAL BULLETIN
Prepared by The Davey Institute
DAVEY

HELP FOR DROUGHT - DAMAGED TREES

Dry soil conditions can significantly reduce the life span of valuable landscape trees. Because trees are both difficult and expensive to replace, they need attention both during and after a period of drought.

Figure 1. Symptoms of drought stress include wilting and yellowing of foliage. Tree in right foreground was not fertilized. Tree in left background was fed with Davey Arbor Green®.

SYMPTOMS: Noticeable symptoms of drought stress include wilted foliage, a sparse canopy of off-color and undersized leaves, leaf scorch, yellowing, leaf drop, and premature fall coloration. Closer inspection will reveal limited twig growth and small, poorly formed buds. Growth the next season will be stunted even if there is sufficient rainfall later in the year.

Surface-rooted trees, such as maples and dogwoods, and newly transplanted trees are especially susceptible to damage resulting from dry soil conditions. However, even large established trees may show the effects of drought. Elm, maple, sycamore, ash, tuliptree and beech are often affected in forests as well as in urban landscapes. Other species may be injured if a drought is severe.

Perhaps more life-threatening than anything to trees weakened by drought is invasion by borers and other secondary pests. Studies of trees' annual rings have shown that the growth of trees can be reduced for several years following a drought. During this recuperation period, trees are more susceptible to attack by various insects and disease-causing organisms. For example, elms subjected to drought are more likely to succumb to Dutch elm disease, sweetgums are more vulnerable to bleeding canker, and white-barked birches are extremely susceptible to bronze birch borer.

SOLUTION: The practices that have been saving drought-stressed trees for years are still valid today: watering whenever the soil is dry, fertilizing to enlarge root systems, mulching to conserve moisture, using pest management to control insects and diseases, and pruning to remove dead and dying branches.

- **Water, Water, Water!** Since most of a tree's active roots are within the top 12 inches of soil, a watering lance attached to a hose is the most efficient way of getting water directly to the roots while reducing evaporation and runoff. Apply 1 to 3 gallons of water using 3-foot spacings with the lance. If this is impractical, simply place a lawn sprinkler beneath the tree and let it run slowly until 2 inches of water has collected in a coffee can. Be sure to water the entire root zone beneath the tree canopy.

- **Fertilize** - Fertilizer will help reduce the severity of drought injury and enable trees to recover more quickly. Fertilizer enhances root development, and the expanded root system supplies more water to the tree. In addition, fertilizer helps promote the production of carbohydrates, which supply the energy necessary for growth and development. Because of the concentration of salts found in most fertilizers, drought-stressed trees are particularly sensitive to over fertilization. Davey Arbor Green' is specially formulated to avoid injury to trees weakened by drought. This unique deep-root fertilizer releases nutrients slowly to provide a continuous, uniform supply.

  Arbor Green is injected with a high pressure watering lance to a depth of 6 to 12 inches. This technique not only distributes the nutrients for more efficient absorption by roots but also improves the porosity of soil. Dry soils, particularly those subjected to high temperatures, often become compacted and resist both water and oxygen penetration, thereby restricting root growth and function. See Figure 1 for the difference fertilizer makes.

- **Mulch** - Mulching the soil surface around the root system will help reduce water loss and keep the soil cool. Use wood chips, bark shavings or other suitable material. Add the mulch to a depth of about 3 inches. Be careful not to mound mulch against the base of the trunk.

- **Use Pest Management** - Insect infestations and disease should be controlled to prevent further weakening or death of declining trees. Drought-weakened trees are particularly susceptible to woodboring insects that can tunnel through the nutrient-conducting tissues and cause rapid death of the tree or shrub. Proper identification of a pest and its life cycle is necessary for effective control.

- **Prune -** Remove dead and dying branches that attract bark beetles and other wood-boring insects and that are susceptible to destructive fungal diseases. Pruning will also enable tree roots to sustain the rest of the tree more efficiently.

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TECHNICAL BULLETIN DAVEY
Prepared by The Davey Institute

Girdling Roots: A Problem Of Shade Trees

Trees can slowly weaken and die over a period of several years by the strangling or girdling action of roots. Some tree roots that begin to grow around or along the main trunk and larger lateral roots can cut off or restrict the movement of moisture and plant nutrients into the tree.

SYMPTOMS: Over a period of time, branches on the sides of the tree affected by the girdling root will slow down in growth. Injury may eventually show up as weakened top growth, short terminal twigs, and smaller, lighter green leaves. The branches will eventually become weakened by strangulation and the tree may die over a period of 5 to 15 years. Good cultural practices of fertilization, watering, and pruning will not offset the slow death by girdling roots.

