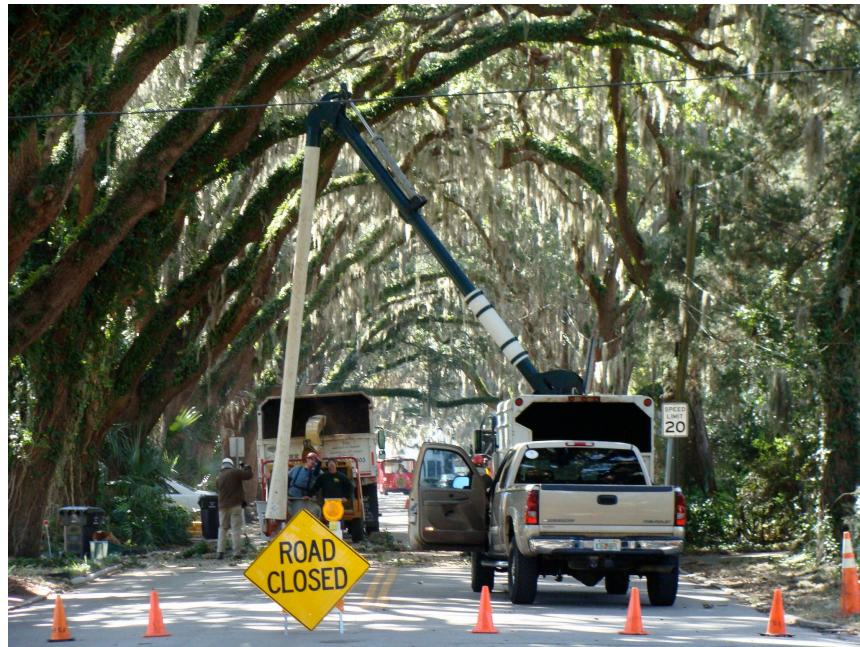


# City of St. Augustine



## Tree Inventory and Risk Assessment Report

by  
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## **Introduction**

### **Background**

In 2011 the City of St. Augustine applied to the Florida Forest Service for an Urban and Community Forest Grant to perform a Tree Risk Assessment and Inventory. This report is the result of the awarded grant.

### **Assignment**

In February 2012, Advanced Tree Care was given the assignment of performing a Tree Survey and Risk Assessment for the City of St. Augustine, Florida on approximately 500 trees in various parks, right-of-ways and other public areas specified in the Tree Inventory Application submitted for the Urban and Community Forestry Grant Program. The survey included Fullerwood Park, Oglethorpe Park, Lighthouse Park, The Lightner Museum, Project Swing Park, Magnolia Avenue and various other parks and city street right-of-ways. The Project was begun in March 2012 and completed July 2012. The tree evaluations as well as this report were completed with the valued assistance of Danny Lippi, who is an ISA Certified Arborist (FL6145A) and experienced in doing detailed risk assessments on more than 4,000 trees during the past year.

Our assignment was to:

1. Assess the current condition of the trees on the city right-of-ways, assigned parks and public use areas.
2. Make recommendations to reduce risk
3. Make recommendations to maintain healthy trees and improve health and structural problems

### **Limits of the Assignment**

We visually inspected each tree for the inventory and assessment. We did not survey any palm trees or broadleaf or conifer trees under 6 inches in diameter.

Arborists cannot detect every condition that could possibly lead to the structural failure of a tree. Trees are living organisms that fail in ways we do not fully understand. Conditions are often hidden within trees, below ground or not clearly visible from the vantage point on the ground. Arborists cannot guarantee that a tree will be healthy, safe or adequately protected under all circumstances or for a specified period of time. Likewise, remedial, protective and mitigating treatments and recommendations cannot be guaranteed.

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## Purpose and Use of the Report

This report is prepared for the City of St. Augustine and is public record. The main purpose of the tree inventory is risk assessment. A tree inventory identifies apparent tree problems and provides the starting point for a long-term management plan, which allows for effective use of tree funds, and allows for more accurate budget projections. This tree inventory and assessment provides information on the species, size and condition of the street trees in the City of St. Augustine. An additional benefit is the City is on record as having risk assessment procedures in place and an on-going risk assessment program.

## Assumptions

The tree survey was done between March 1 and June 30, 2012. Our observations and conclusions are as of that period. A severe storm or other environmental factors can change the observations and maintenance recommendations.

## Testing and Analysis

The Risk Assessment was done in accordance with ***ANSI A300 Standards on Tree Risk Assessment*** and the companion publication ***Best Management Practices, Tree Risk Assessment***.<sup>1,2</sup> Tree health recommendations follow procedures and techniques of two of the country's leading arboricultural researchers: Dr. Ed Gilman, professor of environmental horticulture at the University of Florida and Dr. Kim Coder, professor at the University of Georgia.

On each tree evaluated we performed a **Level 2 Basic Assessment**, which is a detailed visual inspection of a tree and its surrounding site. The **Level 2 Assessment** includes a 360-degree visual inspection from ground level on each tree and sound testing of the lower trunk and root flares with a rubber mallet to listen for tonal variations that may indicate dead bark or internal hollows. When there is sufficient evidence gathered under a Level 2 Assessment for additional evaluation of a tree found to have significant structural defects such as visible cavities, decay or indications of possible decay from a sounding test, we recommend a **Level 3 Advanced Assessment** with a Resistograph to determine the extent of internal decay and strength loss. A Resistograph is a drilling device that measures and graphs decay as the narrow  $\frac{1}{8}$ -inch drill bit passes through the different layers of solid and decayed wood. Level 3 Advanced Assessment is

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not part of the scope of this assignment and can be arranged in a separate contract.

We identified the species of each tree, measured the diameter and added a uniquely numbered black nylon tag secured to the tree with a 3-inch stainless steel nail. Each nail was driven only partially into the tree to allow room for tree growth in diameter, which pushes the tag outward along the nail toward the nail head as the tree grows in girth. Generally, we attach the tags to trees at a height of about 7 to 8 feet out of reach of the curious and facing away from the street or on the least conspicuous side of the tree whenever possible.

### **Data Collection**

Both empirical data as well as subjective data was gathered on each tree. Data was collected on HanDBase, a data collection database application used on our handheld smartphones.

