Park Tree Management Plan

City of Sedalia, Missouri

February, 2011

DAVEY RESOURCE GROUP

A Division of The Davey Tree Expert Company

Park Tree Management Plan

City of Sedalia, Missouri

February, 2011

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Acknowledgement

Davey Resource Group conducted this project for the City of Sedalia, Missouri, and materials were prepared using grant funds received through the Missouri Department of Conservation. The City acknowledges and agrees that the use of this report and other printed materials produced as part of this project shall not be restricted under the copyright laws of the United States of America.

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Executive Summary

The City of Sedalia, Missouri is a thriving municipality that combines beautiful neighborhoods, parks, and recreational opportunities to create an attractive community in which to live, work, and play. The economic health of Sedalia relates to the ability of its municipal government to supply its citizens and visitors with efficient services, safe public spaces, and properly maintained infrastructure. Trees are an integral asset within Sedalia and with the proper care will continue to appreciate in value.

Trees provide significant economic, functional, and structural benefits to the community that helps to improve the quality of life within the City. 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.

Sedalia has commissioned a study of its park trees to inventory and evaluate their current conditions and to establish an effective planning and management program for this valuable resource. The City included all seven parks in the inventory: Centennial Park, Clover Dell Park, Housel Park, Hubbard Park, Katy Park, Liberty Park, and Vermont Park. Since the parks receive many visitors throughout the year, it is important to conduct inspections of these trees to ensure they are structurally sound. This document will review the current conditions as well as explore future management options for Sedalia's park trees.

Sedalia Park Tree Population

Davey Resource Group performed a park tree inventory for the City of Sedalia. Data concerning park trees have been collected and analyzed, providing information about species composition, condition, and maintenance requirements. This report evaluates the parks' tree composition, general health, recommends best management practices, and provides long-term planning strategies that will improve maintenance efficiency and tree health.

The major findings of the Sedalia *Park Tree Management Plan* include the following:

- Davey Resource Group inventoried 912 total trees and 2 stumps. Sedalia's inventoried park tree population is comprised of 76 species representing 44 genera.
- The genus *Acer* (maple) comprises 20.94% of the overall population, followed by *Fraxinus* (ash) at 18.20%, *Quercus* (oak) at 10.75%, *Celtis* (hackberry) at 8.11%, and *Juniperus* (redcedar) at 5.04% of the population. All other genera comprise the remaining 36.96% of the total park tree population.
- The inventoried tree population consists of 45.95% (419 trees) medium-sized (7 to 24 inches in diameter at breast height [DBH]) trees. Small trees, which are 6 inches and less in DBH, represent 33.99% (310 trees) of the total population, and the remaining 19.88% (183) of trees are large sized (greater than 25 inches in DBH).
- Of Sedalia's inventoried tree population, 1 (0.11%) tree is in Excellent condition, 11 (1.21%) are in Very Good condition, 170 (18.63%) are in Good condition, 552 (60.53%) are in Fair condition, 148 (16.23%) are in Poor condition, and 26 (2.85%) are in Critical condition. There are 4 (0.44%) Dead trees throughout the parks.
- Sedalia's Primary Maintenance requirements include 63 (6.89%) Removals, 551 (60.28%) trees for Large Tree Clean, 47 (5.15%) trees for Small Tree Clean, 251 (27.46%) trees are recommended for Young Tree Train, and 2 (0.22%) Stump Removals.

Park Tree Management Plan Recommendations

Based upon the results of this study, Davey Resource Group recommends the following action plan for managing Sedalia's park trees.

A *Five-Year Park Tree Management Program* is explained and outlined in Chapter 2 and includes estimated budgets for each activity. Specific management recommendations are detailed in Chapter 2, which include:

- Perform all identified Severe- and High-Risk tree removals and pruning activities in the first two years of the proposed five-year budget.
- Beginning in Year 3, implement a five-year cyclical tree pruning program for the entire tree population to ensure the pruning and inspection of all trees every five years.
- Beginning in Year 1, implement a three-year *Young Tree Training Program* for newly planted trees.
- Establish a tree-planting program to improve species diversity, seasonal interest, and establish replacements for significant landscape trees that currently influence the aesthetics of Sedalia parks, but are approaching senescence.
- Educate Park Board members and/or contractors concerning proper mulching, pruning, general arboricultural treatments and techniques, and get two Certified Arborists among the City staff.
- Present an educational program to highlight the findings of this report and to prepare the personnel and operations budget administrators for inevitable removals, the importance of healthy trees, and the need for continual preventive maintenance and planting.

Introduction

Importance of the Urban Forest

Trees are a significant component of Sedalia's urban environment. The public trees are an integral part of the City's infrastructure, no less so than its streets, utilities, buildings, and sidewalks. Unlike other infrastructure components, the tree population, when properly cared for, will actually increase in value as the trees mature over time.

Photograph 1. A diverse and healthy community forest is a valuable asset.

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 City's quality of life and soften the hard appearance of man-made structures and streets, moderating harsh urban conditions. Trees also help stabilize soils by controlling wind and water erosion and they provide shade that can help reduce energy costs. Trees also reduce noise levels, cleanse air of pollutants, produce oxygen, and absorb carbon dioxide. Additionally, they provide significant economic benefits by increasing real estate values, improving settings in which to conduct business activities, and enhancing the aesthetic appeal of the City.

Sedalia city officials, the Missouri Department of Conservation, and local residents have recognized these benefits and realized the need to protect this investment by implementing a comprehensive urban forest management program for its park trees. An urban forest management program begins with a tree inventory that outlines important information and attributes about Sedalia park trees. Information obtained during the park tree inventory was used to compose this *Park Tree Management Plan*.

Statement of Purpose

The purpose of the *Park Tree Management Plan* is to provide a five-year plan of action for the inventoried tree population throughout Sedalia city parks. The inventory focused on park trees that were on maintained or manicured portions of the parks. The inventory draws attention to immediate problems and provides the basis for designing a long-term management plan. The management plan provides guidelines for the future, which allows for effective use of tree care funds, and allows for more accurate budget projections.

Scope

This document provides a comprehensive action plan for Sedalia's inventoried park tree population. This plan includes an analysis of the current inventoried tree population, their individual maintenance recommendations, as well as long-range management recommendations for the entire park tree population. It discusses the findings of the public tree inventory performed by Davey Resource Group. The scope of this discussion includes:

Photograph 2. Davey Resource Group (Davey) conducted a park tree inventory on all maintained and manicured portions of the parks. Clover Dell Park has many natural areas throughout the park, but they were not included in the inventory.

- 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 needs for each tree including the pruning or removal of trees to reduce potential safety risks, as well as developing a cyclical pruning program.
- A budget for the *Five-Year Park Tree Management Program.*

Goals

The *Park Tree Management Plan* intends to achieve the following goals:

- To gain an overall understanding of the inventoried park tree population in terms of genus and species composition.
- To analyze the individual and overall health (condition) of the inventoried tree population.
- To identify and take remedial action for trees with structural or other defects that are hazards or could become potential hazards to residents, vehicles, and property.
- To establish a tree pruning and removal program that will alleviate all identified potential Severe- and High-Risk situations by the end of Year 2 of the Plan.
- To establish a five-year cyclical tree pruning program beginning in Year 3 of the Plan.
- To establish a planting program beginning in Year 1 of the Plan.

- To establish a three-year cyclical tree training program for all newly planted trees beginning in Year 1 of the Plan.
- To build a strong public educational program to achieve urban forest preservation and protection goals.

Evaluating and Updating This Plan

This Plan intends to provide the City of Sedalia with management guidelines for the next five years. In order to measure the effectiveness of this Plan, an evaluation method should be followed. Specific accomplishments are measured in comparison to the Plan's goals and recommendations. These include:

- The near completion of all identified priority tree maintenance recommendations in Year 2 of the Plan.
- Beginning in Year 3, establish a *Routine Pruning Program* and evaluate the number of trees pruned annually to match the goal of the five-year program.
- In Year 3 of the Plan, evaluate the number of trees pruned annually in the *Young Tree Training Program.*
- Annually compare the number of trees planted to the desired number of plantings and the number of removals per year.
- Annually evaluate the species of trees being planting each year, keeping in mind species diversity.
- Annually assess urban forestry education and training programs and determine what programs were successful, and what programs need improved.

By annually evaluating the progress of the above components of the program, Sedalia can make appropriate adjustments in areas that are not meeting the stated goals.

Photograph 3. The City should continue to evaluate the current condition of the urban forest, and make the appropriate adjustments to meet the goals and objectives set in the *Park Tree Management Plan*.

Chapter 1: Sedalia's Park Tree Population

Summary

The urban forest in Sedalia is a complex system of trees, each with individual conditions and maintenance needs. 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 Sedalia's inventoried park tree population. This information comes from an analysis of the data collected by Davey Resource Group's urban foresters during the tree inventory. Specific information detailed in this chapter includes:

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

By analyzing 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 safe and diverse tree population for the coming years and to plan for future tree maintenance operations.

Tree Population Characteristics

The characteristics of the urban forest include species, DBH, condition, and other related tree and location factors. By identifying the species, DBH, and condition of trees in the urban forest, one can learn much about the forest's composition, relative age, and health. Species composition data are essential because tree species vary considerably in tree structure and strength, life expectancy, and susceptibility to pests and diseases. The types of trees present in Sedalia's parks greatly affect tree maintenance activities and the municipal budget. Similarly, tree diameter and size class data help to define the general age and size distribution of the park tree population. The following sections characterize Sedalia's inventoried park tree population. Appendix A has a list of definitions and the inventory methodology utilized during Sedalia's park tree inventory.

Species Composition and Diversity

Sedalia's inventoried park tree population is comprised of 912 trees distributed among 44 genera (a genera or genus is a group of closely related species) and 76 species. Table 1 illustrates species composition throughout Sedalia parks. Tables 2-8 illustrate species composition in each individual park inventoried. Complete species and genus frequency reports with current binomial nomenclature (botanical names) are included in Appendix B. In addition, there is an inclusive list of all inventoried sites arranged by park and maintenance recommendations in the *Park Tree Inventory Workbook*.

Table 1. Species Composition of Sedalia Parks

Scientific Name	Common Name	Number	Percentage
Fraxinus pennsylvanica	green ash	126	13.82
Celtis occidentalis	common hackberry	74	8.11
Quercus palustris	pin oak	73	8.00
Juniperus virginiana	eastern redcedar	46	5.04
Acer saccharum	sugar maple	45	4.93
Acer x *freemanii*	Freeman maple	45	4.93
Acer rubrum	red maple	40	4.39
Fraxinus americana	white ash	40	4.39
Acer saccharinum	silver maple	39	4.28
Pyrus calleryana	callery pear	33	3.62
Ulmus pumila	Siberian elm	22	2.41
Platanus occidentalis	American sycamore	20	2.19
Malus spp.	flowering crabapple	20	2.19
other species	other species	289	31.70
Totals		**912**	**100.00**

Table 2. Species Composition of Centennial Park

Scientific Name	Common Name	Number	Percentage
Acer x *freemanii*	Freeman maple	20	16.67
Quercus palustris	pin oak	18	15.00
Pyrus calleryana	callery pear	15	12.50
Acer saccharinum	silver maple	12	10.00
Acer rubrum	red maple	8	6.67
Platanus occidentalis	American sycamore	7	5.83
Fraxinus pennsylvanica	green ash	7	5.83
Juniperus virginiana	eastern redcedar	6	5.00
Celtis occidentalis	common hackberry	5	4.17
other species	other species	22	18.33
Totals		**120**	**100.00**

Table 3. Species Composition of Clover Dell Park

Scientific Name	Common Name	Number	Percentage
Juniperus virginiana	eastern redcedar	29	29.59
Fraxinus pennsylvanica	green ash	15	15.31
Acer rubrum	red maple	9	9.18
Prunus serotina	black cherry	5	5.10
Pyrus calleryana	callery pear	4	4.08
Cercis canadensis	eastern redbud	3	3.06
Maclura pomifera	osage-orange	3	3.06
Quercus palustris	pin oak	3	3.06
Tilia cordata	littleleaf linden	3	3.06
Betula nigra	river birch	3	3.06
other species	other species	21	21.44
Totals		98	100.00

Table 4. Species Composition of Housel Park

Scientific Name	Common Name	Number	Percentage
Ulmus pumila	Siberian elm	2	22.22
Fraxinus pennsylvanica	green ash	2	22.22
Pinus sylvestris	Scotch pine	1	11.11
Quercus palustris	pin oak	1	11.11
Morus alba	white mulberry	1	11.11
Acer X *freemanii*	Freeman maple	1	11.11
Celtis occidentalis	common hackberry	1	11.11
Total		9	100.00

Table 5. Species Composition of Hubbard Park

Scientific Name	Common Name	Number	Percentage
Fraxinus pennsylvanica	green ash	36	29.27
Quercus palustris	pin oak	11	8.94
Acer saccharinum	silver maple	11	8.94
Celtis occidentalis	common hackberry	11	8.94
Picea glauca	white spruce	7	5.69
Pinus strobus	eastern white pine	5	4.07
Malus spp.	flowering crabapple	5	4.07
Acer buergerianum	trident maple	4	3.25
Acer rubrum	red maple	4	3.25
Acer X *freemanii*	Freeman maple	4	3.25
other species	other species	25	20.33
Total		123	100.00

Table 6. Species Composition of Katy Park

Scientific Name	Common Name	Number	Percentage
Fraxinus pennsylvanica	green ash	41	21.03
Celtis occidentalis	common hackberry	30	15.38
Acer saccharum	sugar maple	24	12.31
Fraxinus americana	white ash	16	8.21
Liriodendron tulipifera	tuliptree	11	5.64
Gymnocladus dioicus	Kentucky coffeetree	6	3.08
Ulmus pumila	Siberian elm	6	3.08
Pinus nigra	Austrian pine	5	2.56
Quercus palustris	pin oak	5	2.56
Ulmus americana	American elm	5	2.56
other species	other species	46	23.59
Total		195	100.00

Table 7. Species Composition of Liberty Park

Scientific Name	Common Name	Number	Percentage
Quercus palustris	pin oak	33	10.00
Celtis occidentalis	common hackberry	20	6.06
Fraxinus pennsylvanica	green ash	20	6.06
Fraxinus americana	white ash	18	5.45
Acer rubrum	red maple	16	4.85
Malus spp.	flowering crabapple	15	4.55
Pyrus calleryana	callery pear	13	3.94
Acer saccharum	sugar maple	13	3.94
Platanus occidentalis	American sycamore	11	3.33
Acer X freemanii	Freeman maple	11	3.33
Ulmus pumila	Siberian elm	11	3.33
Cercis canadensis	eastern redbud	10	3.03
Acer saccharinum	silver maple	10	3.03
Liquidambar styraciflua	American sweetgum	9	2.73
Taxodium distichum	common baldcypress	9	2.73
other species	other species	111	33.64
Total		332	100.00

Table 8. Species Composition of Vermont Park

Scientific Name	Common Name	Number	Percentage
Celtis occidentalis	common hackberry	7	18.92
Fraxinus pennsylvanica	green ash	5	13.51
Fraxinus americana	white ash	4	10.81
Acer saccharum	sugar maple	3	8.11
Acer x *freemanii*	Freeman maple	3	8.11
Pinus sylvestris	Scotch pine	2	5.41
Quercus palustris	pin oak	2	5.41
Morus alba	white mulberry	2	5.41
Acer saccharinum	silver maple	2	5.41
Ulmus americana	American elm	2	5.41
other species	other species	5	13.50
Total		27	100.00

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 should comprise more than 15% of the total population. Table 1 shows that green ash (*Fraxinus pennsylvanica*) comprises approximately 14% of the total inventoried tree population. As seen in Figure 1, the genera maple (*Acer*) and ash (*Fraxinus*) comprise approximately 21% and 18%, respectively, of the inventoried population. These two genera including oak (*Quercus*) comprise almost 50% of the entire park tree population.

It is also important to monitor species and genus at the individual park level as well. For example, in Katy Park, green ash, common hackberry (*Celtis occidentalis*), and sugar maple (*Acer saccharum*) all exceed 10% of the total tree population in the Park.

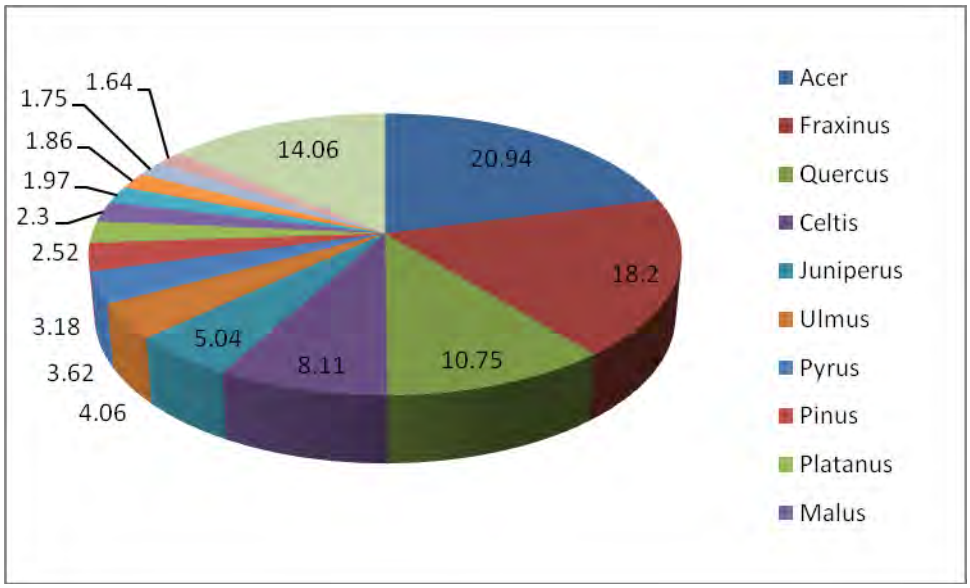

Figure 1. Sedalia Parks Distribution of Trees by Genus

Sedalia officials should strive to increase the species diversity throughout the parks. 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 [DED] (*Ophiostoma ulmi)* arrived in the United States in the 1930s, the resulting tree losses were devastating. Similar scenarios are now foreseeable for the Asian longhorned beetle [ALB] (*Anoplophora glabripennis)* and emerald ash borer [EAB] (*Agrilus planipennis*).

Some pest and diseases are species-specific, such as DED that mostly affect native elm trees such as American elm. Other pests and diseases are genus-specific such as EAB that affect the entire genus of ash. A variety of tree species and genera can decrease the impact of species-/genus-specific pests and diseases by limiting the number of trees that are susceptible to a particular pest or disease. This reduces the time and money spent on mitigating problems resulting from a devastating episode, such as the one described above with DED. In addition, species of trees have different density of wood, growth structure, and growth rates which planting a wide variety of tree species can also minimize the impacts from a number of abiotic (nonliving) disorders such as strong storms, wind, ice, flooding, drought, etc. The following disorders should be of concern for Sedalia city managers.

Emerald Ash Borer

Emerald ash borer (EAB) is an exotic beetle discovered in southeastern Michigan during the summer of 2002. Since its discovery, EAB has spread quickly and in a matter of eight years, has established itself throughout Michigan, as well as in regions of Illinois, Indiana, Iowa, Kentucky, Maryland, Minnesota, Missouri, New York, Ohio, Pennsylvania, Tennessee, Virginia, Wisconsin, West Virginia, and Ontario, Canada. EAB has already killed more than 30 million ash trees in southeastern Michigan alone. Ash trees infested with EAB typically die within a few years. This pest belongs to a group of metallic wood-boring beetles commonly found in Asia. Adults are dark green, one-half inch in length, and one-eighth inch wide, and only fly from early May until September. Larvae spend the rest of the year beneath the bark of ash trees, and when they emerge as adults, leave D-shaped holes in bark about one-eighth inch wide. The larva feed on the inner bark of ash trees, disrupting trees' ability to transport water and nutrients. EAB has been found in southeastern Missouri and is almost inevitable to reach the area of Sedalia.

Currently, Sedalia park tree population consists of 166 (18.20%) ash trees, which include green ash and white ash (*Fraxinus americana*). Davey recommends that the City stop planting ash species throughout the City and plant other large-growing, urban-tolerant, and pest-free species. A thoughtful plan of increasing genus and species diversity is highly recommended for Sedalia. Appendix C presents a list of tree species recommended for future plantings. Davey also suggests conducting a tree inventory of all remaining public trees, and composing an EAB response plan. There are several options available to control EAB, and research has shown treatments can be successful. Appendix D has more information on EAB.

Gypsy Moth

Gypsy moth (GM) is a devastating forest pest throughout the United States. The species originally evolved in Europe and Asia and existed there for many years. In the late 1800s, GM was accidentally introduced in the eastern United States. Since then, it has continued to spread west into the Ozark Mountains. It is inevitable that GM will continue to expand its range in the future.

It is known that GM feed on the foliage of hundreds of plants in North America, but its most common and favored hosts are oak species. Several successive years of defoliation, in conjunction with other biotic and abiotic stress factors, may ultimately result in tree mortality. In most northeastern forests of the United States, GM causes less than 20% mortality, but occasionally tree mortality may be much greater.

A female moth lays from 75 to 100 eggs, can be found on trees, rocks, walls, firewood, and even the undersides of vehicles. Accidental transportation of egg masses has accounted for the spread of GM from state to state.

Due to long hatch periods, two or three foliar treatments may be necessary to control GM caterpillars. *Bacillus thuringiensis* (B.t.), a common bacterial pathogen, will control GM, but it is most effective while the larvae are young.

Sedalia's park tree population consists of 98 (10.75%) oak trees that should be monitored for the presence of GM. GM is relatively easy to manage with proper techniques and timing. If Sedalia is unable to respond properly and a heavy GM infestation occurs, then the City should properly water and fertilize the affected trees throughout the season. This will help the trees respond from the heavy defoliation and possibly the trees will leaf out with little repercussion the following season. More information on gypsy moth is in Appendix E.

Thousand Cankers Disease (TCD)

Thousand cankers is a disease primarily of black walnut (*Juglans nigra)* and caused by a fungus (*Geosmithia morbida)* that is transported into the tree by the walnut twig beetle (*Pityophthorous juglandis)*. The beetle transports the fungus into the tree where it causes patches of the phloem tissue to die. The disease has caused widespread death of black walnut throughout many western states. In 2010, TCD was detected in eastern Tennessee.

TCD rarely show external symptoms like other canker producing fungi. The most noticeable symptoms are the yellowing of foliage as well as thinning of the upper crown. As the canker persists in the tree, larger branches die which have dead spotted leaves associated with them. As TCD kills the tree, other prevalent cankers will start to show in the trunk of the affected tree. Sedalia only has 3 (0.33%) inventoried black walnuts, but there are several natural areas throughout the parks with standing black walnuts. The City should monitor for TCD in both inventoried park trees, and those trees occurring in natural areas throughout the parks.

Miscellaneous Biotic Disorders

Several other biotic (living) disorders were identified during the park tree inventory. Although these pests and diseases currently do not significantly affect the park urban forest, it is important for city managers to be aware of their presence and be able to communicate information about biotic disorders with residents. These pests and diseases include anthracnose (*Gnomonia plantani*), bagworms (*Thyridopteryx ephemeraeformis*), cedar rusts (*Gymnosporangium* spp.), Dutch elm disease, and native borer damage (not from EAB). Additional information about these biotic disorders can be found in Appendix E.

Size Class Distribution

Tree species have different lifespans and mature at different diameters, heights, and crown spreads. Measuring tree diameters at breast height (DBH) is one tool urban forest managers often use to help classify the size of an urban forest. The DBH of a tree cannot assume the actual age of a tree, but general classifications of size, such as small, medium, and large, can be derived by measuring the DBH. The DBH of each individual tree can then be placed into a size class, which can help mangers describe general characteristics of the Sedalia park tree population. This is not a substitute for age classes, which give the actual age and maturity of trees. The breakdown by diameter and size class can be found in Appendix F.

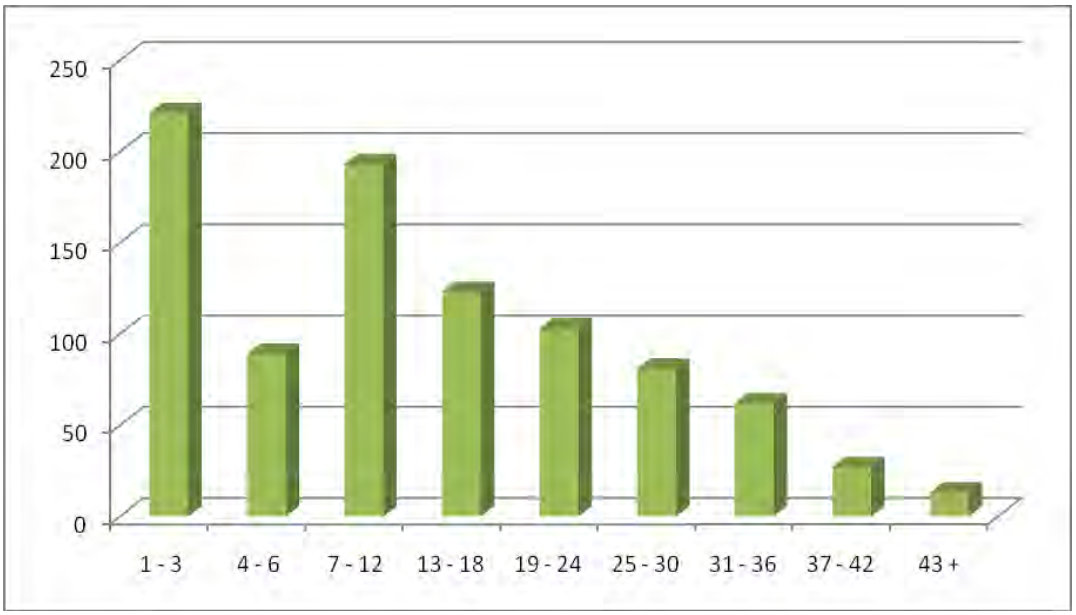

Figure 2. Diameter Size Class Distribution of the Sedalia Park Tree Population

Davey Resource Group believes that the "ideal" distribution of tree ages should be 40:50:10, reflecting the percentage of trees in each size group and representing a uniform range of tree ages from young, to mature, to overmature. By comparison, Sedalia's current urban forest is a 34:46:20 mix of small, medium, and large trees. The City should strive to maintain the ideal distribution of an uneven-aged stand so that the public urban forest is sustainable. A sustainable forest is one that survives or persists, taking severe storms and natural mortality into account.

As illustrated in Figure 2, small trees, which are six inches or less in diameter, represent approximately 34% of Sedalia's park tree population. Green ash, eastern redcedar (*Juniperus virginiana*), and red maple (*Acer rubrum*) make up the majority of these trees. In fact, green ash contributes to 20% of all small trees in Sedalia's city parks. Small trees include mature, small-growing species as well as young trees that will grow out of this size class.

Currently, the number of small trees is slightly lower than the recommended size distribution. Since 20% of these trees are green ash, they may succumb to EAB before they ever reach maturity. If Sedalia replants enough small trees to replace the aging mature or large tree population, and those that may succumb to EAB, then Davey estimates that the park tree size class distribution would eventually move towards the "ideal" 40:50:10 distribution.

The City should properly prune young, deciduous trees to encourage good growth-habit and to minimize future maintenance requirements. Although maintenance requirements can be more intensive in young trees, this care can be performed efficiently by ground crews and without costly equipment (see the *Young Tree Training Program* section in Chapter 2 for more information). Increasing the percentage and properly maintaining the population of small-sized trees ensures an adequate and healthy urban forest to replace older, larger trees as they naturally approach senescence.

Approximately 46% of the inventoried urban forest falls under the medium-sized classification with a diameter range of 7- to 24-inch DBH. Green ash, sugar maple, and common hackberry dominate this size class. Currently, the percentage of medium-sized trees is slightly below the recommended size distribution for the urban forest. A well-balanced size-class distribution can help predict general maintenance patterns easily, which can help budget maintenance activities. This is one step in moving a tree care program from a "re-active" to a "pro-active" approach concerning tree maintenance activities.

Large trees which are 25 inches and greater in diameter comprise approximately 20% of Sedalia's inventoried park tree population. Pin oak (*Quercus palustris*), silver maple (*Acer saccharinum*), and hackberry dominate Sedalia's large trees. The City should thrive to maintain these trees for the future. Large, mature trees provide the greatest amount of benefits in an urban forest.

Planning for tree planting in Sedalia parks will require careful consideration of species selection, as well as a commitment to long-term care. The species composition of the small size class should be composed of both large-growing, long-lived species and small-growing, shorter-lived species. Achieving species diversity among the all size class addresses manageable maintenance needs helps maximize planting space, and promotes aesthetic benefits such as spring flowers and fall color. Proper long-term tree maintenance ensures the health and longevity of the trees, especially those with a high potential to reach maturity. The greater the care a tree receives the greater the potential for that tree to reach maturity, maintain good health, and maximize the benefits for Sedalia. Proper tree care includes fertilizing, watering, mulching, and pruning, which will be discussed in Chapter 2.

General Health and Condition

The condition of a tree is evaluated by considering several factors, including root characteristics, the trunk, branch structure, the canopy, foliage, and presence or absence of pests. Based on these factors, each tree is given a condition rating based on those defined by the International Society of Arboriculture (ISA®). See Appendix A for more information about the condition ratings.

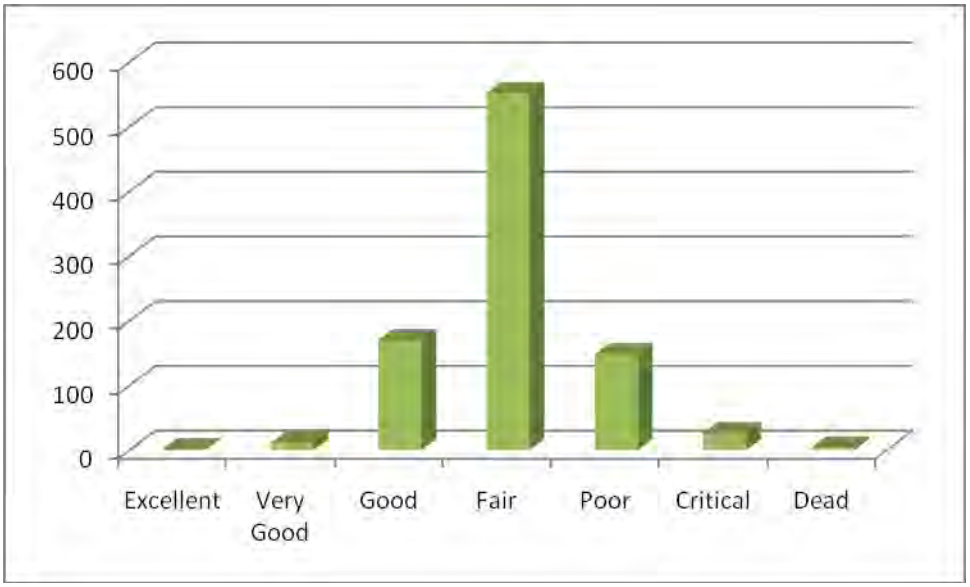

Figure 3. Sedalia Park Tree Conditions

As can be seen in Figure 3, a significant proportion (80.49%) of Sedalia's park tree population is in Excellent, Very Good, Good or Fair condition. Dead trees and those in Poor and Critical condition comprise 19.51% of the total inventoried park tree population. The Poor and Critical condition ratings given to trees are generally due to visible signs of decline and stress, including, but not limited to, decay, dead limbs, sparse branching, or poor structure. Appendix G includes condition ratings breakdown for all the parks in the City, and each individual park.

When trees are stressed or where physical damage has occurred, they become more susceptible to pests, diseases, and other problems. The additional stress can substantially reduce the tree's ability to sustain defense mechanisms and maintain growth. The tree will begin to spirally decline, exerting most of its energy into survival instead of growth. When trees are in good health, most have the ability to withstand pest or disease problems by sustaining defense mechanisms.

A 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, lawn mowers, string trimmers, and poor pruning and installation practices. Also, they are often vandalized because of their small size.

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

Useful Life

The useful life of a public tree has ended when the cost of maintenance is greater than the value added by the tree to the City. 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, diseases, insects, mechanical injury, pollution, and vandalism, among others, can cause stress. Although some species are more resistant to these urban stresses than others, all trees in urban settings will eventually decline, 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 diseases that continue to reduce its vigor. Often, the first symptoms of a problem appear at this point.

Photograph 4. This northern catalpa has numerous cavities and is in serious decline. This weakens the tree's natural defenses, leaving it more susceptible to injury from pests and weather. This tree has reached its "Useful Life" and should be removed, then replaced with a newly planted tree.

The age at which a tree reaches the end of its useful life differs by genus and for certain species within a genus. Slow-growing trees, such as Kentucky coffeetree, are most valuable when they attain maturity. Faster-growing species, such as red maple, are most valuable as juvenile trees because they provide benefits quickly and become expensive to maintain as they reach maturity.

The end of a 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 in a limited growth space can cause hardscape damage at an early age and periodically throughout its lifetime. This tree reaches its useful life 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. Its useful life would most likely be reached only when it started to decline due to senescence. In this example, a smaller tree is a better choice for this site location.

Risk Rating Analysis

A major objective of this inventory was to quantify the risk of each tree in addition to the risk of the park tree population as a whole. Davey assigned a Risk Rating to each tree using an assessment protocol based on the *USDA Forest Service Community Tree Risk Rating System*. This system analyzes risk in four separate categories (Probability of Failure, Size of Defective Part, Probability of Target Impact, and Other Risk Factors) and then uses a point system to calculate a risk rating value from 3–10, with 10 being the most severe. The Risk Rating value assigned to each tree is an important tool that can be used to prioritize work throughout Sedalia parks. Davey urban foresters made all Risk Rating determinations for the park tree inventory. This section discusses the Risk Rating system and its protocol; the use of the Risk Rating system as it pertains to tree maintenance is discussed in the *Tree Maintenance Recommendations* section in this chapter. Appendix A has a more detailed summary of the *USDA Forest Service Community Tree Risk Rating System.*

The first step in using the Risk Rating system is to understand the four separate categories of the protocol. The four categories include:

- **Probability of Failure** identifies the most likely structural defect (s) in the tree that will most likely fail in the future. It then rates the likelihood that the structural defect(s) will result in failure based on the observed current conditions of the defect, the tree, and its surrounding environment. The Probability of Failure is given 1 to 4 points depending upon the likelihood the tree will fail.

Photograph 5. This photograph depicts a dead Scotch pine (*Pinus sylvestris*) that has a picnic table, basketball court, and road underneath its canopy. The Probability of Target Impact is a rated as a 3.

