A GUIDE FOR TREE AND PALM MAINTENANCE ALONG FLORIDA ROADSIDES

Prepared by: University of Florida Urban Tree and Landscape Lab in conjunction with the Florida Department of Transportation Office of Maintenance

This guide is a resource for FDOT personel and contractors who participate in landscape design, installation, and maintenance that serve the goals of the state.

As a subtask of grant BDV31-977-75, this guide is intended (in conjunction with all other pertinent policy, resources, and regulations) to enhance the benefits produced by Florida's roadside urban forest.

FDOT Resources

- A Guide for Roadside Vegetation Management
- Roadway and Roadside Maintenance 850-000-015-j
- Maintenance Rating Program Standards: Vegetation and Aesthetics

External Resources

- Structural Pruning: A Guide for the Green Industry (Gilman, et al., 2013)
- American National Standard for Tree Care Operations - Tree, Shrub, and Other Woody Plant Maintenance - Standards Practices

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Chapter 1: Introduction

This guide was created to assist in the development and improvement of the Florida Department of Transportation Vegetation Management Plans as required by the Roadway and Roadside Procedure #850-000-015. Incorporating the use of a comprehensive tree and plant management program into landscaping practices can improve both the overall health and aesthetic value of the vegetation found alongside state roadways. In addition, the implementation of a sound landscape management plan can also greatly reduce the costs associated to the maintenance, replacement or removal of diseased and dying vegetation. The following chapters presented in this guidebook will provide methods for maintaining healthy trees and palms throughout roadside landscape areas. This guide seeks to provide direction to FDOT personnel and contractors for prescribing and preforming tree maintenance, while also providing a foundation for contract specification writing.

Chapter 2: Maintenance Rating Program and Clear Recovery Zone Policy

The Florida Department of Transportation defines landscaping areas as areas that have been changed by the installation of trees, palms, shrubs, or ground cover plants that will require weeding, mulching, edging, insect spraying, fertilizing, pruning, and replacement of dead or dying plant material. Formerly, there were two classifications of landscape areas: Traditional (i.e., vegetation located behind curb and gutter) and Bold (i.e., large specimen trees on interchanges). They are now grouped together under Maintenance Rating Program (MRP) criteria for simplicity and consistency. FDOT landscaping can be installed as a standalone project or during or after roadway construction through agreements with local governments, permits with abutting property owners, through a Florida Highway Beautification Council Grant, or District landscape funding processes. In some cases, these projects may have a memorandum of agreement (MOA), or joint participation agreement (JPA) by a local agency or government.

All landscape areas should be regularly evaluated using the most recent version of the MRP Handbook**.** Appropriate MRP criteria can be found in two sections: "Landscaping" and "Tree Trimming". The criteria from these sections are summarized below.

MRP Criteria for Rating Landscape Areas

Landscaping is defined as those areas that have been changed by the placing of trees, shrubs, groundcovers or flowers that occasionally require maintenance (e.g. Weeding, mulching, trimming, pruning, etc.). The objective of rating landscape areas is to ensure that 90% of landscape vegetation is maintained in a healthy, attractive condition.

Evaluation: Inspect the landscaped areas[1]. Determine if the plants are in a healthy attractive condition. Landscaped areas that appear unhealthy or unattractive due to poor maintenance (e.g. lack of water, presence of weeds, dead or dying plants or overgrown appearance) cause this characteristic not to meet the desired maintenance condition.

For MRP purposes, the presence of weeds in more than 10% of the landscaped area is considered undesirable. Consider evaluating all trees in the landscape areas for tree trimming.

Landscaping does not meet MRP standards when any of the following exist:

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[1] Note: *Rate all landscaping in the sample point located within the limits of the right-of-way*.

1) If more than 10% of the landscaping areas appear unhealthy or unattractive due to poor maintenance (lack of water, presence of weeds, dead or dying plants or overgrown appearance).
2) Any landscaping is within the limits of the clear sight window as per Florida Design Manual 212.11.6.

MRP Criteria for Rating Tree Trimming

The objective for rating tree trimming is to ensure proper right-of-way clearance. Proper clearance can be achieved by either guiding or preventing the encroachment of trees, limbs, or vegetation in or over the travel way or clear zone with thresholds defined below. Proper evaluation of potential conflicting tree structure can circumvent future encroachment violates the horizontal clearance as defined in this standard.

TREE TRIMMING: No encroachment of trees, tree limbs or vegetation in or over the travel way lower than 14-1/2 feet or lower than 8-1/2 feet over sidewalks. No vegetation violates the horizontal clearance as defined by this standard.

For MRP purposes, trees to be evaluated:

1. Trees with diameters greater than 4 inches when measured 6 inches above the ground
2. Tree limbs with diameters greater than 1 inch at or above 3 feet from the ground

Evaluation: All samples are to be evaluated for tree trimming. Dead or dying trees within the right-of-way that could fall in the clear zone[2], across the right-of way fence, or present a hazard to vehicles, adjacent property owners or pedestrians does not meet desired conditions.

In areas with curb and gutter, there should be no vegetation over the roadway lower than 14-1/2 feet from the face of curb to the face of curb.

In areas without curb and gutter, there should be no tree or trees limbs over the roadway and shoulder lower than 14-1/2 feet.

In cases where guardrail is present, there should be no vegetation lower than 14-1/2 feet from the face of guardrail. In areas with sidewalk, there should be no encroachment of trees, tree limbs or vegetation over the sidewalk lower than 8-1/2feet.

In an area with a bike path, there should be no encroachment of trees or tree limbs over the bike path lower than 8-1/2 feet.

Rate trees in all landscape areas for tree trimming.

Tree trimming does not meet MRP standards when any of the following exist:

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[2] Note: *For MRP purposes see the Standard Plans for the tree trimming clear zone limits.*

1) In curb and gutter areas, vegetation is lower than 14-1/2 feet over the roadway from the face of curb to the face of curb. Limbs within the clear zone lower than 14-1/2 feet are not to be pruned to the trunk or stub cut. Structural pruning in these locations should be done only to promote growth over the roadway.
2) In areas without curb and gutter, vegetation over the roadway and shoulder is lower than 14-1/2 feet.
3) In areas with guardrail, trees or tree limbs are lower than 14-1/2 feet from face of guardrail.
4) Vegetation encroachment of trees, tree limbs or vegetation over the sidewalk is lower than 8-1/2 feet.
5) Dead or dying trees within the right-of-way that could fall in the clear zone, across the right-of-way fence or present a hazard to vehicles, adjacent property owners or pedestrians.
6) Trees and/or vegetation that obscure the message of a traffic sign.
7) Encroachment of trees, tree limbs or vegetation over a bike path lower than 8-1/2 feet.
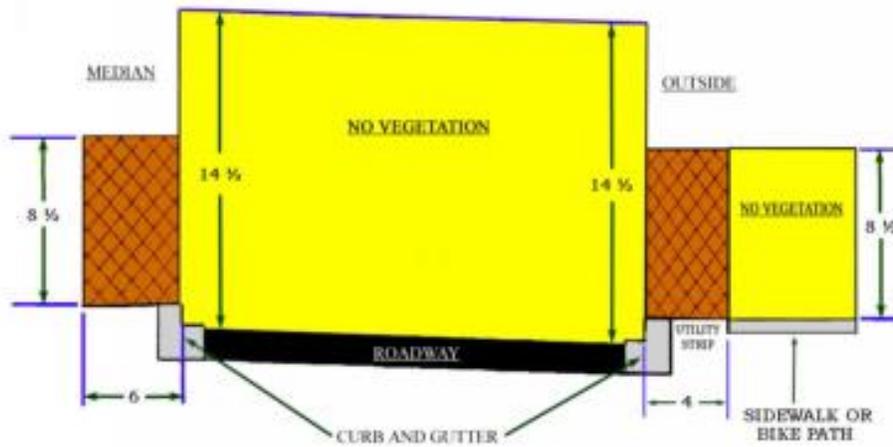
Figure 1. Tree trimming clear zone limits. The cross hatched areas shown above represent areas to be evaluated for horizontal clear zone violations. Violation of clear zone includes the evaluation of trees that have a diameter greater than 4 inches as measured 6 inches above the ground. It also includes the evaluation of tree limbs greater than 1 inch in diameter greater than 3 feet above the ground.
Note: Limbs within the hatched clear zone are only to be cleared up to 8 ½ feet.
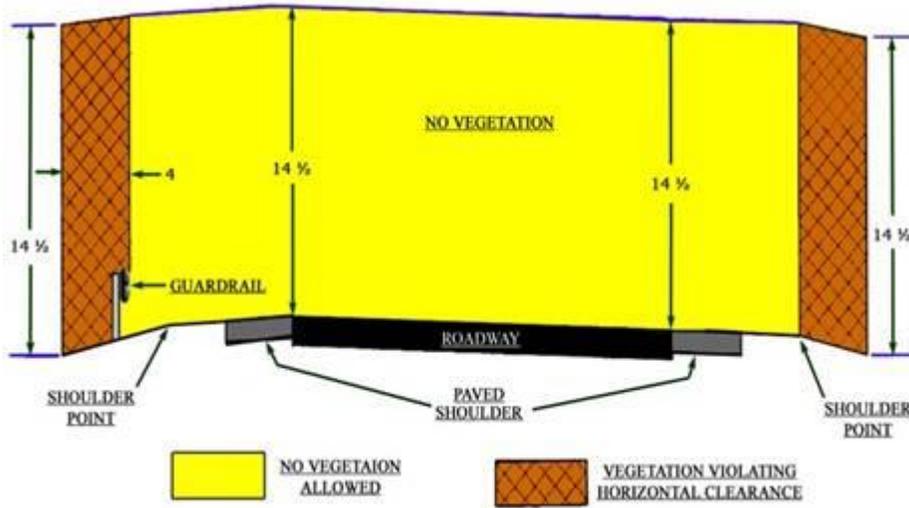
Figure 2. Tree trimming clear zone limits. The cross hatched areas shown above represent areas to be evaluated for horizontal clear zone violations. Violation of clear zone includes the evaluation of trees that have a diameter greater than <u>4 inches</u> as measured <u>6 inches</u> above the ground. It also includes the evaluation of tree limbs greater than <u>1 inch</u> in diameter greater than <u>3 feet</u> above the ground.