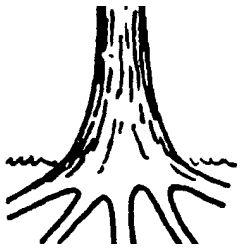

Figure I I tree trunk with flare or buttress at soil line.

Normal trees have a flare or buttress root swelling at the base of the trunk as shown in *Figure 1.* Tree trunks without flare that grow straight up from the ground as if a soil fill has been placed around the tree can be suspected of having girdling roots as illustrated in *Figure 2.* Trunks of trees with a flat side or concave depression at the ground surface instead of a swelling may also have a girdling root as seen in *Figure 3.* Positive diagnosis of girdling roots below ground can be made by carefully digging away the soil around the base of the tree to expose the encircling roots.

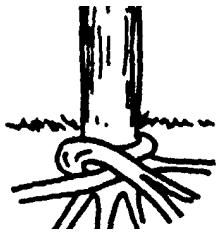

Figure 2. Girdling root. Trunk may grow straight up.

CAUSE: The development of girdling roots on trees is usually the result of unfavorable conditions which prevent the roots from growing in a normal spreading manner. For example, the roots of container-grown plants will grow out to the sides and then spiral and coil around the side and bottom of the container. If the trees are grown in the container too long, they become root-bound. In transplanting container-grown trees or shrubs that are root-bound, 3 or 4 slits should be made down the sides of the root ball with a knife or pruning shear, and then the roots should be spread out by hand. If the encircling roots are not cut and straightened out, they will eventually girdle, or strangle, the stem of the plant.

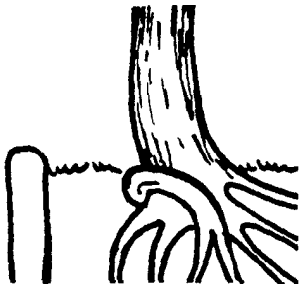

Figure 3. Girdling root caused by obstruction such as curb, sidewalk, wall or compacted soil.

SOLUTION: Positive diagnosis of girdling roots is important since other factors can cause the same symptoms. Girdling roots can be found growing from the soil surface to a depth of a couple feet. The exposed girdling root often can be cut from the trunk or lateral root at the point of attachment with a chisel and mallet. Several inches of the girdling root should be removed to prevent it from growing back together. If there are many girdling roots, the removal process should be gradual, perhaps taking two to three years. This allows new roots to develop and replace those that had been supporting the tree with water and nutrients. After the girdling roots are removed, weakened trees may respond with improved growth if careful pruning, watering, and fertilizer applications are used.

TECHNICAL BULLETIN DAVEY
Prepared by The Davey Institute

Dogwood Anthracnose

(Discula destructiva)

Also referred to as lower branch dieback, dogwood anthracnose usually attacks flowering and pacific dogwood trees, which grow naturally in woodlands and home landscapes.

***SYMPTOMS**:* This disease attacks twigs, branches and trunks as well as leaves, usually appearing during cool, wet weather in the spring. Initially, infected trees develop tan, blotchy leaf spots on lower branches that progress up the tree. This fungus invades the main leaf vein causing total leaf and twig death. Dead leaves often remain attached to the tree. Eventually, the fungus moves into one and two year wood and forms elliptic cankers at the base of dead branches. In advanced stages of the disease, multiple shoots arise below dead branches along the main trunk.

Leaf and twig dieback from dogwood anthracnose.

***CAUSE*:** Dogwood anthracnose is caused by the fungus *Discula destructiva* and is found naturally occurring on forested dogwood at higher elevations. Spores are spread through rain splash, primarily in cool, wet spring and fall weather. Hot, dry conditions will slow disease development. Drought, winter injury, and construction damage weaken trees and increase disease severity. Consecutive years of heavy infection have resulted in extensive destruction of both woodland and ornamental dogwoods.

SOLUTION. Selective pruning, preventive fungicide treatments, fertilization and watering are important preventive measures for controlling dogwood anthracnose. Effective control is possible if the disease is detected before extensive dieback occurs. Prune to improve air circulation and to dispose of diseased twigs and branches that are potential sources of inoculum. Do not transplant wild dogwoods into the landscape and purchase healthy trees from qualified nurserymen.

Maintain healthy dogwood trees by improving water availability with mulch, avoid trunk injury, and fertilize with a slow release fertilizer such as Arbor Green®. Foliar fungicide treatments for dogwood anthracnose and other leafspot fungi should be applied in the spring during leaf expansion to keep disease incidence low.