- **Size of Defective Part** rates the size of the part most likely to fail. If the trunk is the part most likely to fail, the DBH value is used for the size of the defective part. The Size of Defective Part is given 1 to 3 points depending upon the defects size.
- **Probability of Target Impact** rates the use and occupancy of the area that could be struck by a defective part. The target could include people, vehicles, buildings, or other infrastructures within the parks. The Probability of Target Impact is given 1 to 3 points depending upon the likelihood the defect will fail over a target.
- **Other Risk Factors** is used if professional judgment suggests the need to increase the Risk Rating. This optional subjective category can increase the total Risk Rating and invoke immediate corrective action. For example, trees with a numeric Risk Rating of 9 or 10 are High-Priority trees to receive corrective treatments first. An inspector may wish to increase a tree's Risk Rating from 8 to 9 as a means of ensuring the tree will receive immediate corrective treatment.

After each of the four categories are given a value, those values are added together to come up with the Risk Rating value for that tree. See the formula below:

Risk Rating (3–10 points) = probability of failure (1–4 points) + size of defective part (1–3 points) + probability of target impact (1–3 points) + optional subjective Risk Rating (0–2 points)

The Risk Rating formula is a 10-point system. The maximum Risk Rating a tree can assume is a rating of 10. See Appendix A for a more detailed summary on the Risk Rating systems methodology.

Trees assessed as lower risk may fail before trees assessed as higher risk. There are many uncontrollable conditions, such as weather, pests, and human involvement, which can contribute to tree failure. Davey's assigned Risk Rating is to be used as a guideline to make safety-driven maintenance decisions and to direct normal tree maintenance programs efficiently. All risk ratings are based on observable defects at the time of assessment and all observations are made from ground level. The Risk Rating assigned to each tree can be interpreted by the following categories:

- **None:** Numeric Risk Rating equals 0. Used for stumps only
- **Low-Risk:** Numeric Risk Rating equals 3 or 4
- **Moderate-Risk:** Numeric Risk Rating equals 5 or 6
- **High-Risk:** Numeric Risk Rating equals 7 or 8
- **Severe-Risk:** Numeric Risk Rating equals 9 or 10

The first step in maintaining Sedalia's urban forest is to abate or mitigate all of the Severe- or High-Risk trees identified during the inventory. Understanding the risk rating system will allow staff to accurately determine and analyze acceptable and unacceptable amounts of risk. Now that Sedalia has a risk rating system in place, it can be used to make important budgetary decisions. Making removal and maintenance decisions based on risk enables for more efficient use in available funds. The use of these funds can be focused on the highest risk situations, effectively obtaining the highest gain in overall safety for the citizens of Sedalia.

Tree Maintenance Recommendations

The following tree maintenance recommendations are based on the analysis of Sedalia's inventoried park tree population. These tree maintenance recommendations help develop appropriate and realistic management goals. Implementation of these recommendations will allow Sedalia to first address the highest risk maintenance recommendations related to public safety. Appendix H includes maintenance recommendation for the entire park tree population and for each individual park.

Maintenance recommendations are divided into two separate categories—Primary Maintenance needs and Secondary Maintenance needs. Both of these are based on ANSI (American National Standards Institute) A300, which are the American national standards for tree care operations. Primary maintenance for Sedalia's park tree inventory is divided into five separate categories, which include Removal, Large Tree Clean, Small Tree Clean, Young Tree Train, and Stump Removal. Table 9 has a summary of the Primary Maintenance recommendations for all the inventoried park trees. Table 9 does not include Stump Removal (there were only 2 stumps identified during the inventory). Secondary Maintenance is divided into six separate categories including Raise, Reduce, Thin, Utility, Restoration and None. Secondary Maintenance will be discussed later in this section. Appendix A has a list of definitions for both primary and secondary maintenance recommendations that Davey collected during the park tree inventory.

Table 9. Sedalia Primary Maintenance Recommendations for Park Trees

Maintenance Required	Number of Sites	Percentage
Removal	63	6.91
Large Tree Clean	551	60.42
Small Tree Clean	47	5.15
Young Tree Train	251	27.52
Total	**914**	**100**

In order to prioritize the maintenance recommendations for the park trees in Sedalia, Davey did an analysis of the Primary Maintenance compared to the Risk Rating of each tree. As mentioned before, the Risk Rating is based on four different criteria: Probability of Failure, Size of Defect, Probability of Target Impact, and Other Risk Factors. Trees with a Risk Rating of 10 are the most Severe Risk park trees and those with 3 are the Lowest Risk park trees.

Initially, Sedalia should concentrate on mitigating all Severe- and High-Risk trees identified in the inventory. This means addressing all trees identified as requiring Severe- and High-Risk Removal and Severe- and High-Risk Prune (Table 10). Severe- and High-Risk removals and prunes should be concluded by the end of Year 2 of the *Five-Year Park Tree Management Program* if the budget allows. Shortly after all Severe- and High-Risk work is complete, the City should begin all Moderate-Risk tree maintenance. In conjunction with mitigating the backlog of Risk Tree Maintenance, the City should then begin the recommended *Five-year Routine Pruning Program* and *Three-year Young Tree Training Program*. These two programs should include structural pruning that is essential in the development trees and help eliminate a large backlog of Severe- and High-Risk trees. The *Park Tree Inventory Workbook* (Workbook) has an inclusive list of all inventoried sites arranged by park, Risk Rating, and maintenance recommendations. The City should use the Workbook to track maintenance activities as they are completed.

Table 10. Tree Maintenance Recommendations by Risk and Size Class

Tree Diameter Size Class (inches)	Severe-Risk Removal	High-Risk Removal	Moderate-Risk Removal	Low-Risk Removal	Severe-Risk Tree Prune	High-Risk Tree Prune	Moderate-Risk Tree Prune	Low-Risk Tree Prune
1 - 3	0	0	0	4	0	0	1	216
4 - 6	0	0	0	4	0	1	8	76
7 - 12	0	5	4	2	0	9	67	106
13 - 18	0	5	4	0	0	15	52	47
19 - 24	2	6	1	0	0	20	47	27
25 - 30	4	3	0	0	1	15	44	14
31 - 36	3	7	0	0	2	14	33	3
37 - 42	3	3	0	0	2	11	8	0
43 +	3	0	0	0	0	6	4	0
Totals	**15**	**29**	**9**	**10**	**5**	**91**	**264**	**489**

Severe- and High-Risk Tree Maintenance Summary

The following Severe- and High-Risk tree maintenance recommendations are based on the collected park tree inventory data. Where numerous Severe- and High-Risk removal and/or pruning recommendations exist at the same park in Sedalia, the City should do the work at the same time to reduce travel time and costs.

As mentioned earlier, the overall maintenance priorities for mitigating dangerous trees are as follows:

- Removals – Severe-, High-, Moderate-, and Low-Risk
- Pruning – Severe-, High-, Moderate-, and Low-Risk

Although large, short-term expenditures are required for trees with these maintenance recommendations, Severe- and High-Risk trees should be mitigated within the first two years of the Five-Year Management Program's implementation if the budget allows.

Based on the tree inventory's results, Table 10 provides a summary of Severe-, High-, Moderate- and Low-Risk maintenance recommendations for Sedalia's park trees. Following completion of the Severe-, and High-Risk maintenance recommendations, Moderate- and Low-Risk Removals and routine pruning cycles, including Large Tree Clean, Small Tree Clean, and Young Tree Train, should then be addressed. Table 11 provides a summary of the different pruning recommendations by size class.

Table 11. Tree Pruning Recommendations by Type and Size Class

Tree Diameter Size Class (inches)	Severe-Risk Large Tree Clean	High-Risk Large Tree Clean	Moderate-Risk Large Tree Clean	Low-Risk Large Tree Clean	High-Risk Small Tree Clean	Moderate-Risk Small Tree Clean	Low-Risk Small Tree Clean	Young Tree Train
1 – 3	0	0	0	39	0	1	16	161
4 -6	0	1	1	23	0	0	8	57
7 – 12	0	9	49	68	0	6	12	33
13 - 18	0	15	52	46	0	0	1	0
19 -24	0	18	46	27	2	1	0	0
25 - 30	1	15	44	14	0	0	0	0
31 - 36	2	14	33	3	0	0	0	0
37 – 42	2	11	8	0	0	0	0	0
43 +	0	6	4	0	0	0	0	0
Totals	5	89	**237**	220	2	8	37	251

Davey Resource Group strongly encourages the City of Sedalia to schedule all Severe- and High-Risk maintenance recommendations to occur as soon as possible in order to abate/mitigate potential hazards. By doing so, the City will greatly decrease the potential of injury to residents, damage to property, and possible liability litigation. Although it is impossible to expect the City to perform all needed maintenance activities immediately due to budgetary concerns, an organized and systematic program will achieve the needed results in a timely manner and will demonstrate the City's "good faith" effort to keep all streets and parks/public spaces safe for its residents.

Severe-Risk Tree Removals

Trees fail from natural causes, such as disease, insects, and weather conditions, and from physical injury due to vehicles, vandalism, and root disturbances, among others. There are three main reasons why elevated-risk trees should be removed: (1) to reduce risks to persons and/or property; (2) to eliminate breeding sites for insects and diseases; and (3) for aesthetic reasons. A Severe-Risk tree is determined by having a Risk Rating of 9 or 10. Currently, there are 15 (1.64%) trees in Sedalia parks that are categorized as Severe-Risk Tree Removals.

Photograph 6. Severe-Risk trees recommended for removal, like this common hackberry (*Celtis occidentalis*), should be removed in the first year of the *Five-year Urban Forest Management Program.*

High-Risk Tree Removals

High-Risk Tree Removals are those trees recommended for removal that have a risk rating of 7 or 8. These trees have sizeable defects with a moderate to high probability of failure. The location of these trees in relation to their surroundings also affects the Risk Rating. Currently, there are 29 (3.18%) trees recommended as High-Risk Tree Removals. The prompt removal of these trees is strongly recommended to reduce liability and maintain public safety.

Moderate-Risk Tree Removals

Additionally, there are 9 (0.99%) trees marked for removal with a Moderate-Risk rating of 5 or 6. Tree in this category still pose some risk to the City. However, these trees have a smaller size of defect and/or less potential to impact a target. It is important that the City remove these trees after the Severe- and High-Risk Tree Removals because their defects may worsen over time or increase in size, thus creating a higher elevated-risk situation.

Low-Risk Tree Removals

Low-Risk Tree Removals (trees with a risk rating of 3 or 4) pose very little risk to the public. These small dead or poorly formed trees need to be addressed after Moderate-Risk trees are removed. The elimination of these trees will minimize breeding site locations for insects and diseases and increase the aesthetics within the parks. Healthy trees growing in a poor location or undesirable species may also be included in this category. Currently, there are 10 (1.96%) trees recommended for Low-Risk Tree Removal.

Large Tree Clean: Severe-, High-, Moderate-, and Low-Risk Pruning

These trees require the selective removal of dead, dying, broken, and/or diseased wood to minimize potential hazards on large-growth trees. Young coniferous trees that grow into large trees are also included, since they typically do not need a Young Tree Train or structural prune when they are young. The priority of work should be dependent upon the Risk Rating associated with the individual trees. The City should consider the condition of each tree when prioritizing maintenance. For example, a tree in Poor condition with an equivalent risk rating to a similar sized tree in Good condition should be pruned first. Mature trees in this category are large enough to require bucket truck access or manual climbing. There are 551 (60.42%) park trees with a recommended maintenance of Large Tree Clean. Of these 551 trees, 5 (0.91%) have a Severe-Risk rating (9 or 10), 89 (16.15%) have a High-Risk rating (7 or 8), 237 (43.01%) have a Moderate-Risk rating (5 or 6), and 220 (39.93%) have a Low-Risk rating (3 to 4), as seen in Table 10.

All trees with Severe- and High-Risk should be examined closely during pruning operations for severe internal and external decay and/or dieback. If, upon closer inspection, these trees are found to be severely decayed, then they should be removed. Trees requiring pruning for elevated-risk conditions should be attended to as quickly as possible, starting with the highest risk trees first.

Small Tree Clean: Severe-, High-, Moderate-, and Low-Risk Pruning

These trees require selective removal of dead, dying, broken, and/or diseased wood to minimize potential elevated-risk conditions on small-growth trees. Priority of work should be dependent upon the risk rating associated with the individual trees. These trees are comprised of small-growing, young, and mature trees that the City can evaluate and prune from the ground. There are a total of 47 (5.15%) park trees that require this type of pruning. As seen in Table 10, of these 47 trees, no trees have a Severe-Risk rating, 2 (4.26%) have a High-Risk rating (7 or 8), 8 trees (17.02%) have a Moderate-Risk rating (5 or 6), and 37 (78.72%) have a Low-Risk rating.

Photograph 7. This pin oak (*Quercus palustris*) is beginning to develop codominant leaders and needs a Young Tree Train to prune the tree back to one central leader.

Young Tree Train

Young Tree Train, or structural pruning, consists of the removal of dead, dying, diseased, interfering, conflicting, and/or weak branches, as well as selective trimming to direct future branch spacing and growth. The objective of Young Tree Training is to increase structural integrity, which often involves the pruning to one dominant leader. This is species-specific since many trees, such as flowering crabapple (*Malus* spp.), often have more than one leader. This maintenance category applies to all trees less than 20 feet in height that are usually young and newly planted. Trees in this group are typically small enough that the City can prune them from the ground with a pole pruner or pruning shears. In all, 251 (27.52%) of the inventoried park trees are designated for Young Tree Training. See Chapter 2 for more in-depth information concerning the *Young Tree Training Program.*

Secondary Maintenance

As mentioned before, secondary maintenance is divided into six separate categories of pruning including Raise, Reduce, Thin, Utility, Restoration and None. Davey suggests that all secondary maintenance prunes should coincide with primary maintenance activities in order to reduce maintenance costs. In other words, the Risk Rating and the primary maintenance needs of a tree will determine when secondary maintenance activities are completed. Unlike primary maintenance, not every tree was denoted with a secondary maintenance during the park tree inventory. Sedalia parks had 170 (18.64%) trees requiring a secondary maintenance. Of these 170 trees, 62 (36.47%) trees need a Raise, 8 (4.71%) trees need a Reduction prune, 26 (15.29%) trees need a Thin, 10 (5.88%) trees need a Utility prune, and 66 (38.82%) need its canopy Restored. Appendix A has ISA definitions for all Secondary Maintenance needs.

Photograph 8. This photograph depicts a pin oak that is overhanging the outfield fence along a baseball diamond. This tree has a secondary maintenance recommendation to raise the crown to reduce the number of conflicts with residents playing baseball.

Other Data Fields

The following is a discussion on additional data fields that were collected during the park tree inventory. Appendix A has a list of definitions and the methodology used by Davey when collecting these different attributes.

Tree Trunks

Of the 912 inventoried park trees, 820 (89.91%) had a single main trunk and 92 (10.09%) had multiple trunks. Trees with multiple trunks (or leaders), such as large growth-habit trees or weak-wooded species, can pose a high risk to the 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 when necessary. Not all trees with multiple trunks are considered to be elevated-risk trees. For example, some serviceberries (*Amelanchier* spp.) and magnolias (*Magnolia* spp.) often exist as multi-trunked specimens and may develop no problems throughout their lifespan. Therefore, it is recommended that Sedalia park managers develop good pruning techniques to remove structurally weak stems while maintaining the natural form of the park trees.

Observations

Of the 912 trees included in the inventory, 147 (16.12%) trees are recorded with an observation of Poor Structure; 96 (10.53%) have a Cavity or Decay; 77 (8.44%) had Remove Hardware noted; 44 (4.82%) have a Poor Root System; 44 (4.82%) have Mechanical Damage; 42 (4.61%) were Improperly Installed; 25 (2.74%) were in Serious Decline; 19 (2.08%) had a Pest Problem; 9

(0.99%) were in a Poor Location; 7 (0.77%) were Improperly Pruned; 4 (0.44%) have a Nutrient Deficiency; and 3 (0.33%) were Improperly Mulched. There were 395 (43.31%) trees without any observations and were denoted as None. Appendix I has frequency reports of the Observations recorded during the park tree inventory.

Tree Location Type

Of the 912 trees and 2 stumps collected during the inventory, all 914 (100%) are designated as Park/Public Space. Davey encourages the City to conduct a Street Tree Inventory in the future, which will help manage the City's urban forest.

Clearance Requirements

Of the 912 inventoried trees, 874 (95.83%) are identified as requiring a clearance of None Needed, 12 (1.32%) need a Pedestrian clearance, 11 (1.21%) need a Vehicle clearance, 9 (0.99%) need a Building clearance, 5 (0.55%) need a Light clearance, and 1 (0.11%) tree needs a Sign or Signal Clearance. When trees are recorded with a clearance category, there are usually multiple safety issues involved. Typically, trees with clearance requirements require a secondary maintenance such as a Reduce or Raise in order to obtain proper clearance. Appendix J has frequency reports of all Clearance requirements.

Grow Space Type

Of 914 inventoried trees and stumps in the Sedalia parks, 907 (99.45%) are located in an Open or Unrestricted area with 3 (0.33%) located on an Island, and 2 (0.22%) located in a Tree Lawn or Parkway. When evaluating future growing spaces and planting locations, the City must carefully select suitable species for each site's growing conditions. See Appendix C for a *Suggested Tree Species* list broken into small-, medium-, and large-growing trees.

Photograph 9. This photograph depicts a tree that is growing into the utility lines. All trees that were within 10 feet of utility lines were noted during the park tree inventory.

Utilities

Of the 914 trees and stumps that were collected during the inventory, 66 (7.22%) 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-growing species that will not interfere with utility lines as they mature. **With a new planting program, the implementation of the concept "right tree, right location" will aid in the reduction of unnecessary maintenance costs.** See Chapter 2 for more in-depth information concerning the *Park Tree Planting Program*. Appendix J has frequency reports of all Utilities observations.

Further Inspection

A tree inventory by its very nature involves only a ground visual inspection of each tree in order to gather basic information. **No tree received a detailed examination or inspection during the tree inventory process.** In the event a tree may require an additional detailed examination or continual inspection, Davey denoted these trees a requiring a Further Inspection. Of the 912 trees, there were 17 (1.86%) that require Further Inspection. Appendix J has frequency reports of all trees that require a Further Inspection.

Tree Inventory Concerns

During the inventory and subsequent data analysis, specific observations were made by Davey Resource Group's urban foresters which require mention to Sedalia personnel:

Development of a Tree Planting Program: This topic is covered in-depth in the *Public Tree Planting Program* section of Chapter 2, but brief coverage is warranted here. 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 parks with the greatest need for improvement. The space available for a tree is a major factor that dictates the type of species best suited for any given location. While the minimum growth space width is often the limiting factor for selecting which species of tree to plant, spacing between plantings is also important. Davey Resource Group recommends planting small-growing trees at least 20–25 feet apart, medium-growing trees at least 30–35 feet apart, and large-growing trees at least 40–45 feet apart. This spacing will ensure that these trees will have enough unrestricted space to attain their full size at maturity. Davey recommends that the City only plant small-growth trees underneath powerlines. Appendix B has a list of recommended species for the *Public Tree Planting Program*.

Photograph 10. This common hackberry has been damaged from a lawnmower. The City should place mulch around young trees to protect them from maintenance equipment.

The planting program needs to address species diversity throughout Sedalia Parks. Currently, green ash makes up the greatest percentage of newly planted or young trees throughout the parks. As mentioned before, it is almost inevitable that EAB will arrive in Sedalia in time. This would devastate the young tree population in Sedalia, killing many young park trees. The younger trees will eventually need to replace the mature and overmature to maintain the current canopy within the parks. Therefore, diversifying the young tree population will promote a more sustainable urban forest for the future.

Mechanical Damage: Mechanical damage is injury to the tree caused by improper use of tools, machines, and equipment. Maintenance machines, such as lawn mowers and string trimmers, typically cause mechanical damage. Davey observed mechanical damage mostly on newly planted trees that are less than 4 inches in diameter. Since these trees are still trying to establish themselves in the urban environment, damage to the roots and cambium could be devastating to the tree, severely stressing the tree to the point that the tree may die. Davey identified 44 (4.81%) trees with mechanical damage. The City has taken a proactive approach by placing guards on many of the newly planted trees. Although these guards can reduce damage to string trimmers, they do not necessarily prevent damage from lawn mowers. Davey suggests that the City utilize mulch when planting new trees. Mulch will not only keep mechanical tools and machines away from the trees, but also benefits the root systems by maintaining soil temperatures and retaining soil moisture.

***Development of a Young Tree Training Program*:** Currently, 251 trees in the inventoried park tree population have been recommended for Young Tree Training. Therefore, the City would benefit greatly from the implementation of a small-tree trimming operation. Young Tree Training is a relatively inexpensive operation since the trees can be pruned from the ground with minimal staff and equipment expenditures. Young Tree Training will ensure that newly planted and immature trees have a strong central leader and good form as they mature. A *Young Tree Training Program* (discussed in Chapter 2) would enable actions that would be extremely beneficial for the overall health and quality of Sedalia's public trees and will protect its investment in new planting stock.

***Tree Ordinance*:** Sedalia should take a proactive approach in managing its urban forest by implementing or updating its city tree ordinance according to the goals and objectives discussed in the Management Plan. A tree ordinance sets the guidelines that residents, City officials, and contractors must follow in regards to trees in the urban forest. Topics such as planting specifications, tree board requirements, construction and tree preservation guidelines, suggested species lists, tree maintenance restrictions, and duties of city managers should all be included in a tree ordinance. A sample tree ordinance has been included in Appendix K, and can be used as a guide for updating or developing a tree ordinance for the City of Sedalia. A tree ordinance, like all city ordinances, is dynamic and in need of constant review and revision, in order to fit the needs of the community as it moves forward in the future.

Chapter 2: Five-Year Urban Forest Management Program

Summary

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

- Severe-Risk and High-Risk Tree Maintenance Recommendations
- Routine Pruning Program
- Young Tree Training Program
- Public Tree Planting Program
- Five-Year Urban Forestry Management Program and Budget
- Administrative Support
- Public Relations and Education
- Sources of Funding
- Management Recommendations for Updating the Inventory

In this chapter, the management program includes estimated budgets for each activity across a five-year period. Additional sources of funding and recommendations for budgeting the urban forestry program are presented at the end of this chapter. Specific tree management recommendations include:

- Perform all Severe- and High-Risk maintenance recommendations. This includes all removals of all potential Severe- and High-Risk trees identified in the tree inventory during Years 1 and 2 (funds permitting) of the Five-Year Program. If funds exist at the completion of all Severe- and High-Risk maintenance in Year 2, Sedalia should begin the Moderate-Risk maintenance recommendations.

- Beginning in Year 3 of the Five-Year Program, implement a *Routine Pruning Program* that includes cyclical maintenance for the entire tree population ensuring pruning every five years.

- Beginning in Year 1, implement a three-year cyclical *Young Tree Training Program* for immature and newly planted trees.

- Beginning in Year 1, implement a yearly planting program to replace trees that were removed, and increase the tree population and species diversity throughout the parks.

- Implement a public relations program designed to educate the residents and city managers of Sedalia and to generate greater support for the City's urban forestry program.

Severe- and High-Risk Tree Maintenance Recommendations

The following tree maintenance recommendations are based on the analysis of the inventoried portion of Sedalia's park tree population in Chapter 1. The City should follow these recommendations to develop realistic goals. Implementation of these recommendations will allow Sedalia managers to first address the highest risk maintenance recommendations related to public safety.

Initially, Sedalia should concentrate on reducing the highest risk trees identified in the inventory. This means addressing all trees identified as requiring Severe- and High-Risk Removal and Severe- and High-Risk Prune. The City should complete all Severe- and High-risk tree removals and prunes by the end of Year 2 of the *Five-Year Urban Forest Management Program* if the budget allows. Shortly after all the work on Severe- and High-risk is complete, the City should begin work on Moderate and Low-risk removal trees. In conjunction with mitigating the backlog of Severe- and High-risk trees, city managers should begin the recommended three-year *Young Tree Training Pruning Program*.

Photograph 11. All Severe- and High-Risk trees, like this American sycamore (*Platanus occidentalis*), should be addressed in the first two years of the *Five-Year Urban Forestry Management Program.* After the Severe- and High-Risk trees recommended for pruning are addressed, they should be placed in the *Routine Pruning Program*.

<u>Natural Mortality</u>

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 tree populations in municipalities). The mortality rate for Sedalia's trees may represent approximately 9 additional park trees per year. It is important to keep in mind that as the current tree population increases in size and trees mature, routine costs for maintaining it will also increase. Davey factored these anticipated tree removal costs into the budget projection (Table 16) beginning in Year 3 of the Program to account for future tree removals not identified in the inventory. Due to the unpredictability of the size of trees that may succumb to natural mortality, it is very difficult to determine the exact annual costs for removing these trees.

Routine Pruning Program

Routine pruning is an activity that should take place on a cyclical basis for the entire tree population once all Severe- and High-Risk removal and pruning activities have been completed. This activity is extremely beneficial for the overall health and longevity of trees; therefore, Sedalia should try to start a *Routine Pruning Program* as soon as the budget allows. Through routine pruning, potentially serious problems can be avoided since the trees can be closely inspected during these pruning cycles. Sedalia can make proper decisions about declining trees, and any trees that are becoming elevated-risks before any serious incidents occur. Note that trees included in this program will not include young or newly planted trees. These trees are included in the *Young Tree Training Pruning Program* explained later. As these young trees grow larger, they, too, will eventually become part of the *Routine Pruning Program*.

In Year 3, after all priority maintenances are complete, a five-year cycle should be implemented so that approximately 120 (110 large trees and 10 small trees) landscape trees per year are routinely pruned. Tables 12 and 13 present an **estimated** number of trees to be pruned each year for the inventoried Large and Small Routine Pruning Programs. Table 17 illustrates estimated costs for the first three years of the five-year cycle, beginning in Year 3. This budget illustrates estimated costs for each activity and facilitates planning for the inventory's short-term management recommendations.

Table 12. Routine Pruning Program for Public Trees by Diameter Size Class: Large Tree Clean

Diameter Size Class (Inches)	Large Tree Clean Total Trees	Large Tree Clean Approximate Trees/Year (5-Year Pruning Cycle)
1 – 3	39	8
4 – 6	25	5
7 – 12	126	25
13 – 18	113	23
19 – 24	91	18
25 – 30	74	15
31 – 36	52	10
37 – 42	21	4
43+	10	2
Totals	**551**	**110**

Table 13. Routine Pruning Program for Public Trees by Diameter Size Class: Small Tree Clean

Diameter Size Class (Inches)	Small Tree Clean Total Trees	Small Tree Clean Approximate Trees/Year (5-Year Pruning Cycle)
1 – 3	17	3
4 – 6	8	2
7 – 12	18	4
13 – 18	1	0
19 – 24	3	1
25 – 30	0	0
31 – 36	0	0
37 – 42	0	0
43+	0	0
Totals	47	10

Five-Year Cycle

Results from the tree inventory indicate that 598 (65.57%) trees would be included in a cyclical pruning operation—551 Large Tree Cleans and 63 Small Tree Cleans. These include those trees that are currently Severe- and High-Risk trees that require an immediate prune (after the City mitigates the issues associated with these Severe- and High-Risk trees, they are to be included in the *Routine Pruning Program*). The budget in Table 17 is intended to illustrate estimated costs for each activity and facilitate plans for short-term management recommendations and long-term community forestry program objectives. It may not accurately represent the actual number of trees in each size class or maintenance activity each year. In addition, not every tree included in the Five-year cycle may need to be pruned when its turn in the cycle comes around. An example would be a Colorado blue spruce (*Picea pungens*) which has a pyramidal growth form that often requires minimal maintenance. This budget should be used as a **guideline** for implementing the maintenance programs outlined in the *Five-Year Urban Forest Management Program.*

Photograph 12. The City has been divided into five separate management zones for the Routine Pruning Program. Since Liberty Park has numerous mature trees, it has been divided into two separate management zones.

The tree inventory provides the City with exact numbers and locations concerning Tree Cleaning recommendations which can be used to plan, schedule, track, and update tree maintenance activity (the *Park Tree Inventory Workbook* also has all trees and their corresponding Risk Rating and maintenance needs listed for planning maintenance activities). Tree cleaning includes those trees requiring pruning on a cyclical basis to maintain tree form and health. In order to establish a cyclical pruning schedule, Davey developed five different management zones that should be used to annually manage trees in the five-year cycle. These management zones are based on the number and size of trees in each park that will be included in the *Routine Pruning Program*. The management zones are shown in Table 14. Liberty Park is divided into two different zones (Zone 1 and Zone 2) in which half of Liberty Park should be pruned in the initial year of the *Routine Pruning Program*, and the remaining trees should be pruned in the second year of the Program. The remaining zones include Zone 3, Katy Park; Zone 4, Housel, Hubbard, and Vermont Park; and Zone 5, Centennial and Clover Dell Park. By grouping trees into management zones, the City will reduce costs and ensure that every tree is pruned every five years.

Table 14. Management Zones for the Five-Year Routine Pruning Program

Diameter Class	Zone 1 Liberty Park	Zone 2 Liberty Park	Zone 3 Katy Park	Zone 4 Housel, Hubbard, and Vermont Park	Zone 5 Centennial and Clover Dell Park
1 - 3	8	8	3	6	31
4 - 6	5	5	4	12	7
7 - 12	24	23	45	23	29
13 - 18	17	18	57	13	9
19 - 24	25	25	17	17	10
25 - 30	21	21	3	10	19
31 - 36	15	14	1	13	9
37 - 42	6	7	1	5	2
43 +	3	3	0	3	1
Total	124	124	131	102	117

Also, the Sedalia managers should conduct an annual visual survey of all the maintained park trees. This will help to identify any new risks that may occur between pruning cycles. Inspections should also occur after a high wind, ice, or other storm event. Davey suggest that Certified Arborists complete all of the inspections.

Young Tree Training Program

As described previously, a Young Tree Train, or structural prune, consists of the removal of dead, dying, diseased, broken, interfering, conflicting, and/or weak branches, as well as selective trimming to direct future branch growth in trees less than 20 feet in height. The word "train" truly pertains to young or recently planted trees. For these trees, a Young Tree Train 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 they grow, such as codominant 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. A Young Tree Train 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 or where decay can develop at the crossing points of interfering limbs. Trees with poor branching can become elevated risks as they grow larger and may create potential liability for Sedalia in the near future.

All newly planted trees should receive their first Young Tree Train two years following planting. A Young Tree Train should not be performed when a tree is first planted since it is already under stress from transplanting and needs as much of its leaf canopy as possible to manufacture food and increase root growth for proper establishment. Only dead or broken branches should be removed at the time of planting.

Three-Year Cycle

Similar to the *Routine Pruning Program*, the *Young Tree Training Program* would also be accomplished on a cyclical basis, but the work would be scheduled during a three-year cycle, rather than a five-year cycle, due to the faster growth rates (on average) of younger trees. As these young trees mature, they will should be included in the *Routine Pruning Program*. As mentioned above, newly planted trees should receive their first Young Tree Train two years after planting and this work can be accomplished throughout the year. Particularly, since no bucket truck is required, this type of work is highly suitable for properly trained volunteers.

Work Estimates

A three-year pruning cycle would require the *Young Tree Training Program* to prune approximately 50 trees per year. Based on the current inventory data, Table 15 provides the total number of trees that should be trained and an annual average breakdown by diameter size class. The proposed five-year budget in Table 17 recommends that the *Young Tree Training Program* should be implemented beginning in Year 1 of the budget. By implementing the *Young Tree Training Program* in Year One, the overall cost for large tree pruning and the general risk rating will decrease over time due to proper care and pruning of these young trees.

Table 15. Young Tree Training Program by Diameter Size Class

Diameter Size Class (Inches)	Young Tree Training Pruning (Total Trees)	Young Tree Training Pruning (Trees/Year)
1 – 3	161	54
4 – 6	52	17
7 – 12	38	13
Totals	**251**	**84**

Training of Personnel

It has been Davey Resource Group's experience that based on the generally small number of trees in the Young Tree Train maintenance category, one to two properly trained staff members would be capable of accomplishing all the work on an annual basis. Proper training about performing young tree structural pruning should 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 basic tree anatomy and physiology. It is imperative to emphasize proper arboricultural and horticultural techniques and practices for anyone performing the work. The tremendous aesthetic and financial benefits to be gained in the years to come from the proper structural pruning of young trees are a strong incentive for educating personnel concerning proper pruning techniques.

Public Tree Planting Program

Davey did not identify potential planting sites during the park tree inventory, but Sedalia managers should continue to plant new trees and to replace those threes that are removed. Tree species should be selected for their durability and low-maintenance requirements. These attributes are highly dependent on site characteristics and local climate, 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. Trees that are well matched to their environmental conditions are much more likely to resist attack from pathogens and insect pests and will, therefore, require less maintenance.

No planting sites were identified for the inventory, but several open areas, suitable for planting, do exist within parks. It is important to plant trees annually in order to maintain a sustainable urban forest over time. Davey suggests that the City plant approximately 25 trees per year. Planting at least 25 trees per year will replace those trees that will be removed in the *Five-Year Urban Forestry Management Program* and account for natural mortality. The additional trees will help the City increase its current park tree population and help promote a more diverse urban forest for the future.

Based upon the current inventory, Davey has prioritized the locations where additional trees should be planted in the future. These recommendations are based on the current tree population, species distribution, current size distribution, and canopy coverage. Davey did not conduct a detailed canopy study, but was able to do a quick assessment while conducting the inventory. The following are Davey's recommendations for planting additional trees in Sedalia's parks:

1. High priority parks include Housel and Hubbard Park. These parks have low canopy coverage with large openings available for planting. The species diversity in Hubbard Park was low, and the majority of the young trees were ash trees. Housel Park has a very low tree population, and approximately 66% of those trees are in poor condition.
2. Moderate priority parks include Centennial Park, Clover Dell Park, and Katy Park. Centennial Park has good canopy coverage on the northern side of the park, but lacks a dense canopy on the southern half. There are many open areas to plant large-growing species throughout the park. The planting of wetlands trees, such as river birch (*Betula nigra)* along the creek, could increase the parks' aesthetic value. Clover Dell Park is a very large park with many natural areas. The park has very low species diversity throughout the maintained tree population, and has many opportunities to plant large-growing trees. Katy Park has a decent tree population, with several opportunities to plant additional trees. The planting of sugar maple and common hackberry should be limited to increase species diversity.
3. Low priority parks include Liberty Park and Vermont Park, which are both well stocked with mature trees. Although, there are opportunities to plant additional trees at these parks, plantings should be limited to areas with low canopy coverage. Trees should be planted to replace trees that are removed during the *Five-Year Urban Forest Management Program*.