Chapter 3: Pruning Cuts and Techniques

Objectives

Pruning is considered the most commonly used and recognizable tree maintenance practice today. Objectives include reducing tree or branch failures, providing clearance, creating views, stimulating fruit or flowering, improving structure, maintaining health, restoring damaged or vandalized trees, and managing pests. Arborists utilize a variety of different pruning types to meet these objectives. Knowledge of basic tree biology and how a tree responds to pruning is important to understand before cuts are made. Improper pruning can cause long lasting damage to trees and in extreme cases may lead to premature mortality.

All tree maintenance shall be performed under the supervision of an ISA Certified Arborist. FDOT contractors and personnel must follow the most recent guideline for safe tree work operations (ANSI Z133). If utility conflicts exist, contact the utility to either mitigate the hazard, or to make trees safe for a non-electrical certified arborist to maintain. This guide is written in accordance with, but not a substitute for the most up-to-date standards for tree care practices (ANSI A300) [1].

Biology

Trees respond to injuries by reallocating resources to help prevent the spread of **decay** (physically and chemically) by blocking off sections of impacted wood through a process called **compartmentalization**. Injuries to trees can result from a variety of different sources. Please note, this includes improper pruning cuts. The primary features to look for on **branches** before making any pruning cuts are the **branch collar** (Fig. 3) and **branch bark ridge** (Fig. 4). These formations signify strong branch unions and the location of specialized tissue that prevent the spread of decay. The presence and prominence of the branch bark ridge and branch collar is highly variable between different tree species.

Within the branch collar is an area of specialized cells called the **branch protection zone**, which helps retard the spread of decay into the trunk. The branch bark ridge is located above the branch at the union with the trunk and helps provide guidelines for proper pruning locations. The branch bark ridge is formed by the new growth of the branch and trunk wood pushing against each other creating a darkened, rough, raised area. This formation should not to be confused with **included bark** (Fig. 5)**,** which can be indication of a weak branch union.

FIGURE 3. BRANCH COLLAR AS INDICATED BY THE ORANGE ARROW. NOTICE THE SLIGHT SWELLING AND CHANGE IN BARK TEXTURE TO THE RIGHT OF THE ARROW. CUTTING INTO BRANCH COLLAR SHOULD BE AVOIDED TO REDUCE LONG-TERM WOUNDING OF THE TREE (INDICATED WITH RED ARROW).

FIGURE 4. THE BRANCH BARK RIDGE IS CREATED WHEN EXPANDING BRANCH AND TRUNK WOOD CAUSE THE BARK THE RUPTURE OUTWARD (INDICATED WITH RED ARROW)

FIGURE 5. CODOMINANT BRANCHES AND BRANCHES WITH NARROW ATTACHMENTS CAN LEAD TO INCLUDED BARK, A DEFECT WHERE BARK PREVENTS THE NORMAL INTERMINGLING OF BRANCH AND TRUNK WOOD FIBERS (NOTED THE ABSENCE OF THE BRANCH BARK RIDGE ABOVE)

Pruning Cuts

Tree biology dictates cut placement and execution. The branch collar (if visible and present) should always be preserved when making cuts, to allow the branch protection zone to restrict the spread of decay into the trunk. On branches with a visible collar, pruning cuts should be made just outside the collar edge. Branches that have no visible collars should have pruning cuts made perpendicularly to the point where the top of the branch drastically turns into the trunk union. Do not cut into the trunk.

The size and weight of the branch being removed will dictate what equipment and techniques should be employed when pruning. Small, lightweight branches can be removed with hand pruners or loppers. To remove branches over 1 inch in diameter, a saw should be used in place of loppers. Large, heavy branches that can't be supported by hand while cutting them should utilize the **three-cut** method to avoid the branch ripping off and causing serious damage to the tree.

Three-cut method

- <u>Undercut (1)</u>**:** On the under-side of the branch, cut through 1/3 of the diameter in an upward direction, several inches away from the branch collar (Fig. 6).
- <u>Overcut (2)</u>: On the upper-side of the branch, cut downward through the entire stem several inches beyond the undercut, leaving a short stub (Fig. 6).
- <u>Final cut (3)</u>**:** Remove the remainder of the stub just outside of the branch collar at an angle parallel to the axis of the trunk, orientated with the branch collar. This final cut allows the tree to compartmentalize and heal correctly. (Fig. 6).
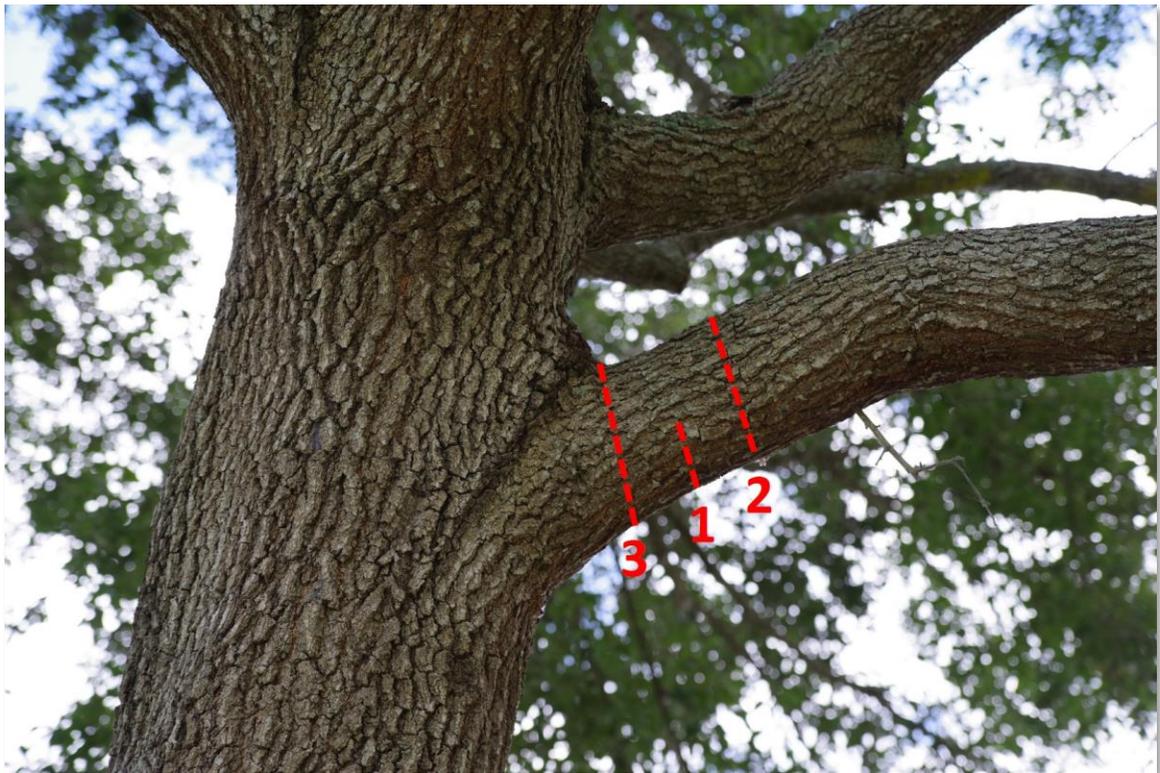
FIGURE 6. THE THREE CUT METHOD HIGHLIGHTING THE 1). UNDERCUT, 2.) OVERCUT, AND 3.) FINAL CUT.

Two Basic Pruning Cuts

1. **Removal Cut:** Removal cuts are used to prune the branch back to the trunk or **parent branch** and can be used in **crown raising**, **cleaning**, and **thinning** practices.
2. **Reduction Cut:** Reduction cuts can be utilized to limit the size of a tree, redirect growth, balance the canopy, reduce competing **leaders**, or reduce the weight of damaged or over-arching branches.

Pruning Methods

Now that an understanding of cuts has been established, it is imperative to learn how they are incorporated to various methods of pruning. Those methods are **cleaning**, **raising**, **reducing**, **thinning**, and **restoring**. Note that it is common to utilize more than one pruning method to accomplish pruning objectives.

Crown Cleaning

The primary objective of crown cleaning is to remove diseased, dead/dying, broken, rubbing, or other hazardous branches. Crown cleaning can be employed at any time of year since it does not remove any living tissue. Cleaning should be the first method used to prune any tree, as it reduces the overall tree **risk**. By first removing dead or detached wood, it makes the remainder of the job safer for the arborist.

Tree limbs of a small diameter that pose no risk may be left in the tree if so desired. Dead, diseased, and broken branches should be removed at its point of origin.