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TECHNICAL BULLETIN DAVEY
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Cottony Maple Scale

The cottony maple scale is a large, flat, brown scale insect found on the twigs and branches of various trees. The white, cottony egg masses, which resemble popcorn, are the most distinguishing feature of this scale. A favored host is silver maple, but it will attack other species of maple as well. Other host preferences are: honeylocust, black locust, white ash, euonymus, oak, boxelder, dogwood, hackberry, sycamore, beech, elm, willow, basswood and poplar.

SYMPTOMS: Injury to trees is caused by the scale insect sucking juices from the twigs and branches. Small twigs begin to die first, leaves become stunted and then a black, sooty mold becomes evident on the tree itself and on objects beneath the tree. This mold grows on honeydew excreted from the scale. A heavy infestation for two or three years may result in the death of large branches.

CAUSES: The fertilized, immature females spend the winter on the twigs and small branches of the host. In the spring, they resume their feeding and development. In late May, the females begin producing eggs which are deposited in masses covered with white, silken fibers. The young scales called crawlers begin hatching in mid-June through early July. The crawlers move up and down twigs and out onto leaves before settling down to suck juices and secrete a waxy coating over themselves. In late summer, adult males emerge, mate with females and die. Just before leaf drop in the fall, the mated females migrate back to the branches where they settle and overwinter.

About the third year after cottony maple scales infest a tree, a population of small lady beetles may be found devouring the egg masses. If these larvae are found in over half of the egg masses, natural control is taking place and additional treatment may not be necessary.

SOLUTION: A horticultural oil treatment may be applied before growth starts in the spring or after leaf drop in the fall. An additional treatment may be applied in Mid-August-September after all the crawlers have hatched and settled on the leaves. However, do not treat sugar maples with oil, as this species reacts adversely to oil and branches may die.

It is extremely important to restore plant vitality because trees weakened by the scale are more susceptible to other insects, diseases and environmental stress. Fertilizing, mulching, and watering, especially during dry periods, are recommended to help maintain tree health.

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TECHNICAL BULLETIN DAVEY
Prepared by The Davey Institute

CORE AERIFICATION

Core aerification (also known as core aeration) is the mechanical means of removing small plugs of thatch and soil from a lawn to allow the exchange of air between soil and the atmosphere to occur. This process is recommended for most home lawns to:

1. relieve soil compaction.
2. "knit" soil interfaces.
3. reduce excessive thatch layers.

Many turfgrass areas suffer from soil compaction due to rainfall and foot or vehicular traffic. Although compaction is most often associated with athletic fields, home lawns can also suffer from compacted soil layers. Reasons for home lawn compaction include construction activity prior to lawn establishment and traffic on high clay content soils, especially when wet.

Aerification improves penetration of air and water into the soil.

1. **Compaction** causes individual soil particles to press together tightly. This decreases the pore space where air and water are held. A compacted layer of soil forms a physical barrier that limits infiltration of water into the soil and availability of soil oxygen. Aerification will improve the penetration of air and water into the soil, which encourages deeper root growth and better turf quality.

2. Aerification is also useful where a **soil interface** exists. Soil interfaces form when one soil type overlays another distinctly different soil type; in many instances, the sod used to establish a lawn is grown on soil that is organic in nature and is distinctly different from the soil over which it is placed. The interface that develops between these two soil layers resists uniform movement of water, air and nutrients, resulting in irregular turf response. Aerifying breaks up the interface and promotes better conditions for turfgrass growth and development.

3. Another benefit of aerification is the **modification of excess thatch layers** (1/2 inch or more). Thatch is a layer of dead and living stems and roots of grass that accumulate between the green grass blades and the soil surface. Multiple aerifications that leave the cores on the lawn surface to break down will incorporate native soil into the thatch layer, thereby improving the water- and nutrient-holding capacities of the thatch. Microorganisms in the soil cores will also help decompose the thatch. Aerification is particularly useful on large turf areas where dethatching is impractical.

Annual aerification is beneficial for most lawns; however, lawns growing on heavy clay soils or lawns exposed to intense use may need more than one aerification per year. It should be performed during the period of most active root growth for a particular grass species. Spring and fall are ideal times to aerify most lawns.

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

Construction Damage and Tree Protection

Preventing damage to trees is much more economical than trying to save a tree injured by careless activity.

Mature trees are valuable assets - they provide shade, wind protection and enhance property value. Most construction damage impacts the root systems of native trees on new home sites. Tree root systems are quite extensive, and vulnerable to disruption of the soil profile and mechanical injury.