Sedalia managers must determine which tree species to plant at each specific park. The phrase "right tree in the right place" is the most important concept in planting. All trees have different characteristics suitable for different landscapes. Davey recommends that all characteristics be recognized including, but not limited to, the desired function (*e.g.*, seasonal flowering, shade canopy, wind resistance), mature size and shape for the intended location, soil conditions, maintenance requirements, and potential pest problems. Proactive planning should be made to plant the right tree in the right place, considering available growing space, presence of utilities, placement between present and future memorial stones, and traffic and pedestrian clearance issues, while obtaining the desired aesthetic effects and function of the landscape tree.

The suggested species list in Appendix C considers maintenance requirements, adaptability to specific planting sites, and suitability to the restrictive conditions of the urban environment, among others. The list is categorized by tree heights (small, medium, and large), providing a number of different species that would be suitable for a variety of planting sites. Selecting trees from this list will help to ensure that appropriate sized trees are planted in a site suitable to sustain the tree's natural habit.

Photograph 13. Currently, green ash makes up 20% of the small tree (1 to 6 inch) population throughout Sedalia parks. The City should plant alternative species to minimize future damage from emerald ash borer (*Agrilus planipennis*) and to increase species diversity.

Tree Species Diversity

Tree plantings add greatly to the aesthetic appeal of parks. However, species diversity in new plantings should be of major importance. The dangers (diseases, insects, etc.) of planting monocultures have proven to be devastating throughout the United States. The goal here should be to increase species diversity throughout the Parks such that no one species represents 10% and that no one genus comprises more than 15% of the total public tree population.

Tree Species Selection

Sedalia occurs in Zone 5 of the USDA Hardiness Zone Map, which identifies the climatic region where the average annual *minimum* temperature is between -10º and -20º F. All tree species selected for planting in the City should be appropriate for this zone and in areas suitable for tree planting within the parks determined by the City.

In addition to considering site characteristics, such as the availability of space, soil pH, and irrigation, the City should evaluate species-specific features. Species such as willow (*Salix* spp.) have weak wood and typically drop many small branches during a growing season. Others trees, such as American sweetgum (*Liquidambar styraciflua*), drop high volumes of syncarps (fruits). In certain species, such as ginkgo (*Ginkgo biloba*), female trees produce offensive fruit; however, male trees produce no fruit. A few species of trees, including hawthorn (*Crataegus* spp.) and honeylocust (*Gleditsia triacanthos*), may have substantial thorns. Sedalia should avoid planting these species in high-traffic areas.

The City should consider seasonal color 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, that is, "right tree, right location". Plants that are well matched to their environmental and site conditions are much more likely to resist pathogens and insect pests and will, therefore, thrive and require less maintenance overall. Refer to Appendix C for additional tree species and cultivars suitable for planting in Sedalia.

The Tree Planting Process

Since Sedalia trees are purchased through local nurseries, the most important considerations should be species selection, inspections of planting material to ensure quality stock, and planting specifications. Once Sedalia has purchased the appropriate trees for planting, the most important detail to ensure success is the preparation of the planting sites. Appendix L 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 soil texture and soil structure inside the planting holes and the surrounding soil. These differences in soil will either wick water away or accumulate in the planting holes.

Tree staking hardware should only be installed when necessary to keep trees from leaning on windy sites or to prevent damage from pedestrians and/or vandals. The City should only attach stakes to trees with a loose, flexible material, and all staking material must be removed within one growing season (Appendix L). Tree guards can be installed to protect the trees from pest predation or mechanical damage; however, the City must implement a program to remove the hardware before it girdles the tree. Davey suggests using mulch as an alternative method for preventing mechanical damage to newly planted trees.

Tree Mulching

The City should apply mulch to the surface of the soil around each newly planted tree. Mulch should never be piled up around the root collar (mulch "volcanoes"), but rather should be pulled away from the root collar. Mulch that buries the root collar provides shelter for insects, fungi, and small 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. Mulch also helps to hold moisture in the surface of the soil where most of the feeder roots are to be established. Appendix L has more information on properly mulching newly planted trees.

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. Therefore, a soil test should be conducted to determine what nutrients are available or unavailable to the tree before any fertilizing is performed. 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 City selected the proper tree, 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 City should only prune 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 M for more information about proper pruning techniques.

Tree Purchasing

Tree prices, of course, vary based on the species selected, but Davey Resource Group has found that many nurseries offer trees of 2.0- to 2.5-inch caliper for $100 to $150. As the City 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 be considered. It is recommended that Sedalia continue to explore local and regional sources for trees and discuss pricing with the current nursery source(s). Due to the requirement to work towards species diversity, it may be necessary to use several nurseries as sources for trees.

Five-Year Park Tree Management Program and Budget

For purpose in aiding all Sedalia managers involved in the urban forestry program, 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 is aware that the portion of Sedalia's budget allocated to park tree resource-related functions might currently be stretched beyond its limits. However, Sedalia must understand that the budgeting recommendations below are only **estimates** and are based on the application of sound urban forestry management principles to municipal forestry operations.

The *Five-Year Urban Forest Management Program* is set up to address the highest risk removal and maintenance recommendations first. This reduces elevated-risk situations for the public and all associated liabilities. **As stated previously, Davey Resource Group strongly encourages the City to schedule these activities to occur in a timely manner in order to abate/mitigate all Severe- and High-Risk trees identified during the inventory.**

Table 16 lists the estimated costs for tree removals, pruning, stump removals, fertilization, and mulching. Tree pruning and removal costs for trees in this 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. These costs are an average and are used to estimate the Severe-, High-, Moderate-, and Low-Risk maintenance recommendations, *Routine Pruning Program*, and *Young Tree Training Pruning Program* budget projections in this plan.

Table 16. Cost Estimates Per Tree 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	$25	$20	$25	$5	$11
4 – 6	$105	$30	$25	$18	$11
7 – 12	$220	$75	$25	$22	$14
13 – 18	$355	$120	$40	$30	$14
19 – 24	$525	$170	$60	$50	$20
25 – 30	$845	$225	$85	$60	$20
31 – 36	$1,140	$305	$110	$90	$28
37 – 42	$1,470	$380	$130	$120	$28
43+	$1,850	$590	$160	$150	$28

Table 17 provides an **estimated** budget for the *Five-Year Urban Forest Management Program* for Sedalia. This budget estimate reflects a program of work above and beyond the City's existing activities. The management objectives discussed in this Plan aim to alleviate all identified elevated-risk trees within the first two years, establish a three-year *Young Tree Training Program* for all young and newly planted trees, and establish a five-year *Routine Pruning Program*.

Table 17 shows the initial investment levels needed for the mitigation of High- and Severe-Risk trees. When the backlog of Severe- and High-Risk trees is addressed, there is an opportunity for a proactive, more predictable maintenance regimen. The *Routine Pruning Program* and the *Young Tree Training Program* are examples of a proactive maintenance regimen. Please note that a proactive maintenance regimen comes with the benefit of a lower, more reliable budget estimate from year to year.

There are many limitations to the proposed five-year budget, such as being able to predict the rising costs of tree maintenance, knowing how many major storm events might occur, or knowing how many trees may die per year due to natural causes. Therefore, this table is a general **guideline** for implementation of the *Five-Year Urban Forest Management Program*. The City can use it to plan future tree care operations and reviewing on-going City forestry operations.

Table 17. Estimated Costs for Sedalia's Five-Year Park Tree Urban Forestry Management Program

Estimated Costs for Each Activity			YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		7-Year Cost
Activity	Diameter Class	Cost/Tree (dollars)	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
Severe Risk Removal	1-3"	$25	0	$0									$0
	4-6"	$105	0	$0									$0
	7-12"	$220	0	$0									$0
	13-18"	$355	0	$0									$0
	19-24"	$525	2	$1,050									$1,050
	25-30"	$845	4	$3,380									$3,380
	31-36"	$1,140	3	$3,420									$3,420
	37-42"	$1,470	3	$4,410									$4,410
	43"+	$1,850	3	$5,550									$5,550
Activity Total(s)			**15**	**$17,810**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$17,810**
High Risk Removal	1-3"	$25	0	$0	0	$0							$0
	4-6"	$105	0	$0	0	$0							$0
	7-12"	$220	3	$660	2	$440							$1,100
	13-18"	$355	3	$1,065	2	$710							$1,775
	19-24"	$525	3	$1,575	3	$1,575							$3,150
	25-30"	$845	1	$845	2	$1,690							$2,535
	31-36"	$1,140	4	$4,560	3	$3,420							$7,980
	37-42"	$1,470	1	$1,470	2	$2,940							$4,410
	43"+	$1,850	0	$0	0	$0							$0
Activity Total(s)			**15**	**$10,175**	**14**	**$10,775**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$20,950**
Moderate Risk Removal	1-3"	$25			0	$0							$0
	4-6"	$105			0	$0							$0
	7-12"	$220			4	$880							$880
	13-18"	$355			4	$1,420							$1,420
	19-24"	$525			1	$525							$525
	25-30"	$845			0	$0							$0
	31-36"	$1,140			0	$0							$0
	37-42"	$1,470			0	$0							$0
	43"+	$1,850			0	$0							$0
Activity Total(s)			**0**	**$0**	**9**	**$2,825**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$2,825**
Low Risk Removal	1-3"	$25					4	$100					$100
	4-6"	$105					4	$420					$420
	7-12"	$220					2	$440					$440
	13-18"	$355					0	$0					$0
	19-24"	$525					0	$0					$0
	25-30"	$845					0	$0					$0
	31-36"	$1,140					0	$0					$0
	37-42"	$1,470					0	$0					$0
	43"+	$1,850					0	$0					$0
Activity Total(s)			**0**	**$0**	**0**	**$0**	**10**	**$960**	**0**	**$0**	**0**	**$0**	**$960**
Severe Risk Clean	1-3"	$20	0	$0									$0
	4-6"	$30	0	$0									$0
	7-12"	$75	0	$0									$0
	13-18"	$120	0	$0									$0
	19-24"	$170	0	$0									$0
	25-30"	$225	1	$225									$225
	31-36"	$305	2	$610									$610
	37-42"	$380	2	$760									$760
	43"+	$590	0	$0									$0
Activity Total(s)			**5**	**$1,595**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$1,595**
High Risk Clean	1-3"	$20	0	$0	0	$0							$0
	4-6"	$30	0	$0	1	$30							$30
	7-12"	$75	3	$225	6	$450							$675
	13-18"	$120	5	$600	10	$1,200							$1,800
	19-24"	$170	7	$1,190	13	$2,210							$3,400
	25-30"	$225	5	$1,125	10	$2,250							$3,375
	31-36"	$305	5	$1,525	9	$2,745							$4,270
	37-42"	$380	3	$1,140	8	$3,040							$4,180
	43"+	$590	2	$1,180	4	$2,360							$3,540
Activity Total(s)			**30**	**$6,985**	**61**	**$14,285**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$21,270**
Large Tree Clean 5-Year Cycle[1]	1-3"	$20					8	$160	8	$160	8	$160	$480
	4-6"	$30					5	$150	5	$150	5	$150	$450
	7-12"	$75					25	$1,875	25	$1,875	25	$1,875	$5,625
	13-18"	$120					23	$2,760	23	$2,760	23	$2,760	$8,280
	19-24"	$170					18	$3,060	18	$3,060	18	$3,060	$9,180
	25-30"	$225					15	$3,375	15	$3,375	15	$3,375	$10,125
	31-36"	$305					10	$3,050	10	$3,050	10	$3,050	$9,150
	37-42"	$380					4	$1,520	4	$1,520	4	$1,520	$4,560
	43"+	$590					2	$1,180	2	$1,180	2	$1,180	$3,540
Activity Total(s)			**0**	**$0**	**0**	**$0**	**110**	**$17,130**	**110**	**$17,130**	**110**	**$17,130**	**$51,390**
Small Tree Clean 5-year Cycle[1]	1-3"	$6					3	$18	3	$18	3	$18	$54
	4-6"	$15					2	$30	2	$30	2	$30	$90
	7-12"	$29					4	$116	4	$116	4	$116	$348
	13-18"	$47					0	$0	0	$0	0	$0	$0
	19-24"	$65					1	$65	1	$65	1	$65	$195
	25-30"	$83					0	$0	0	$0	0	$0	$0
	31-36"	$101					0	$0	0	$0	0	$0	$0
	37-42"	$119					0	$0	0	$0	0	$0	$0
	43"+	$160					0	$0	0	$0	0	$0	$0
Activity Total(s)			**0**	**$0**	**0**	**$0**	**10**	**$229**	**10**	**$229**	**10**	**$229**	**$687**
Young Tree Training Pruning 3-Year Cycle[2]	1-3"	$20	54	$1,080	54	$1,080	54	$1,080	54	$1,080	54	$1,080	$5,400
	4-6"	$30	17	$510	17	$510	17	$510	17	$510	17	$510	$2,550
	7-12"	$75	3	$225	3	$225	3	$225	3	$225	3	$225	$1,125
Activity Total(s)			**74**	**$1,815**	**74**	**$1,815**	**74**	**$1,815**	**74**	**$1,815**	**74**	**$1,815**	**$9,075**
Stump Removal[3]	1-3"	$6	0	$0	0	$0							$0
	4-6"	$15	0	$0	0	$0							$0
	7-12"	$29	3	$87	6	$174							$0
	13-18"	$47	5	$235	6	$282							$0
	19-24"	$65	5	$325	4	$260							$0
	25-30"	$83	5	$415	2	$166							$0
	31-36"	$101	7	$707	3	$303							$0
	37-42"	$119	4	$476	2	$238							$0
	43"+	$160	3	$480	0	$0							$0
Activity Total(s)			**32**	**$2,725**	**23**	**$1,423**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$0**
Planting	Purchasing	$110	25	$2,750	25	$2,750	25	$2,750	25	$2,750	25	$2,750	$13,750
	Planting	$110	25	$2,750	25	$2,750	25	$2,750	25	$2,750	25	$2,750	$13,750
Activity Total(s)			**25**	**$5,500**	**25**	**$5,500**	**25**	**$5,500**	**25**	**$5,500**	**25**	**$5,500**	**$27,500**
1% Natural Mortality Removals [4]	Removals	$700		$0		$0		$0		$0		$0	$0
Activity Total(s)			**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$0**
Activity Grand Total			**196**		**206**		**229**		**219**		**219**		**1,069**
Cost Grand Total				**$46,605**		**$36,623**		**$25,634**		**$24,674**		**$24,674**	**$158,210**

[1]Pruning Cycles begin in year 3 and only the first three years of the cycle are in the Five-year Budget

[2]The Young Tree Training Program begins in year 1 and repeats every 3 years

[3]Stump Removals are based upon the number of trees removed each year, and include the stumps from the inventory

[4]Removal Costs for Natural Mortality is based on the average inventoried tree size

Table 18. Arboricultural Planning Chart for Tree Management Activities

ACTIVITY/ TREATMENT	YEAR*	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
REMOVALS													
Severe and High Risk (Inventory)	1	X	X	X							X	X	X
Moderate Risk (Inventory)	1	X	X	X							X	X	X
Removals (Anticipated)	2A	X	X	X							X	X	X
Stump Removal	1A	X	X	X							X	X	X
PRUNING													
High Risk	1	X	X	X							X	X	X
Moderate Risk	1	X	X	X							X	X	X
Routine Pruning (Seven-Year Rotation)	2A	X	X	X							X	X	X
Young Tree Training Pruning (Three-Year Rotation)	2A	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	N	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	5-10	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 18 can help Sedalia managers organize the tree maintenance program, 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 City should schedule these maintenance activities during optimal seasonal periods to sustain vigorous tree health and to ensure the best chance for survival of the City's trees.

Administrative Support

Trees are unique compared to other assets that the City manages. Trees are living, growing organisms that have potentially very long service lives, provide multiple benefits, and have public safety implications. The care and management of this natural resource requires specialized equipment, but most importantly, they need both professional expertise and a volunteer workforce to assist with special projects and program needs.

Professional Staff

An adequate complement of professionals who, individually or collectively, understand the technical, operational, and administrative factors in urban forest management is needed to prescribe and monitor the City's urban forestry activities, enforce policies and regulations, apply technical standards and practices, perform tree planting and maintenance, and review plans that affect the forest resource. Without this professional component in sufficient numbers, urban forest management decisions and actions often default to inadequately trained staff, which can have long-term, negative consequences for the forest resource.

Photograph 14. Davey suggests that at least one city employee become a Certified Arborist through the International Society of Arboriculture (ISA). A Certified Arborist would be able to conduct tree risk assessments and identify tree defects that need to be addressed, like the codominant leaders on this pin oak.

Davey recommends that the City continue to provide urban forestry education and training opportunities for both urban forestry managers and maintenance crews. It is recommended that at least one city manager and one maintenance personnel obtain certification through the International Society of Arboriculture (ISA). As a Certified Arborist, an urban forestry manager can help implement strategies and achieve the goals described in this Management Plan. A Certified Arborist working on the maintenance crew can monitor implementation activities in the field, and educate and train other personnel on proper tree care practices.

Volunteer Resources

Volunteers are the backbone of any community initiative. The management, protection, and enhancement of Sedalia's urban forest can be advanced with the inclusion of volunteers in many aspects of the program. Many benefits and efficiencies can be realized by effectively using volunteers. Volunteer resources can help create community partnerships for funding, increase the awareness of urban forestry issue and challenges, help deliver important messages, and advance public outreach and education. Volunteers also provide valuable resources to fill gaps in skills, experiences, and staffing needs; and giving the urban forestry program the credibility, support, and human resources that are essential in order to advance the program's goals.

Public Relations and Education

Through years of experience and research, Davey Resource Group has found that public education and participation is the true key to reaching the goals of an urban forestry program in communities. Only by educating citizens, City officials, developers, and all contractors working within the City will it 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 are often 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 personnel have consistently found resistance from builders and developers who implemented many ingenious methods to circumvent ordinances. Only when a tree preservation educational seminar was developed (with attendance required by all contractors working within City limits) did communities begin to see greater cooperation from contractors. Appendix N includes a sample of a tree preservation ordinance. In addition, Appendix O includes sample specifications for contracting tree work.

By requiring various community stakeh**o**lders to attend educational sessions to learn about the City's urban forest, urban forest preservation, and the importance of it all to the future of the City, Sedalia 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 Sedalia 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 City to undertake:

- Hold a seminar or public meeting to discuss the tree inventory project, its results, and its importance for the City.
- 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.
- Write a monthly "Tree Talk" article for local newspapers and publish the City's recommended tree species list.
- Send letters to residents in areas of the City where new tree plantings will be conducted each year and describe the tree planting program and the species that are being planted.
- Develop a "Caring for New Trees" 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 to increase public interest in the City's tree programs. Refer to the National Arbor Day Foundation (visit www.arborday.org) for publications that provide great Arbor Day ideas to assist in planning this event.

Sources of Funding

Funding sources for tree care range from the City's general funds to joint programs with local companies. Davey Resource Group encourages Sedalia 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 will support a variety of urban forestry program development projects, including training and education. Further information can be obtained by visiting the Missouri Department of Conservation (MDC) website at http://mdc.mo.gov/landwater-care/communities.

Other Grants: *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 March 31 of each year:

- The Conservation Fund
  1655 North Fort Myer Drive, Suite 1300
  Arlington, Virginia 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:

- American Forests
  Attn: Margo Dawley
  P.O. Box 2000
  Washington, D.C. 20013
  202-737-1944, ext. 224
  www.americanforests.org/global_releaf/

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:

- U.S. EPA/Office of Environmental Justice
  1200 Pennsylvania Avenue NW, Room 2232E
  Washington, D.C. 20004
  202-564-5396
  www.epa.gov/compliance/environmentaljustice/grants/index.html

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:

- The National Urban and Community Forestry Advisory Council
  Nancy Stremple, RLA
  U.S. Forest Service
  Executive Staff to NUCFAC/U&CF Program Specialist
  1400 Independence Avenue SW
  Yates Building (1 Central)
  Washington, D.C. 20250
  202-309-9873
  nstremple@fs.fed.us

The National Arbor Day Foundation's (NADF) goal is to positively influence organizations and institutions in the planting and proper care of trees. Through conferences and seminars, positive recognition programs, conservation models, and how-to materials, the NADF educates and motivates cities, utility companies, schools, and other organizations to plant and care for trees, and to support related environmental stewardship activities. Whenever possible, the NADF works through existing structures of organizations and individuals who care about trees to achieve their objectives. The NADF has created programs and educational tools that can be effectively utilized by existing agencies. The NADF is most notably known for its Tree City USA and TreeLine USA accreditation programs.

- The National Arbor Day Foundation
  100 Arbor Avenue
  Nebraska City, Nebraska 68410
  1-888-448-7337
  www.arborday.org

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.

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 timeframe 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.

Management Recommendations for Updating the Inventory

An up-to-date inventory is the best way for the City to monitor the progress of its tree care operations. The major benefit of an accurate tree inventory is that the City can budget, plan, and anticipate tree-related problems and situations in the most cost-effective manner possible. **The City must establish procedures for keeping the tree inventory information current.** There are several software suits available for municipal governments to manage an urban forest and their tree inventory. This software helps keep accurate records of work completed on specific trees and tracks removals and installations, which will help keep the inventory updated. Davey suggests that the City designate one or two personnel to keep track of maintenance activities and records by updating the inventory. If Sedalia would like to know some efficiency tips or recommendations on updating their inventory, Davey is able to help answer questions.

Summary and Conclusions

Sedalia has a park tree population in relatively fair to good condition that adds to the beauty and livability of the City. Although the parks' urban forest is in fair condition at the present time, the City should strive to improve its current condition. As trees get older, they become increasingly inefficient in withstanding the inherent stresses of an urban environment and are subject to decline without proper management. With that in mind, Sedalia should strive to achieve the goals of this management plan.

Generally stated, Sedalia's goals include:

1. **Understand the inventoried public tree population in terms of species and genus.** Currently, green ash comprises approximately 14% of the park tree population. The City must begin planting different species to increase its overall diversity in the future. Species diversity will help avoid potential catastrophic tree losses due to disease outbreaks and/or insect infestations. Additionally, different tree species can add to the City's aesthetic appeal. Every effort must be made to budget enough money each year for new tree plantings, and these new plantings should include many different species of trees suited to the local climate.

2. **Evaluate the condition of the inventoried tree population.** Site conditions and local climate will influence the general health and longevity of the tree population. Stresses due to improper species selection make trees more prone to pest and disease problems. Although the park tree population is in fair condition, approximately 20% of the inventoried public trees are in poor or critical condition or dead. Trees in good health and proper site locations can generally withstand the onset of pest and/or disease problems. Controlling the decline, removal, and replacement of trees in a timely and cost-effective manner is the ultimate goal of the public tree management process.

3. **Identify trees with Severe- or High- Risk**. The ability to understand the Risk Rating of a tree is very important for Sedalia managers. The Risk Rating system allows managers to prioritize work and attend to those trees in need of immediate attention. Davey established a Risk Rating for every maintained tree within Sedalia's Parks. However, there is a need for continuous tree inspections to occur throughout the parks. The City should thrive to get a Certified Arborist on staff who has the training and knowledge to conduct tree risk assessments throughout the parks.

4. **Initiate, establish, and continue tree pruning and removal programs that abate and mitigate potential Severe- and High-Risk conditions without delay.** These trees are a greater risk to people and/or property. 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 have resulted in costly judgments against the defendants. One of the primary concerns in Sedalia must be public safety and tree removals and pruning are a vital part of risk abatement/mitigation. Sedalia inventoried park trees are mostly in fair condition; however, there are large trees with varying degrees of decay existing in the scaffold limbs, trunks, and roots. The *Five-Year Urban Forest Management Program* is designed to address trees with the highest amounts of risk first. Consideration must always be given to area usage and the threat of falling limbs or trees to persons and property when placing a pruning and removal plan into action. This inventory has provided a prioritization scheme for risk abatement/mitigation, and it is strongly recommended that the *Five-Year Urban Forest Management Program* be followed accordingly.

5. **Establish a *Routine Pruning Program* for all established trees.** The City should begin and continue a five-year pruning cycle. This cycle will allow for maintenance of all park trees in Sedalia, thus decreasing the occurrence of structural problems and risks in the City's public tree population.
6. **Establish a *Young Tree Training Program* for all newly planted and immature trees.** Many young trees may have branch structure that can lead to potential problems as they grow, but these problems can be remedied easily and inexpensively through Young Tree Training. The City should accomplish the training on a three-year cyclical basis and all newly planted trees should receive their first training prune two years after planting. Based on the generally small size of the trees in this category, one to two properly trained personnel would be capable of accomplishing the work throughout the year. Training young trees would help decrease the occurrence of costly structural problems and potential hazards in the City's inventoried park tree population.
7. **Create a strong public educational program that promotes the value of quality trees and quality tree care.** Arbor Day ceremonies, articles in City newsletters and local newspapers, and training seminars are a few examples of ways to accomplish this goal.
8. **Establish, review, and update the City's tree ordinance often.** A tree ordinance specific to Sedalia and the tree-related problems it will encounter will be important for the enhancement and protection of the City's park tree resources. Be sure the City has adequate staff to understand and enforce a tree ordinance, and it is highly recommended that the individual responsible for overseeing the tree ordinance is an ISA® Certified Arborist.

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 residents; the pressures of local economics; the concerns for liability issues; the physical aspects of trees; the forces of nature and severe weather events; and the desires for all of these factors to be met simultaneously is quite a daunting task. **Sedalia city managers must carefully consider each specific issue and balance these pressures with a knowledgeable understanding of trees and their needs**. If balance is achieved, the City's beauty will flourish and the health and safety of its trees and citizens will be maintained.

Appendix A
Inventory Definitions and Methodology

Definitions and Inventory Methodology

Summary

This appendix provides a description of the procedures used by Davey Resource Group in conducting the Sedalia Park 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 perennial woody plant that may grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow as multi-stemmed forms. A "public tree" is defined as a tree growing in a park/public space, or within the street ROW and was planted by the City or its residents.

Methodology

The inventory was conducted using pen-based data collection units along with global positioning system (GPS) receivers. The City of Sedalia provided Davey Resource Group with all basemap layers used in customizing the geographic information system (GIS) for pen-based computers. These layers consisted of streets, park boundaries, and digital orthophotographs. The combination of GPS with GIS seamlessly facilitates an efficient map-based data collection system. This system allowed Davey Resource Group to populate a tree layer in the field as each tree's location and the trees data attributes were recorded. During the course of the inventory, the tree layers are placed into ArcView® and Davey's Tree Collector Interface® for quality control review. Upon completion of all data collection, Davey merged the files into a final tree layer for delivery as the current park tree inventory.

Photograph 1. A Davey urban forester using a pen-based computer (stock photograph).

Data Attributes

During the inventory of Sedalia parks, all trees were individually examined, identified, measured, and their attributes were recorded by Davey Resource Group's urban foresters. The following data attributes were collected during the Park Tree Inventory:

- Mapping Coordinate
- Area
- Tree Location Type
- Tree Genus and Species
- Tree Diameter
- Stems
- Condition
- Tree Maintenance
- Risk Assessment
- Observations
- Further Inspection Required
- Location Value
- Overhead Utilities
- Clearance Requirements
- Hardscape Damage
- Growing Space Type
- Growing Space Size
- Additional Comments (Field Notes)

Mapping Coordinate

The mapping coordinates or X and Y coordinates for each individual tree was recorded. These coordinated were determined by using a combination of GIS and GPS technology.

Area

The Area data field denotes the park in which the tree was located. Davey collected data at seven different parks in Sedalia, which include Centennial Park, Liberty Park, Clover Dell Park, Housel Park, Hubbard Park, Katy Park, and Vermont Park.

Tree Location Type

The physical location of trees in relation to the public ROW and/or public space is recorded. Location types include: *Borderline*, *Off ROW*, *Park/Public Space*, *Street*, and *Unknown*. Since this was a park tree inventory, all trees were denoted as *Park/Public Space*.

Tree Genus and Species

The City's trees are identified by genus and species and by cultivars where appropriate (cultivar names are recorded in the Assigned Cultivar section of each tree record, when applicable). However, both botanical and common names are included in this document. 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. In some instances, trees were only identified to their genus, such as *Malus*, *Salix*, *Prunus*, and *Amelanchier*, since these are difficult to sometimes impossible to identify trees without leaves or genetic tests.

Photograph 2. A Davey Inventory urban forester showing how to correctly measure a tree's diameter with the Biltmore® Cruiser™ stick (stock photograph).

Tree Diameter

Diameter at breast height (DBH) is a standard forestry measurement taken at 4.5 feet above the ground. Each tree diameter was measured to the nearest inch with a 25-inch reach Biltmore® Cruiser™ stick or DBH tape. The largest trunk DBH is measured and recorded for trees with multiple trunks. Stump diameters were measured at ground level to indicate the size of the stump requiring a grinding.

Stems

During the inventory, each tree was evaluated for the total number of stems present. A stem was counted if it had an independent pith that went into the ground.

Tree Condition

Condition indicates the current state of a tree's health, structural soundness, overall shape, and growth rate 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 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. It also applies to large trees that have established themselves successfully in the landscape.

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 mechanical damage, may have only minor aesthetic insect, disease, or structure problems, and yet is in good health.

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, or stunted growth compared to adjacent trees. This condition also includes trees that have been topped but show reasonable vitality and show no obvious signs of decay.

Poor

40%–21% condition class. The tree appears unhealthy and may have structural defects, such as co-dominant stems, severe included bark, or severe trunk and/or limb decay. A tree in this category may also have severe mechanical damage, crown dieback, or poor vigor threatening its ability to thrive. Trees in poor condition may respond to appropriate maintenance procedures, although these procedures may be cost-prohibitive to undertake.

Critical

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

Dead

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

Tree Maintenance

Maintenance requirement information is collected to provide a basis for determining and prioritizing the primary maintenance needs of the City's inventoried tree population. The Primary Maintenance Recommendations are the main maintenance needs of the urban forest and should be addressed first; the Secondary Maintenance Recommendations are not high-risk safety pruning activities, but rather practices directed at improving the overall health, stability, and aesthetics of the urban forest. Davey Resource Group has identified maintenance activities that are of greatest importance to the overall management of the public tree population. This information is useful for preparing accurate budgets and for developing maintenance schedules. The following terms, based on the *ANSI A300 Standards for Tree Pruning* (2nd edition, 2001), are used to describe the maintenance requirements of each tree:

Primary Maintenance Needs

Removal

Trees designated for removal have defects that cannot be cost-effectively or practically treated. The majority of the trees in this category have a large percentage of dead crown. All trees with safety risks that could be seen as potential threats to persons or property and seen as potential liabilities to the client would be in this category. This category includes large, dead and dying trees that are high-liability risks as well as those that pose minimal liability to persons or property (such as trees in poor locations or undesirable species).

Large Tree Clean

These trees require selective removal of dead, dying, broken, and/or diseased wood to minimize potential risk. Priority of work should be dependent upon the Risk Rating associated with the individual trees. Trees in this category are large enough to require bucket truck access or manual climbing.

Small Tree Clean

These trees require selective removal of dead, dying, broken, and/or diseased wood to minimize potential risk. Priority of work should be dependent upon the Risk Rating associated with the individual trees. These trees are small-growing, mature trees that can be evaluated and pruned from the ground.

Young Tree Train

These are young trees that must be pruned to correct or eliminate weak, interfering, or objectionable branches in order to minimize future maintenance requirements. Generally these trees may be up to 20 feet in height and can be worked with a pole pruner by a person standing on the ground.

Stump Removal

This category indicates a stump that should be removed.

Secondary Maintenance Needs

Raise

Trees requiring pruning to remove low branches that interfere with sight and/or traffic. The following specs were used to denote a clearance issue; 8 feet over sidewalk for pedestrian clearance, 14 feet over roads for traffic clearance, and 7 feet in park and public space areas to allow for grounds maintenance.

Reduce

This is the selective pruning to decrease height and/or spread of the crown in order to provide structural clearance. This is often used in connection with a light or building clearance issue.

Thin

The selective removal of water sprouts, epicormic branches, and live branches to reduce density.

Restoration

Selective pruning to improve the structure, form, and appearance of trees that have been severely headed, vandalized, or damaged.

Utility

Selective pruning to prevent a loss of service, comply with mandated clearance laws, prevent damage to equipment, avoid access impairment, and uphold the intended usage of the facility/utility space.

None

No secondary maintenance is recommended for the tree. This is used as the default value when the Primary Maintenance is Removal or Stump Removal.

Risk Rating

A Risk Rating was assigned to each tree using an assessment protocol based on the *USDA Forest Service Community Tree Risk Rating System*. This system analyzes risk in four separate categories and then uses a point system to calculate a Risk Rating number. All trees are listed numerically (descending order from 10 to 3) by Risk Rating in the *Public Tree Inventory Workbook* to assist in locating and abating/mitigating all trees that require maintenance.

1. Probability of Failure (1–4 points). Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.

   a) Low: some minor defects present.
      - minor branch/crown dieback
      - minor defects or wounds

   b) Moderate: several moderate defects present
      - stem decay or cavity within safe shell limits: shell thickness >1 inch of sound wood for each 6 inches of stem diameter
      - crack(s) without extensive decay
      - defect(s) affecting 30–40% of the tree's circumference
      - crown damage/breakage: hardwoods up to 50%; conifers up to 30%
      - weak branch union: major branch or codominant stem has included bark
      - stem girdling roots: <40% tree's circumference with compressed wood
      - root damage: <40% of roots damaged within the critical root radius

   c) High: multiple of significant defects present:
      - stem decay or cavity at or exceeding shell safety limits: minimum shell thickness = 1 inch of sound wood for each 6 inches of stem diameter
      - cracks, particularly those in contact with the soil or associated with other defects
      - defect(s) affecting >40% of the tree's circumference
      - crown damage/breakage: hardwoods >50%; pines >30%
      - weak branch union with crack or decay
      - girdling roots with >40% of tree's circumference with compressed wood
      - root damage: >40% of roots damaged within the critical root radius
      - leaning tree with recent root breakage or soil mounding, crack or extensive decay
      - dead tree: standing dead without other significant defects

   d) Extremely High: multiple and significant defects present; visual obstruction of traffic signs/lights or intersections:
      - stem decay or cavity exceeding shell safety limits and severe crack
      - cracks: when a stem or branch is split in half or has cracks on opposite sides
      - defect(s) affecting >40% of tree's circumference or critical root radius and extensive decay or crack(s)
      - weak branch union with crack and decay
      - leaning tree with recent root breakage or soil mounding and crack or extensive decay
      - dead branches: broken (hangers) or with a crack

- dead trees: standing dead with other defects such as cracks, hangers, extensive decay, or major root damage
- visual obstruction of traffic signs/lights or intersections
- physical obstruction of pedestrian or vehicle traffic

2. Size of Defective Part (1–3 points). Rates the size of the part most likely to fail. If the trunk is the part most likely to fail, tree will be recommended for removal and the DBH value will be used for the size of the defective part.

   a) Parts less than 4 inches in diameter
   b) Parts from 4 to 20 inches in diameter
   c) Parts greater than 20 inches in diameter

3. Probability of Target Impact (1–3 points). Rates the use and occupancy of the area that would be struck by defective part.

   a) Occasional Use: low-use roads and park trails; parking lots adjacent to low-use areas; natural areas such as woods or riparian zones; transition areas with limited public use; industrial areas.

   b) Intermediate Use: moderate- to low-use school playgrounds, parks, and picnic areas; parking lots adjacent to moderate-use areas; secondary roads (neighborhoods) and park trails within moderate- to high-use areas; and dispersed campgrounds.

   c) Frequent Use: emergency access routes, medical and emergency facilities and shelters, and handicap access areas; high-use school playgrounds, parks, and picnic areas; bus stops; visitor centers, shelters, and park administrative buildings and residences; main thoroughfares and congested intersections in high-use areas; parking lots adjacent to high-use areas; interpretive signs, kiosks; scenic vistas; and campsites (particularly drive-in).