Crown Raising

Crown raining is the removal of lower branches in the canopy to provide clearance for a view, vehicles or human accessibility. Often, low branches go unchecked until the tree is rather large. At that point, branch removals can result in the creation of a large wounds, significant energy loss, and increased chances of toppling or trunk breakage. However, it is not advised to remove all low branches at one time when a tree is young either. It is recommended the arborist to select and remove small diameter branches over time as the tree grows.

Not all trees need to be raised. Many landscape areas along interchanges are very open and a great distance from the **clear zone**. Districts need to determine if raising for mowing practices in these areas are necessary, or if alternatives to raising exist, such as expanding the mulch area.

Crown Reduction

The primary objective of crown reduction is to decrease canopy size utilizing reduction cuts. In many instances, this pruning method is used to provide clearance to roads and structures, redirect growth, redistribute individual branch or total canopy weight, and reduce failure potentials. Crowns can be reduced horizontally or vertically. Note: Reduction pruning generally results in re-growth, so frequent maintenance after reduction is common.

Reduce trees by cutting stems and branches back to living lateral branches

Before canopy reduction

Outer edge of new smaller canopy

After inappropriate reduction

Heading cut

Heading cuts are not appropriate on landscape trees

After appropriate reduction

Reduction cut

Reduction cuts are the recommended method for reducing landscape trees
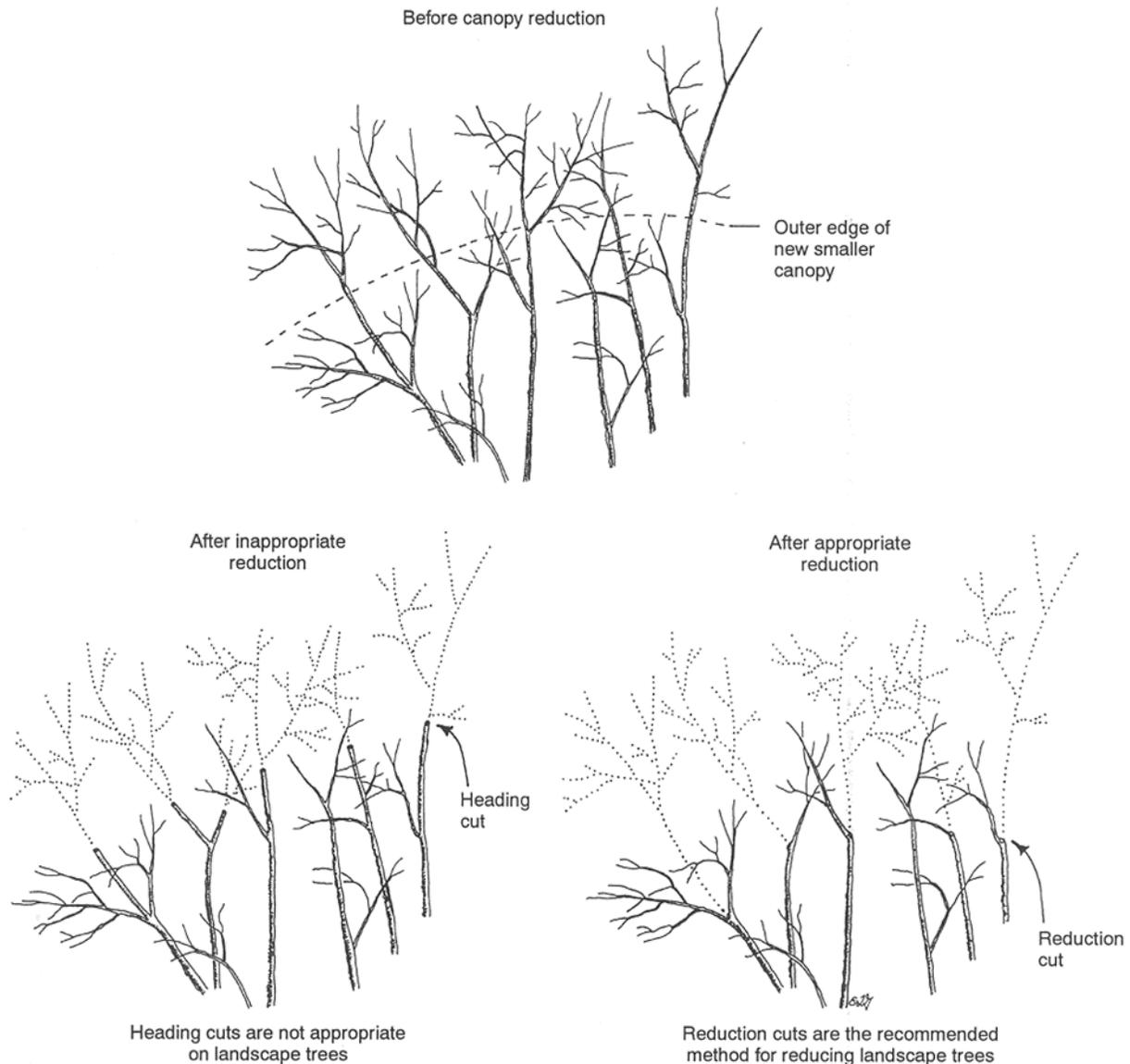
FIGURE 7. USE OF REDUCTION CUTS TO REDUCE OVERALL CANOPY SIZE. CREDIT: ED GILMAN.

Crown Thinning

The primary objective of thinning is to carefully remove living, small (1- to 3-inch diameter), mainly secondary limbs in the outer periphery of the canopy. Canopy thinning is often used to improve air flow, sunlight penetration, branch taper, and even remove **epicormic shoots** and watersprouts. This practice can improve taper of interior branches, reduce wind drag during storms, and possibly reduce insects. Thinning should be executed with a handsaw, to help discourage the removal of large branches. Branches selected for removal should be those that lack vigor or are competing with other branches. A thinned tree can look as though it was unpruned, because the size and shape should not be influenced. No more than one-quarter of the living crown should be removed at a time when

thinning. If crown cleaning removes living tissue, the percentage removed in thinning should be adjusted.

It is common to see "**lions-tailing**" improperly portrayed as a version of crown thinning. This harmful practice removes all interior branches on a limb giving it the appearance of a lion's tail. This leads to sunscald, lack of taper, and branch breakage. Over-thinned trees often produce numerous epicormic sprouts.

Structural Pruning

The primary objective of structural pruning is to establish strong tree **structure**. Desirable structure includes a **dominant leader** through the top of the crown, appropriately spaced **scaffold** branches, good taper, small branch-to-trunk diameter (**aspect ratio**), natural form, non-competing branches, and few "V" shaped branch unions and bark inclusions. Structural pruning is highly important in tree species with **decurrent** crowns. These trees typically survive in a tight-competing environment, growing upward and competing for sunlight. In our urban roadside environment, above-ground space can be ample, causing tree growth to be sporadic and incompatible with our goals and even its own structural stability

Young Trees

Structural pruning can generally be thought of as "young tree training," although it is possible to address any age. Establishing a pruning program when trees are young and more resilient gives the advantage of future wind resistance, smaller pruning wounds, less biomass to chip or move off-site, safer work conditions, reduced future risks, and lower maintenance costs. Following steps and guidelines in the selection of nursery stock outlined in Florida Grades and Standards for Nursery Plants, is the first step in ensuring long-term quality tree structure. Trees that do not meet a specified grade, may attain a desirable grade with careful placement of pruning cuts at the time of planting. Implementing this concept into tree planting projects can reduce occurrences of tree replacement.
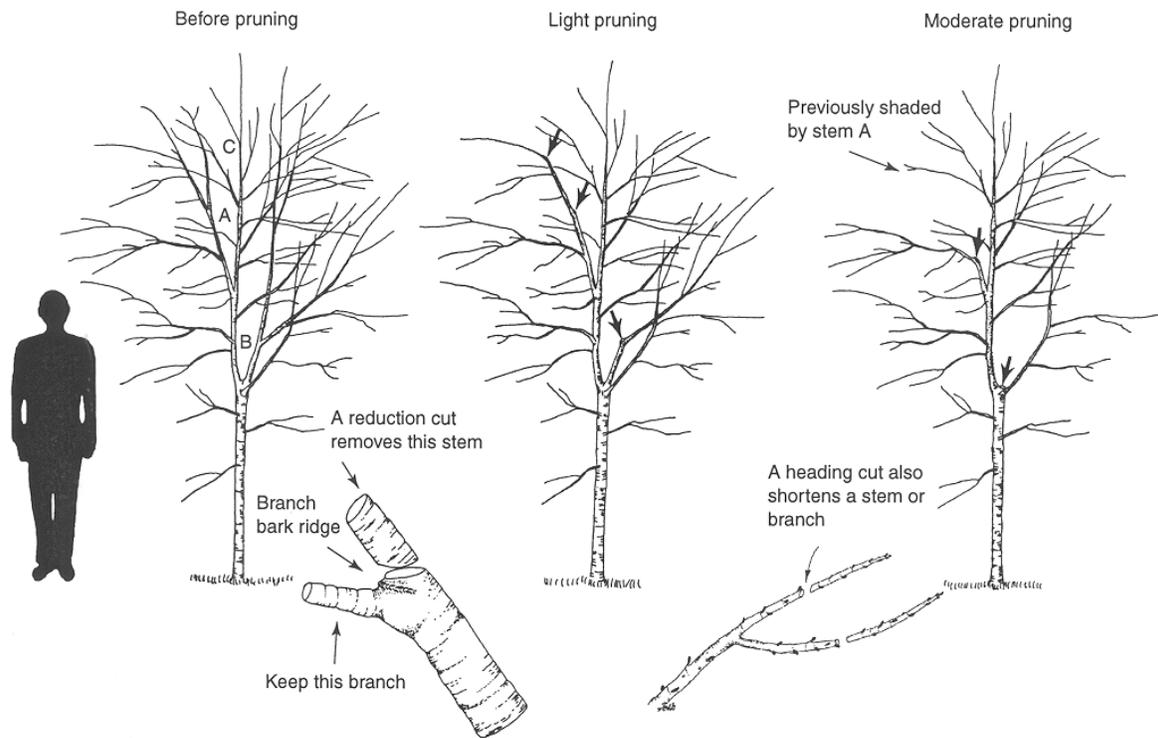
FIGURE 8. USE OF SUBORDINATION CUTS (COMPETING/CODOMINANT BRANCHES A AND B) AND A REMOVAL CUT (COMPETING/CODOMINANT BRANCH C) TO ESTABLISH ONE CENTRAL LEADER IN A YOUNG TREE. CREDIT: ED GILMAN

Identify the lowest permanent branches depending on tree location, clear zone requirements, and other spacing needs. For example, all branches overhanging a curb and gutter area will eventually be removed up to 14 ½ feet. Trees located near curb and gutter areas should be pruned to redirect upward growth to extend over roadways above 14 ½ feet.