#### **Empirical data included:**

1. tree tag number
2. tree species
3. tree diameter (DBH)
4. location

#### **The subjective data included:**

1. health condition (excellent, good, fair, poor, dead)
2. structural condition (excellent, good, fair, poor)
3. structural problems such as codominant leaders, dead branches, decay/ cavities, health problems such as decay fungi, sparse foliage, declining
4. maintenance recommendations such as pruning, dead branch removal and other work
5. risk assessment rating (see below)

### **Risk Assessment Rating System**

The risk rating score used to be an appropriate measure of relative tree health and structural condition on the diverse tree populations found along the city's right-of-way. We rated each tree evaluated according to a risk assessment rating system developed by consulting arborists Dr. James Clark and Dr. Nelda Matheny. The Clark-Matheny rating system applies a score for three tree characteristics (items 1 through 3 below). We added the forth category.

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1. **Probability of failure** of the tree or part of the tree (1=low probability, 2=moderate probability, 3=moderate to high probability, 4=high probability)
2. **Size of the tree part** that may fail (1-smaller branch, 2=large branch, 3=entire tree)
3. **Target** (person or property) that could be injured or damaged if the tree failed (low target value, 2=moderately occupied or valued target, 3=moderate to high target value, 4=high target value such as busy street, occupied home, playground)
4. **Tree species** (1=strong, decay resistant species, 2=moderate decay and wind resistance, 3=weaker, decay prone species)

Based upon our experience and in consideration of research at the University of Florida for wind resistance, wood strength and decay resistance, we have added a forth category -- tree species (item 4 above). Different tree species vary in their strength, wind resistance, tolerance of construction damage (fill soil, cutting roots, soil compaction), life span and susceptibility to decay or other pests. In our opinion, tree species will affect how trees respond to urban landscape stresses and should be considered as part of the tree risk assessment. Tree species were rated on a 3-point scale with a "1" rating given to a long-lived, strong tree such as a live oak . A "2" rating was given to trees with moderate lifespans and strength such as a sweetgum (*Liquidambar styraciflua*). A rating of "3" rating was given to trees with relatively short life spans and generally poor strength such as laurel oaks (*Quercus laurifolia*).

Trees were rated in each category and the sum of the four categories represents the Hazard Score. The higher score means a higher risk for that category. The highest risk tree could attain a hazard rating of 14. The lowest risk tree could have a hazard rating of 4. Trees receiving a score in the mid-range, 8 to 10 may or may not require maintenance depending on budget considerations and available resources. Trees with a rating between 10 to 14 should be mitigated, in our opinion.

According to Clark and Matheny.<sup>3</sup> "Thus hazard ratings cannot strictly define a numerical line for action between either removal and retention or treatment and no treatment. This must be an administrative decision, one made by owner and manager. In municipal situations, where an agency might manage a very large number of trees, there may be practical limits to the amount of work that can be undertaken and only the most severe and significant hazards may be addressed. Some level of risk will always be present when people live among trees. The decision of how much risk is tolerable remains with the owner and manager."

## Pruning Categories

Trees that were marked for some form of maintenance received one of the following descriptive classifications. All work should follow ANSI A300 Pruning Standards:

- **Priority 1 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, decay and/or pose an elevated level of risk for failure. Any hazards that could be seen as potential dangers to persons or property and seen as potential liabilities to the client would be in this category. Large dead and dying trees that are high liability risks are included in this category. These trees are the first ones that should be removed.
- **Priority 2 Removal** Trees that should be removed but do not pose a liability as great as the first priority will be identified here. This category would need attention as soon as "Priority 1" trees are removed and Priority 1 Prune is done.
- **Priority 3 Removal** Trees that should be removed, but pose minimal liability to persons or property, will be identified in this category.
- **Priority 1 Prune** Trees that require priority one pruning are recommended for trimming to remove hazardous deadwood, hangers, or broken branches. These trees have broken or hanging limbs, hazardous deadwood, and dead, dying, or diseased limbs or leaders greater than four inches in diameter.
- **Priority 2 Prune** These trees have dead, dying, diseased, or weakened branches between two and four inches in diameter and are potential safety hazards.
- **Large Tree Routine Prune** These trees require routine horticultural pruning to correct structural problems, remove dead branches or vines, or correct growth patterns which would eventually obstruct traffic or interfere with utility wires or buildings. End weight reduction pruning is considered part of "Routine" pruning. Trees in this category are large enough to require bucket truck access or manual climbing.
- **Small Tree Routine Prune** These trees require routine horticultural pruning to correct structural problems, remove dead branches or vines, or correct growth patterns which would eventually obstruct traffic or interfere with utility wires or buildings. Trees in this category are small enough to use a ladder or pole saw.
- **Training Prune** These are generally smaller trees that can benefit from early structural pruning that will improve the structure by reducing or eliminating codominant leaders, unbalanced crowns and other structural problems.

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## Observations

### Tree Species Distribution

There were 506 trees evaluated in this inventory/risk assessment. In all 20 species of trees were found in the areas surveyed. Figure 1 illustrates the distribution of the major different tree species. Live oaks (*Quercus virginiana*) were by far the predominant species followed by Southern red cedars (*Juniperus silicicola*) and laurel oaks (*Quercus laurifolia*).