4. Other Risk Factors (0–2 points). This category can be used if professional judgment suggests the need to increase the risk rating. It is especially helpful to use when tree species growth characteristics become a factor in risk rating. For example, some tree species have growth patterns that make them more vulnerable to certain defects, such as weak branch unions in silver maple (*Acer saccharinum*) and branch shedding in American beech (*Fagus grandifolia*). This optional subjective Risk Rating is used if professional judgment suggests the need to increase the total Risk Rating and invoke immediate corrective action. For example, trees with a numeric Risk Rating of 9 or 10 would be considered as high-priority trees to receive corrective treatments first. An inspector may wish to increase a tree's Risk Rating from 8 to 9 as a means of ensuring the tree will receive immediate corrective treatment.

Generally, trees with the highest numeric risk ratings should receive corrective treatment first. The overall Risk Rating of the tree will be indicated, based on the sum of the above risk assessment field values. See the formula below:

Risk Rating (3–10 points) = probability of failure (1–4 points) + size of defective part (1–3 points) + probability of target impact (1–3 points) + optional subjective Risk Rating (0–2 points)

The Risk Rating formula is designed to be a 10-point system. The maximum Risk Rating a tree can assume is a rating of 10. The optional subjective Risk Rating category is used only when an urban forester feels that the risk rating may need to be elevated up to, but not exceed, 10 points.

Trees assessed as lower risk may fail before trees assessed as higher risk. There are many uncontrollable conditions, such as weather, pests, and human involvement, which can contribute to tree failure. Davey's assigned risk is meant only to be used as a guideline to make safety-driven maintenance decisions and to direct normal tree maintenance programs efficiently. All risk ratings are based on observable defects at the time of assessment and all observations are made from ground level. The Risk Rating assigned to each tree can be interpreted by the following categories:

1. None. Numeric Risk Rating equals 0. Used for planting and stump sites only.
2. Low. Numeric Risk Rating equals 3 or 4. Trees designated as presenting a Low risk have minor visible structural defects or wounds in areas with moderate to low public access. At the current time, the observable defects—using visual inspection—do not meet the threshold of failure. No corrective action is required.
3. Moderate. Numeric Risk Rating equals 5 or 6. Trees designated as presenting a Moderate risk have defects that may be cost-effectively or practically treated. The majority of trees in this category exhibit several moderate defects affecting <40% of a trunk, crown, or critical root zone. This category may also include young or newly planted trees in frequent public use areas such as downtown business districts or popular parks. At the current time, the observable defects—using visual inspection—do not meet the threshold of failure. The defects may or may not result in eventual tree failure. These trees can be recommended for pruning or removal and should be addressed after all Severe- and High-Risk tree maintenance work has been performed.
4. High. Numeric Risk Rating equals 7 or 8. Trees designated as presenting a High Risk have defects that cannot be cost-effectively or practically treated. The majority of the trees in this category have multiple or significant defects affecting >40% of the trunk, crown, or critical root zone. Defective trees and/or tree parts are most likely between 4–20 inches in diameter and can be found in areas of frequent occupation, such as a main thoroughfare, congested streets, and/or near schools. Currently, these defects indicate that the tree is failing, is in immediate danger of failing, or has already partially failed. These trees can be recommended for pruning or removal and should be addressed immediately after all Severe Risk removals.
5. Severe. Numeric Risk Rating equals 9 or 10. Trees designated as presenting a Severe Risk have defects that cannot be cost-effectively or practically treated. The majority of the trees in this category have multiple and significant defects present in the trunk, crown, or critical root zone. Defective trees and/or tree parts are most likely larger than 20 inches in diameter and can be found in areas of frequent occupation, such as a main thoroughfare, congested streets, and/or near schools. Currently, these defects indicate that the tree is failing, is in immediate danger of failing, or has already partially failed. Large dead and dying trees that are high-liability risks are included in this category. This category is reserved for the tree conditions that require immediate attention. These trees are removals only and corrective action should be taken as soon as possible.

Observations

General observations concerning tree health, structure, and location have been recorded for each tree in the inventory, when applicable. Observation types include *Cavity or Decay*, *EAB*, *Grate or Guard*, *Improperly Installed*, *Improperly Mulched*, *Improperly Pruned*, *Mechanical Damage*, *Memorial Tree*, *Nutrient Deficiency*, *Pest Problem*, *Poor Location*, *Poor Root System*, *Poor Structure*, *Remove Hardware*, *Serious Decline*, *Storm Damage*, and *Signs of Stress*. *None* indicates no observation types were recorded.

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 tree received a detailed examination or inspection during the tree inventory process.** Davey Resource Group's urban foresters recorded certain trees as having pruning, removal, or other maintenance recommendations based on ground observations. In some instances, trees may warrant an additional inspection to monitor a defect or possible defect that may be an issue in time. These trees require a Further Inspection. An ISA® Certified Arborist should perform the inspection with the assistance of mechanical equipment when necessary to determine what measures, if any, are needed to abate or mitigate potential risk of personal injury or property damage.

Location Value

Tree Location Value is based on existing land use of the site, the functional and aesthetic contributions of the tree to the site, and surrounding structures or landscapes. For example, a large tree growing in a high-maintenance landscape receives a high location value. However, a single tree within a stand of similar trees in a low-maintenance landscape receives a relatively low location value because it's not unique and does not contribute appreciably to the site. Categories for location value include:

Excellent

The quality of the location, the environment and aesthetic contributions, and the placement of the tree relative to adjacent structures and landscaping are all exceptional.

Good

The location, contribution, and placement of the tree are all favorable. In a good site, a tree should thrive and provide benefits to the surrounding environment.

Fair

A fair tree location has minor evident limitations that would seriously impede growth, but relative placement, location quality, or environmental and aesthetic contributions of the tree do not enhance potential benefits of this specific plant.

Poor

Some characteristics of the site or the tree make this location unfavorable, or the tree exhibits an undesirable trait, such as shading solar panels.

Overhead Utilities

The presence of high- and low-voltage and cable and telephone overhead utility lines and associated hardware, such as guy wires, is noted during the inventory. This information is important in planning for pruning projects and for future tree plantings. For the purpose of this inventory, the presence of utility lines is indicated as *Yes* or *No*.

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 or Signals*, or *Lights*. This allows conflicts to be identified and mitigated during other maintenance activities.

Hardscape Damage

Damage to sidewalks, parking lots, drives, and curbs by tree roots is noted.This is more commonly noted during a street tree inventory more often than a park tree inventory.

Growing Space Type

The type of space available for tree growth is noted. The common growing space types include: *Island*, *Median*, *Natural Area*, *Open or Unrestricted* (areas such as yards or parks), *Raised Planter*, *Tree Lawn or Parkway*, and *Well or Pit*.

Growing Space Size

The shortest dimension (width in feet) of each growing space type is noted. When the growing space type was denoted as *Open or Unrestricted*, a default value of 99 was used to indicate that the tree roots are not restricted.

Additional Comments (Field Notes)

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

Appendix B
Genus and Species Composition

Sedalia, MO

Quantity Report: Genus

Genus	Total	Percentage of Entire Population
Acer	191	20.90%
Aesculus	3	0.33%
Albizia	1	0.11%
Amelanchier	2	0.22%
Betula	12	1.31%
Carya	1	0.11%
Catalpa	8	0.88%
Celtis	74	8.10%
Cercidiphyllum	2	0.22%
Cercis	15	1.64%
Chamaecyparis	1	0.11%
Cornus	9	0.98%
Crataegus	2	0.22%
Cupressus	1	0.11%
Diospyros	4	0.44%
Fraxinus	166	18.16%
Ginkgo	2	0.22%
Gleditsia	4	0.44%
Gymnocladus	6	0.66%
Juglans	3	0.33%
Juniperus	46	5.03%
Laburnum	1	0.11%
Liquidambar	11	1.20%
Liriodendron	16	1.75%
Maclura	3	0.33%
Magnolia	3	0.33%
Malus	21	2.30%
Metasequoia	2	0.22%
Morus	12	1.31%
Phellodendron	1	0.11%
Picea	17	1.86%
Pinus	29	3.17%
Platanus	23	2.52%
Populus	1	0.11%
Prunus	18	1.97%

Genus	Total	Percentage of Entire Population
Pyrus	33	3.61%
Quercus	98	10.72%
Robinia	3	0.33%
Salix	5	0.55%
Stump	2	0.22%
Tamarix	2	0.22%
Taxodium	12	1.31%
Thuja	2	0.22%
Tilia	8	0.88%
Ulmus	37	4.05%
unknown	1	0.11%
Grand Total	*914*	*100%*

Sedalia, MO

Quantity Report: Genus

Genus	Total	Percentage of Entire Population
Acer	191	20.90%
Fraxinus	166	18.16%
Quercus	98	10.72%
Celtis	74	8.10%
Juniperus	46	5.03%
Ulmus	37	4.05%
Pyrus	33	3.61%
Pinus	29	3.17%
Platanus	23	2.52%
Malus	21	2.30%
Prunus	18	1.97%
Picea	17	1.86%
Liriodendron	16	1.75%
Cercis	15	1.64%
Taxodium	12	1.31%
Morus	12	1.31%
Betula	12	1.31%
Liquidambar	11	1.20%
Cornus	9	0.98%
Tilia	8	0.88%
Catalpa	8	0.88%
Gymnocladus	6	0.66%
Salix	5	0.55%
Gleditsia	4	0.44%
Diospyros	4	0.44%
Robinia	3	0.33%
Magnolia	3	0.33%
Maclura	3	0.33%
Juglans	3	0.33%
Aesculus	3	0.33%
Thuja	2	0.22%
Tamarix	2	0.22%
Stump	2	0.22%
Metasequoia	2	0.22%
Ginkgo	2	0.22%

Genus	Total	Percentage of Entire Population
Crataegus	2	0.22%
Cercidiphyllum	2	0.22%
Amelanchier	2	0.22%
unknown	1	0.11%
Populus	1	0.11%
Phellodendron	1	0.11%
Laburnum	1	0.11%
Cupressus	1	0.11%
Chamaecyparis	1	0.11%
Carya	1	0.11%
Albizia	1	0.11%
Grand Total	*914*	*100%*

Sedalia, MO

Quantity Report: Common

Common	Total	Percentage of Entire Population
Amur corktree (Phellodendron amurense)	1	0.11%
apple, common (Malus pumila)	1	0.11%
arborvitae, eastern (Thuja occidentalis)	2	0.22%
ash, green (Fraxinus pennsylvanica)	126	13.79%
ash, white (Fraxinus americana)	40	4.38%
baldcypress, common (Taxodium distichum)	12	1.31%
birch, paper (Betula papyrifera)	2	0.22%
birch, river (Betula nigra)	10	1.09%
boxelder (Acer negundo)	3	0.33%
buckeye, Ohio (Aesculus glabra)	1	0.11%
catalpa, northern (Catalpa speciosa)	8	0.88%
cherry, black (Prunus serotina)	7	0.77%
cherry/plum, spp. (Prunus spp.)	10	1.09%
chokecherry, common (Prunus virginiana)	1	0.11%
cottonwood, eastern (Populus deltoides)	1	0.11%
crabapple, flowering (Malus spp.)	20	2.19%
cypress, Kashmir (Cupressus cashmeriana)	1	0.11%
dawn redwood (Metasequoia glyptostroboides)	2	0.22%
dogwood, flowering (Cornus florida)	7	0.77%
dogwood, Kousa (Cornus kousa)	2	0.22%
elm, American (Ulmus americana)	13	1.42%
elm, Siberian (Ulmus pumila)	22	2.41%
elm, slippery (Ulmus rubra)	2	0.22%
falsecypress, Nootka (Chamaecyparis nootkatensis)	1	0.11%
ginkgo (Ginkgo biloba)	2	0.22%
goldenchain tree (Laburnum x watereri)	1	0.11%
hackberry, common (Celtis occidentalis)	74	8.10%
hawthorn, spp. (Crataegus spp.)	1	0.11%
hawthorn, Washington (Crataegus phaenopyrum)	1	0.11%
hickory, bitternut (Carya cordiformis)	1	0.11%
honeylocust (Gleditsia triacanthos)	1	0.11%
honeylocust, thornless (Gleditsia triacanthos inermis)	3	0.33%
horsechestnut (Aesculus hippocastanum)	2	0.22%
katsuratree (Cercidiphyllum japonicum)	2	0.22%
Kentucky coffeetree (Gymnocladus dioicus)	6	0.66%

Common	Total	Percentage of Entire Population
linden, American (Tilia americana)	3	0.33%
linden, littleleaf (Tilia cordata)	5	0.55%
locust, black (Robinia pseudoacacia)	3	0.33%
magnolia, saucer (Magnolia x soulangiana)	3	0.33%
maple, Amur (Acer tataricum ginnala)	1	0.11%
maple, Freeman (Acer x freemanii)	45	4.92%
maple, Norway (Acer platanoides)	5	0.55%
maple, red (Acer rubrum)	40	4.38%
maple, silver (Acer saccharinum)	39	4.27%
maple, sugar (Acer saccharum)	45	4.92%
maple, trident (Acer buergerianum)	13	1.42%
mimosa (Albizia julibrissin)	1	0.11%
mulberry, white (Morus alba)	12	1.31%
oak, bur (Quercus macrocarpa)	1	0.11%
oak, northern red (Quercus rubra)	13	1.42%
oak, pin (Quercus palustris)	73	7.99%
oak, scarlet (Quercus coccinea)	1	0.11%
oak, shingle (Quercus imbricaria)	4	0.44%
oak, Shumard (Quercus shumardii)	4	0.44%
oak, swamp white (Quercus bicolor)	2	0.22%
osage-orange (Maclura pomifera)	3	0.33%
pear, Callery (Pyrus calleryana)	33	3.61%
persimmon, common (Diospyros virginiana)	4	0.44%
pine, Austrian (Pinus nigra)	10	1.09%
pine, eastern white (Pinus strobus)	10	1.09%
pine, Scotch (Pinus sylvestris)	8	0.88%
pine, spp. (Pinus spp.)	1	0.11%
planetree, London (Platanus x acerifolia)	3	0.33%
redbud, eastern (Cercis canadensis)	15	1.64%
redcedar, eastern (Juniperus virginiana)	46	5.03%
serviceberry, spp. (Amelanchier spp.)	2	0.22%
spruce, Colorado (Picea pungens)	5	0.55%
spruce, Norway (Picea abies)	3	0.33%
spruce, white (Picea glauca)	9	0.98%
stump (stump)	2	0.22%
sweetgum, American (Liquidambar styraciflua)	11	1.20%
sycamore, American (Platanus occidentalis)	20	2.19%
Tamarix spp. (Tamarix spp.)	2	0.22%

Common	Total	Percentage of Entire Population
tuliptree (Liriodendron tulipifera)	16	1.75%
unknown tree (unknown tree)	1	0.11%
walnut, black (Juglans nigra)	3	0.33%
willow, spp. (Salix spp.)	1	0.11%
willow, weeping (Salix babylonica)	4	0.44%
Grand Total	*914*	*100%*

Sedalia, MO

Quantity Report: Common

Common	Total	Percentage of Entire Population
ash, green (Fraxinus pennsylvanica)	126	13.79%
hackberry, common (Celtis occidentalis)	74	8.10%
oak, pin (Quercus palustris)	73	7.99%
redcedar, eastern (Juniperus virginiana)	46	5.03%
maple, sugar (Acer saccharum)	45	4.92%
maple, Freeman (Acer x freemanii)	45	4.92%
maple, red (Acer rubrum)	40	4.38%
ash, white (Fraxinus americana)	40	4.38%
maple, silver (Acer saccharinum)	39	4.27%
pear, Callery (Pyrus calleryana)	33	3.61%
elm, Siberian (Ulmus pumila)	22	2.41%
sycamore, American (Platanus occidentalis)	20	2.19%
crabapple, flowering (Malus spp.)	20	2.19%
tuliptree (Liriodendron tulipifera)	16	1.75%
redbud, eastern (Cercis canadensis)	15	1.64%
oak, northern red (Quercus rubra)	13	1.42%
maple, trident (Acer buergerianum)	13	1.42%
elm, American (Ulmus americana)	13	1.42%
mulberry, white (Morus alba)	12	1.31%
baldcypress, common (Taxodium distichum)	12	1.31%
sweetgum, American (Liquidambar styraciflua)	11	1.20%
pine, eastern white (Pinus strobus)	10	1.09%
pine, Austrian (Pinus nigra)	10	1.09%
cherry/plum, spp. (Prunus spp.)	10	1.09%
birch, river (Betula nigra)	10	1.09%
spruce, white (Picea glauca)	9	0.98%
pine, Scotch (Pinus sylvestris)	8	0.88%
catalpa, northern (Catalpa speciosa)	8	0.88%
dogwood, flowering (Cornus florida)	7	0.77%
cherry, black (Prunus serotina)	7	0.77%
Kentucky coffeetree (Gymnocladus dioicus)	6	0.66%
spruce, Colorado (Picea pungens)	5	0.55%
maple, Norway (Acer platanoides)	5	0.55%
linden, littleleaf (Tilia cordata)	5	0.55%
willow, weeping (Salix babylonica)	4	0.44%

Common	Total	Percentage of Entire Population
persimmon, common (Diospyros virginiana)	4	0.44%
oak, Shumard (Quercus shumardii)	4	0.44%
oak, shingle (Quercus imbricaria)	4	0.44%
walnut, black (Juglans nigra)	3	0.33%
spruce, Norway (Picea abies)	3	0.33%
planetree, London (Platanus x acerifolia)	3	0.33%
osage-orange (Maclura pomifera)	3	0.33%
magnolia, saucer (Magnolia x soulangiana)	3	0.33%
locust, black (Robinia pseudoacacia)	3	0.33%
linden, American (Tilia americana)	3	0.33%
honeylocust, thornless (Gleditsia triacanthos inermis)	3	0.33%
boxelder (Acer negundo)	3	0.33%
Tamarix spp. (Tamarix spp.)	2	0.22%
stump (stump)	2	0.22%
serviceberry, spp. (Amelanchier spp.)	2	0.22%
oak, swamp white (Quercus bicolor)	2	0.22%
katsuratree (Cercidiphyllum japonicum)	2	0.22%
horsechestnut (Aesculus hippocastanum)	2	0.22%
ginkgo (Ginkgo biloba)	2	0.22%
elm, slippery (Ulmus rubra)	2	0.22%
dogwood, Kousa (Cornus kousa)	2	0.22%
dawn redwood (Metasequoia glyptostroboides)	2	0.22%
birch, paper (Betula papyrifera)	2	0.22%
arborvitae, eastern (Thuja occidentalis)	2	0.22%
willow, spp. (Salix spp.)	1	0.11%
unknown tree (unknown tree)	1	0.11%
pine, spp. (Pinus spp.)	1	0.11%
oak, scarlet (Quercus coccinea)	1	0.11%
oak, bur (Quercus macrocarpa)	1	0.11%
mimosa (Albizia julibrissin)	1	0.11%
maple, Amur (Acer tataricum ginnala)	1	0.11%
honeylocust (Gleditsia triacanthos)	1	0.11%
hickory, bitternut (Carya cordiformis)	1	0.11%
hawthorn, Washington (Crataegus phaenopyrum)	1	0.11%
hawthorn, spp. (Crataegus spp.)	1	0.11%
goldenchain tree (Laburnum x watereri)	1	0.11%
falsecypress, Nootka (Chamaecyparis nootkatensis)	1	0.11%
cypress, Kashmir (Cupressus cashmeriana)	1	0.11%

Common	Total	Percentage of Entire Population
cottonwood, eastern (Populus deltoides)	1	0.11%
chokecherry, common (Prunus virginiana)	1	0.11%
buckeye, Ohio (Aesculus glabra)	1	0.11%
apple, common (Malus pumila)	1	0.11%
Amur corktree (Phellodendron amurense)	1	0.11%
Grand Total	*914*	*100%*

Sedalia, MO

Frequency Report: Area by Genus

Genus	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Centennial Park			
Acer	45	37.50%	4.93%
Quercus	19	15.83%	2.08%
Pyrus	15	12.50%	1.64%
Platanus	9	7.50%	0.99%
Fraxinus	7	5.83%	0.77%
Juniperus	6	5.00%	0.66%
Celtis	5	4.17%	0.55%
Prunus	3	2.50%	0.33%
Pinus	2	1.67%	0.22%
Liquidambar	2	1.67%	0.22%
Cercis	2	1.67%	0.22%
Catalpa	2	1.67%	0.22%
Taxodium	1	0.83%	0.11%
Picea	1	0.83%	0.11%
Morus	1	0.83%	0.11%
Summary for Centennial Park (15 items)			
Sum	*120*	*100%*	*13.16%*
Clover Dell Park			
Juniperus	29	29.59%	3.18%
Fraxinus	17	17.35%	1.86%
Acer	12	12.24%	1.32%
Quercus	8	8.16%	0.88%
Prunus	5	5.10%	0.55%
Pyrus	4	4.08%	0.44%
Tilia	3	3.06%	0.33%
Maclura	3	3.06%	0.33%
Cercis	3	3.06%	0.33%
Betula	3	3.06%	0.33%

Genus	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Robinia	2	2.04%	0.22%
Picea	2	2.04%	0.22%
Cercidiphyllum	2	2.04%	0.22%
Taxodium	1	1.02%	0.11%
Salix	1	1.02%	0.11%
Metasequoia	1	1.02%	0.11%
Liriodendron	1	1.02%	0.11%
Ginkgo	1	1.02%	0.11%
Summary for Clover Dell Park (18 items)			
Sum	*98*	*100%*	*10.75%*
Housel Park			
Ulmus	2	22.22%	0.22%
Fraxinus	2	22.22%	0.22%
Quercus	1	11.11%	0.11%
Pinus	1	11.11%	0.11%
Morus	1	11.11%	0.11%
Celtis	1	11.11%	0.11%
Acer	1	11.11%	0.11%
Summary for Housel Park (7 items)			
Sum	*9*	*100%*	*0.99%*
Hubbard Park			
Fraxinus	36	29.27%	3.95%
Acer	27	21.95%	2.96%
Quercus	12	9.76%	1.32%
Celtis	11	8.94%	1.21%
Picea	8	6.50%	0.88%
Pinus	6	4.88%	0.66%
Malus	5	4.07%	0.55%
Ulmus	4	3.25%	0.44%
Platanus	3	2.44%	0.33%
Thuja	2	1.63%	0.22%
Tamarix	2	1.63%	0.22%

Genus	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Prunus	2	1.63%	0.22%
Morus	2	1.63%	0.22%
unknown	1	0.81%	0.11%
Liriodendron	1	0.81%	0.11%
Juniperus	1	0.81%	0.11%
Summary for Hubbard Park (16 items)			
Sum	*123*	*100%*	*13.49%*
Katy Park			
Fraxinus	57	29.23%	6.25%
Acer	39	20.00%	4.28%
Celtis	30	15.38%	3.29%
Ulmus	11	5.64%	1.21%
Liriodendron	11	5.64%	1.21%
Quercus	10	5.13%	1.10%
Pinus	7	3.59%	0.77%
Gymnocladus	6	3.08%	0.66%
Morus	4	2.05%	0.44%
Juniperus	4	2.05%	0.44%
Diospyros	4	2.05%	0.44%
Prunus	3	1.54%	0.33%
Picea	2	1.03%	0.22%
Gleditsia	2	1.03%	0.22%
Tilia	1	0.51%	0.11%
Taxodium	1	0.51%	0.11%
Salix	1	0.51%	0.11%
Pyrus	1	0.51%	0.11%
Betula	1	0.51%	0.11%
Summary for Katy Park (19 items)			
Sum	*195*	*100%*	*21.38%*
Liberty Park			
Acer	58	17.58%	6.36%
Quercus	45	13.64%	4.93%

Genus	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Fraxinus	38	11.52%	4.17%
Celtis	20	6.06%	2.19%
Ulmus	17	5.15%	1.86%
Malus	16	4.85%	1.75%
Pyrus	13	3.94%	1.43%
Platanus	11	3.33%	1.21%
Pinus	11	3.33%	1.21%
Cercis	10	3.03%	1.10%
Taxodium	9	2.73%	0.99%
Liquidambar	9	2.73%	0.99%
Cornus	9	2.73%	0.99%
Betula	8	2.42%	0.88%
Juniperus	6	1.82%	0.66%
Catalpa	6	1.82%	0.66%
Prunus	5	1.52%	0.55%
Tilia	4	1.21%	0.44%
Picea	4	1.21%	0.44%
Salix	3	0.91%	0.33%
Magnolia	3	0.91%	0.33%
Liriodendron	3	0.91%	0.33%
Juglans	3	0.91%	0.33%
Aesculus	3	0.91%	0.33%
Morus	2	0.61%	0.22%
Crataegus	2	0.61%	0.22%
Amelanchier	2	0.61%	0.22%
Robinia	1	0.30%	0.11%
Populus	1	0.30%	0.11%
Phellodendron	1	0.30%	0.11%
Metasequoia	1	0.30%	0.11%
Laburnum	1	0.30%	0.11%
Gleditsia	1	0.30%	0.11%
Ginkgo	1	0.30%	0.11%

Genus	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Cupressus	1	0.30%	0.11%
Chamaecyparis	1	0.30%	0.11%
Albizia	1	0.30%	0.11%
Summary for Liberty Park (37 items)			
Sum	*330*	*100%*	*36.18%*
Vermont Park			
Fraxinus	9	24.32%	0.99%
Acer	9	24.32%	0.99%
Celtis	7	18.92%	0.77%
Ulmus	3	8.11%	0.33%
Quercus	3	8.11%	0.33%
Pinus	2	5.41%	0.22%
Morus	2	5.41%	0.22%
Gleditsia	1	2.70%	0.11%
Carya	1	2.70%	0.11%
Summary for Vermont Park (9 items)			
Sum	*37*	*100%*	*4.06%*
Grand Total	*912*		

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Centennial Park			
maple, Freeman (Acer x freemanii)	20	16.67%	2.19%
oak, pin (Quercus palustris)	18	15.00%	1.97%
pear, Callery (Pyrus calleryana)	15	12.50%	1.64%
maple, silver (Acer saccharinum)	12	10.00%	1.32%
maple, red (Acer rubrum)	8	6.67%	0.88%
sycamore, American (Platanus occidentalis)	7	5.83%	0.77%
ash, green (Fraxinus pennsylvanica)	7	5.83%	0.77%
redcedar, eastern (Juniperus virginiana)	6	5.00%	0.66%
hackberry, common (Celtis occidentalis)	5	4.17%	0.55%
maple, trident (Acer buergerianum)	3	2.50%	0.33%
cherry/plum, spp. (Prunus spp.)	3	2.50%	0.33%
sweetgum, American (Liquidambar styraciflua)	2	1.67%	0.22%
redbud, eastern (Cercis canadensis)	2	1.67%	0.22%
planetree, London (Platanus x acerifolia)	2	1.67%	0.22%
maple, sugar (Acer saccharum)	2	1.67%	0.22%
catalpa, northern (Catalpa speciosa)	2	1.67%	0.22%
spruce, Norway (Picea abies)	1	0.83%	0.11%
pine, spp. (Pinus spp.)	1	0.83%	0.11%
pine, eastern white (Pinus strobus)	1	0.83%	0.11%
oak, northern red (Quercus rubra)	1	0.83%	0.11%
mulberry, white (Morus alba)	1	0.83%	0.11%
baldcypress, common (Taxodium distichum)	1	0.83%	0.11%
Summary for Centennial Park (22 items)			
Sum	*120*	*100%*	*13.16%*
Clover Dell Park			
redcedar, eastern (Juniperus virginiana)	29	29.59%	3.18%
ash, green (Fraxinus pennsylvanica)	15	15.31%	1.64%
maple, red (Acer rubrum)	9	9.18%	0.99%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
cherry, black (Prunus serotina)	5	5.10%	0.55%
pear, Callery (Pyrus calleryana)	4	4.08%	0.44%
redbud, eastern (Cercis canadensis)	3	3.06%	0.33%
osage-orange (Maclura pomifera)	3	3.06%	0.33%
oak, pin (Quercus palustris)	3	3.06%	0.33%
linden, littleleaf (Tilia cordata)	3	3.06%	0.33%
birch, river (Betula nigra)	3	3.06%	0.33%
spruce, white (Picea glauca)	2	2.04%	0.22%
oak, swamp white (Quercus bicolor)	2	2.04%	0.22%
maple, Freeman (Acer x freemanii)	2	2.04%	0.22%
locust, black (Robinia pseudoacacia)	2	2.04%	0.22%
katsuratree (Cercidiphyllum japonicum)	2	2.04%	0.22%
ash, white (Fraxinus americana)	2	2.04%	0.22%
willow, weeping (Salix babylonica)	1	1.02%	0.11%
tuliptree (Liriodendron tulipifera)	1	1.02%	0.11%
oak, Shumard (Quercus shumardii)	1	1.02%	0.11%
oak, shingle (Quercus imbricaria)	1	1.02%	0.11%
oak, scarlet (Quercus coccinea)	1	1.02%	0.11%
maple, Norway (Acer platanoides)	1	1.02%	0.11%
ginkgo (Ginkgo biloba)	1	1.02%	0.11%
dawn redwood (Metasequoia glyptostroboides)	1	1.02%	0.11%
baldcypress, common (Taxodium distichum)	1	1.02%	0.11%
Summary for Clover Dell Park (25 items)			
Sum	*98*	*100%*	*10.75%*
Housel Park			
elm, Siberian (Ulmus pumila)	2	22.22%	0.22%
ash, green (Fraxinus pennsylvanica)	2	22.22%	0.22%
pine, Scotch (Pinus sylvestris)	1	11.11%	0.11%
oak, pin (Quercus palustris)	1	11.11%	0.11%
mulberry, white (Morus alba)	1	11.11%	0.11%
maple, Freeman (Acer x freemanii)	1	11.11%	0.11%
hackberry, common (Celtis occidentalis)	1	11.11%	0.11%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Housel Park (7 items)			
Sum	*9*	*100%*	*0.99%*
Hubbard Park			
ash, green (Fraxinus pennsylvanica)	36	29.27%	3.95%
oak, pin (Quercus palustris)	11	8.94%	1.21%
maple, silver (Acer saccharinum)	11	8.94%	1.21%
hackberry, common (Celtis occidentalis)	11	8.94%	1.21%
spruce, white (Picea glauca)	7	5.69%	0.77%
pine, eastern white (Pinus strobus)	5	4.07%	0.55%
crabapple, flowering (Malus spp.)	5	4.07%	0.55%
maple, trident (Acer buergerianum)	4	3.25%	0.44%
maple, red (Acer rubrum)	4	3.25%	0.44%
maple, Freeman (Acer x freemanii)	4	3.25%	0.44%
maple, sugar (Acer saccharum)	3	2.44%	0.33%
Tamarix spp. (Tamarix spp.)	2	1.63%	0.22%
sycamore, American (Platanus occidentalis)	2	1.63%	0.22%
mulberry, white (Morus alba)	2	1.63%	0.22%
elm, Siberian (Ulmus pumila)	2	1.63%	0.22%
elm, American (Ulmus americana)	2	1.63%	0.22%
cherry/plum, spp. (Prunus spp.)	2	1.63%	0.22%
arborvitae, eastern (Thuja occidentalis)	2	1.63%	0.22%
unknown tree (unknown tree)	1	0.81%	0.11%
tuliptree (Liriodendron tulipifera)	1	0.81%	0.11%
spruce, Norway (Picea abies)	1	0.81%	0.11%
redcedar, eastern (Juniperus virginiana)	1	0.81%	0.11%
planetree, London (Platanus x acerifolia)	1	0.81%	0.11%
pine, Scotch (Pinus sylvestris)	1	0.81%	0.11%
oak, northern red (Quercus rubra)	1	0.81%	0.11%
boxelder (Acer negundo)	1	0.81%	0.11%
Summary for Hubbard Park (26 items)			
Sum	*123*	*100%*	*13.49%*
Katy Park			