Raising the canopy

40% live
crown
ratio

• Live crown ratio
too small

• Trunk cracks can
form from too many
branches removed
at once

Before pruning

Too many branches removed

70% live
crown
ratio

Small branches
remain to shade
trunk and help
minimize cracking

One branch
removed,
others
shortened

Properly removing lower branches

Properly thinning and reducing lower branches

FIGURE 9. RAISING THE CROWN OF A TREE THROUGH REDUCTION AND THINNING CUTS. CREDIT: ED GILMAN.

Medium-Aged Trees

Medium-aged trees can be structurally pruned to complete the crown raising process, balance the crown, and even redirect growth. Medium-age trees will also be less tolerant of the same pruning dose received by a young tree.

Mature Trees

If necessary, mature trees can be structurally pruned to help minimize the risk of current defects. Removal of live foliage should be carefully assessed with mature trees, instead placing an emphasis on branch reduction. Reducing a codominant stem with less desirable form can alleviate the stress placed on weak branch unions. Overextended branches can be reduced as well to help redistribute weight and tensions. Branches that are more than 1/3 the diameter of the trunk should not be removed on mature trees.

Restoration Pruning

The primary objective of restoration pruning is to improve tree health, structure, and appearance. Restoration pruning is often utilized after the occurrence of storm damage, topping, or other forms of mechanical damage. This pruning style employs concepts of reduction, thinning, and removal to remediate damaged crowns.

Practices to Avoid

The term "pruning" indicates a judicious, careful selection and execution of removing tree parts. Unfortunately, it is commonplace to see improperly pruned trees in the landscape. Every cut made to a tree will impact it in one way or another. Improper pruning practices commonly induce stresses on trees that insect or pathogens can then capitalize on. However, considerations of normally avoided practices may be necessary depending on tree species type or in special situations (storm restoration pruning and rural tree trimming practices requiring large machinery). This section will review practices that should be avoided in general.

Flush Cuts

Flush cuts remove the branch collar, cutting into trunk tissue and may result in a larger wound (Fig. 10). Care must be exercised to preserve the branch collar, so the branch protection zone can start to compartmentalize decay. NEVER flush cut a branch.

FIGURE 10. FLUSH CUT.

Stub Cuts

While avoiding flush cuts into the branch collar, problems can also arise from leaving too much material beyond the collar (Fig. 11). Branch stubs are susceptible to decay and once infected can allow the decay to break through the branch protection zone into the trunk of the tree.

FIGURE 11. STUB CUT.

Topping

Never top a tree. Topping is the result of indiscriminate cuts of large diameter branches in order to reduce a tree to a certain height (Fig. 12). This practice can result in the excessive generation of watersprouts**,** wood cracks, and increased future maintenance. If a tree requires topped for any reason, consider replacing the tree with a species that is more appropriate for that location. Topping trees is dangerous for all parties involved from the tree worker to the pubic after the fact.

FIGURE 12. TOPPING.

Rounding-over

Rounding over consists of making internodal cuts of small diameter branches to create a desired, often unnatural, canopy shape (Fig. 13). This pruning practices results in many branches of similar diameter but can be hard to correct. While more maintenance intensive, this practice is considered acceptable and commonplace on limited species like crapemyrtles (*Lagerstroemia spp.*).

FIGURE 13. ROUNDING-OVER OR TIPPING.

Lions-Tailing

Lions-tailing is an ineffective thinning practice focused on the removal of interior branches only (Fig. 14). This exposes the parent branch to sunscald, drastically reduces photosynthetic area, and redistributes the load solely to the end of a branch. This load redistribution results in branch failures by creating a strong lever arm. Problems are amplified by the poor branch taper development that follows lions-tailing. Never lion-tail a tree.

FIGURE 14. LIONS-TAILING

Over-pruning

Removal of more than 25% of live foliage in one growing season is considered to be excessive and does not meet professional industry standards (Fig. 15). Younger trees in a thriving environment may be able to sustain more foliage removal, while mature trees are typically more sensitive to over pruning. Never over prune a tree.

FIGURE 15. OVER-PRUNING

Excessive Raising

One type of over-pruning is excessive raising. When tree canopies are not gradually raised over time, they often get the majority of low limbs removed in one pruning event (Fig. 16). At all times, the live crown ratio of the tree should be at least 60%. When excessively raised, new growth is all directed upright into the crown leading to poor form. Other issues associated with excessive raising are large-diameter wounds that fail to compartmentalize, sunburn from recently exposed bark, a lack of taper development, and less mass-damping of wind loads during storm events. Never over-prune a tree to raise the canopy in one pruning event.

FIGURE 16. EXCESSIVE RAISING

Lack of Structural Pruning

Trees that were neglected of structural pruning practices when young will often times require higher levels of maintenance as they mature and may ultimately need to be removed and replaced. Easily correctable problems in young trees can become significant weakness as trees gets larger. Bark inclusions, lollipop shaped crowns, large wounds, codominant stems, and v-shaped branch unions are all characteristics that increase the likelihood of failure when trees aren't structurally maintained.

Chapter 5: Tree Type Considerations and Pruning

Palms

Objectives

Pruning on palms is mainly performed for aesthetic reasons like the removal of dead, diseased, or chlorotic lower fronds. Additional pruning goals include the removal of flowering and fruiting stalks to encourage leaf production and prevent risk from fallen fruits. Pruning of sprouts on multi-stemmed species is performed to maintain a single stem. The removal of completely dead fronds can improve appearance, eliminate hiding places for vermin, and decrease the chance injury or damage from falling fronds. However, pruning of dead fronds may be unnecessary on some species with crownshafts (e.g., royal palm, *Roystonea regia*) or mature Mexican fan palms (*Washingtonia robusta*) over thirty feet tall.

Timing & Dosage

Ideally, pruning would be timed to remove dead or severely damaged lower fronds as they appear and flowering stalks once they extend and before they drop flowers or fruit. (Fig. 17). Since this is not always realistic, a more typical pruning schedule is once or twice per year. In addition, dead leaves and flowers or fruit should be pruned before the start of hurricane season to prevent them from becoming hazards. On palm species with sharp spines, the spines should be removed if the tree is low enough to pose a threat to people.

FIGURE 17. SABAL PALM WITH FULL CROWN. THE COMPLETELY BROWN FRONDS AGAINST THE TRUNK SHOULD BE PRUNED. CREDIT: GITTA HASING
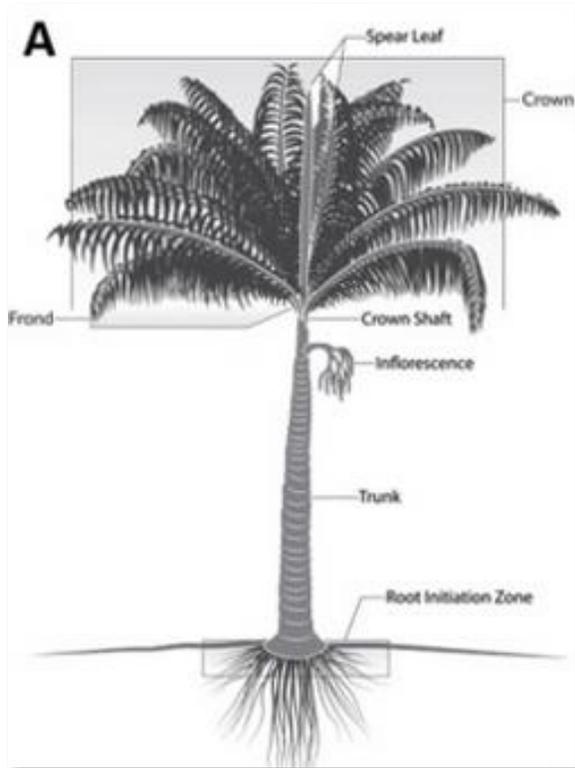
FIGURE 18. TYPICAL ANATOMY OF A PALM.