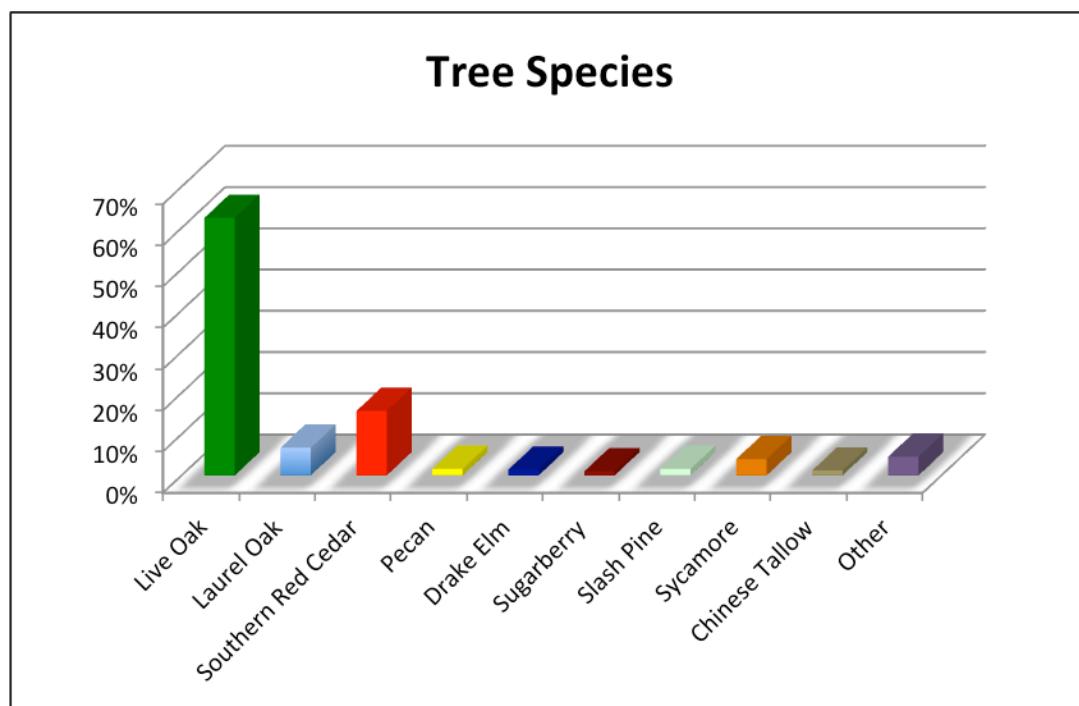


Figure 1

### General Tree Species Characteristics

**Live Oaks** Because the Southern live oak is such a predominant street tree, it is worth noting some of its attributes. The Southern live oak is a native tree, which is considered to be one of the premier tree species in the United States. According to Dr. Ed Gilman, Environmental Horticulture Professor at the University of Florida and one of the country's leading arboriculture researchers, "A large, sprawling, picturesque tree, usually graced with Spanish moss and

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strongly reminiscent of the Old South, live oak is one of the broadest-spreading of the oaks, providing large areas of deep, inviting shade. An amazingly durable American native, it can measure its lifetime in centuries if properly located and cared for in the landscape.”<sup>4</sup> He goes on to say live oaks have a reputation for being a tough tree and have very good wind resistance.

Pamela Crawford, a landscape architect who studied storm damage in the fall of 2004 following the hurricanes, wrote in her book ***Stormscaping: Landscaping to Minimize Wind Damage in Florida***, “Live oak is a large tree that has consistently been categorized as the most wind-tolerant shade tree for the entire state of Florida.”<sup>5</sup>

**Laurel Oaks** Another commonly found street tree and park tree is the laurel oak (*Quercus laurifolia*). Gilman describes the tree, “Laurel Oaks have a life span of 50 to 70 years. Tree trunks and large branches often hollow from decay and wood rot. The smallest trunk injury or improper pruning cut can result in columns of decay inside the trunk which are 10, 20 or more feet long.” Gilman goes on to say, “It (the laurel oak) grows well as a street tree and will serve the community well, but hollows with age as it approaches 50 years old.”<sup>6</sup>

Dr. Mary Duryea, Associate Dean for Research and Forestry Professor at the Institute of Food and Agricultural Sciences of the University of Florida, has been studying hurricane damage on the trees for the past 20 years. Dr. Duryea has made lists of the trees she has found to have the lowest wind resistance and the highest wind resistance. The live oak is on her list of the trees with the highest wind resistance. The laurel oak (*Quercus laurifolia*) on the contrary is listed as having medium-low to low wind resistance. The wind-resistance list has subsequently been incorporated in several University of Florida Extension Service Publications.<sup>7, 8</sup>

Pamela Crawford, a landscape architect who studied storm damage in the fall of 2004 following the multiple hurricanes, wrote in her book ***Stormscaping: Landscaping to Minimize Wind Damage in Florida***, “Live oak is a large tree that has consistently been categorized as the most wind-tolerant shade tree for the entire state of Florida. Regarding the laurel oak, Crawford said, “We had more reports of laurel oaks down than any other tree in central and north Florida. If you have one of these within falling distance of your house, remove it, especially if it is an older tree. Laurel oaks are weaker and shorter lived than live oaks and the four storms of 2004 proved that the older ones were particularly dangerous.”<sup>9</sup>

## Discussion of Problems and Defects Observed

### Tree Health and Structural Condition

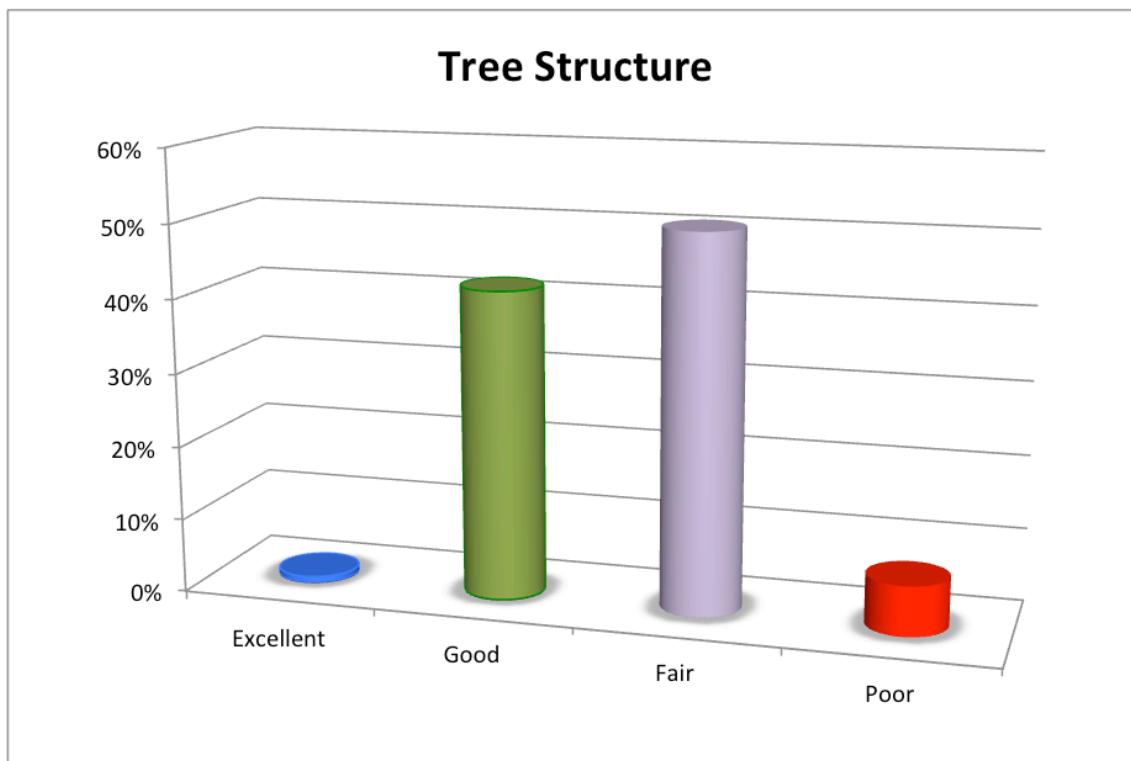


Figure 2

Each tree was also evaluated as to its overall health and structure. It is important to understand that health and structure are two separate and independent considerations. A tree can be healthy yet have poor and hazardous structure. Live (green) trees can fail and sometimes do. Structurally sound trees sometimes decline and die from poor health. Most of the trees evaluated (51 percent) had only fair structure mostly because of codominant leaders (Figure 2). Forty two percent of the trees had good structure. Trees with codominant leaders can be classified as “codominant leader without included bark” and “codominant leaders with included bark”. Trees with codominant leaders with included bark are much more prone to failure than trees with codominant leader and no included bark. A codominant leader with included bark is shown in Figure 6. The two leaders can more readily split than when there is a small u-shape in the crotch between two or more codominant leaders.