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
ash, green (Fraxinus pennsylvanica)	41	21.03%	4.50%
hackberry, common (Celtis occidentalis)	30	15.38%	3.29%
maple, sugar (Acer saccharum)	24	12.31%	2.63%
ash, white (Fraxinus americana)	16	8.21%	1.75%
tuliptree (Liriodendron tulipifera)	11	5.64%	1.21%
Kentucky coffeetree (Gymnocladus dioicus)	6	3.08%	0.66%
elm, Siberian (Ulmus pumila)	6	3.08%	0.66%
pine, Austrian (Pinus nigra)	5	2.56%	0.55%
oak, pin (Quercus palustris)	5	2.56%	0.55%
elm, American (Ulmus americana)	5	2.56%	0.55%
redcedar, eastern (Juniperus virginiana)	4	2.05%	0.44%
persimmon, common (Diospyros virginiana)	4	2.05%	0.44%
oak, northern red (Quercus rubra)	4	2.05%	0.44%
mulberry, white (Morus alba)	4	2.05%	0.44%
maple, silver (Acer saccharinum)	4	2.05%	0.44%
maple, Freeman (Acer x freemanii)	4	2.05%	0.44%
maple, red (Acer rubrum)	3	1.54%	0.33%
maple, Norway (Acer platanoides)	3	1.54%	0.33%
pine, eastern white (Pinus strobus)	2	1.03%	0.22%
honeylocust, thornless (Gleditsia triacanthos inermis)	2	1.03%	0.22%
cherry/plum, spp. (Prunus spp.)	2	1.03%	0.22%
willow, spp. (Salix spp.)	1	0.51%	0.11%
spruce, Norway (Picea abies)	1	0.51%	0.11%
spruce, Colorado (Picea pungens)	1	0.51%	0.11%
pear, Callery (Pyrus calleryana)	1	0.51%	0.11%
oak, shingle (Quercus imbricaria)	1	0.51%	0.11%
linden, littleleaf (Tilia cordata)	1	0.51%	0.11%
cherry, black (Prunus serotina)	1	0.51%	0.11%
boxelder (Acer negundo)	1	0.51%	0.11%
birch, paper (Betula papyrifera)	1	0.51%	0.11%
baldcypress, common (Taxodium distichum)	1	0.51%	0.11%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Katy Park (31 items)			
Sum	*195*	*100%*	*21.38%*
Liberty Park			
oak, pin (Quercus palustris)	33	10.00%	3.62%
hackberry, common (Celtis occidentalis)	20	6.06%	2.19%
ash, green (Fraxinus pennsylvanica)	20	6.06%	2.19%
ash, white (Fraxinus americana)	18	5.45%	1.97%
maple, red (Acer rubrum)	16	4.85%	1.75%
crabapple, flowering (Malus spp.)	15	4.55%	1.64%
pear, Callery (Pyrus calleryana)	13	3.94%	1.43%
maple, sugar (Acer saccharum)	13	3.94%	1.43%
sycamore, American (Platanus occidentalis)	11	3.33%	1.21%
maple, Freeman (Acer x freemanii)	11	3.33%	1.21%
elm, Siberian (Ulmus pumila)	11	3.33%	1.21%
redbud, eastern (Cercis canadensis)	10	3.03%	1.10%
maple, silver (Acer saccharinum)	10	3.03%	1.10%
sweetgum, American (Liquidambar styraciflua)	9	2.73%	0.99%
baldcypress, common (Taxodium distichum)	9	2.73%	0.99%
dogwood, flowering (Cornus florida)	7	2.12%	0.77%
birch, river (Betula nigra)	7	2.12%	0.77%
redcedar, eastern (Juniperus virginiana)	6	1.82%	0.66%
oak, northern red (Quercus rubra)	6	1.82%	0.66%
maple, trident (Acer buergerianum)	6	1.82%	0.66%
catalpa, northern (Catalpa speciosa)	6	1.82%	0.66%
pine, Austrian (Pinus nigra)	5	1.52%	0.55%
spruce, Colorado (Picea pungens)	4	1.21%	0.44%
pine, Scotch (Pinus sylvestris)	4	1.21%	0.44%
elm, American (Ulmus americana)	4	1.21%	0.44%
willow, weeping (Salix babylonica)	3	0.91%	0.33%
walnut, black (Juglans nigra)	3	0.91%	0.33%
tuliptree (Liriodendron tulipifera)	3	0.91%	0.33%
oak, Shumard (Quercus shumardii)	3	0.91%	0.33%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
magnolia, saucer (Magnolia x soulangiana)	3	0.91%	0.33%
linden, American (Tilia americana)	3	0.91%	0.33%
cherry/plum, spp. (Prunus spp.)	3	0.91%	0.33%
serviceberry, spp. (Amelanchier spp.)	2	0.61%	0.22%
pine, eastern white (Pinus strobus)	2	0.61%	0.22%
oak, shingle (Quercus imbricaria)	2	0.61%	0.22%
mulberry, white (Morus alba)	2	0.61%	0.22%
horsechestnut (Aesculus hippocastanum)	2	0.61%	0.22%
elm, slippery (Ulmus rubra)	2	0.61%	0.22%
dogwood, Kousa (Cornus kousa)	2	0.61%	0.22%
oak, bur (Quercus macrocarpa)	1	0.30%	0.11%
mimosa (Albizia julibrissin)	1	0.30%	0.11%
maple, Norway (Acer platanoides)	1	0.30%	0.11%
maple, Amur (Acer tataricum ginnala)	1	0.30%	0.11%
locust, black (Robinia pseudoacacia)	1	0.30%	0.11%
linden, littleleaf (Tilia cordata)	1	0.30%	0.11%
honeylocust, thornless (Gleditsia triacanthos inermis)	1	0.30%	0.11%
hawthorn, Washington (Crataegus phaenopyrum)	1	0.30%	0.11%
hawthorn, spp. (Crataegus spp.)	1	0.30%	0.11%
goldenchain tree (Laburnum x watereri)	1	0.30%	0.11%
ginkgo (Ginkgo biloba)	1	0.30%	0.11%
falsecypress, Nootka (Chamaecyparis nootkatensis)	1	0.30%	0.11%
dawn redwood (Metasequoia glyptostroboides)	1	0.30%	0.11%
cypress, Kashmir (Cupressus cashmeriana)	1	0.30%	0.11%
cottonwood, eastern (Populus deltoides)	1	0.30%	0.11%
chokecherry, common (Prunus virginiana)	1	0.30%	0.11%
cherry, black (Prunus serotina)	1	0.30%	0.11%
buckeye, Ohio (Aesculus glabra)	1	0.30%	0.11%
birch, paper (Betula papyrifera)	1	0.30%	0.11%
apple, common (Malus pumila)	1	0.30%	0.11%
Amur corktree (Phellodendron amurense)	1	0.30%	0.11%

Common	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Liberty Park (60 items)			
Sum	*330*	*100%*	*36.18%*
Vermont Park			
hackberry, common (Celtis occidentalis)	7	18.92%	0.77%
ash, green (Fraxinus pennsylvanica)	5	13.51%	0.55%
ash, white (Fraxinus americana)	4	10.81%	0.44%
maple, sugar (Acer saccharum)	3	8.11%	0.33%
maple, Freeman (Acer x freemanii)	3	8.11%	0.33%
pine, Scotch (Pinus sylvestris)	2	5.41%	0.22%
oak, pin (Quercus palustris)	2	5.41%	0.22%
mulberry, white (Morus alba)	2	5.41%	0.22%
maple, silver (Acer saccharinum)	2	5.41%	0.22%
elm, American (Ulmus americana)	2	5.41%	0.22%
oak, northern red (Quercus rubra)	1	2.70%	0.11%
honeylocust (Gleditsia triacanthos)	1	2.70%	0.11%
hickory, bitternut (Carya cordiformis)	1	2.70%	0.11%
elm, Siberian (Ulmus pumila)	1	2.70%	0.11%
boxelder (Acer negundo)	1	2.70%	0.11%
Summary for Vermont Park (15 items)			
Sum	*37*	*100%*	*4.06%*
Grand Total	*912*		

Appendix C
Recommended Planting List

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 soil and climate (USDA Zones 5 and 6) conditions found throughout Missouri.

Deciduous Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer rubrum[1]	red maple	Red Sunset®
Acer saccharum[1]	sugar maple	'Legacy'
Acer nigrum[1]	black maple	
*Betula alleghaniensis**	yellow birch	
*Betula lenta**	sweet birch	
Betula nigra	river birch	Heritage®
Carpinus betulus	European hornbeam	'Franz Fontaine'
*Carya illinoensis**	pecan	
*Carya lacinata**	shellbark hickory	
*Carya ovata**	shagbark hickory	
*Castanea mollissima**	Chinese chestnut	
Celtis laevigata	sugarberry	
Celtis occidentalis	common hackberry	'Prairie Pride'
Cercidiphyllum japonicum	katsuratree	'Aureum'
*Diospyros virginiana**	common persimmon	
*Fagus grandifolia**	American beech	
*Fagus sylvatica**	European beech	(Numerous exist)
Ginkgo biloba	ginkgo	(Choose male trees only)
Gleditsia triacanthos inermis	thornless honeylocust	'Shademaster'
Gymnocladus dioica	Kentucky coffeetree	Prairie Titan®
*Juglans nigra**	black walnut	
*Larix decidua**	European larch	
Liquidambar styraciflua	American sweetgum	'Rotundiloba'
Liriodendron tulipifera	tuliptree	'Fastigiatum'
*Magnolia acuminata**	cucumbertree magnolia	(Numerous exist)
*Magnolia macrophylla**	bigleaf magnolia	
Metasequoia glyptostroboides	dawn redwood	'Emerald Feathers'
Nyssa sylvatica	blackgum	
Platanus occidentalis	American sycamore	
Platanus x *acerifolia*	London planetree	'Yarwood'
Quercus alba	white oak	

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

Scientific Name	Common Name	Cultivar
Quercus bicolor	swamp white oak	
Quercus coccinea	scarlet oak	
Quercus lyrata	overcup oak	
Quercus macrocarpa	bur oak	
Quercus montana	chestnut oak	
Quercus muehlenbergii	chinkapin oak	
Quercus palustris	pin oak	
Quercus imbricaria	shingle oak	
Quercus phellos	willow 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 x *euchlora*	Crimean linden	
Tilia tomentosa	silver linden	'Sterling'
Ulmus parvifolia	Chinese 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 cordata	Italian alder	
*Asimina triloba**	pawpaw	
Cladrastis kentukea	American yellowwood	'Rosea'
Corylus colurna	Turkish filbert	
Eucommia ulmoides	hardy rubber tree	
Koelreuteria paniculata	goldenraintree	
Ostrya virginiana	American hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Phellodendron amurense	Amur corktree	'Macho'
Pistacia chinensis	Chinese pistache	
Prunus maackii	Amur chokecherry	'Amber Beauty'
Prunus sargentii	Sargent cherry	
*Pterocarya fraxinifolia**	Caucasian wingnut	
*Pyrus calleryana**	Callery pear	'Earlyred'
Quercus acutissima	sawtooth oak	
Quercus cerris	European turkey oak	
*Sassafras albidum**	sassafras	

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer buergerianum[1]	trident maple	Streetwise®
Acer campestre[1]	hedge maple	Queen Elizabeth™
Acer cappadocicum[1]	coliseum maple	'Aureum'
Acer ginnala[1]	Amur maple	Red Rhapsody™
Acer griseum[1]	paperbark maple	
Acer oliverianum[1]	Chinese maple	
Acer pensylvanicum[1]*	striped maple	
Acer triflorum[1]	three-flower 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 alternifolia	pagoda dogwood	
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'
Laburnum x *watereri*	goldenchain tree	
Maackia amurensis	Amur maackia	
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	Higan cherry	'Pendula'
Prunus virginiana	common chokecherry	'Schubert'
*Staphylea trifolia**	American bladdernut	
Stewartia ovata	mountain stewartia	
*Styrax japonicus**	Japanese snowbell	'Emerald Pagoda'
Syringa reticulata	Japanese tree lilac	'Ivory Silk'

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

[1] The planting of maple trees should be limited since they make up approximately 21% of the park tree population.

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'
Cedrus libani	cedar-of-Lebanon	
Chamaecyparis nootkatensis	Nootka falsecypress	'Pendula'
Cryptomeria japonica	Japanese cryptomeria	'Sekkan-sugi'
X *Cupressocyparis leylandii*	Leyland cypress	
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	
Pinus taeda	loblolly pine	
Pinus virginiana	Virginia pine	
Psedotsuga menziesii	Douglas-fir	
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	
Pinus parviflora	Japanese white 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: Coniferous species are **not** 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 recommendations only and are based on Davey Resource Group's experience; tree availability will vary by nursery.

Appendix D
Emerald Ash Borer Information

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

EMERALD ASH BORER

(Agrilus planipennis)

The emerald ash borer is an exotic Asian insect pest whose presence has been confirmed in Michigan, Ohio, Maryland and Ontario, Canada. Infested trees have been found in urban areas, woodlots and nursery stock. This borer has killed millions of trees, from small, young specimens to established, mature specimens.

Figure 1. Adult borers grow to ⅝" in length.

HOSTS: In the United States, the borer has been detected only on ash tree species, including black ash (*Fraxinus nigra*), blue ash (*F. quadrangulata*), green ash (*F. pennsylvanica*) and white ash (*F. americana*).

IDENTIFICATION AND LIFE CYCLE: The adult beetle is elongate, metallic green and ⅜ to ⅝ inches long (Figure 1). In Michigan and Ohio, adults emerge from early to mid-June until early August, feeding on a small amount of foliage (this causes jagged leaf edges). Females lay one to two eggs deep into bark crevices and lower main branches. After eggs hatch, the larvae tunnel through the bark and feed on the phloem and outer sapwood for several months. The mature larvae are cream colored and 1 to 1¼ inches long (Figure 2). Fully-grown larvae overwinter under the bark or sometimes in pupal cells made of outer sapwood. There is one generation per year.

Figure 2. Larva (Photo credit: Michigan State University).

SYMPTOMS AND SIGNS: Initial symptoms include yellowing and/or thinning of the foliage and longitudinal bark splitting (Figure 3). The entire canopy may die back, or symptoms may be restricted to certain branches. Declining trees may sprout epicormic shoots at the tree base or on branches. Removal of bark reveals tissue callusing and frass-filled, serpentine tunneling. The S-shaped larval feeding tunnels are about ¼ inch in diameter. Tunneling may occur from upper branches to the trunk and root flare. Adults exit from the trunk and branches in a characteristic D-shaped exit hole about ⅛ inch in diameter. The intense tunneling disrupts water and nutrient flow, causing trees to lose between 30 and 50 percent of their canopies during the first year of infestation. Trees often die within two years following infestation.

Figure 3. Bark splitting.

MANAGEMENT: Removal and chipping or incineration of infested wood is recommended. Stumps should be ground out. Quarantines have been set up to prevent movement of untreated ash lumber, firewood or nursery stock from the affected areas. Those who are concerned about protecting valuable trees should contact a Davey arborist.

Printed in the U.S.A.

T 15243 – 02/04

GREEN MISSOURI INSECTS:
Identifying the Emerald Ash Borer

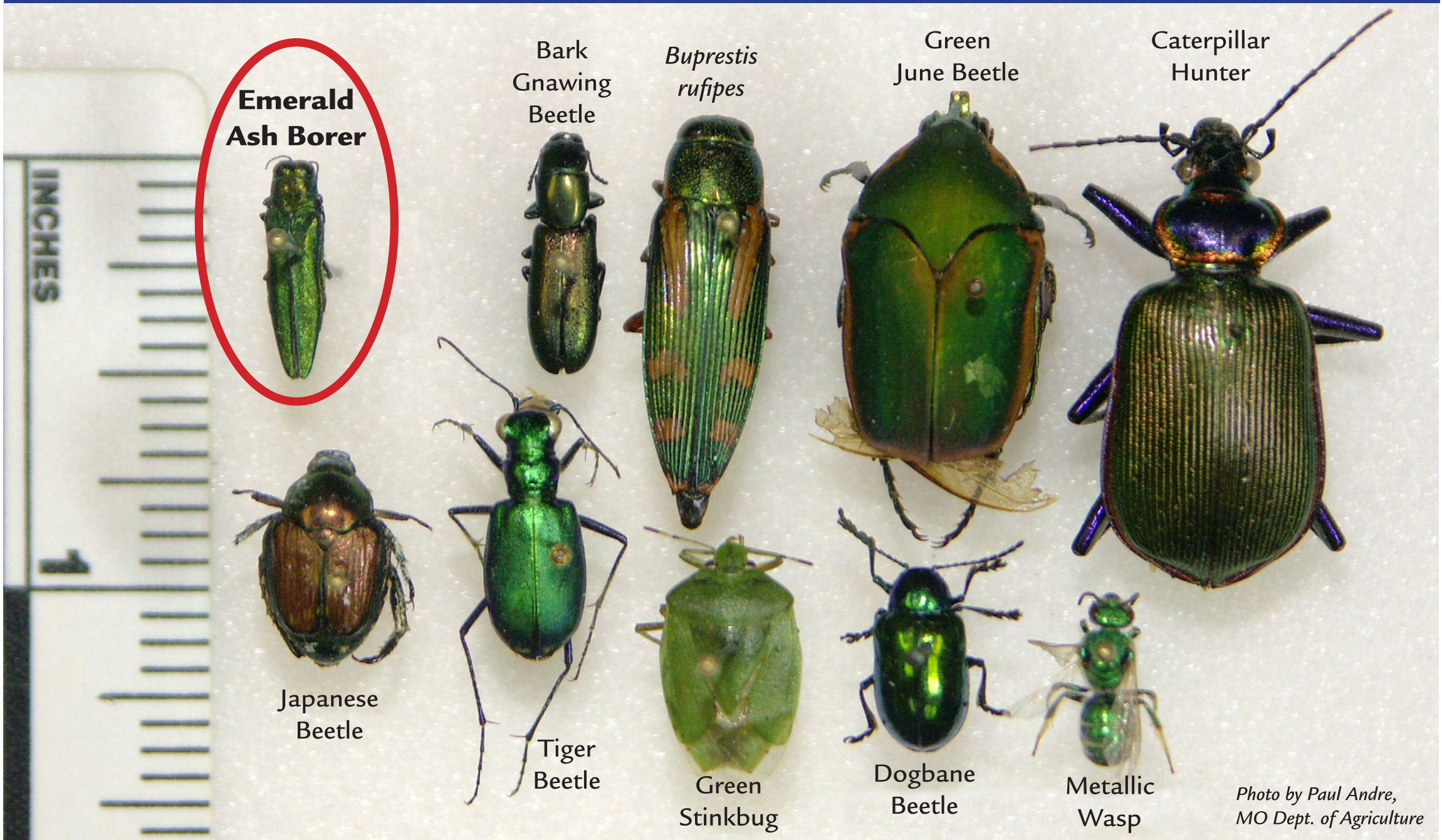

Photo by Paul Andre, MO Dept. of Agriculture

www.emeraldashborer.info

Insecticide Options for Protecting Ash Trees From Emerald Ash Borer

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Emerald ash borer (*Agrilus planipennis* Fairmaire), an invasive insect native to Asia, has killed tens of millions of ash trees in urban, rural and forested settings. This beetle was first discovered in 2002 in southeast Michigan and Windsor, Ontario. As of May 2009, emerald ash borer (EAB) infestations were known to be present in 11 states and two Canadian provinces. Many homeowners, arborists and tree care professionals want to protect valuable ash trees from EAB. Scientists have learned much about this insect and methods to protect ash trees since 2002. This bulletin is designed to answer frequently asked questions and provide the most current information on insecticide options for controlling EAB.

EAB larvae damage the vascular system of the tree as they feed, which interferes with movement of systemic insecticides in the tree.

EAB adults must feed on foliage before they become reproductively mature.

Answers to Frequently Asked Questions

What options do I have for treating my ash trees?

If you elect to treat your ash trees, there are several insecticide options available and research has shown that treatments can be effective. Keep in mind, however, that controlling insects that feed under the bark with insecticides has always been difficult. This is especially true with EAB because our native North American ash trees have little natural resistance to this pest. In university trials, some insecticide treatments were effective in some sites, but the same treatments failed in other sites. Furthermore, in some studies conducted over multiple years, EAB densities continued to increase in individual trees despite annual treatment. Some arborists have combined treatments to increase the odds of success (e.g., combining a cover spray with a systemic treatment).

Healthy ash trees that have been protected with insecticides growing next to untreated ash trees killed by EAB.

Our understanding of how EAB can be managed successfully with insecticides has increased substantially in recent years. The current state of this understanding is detailed in the bulletin. It is important to note that research on management of EAB remains a work in progress. Scientists from universities, government agencies and companies continue to conduct intensive studies to understand how and when insecticide treatments will be most effective.

I know my tree is already infested with EAB. Will insecticides still be effective?

If a tree has lost more than 50 percent of its canopy, it is probably too late to save the tree. Studies have shown that it is best to begin using insecticides while ash trees are still relatively healthy. This is because most of the insecticides used for EAB control act systemically — the insecticide must be transported within the tree. In other words, a tree must be healthy enough to carry a systemic insecticide up the trunk and into the branches and canopy. When EAB larvae feed, their galleries injure the phloem and xylem that make up the plant's circulatory system. This interferes with the ability of the tree to transport nutrients and water, as well as insecticides. As a tree becomes more and more infested, the injury becomes more severe. Large branches or even the trunk can be girdled by the larval galleries.

Studies have also shown that if the canopy of a tree is already declining when insecticide treatments are initiated, the condition of the tree may continue to deteriorate during the first year of treatment. In many cases, the tree canopy will begin to improve in the second year of treatment. This lag in the reversal of canopy decline probably reflects the time needed for the tree to repair its vascular system after the EAB infestation has been reduced.

My ash tree looks fine but my county is quarantined for EAB. Should I start treating my tree?

Scientists have learned that ash trees with low densities of EAB often have few or no external symptoms of infestation. Therefore, if your property is within a county that has been quarantined for EAB, your ash trees are probably at risk. Similarly, if your trees are outside a quarantined county but are still within 10-15 miles of a known EAB infestation, they may be at risk. If your ash trees are more than 15 miles beyond this range, it is probably too early to begin insecticide treatments. Treatment programs that begin too early are a waste of money. Remember, however, that new EAB infestations have been discovered every year since 2002 and existing EAB populations will build and spread over time. Stay up to date with current EAB quarantine maps and related information at **www.emeraldashborer.info**. You can use the links in this Web site to access specific information for individual states. When an EAB infestation is detected in a state or county for the first time, it will be added to these maps. Note, however, that once an area has been quarantined, EAB surveys generally stop, and further spread of EAB in that area will not be reflected on future maps.

I realize that I will have to protect my ash trees from EAB for several years. Is it worth it?

The economics of treating ash trees with insecticides for EAB protection are complicated. Factors that can be considered include the cost of the insecticide and expense of application, the size of the trees, the likelihood of success, and potential costs of removing and replacing the trees. Until recently, insecticide products had to be applied every year. A new product that is effective for two years or even longer (emamectin benzoate) has altered the economics of treating ash trees. As research progresses, costs and methods of treating trees will continue to change and it will be important to stay up to date on treatment options.

Benefits of treating trees can be more difficult to quantify than costs. Landscape trees typically increase property values, provide shade and cooling, and contribute to the quality of life in a neighborhood. Many people are sentimental about their trees. These intangible qualities are important and should be part of any decision to invest in an EAB management program.

It is also worth noting that the size of EAB populations in a specific area will change over time. Populations initially build very slowly, but later increase rapidly as more trees become infested. As EAB populations reach their peak, many trees will decline and die within one or two years. As untreated ash trees in the area succumb, however, the local EAB population will decrease substantially. Scientists do not yet have enough experience with EAB to know what will happen over time to trees that survive the initial wave of EAB. Ash seedlings and saplings are common in forests, woodlots, and right-of-ways, however, and it is unlikely that

EAB will ever completely disappear from an area. That means that ash trees may always be at some risk of being attacked by EAB, but it seems reasonable to expect that treatment costs could eventually decrease as pest pressure declines after the EAB wave has passed.

Insecticide Options for Controlling EAB

Insecticides that can effectively control EAB fall into four categories: (1) systemic insecticides that are applied as soil injections or drenches; (2) systemic insecticides applied as trunk injections; (3) systemic insecticides applied as lower trunk sprays; and (4) protective cover sprays that are applied to the trunk, main branches, and (depending on the label) foliage.

Insecticide formulations and application methods that have been evaluated for control of EAB are listed in Table 1. Some are marketed for use by homeowners while others are intended for use only by professional applicators. The "active ingredient" refers to the compound in the product that is actually toxic to the insect.

Formulations included in Table 1 have been evaluated in multiple field trials conducted by the authors. Inclusion of a product in Table 1 does not imply that it is endorsed by the authors or has been consistently effective for EAB control. Please see the following sections for specific information about results from these trials. Results of some tests have also been posted on **www.emeraldashborer.info**.

Strategies for the most effective use of these insecticide products are described below. It is important to note that pesticide labels and registrations change constantly and vary from state to state. It is the legal responsibility of the pesticide applicator to read, understand and follow all current label directions for the specific pesticide product being used.

Table 1. Insecticide options for professionals and homeowners for controlling EAB that have been tested in multiple university trials. Some products may not be labeled for use in all states. Some of the listed products failed to protect ash trees when they were applied at labeled rates. Inclusion of a product in this table does not imply that it is endorsed by the authors or has been consistently effective for EAB control. See text for details regarding effectiveness.

Insecticide Formulation	Active Ingredient	Application Method	Recommended Timing
		Professional Use Products	
Merit® (75WP, 75WSP, 2F)	Imidacloprid	Soil injection or drench	Mid-fall and/or mid- to late spring
Xytect™ (2F, 75WSP)	Imidacloprid	Soil injection or drench	Mid-fall and/or mid- to late spring
IMA-jet®	Imidacloprid	Trunk injection	Early May to mid-June
Imicide®	Imidacloprid	Trunk injection	Early May to mid-June
Pointer™	Imidacloprid	Trunk injection	Early May to mid-June
TREE-äge™	Emamectin benzoate	Trunk injection	Early May to mid-June
Inject-A-Cide B®	Bidrin®	Trunk injection	Early May to mid-June
Safari™ (20 SG)	Dinotefuran	Systemic bark spray	Early May to mid-June
Astro®	Permethrin	Preventive bark and foliage cover sprays	2 applications at 4-week intervals; first spray should occur when black locust is blooming (early May in southern Ohio to early June in mid-Michigan)
Onyx™	Bifenthrin		
Tempo®	Cyfluthrin		
Sevin® SL	Carbaryl		
		Homeowner Formulation	
Bayer Advanced™ Tree & Shrub Insect Control	Imidacloprid	Soil drench	Mid-fall or mid- to late spring

Using Insecticides to Control EAB

Soil-Applied Systemic Insecticides

Systemic insecticides applied to the soil are taken up by the roots and translocated throughout the tree. The most widely tested soil-applied systemic insecticide for control of EAB is imidacloprid, which is available under several brand names for use by professional applicators and homeowners (see Table 1). All imidacloprid formulations can be applied as a drench by mixing the product with water, then pouring the solution directly on the soil around the base of the trunk. Dinotefuran is also labeled for use as a soil treatment, but to date it has been tested only as a basal trunk spray (discussed below). Studies to test its effectiveness as a soil treatment are currently underway.

Imidacloprid soil applications should be made when the soil is moist but not saturated. Application to water-logged soil can result in poor uptake if the insecticide becomes excessively diluted and can also result in puddles of insecticide that could wash away, potentially contaminating surface waters and storm sewers. Insecticide uptake will also be limited when soil is excessively dry. Irrigating the soil surrounding the base of the tree before the insecticide application can improve uptake.

The application rates for the homeowner product (Bayer Advanced™ Tree & Shrub Insect Control) and professional formulations of imidacloprid are very similar. Homeowners apply the same amount of active ingredient that professionals apply. However, there are certain restrictions on the use of homeowner formulations that do not apply to professional formulations. Homeowner formulations of imidacloprid can be applied only as a drench. It is not legal to inject these products into the soil, although some companies have marketed devices to homeowners specifically for this purpose. Homeowners are also restricted to making only one application per year. Several generic products containing imidacloprid are available to homeowners, but the formulations vary and the effectiveness of these products has not yet been evaluated in university tests.

Soil drenches offer the advantage of requiring no special equipment for application other than a bucket or watering can. However, imidacloprid can bind to surface layers of organic matter, such as mulch or leaf litter, which can reduce uptake by the tree. Before applying soil drenches, it is important to remove, rake or pull away any mulch or dead leaves so the insecticide solution is poured directly on the mineral soil.

Imidacloprid formulations labeled for use by professionals can be applied as a soil drench or as soil injections. Soil injections require specialized equipment, but offer the advantage of placing the insecticide under mulch or turf and directly into the root zone. This also can help to prevent runoff on sloped surfaces. Injections should be made just deep enough to place the insecticide beneath the soil surface (2-4 inches). Soil injections should be made within 18 inches of the trunk where the density of fine roots is highest. As you move away from the tree, large radial roots diverge like spokes on a wheel and studies have shown that uptake is higher when the product is applied at the base of the trunk. There are no studies that show that applying fertilizer with imidacloprid enhances uptake or effectiveness of the insecticide.

Optimal timing for imidacloprid soil injections and drenches is mid-April to mid-May, depending on your region. Allow four to six weeks for uptake and distribution of the insecticide within the tree. In southern Ohio, for example, you would apply the product by mid-April; in southern Michigan, you should apply the product by early to mid-May. When treating larger trees (e.g., with trunks larger than 12 inches in diameter), treat on the earlier side of the recommended timing. Large trees will require more time for uptake and transportation of the insecticide than will small trees. Recent tests show that imidacloprid soil treatments can also be successful when applied in the fall.

Trunk-Injected Systemic Insecticides

Several systemic insecticide products can be injected directly into the trunk of the tree including formulations of imidacloprid and emamectin benzoate (see Table 1). An advantage of trunk injections is that they can be used on sites where soil treatments may not be practical or effective, including trees growing on excessively wet, compacted or restricted soil environments. However, trunk injections do wound the trunk, which may cause long-term damage, especially if treatments are applied annually.

Products applied as trunk injections are typically absorbed and transported within the tree more quickly than soil applications. Allow three to four weeks for most trunk-injected products to move through the tree. Optimal timing of trunk injections occurs after trees have leafed out in spring but before EAB eggs have hatched, or generally between mid-May and mid-June. Uptake of trunk-injected insecticides will be most efficient when trees are actively transpiring. Best results are usually obtained by injecting trees in the morning when soil is moist but not saturated. Uptake will be slowed by hot afternoon temperatures and dry soil conditions.

Noninvasive, Systemic Basal Trunk Sprays

Dinotefuran is labeled for application as a noninvasive, systemic bark spray for EAB control. It belongs to the same chemical class as imidacloprid (neonicotinoids) but is much more soluble. The formulated insecticide is sprayed on the lower five to six feet of the trunk using a common garden sprayer and low pressure. Research has shown that the insecticide penetrates the bark and moves systemically throughout the rest of the tree. Dinotefuran can be mixed with surfactants that may facilitate its movement into the tree, particularly on large trees with thick bark. However, in field trials, adding a surfactant did not consistently increase the amount of insecticide recovered from the leaves of treated trees.

The basal trunk spray offers the advantage of being quick and easy to apply and requires no special equipment other than a garden sprayer. This application technique does not wound the tree, and when applied correctly, the insecticide does not enter the soil.

Protective Cover Sprays

Insecticides can be sprayed on the trunk, branches and (depending on the label) foliage to kill adult EAB beetles as they feed on ash leaves, and newly hatched larvae as they chew through the bark. Thorough coverage is essential for best results. Products that have been evaluated as cover sprays for control of EAB include some specific formulations of permethrin, bifenthrin, cyfluthrin and carbaryl (see Table 1).

Protective cover sprays are designed to prevent EAB from entering the tree and will have no effect on larvae feeding under the bark. Cover sprays should be timed to occur when most adult beetles are feeding and beginning to lay eggs. Adult activity can be difficult to monitor because there are no effective pheromone traps for EAB. However, first emergence of EAB adults generally occurs between 450-550 degree days (starting date of January 1, base temperature of 50°F), which corresponds closely with full bloom of black locust (*Robinia pseudoacacia*). For best results, consider two applications, one at 500 DD_{50} (as black locust approaches full bloom) and a second spray four weeks later.

How Effective Are Insecticides for Control of EAB?

Extensive testing of insecticides for control of EAB has been conducted by researchers at Michigan State University (MSU) and The Ohio State University (OSU). Results of some of the MSU trials are available at **www.emeraldashborer.info**.

Soil-Applied Systemic Insecticides

Efficacy of imidacloprid soil injections for controlling EAB has been inconsistent; in some trials EAB control was excellent, while others yielded poor results. Differences in application protocols and conditions of the trials have varied considerably, making it difficult to reach firm conclusions about sources of variation in efficacy. For example, an MSU study found that low-volume soil injections of imidacloprid applied to small trees averaging 4 inches in DBH (diameter of the trunk at breast height) using the Kioritz applicator (a hand-held device for making low-volume injections) provided good control at one site. However, control was poor at another site where the same application protocols were used to treat larger trees (13-inch DBH). Imidacloprid levels may have been too low in the larger trees to provide adequate control. Higher pest pressure at the second site also may have contributed to poor control in the large trees.

In the same trials, high-pressure soil injections of imidacloprid (applied in two concentric rings, with one at the base of the tree and the other halfway to the drip line of the canopy) provided excellent control at one

site. At another site, however, soil injections applied using the same rate, timing and application method were completely ineffective, even though tree size and infestation pressure were very similar. It should be noted that recent studies have shown that imidacloprid soil injections made at the base of the trunk result in more effective uptake than applications made on grid or circular patterns under the canopy.

Imidacloprid soil drenches have also generated mixed results. In some studies conducted by MSU and OSU researchers, imidacloprid soil drenches have provided excellent control of EAB. However, in other studies, control has been inconsistent. Experience and research indicate that imidacloprid soil drenches are most effective on smaller trees and control of EAB on trees with a DBH that exceeds 15 inches is less consistent.

This inconsistency may be due to the fact that application rates for systemic insecticides are based on amount of product per inch of trunk diameter or circumference. As the DBH of a tree increases, the amount of vascular tissue, leaf area and biomass that must be protected by the insecticide increases exponentially. Consequently, for a particular application rate, the amount of insecticide applied as a function of tree size is proportionally decreased as trunk diameter increases. Hence, the DBH-based application rates that effectively protect relatively small trees can be too low to effectively protect large trees. Some systemic insecticide products address this issue by increasing the application rate for large trees.

In an OSU study with larger trees (15- to 22-inch DBH), Xytect™ (imidacloprid) soil drenches provided most consistent control of EAB when applied experimentally at twice the rate that was allowed at that time. Recently, the Xytect™ label was modified to allow the use of this higher rate, which we now recommend when treating trees larger than 15-inch DBH. Merit® imidacloprid formulations, however, are not labeled for application at this high rate. Therefore, when treating trees greater than 15-inch DBH with Merit® soil treatments, two applications are recommended, either in the fall and again in the spring, or twice in the spring, about four weeks apart (for example in late April and again in late May). This is not an option for Bayer Advanced™ Tree and Shrub Insect Control and other homeowner formulations of imidacloprid, which are limited by the label to one application per year. Homeowners wishing to protect trees larger than 15-inch DBH should consider having their trees professionally treated.

All treatment programs must comply with the limits specified on the label regarding the maximum amount of insecticide that can be applied per acre during a given year.

Trunk-Injected Systemic Insecticides

Emamectin benzoate

In several intensive studies conducted by MSU and OSU researchers, a single injection of emamectin benzoate in mid-May or early June provided excellent control of EAB for at least two years, even under high pest pressure. For example, in a highly-replicated study conducted on trees ranging in size from 5- to 20-inch DBH at three sites in Michigan, untreated trees had an average of 68 to 132 EAB larvae per m^2 of bark surface, which represents high pest pressure. In contrast, trees treated with emamectin benzoate had, on average, only 0.2 larvae per m^2, a reduction of > 99 percent. When additional trees were felled and debarked two years after the emamectin benzoate injection, there were still virtually no larvae in the treated trees, while adjacent, untreated trees at the same sites had hundreds of larvae.