FIGURE 19. MATURE MEXICAN FAN PALM. NOTICE IT NO LONGER RETAINS A "SKIRT" OF OLD LEAVES. CREDIT: GITTA HASING

One important factor to consider when removing fronds is to avoid over pruning palms. Excessive pruning can potentially make the palm more susceptible to cold damage, pests, and disease (Rosenfeld 2009). Palm fronds take a long time to grow and mature, so removing more than just the dead fronds sets the tree back in production, particularly for nutrient-deprived palms. While studies show that pruning fronds does increase the number of fronds produced afterwards, these leaves are usually much smaller than the original leaves and suggest that over-pruning can also be linked to a decrease in stem diameter since the plant is being deprived of its food source.

According to ANSI pruning standards, only fronds whose tips fall below the 9 to 3 o'clock angles on a clock face should be removed (Fig. 20). Unfortunately, a common practice seen on palms in landscapes is hurricane cuts, also known as "rooster-tailing", in which only a few newer fronds are left around the top of the tree (Fig. 21). This practice actually cause the tree to be more susceptible to wind damage [2], [3]. The only exception to the 9 to 3 o'clock rule is during the transplanting of Sabal palms (*Sabal palmetto*), in which case pruning away the mature, live fronds prevents transpiration during transplanting and establishment [4].

FIGURE 20. CHINESE FAN PALM PRUNED PROPERLY AT 9 AND 3 O'CLOCK OR HORIZONTAL.

FIGURE 21. PALMS THAT HAVE BEEN OVER-PRUNED.

Tools & Techniques

In general, handsaws are preferred over chainsaws since chainsaws can damage palms more easily and are harder to disinfect. For species with smaller fronds, you can use hand clippers or a sharp saw. A small chainsaw can be used to prune larger fronds, but a handsaw should still be used to remove flower and fruit stalks. For species with heavier fronds, such as *Phoenix canariensis*, you will want to implement the same 3-cut method used for pruning large branches in order to avoid the frond prematurely breaking and tearing.

Take care not to injure the remaining live fronds or the trunk in the process of pruning. Remember to properly disinfect pruning tools before pruning each tree to prevent the transfer of disease. Many of Florida's commonly planted palms are susceptible to diseases like Ganoderma butt rot, Fusarium wilt, lethal yellowing, and Texas Phoenix palm decline. Our hot, humid climate exacerbates the spread of some diseases. If a diseased tree is confirmed in the field, remove at first notice to prevent the spread of disease to healthy trees.

Workers should be prepared to encounter animals living in palm canopies when pruning. On palm species that hold on to their fronds as persistent skirts, large sections of fronds can come loose during pruning and potentially injure workers. Make sure to plan to work from the top down when removing portions of the skirts. Be cautious any heavy fruiting (such as coconuts) that may pose a threat if dropped. Finally, keep in mind that fronds can travel far from the trunk once they are dropped, so communicate with the crew below and give proper clearance.

FIGURE 22. LARGE FRUIT LIKE THOSE ON COCONUT SHOULD BE REMOVED IN AREAS WHERE THEY OVERHANG PEDESTRIAN OR VEHICULAR TRAFFIC.

FIGURE 23. WIND-DAMAGED FRONDS LIKE THE TWO DROOPING BENEATH THIS BISMARCK PALM MAY BE REMOVED.

Practices to Avoid for Palms

FIGURE 24. AVOID FLUSH CUTTING THE PETIOLES OF PALMS.

Palm Pruning Review

What to Prune
- Dead fronds that are entirely brown (petiole included)
  - If NOT K-deficient (unlikely), can remove as many green fronds as can be produced in the next period between pruning, leaving at least two layers of mature fronds below the newest inflorescence.
- Flowers and fruit, especially large fruit like coconuts before storms (Figure 8)
- Fronds with damaged, twisted petioles
- Targeted trunks (sprouts) of multi-stemmed species

Practices to Avoid
- "Hurricane-cuts"
- Pruning beyond 9 to 3 shape
- Flush cuts of petioles and damage to living petioles (Figure 10)
  - Creates opening for pests/disease
  - Permissible to pull off loose boots by hand, but leave them if they don't come off easily
- Trunk damage with pruning tools or climbing spikes
  - Creates an opening for pests and disease
  - Creates unsightly, permanent wounds in the trunk
- Removal of nutrient deficient leaves

Crapemyrtle

Crapemyrtle (*Lagerstroemia spp.*) is a highly utilized species by the department of transportation. This is a reflection of the species' ability to tolerate a wide range of site conditions, as well as its highly desirable aesthetic appeal in highway beautification. Cultivars utilized by the department include 'Muskogee', 'Natchez', and 'Tuscarora.' Its popularity, unique and multiple growth habits, and past crapemyrtle pruning practices in the landscape industry all drive the need for specialized attention and care.

Past history

Crapemyrtles should require very little pruning if properly placed in the landscape. Traditionally, crapemyrtles have been topped or headed annually to stimulate sprout regrowth that creates a "bushy" look and maintains plant size. This improper pruning technique is due to a lack of training and the incorrect notion that topping is appropriate. However, not only are topping cuts more likely to decay causing more work down the line but the sprouts that do emerge from cuts are more susceptible to breakage. The numerous sprouts that are produced from topping cuts compete vigorously with one another for sunlight and resources. This leads to an increase in dead wood and overtime requires more maintenance. Never top a crapemyrtle.

Objectives

The primary objectives for pruning crapemyrtle are to enhance structure, aesthetics and stem growth. Pruning can also be performed to help remove diseased or dead branches, reduce canopy size, or provide clearance for sidewalks and roadways. Multi-stemmed crapemyrtles can grow long, extending branches, so it is imperative to select a planting location with enough space to reduce pruning requirements.

Timing and Dosage

In general, lighter pruning should be performed in the growing season, while heavier pruning, if needed, should be limited to the dormant season. As always, pruning for safety can be done at any time if necessary.

Tools and Techniques

Branches or limbs that are encroaching into the clear zone can be pruned to meet standards. When encroaching upon the clear zone, upward sloping branches should pruned to encourage upward growth while less favorable downward sloping limbs can be removed altogether. If the entire tree is in violation of the clear zone policy, obstructing views, or creating a hazard to the travelling public; it should be removed from the right-of-way to limit future problems.

For multi-stemmed crapemyrtles, it is best practice to retain 3-5 main stems. Root and basal sprouts should be removed annually to reduce competition with the main stem(s) and also prevent rubbing between stems.

A pruning option that is acceptable on crapemyrtles is known as tipping or rounding-over (see chapter 4 for more information). This practice utilizes heading cuts, but only on pencil-thin twigs to produce a desirable shape. During the growing season, this method will enhance flowering while it delays the onset of flowering when performed in the dormant season. Tipping encourages resprouting, so maintenance time will likely increase with each pruning event. Pruning should be performed with pole pruners as chainsaws are NOT recommended for use on crapemyrtle.

Crapemyrtle Pruning Review

What to Prune	Practices to Avoid
• Basal sprouts and crossing/rubbing limbs	• Pollarding if incapable of annual pruning
• Diseased, broken branches	• Chainsaw use
• Prune before budbreak if seeking to enhance flower production	• Heavy pruning events in growing season
• Remove downward sloping limbs	• "Crapemurder" (severe heading cuts)
• Overextending limbs	

Chapter 6: Rural Tree Pruning

The purpose of this chapter is to establish uniform and proper procedures for managing woody vegetation along Florida's rural roadways. It seeks to guide safe, effective, and efficient use of labor, equipment, and materials as it pertains to rural tree pruning. For the purposes of this guide, rural areas are defined as tree-covered areas not directly adjacent to residences and not intentionally installed in the landscape. Extensive management of woody ingrown vegetation is often required along rural sites within and alongside the right-of-way (ROW).

Rural ROW maintenance consumes a high percentage of FDOT resources, partly due to higher vegetative growth rates than the remaining United States. Challenges exist in balancing proper clearance, driver safety, tree health, and structure. This chapter is written in accordance with International Society of Arboriculture's Best Management Practices: Integrated Vegetation Management. While some department of transportation agencies employ the practice of chemical side trimming, it is not covered in this section (see Appendix B).

Objectives

In integrated vegetation management practices, segments of ROW as opposed to individual trees, are often managed as individual units due to large populations [5]. This approach should still meet the previously discussed pruning standards, keeping focus on clearance and safety. Pruning practices should efficiently improve visibility, reduce stem and branch failure, create safe operations for motorists and pedestrians [6], minimize regrowth to lengthen pruning cycles [7], and mitigate hazardous trees.. Crown raising and crown reduction to a predetermined clearance will be the most common approaches to rural tree pruning, while crown cleaning techniques will mitigate dead and hazardous limbs overhanging the roadway. These pruning techniques are outlined in more detail in Chapter 4: Pruning Methods.

Mechanical Pruning

Mechanical pruning equipment used on roadsides is divided into two main categories in this guide: skidder-mounted or tractor-mounted. This type of pruning is performed with heavy, specialized machinery equipped with saw blades. Similar to other pruning operations, cuts made during mechanical pruning operations should be made close to the main stem and outside of the branch collar. Precautions should be made to avoid the stripping or tearing of bark and the creation of excessive wounds [8]. The following practices may help ensure that proper cuts are made and these precautions are meet: positioning equipment to improve operator visibility, pruning at appropriate angles to the tree line to avoid high-surface area wounds, maintaining sharp cutting surfaces, working in clear conditions, and making each swath cut with caution. Recent research has shown that smaller tree wounds result in less decay (Gilman, et al. 2013) therefore, branches should be directionally pruned before reaching large diameters. Appropriate cutting angles may be parallel with the tree line or roadway but should always correspond with the angle of the branch attachment. Pruning

equipment used on state roadways in rural areas should be equipment with saw blades. Do not use flail-type cutters.