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The evaluation of **tree health** classified the trees as having excellent, good, fair, poor, declining and dead. Figure 3 shows the distribution of tree health categories. In general tree health is good for the trees evaluated.

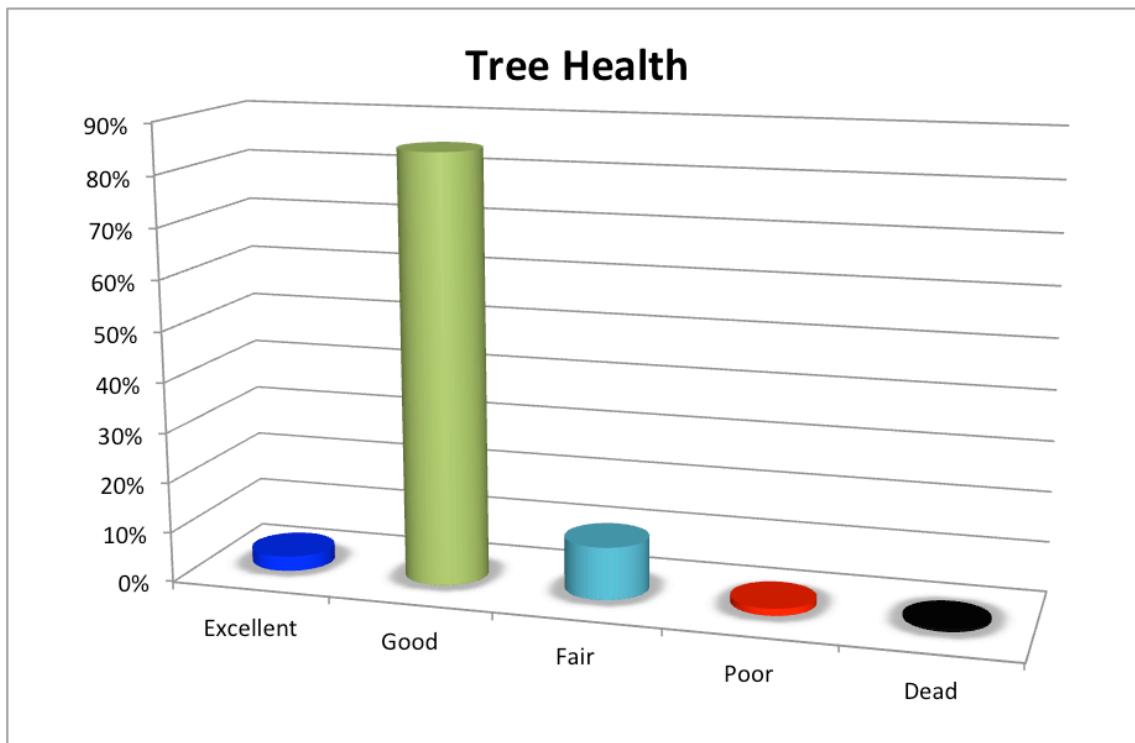


Figure 3

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## Problems and Defects Observed

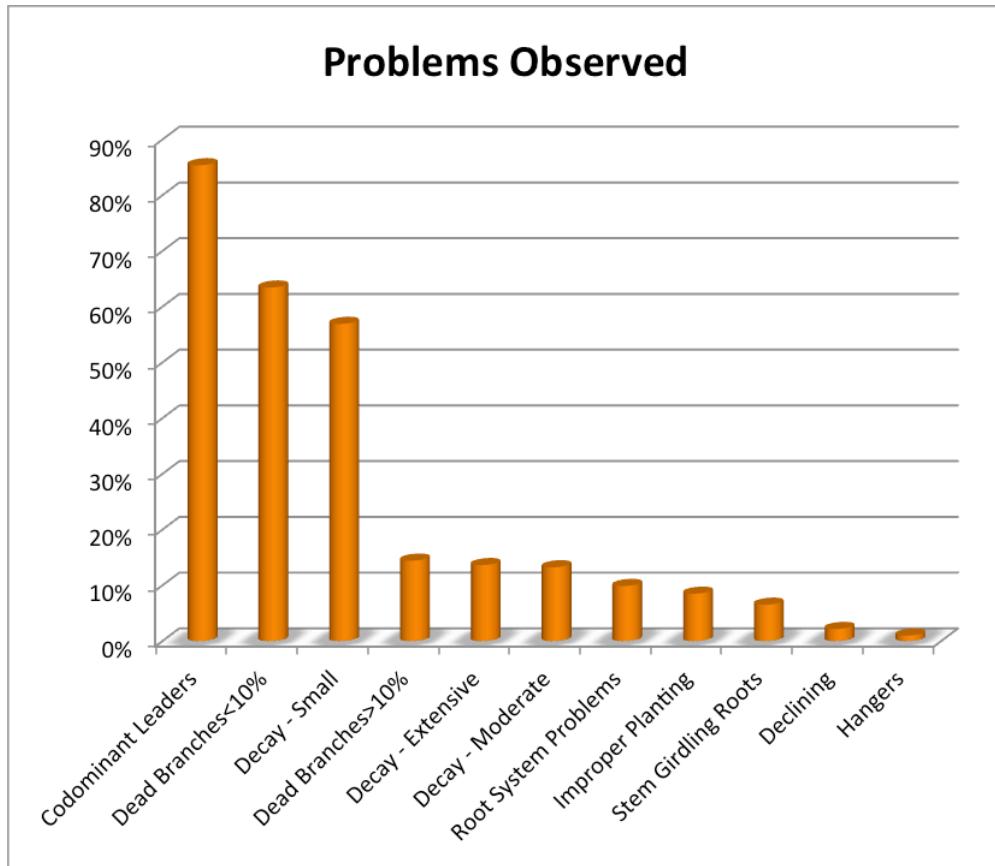


Figure 4

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**Codominant Leaders** -- The main defect observed was codominant leaders. The portion of trees with codominant leaders with included bark is only 19 percent of the total number of trees with codominant leaders (Figure 5). Eighty one percent of the trees with codominant leaders did not have included bark and are less of a hazard (Figure 6). Generally we recommend end weight reduction pruning on codominant leaders especially leaders with included bark.