In two OSU studies conducted in Toledo with street trees ranging in size from 15- to 25-inch DBH, a single application of emamectin benzoate also provided excellent control for two years. There was no sign of canopy decline in treated trees and very few emergence holes, while the canopies of adjacent, untreated trees exhibited severe decline and extremely high numbers of emergence holes.

One study suggests that a single injection of emamectin benzoate may even control EAB for three years. Additional studies to further evaluate the long-term effectiveness of emamectin benzoate are underway. To date, this is the only product that controls EAB for more than one year with a single application. In addition, in side-by-side comparisons with other systemic products (neonicotinoids), emamectin benzoate was more effective.

Imidacloprid

Trunk injections with imidacloprid products have provided varying degrees of EAB control in trials conducted at different sites in Ohio and Michigan. In an MSU study, larval density in trees treated with Imicide® injections were reduced by 60 percent to 96 percent, compared to untreated controls. There was no apparent relationship between efficacy and trunk diameter or infestation pressure. In another MSU trial, imidacloprid trunk injections made in late May were more effective than those made in mid-July, and IMA-jet® injections provided higher levels of control than did Imicide®, perhaps because the IMA-jet® label calls for a greater amount of active ingredient to be applied on large trees. In an OSU study in Toledo, IMA-jet® provided excellent control of EAB on 15- to 25-inch trees under high pest pressure when trees were injected annually. However, trees that were injected every other year were not consistently protected.

In a discouraging study conducted in Michigan, ash trees continued to decline from one year to the next despite being treated in both years with either imidacloprid (Imicide®, Pointer™) or Bidrin (Inject-A-Cide B®) trunk injections. Imicide®, Pointer™ and Inject-A-Cide B® trunk injections all suppressed EAB infestation levels in both years, with Imicide® generally providing best control under high pest pressure in both small (six-inch DBH) and larger (16-inch DBH) caliper trees. However, larval density increased in treated and untreated trees from one year to the next. Furthermore, canopy dieback increased by at least 67 percent in all treated trees (although this was substantially less than the amount of dieback observed in untreated trees). Although untreated trees were more severely impacted, these results indicate that even consecutive years of treatment with these trunk-injection treatments may only slow or delay ash decline when pest pressure is severe.

In three other side-by-side comparisons, Imicide® consistently provided higher levels of control than did Pointer™. In another MSU study, ACECAP® trunk implants (active ingredient is acephate) were not effective under high pest pressure.

Noninvasive Basal Trunk Sprays with Dinotefuran

Studies to date indicate that systemic basal trunk sprays with dinotefuran are about as effective as imidacloprid treatments. MSU and OSU studies have evaluated residues in leaves from trees treated with the basal trunk spray. Results show that the dinotefuran effectively moved into the trees and was translocated to the canopy at rates similar to those of other trunk-injected insecticides, and faster than other soil-applied neonicotinoid products.

As with imidacloprid treatments, control of EAB with dinotefuran has been variable in research trials. In an MSU study conducted in 2007 and 2008, dinotefuran trunk sprays reduced EAB larval density by approximately 30 percent to 60 percent compared to the heavily infested untreated trees. The treatment was effective for only one year and would have to be applied annually. In general, control is better and more consistent in smaller trees than in large trees, but more research is needed with larger trees. Studies to address the long-term effectiveness of annual dinotefuran applications for control of EAB are underway.

Protective Cover Sprays

MSU studies have shown that applications of Onyx™, Tempo® and Sevin® SL provided good control of EAB, especially when the insecticides were applied in late May and again in early July. Acephate sprays were less effective. BotaniGard® (*Beauvaria bassiana*) was also ineffective under high pest pressure. Astro® (permethrin) was not evaluated against EAB in these tests, but has been effective for controlling other species of wood borers and bark beetles.

In another MSU study, spraying Tempo® just on the foliage and upper branches or spraying the entire tree were more effective than simply spraying just the trunk and large branches. This suggests that some cover sprays may be especially effective for controlling EAB adults as they feed on leaves in the canopy. A single, well-timed spray was also found to provide good control of EAB, although two sprays may provide extra assurance given the long period of adult EAB activity.

It should be noted that spraying large trees is likely to result in a considerable amount of insecticide drift, even when conditions are ideal. Drift and potential effects of insecticides on non-target organisms should be considered when selecting options for EAB control.

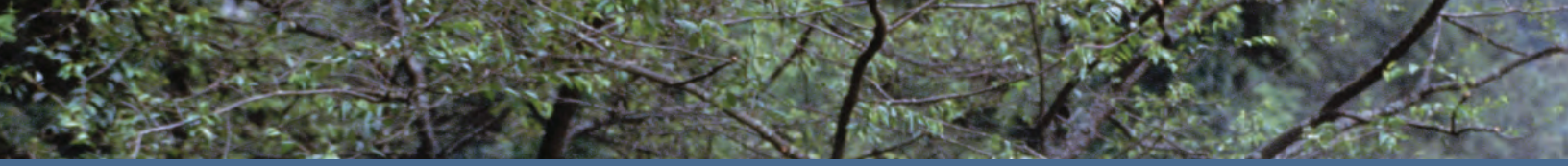
Key Points and Summary Recommendations

- Insecticides can effectively protect ash trees from EAB.
- Unnecessary insecticide applications waste money. If EAB has not been detected within 10-15 miles, your trees are at low risk. Be aware of the status of EAB in your location. Current maps of known EAB populations can be found at **www.emeraldashborer.info**. Remember, however, that once a county is quarantined, maps for that county are no longer updated.
- Trees that are already infested and showing signs of canopy decline when treatments are initiated may continue to decline in the first year after treatment, and then begin to show improvement in the second year due to time lag associated with vascular healing. Trees exhibiting more than 50 percent canopy decline are unlikely to recover even if treated.
- Emamectin benzoate is the only product tested to date that controls EAB for more than one year with a single application. It also provided a higher level of control than other products in side-by-side studies.
- Soil drenches and injections are most effective when made at the base of the trunk. Imidacloprid applications made in the spring or the fall have been shown to be equally effective.
- Soil injections should be no more than 2-4 inches deep, to avoid placing the insecticide beneath feeder roots.
- To facilitate uptake, systemic trunk and soil insecticides should be applied when the soil is moist but not saturated or excessively dry.
- Research and experience suggest that effectiveness of insecticides has been less consistent on larger trees. Research has not been conducted on trees larger than 25-inch DBH. When treating very large trees under high pest pressure, it may be necessary to consider combining two treatment strategies.
- Xytect™ soil treatments are labeled for application at a higher maximum rate than other imidacloprid formulations, and we recommend that trees larger than 15-inch DBH be treated using the highest labeled rate. Merit® imidacloprid formulations are not labeled for use at this higher rate. When treating larger trees with Merit® soil treatments, best results will be obtained with two applications per year. Imidacloprid formulations for homeowners (Bayer Advanced™ Tree & Shrub Insect Control and other generic formulations) can be applied only once per year.
- Homeowners wishing to protect trees larger than 15-inch DBH should consider having their trees professionally treated.
- All treatment programs must comply with label restrictions on the amount of insecticide that can be applied per acre in a given year.

Acknowledgements

Production and distribution of this bulletin were supported in part by cooperative agreements from the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS) and the U.S. Forest Service, Northeastern Area, Forest Health Protection. This bulletin may not necessarily express the views of the USDA.

May 2009



Extension Bulletin E-2942 New, May 2005

Ash Tree Identification

Ash species attacked by emerald ash borer include green (*Fraxinus pennsylvanica*), white (*F. americana*), black (*F. nigra*), and blue (*F. quadrangulata*), as well as horticultural cultivars of these species. Green and white ash are the most commonly found ash species in the Midwest with blue ash being rare.

While other woody plants, such as mountainash and pricklyash, have "ash" in their name, they are not true ash, or *Fraxinus* species. Only true ash are susceptible to attack by emerald ash borer.

To properly identify ash trees, use the following criteria:

Branch and Bud Arrangement

Branches and buds are directly across from each other and not staggered. When looking for opposite branching in trees, please consider that buds or limbs may die; hence not every single branch will have an opposite mate.

Diane Brown-Rytlewski

Leaves

Leaves are compound and composed of 5-11 leaflets. Leaflet margins may be smooth or toothed. The only other oppositely branched tree with compound leaves is boxelder (*Acer negundo*), which almost always has three to five leaflets. White ash (on left) and green ash (on right)

**Paul Wray, Iowa State University*

Bark

On mature trees (left), the bark is tight with a distinct pattern of diamond-shaped ridges. On young trees (right), bark is relatively smooth.

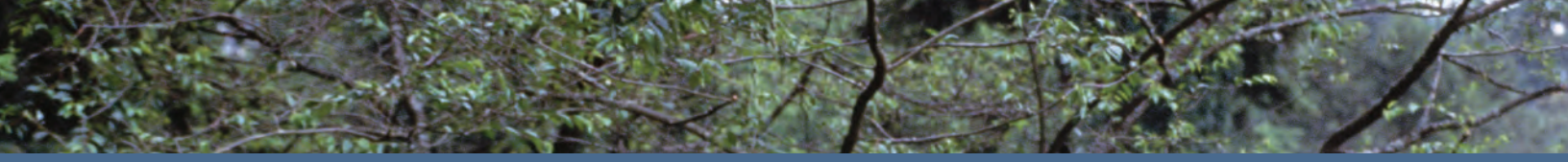
**Paul Wray, Iowa State University*

Seeds

When present on trees, seeds are dry, oar-shaped samaras. They usually occur in clusters and typically hang on the tree until late fall, early winter.

MICHIGAN STATE UNIVERSITY EXTENSION

Emerald Ash Borer



Tree Species Resembling Ash

Boxelder *(Acer negundo)*

Exhibits opposite branching and compound leaves. However, has 3 to 5 leaflets (instead of 5 to 11) and the samaras are always in pairs instead of single like the ash.

*Paul Wray, Iowa State University

*Bill Cook, Michigan State University

European Mountainash *(Sorbus aucuparia)*

Leaves are compound with alternate (staggered) branching. Tree bears clusters of creamy white flowers in May. Fruits are fleshy, red-orange berries.

Diane Brown-Rytlewski

*Boris Hrasovec, University of Zagreb

Shagbark Hickory *(Carya ovata)*

Leaves are compound with 5 to 7 leaflets, but the plant has an alternate branching habit. Fruit are hard-shelled nuts in a green husk.

*Paul Wray, Iowa State University

*Paul Wray, Iowa State University

Elm *(Ulmus species)*

Branching is alternate and the leaves are simple with an unequal leaf base.

*Paul Wray, Iowa State University

*Paul Wray, Iowa State University

*Paul Wray, Iowa State University

Black Walnut *(Juglans nigra)*

Leaves are compound with 9 to 15 leaflets, but the plant has an alternate branching habit. Fruit is a large dark brown nut inside a green husk.

*Paul Wray, Iowa State University

Authors: Kimberly Rebek and Mary Wilson

*www.forestryimages.org

MICHIGAN STATE UNIVERSITY EXTENSION

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Appendix E
Pest and Diseases

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

ANTHRACNOSE DISEASES OF DECIDUOUS TREES

Gleosporium spp. *and Apiognomonia* spp.

Figure 1. Damage by ash anthracnose causes brown lesions. Leaves and leaflets drop early in the spring.

Figure 2. Symptoms of sycamore anthracnose disease are evident on newly expanding leaves.

Anthracnose diseases are caused by a common and destructive group of fungal pathogens that can attack various shade trees. Extended periods of cool, wet weather can make these diseases devastating and difficult to control with foliar applications of fungicides.

SYMPTOMS: Symptoms vary and are listed below by host.

Ash (*Fraxinum* spp.) – Brown areas with irregular shapes occur along the new leaves; brown blotches occur on leaf tips, veins and margins. Infected leaves drop prematurely in the spring (Figure 1). Twigs may be girdled and die, especially during cool, wet weather.

Maple (*Acer* spp.) – There are several fungi that cause anthracnose-type leaf spotting on maples. Foliar symptoms include brown vein lesions originating at the veins, to irregular browning of margins that extend inward.

Oak (*Quercus* spp.) – White oak is severely affected when new leaves are expanding and cool, moist weather occurs for a prolonged period. Leaves have large dead areas between the leaf veins, usually on lower branches. These leaves become twisted and droop with downward cupping. Twig and branch dieback may be evident the following spring.

Sycamore (*Platanus* spp.) – Areas along leaf veins turn tan to brown (Figure 2). As the fungus invades the leaf tissue it moves into petioles and stems. Buds turn gray-brown and wilt. Twigs and branches show discoloration around infected buds or exhibit dead sunken areas in the stems (cankers). Continuous years of infection cause severe canopy reduction and a witches'-broom stunting of branches.

CAUSE: The fungus generally overwinters in infected, dead leaves on the ground. With the sycamore disease, it also winters in the infected buds or twig and branch cankers. During cool wet springs, minute blister-like swelling in the infected tissues releases thousands of spores that are wind-dispersed to new leaves. These new infections cause death of the leaf tissues, which results in tan-to-brown dead areas. Varying amounts of leaf drop

take place, depending upon the severity of the disease that season. The inoculum is present to repeat the cycle the following year.

SOLUTIONS: Current recommendations for preventing or correcting anthracnose diseases of shade trees include the following:

1. Fertilize trees that have become infected, and water during dry periods. This will help the tree overcome the stress brought on by the disease and the resulting defoliation.
2. Rake up and destroy infected leaves, and prune off cankered branches to reduce the potential for infection.
3. Usually, a fungicide applied to tree foliage during leaf expansion will aid in minimizing leaf infection and defoliation. However, if the weather is cool and wet for prolonged periods of time, foliar applications may not provide satisfactory results.

For management of sycamore anthracnose disease on trees greater than 2 feet in diameter, trunk injections of Arbotect® fungicide are recommended. This treatment provides two years of disease suppression from one application. The trunk injections are effective even when there is cool, wet weather that favors disease development.

Printed in the U.S.A.

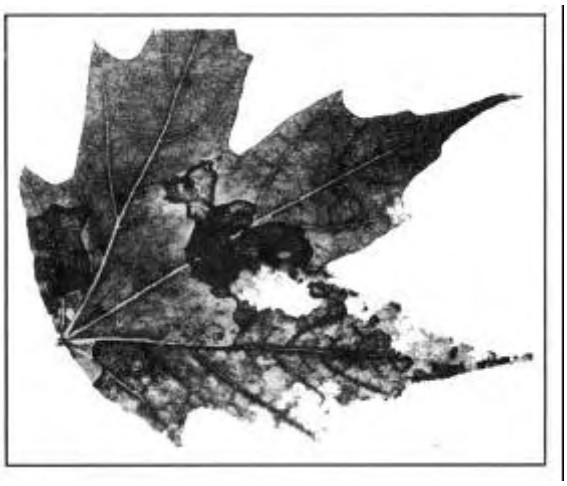
T15065-9/2000

TECHNICAL BULLETIN
Prepared by The Davey Institute

Anthracnose

Gnomonia plantani

Anthracnose is one of the most common and destructive foliar diseases of shade trees caused by fungi. Leaf tissue will be killed and defoliation may occur, thus reducing the aesthetic value and vitality of the affected trees.

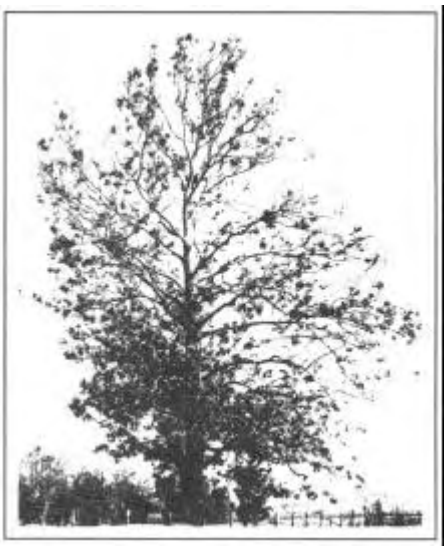


Anthracnose on sugar maple leaf.

The disease affects many different kinds of trees. It is more common and serious on American sycamore and white oak than on sugar and Norway maple or ash. Although the disease can occur throughout the United States, it is most prevalent in the north central and northeastern states.

SYMPTOMS: Leaf symptoms vary somewhat, depending upon the tree affected.

SYCAMORE *(Platanus)* - *Areas* along the major veins turn brown. Gradually more and more of the leaf will be killed as the fungus spreads. Infected buds may not open in the spring or, if they do, the leaves will be killed before they reach full size. Twigs and branches may show discoloration around infected buds or exhibit dead sunken areas in the bark (cankers).



Large sycamore tree mostly defoliated by anthracnose.

OAK *(Quercus)* - *The* affected area shows light tan blotches or spots with distinct borders. Leaves may be twisted or distorted.

MAPLE *(Acer)* - *The* disease is severe on sugar and silver. maples. Norway maple leaves turn purple along the major veins, while large irregular tan-to-brown blotches are produced in sugar maples.

ASH *(Fraxinus)* - Brown areas with irregular shapes occur, especially along the leaf margin. Leaf distortion and premature leaf drop may occur.

CAUSE: The fungus generally overwinters in infected, dead leaves on the ground. In sycamore it also overwinters in infected buds or in cankers formed at the base of an infected leaf or twig.

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.

During cool and wet springs, minute blister-like swellings in the infected tissues release thousands of spores. These get blown around, land on newly developed leaves, and cause infection and death of the tissue resulting in the tan-to-brown areas.

Varying amounts of leaf drop take place, depending upon the severity of the disease that season. Conditions are then ready to repeat the cycle the following year.

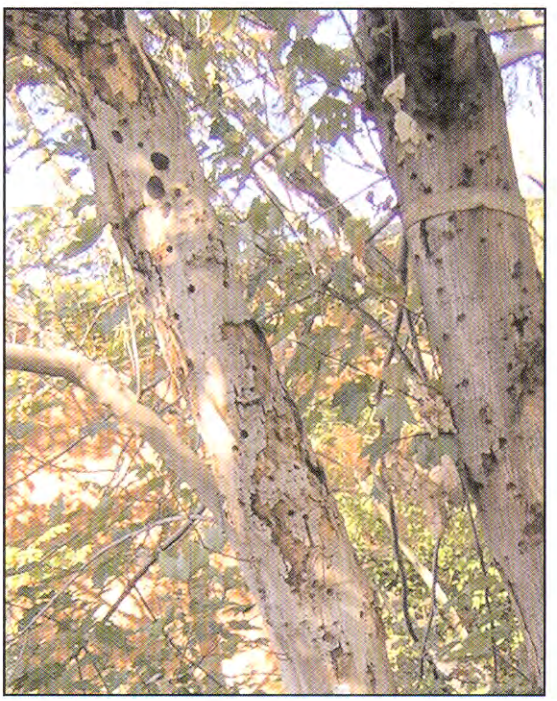
SOLUTIONS: Current recommendations for preventing or correcting anthracnose in shade trees include the following:

1. Fertilize trees that have become infected and water during dry periods. This will help the tree overcome the stress brought on by the disease and the resulting defoliation.
2. Rake up and destroy infected leaves and prune off cankered branches. This will reduce the potential for infection.
3. Fungicidal treatments during leaf development will aid in preventing leaf infection and defoliation. Trunk injections of Arbotech can also be used to manage Sycamore Anthracnose.

Prepared By The Davey Institute

Borers

SYMPTOMS: Presence of sawdust-like material and/or sap and resin oozing from small holes in the trunk or in the branches, are often the first signs of a borer attack. Bark appears swollen, knotty and callused and may develop cracks that eventually could cause small areas to break off. Leaves in the upper part of the tree are undersized and discolored, and branches begin to die.



Davey Technicians examine damaging holes in the trunk of a Maple where Borers have attacked. Bark is starting to break away.

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, black locust, cherry, dogwood, elm, honey locust, lilac, maple, mountain ash, 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 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.

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

CEDAR RUSTS

Gymnosporangium spp.

Figure 1. *Cedar-quince twig gall.*

Figure 2. *Cedar-hawthorn rust pustules on hawthorn leaves.*

The cedar rust disease occurs 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, cedar-hawthorn rust, and cedar-apple rust.

SYMPTOMS: Cedar-quince rust commonly affects the twigs and fruits of hawthorns. On fruits, elongated pink spore-bearing structures will form, giving the fruit a prickly appearance. On twigs, cankers develop, resulting in dieback (Figure 1).

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 (Figure 2).

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 are recommended in the spring to help prevent infection on crabapples, hawthorns and other susceptible hosts. Susceptible junipers can also be sprayed in mid-to-late summer to control the stages of the cedar rust disease. Fertilization of affected plants with slow-release nitrogen source will help promote recovery.

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

DUTCH ELM DISEASE

Ophiostoma ulmi (syn. Ceratocystis ulmi)

Dutch elm disease is one of the most destructive shade tree diseases in the United States and Canada, and has killed millions of elm trees since its introduction from Europe in 1930. Despite this loss, many elms still remain as street trees or specimen shade trees providing grace and beauty to our landscapes.

SYMPTOMS: Infected elm trees display wilted leaves on one or a few branches in the crown of the tree – called flagging. The wilted leaves may turn yellow, curl, and/or turn brown. Leaves can remain attached to the stem or prematurely fall off. Stems exhibiting flagging typically die back.

If bark is peeled away from stems exhibiting yellow, brown or wilted leaves, brown streaking may be visible in the sapwood just under the bark. Sometimes streaking is embedded deeper in the wood, which indicates that the infection occurred in previous years.

CAUSE: The disease is caused by the fungus *Ophiostoma ulmi*. Both the smaller European elm bark beetle and native elm bark beetle can transfer fungal spores of the disease from infected elms to healthy elms. The fungus is transmitted to healthy trees when beetles carry fungal spores after feeding in stem crotches of diseased elms.

Direct transmission of the disease occurs when diseased trees and healthy trees in proximity to each other have connecting root grafts. Elms that are within 40 feet of each other have a good chance of having root grafts.

SOLUTIONS:

1. All infected elms and dead or dying branches on healthy elms should be promptly removed and destroyed to prevent build-up of beetle and fungal populations. Prompt removal of diseased branches can help stop the spread of the disease in a tree if it has not progressed within 10 feet of the main trunk.
2. To prevent root graft transmission of the disease from infected to healthy elm trees, trees suspected of having root grafts should have them severed by trenching or soil fumigation.
3. Systemic fungicides can be trunk injected for preventive and therapeutic treatment. Trees receiving therapeutic fungicide treatments have the best response if the crown has 5% or less infection.
4. Research indicates that attempts to manage the bark beetle with insecticides may not be effective. The feeding sites of beetles (stem crotches) must be protected with insecticides, which is difficult with current equipment, pesticides and technology. The alternate option is the protection of susceptible trees with preventative trunk injections of recommended fungicides.
5. Trees maintained with good cultural practices such as fertilization, watering, mulching and selective pruning will have the best health and vitality.

Prepared By The Davey Institute

Gypsy Moth

Lymantria dispar

SYMPTOMS: Trees may be partially or completely defoliated by large numbers of dark, hairy caterpillars. The caterpillars hatch from beige-colored egg masses in early April to late May and begin feeding on new tree leaves that are emerging at the same time. When the population is high, the caterpillars are a nuisance in residential areas and parks as they crawl on buildings, outdoor furniture, cars, and lawns. Their excrement seemingly "rains" out of trees, and sounds of their feeding can be heard as they rapidly devour leaves.

Female Gypsy Moth with egg mass.

CAUSE: The gypsy moth is one of the most destructive insects in the United States. In 1981, 12.9 million acres of forests were defoliated. Infestations are primarily in the northeastern states, but it is spreading southward and westward.

Oaks, especially white and chestnut oak, are the preferred food source of gypsy moth caterpillars. Other preferred species include: alder, aspen, basswood, birch, hawthorn, and willow. Least preferred species include: American holly, ash, black locust, flowering dogwood, sycamore, and tulip tree.

Young caterpillars spin down from treetops on silken threads and are easily spread by the wind. Fully-grown caterpillars can be identified from other caterpillar species by the five pairs of blue spots followed by six pairs of red spots on their back. The caterpillars are ravenous feeders. It is estimated that a single caterpillar consumes about 10.8 sq. ft. of foliage during its development. Defoliation weakens trees and complete defoliation can kill stressed conifers and hardwoods in one year. A tree weakened by gypsy moth feeding is more susceptible to injury from insects and diseases. Sunscald, dieback, and overall decline of trees are often associated with defoliation.

Adult moths begin to emerge in July after the caterpillars have pupated. A female moth lays from 75 to 100 eggs, which can be found on trees, rocks, walls, firewood, even the underside of vehicles. In fact, accidental transportation of egg masses has accounted for the spread of the gypsy moth from state to state.

SOLUTION: Because of the long hatch periods, two or three foliar treatments may be necessary to control gypsy moth caterpillars. The bacterial pathogen, B.t., will control gypsy moth, but it is most effective while the larvae are young.

In addition, trees should be fertilized to improve their ability to recover from gypsy moth damage.

Appendix F
Diameter Class Distribution

Sedalia, MO

Quantity Report: Diameter Class

Diameter Class	Total	Percentage of Entire Population
1 - 3	221	24.18%
4 - 6	89	9.74%
7 - 12	193	21.12%
13 - 18	125	13.68%
19 - 24	103	11.27%
25 - 30	81	8.86%
31 - 36	62	6.78%
37 - 42	27	2.95%
43 +	13	1.42%
Grand Total	*914*	*100%*

Sedalia, MO

Frequency Report: Area by Diameter Class

Diameter Class	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Centennial Park			
1 - 3	11	9.17%	1.21%
4 - 6	21	17.50%	2.30%
7 - 12	32	26.67%	3.51%
13 - 18	10	8.33%	1.10%
19 - 24	13	10.83%	1.43%
25 - 30	20	16.67%	2.19%
31 - 36	9	7.50%	0.99%
37 - 42	2	1.67%	0.22%
43 +	2	1.67%	0.22%
Summary for Centennial Park (9 items)			
Sum	*120*	*100%*	*13.16%*
Clover Dell Park			
1 - 3	69	70.41%	7.57%
4 - 6	14	14.29%	1.54%
7 - 12	14	14.29%	1.54%
37 - 42	1	1.02%	0.11%
Summary for Clover Dell Park (4 items)			
Sum	*98*	*100%*	*10.75%*
Housel Park			
1 - 3	1	11.11%	0.11%
7 - 12	2	22.22%	0.22%
13 - 18	2	22.22%	0.22%
19 - 24	1	11.11%	0.11%
25 - 30	2	22.22%	0.22%
31 - 36	1	11.11%	0.11%
Summary for Housel Park (6 items)			
Sum	*9*	*100%*	*0.99%*
Hubbard Park			
1 - 3	47	38.21%	5.15%
4 - 6	20	16.26%	2.19%
7 - 12	22	17.89%	2.41%
13 - 18	10	8.13%	1.10%
19 - 24	13	10.57%	1.43%

Diameter Class	Total	Percent of Sub-Category Pop.	Percent of Entire Population
25 - 30	5	4.07%	0.55%
31 - 36	3	2.44%	0.33%
37 - 42	3	2.44%	0.33%
Summary for Hubbard Park (8 items)			
Sum	*123*	*100%*	*13.49%*
Katy Park			
1 - 3	47	24.10%	5.15%
4 - 6	11	5.64%	1.21%
7 - 12	53	27.18%	5.81%
13 - 18	61	31.28%	6.69%
19 - 24	18	9.23%	1.97%
25 - 30	3	1.54%	0.33%
31 - 36	1	0.51%	0.11%
37 - 42	1	0.51%	0.11%
Summary for Katy Park (8 items)			
Sum	*195*	*100%*	*21.38%*
Liberty Park			
1 - 3	46	13.94%	5.04%
4 - 6	22	6.67%	2.41%
7 - 12	64	19.39%	7.02%
13 - 18	38	11.52%	4.17%
19 - 24	52	15.76%	5.70%
25 - 30	47	14.24%	5.15%
31 - 36	37	11.21%	4.06%
37 - 42	17	5.15%	1.86%
43 +	7	2.12%	0.77%
Summary for Liberty Park (9 items)			
Sum	*330*	*100%*	*36.18%*
Vermont Park			
4 - 6	1	2.70%	0.11%
7 - 12	6	16.22%	0.66%
13 - 18	2	5.41%	0.22%
19 - 24	6	16.22%	0.66%
25 - 30	4	10.81%	0.44%
31 - 36	11	29.73%	1.21%
37 - 42	3	8.11%	0.33%
43 +	4	10.81%	0.44%

Diameter Class	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Vermont Park (8 items)			
Sum	*37*	*100%*	*4.06%*
Grand Total	*912*		

Sedalia, MO

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
Amur corktree				1							1
apple, common			1								1
arborvitae, eastern		2									2
ash, green		62	7	19	9	11	6	5	1	6	126
ash, white		5		6	10	4	2	8	3	2	40
baldcypress, common		1	1	3	5	2					12
birch, paper		2									2
birch, river		3		2	2	2	1				10
boxelder				1	1			1			3
buckeye, Ohio		1									1
catalpa, northern							3	1	3	1	8
cherry, black		1	2	2	1			1			7
cherry/plum, spp.		5	3	2							10
chokecherry, common		1									1
cottonwood, eastern									1		1
crabapple, flowering		5	3	8	1	3					20
cypress, Kashmir		1									1
dawn redwood		1		1							2
dogwood, flowering		4	1	2							7
dogwood, Kousa		2									2
elm, American				3	1	5	1		2	1	13
elm, Siberian			1	1	4	8	5	2	1		22

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
elm, slippery								1	1		2
falsecypress, Nootka		1									1
ginkgo		2									2
goldenchain tree		1									1
hackberry, common		1		12	25	13	15	5	2	1	74
hawthorn, spp.		1									1
hawthorn, Washington			1								1
hickory, bitternut					1						1
honeylocust								1			1
honeylocust, thornless			1		1	1					3
horsechestnut							2				2
katsuratree		2									2
Kentucky coffeetree		6									6
linden, American							2		1		3
linden, littleleaf		3		1	1						5
locust, black		1		1	1						3
magnolia, saucer		1	1	1							3
maple, Amur		1									1
maple, Freeman		2	10	29	4						45
maple, Norway		2	1	2							5
maple, red		21	12	2	2	3					40
maple, silver			1	3	7	9	6	10	2	1	39
maple, sugar		1	1	16	19	5	1	1	1		45
maple, trident			4	9							13

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
mimosa				1							1
mulberry, white		1	1	3	5	1	1				12
oak, bur								1			1
oak, northern red			2	5	1		4	1			13
oak, pin		6	3	6	6	11	16	17	7	1	73
oak, scarlet		1									1
oak, shingle					1		1	1	1		4
oak, Shumard		1		3							4
oak, swamp white		2									2
osage-orange			2	1							3
pear, Callery		1	12	20							33
persimmon, common		1			3						4
pine, Austrian			3	2	2	2		1			10
pine, eastern white		2	4	4							10
pine, Scotch				1	2	5					8
pine, spp.						1					1
planetree, London			1			1		1			3
redbud, eastern		8	1	6							15
redcedar, eastern		30	1	8	4	2	1				46
serviceberry, spp.		2									2
spruce, Colorado		4	1								5
spruce, Norway		2		1							3
spruce, white		2	7								9
stump					2						2

Species	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
sweetgum, American				1		7	3				11
sycamore, American				1		3	11	4	1		20
Tamarix spp.		2									2
tuliptree		13			2	1					16
unknown tree		1									1
walnut, black				1	1	1					3
willow, spp.				1							1
willow, weeping				1	1	2					4
Grand Total		*221*	*89*	*193*	*125*	*103*	*81*	*62*	*27*	*13*	*914*

Appendix G
Condition Ratings

Sedalia, MO

Quantity Report: Condition

Condition	Total	Percentage of Entire Population
Fair	552	60.53%
Good	170	18.64%
Poor	148	16.23%
Critical	26	2.85%
Very Good	11	1.21%
Dead	4	0.44%
Excellent	1	0.11%
Grand Total	*912*	*100%*

Sedalia, MO

Frequency Report: Area by Condition

Condition	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Centennial Park			
Fair	71	59.17%	7.77%
Good	26	21.67%	2.84%
Poor	19	15.83%	2.08%
Very Good	2	1.67%	0.22%
Dead	1	0.83%	0.11%
Critical	1	0.83%	0.11%
Summary for Centennial Park (6 items)			
Sum	*120*	*100%*	*13.13%*
Clover Dell Park			
Fair	83	84.69%	9.08%
Good	8	8.16%	0.88%
Poor	5	5.10%	0.55%
Critical	2	2.04%	0.22%
Summary for Clover Dell Park (4 items)			
Sum	*98*	*100%*	*10.72%*
Housel Park			
Poor	6	66.67%	0.66%
Fair	1	11.11%	0.11%
Excellent	1	11.11%	0.11%
Dead	1	11.11%	0.11%
Summary for Housel Park (4 items)			
Sum	*9*	*100%*	*0.98%*
Hubbard Park			
Fair	83	67.48%	9.08%
Good	24	19.51%	2.63%
Poor	9	7.32%	0.98%
Critical	4	3.25%	0.44%
Very Good	2	1.63%	0.22%
Dead	1	0.81%	0.11%

Condition	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Hubbard Park (6 items)			
Sum	*123*	*100%*	*13.46%*
Katy Park			
Fair	118	60.51%	12.91%
Good	47	24.10%	5.14%
Poor	27	13.85%	2.95%
Very Good	2	1.03%	0.22%
Critical	1	0.51%	0.11%
Summary for Katy Park (5 items)			
Sum	*195*	*100%*	*21.33%*
Liberty Park			
Fair	179	53.92%	19.58%
Poor	68	20.48%	7.44%
Good	60	18.07%	6.56%
Critical	17	5.12%	1.86%
Very Good	5	1.51%	0.55%
N/A	2	0.60%	0.22%
Dead	1	0.30%	0.11%
Summary for Liberty Park (7 items)			
Sum	*332*	*100%*	*36.32%*
Vermont Park			
Fair	17	45.95%	1.86%
Poor	14	37.84%	1.53%
Good	5	13.51%	0.55%
Critical	1	2.70%	0.11%
Summary for Vermont Park (4 items)			
Sum	*37*	*100%*	*4.05%*
Grand Total	*914*		