A construction project accounts for existing trees on the drawing board. Trees that face serious impact may be removed or carefully transplanted. Trees that require special protection with barriers can be determined. The best approach for tree preservation is to have all trees properly fertilized with Arbor Green® before construction begins.

Tree decline caused by adding soil over the root system during construction.

On very large projects, consulting arborists can be directly involved They may post signs for protected zones, designate parking and storage areas away from trees and help supervise construction activity to minimize tree damage.

SOIL DISRUPTION: *A* common problem associated with construction is lack of soil aeration, often resulting from compaction. *A* few species withstand such conditions, but most will suffer. *A* barrier placed at the perimeter of the tree canopy (dripline) will direct construction workers away. If this is not feasible, construction workers should be advised not to lay equipment or materials under the tree or to trample the soil underneath.

Soil compaction can also be reduced by laying down a 12 -inch layer of wood chip mulch under the tree. If soil needs to be removed to lower the grade beyond the dripline of the tree, mulching with organic materials can retain moisture and stimulate root production. If extensive soil removal is needed, a retaining wall creating a terrace or the formation of a tree well will keep much of the original soil beneath the tree intact. Soil should never be added within the dripline of the tree. Even 1 -inch of additional soil can suffocate the root system.

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***ROOT DAMAGE**:* At a minimum, the root zone diameter is 1- 1/2 times the height of the tree. This area normally extends past the tree canopy. Any piles of sand, gravel, or excavated soil should be stored outside this zone. Lime or limestone should be kept away from roots to avoid raising soil alkalinity and caustic materials such as paint thinner should not be discarded over the root zone.

Utility trenching should be done as far away from tree roots as possible. Installation of driveways should be planned so as to minimize tree root damage. In the event of root damage, the tree should be mulched and watered.

MECHANICAL INJURY: Some type of fencing should be erected around the tree to protect its trunk and lower branches. At the very least, trunks and large exposed roots should be covered with protective materials to prevent mechanical injury. Branches directly interfering with construction work should be properly pruned back.

If a tree is severely injured it should be removed. Trees that are only slightly damaged may be restored to a healthy condition. This can be accomplished by pruning out dead or dying portions, watering and fertilizing.

TECHNICAL BULLETIN
DAVEY
Prepared by The Davey Institute

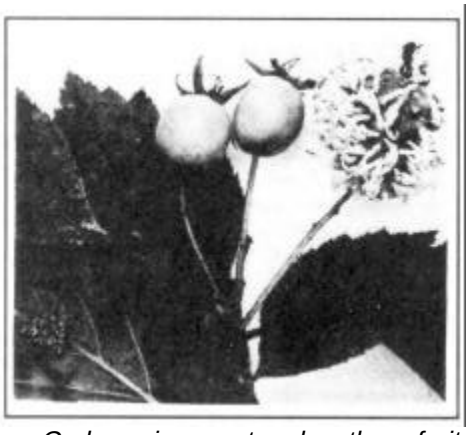
Cedar Rusts

Gymnosporangium juniperi-virginlana

The cedar rust diseases occur frequently on flowering crabapple, hawthorn, apple, and occasionally on flowering quince, serviceberry, and mountain ash. The disease fungi spend part of their life cycles on certain species and cultivars of juniper, and the other part on the previously mentioned hosts. There are really three diseases involved in this complex: cedar-quince rust, cedarhawthorn rust, and cedar-apple rust.

Cedar-hawthorn rust pustules on hawthorn leaves.

SYMPTOMS: Cedar-quince rust commonly affects the twigs and fruits of hawthorns. On fruits, elongated yellowish spore-bearing structures will form, giving the fruit a prickly appearance. On twigs, cankers develop, resulting in dieback.
Both cedar-apple rust and cedar-hawthorn rust affect the leaves of crabapple and hawthorn, respectively, by causing orange spots in late spring and early summer.



Cedar-quince rust on hawthorn fruit.

CAUSE: The fungi that cause the cedar rust diseases overwinter in galls or cankers on susceptible junipers, especially Eastern red cedar (actually a species of juniper). During warm spring rains, the galls swell and produce orange, gelatinous spore horns. From these horns, spores are blown to nearby susceptible trees and shrubs. During wet periods, the spores infect the leaves, fruit, and stems of these alternate host plants (i.e., crabapple, hawthorn, etc.). The junipers are then reinfected in late summer by spores produced from infected tissue on the alternate hosts.

SOLUTION: At least two fungicide treatments in the spring to prevent infection on crabapples, hawthorns and other susceptible hosts are recommended.

Susceptible junipers can also be sprayed in mid- to late summer to control the other stage of the cedar rust disease. Fertilization of affected plants will help promote recovery.