Follow-up pruning can be performed by climbing or bucket crews to help clean up cuts from machinery. This practice of "cleaning up" can help eliminate stubs that are not capable of compartmentalizing decay and re-sprout vigorously. This method is likely not cost-effective, stressing the importance of operator skill and experience while mechanical pruning.

Skidder-mounted Pruners

A skidder-mounted pruner typically consists of a long, telescoping boom with a large (up to 24-inch), high speed, carbide rotary cutting head at the end (Figure 3). The cab (driver's compartment) and the boom can either rest on rubber tires or a tracked undercarriage system. Tracked skidders will be more desirable in wetter areas, as the skidder's weight is more evenly distributed on the ground with the track undercarriage system. Benefits of skidder-mounted pruners include reduced pruning costs on long, contiguous stretches of right-of-way. The skidder-mounted pruner also eliminates the need for bucket operators or climbers, thus reducing risk of injury. Proper cut placement of the saw blade is essential to help reduce unnecessary injury to trees and suppress undesirable side-growth for an extended period. Advancements in technology have resulted in blades that tilt for cut improvements but are not widely used yet.

Side-mounted mowers

Another type of mechanical tree pruner is a side-mounted, boom mower used on low-growing and dense vegetation barriers. Typically yielding 20-25-foot folding arm, side-mounted mowers are mounted to tractors or side-by-side ATVs. Side mounted mowers commonly use two types of cutting heads: rotary and flail heads. Since rotary heads cut by impact, vegetation will often rip and tear creating excessive debris. Either technique must not be used per on state roadways for vegetation greater than 12" in height per Roadside Procedure #850-000-015 (2.4).

Site Selection

Site selection is important to consider when using heavy machinery for rural pruning. Soil compaction and disturbance from the machinery can have negative effects on tree health creating potential future hazards and contradicting maintenance goals. Fortunately, many roadside situations will allow mechanical pruners to work from the roadway and shoulder, dependent on ROW width and desired clearance. Here is a list of common issues that can occur when heavy machinery compacts or disturbs the soils [9]:

- Soil compaction reduces root growth by limiting moisture and oxygen content. Compaction primarily occurs on clay and loam soils.
- Soil rutting can alter water drainage to the extent that standing water creeps into the roadway. Churning of soil can expose seeds of undesirable vegetation to sunlight and accelerate ingrowth. Soil rutting and churning most often occurs on clayey soils

- Soil displacement can kill a tree if soil surrounds the trunk. Harbored moisture will increase reproduction of decay fungi and reduce oxygen in the soil.

Sanitation

Sanitation of equipment before use and in between different sites is important to help limit the spread of pests, diseases, and invasive weeds. Per Roadside Procedure 850-000-015-j (2.4), all maintenance equipment must be cleaned of all invasive seeds, spores, and active rhizomes in a designated containment area that can be monitored and treated if necessary. Cleaning of maintenance equipment should not only include vehicles and machinery but should extend down to any pruning tools used as well. Per Roadside Procedure 850-000-015-j (6.2), cleaning solvents must not contact plants, grass, shrubs, or bodies of water, only directed into containers. Tools should be soaked for at least 5 minutes using industrial disinfectants such as quaternary ammonium compounds (q-salts) or hydrogen dioxide products [10]. Various spray solutions also exist to help sanitize equipment.

Debris Disposal

Large amounts of debris can be generated quickly when using machinery for pruning or mowing in rural areas. If this debris is not properly managed it may cause environmental problems and hinder future maintenance work. Build-up of debris adds to fuel loads in the event of wildfire and obstructs natural water flows by clogging culverts and ditches (Miller, 2007). Improper and untimely methods of brush disposal may also interfere with future mowing practices and impact the health of surrounding vegetation.

Sites that are suitable for mechanical pruners may also be suitable for a mower with a mulching head to follow behind and mulch down debris. Per Roadside Procedure 850-000-015j (5.2), all debris should be directed away from traffic and drainage structures. Once brush is chipped into mulch it can lightly spread throughout the site. Mulch depth should be minimized to a couple inches and not spread in maintained grass or wildflower areas. Deep mulch can create anaerobic soil conditions and reduced water reaching the desirable vegetation. If the work site is nearby to landscaped areas, consider chipping debris into a dump trunk for relocation to the landscaped area.

Limitations

Some limitations of mechanical pruners:

1. Less selective for individual tree care.
2. Not for use in environmentally sensitive areas.
3. Not for use on yard trees, ornamentals, and historic trees.
4. Can increase operational costs due to possible lane closures.

Natural Areas and Wildflower Areas

To conduct tree maintenance adjacent to environmentally sensitive sites (e.g. riparian areas), FDOT should coordinate with the proper agencies and consult with a staff arborist, biologist, or botanist.

Work performed in or adjacent to wildflower areas, should be done in a manner and timeframe that does not disturb their growing, blooming, or seed-ripening seasons per procedure 850-000-015j (4.0). Consult with the respective FDOT District Wildflower Coordinator before working in these areas. Rural tree lines adjacent to National Forest are generally managed by the US Forest Service.

Rural Tree Pruning Practices to Avoid

- Excessive pruning
  - No more than 25% of a mature canopy should be removed in one growing season.
  - Live crown ratio should be no less than 2/3. Removing more can result in an unstable canopy.
  - Removal of large diameter limbs can result in vigorous, fast-growing sprouts with weak branch attachments, and an inability to compartmentalize. Certain species may be less tolerant to large cuts than others, such as laurel oak [31].
  - Pines should not be reduced to the main stem but to lateral limbs.
- Flush-cutting
  - Removing the branch collar prevents the tree's ability to compartmentalize the wound and decay will occur
- Topping by making cuts between nodes causes vigorous sprouting and decay.
- Lions-tailing when removing most internal foliage from branches.
  - Results in sunscald and reduced dampening in high winds.

Chapter 7 Storm Damaged Trees

Decisions often need to be made regarding whether a storm damaged tree will be removed or can be mitigated through restoration work. Young, disease free trees with good initial structure and the capability to live for a long time are the best candidates for restoration work. Sometimes the amount or location of the damage may warrant tree removal instead of other mitigation practices for economic reasons. Trees with numerous cracks, large pockets of decay, split trunks, large wounds, poor structure, or leans towards potential targets should be considered for removal. Decisions of removal versus restoration will ultimately be dictated by the agency performing the mitigation work, the financial budget, resource allocations, and the scope of work.

Develop Plan of Action and Storm Response Priorities

Choosing the right steps following a severe weather event can have almost as much influence on a tree population as the weather event itself. Initial selection of quality nursery stock and young structural tree training can help develop storm resilient trees. However, the necessity for restoration pruning is likely inevitable especially in hurricane prone regions like Florida. It is highly recommended that a well-communicated, thorough plan exists to address trees during storm response. Guidelines for work prioritization and risk mitigation methods are as follows:

Immediate priorities should seek to mitigate eminent safety hazards, generally with whole tree removal or removal of hazardous, hanging limbs. Examples of immediate priorities include:
- Roadway blockages (evacuation routes and hospital routes should take priority)
- High-stakes targets (power lines, infrastructure, people, high-trafficked areas)
- Drainage blockages
- Large, hazardous trees and limbs before smaller trees

Intermediate priorities can be completed after immediate hazards are mitigated. This will be accomplished by ensuring survival of toppled trees and cleaning crowns of damaged trees. Examples of intermediate priorities include:
- Blown over trees
- Trees with crown damage, and deadwood

FIGURE 25. BROKEN TOP AFTER HURRICANE IRMA. LITTLE CAN BE DONE TO IMPROVE THE CONDITION AND IT DOES NOT POSE A HAZARD; THEREFORE, IT WOULD BE LOW PRIORITY.

Crown Cleaning Storm Damaged Trees

Storm damaged trees may continue to experience dieback for a few years after an extreme weather event. Therefore, crown cleaning should be considered during the next couple years when revisiting these trees. Storms can result in unpredictable, hazardous conditions in the tree canopy. Special care should be given to safety when working with storm damaged trees.

- Look up for loose, hanging branches in the canopy
- Visually inspect tree stability before entering the tree.
- Prune torn, or hanging branches first to reduce hazards

Re-standing Trees

Blown over trees < 4" **DBH** may be candidates for re-standing if roots are healthy and intact.

- Exposed root balls dry quickly, so trees should be dealt with in a timely manner.
- When pulling trees upright, care should be taken to protect the stem.
- Torn, jagged roots can be root-pruned to encourage regeneration and wound closure.
- Trees should be staked, monitored, and cared for as if recently transplanted.

Restoration of storm damaged trees

Restoration pruning will begin after hazards are mitigated, canopies have been cleaned of deadwood, and time has passed (1-2 years for young trees and 2+ years for mature trees). Patience is vital and serves multiple purposes:

- Time for an accurate diagnosis as issues may not be immediately visible, especially for pines
- Time for epicormic sprouts to replenish carbohydrate reserves
- Discourage over-pruning by recognizing that desirable structure is likely unattainable in one pruning event. Repeated visits are often necessary, especially for trees that are large at maturity.

Damaged trees may need managed to compensate for strong leans or asymmetrical crowns that result directly from weather or having to remove large sections of canopy. Large sections of wood should not be removed at once, so reduction cuts should aim to achieve balance over time, centered over the trunk.