Sedalia, MO

Species/Condition Frequency Matrix

Common Name	N/A	Dead	Critical	Poor	Fair	Good	Very Good	Excellent	TOTAL
Amur corktree					1				1
apple, common					1				1
arborvitae, eastern						2			2
ash, green				20	100	6			126
ash, white			3	11	20	6			40
baldcypress, common					1	6	5		12
birch, paper					2				2
birch, river					9	1			10
boxelder				2	1				3
buckeye, Ohio					1				1
catalpa, northern			4	4					8
cherry, black			1	1	5				7
cherry/plum, spp.				1	4	5			10
chokecherry, common					1				1
cottonwood, eastern						1			1
crabapple, flowering				5	14	1			20
cypress, Kashmir						1			1
dawn redwood					1	1			2
dogwood, flowering			1	1	4	1			7
dogwood, Kousa					2				2
elm, American				4	7	2			13
elm, Siberian				15	7				22
elm, slippery			1	1					2
falsecypress, Nootka						1			1
ginkgo					2				2
goldenchain tree					1				1

Common Name	N/A	Dead	Critical	Poor	Fair	Good	Very Good	Excellent	TOTAL
hackberry, common			5	19	27	23			74
hawthorn, spp.					1				1
hawthorn, Washington					1				1
hickory, bitternut					1				1
honeylocust				1					1
honeylocust, thornless				1	2				3
horsechestnut			1	1					2
katsuratree					2				2
Kentucky coffeetree					6				6
linden, American				2	1				3
linden, littleleaf					5				5
locust, black			1	1	1				3
magnolia, saucer				1	2				3
maple, Amur					1				1
maple, Freeman				11	30	4			45
maple, Norway				1	4				5
maple, red			1	2	35	2			40
maple, silver			1	12	24	2			39
maple, sugar			1	6	32	6			45
maple, trident					6	7			13
mimosa					1				1
mulberry, white				9	3				12
oak, bur						1			1
oak, northern red				1	9	3			13
oak, pin			1	5	26	37	3	1	73
oak, scarlet					1				1
oak, shingle			1		3				4
oak, Shumard					4				4
oak, swamp white					2				2
osage-orange					3				3

Common Name	N/A	Dead	Critical	Poor	Fair	Good	Very Good	Excellent	TOTAL
pear, Callery					30	3			33
persimmon, common				2	1	1			4
pine, Austrian		1	2	1	3	3			10
pine, eastern white					6	4			10
pine, Scotch		1	1		3	3			8
pine, spp.		1							1
planetree, London					2		1		3
redbud, eastern					11	4			15
redcedar, eastern			1	1	34	10			46
serviceberry, spp.					2				2
spruce, Colorado					3	2			5
spruce, Norway					1	2			3
spruce, white				2	7				9
stump	2								2
sweetgum, American				1	5	3	2		11
sycamore, American				1	7	12			20
Tamarix spp.					2				2
tuliptree				1	14	1			16
unknown tree		1							1
walnut, black					1	2			3
willow, spp.					1				1
willow, weeping				1	2	1			4
Grand Total:	2	4	26	148	552	170	11	1	914

Appendix H
Maintenance Recommendations

Sedalia, MO

Quantity Report: Primary Maintenance

Primary Maintenance	*Total*	*Percentage of Entire Population*
Large Tree Clean	551	60.28%
Young Tree Train	251	27.46%
Removal	63	6.89%
Small Tree Clean	47	5.14%
Stump Removal	2	0.22%
Grand Total	*914*	*100%*

Sedalia, MO

Frequency Report: Area by Primary Maintenance

Primary Maintenance	*Total*	*Percent of Sub-Category Pop.*	*Percent of Entire Population*
Centennial Park			
Large Tree Clean	72	60.00%	7.88%
Young Tree Train	35	29.17%	3.83%
Removal	8	6.67%	0.88%
Small Tree Clean	5	4.17%	0.55%
Summary for Centennial Park (4 items)			
Sum	*120*	*100%*	*13.13%*
Clover Dell Park			
Young Tree Train	56	57.14%	6.13%
Large Tree Clean	39	39.80%	4.27%
Removal	2	2.04%	0.22%
Small Tree Clean	1	1.02%	0.11%
Summary for Clover Dell Park (4 items)			
Sum	*98*	*100%*	*10.72%*
Housel Park			
Large Tree Clean	7	77.78%	0.77%
Removal	2	22.22%	0.22%
Summary for Housel Park (2 items)			
Sum	*9*	*100%*	*0.98%*
Hubbard Park			
Large Tree Clean	57	46.34%	6.24%
Young Tree Train	52	42.28%	5.69%
Small Tree Clean	8	6.50%	0.88%
Removal	6	4.88%	0.66%
Summary for Hubbard Park (4 items)			
Sum	*123*	*100%*	*13.46%*
Katy Park			
Large Tree Clean	129	66.15%	14.11%
Young Tree Train	55	28.21%	6.02%
Removal	9	4.62%	0.98%

Primary Maintenance	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Small Tree Clean	2	1.03%	0.22%
Summary for Katy Park (4 items)			
Sum	*195*	*100%*	*21.33%*
Liberty Park			
Large Tree Clean	217	65.36%	23.74%
Young Tree Train	53	15.96%	5.80%
Small Tree Clean	31	9.34%	3.39%
Removal	29	8.73%	3.17%
Stump Removal	2	0.60%	0.22%
Summary for Liberty Park (5 items)			
Sum	*332*	*100%*	*36.32%*
Vermont Park			
Large Tree Clean	30	81.08%	3.28%
Removal	7	18.92%	0.77%
Summary for Vermont Park (2 items)			
Sum	*37*	*100%*	*4.05%*
Grand Total	*914*		

Sedalia, MO

Quantity Report: Secondary Maintenance

Secondary Maintenance	*Total*	*Percentage of Entire Population*
None	742	81.18%
Restoration	66	7.22%
Raise	62	6.78%
Thin	26	2.84%
Utility	10	1.09%
Reduce	8	0.88%
Grand Total	*914*	*100%*

Sedalia, MO

Frequency Report: Area by Secondary Maintenance

Secondary Maintenance	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Centennial Park			
None	85	70.83%	9.30%
Raise	16	13.33%	1.75%
Thin	6	5.00%	0.66%
Reduce	5	4.17%	0.55%
Utility	4	3.33%	0.44%
Restoration	4	3.33%	0.44%
Summary for Centennial Park (6 items)			
Sum	*120*	*100%*	*13.13%*
Clover Dell Park			
None	97	98.98%	10.61%
Reduce	1	1.02%	0.11%
Summary for Clover Dell Park (2 items)			
Sum	*98*	*100%*	*10.72%*
Housel Park			
None	6	66.67%	0.66%
Raise	2	22.22%	0.22%
Utility	1	11.11%	0.11%
Summary for Housel Park (3 items)			
Sum	*9*	*100%*	*0.98%*
Hubbard Park			
None	104	84.55%	11.38%
Raise	14	11.38%	1.53%
Thin	3	2.44%	0.33%
Utility	1	0.81%	0.11%
Restoration	1	0.81%	0.11%
Summary for Hubbard Park (5 items)			
Sum	*123*	*100%*	*13.46%*
Katy Park			
None	170	87.18%	18.60%

Secondary Maintenance	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Restoration	15	7.69%	1.64%
Raise	6	3.08%	0.66%
Thin	4	2.05%	0.44%
Summary for Katy Park (4 items)			
Sum	*195*	*100%*	*21.33%*
Liberty Park			
None	253	76.20%	27.68%
Restoration	39	11.75%	4.27%
Raise	22	6.63%	2.41%
Thin	13	3.92%	1.42%
Utility	4	1.20%	0.44%
Reduce	1	0.30%	0.11%
Summary for Liberty Park (6 items)			
Sum	*332*	*100%*	*36.32%*
Vermont Park			
None	27	72.97%	2.95%
Restoration	7	18.92%	0.77%
Raise	2	5.41%	0.22%
Reduce	1	2.70%	0.11%
Summary for Vermont Park (4 items)			
Sum	*37*	*100%*	*4.05%*
Grand Total	*914*		

Sedalia, MO

Primary Maintenance/DBH Class Matrix Report

Primary Maintenance	*N/A*	*1 - 3*	*4 - 6*	*7 - 12*	*13 - 18*	*19 - 24*	*25 - 30*	*31 - 36*	*37 - 42*	*43 +*	*TOTAL*
Large Tree Clean		39	25	126	113	91	74	52	21	10	551
Removal		4	4	11	9	9	7	10	6	3	63
Small Tree Clean		17	8	18	1	3					47
Stump Removal					2						2
Young Tree Train		161	52	38							251
Grand Total		*221*	*89*	*193*	*125*	*103*	*81*	*62*	*27*	*13*	*914*

Sedalia, MO

Species/Primary Maintenance Frequency Report

Common Name	Removal	Young Tree Train	Small Tree Clean	Large Tree Clean	Stump Removal	TOTAL
Amur corktree				1		1
apple, common			1			1
arborvitae, eastern			2			2
ash, green	5	73		48		126
ash, white	8	5		27		40
baldcypress, common				12		12
birch, paper		2				2
birch, river		3		7		10
boxelder				3		3
buckeye, Ohio		1				1
catalpa, northern	4			4		8
cherry, black	1			6		7
cherry/plum, spp.		2	8			10
chokecherry, common		1				1
cottonwood, eastern				1		1
crabapple, flowering		4	16			20
cypress, Kashmir				1		1
dawn redwood		1		1		2

Common Name	Removal	Young Tree Train	Small Tree Clean	Large Tree Clean	Stump Removal	TOTAL
dogwood, flowering	2	3	2			7
dogwood, Kousa		1	1			2
elm, American	1			12		13
elm, Siberian	4			18		22
elm, slippery	1			1		2
falsecypress, Nootka			1			1
ginkgo		2				2
goldenchain tree			1			1
hackberry, common	7	1		66		74
hawthorn, spp.		1				1
hawthorn, Washington			1			1
hickory, bitternut				1		1
honeylocust				1		1
honeylocust, thornless	1			2		3
horsechestnut	2					2
katsuratree		2				2
Kentucky coffeetree		6				6
linden, American				3		3
linden, littleleaf		3		2		5
locust, black	1			2		3

Common Name	Removal	Young Tree Train	Small Tree Clean	Large Tree Clean	Stump Removal	TOTAL
magnolia, saucer			3			3
maple, Amur		1				1
maple, Freeman		18		27		45
maple, Norway		5				5
maple, red	1	32		7		40
maple, silver	5	1		33		39
maple, sugar	2	5		38		45
maple, trident		5		8		13
mimosa				1		1
mulberry, white	6			6		12
oak, bur				1		1
oak, northern red		2		11		13
oak, pin	1	12		60		73
oak, scarlet		1				1
oak, shingle	1			3		4
oak, Shumard		2		2		4
oak, swamp white		2				2
osage-orange		1		2		3
pear, Callery		24		9		33
persimmon, common	1	1		2		4

Common Name	Removal	Young Tree Train	Small Tree Clean	Large Tree Clean	Stump Removal	TOTAL
pine, Austrian	3			7		10
pine, eastern white				10		10
pine, Scotch	2			6		8
pine, spp.	1					1
planetree, London		1		2		3
redbud, eastern		5	10			15
redcedar, eastern	2	4		40		46
serviceberry, spp.		2				2
spruce, Colorado				5		5
spruce, Norway				3		3
spruce, white				9		9
stump					2	2
sweetgum, American				11		11
sycamore, American				20		20
Tamarix spp.		2				2
tuliptree		13		3		16
unknown tree	1					1
walnut, black				3		3
willow, spp.			1			1
willow, weeping		1		3		4

Common Name	Removal	Young Tree Train	Small Tree Clean	Large Tree Clean	Stump Removal	TOTAL
Grand Total	63	251	47	551	2	914

Sedalia, MO

Frequency Report: Primary Maintenance by Rating

Rating	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Large Tree Clean			
3	111	20.15%	12.17%
4	109	19.78%	11.95%
5	112	20.33%	12.28%
6	125	22.69%	13.71%
7	60	10.89%	6.58%
8	29	5.26%	3.18%
9	3	0.54%	0.33%
10	2	0.36%	0.22%
Summary for Large Tree Clean (8 items)			
Sum	*551*	*100%*	*60.42%*
Removal			
3	3	4.76%	0.33%
4	7	11.11%	0.77%
5	3	4.76%	0.33%
6	6	9.52%	0.66%
7	20	31.75%	2.19%
8	9	14.29%	0.99%
9	12	19.05%	1.32%
10	3	4.76%	0.33%
Summary for Removal (8 items)			
Sum	*63*	*100%*	*6.91%*
Small Tree Clean			
3	27	57.45%	2.96%
4	10	21.28%	1.10%
5	5	10.64%	0.55%
6	3	6.38%	0.33%
7	2	4.26%	0.22%
Summary for Small Tree Clean (5 items)			
Sum	*47*	*100%*	*5.15%*
Young Tree Train			
3	195	77.69%	21.38%
4	37	14.74%	4.06%
5	15	5.98%	1.64%

Rating	Total	Percent of Sub-Category Pop.	Percent of Entire Population
6	4	1.59%	0.44%
Summary for Young Tree Train (4 items)			
Sum	*251*	*100%*	*27.52%*
Grand Total	*912*		

Sedalia, MO

Frequency Report: Area by Rating

Rating	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Centennial Park			
3	18	15.00%	1.97%
4	28	23.33%	3.07%
5	26	21.67%	2.85%
6	30	25.00%	3.29%
7	11	9.17%	1.21%
8	3	2.50%	0.33%
9	4	3.33%	0.44%
Summary for Centennial Park (7 items)			
Sum	*120*	*100%*	*13.16%*
Clover Dell Park			
3	89	90.82%	9.76%
4	4	4.08%	0.44%
5	4	4.08%	0.44%
8	1	1.02%	0.11%
Summary for Clover Dell Park (4 items)			
Sum	*98*	*100%*	*10.75%*
Housel Park			
4	3	33.33%	0.33%
6	2	22.22%	0.22%
7	1	11.11%	0.11%
8	3	33.33%	0.33%
Summary for Housel Park (4 items)			
Sum	*9*	*100%*	*0.99%*
Hubbard Park			
3	69	56.10%	7.57%
4	24	19.51%	2.63%
5	9	7.32%	0.99%
6	9	7.32%	0.99%
7	5	4.07%	0.55%
8	4	3.25%	0.44%
9	2	1.63%	0.22%
10	1	0.81%	0.11%

Rating	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Hubbard Park (8 items)			
Sum	*123*	*100%*	*13.49%*
Katy Park			
3	69	35.38%	7.57%
4	53	27.18%	5.81%
5	28	14.36%	3.07%
6	28	14.36%	3.07%
7	15	7.69%	1.64%
8	2	1.03%	0.22%
Summary for Katy Park (6 items)			
Sum	*195*	*100%*	*21.38%*
Liberty Park			
3	89	26.97%	9.76%
4	46	13.94%	5.04%
5	60	18.18%	6.58%
6	59	17.88%	6.47%
7	43	13.03%	4.71%
8	22	6.67%	2.41%
9	8	2.42%	0.88%
10	3	0.91%	0.33%
Summary for Liberty Park (8 items)			
Sum	*330*	*100%*	*36.18%*
Vermont Park			
3	2	5.41%	0.22%
4	5	13.51%	0.55%
5	8	21.62%	0.88%
6	10	27.03%	1.10%
7	7	18.92%	0.77%
8	3	8.11%	0.33%
9	1	2.70%	0.11%
10	1	2.70%	0.11%
Summary for Vermont Park (8 items)			
Sum	*37*	*100%*	*4.06%*
Grand Total	*912*		

Appendix I
Observations

Sedalia, MO

Quantity Report: Observations

Observations	Total	Percentage of Entire Population
None	395	43.31%
Poor Structure	147	16.12%
Cavity or Decay	96	10.53%
Remove Hardware	77	8.44%
Poor Root System	44	4.82%
Mechanical Damage	44	4.82%
Improperly Installed	42	4.61%
Serious Decline	25	2.74%
Pest Problem	19	2.08%
Poor Location	9	0.99%
Improperly Pruned	7	0.77%
Nutrient Deficiency	4	0.44%
Improperly Mulched	3	0.33%
Grand Total	*912*	*100%*

Sedalia, MO

Frequency Report: Area by Observations

Observations	*Total*	*Percent of Sub-Category Pop.*	*Percent of Entire Population*
Centennial Park			
None	48	40.00%	5.26%
Poor Structure	32	26.67%	3.51%
Poor Root System	15	12.50%	1.64%
Cavity or Decay	14	11.67%	1.54%
Mechanical Damage	5	4.17%	0.55%
Improperly Installed	5	4.17%	0.55%
Serious Decline	1	0.83%	0.11%
Summary for Centennial Park (7 items)			
Sum	*120*	*100%*	*13.16%*
Clover Dell Park			
None	53	54.08%	5.81%
Improperly Installed	15	15.31%	1.64%
Mechanical Damage	8	8.16%	0.88%
Remove Hardware	7	7.14%	0.77%
Poor Structure	5	5.10%	0.55%
Pest Problem	5	5.10%	0.55%
Serious Decline	3	3.06%	0.33%
Poor Location	1	1.02%	0.11%
Nutrient Deficiency	1	1.02%	0.11%
Summary for Clover Dell Park (9 items)			
Sum	*98*	*100%*	*10.75%*
Housel Park			
Poor Structure	5	55.56%	0.55%
Poor Location	1	11.11%	0.11%
Pest Problem	1	11.11%	0.11%
None	1	11.11%	0.11%
Cavity or Decay	1	11.11%	0.11%
Summary for Housel Park (5 items)			
Sum	*9*	*100%*	*0.99%*

Observations	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Hubbard Park			
None	50	40.65%	5.48%
Remove Hardware	28	22.76%	3.07%
Poor Structure	14	11.38%	1.54%
Mechanical Damage	9	7.32%	0.99%
Cavity or Decay	8	6.50%	0.88%
Poor Root System	5	4.07%	0.55%
Serious Decline	3	2.44%	0.33%
Nutrient Deficiency	2	1.63%	0.22%
Improperly Installed	2	1.63%	0.22%
Poor Location	1	0.81%	0.11%
Pest Problem	1	0.81%	0.11%
Summary for Hubbard Park (11 items)			
Sum	*123*	*100%*	*13.49%*
Katy Park			
None	96	49.23%	10.53%
Remove Hardware	34	17.44%	3.73%
Poor Structure	22	11.28%	2.41%
Cavity or Decay	10	5.13%	1.10%
Mechanical Damage	9	4.62%	0.99%
Poor Root System	6	3.08%	0.66%
Improperly Installed	5	2.56%	0.55%
Pest Problem	4	2.05%	0.44%
Serious Decline	3	1.54%	0.33%
Improperly Mulched	3	1.54%	0.33%
Improperly Pruned	2	1.03%	0.22%
Poor Location	1	0.51%	0.11%
Summary for Katy Park (12 items)			
Sum	*195*	*100%*	*21.38%*
Liberty Park			
None	136	41.21%	14.91%
Poor Structure	65	19.70%	7.13%

Observations	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Cavity or Decay	45	13.64%	4.93%
Poor Root System	17	5.15%	1.86%
Serious Decline	15	4.55%	1.64%
Improperly Installed	15	4.55%	1.64%
Mechanical Damage	13	3.94%	1.43%
Remove Hardware	8	2.42%	0.88%
Pest Problem	8	2.42%	0.88%
Improperly Pruned	4	1.21%	0.44%
Poor Location	3	0.91%	0.33%
Nutrient Deficiency	1	0.30%	0.11%
Summary for Liberty Park (12 items)			
Sum	*330*	*100%*	*36.18%*
Vermont Park			
Cavity or Decay	18	48.65%	1.97%
None	11	29.73%	1.21%
Poor Structure	4	10.81%	0.44%
Poor Location	2	5.41%	0.22%
Poor Root System	1	2.70%	0.11%
Improperly Pruned	1	2.70%	0.11%
Summary for Vermont Park (6 items)			
Sum	*37*	*100%*	*4.06%*
Grand Total	*912*		

Appendix J
Clearance Recommendation, Utilities, and Further Inspections

Sedalia, MO

Quantity Report: Clearance

Clearance	*Total*	*Percentage of Entire Population*
None needed	876	95.84%
Pedestrian	12	1.31%
Vehicle	11	1.20%
Building	9	0.98%
Light	5	0.55%
Sign or Signal	1	0.11%
Grand Total	*914*	*100%*

Sedalia, MO

Frequency Report: Area by Clearance

Clearance	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Centennial Park			
None needed	103	85.83%	11.27%
Pedestrian	10	8.33%	1.09%
Building	6	5.00%	0.66%
Vehicle	1	0.83%	0.11%
Summary for Centennial Park (4 items)			
Sum	*120*	*100%*	*13.13%*
Clover Dell Park			
None needed	97	98.98%	10.61%
Sign or Signal	1	1.02%	0.11%
Summary for Clover Dell Park (2 items)			
Sum	*98*	*100%*	*10.72%*
Housel Park			
None needed	8	88.89%	0.88%
Vehicle	1	11.11%	0.11%
Summary for Housel Park (2 items)			
Sum	*9*	*100%*	*0.98%*
Hubbard Park			
None needed	119	96.75%	13.02%
Vehicle	2	1.63%	0.22%
Pedestrian	1	0.81%	0.11%
Building	1	0.81%	0.11%
Summary for Hubbard Park (4 items)			
Sum	*123*	*100%*	*13.46%*
Katy Park			
None needed	191	97.95%	20.90%
Vehicle	3	1.54%	0.33%
Pedestrian	1	0.51%	0.11%
Summary for Katy Park (3 items)			
Sum	*195*	*100%*	*21.33%*

Clearance	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Liberty Park			
None needed	322	96.99%	35.23%
Vehicle	4	1.20%	0.44%
Light	4	1.20%	0.44%
Building	2	0.60%	0.22%
Summary for Liberty Park (4 items)			
Sum	*332*	*100%*	*36.32%*
Vermont Park			
None needed	36	97.30%	3.94%
Light	1	2.70%	0.11%
Summary for Vermont Park (2 items)			
Sum	*37*	*100%*	*4.05%*
Grand Total	*914*		

Sedalia, MO

Quantity Report: Utilities

Utilities	*Total*	*Percentage of Entire Population*
No	848	92.78%
Yes	66	7.22%
Grand Total	*914*	*100%*

Sedalia, MO

Frequency Report: Area by Utilities

Utilities	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Centennial Park			
No	115	95.83%	12.58%
Yes	5	4.17%	0.55%
Summary for Centennial Park (2 items)			
Sum	*120*	*100%*	*13.13%*
Clover Dell Park			
No	98	100.00%	10.72%
Summary for Clover Dell Park (1 item)			
Sum	*98*	*100%*	*10.72%*
Housel Park			
No	7	77.78%	0.77%
Yes	2	22.22%	0.22%
Summary for Housel Park (2 items)			
Sum	*9*	*100%*	*0.98%*
Hubbard Park			
No	115	93.50%	12.58%
Yes	8	6.50%	0.88%
Summary for Hubbard Park (2 items)			
Sum	*123*	*100%*	*13.46%*
Katy Park			
No	179	91.79%	19.58%
Yes	16	8.21%	1.75%
Summary for Katy Park (2 items)			
Sum	*195*	*100%*	*21.33%*
Liberty Park			
No	304	91.57%	33.26%
Yes	28	8.43%	3.06%
Summary for Liberty Park (2 items)			
Sum	*332*	*100%*	*36.32%*
Vermont Park			
No	30	81.08%	3.28%
Yes	7	18.92%	0.77%

Utilities	Total	Percent of Sub-Category Pop.	Percent of Entire Population
Summary for Vermont Park (2 items)			
Sum	*37*	*100%*	*4.05%*
Grand Total	*914*		

Sedalia, MO

Quantity Report: Further Inspection

Further Inspection	*Total*	*Percentage of Entire Population*
No	897	98.14%
Yes	17	1.86%
Grand Total	*914*	*100%*

Sedalia, MO

Frequency Report: Area by Further Inspection

Further Inspection	*Total*	*Percent of Sub-Category Pop.*	*Percent of Entire Population*
Centennial Park			
No	116	96.67%	12.69%
Yes	4	3.33%	0.44%
Summary for Centennial Park (2 items)			
Sum	*120*	*100%*	*13.13%*
Clover Dell Park			
No	98	100.00%	10.72%
Summary for Clover Dell Park (1 item)			
Sum	*98*	*100%*	*10.72%*
Housel Park			
No	9	100.00%	0.98%
Summary for Housel Park (1 item)			
Sum	*9*	*100%*	*0.98%*
Hubbard Park			
No	123	100.00%	13.46%
Summary for Hubbard Park (1 item)			
Sum	*123*	*100%*	*13.46%*
Katy Park			
No	194	99.49%	21.23%
Yes	1	0.51%	0.11%
Summary for Katy Park (2 items)			
Sum	*195*	*100%*	*21.33%*
Liberty Park			
No	320	96.39%	35.01%
Yes	12	3.61%	1.31%
Summary for Liberty Park (2 items)			
Sum	*332*	*100%*	*36.32%*
Vermont Park			
No	37	100.00%	4.05%
Summary for Vermont Park (1 item)			
Sum	*37*	*100%*	*4.05%*
Grand Total	*914*		

Appendix K
Sample 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 tense and words in the present tense shall include the future tense.
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 in so far 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, 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 obtain 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 a 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

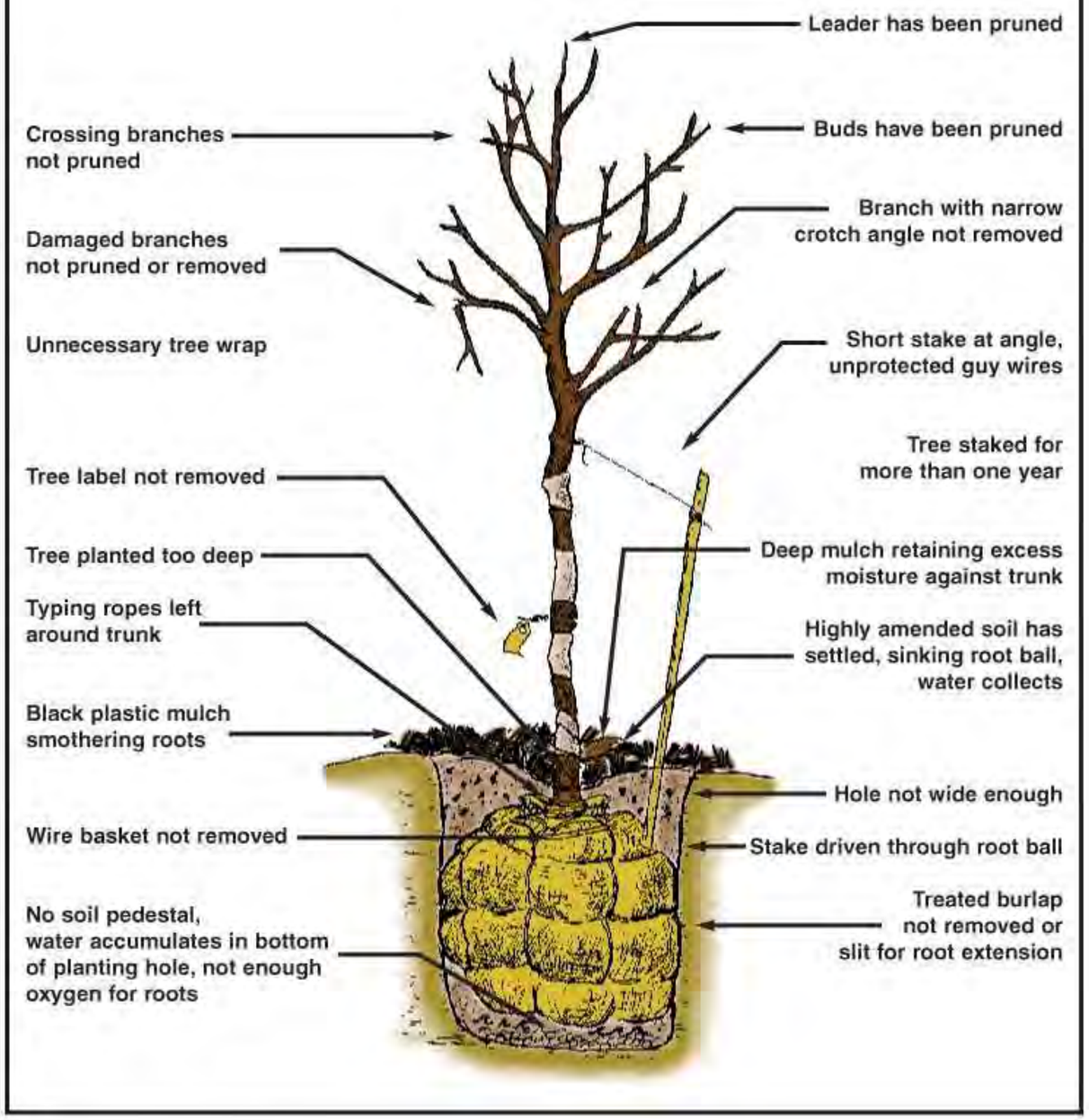
Any Ordinance of part thereof heretofore adopted which in any manner conflicts with any provisions of this Ordinance is hereby repealed to the extent of such conflict.

Appendix L
Planting Guidelines

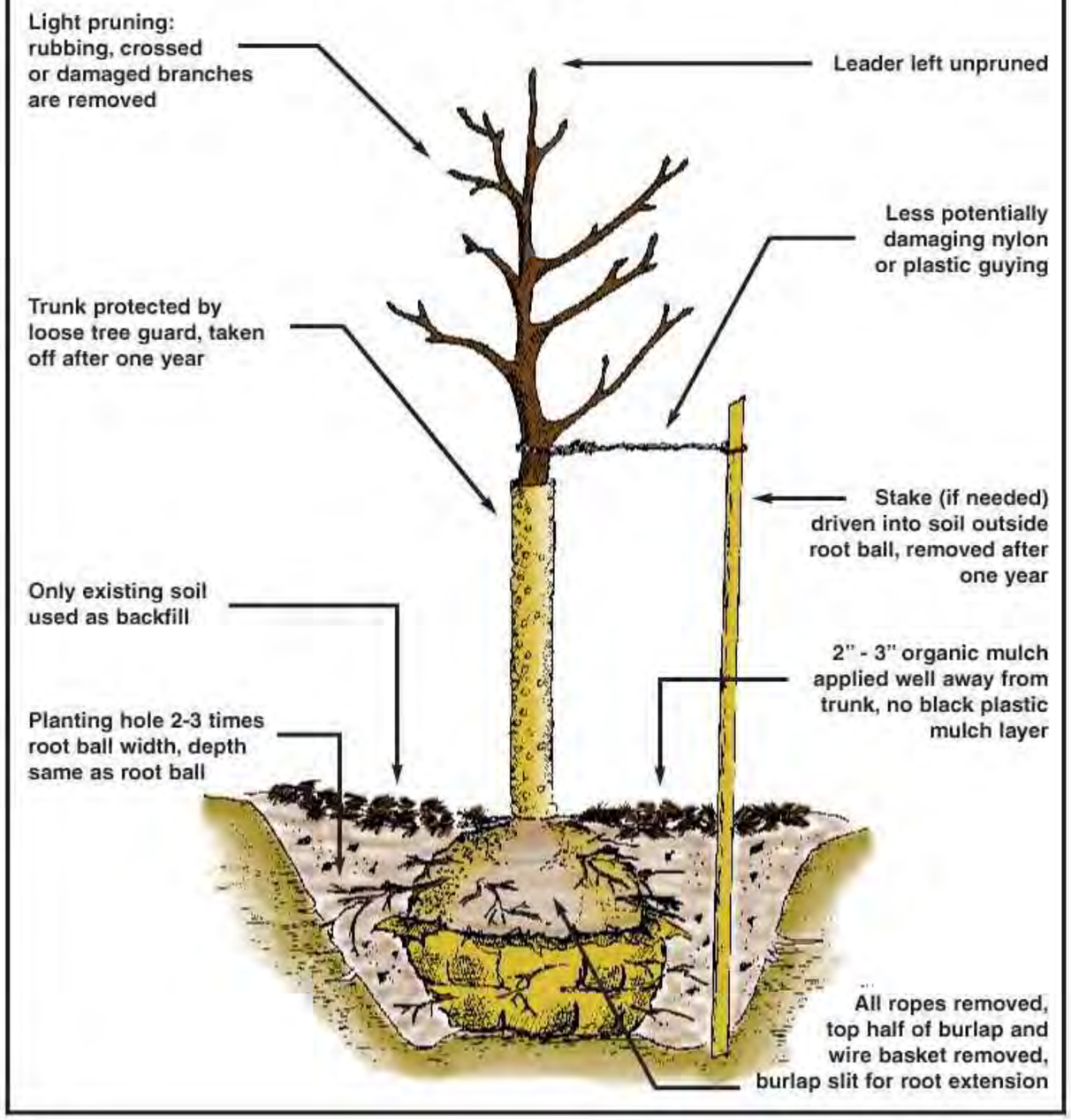
Tree Planting

To ensure healthy trees, start with Right Tree/Right Location.
Once you select a tree suited for your site and its microclimate, be sure to plant the tree correctly!

Incorrect



Correct



Poster Design by:
Dr. Bonnie Appleton
Virginia Tech University
Illustrations/Layout: S.K. Kane

Funds provided by the Urban and Community Forestry Assistance Grants Program of the U.S. Forest Service in cooperation with the Virginia Department of Forestry. © 1995

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 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- to 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.

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

MULCH INSTALLATION AND RENOVATION

Mulch, as a protective and ornamental feature among herbaceous and woody plants, has gained wide popularity in contemporary landscapes.

BENEFITS: Mulches promote root growth and plant survival in a number of ways.

- Mulch materials allow for the exchange of gases between the atmosphere and soil (oxygen into soil, carbon dioxide out).
- Mulches help provide for better water penetration into soil.
- Mulches reduce evaporation of soil water, conserving soil moisture for optimal root development.

The insulating effect of mulch is an important feature because it moderates extremes of soil temperature. Mulched soil does not get as cold in the winter or as hot in the summer as unmulched soil. This is important because the root systems of most plants are not effective in taking up water and elements at unusually low or high temperatures. Also, mulches cause soil temperatures to lag behind air temperatures. Thus, soil cools slowly in fall (allowing a longer period of high root activity) and warms slowly in spring.

Mulches are also useful in suppressing weeds that compete with desirable plants for moisture and nutrients. However, they will not totally eliminate weeds. Maximum weed control can be achieved with the use of pre-emergent herbicides and/or landscape fabric (not sheet plastic) before applying mulch.

Mulch makes a layer of well-aerated soil near the surface available for long periods of almost continuous root activity. This layer is normally unavailable because of reoccurring periods of extreme dryness and fluctuating temperatures.