TECHNICAL BULLETIN
Prepared by The Davey Institute

CABLING of TREES

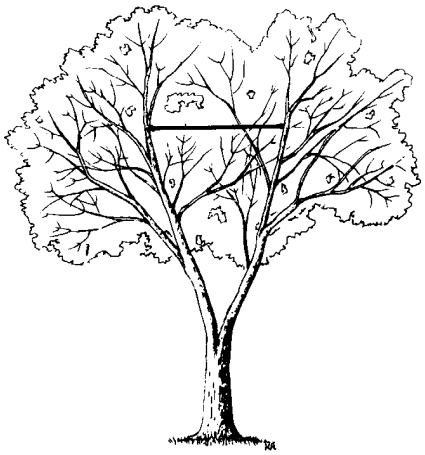


Figure 1.

Cabling is the installation of flexible steel strand cables in trees to reduce stress damage from high winds, the weight of ice or snow and heavy foliage. Multi-stemmed trees or those with narrow V-shaped forks are especially susceptible to this type of damage (Figure 1). This procedure is used by arborists to improve your tree's chances to survive storms and minimize property damage when branches fall (Figure 2).

BENEFITS: The usefulness of a cable lies in its ability to transfer part of the weight of a weak branch or limb to a stronger one. In addition, a cable may provide mutual support to limbs that are joined by a narrow V-shaped fork. It is intended to prolong the life of the tree. Branches or trees that pose a potential threat to property or people are candidates for cabling.

***EVALUATION*:** In determining whether cabling is warranted, the condition of the tree must first be assessed. The arborist and customer must then determine if cables will help to make the tree reasonably safe. If the root system is not structurally sound, or if the tree contains excessive decay, removal of the tree may be the better choice.

PROCEDURE: Before installing cables, trees should be pruned to remove hazardous branches, reduce foliage weight, and help improve its structure. This pruning will help insure weight reduction of limbs to be cabled.

Figure 2. *This damage was due to poor tree structure. Cabling would have minimized or avoided the damage.*

After installation, cables should be inspected periodically for deterioration of materials and changes in the tree which may make adjustments necessary. In addition to pruning on a regular basis, the tree should be fertilized to help improve its health and vigor.

Our arborists adhere strictly to procedural and safety guidelines for cabling.

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TECHNICAL BULLETIN
DAVEY
Prepared by The Davey Institute

Borers

SYMPTOMS: At first, small holes in the branches and trunk can be seen with sawdust-like material and/or sap and resin coming out of the holes. The trunk and branches may be swollen, knotty, and calloused. The bark may develop cracks and eventually break off in small sections. Leaves in the upper part of the tree are undersized and discolored, and branches begin to die.

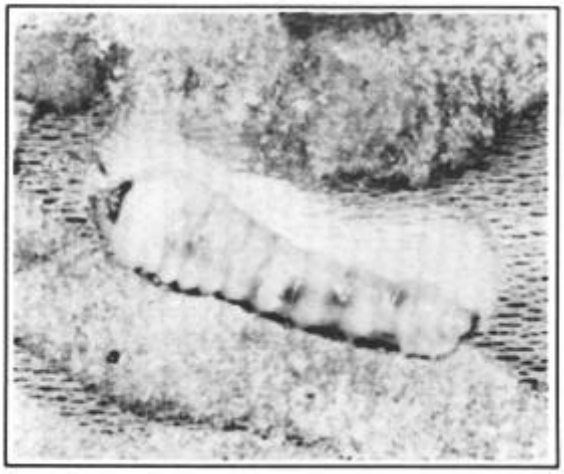
CAUSE: Insects, usually the larval stages, that feed on the inner bark and/or wood are called borers. These borers are chewing insects and many species are the larvae of beetles.
However, some borers are wood-boring caterpillars (adult is a clearwing moth). Borers feed unseen inside the roots, trunks, branches and twigs of many trees.

Borers girdle the vascular system and disrupt the normal flow of water and nutrients. They are particularly destructive to newly planted trees and those in poor health. Vulnerable landscape plants that require close monitoring are: ash, azalea, birch, blacklocust, cherry, dogwood, elm, honeylocust, lilac, mountainash, oak, pecan, pine, plum, poplar, and rhododendron.

SOLUTION: Healthy trees have fewer problems with borers. Therefore, the best management recommendation is to keep the tree healthy in the first place by providing fertilizer, mulching, water, and controlling other insects and diseases. These practices will help increase your tree's tolerance or avoidance to borer attacks and also help it to recover if borers are already present.