Figure 5 Two leaders with included bark are shown. These two leaders are more prone to failure by splitting when the tree crown becomes larger and strong wind conditions occur.

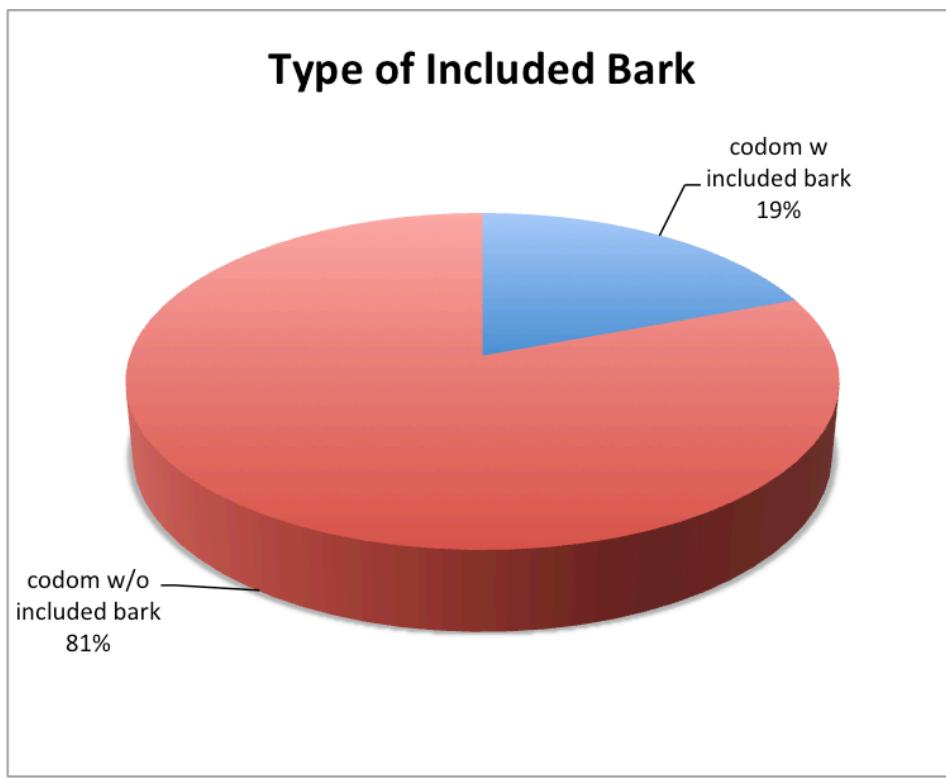


Figure 6

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**Dead Branches** -- Trees were evaluated by the amount of dead branches observed in relation to the size of the crown. There are two classifications: "Decayed branches less than 10 percent of the crown" and "Decayed branches greater than 10 percent of the crown". Large dead lateral branches are an indication of significant tree health and structure problems. But dead branches are not always an indication of a tree problem. Mature trees naturally shed lower and interior branches that are getting too much shade and not producing sufficient carbohydrates. Gravity will eventually cause dead branches to fall. And dead branches over streets and sidewalks can become hazardous. So a regular program of dead branch spotting and removal is an important aspect of any tree maintenance program.

Dead branches appearing in the upper crown of a tree can be a sign of more serious problems usually associated with root problems. Dead branches in the upper crown should be examined by a qualified arborist.

**Decay** -- The number of trees found with some degree of decay is 81 percent. However, 57 percent of the trees had only a small amount of decay or small cavities which is quite normal for middle-aged and older trees. Thirteen percent of the trees had moderate levels of decay or moderately sized cavities and 14 percent of the trees had large cavities or extensive decay. Decay is more common as trees age. Some species such as live oak are more resistant to decay and can live many years with cavities that appear to be quite large. Laurel oaks, on the other hand, do not resist decay well and often become hollow and weakened by decay because of a small wound or broken branch that allows infection by decay organisms.

**Vines** -- Vines are sometimes found on trees but are not beneficial for the tree. Vines can excessively shade trees by growing over the tops of trees, even tall trees. Vines can hide structural defects such as decay and cavities that might require further investigation. Vine foliage can also catch wind increasing the wind load on a tree and make a tree more susceptible to wind failure in a strong wind storm. Some vines are deliberately planted as ornamentals. Some vines are aggressive native vines. These vines should be removed or at least cut back severely and maintained in a cut back condition.

**Live Oak Age Distribution** -- Because the live oak was the predominant tree found in the survey on the public right-of-way, We analyzed the DBH of the live oak population (Figure 7). We found although there are some very old, large live oaks, the majority of the live oaks have a DBH of 30 inches or less. The majority

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of the live oaks are in the 10-inch to 19-inch DBH range which means the parks have a relatively young live oak population. As a rough estimate, live oaks with a DBH of 30 inches could be somewhere in the range of 50 to 100 years old, maybe older.