Palm Restoration

Palms have a few differences in how they should be addressed after storm damage, but general concepts do not change.

- Remove living tissue only if hazardous. Do not "hurricane cut".
  - Fronds provide a dampening effect in high wind events.
- Leave chlorotic and bent fronds intact.
  - They continue to provide nutrition.

Ensure the apical bud is not covered with other fronds. It is the only growing point for the palm.

Chapter 8 Tree Risk Mitigation

Tree Risk

A frequently discussed objective in this guidebook is risk management. The three main components of tree risk management are the identification of a potential target(s), the likelihood of failure of a tree or tree part(s), and the potential consequences of failure when the tree part strikes the target [11]. Once potential risks are identified they can be mitigated through various practices. Mitigation is the process of reducing the failure potential of a tree. Pruning, monitoring, and tree removals will be the most common forms of mitigation practices for hazardous trees alongside state roadways.

Indicators of Failure

The identification of certain tree defects can help determine the likelihood of failure. Some common defects to look for in risk assessments include but are not limited to: codominant leaders with included bark, strong leans, large decay pockets, trunk damage, horizontal branch cracks, and trunk girdling roots. However, not all tree species are as sensitive to these defects as others. Knowing a tree species profile can help determine how a defect will affect the tree health and stability. Consult an ISA Arborist for clarification prior to the work.

Since it is likely inefficient and too expensive to closely examine every tree in a large population, some form of prioritization is recommended. One example of prioritizing work is to stratify tree populations by traffic density or road priorities. This helps identify trees with the highest level of risk that should receive mitigation efforts first. The use of consistent tree marking practices as well as GPS coordinates can help accurately relocate the problem trees for further inspections.

Rural rights-of-way are often adjacent to forested stands, yielding the unique element of natural tree mortality where tree populations constantly decline with age due to competition for resources [12]. Other indicators of risk in rural areas include recent construction, land-clearing activities, steep slopes, water-logged or shallow soils, a history of tree failures, and past vehicular strikes [13].

Mitigation

Once a hazard tree is identified, FDOT should seek to mitigate the hazard. For hazard trees beyond the ROW, coordination with landowners and other groups may be required unless an emergency situation exists. Proper record-keeping and owner notification is essential to avoid future claims and disputes. FDOT personnel should refer to an internal system of property owner maintenance notifications. All work should strive to ensure that site conditions, desirable trees and groundcover, public and personal property, and FDOT resources remain undisturbed and intact.

Another consideration for best practices is to adopt a public notification process of planned work prior to commencing. Announcements should contain the location of the work, extent, herbicides used, planned dates, the goal or reason for the work, a description of the care to be used, a phone number or email for responses, and a statement that the work will be following the most current standards. This can be used for trimming, spraying, or removal work.

Maintaining Ecological Services in Natural Areas

Trees in natural areas provide buffer zones, erosion control on slopes, wildlife habitats and other ecological benefits. Even dead trees can still provide ecological services and <u>should be kept if possible</u>. Natural areas are often far enough away from the roadsides that there shouldn't be many potential targets for a tree or tree part to strike. If mitigation work in natural areas is unavoidable due to clear zone violations, agencies should check first to see if permits are needed. In addition, mitigation options beyond tree removals, like height reduction, should be explored if possible.

Stump Treatment and Removals

Tree stumps left in the ROW or along roadside can present risk to motorists and maintenance workers. In mowable areas identified as T-1 by Ferrell et al., (2012), stumps and roots should be removed below ground level as they can snag the underside of vehicles that exit the roadway [6].This work should be performed with specialized stump removal equipment and prohibit burning, blasting, physical, and chemical removal. Forcing stump removal with a bulldozer can have consequences to the surrounding tree line or pavement so care should be taken to examine the sites surroundings before work is performed. Where holes remain from stump removals, suitable soil fill should be added and compacted back into the hole at grade or slightly above grade if soil settling is anticipated.

In non-mowable areas identified as T-2 by Ferrell et al., (2012), stumps can remain but height should be limited. If stumps should be removed here, they can be bulldozed out. Many tree species are capable of resprouting from stumps. It is important to apply an herbicide treatment to the outer, cambium layer of trunk to help restrict sprouting from stump. Follow all labels, state, and federal regulations. Document the application using the department's Herbicide Application Log **(Form No. 850-000-15).**
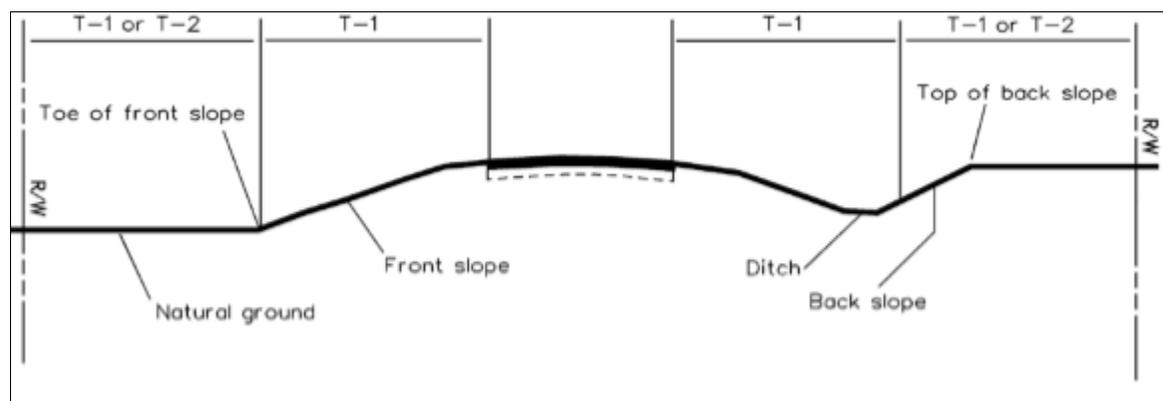
FIGURE 26. TYPICAL ROADWAY FROM FERRELL ET AL., (2012).

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Appendix

Appendix A: Drafting Pruning Specifications

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Disclaimer and Responsibility of the User

Use of this document: The following specification examples have been prepared by Wood Architecture, LLP, Jacksonville, Florida CA for the Florida Department of Transportation and they are copyrighted 2019. Permission is granted for use of this material to prepare specifications. It may not be reproduced in part or in its entirety for sale or profit.

Reading this document in its entirety is recommended so specifier can grasp the complexity of drafting pruning specifications that result in meeting tree owner objectives.

Instruction to the Specification Writer

This document is intended as a guide to writing project-specific specifications. Each project is unique and the specification should be developed accordingly. DO NOT USE THE FOLLOWING SPECIFICATIONS WITHOUT MAKING IMPORTANT ADJUSTMENTS to reflect local conditions, regulations, market standards, and project schedules. The following are specific items that need to be addressed.

1. General instructions for using these specifications: These instructions are intended to guide the specification writer (the specifier) through the process of editing this document into a pruning specification. Be sure to delete these instructions (i.e. all the text in red) before issuing the specifications.

2. General requirements, Division 01 (Construction Specification Institute) specifications and other contract elements: This specification is designed to be used in conjunction with Standard Division 01 specifications, which cover project general conditions and project-wide contract elements. THIS IS NOT A STAND-ALONE SPECIFICATION and should not be used as a contract to prune plants. Important issues of project ownership, liability, insurance, contract language, project controls, instructions to bidders, change orders and review and approval of the work are normally in the Division 01 specifications.

3. The construction team: As with any good contract there are protections for all parties; that the Owner will get the quality of project that they desire within the time limits and budget available; and the Contractor will be paid for the work satisfactorily completed. In between the initial bidding and the final completion there will be places where parts of the project do not work out as originally intended. This is normal and a good contract should allow for these changes in a manner that is equitable to both the Owner and the Contractor. To get there, a team approach and spirit must prevail. All parties must assume that each is operating in the best interest of the project goals. A clear set of objectives including a detailed description of the project results in a smooth flow during the project. The more each of the team members

can trust the other members, the better the project. This should be a critical principle in approaching interpretation of the specification.

4. Other project documents: These specifications are intended to be used in conjunction with other project documents including the bid forms, the pruning contract, Division 1 specifications, other specifications directly related. It is very critical that all these documents be prepared with consistent terminology and that they be coordinated. The terms used for the parts of trees and other plants must be consistent across disciplines. A very common mistake is the use of different terms and details for the work. The terms and details must be well coordinated.

5. Reviewing and approval authority: Each specification should identify a certain entity as responsible for the review and approval of the work, project submittals, changes to the work, and acceptance of the work. The entity is normally identified in Division 1.

6. Notes to specifiers: Before issuing the document, be sure to remove all "*Notes to specifiers*" incorporated into this document in red text after you have read them and responded to the recommendations.

7. Specification modifications: There are locations in these sample specifications where additional information is required to reflect project region or contract or tree conditions. Please insert the requested information and make adjustments where needed.