Borer treatments will not kill large larvae inside the plant; however, trees can be treated to help prevent further infestations by future borer generations.

Davey technicians examine susceptible plants species for sawdust, such as this azalea.



Vascular damage by borer larva which severs the nutrient pipelines and causes plant death.

TECHNICAL BULLETIN DAVEY
Prepared by The Davey Institute

Black Vine Weevil

Otiorhynchus sulcatus

SYMPTOMS: Look for **feeding notches** on the edge of the needles or leaves as shown. Frequently the notched leaves are on the lower portion of the plant and toward the center.

HOSTS: Taxus, Japanese holly, rhododendron, azalea, and euonymus are frequently injured plants.

Adult feeding is an aesthetic type of damage, but it also means that there is a more sinister type of damage, the destruction of small, feeder roots and bark cambium by the weevil larvae. Check the larger roots and the root crown area for chewing damage. Larval feeding can result in **yellowing, wilting and death** of the plant.

Black vine weevil and shallow notching on taxus foliage.

CAUSE: The 3/8-inch long black adult weevils feed on foliage and the white c-shaped grubs (larvae) feed on the roots. The black vine weevil is also referred to as the taxus weevil. This weevil feeds on more than 100 plant species and is found throughout the northern half of the United States and southern Canada. Homeowners can unwittingly introduce this cryptic insect into their landscape by purchasing infested shrubs or annuals such as primrose or impatiens.

This pest overwinters as a mature larva (grub) in the soil. Since they feed during the night, weevils are seldom seen. During the day they hide in debris on the ground or in the soil. One generation occurs each year with adults emerging between early June and mid-July. Each weevil can produce up to 400 eggs, thus a large population can be produced by just a few weevils. Adults feed about 3 to 4 weeks before they are capable of producing eggs. Larvae hatch in about two weeks and the small white grubs crawl into the soil and feed on tender roots.

SOLUTION: Control of black vine weevil is aimed at the adult. Attempts to control the larval stage have been unsatisfactory. We recommend two or three insecticide applications starting in mid-June. Treatment can reduce adult numbers and thereby prevent eggs from being deposited. Thus, the likelihood of plant loss or root damage by weevil grubs is reduced.

Monitor for weevil emergence by providing harborage. Weevils hide under debris during the day. Place a piece of plywood or burlap (12 x 12 inches), or whatever is in the scrap pile, in the mulch of the host plant and check underneath it in the morning for hiding weevils.

TECHNICAL BULLETIN DAVEY

Prepared by The Davey Institute

Bagworms

Bagworms *(Thyridopteryx ephemeraeformis) are native to North America and are serious pests of shrubs and woody ornamentals. Since their spindle-shaped, protective bags are made of silk, debris and portions of foliage, they're camouflaged and often go unnoticed until serious plant damage has occurred.*

LIFE CYCLE AND HABITS: Bagworms overwinter as eggs within the bag of the adult female (Figure 1). Eggs hatch in mid to late April (may vary by location), and the larvae begin to look for food. Larvae disperse by first producing silk strands that are attached to branches. They then swing down and are caught in wind currents (ballooning). Once on a host plant, larvae feed and begin construction of tiny, cone-shaped bags around themselves. By adding plant material and silk, growing larvae increase their bag size and are protected from predators through pupation. In early August, adult males emerge as black moths with fuzzy bodies, while adult females remain wingless and never leave the bag. Mated females may produce up to 1,000 eggs, and bagworms have one generation per year.

Figure 1. *Adult female bagworms.*

HOSTS: Bagworms attack more than 120 species of both deciduous and evergreen trees and shrubs. Some of these hosts include juniper, arborvitae, cedar, spruce, honeylocust, linden, willow, maple, oak, birch, elm and poplar.

SYMPTOMS: Bagworm caterpillars consume foliage, and heavy infestations may lead to defoliation (Figure 2). In evergreens, no re-growth occurs and attacked branches often die.

Figure 2. *Defoliation caused by bagworm infestation.*

Management

CULTURAL: Management of bagworms by homeowners may involve hand picking. Make sure that all bags are removed and destroyed, since even one bag left behind could lead to re-infestation.

BIOLOGICAL/CHEMICAL: When hand picking is not practical, foliar applications of Bt (*Bacillus thuringiensis*), or any insecticide recommended by Davey Tree, should be made when young larvae are first observed. While spraying, thorough coverage of the foliage is critical. Two applications, two weeks apart, may be necessary for heavy infestations.