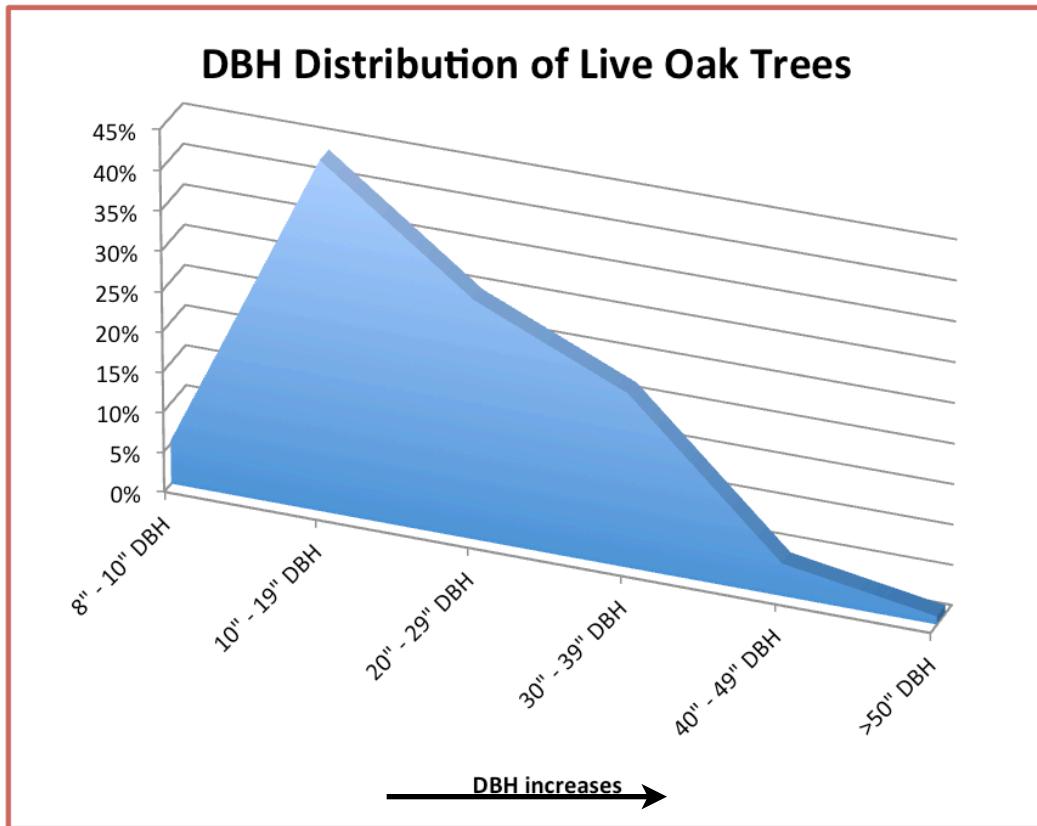


Figure 7

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## Maintenance

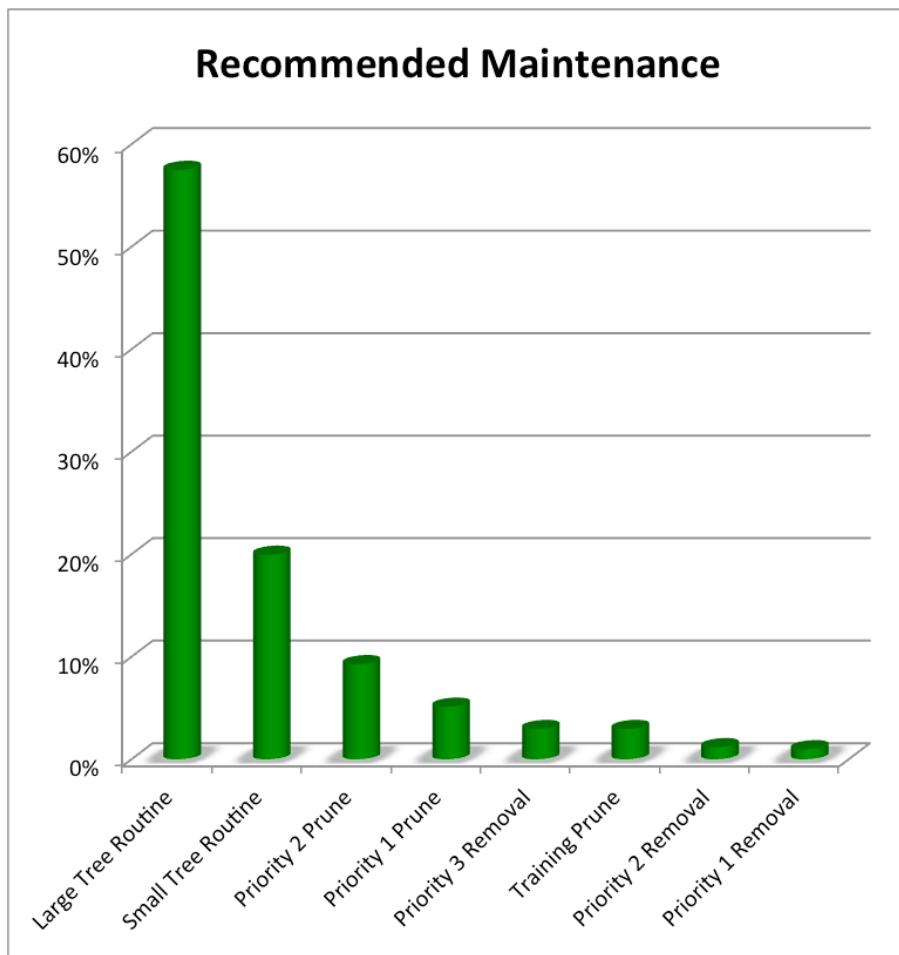


Figure 8

**Maintenance** -- Maintenance needs and recommendations are shown in Figure 8. Individual tree information is found in the data sheets in Appendix B.

**Tree Removal** - Only 5 percent of the trees have been recommended for removal (Figure 8) and only 4 trees (three laurel oaks and one red cedar) were given a Priority 1 Removal. The urgency of the removal is dependent upon the risk assessment score corresponding to each tree and their Priority classification. Not all removals have the same urgency. The urgency is determined by the likelihood of failure, size of tree part likely to fail, the target and the tree species.

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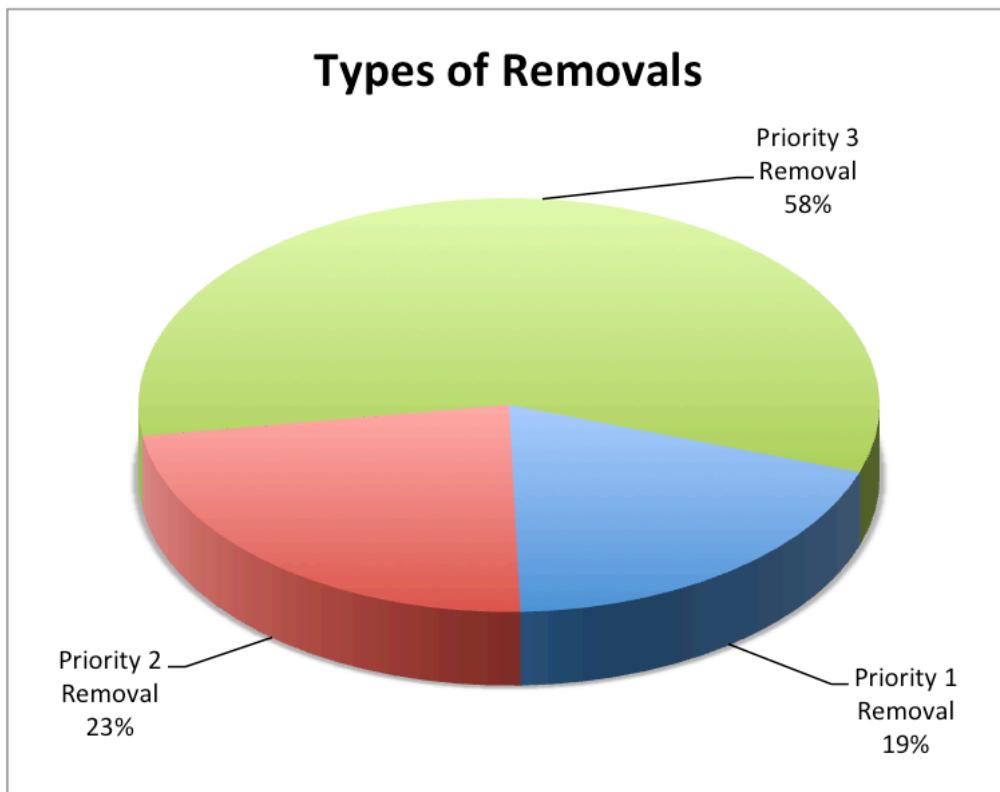
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Figure 9