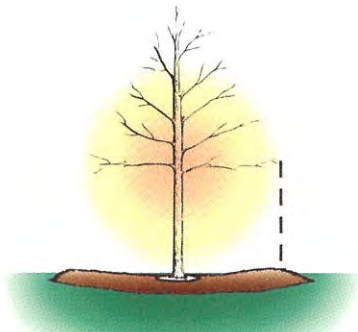
EVALUATION & PROCEDURE: Two common mistakes in mulch distribution are applying material too thickly or deeply and mounding up mulch on plant stems. Effects of too much mulch in planting areas include excessive moisture, reduced oxygen and fungal growth. Decay fungi are also promoted when mulch is piled on stems. Just outside of the stem, mulch dressing should be no more than ½ inch deep.

Most mulches need only be applied and maintained at 2- to 4-inch depths at the plants' dripline, ranging from 2 inches on heavy clay

This shrub has outgrown its original mulch bed, and the mulch is piled up around the stem. Mulch should be no more than ½ inch deep just outside the stem.

Clear excess mulch from the stem area.

This shows the drip line.



Extend mulch to the drip line.

(over)

soils to 4 inches on sandy soils. One to 2 inches of mulch in maintained beds can be added every two to three years as original mulch decomposes.

As woody plants develop over subsequent growing seasons, mulch under the crowns can be annually raked out to the expanding drip lines. Use of this mulch management technique achieves several objectives. Mulch is brought out from under plants, stirred, fluffed, exposed to air and light, and arranged to continue to provide soil protection. At this time, the mulch can be evaluated for any redressing needs or removal. Waterlogged or compressed mulch material can be stirred, turned over, or broken up, if necessary, to improve aeration and water diffusion capability.

Printed in the U.S.A. T15089-09/03

TECHNICAL BULLETIN

DAVEY

Prepared by The Davey Institute

POST-PLANTING CARE OF WOODY PLANTS

SYMPTOMS: Transplanted trees and shrubs frequently undergo a prolonged period (2 to 5 years) of slow growth and reduced vigor due to transplant shock.

CAUSE: Problems with transplant shock following successful tree or shrub planting are usually due to improper post-planting care.

SOLUTIONS: Proper site selection and good planting techniques help induce root growth into surrounding soil so that the original balance between roots and above-ground shoots is restored as quickly as possible, minimizing the severity and duration of transplant shock.

If the plant has been suitably matched to the environment in which it is placed and has been correctly planted, post-planting care to minimize transplant shock should include proper watering, mulching, staking, pruning and fertilizing.

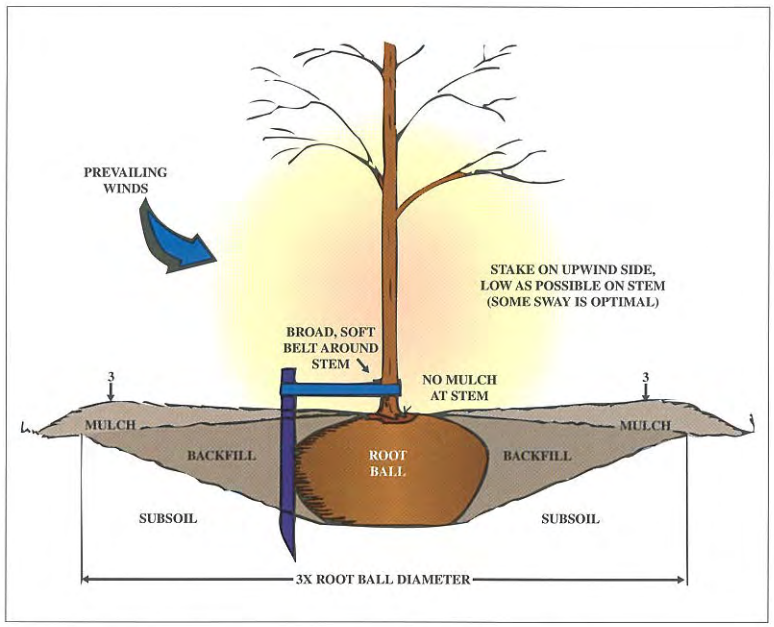


Figure 1. Some elements of good planting and post-planting care are illustrated.

Proper irrigation (**watering**) is crucial to balance water and oxygen supply to new roots. The most common problem with young trees and shrubs is either too little or too much water in the soil. Most woody plants do best with deep, but infrequent, watering. Soils should ideally contain 25% water and 25% air space.

Newly transplanted trees should be **mulched**. Good mulch beds replicate organic forest-litter "sponges" that buffer water, air and temperature extremes in nature. The ideal mulch pattern tapers from a two- to four-inch depth of well-composted organic matter at the dripline of trees and shrubs to bare soil at the trunk. Sandy soils need deeper mulch layers over the new root zone than clay soils.

Trees that are **staked** when installed in spring for protection from prevailing winds generally can have staking and banding material removed in fall; fall-planted trees can be freed late the following spring. Tree wrap should generally be removed at planting time; however, some fall-planted trees with thin, smooth bark may overwinter with wrap, as long as it is removed before leaf growth in the spring.

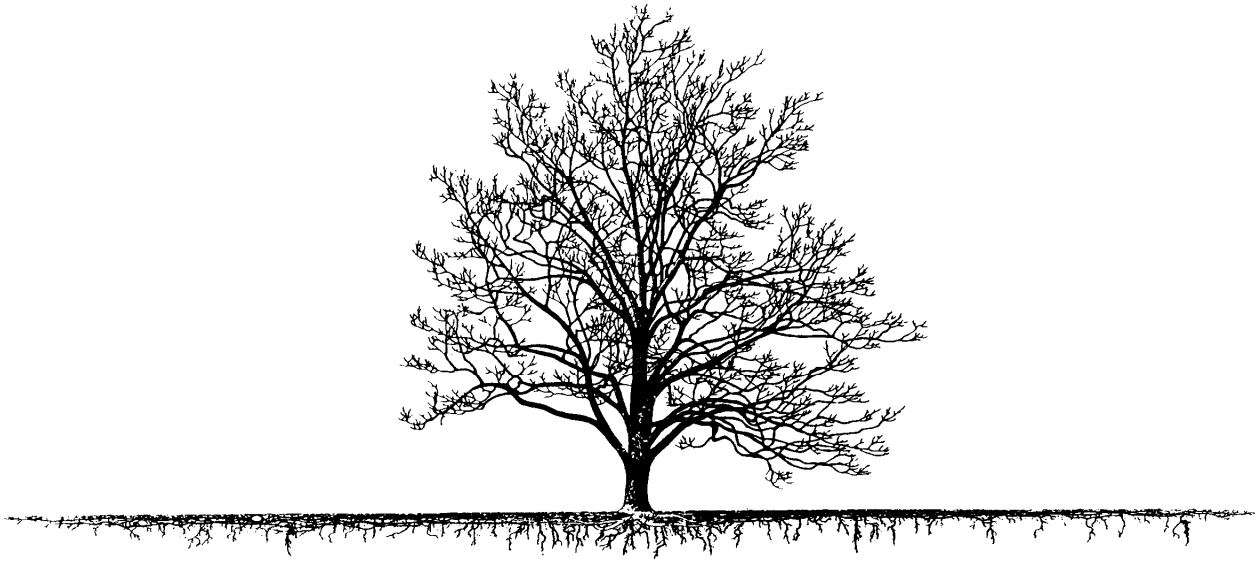
All injured, malformed, crossing and poorly attached branches should be **pruned** at the time of planting. Pruning to branch growth can be initiated after one full growing season has passed, but winter-killed and dead wood should be removed promptly. Avoid the practice of "balancing" above-ground shoot growth with the root system upon installation. Root systems require as many branch tips left intact to trigger other growth.

If the transplant was not fertilized at planting time, **fertilize** with a low-burn/low-salt-index material that will provide slow-release nitrogen. The nitrogen benefits shoot and root growth within the first growing season following application. Davey's Arbor Green® fertilizer is a superior source of controlled-release nutrients.

Printed in the U.S.A. T15091-4/2001

Appendix M
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 adhere 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 *corrective* nature to be beneficial to woody plant health.

Health

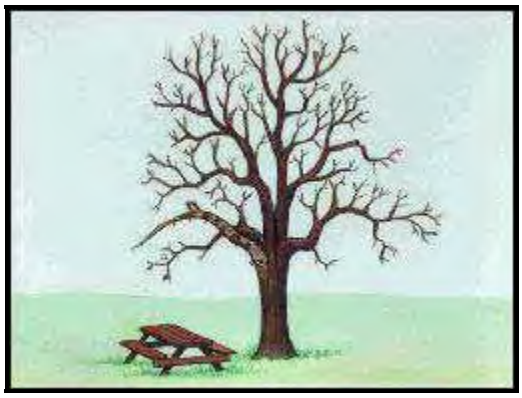
- *Sanitation* by removing dead, broken, decayed, diseased, or insect-infested wood (crown cleaning).
- *Thinning* to improve penetration of light and air, and to reduce wind resistance and potential storm damage.
- Reduction of the number of poorly attached *epicormic branches.*
- *Girdling root* removal.
- 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).

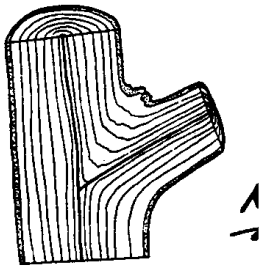
Convenience or Safety of Property and People

- 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



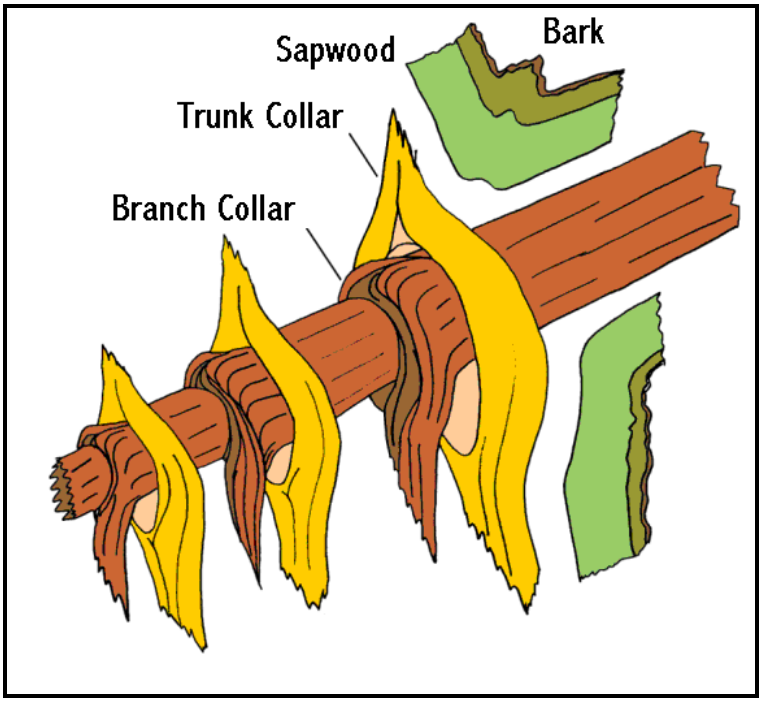
New branch tissues generated by the vascular cambium usually start growth before trunk tissues. As current-year branch tissue develops from branch ends toward the trunk, it turns abruptly downward at the branch base to form a *collar*.

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.

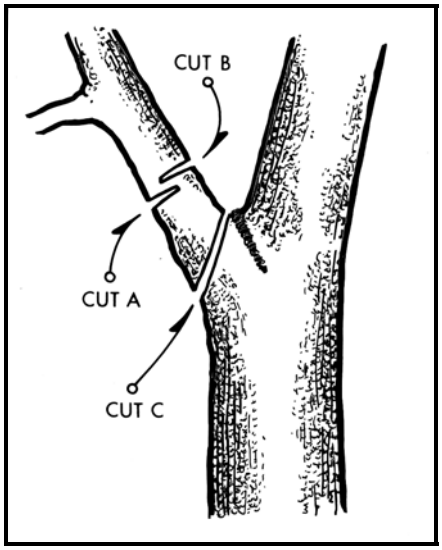
Do not cut into the collar to stimulate callus production and rapid closure. Although closure is desirable for appearance, such a cut promotes decay and future hazards. Never put a pruning tool behind the branch bark ridge.

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.

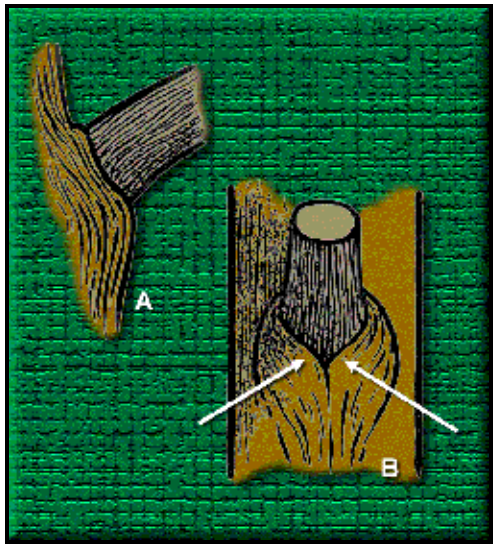
Callus and Woundwood

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.

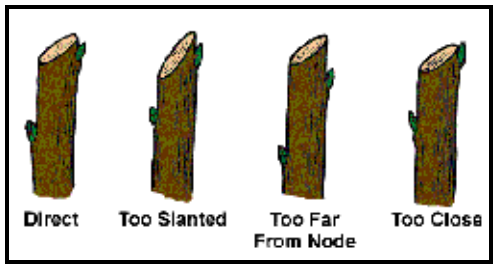
A *complete* ring of callus and subsequent woundwood will develop around and eventually over proper cuts. Woundwood forms only to the sides of improper cuts (flush cuts), which means the collar and branch protection zone is damaged and the trunk is wounded.

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.

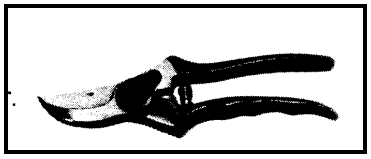
Pruning Tools

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

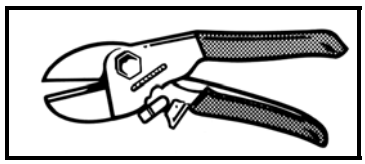
Pruning Shears

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.



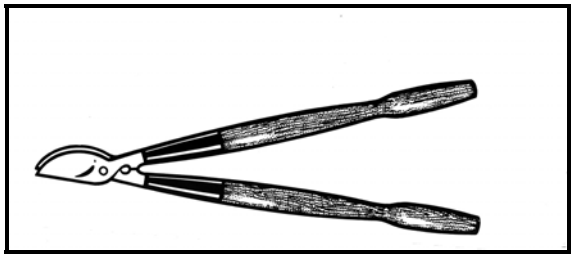
- Anvil (straight-blade): good for only soft-tissued wood; will crush harder wood (inappropriate per A300 standards).



Lopping shears

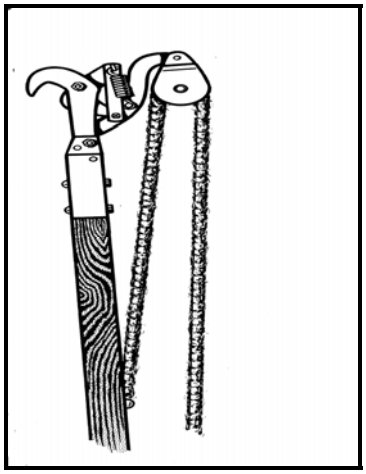
Two-hand shears:

- 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.



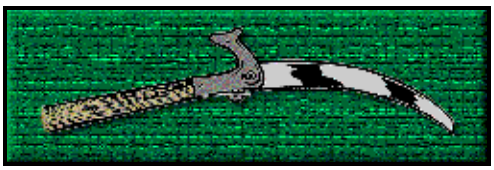
Cut at the outer side of the branch bark ridge at a slightly outward angle so as not to injure or remove the branch collar. Hook the pruner head around the limb to be cut with the blade side against the lateral branch or stem to remain. The arborist must be in a safe working position and the pruner handle 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.

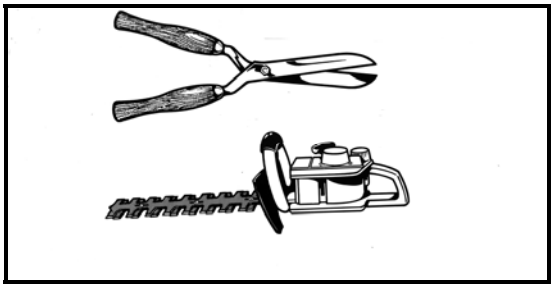
Arborist saws cut on the *pull* stroke:

- 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.

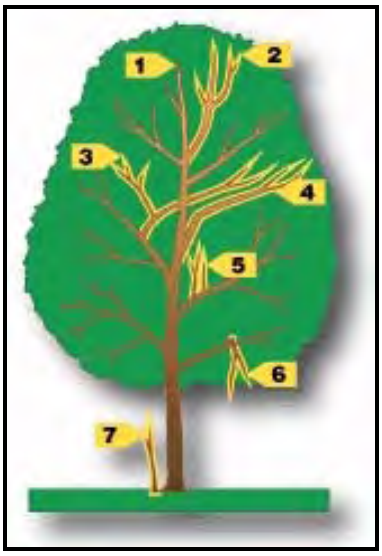
Thinning of lower branches can ‘raise’ a limb. If, after crown raising, the remaining leaf material is insufficient for limb size, consider complete removal. The client's opinion is important.

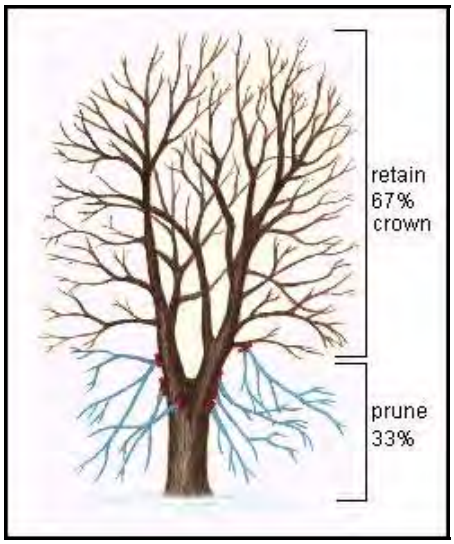
Never perform excessive thinning, which is stressful, especially on thin-barked or young trees prone to sunscald.

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.

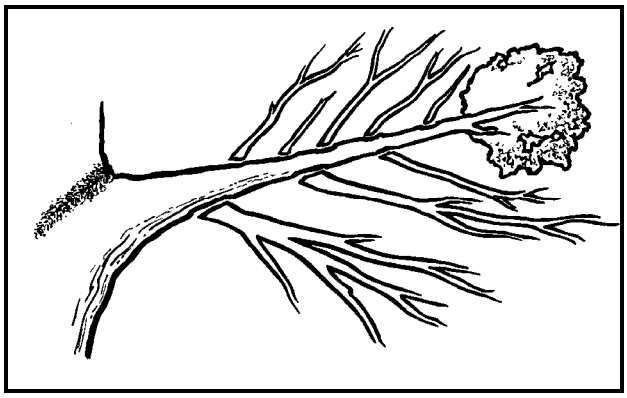
When thinning laterals from a limb, maintain well-spaced inner branches to achieve more distribution of foliage along the branch.





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.

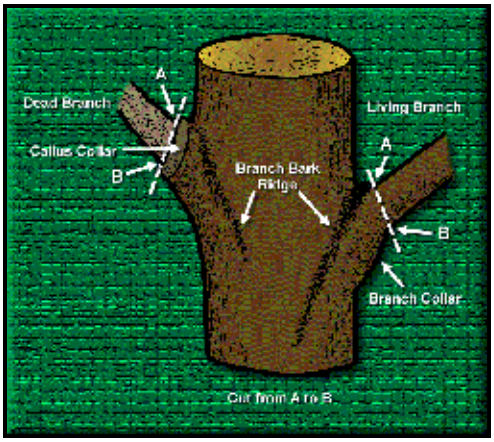
The life of large limbs, weakened by decay or cracks, can often be extended by "shortening" or weight removal using highly selective thinning cuts. Cabling and/or rigid bracing may be required to secure limbs or codominant stems if removal is not possible.

Deadwood Removal

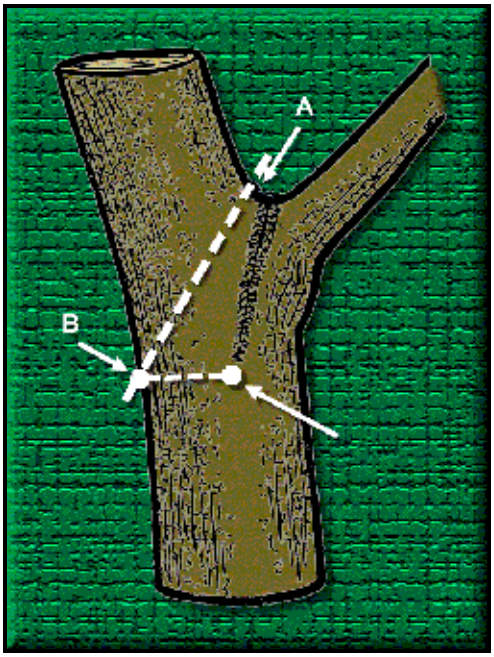
Sanitation and hazard reduction pruning:

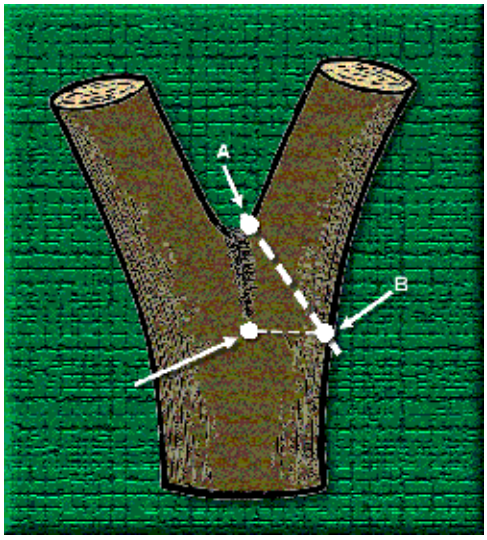
- Dead branches and stubs are an energy source (cellulose, glucose).
- Decay fungi.
- Boring insects.

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.

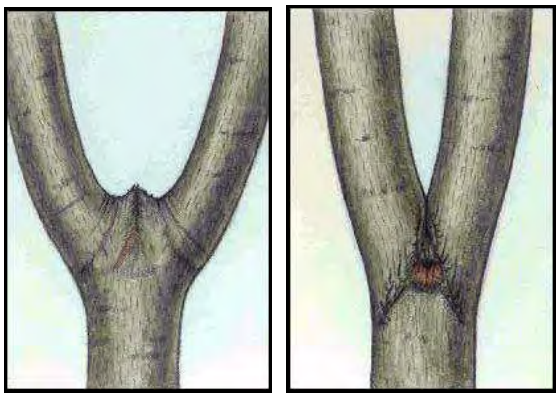
Never remove both stems!

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.

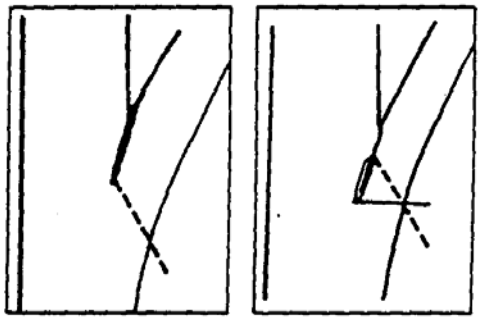
The stems have *included bark* squeezed or embedded *between* them.



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* stems 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 or 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":

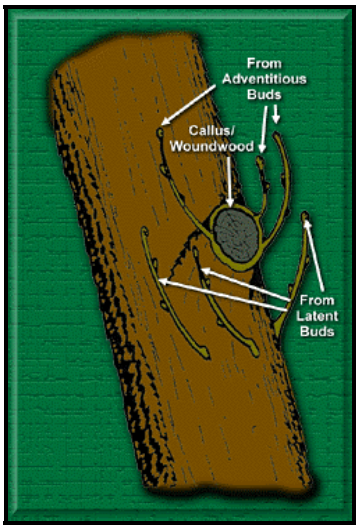
- Adventitious buds.
- Latent (dormant) buds or meristematic points.

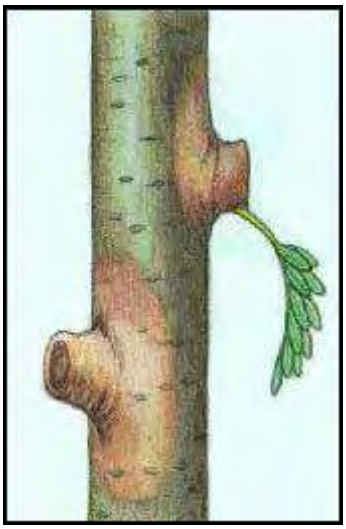
Adventitious epicormics come from meristematic tissue generated anew by the cambium. Most adventitious buds develop from callus tissues moving over a wound, or from root tissue.

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 <u>above</u> 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.
- Budbreak 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.

Excurrent

Decurrent

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

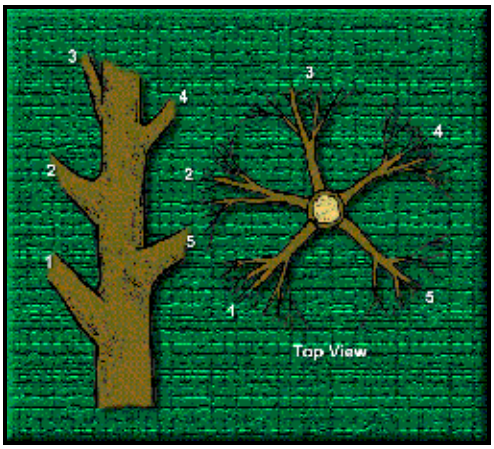
Trees that will be large at maturity should have a sturdy, tapered trunk, with well-spaced branches smaller in diameter than the trunk.

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.

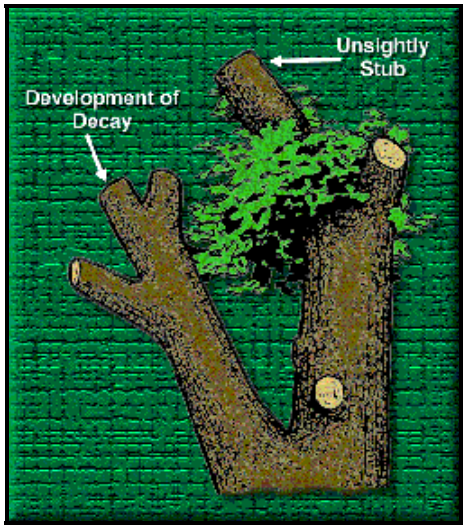
The height of the lowest scaffold branch will depend on the intended function of the tree: screen an unsightly view, provide a windbreak, shade a patio, installed as a walkway or street tree.

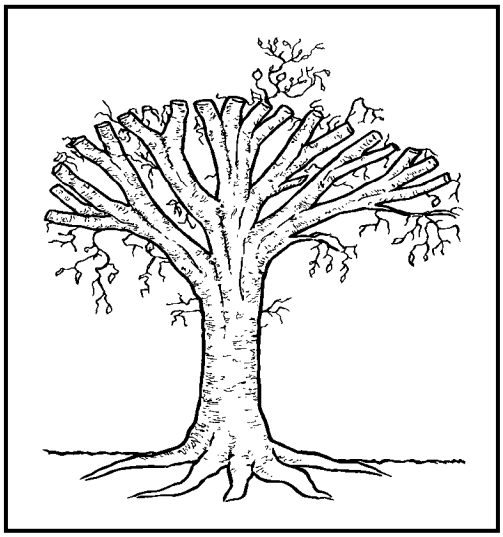
Pruning at Planting

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 bare-root trees). This practice has since been discovered to prolong *transplant shock.*

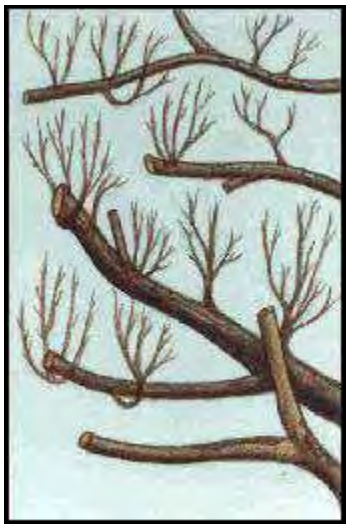
- Transplant pruning should be limited to removal of dead, broken, diseased, or interfering branches.
- Leave small shoots along the trunk for later removal.
- Protect the trunk from ‘sunburn’.
- Aid in development of proper trunk taper.
- Leave as many terminal buds as possible.
- Stimulate root growth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

Topping, Tipping, and Roundover

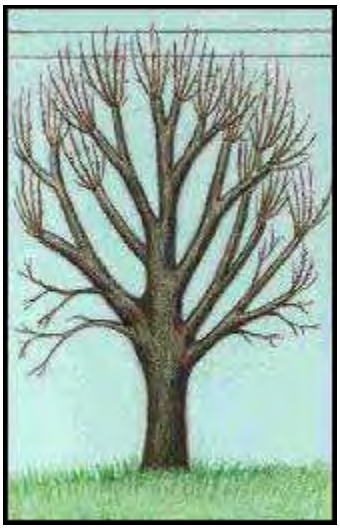




Topping: cutting vertical branches and stems back to inadequate nodes (heading) or to internodes (stubbing).



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.

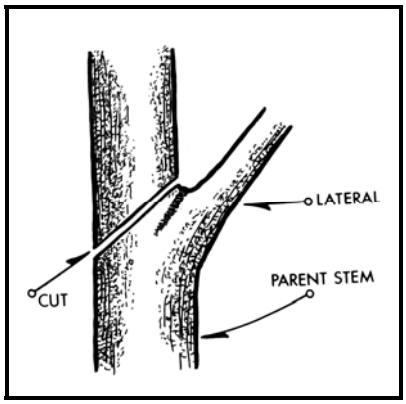
The International Society of Arboriculture (ISA) and the National Arborist Association (NAA) consider heading-back to stubs an unacceptable arboricultural practice. Modern pruning standards do not include heading-back as any sort of a recommended technique.

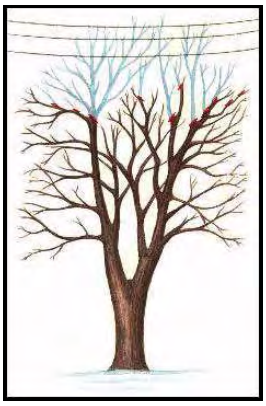
- Topping removes a major portion of a tree's leaves that are necessary for the production of carbohydrates.
- Stimulation of epicormic branches at or just below an internodal stub cut causes a topped tree to grow back to its original height faster and denser than a properly pruned tree. The sprouts 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.

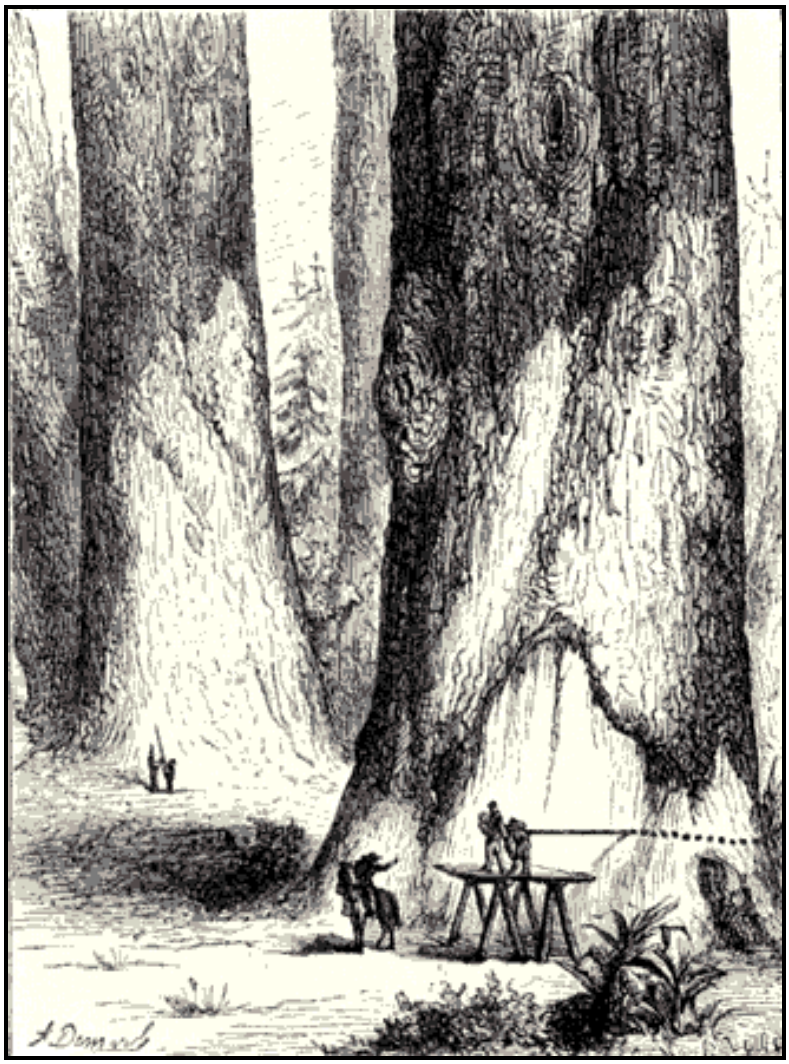
Utility Space – The physical area occupied by the utility's facilities and the additional space required, ensuring its operation.

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 N
Tree Preservation Ordinance

SAMPLE TREE PRESERVATION ORDINANCE

1.0 Intent
1.1 Purpose
2.0 Definitions
3.0 Tree Destruction Permit
3.1 Exceptions
4.0 Enforcement Authority
5.0 City Tree Board
6.0 Application for Tree Destruction Permits
7.0 Approval of the Tree Destruction Permit
8.0 Appeal Procedure
9.0 Tree Restoration and Mitigation Standards
10.0 Timelines
11.0 Tree Protection During Development
12.0 Bonding Procedure and Re-Inspection Process
13.0 Penalties
14.0 Severability
15.0 Effective date

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 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 ensure the stabilization of soil by the prevention of erosion and sedimentation; to reduce stormwater 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 14 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 14 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 2 inches by 4 inches or larger, or equivalent, shall be implanted deep enough in the ground to be stable, with at least 3 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 6 inches for each 1 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 14 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 $500 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 O
Sample Specifications for 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 timeframe. 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.