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TECHNICAL BULLETIN
DAVEY
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ARBORVITAE (CEDAR) LEAFMINERS

Argyresthia thuiella and other species

A cedar or arborvitae leafminer larva tunnels inside the foliage and can cause severe browning and canopy thinning. (photo by M. Kennedy)

A cedar "hedge " defoliated by leafminer outbreak loses the desired function of a screen.

SYMPTOMS: Larvae of several moth species tunnel inside the leaf tissue of cedars or arborvitae shrubs. This causes plants to turn brown and defoliate prematurely. In June, this damage can be distinguished from winter browning or desiccation by the distinct yellow to brown discoloration pattern of the prior year's foliage; the new growth is green. Leafminer damage is generally more severe on the lower 3/4 and interior portions of the canopy. Tear open the brown foliage to confirm leafminer activity by the blackish frass or larvae in the hollowed out leaves. Larger trees and hedges lose their effectiveness as a screen and become unsightly. Infested cedars become more susceptible to spider mites and gradually decline if treatments are not applied.

CAUSE: Cedar leafminers are the larvae or caterpillars of a small, 3/8" long, silver and tan moths which resemble miniature sod webworm moths in that they hold their wings close to their abdomen and not fanned out. In Canada, the moths emerge from the leaves in mid-June through mid-July and deposit eggs on the leaves. The larvae soon hatch and start mining the leaves the rest of the season and during the winter. Feeding continues into the early spring.

SOLUTIONS: Damage by these larvae can be minimized by two applications, one in early May and again in late August. Cedars benefit from mulching and watering during dry periods. Keep cedars vigorous with patented, slow-release, Davey Arbor Green' fertilizer applications.

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APPLE SCAB DISEASE OF CRABAPPLES

Venturia inaequalis

Figure 1. Leaf spots from infection by the apple scab fungus.

Figure 2. The 'Hopa' crabapple tree on the left was not treated the previous year. Due to defoliation caused by scab disease, it has very poor flowering. The tree on the right was treated and is contributing to the beauty of the landscape.

SYMPTOMS: Olive-green or brown spots develop on leaves in May through early June. On older leaves the spots are slightly raised, velvety and dark colored (Figure 1). As the disease develops, the leaves turn yellow and drop prematurely. The symptoms on the blossoms and fruit are similar to those on the leaves. Fruit may be deformed if heavily infected. Typical fruit lesions are circular brown spots with black margins and a corky appearance.

CAUSE: Apple scab, caused by the fungus *Venturia inaequalis, is* one of the most devastating diseases of ornamental crabapples. It also can be a problem on cotoneaster, firethorn, and mountainash. This fungus overwinters on infected fallen leaves, or, rarely, on twigs of the tree. Spores, which infect the new leaves in the spring, are produced on the fallen leaves during warm rains in April and May.

Trees can be defoliated by late June with only a few leaves remaining for the rest of the summer. Not only does this alter the aesthetic appeal of the property, but it also reduces the vigor of the tree making it more susceptible to other disorders. Flowering may be reduced the next season because of this year's defoliation. Defoliation minimizes carbohydrates available for flower bud production. Some varieties exhibit flower decline more than others (Figure 2).

SOLUTION: Fungicide treatments in the spring will help minimize infection. During prolonged, wet spring conditions, which favor fungal growth, some infections will occur but fungicide treatments will help keep leaves on the trees. Additional applications may be purchased if there is an unusually wet growing season.

Rake and remove infected fallen leaves in autumn to reduce the potential for infection the following spring. Also, many cultivars of crabapple are resistant to apple scab and should be planted whenever possible. Check with your local extension service or call your Davey technical advisor for a current listing.

TECHNICAL BULLETIN DAVEY
Prepared by The Davey Institute

APHIDS

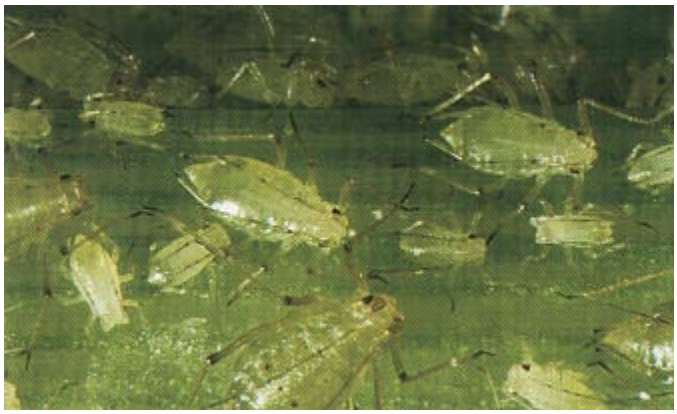


Figure 1. *A colony of aphids feeding on a stem.*

Figure *2. The new growth of this burning bush euonymus is distorted and cupped by aphids. Note the honeydew on the leaf in bottom left view.*

Aphids, sometimes referred to as plant lice, are soft-bodied, sucking insects (Figure 1) that feed on the leaves of evergreens and deciduous trees. They tend to cluster in large colonies on new growth.