**Risk Assessment** -- Each tree has a Risk Assessment score based upon the four risk factors -- likelihood of failure, size of tree part likely to fail, target, and tree species. The higher the score, the higher the risk. Scores for trees that are indicated for additional testing are subject to change based upon the subsequent testing results. The distribution of the Risk Assessment scores is shown in Figure 10.

**Sidewalks** -- Dealing with sidewalk lifting is an important aspect of controlling risk and improving safety. There are many new construction techniques that are better for trees than simply cutting roots, which can destabilize a tree. In effect cutting roots substitutes one risk (tripping) for another (tree instability). An arborist knowledgeable in sidewalk construction techniques should always be part of the sidewalk repair process.

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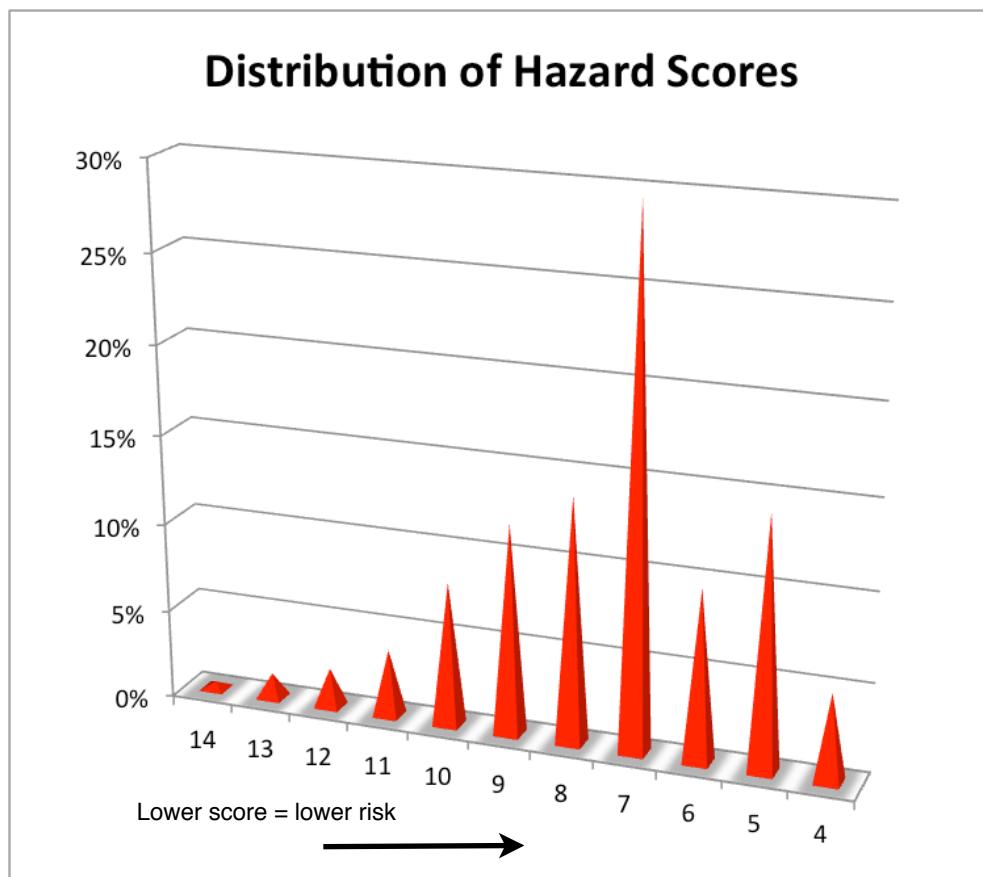
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Figure 10

**William-Gallimore Center**

Most of the young trees planted around the William-Gallimore Center showed evidence of improper installation. Nylon installation straps, as well as wire baskets were found in place around the root flare (Figures 11 and 12). The purpose of these materials is to support the root ball during transport and transplanting. Once a tree is planted, these straps and other installation materials should be removed. Leaving them in place can prevent the tree's lateral spread of root growth and girdle the tree. This can lead to multiple problems including shortened life, causing a live oak to die at 20-30 years as opposed to 200 to 300 years. Another problem is stability. Without lateral roots to counter wind loads from significant climatic events, a tree will be more likely to fall. Also health will be severely impaired. As noted in the pictures, many of the specimens are suffering from girdled stems, roots and root flares. Girdling will cut off the vascular tissue beneath the bark layer and can lead to crown dieback (which is already visible in some trees), instability, compromised health, decline even death. Removal of

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installation materials on established trees is not always recommended. In cases such as Figure \_\_ where much of the strap is exposed, cutting away portions of the strap that have not been grown over is recommended. But if the strap has been overgrown, then it should be left alone. Trying to remove an already overgrown strap will typically cause more harm than good and exacerbate conditions.



Figure 11 The wide nylon strap left over from the nursery should have been removed. Now it has been overgrown by the tree and cannot be removed without causing further damage to the tree. The exposed end only should be removed.



Figure 12 On this tree more of the straps left by the nursery and transplanters are exposed and the exposed sections of strap can be removed without damaging the tree.

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## Conclusions

A tree inventory and risk assessment provides valuable information for managing and maintaining an urban forest. Although no tree can be deemed safe and risk-free, a properly executed tree inventory and risk assessment can provide an organized and methodical way to deal with the trees that present the greatest risk. It allows for using limited resources to take care of the trees in greatest need of maintenance first and then taking care of trees with lower risk assessment scores as the budget permits. Use the tree inventory as a baseline for your on-going tree maintenance. Update each tree record when pruning work, sidewalk work or any excavation around a tree is done. Also record tree branch failures.

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## Appendix A

### Definitions

**Air Spade** – equipment used to excavate soil from roots using high velocity air expelled through a special nozzle. The air moves soil but generally does not harm roots or other solid obstacles. The Air Spade is generally a non-invasive diagnostic tool for examining roots, tree crowns and root flares.