SYMPTOMS: Early season aphids cause leaf curling and distortion of new growth (Figure 2), which is similar to the damage caused by broadleaf weed herbicides. If populations are large, twig dieback and stunting can occur.

Many aphids that feed in the summer excrete a sugary substance called honeydew. The honeydew collects on lower leaves and objects underneath the infested tree, such as cars, lawn furniture, or sidewalks. Sooty mold fungi often colonize the honeydew on these surfaces due to the high sugar content. Sooty mold gives leaves a black or "sooty" appearance. Leaves are not injured directly by this coating, but it blocks sunlight, thereby reducing photosynthesis and causing premature leaf drop.

CAUSE: Aphids are fragile insects that come in an array of species that may be green, black, red, orange, woolly, spotted or bull-legged. They have many rapidly appearing generations in a short time.

SOLUTION: Aphids can be controlled with horticultural soap treatments or other insecticides so honeydew or sooty mold will not occur. Sooty mold can also be removed or cleaned up with soap or horticultural oil applications.

Aphids have many insects enemies, such as lady beetles, which will not be affected by the soap treatments as much as with other insecticides that leave a residual. Frequent inspections for aphids on susceptible plants is necessary to prevent plant injury.

TECHNICAL BULLETIN

DAVEY

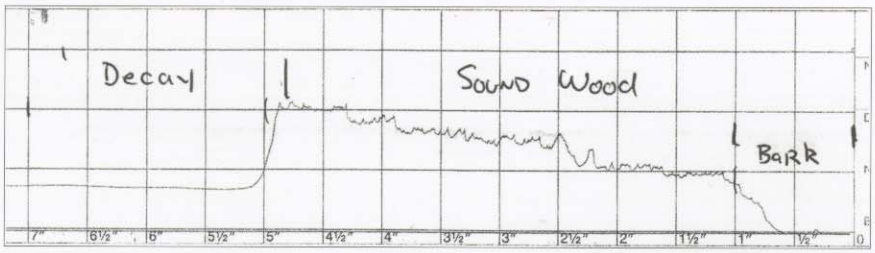
Prepared by The Davey Institute

ADVANCED DECAY DETECTION USING THE RESISTOGRAPH

WHY TEST FOR DECAY?

Wood decay in shade and ornamental trees is the most common disease in the urban forest. Decay and other tree defects can result in failure of branches, large stems or the entire tree. Importantly, not all trees with decay require treatment. The presence of decay does not necessarily mean that the tree is hazardous or requires treatment. More important than the presence of decay is the location and amount of decay.

In many cases, visual assessment of decay, simply sounding with a hammer, or probing with a sharp tool can provide adequate information to judge the amount of decay in a tree. However, because decay is often hidden internally by the bark, more advanced tools may be needed to make better judgments on how much decay is present.



Labeled Resistograph chart.

SYMPTOMS OF DECAY: There are many symptoms or indicators of decay in trees. A few examples include cavities; decayed branch stubs; loose or missing bark; fruiting bodies of wood decay fungi on roots, the trunk, or stems; or the presence of carpenter ants. These indicators do not tell how much decay might be present in a tree.

CAUSE: Wood decay in trees is caused by a closely related group of basidiomycete fungi that can digest the cellulose and lignin components of wood. These fungi may fruit on a tree in the area where the decay is present.

SOLUTION: The first step in the treatment of trees with indicators or symptoms of decay is to make an assessment of the amount of decay. If visual observation, sounding or probing techniques cannot adequately provide enough information, more advanced techniques may be needed.

The Resistograph is a relatively new tool in arboriculture that provides a means to assess and document hidden decay in a tree. This tool has a very small (3 mm), non-spiraled bit that can probe areas in the tree where decay is suspected. The distance the bit has traveled and the resistance to the bit are recorded on graphs. Reading these charts allows your Davey arborist to determine the presence and amount of decay in a particular location.

Once an evaluation of the amount of decay in a tree is made, treatment options can be developed. Unfortunately, there are no treatments to stop decay once it starts inside a tree. Treatments such as removal, pruning, cabling, bracing or moving of the target (what the tree might hit if it or a part of it fails) are potential options that can be developed with your Davey arborist.

Drilling into a sycamore with a Resistograph.

Fungal conks indicate internal decay in a tree.

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