**Codominant Leaders** – a tree with multiple trunks often beginning as a single leader and dividing into two or more leaders of similar size higher up on the trunk. Codominant leaders are considered a structural defect because they can be prone to failure (splitting)

**Compartmentalization** – the ability of a tree to isolate (wall off) damage and decay and continue to grow around the damaged area. Trees that are good compartmentalizers are better able to withstand damage from injuries such as pruning cuts, gashes, lightning strikes, etc.

**Condition** – an evaluation of a tree's structure and health

**Critical Root Zone** – this an area around a tree where roots must be protected and is another term for Tree Protection Zone

**DBH** – diameter at breast height, a measurement of a tree's diameter usually measured approximately four and one half feet above the ground

**Dripline** – the outer edge of a tree canopy

**Epicormic sprouts** – Excessive sprouting. Short twigs and small leaves growing along the upper surface of one or more main branches. The presence of epicormic sprouts are an indication of poor tree health, over-pruning, a weakened tree.

**Florida Grades and Standards** – Guidelines established by the Florida Department of Agriculture and Consumer Services. Acceptable grades are Florida #1 and Florida Fancy. Florida #2 and Culls are not acceptable grades.

**Radial Trenching** -- radial trenches about 18 to 24 inches deep and 4 to 14 inches wide are dug radially outward from about 10 feet from the trunk. The trench is filled with improved soil or leaf compost. This process is also known as **soil removal and replacement**.

**Reduction Pruning** – A recommended pruning method that reduces (subordinates) codominant leaders and large side branches by reducing their size from the outside in. Reduction pruning is often the preferred method of taking weight off the ends of branches versus the commonly utilized but undesirable method known as “lion tailing” which removes interior branches and keeps only the branches out at the end creating instability and increasing risk of branch or trunk failure.

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**Resistograph** – a diagnostic tool that utilizes a 1/8-inch diameter drill bit to measure decay inside a tree trunk or branch by measuring and graphing the resistance of the drill bit as it moves through the wood.

**Root Flare** – the area at the base of the tree trunk that becomes wider (flares out) where roots grow horizontally in the soil. The individual root flares are where the roots are connected to the base of the tree trunk.

**Root Plate** – a circular area with an outer boundary that is usually considered to be a distance from the tree trunk that is three times the diameter of the tree.

**Root Tracing** – a non-invasive technique utilizing an Air Spade to locate and follow tree roots. This procedure allows an arborist to precisely determine the location of large roots in relation to planned buildings or other infrastructure.

**Vertical Excavation** -- Also known as **vertical mulching**, the process of reinvigorating a tree's root system by making vertical holes about 2 inches in diameter and 18 inches deep in the soil starting near the base of the trunk and working outward toward the dripline of the crown. Holes are spaced 1½ to 4½ feet apart. Holes can be made with a 2-inch auger or a high velocity Air Spade. This process improves the soil and soil aeration.

Chuck Lippi, Advanced Tree Care, Inc.

Registered Consulting Arborist #443   Board Certified Master Arborist FL-0501B

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### **Certification of Performance**

I, Chuck Lippi, certify that:

- Arborists cannot detect every condition that could possibly lead to the structural failure of a tree. Trees are living organisms that fail in ways we do not fully understand. Conditions are often hidden within trees and below ground. Arborists cannot guarantee that a tree will be healthy, safe or adequately protected under all circumstances or for a specified period of time. Likewise, remedial, protective and mitigating treatments and recommendations cannot be guaranteed.
- I have no current or prospective interest in the vegetation or the property that is the subject of this report and have no personal interest or bias with respect to the party or parties involved.
- I certify that all the statements made in this report are true, complete and correct to the best of my knowledge and belief and are made in good faith.
- The analysis, opinions and conclusions stated herein are my own and are based on current scientific procedures and facts.
- My analysis, opinions and conclusions were developed and this report has been prepared according to commonly accepted arboricultural practices.
- My compensation is not contingent upon the reporting of a predetermined conclusion that favors the cause of the client or any other party nor upon the results of the assessment, the attainment of stipulated results or the occurrence of any subsequent events.
- There is no warranty or guarantee, expressed or implied, that problems or deficiencies of the plants or property in question may not arise in the future.
- I reserve the right to change my reports/opinions on the basis of new or different evidence.
- Loss or alteration of any part of this report invalidates the entire report.

I further certify that I am a member in good standing of the American Society of Consulting Arborists (ASCA), the International Society of Arboriculture (ISA) and the Florida Urban Forestry Council and am an ISA Board Certified Master Arborist FL-0501B and an ASCA Registered Consulting Arborist #443.

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## References

<sup>1</sup> American National Standards Institute (ANSI) A300 Risk Assessment Part 9 Tree, Shrub, and Other Woody Plant Management Standard Practices (***Tree Risk Assessment*** a. Tree Structure Assessment), 2011.

<sup>2</sup> Thomas Smiley, Nelda Matheny and Sharon Lilly, ***Best Management Practices Tree Risk Assessment***, International Society of Arboriculture, Champaign, Illinois, 2011.

<sup>3</sup> Dr. James R. Clark and Dr. Nelda P. Matheny, ***A Photographic Guide to the Evaluation of Hazard Trees in Urban Areas***, 2<sup>nd</sup> edition, International Society of Arboriculture, 1994, pp. 37 – 57.

<sup>4</sup> Dr. Ed Gilman, ***Trees for Urban and Suburban Landscape***, Delmar Publisher, New York, 1996, p. 497.

<sup>5</sup> Pamela Crawford, ***Stormscaping: Landscaping to Minimize Wind Damage in Florida***, Color Garden Publishing, 2005, p. 41.

<sup>6</sup> Dr. Ed Gilman, ***Trees for Urban and Suburban Landscape***, Delmar Publisher, New York, 1996, p. 483.

<sup>7</sup> Dr. Ed Gilman, Dr. Mary Duryea, Dr. Eliana Kampf, Dr. Traci Jo Partin, Dr. Astrid Delgado, Dr Carol Lehtola, ***Assessing Damage and Restoring Trees After a Hurricane***, University of Florida Department of Environmental Horticulture Publication ENH1036, 2006, pp. 10-11.

<sup>8</sup> Dr. Mary Duryea and Dr. Eliana Kampf, ***Wind and Trees: Lesson Learned from Hurricanes, Chapter 5***, University of Florida Department of Forestry Publication FOR 118, 2006, p. 6.

<sup>9</sup> Pamela Crawford, ***Stormscaping: Landscaping to Minimize Wind Damage in Florida***, Color Garden Publishing, 2005, p. 41.