Current vs Future Situation

Many trees are currently allowed to develop **branch architecture** with several large upright pruned branches in the first 20 years in a manner shown in Figure 1, left. Although common, this creates challenging management decisions for the FDOT described elsewhere (Gilman 2012; Gilman et al. 2013). Despite the difficulty of pruning trees with inferior branch architecture (Figure 1, left), this document includes specifications that can be used to guide the pruning of trees in this condition. However, it is difficult which means it requires structural pruning experience, skill, and well written specifications.
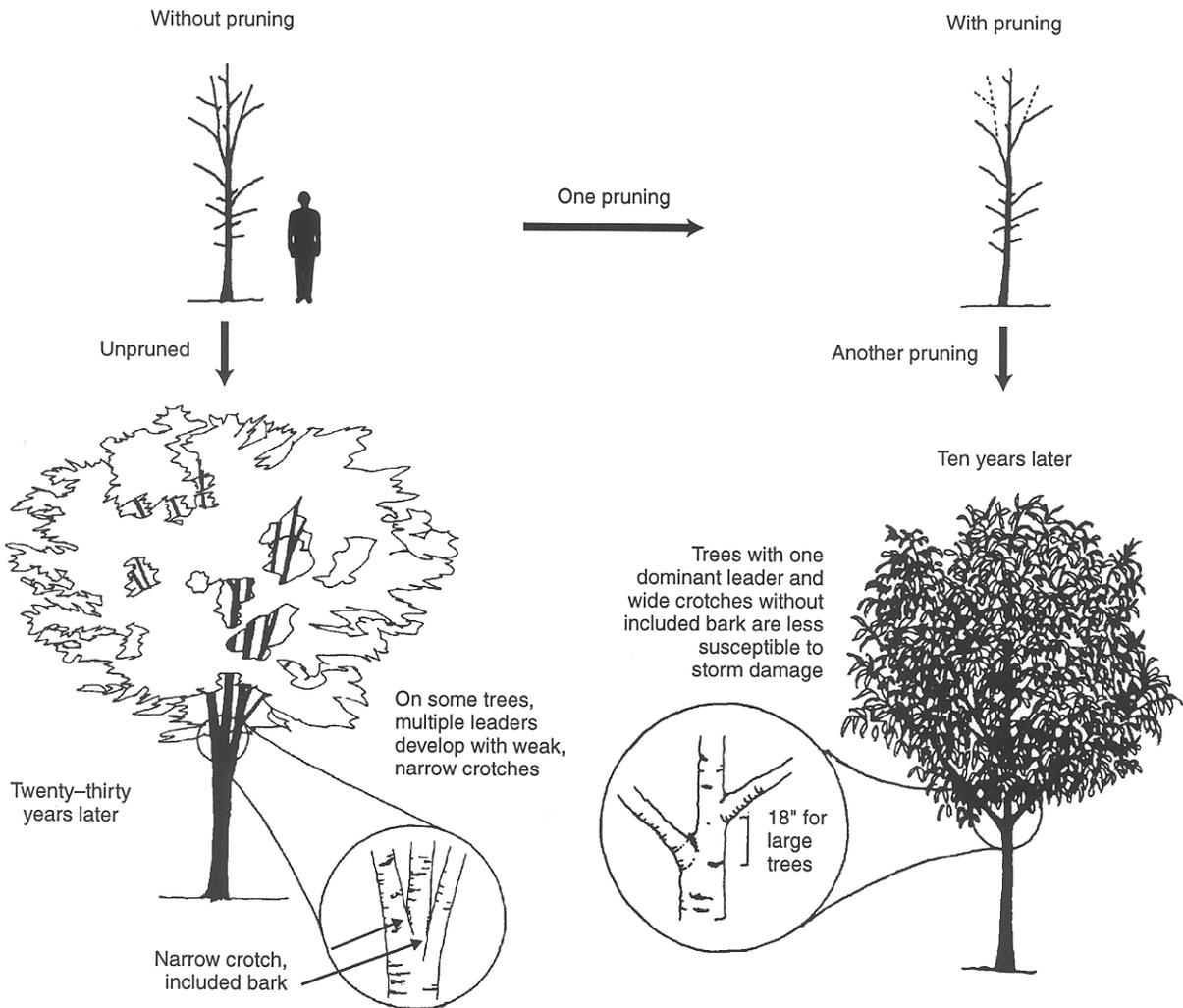
Figure 1. Many trees are left unpruned or they are pruned to encourage inferior branch architecture with several codominant stems (left). This form is weaker than the architecture that develops following pruning to encourage just one leader to dominate the tree (right)
.

Trees in and near rights of way can be managed in a manner that reduces risk of failure and minimizes current interference and clearance issues. This simplifies tree pruning by creating a more manageable situation (i.e. less pruning) in the future (Figure 1, right). Specifications in this document were developed to prevent the problems created by tree pruning as currently practiced. The strategy focuses on pruning trees at planting and then periodically during the next 20 to 30 years. This results in higher clearance sooner without sacrificing tree health by removing and guiding branches to position permanent branches higher off the ground.

Approach to Pruning

There are three major objectives to pruning trees in highly visible areas. These are to develop and maintain a stable structure to reduce risk of failure; provide visibility and clearance for safe passage of vehicles and pedestrians; and maintain or enhance aesthetics. Tree owners (the Florida Department of Transportation) determine objectives and contractors perform the work to meet objectives within the guidelines detailed in the specifications. Different pruning strategies are employed to accomplish each objective. For example, reduction cuts are commonly used for reducing risk and for training young trees (both these objectives are important to FDOT); whereas, branch removal cuts and reduction cuts are the choice for clearance pruning.

Urban and suburban areas - From training young trees to pruning mature ones, structural pruning manages risk by improving tree architecture and should be a primary goal each time a tree is pruned. The DOT may decide that structural pruning is particularly important for highway entrance and exit ramps, rest stops, streets, and other locations where trees or tree parts could impact travel lane, pedestrians, and structures.

A well-structured tree is aesthetically pleasing, supports the crown as it grows larger, is long-lived, and provides the greatest benefits at the lowest cost. Trees such as oaks and mahogany that become medium-sized to large at maturity (and are likely to live for decades due to their location) should be considered for structural pruning each time they are pruned. Most small-maturing trees such as crapemyrtle, ligustrum, and buttonwood remain less than 30 feet tall and DOT may decide that structural pruning is a lower priority because trees may not grow large and will cause less damage if they fail.

Pruning for structure differs than other pruning objectives because it focuses on directing growth and developing the framework (i.e., branch architecture) of the tree to enable it to withstand future wind loads. Management objectives transition to managing load once the framework is developed. Skill at structural pruning comes with experience. The primary focus is on pruning the parts of the crown that currently contribute to – or will contribute to - weakness. Rather than a one-time event, structural pruning should be thought of as a training process that improves tree structure over a period of a decade or more. It should begin the day trees are planted. A suggested 25-year management strategy can be found below.

Trees that do not receive structural pruning when young can be more problematic to maintain as they mature. Structural deficiencies that were ignored early can become significant weaknesses when trees are bigger and support larger loads (taller and longer branches). Poor tree architecture or inferior branch structure such as codominant stems (especially in the lower 15 feet of the tree), bark inclusions, over-extended branches, and leaning trees can lead to tree failure and early tree removal, eliminating the benefits that could have been provided by a mature tree. During storms, trees with poor structure are usually the first to fail, knocking out power lines, blocking traffic flow and evacuation routes, increasing the costs for clean-up, and sometimes interfering with emergency operations. Trees also can injure people sometimes resulting in fatalities.

In most cases structural pruning employs two primary strategies: 1) on young trees, develop and maintain a single, dominant trunk with smaller primary branches by removing some primary branches or pruning the

ends of the largest, most aggressive, dense, or the longest primary branches; and 2) on older trees, reduce the likelihood of tree failure caused by defects in structure and poor weight distribution by reducing load on the ends of large and/or long branches.

Structural pruning is accomplished using branch removal, reduction, and (occasionally) heading cuts (where appropriate). Removing branches from a limb slows growth on that limb which encourages other parts of the tree to grow larger. This approach is called *subordination* because it subordinates or slows growth on pruned limbs relative to other parts of the tree. By using subordination treatments, limb diameter remains small because the parent trunk continues to grow rapidly. Thus, cuts are small when the pruned limbs are removed for visual clearance in the future. This strategy makes clearance a less labor-intensive task in the future and reduces the likelihood of decay in the tree because cuts are small.

Clearance of travel lanes, buildings, sight lines to signs, and access is important in many instances. Clearance is often expressed as distance from the ground or from an object (e.g. a building) or location such as a roadway edge. Clearance includes removal of primary branches and secondary branches (using branch removal cuts), and reduction in branch length (using reduction cuts). Clearance pruning is often combined with structural pruning to meet the two objectives of creating clear site lines and reducing risk. Clearance pruning is commonly practiced on small-maturing trees for aesthetic, visibility, herbicide application, and for other reasons. Low branches that will eventually be removed from trees due to interference with buildings, vehicle or pedestrian traffic, maintenance, or blockage of sight lines should be subordinated or removed sooner than later. This prevents having to execute large pruning cuts in the future which can reduce tree vitality and shorten their life span.

Aesthetics is a reasonable objective especially in highly visible areas such as rest stops, highway interchanges, and areas where the DOT manages trees through municipal rights of way. Aesthetic pruning can include strategies such as visually balancing the tree which presents a symmetrical crown outline or thinning dense crown clusters at the crown exterior. The crown interior should not be removed under most circumstances; in other words trees should not be lion tailed.

Rural areas – In contrast to urban areas, the DOT could decide that structural pruning may not be as important in rural regions where structural integrity may be judged by DOT as less important.

Pruning Process

Pruning is accomplished using primarily branch removal cuts and reduction cuts. Heading cuts can be used along stretches of rural roadway to **reduce length** of branches near travel lanes. However, headed branches on certain species such as pines often die back to the trunk; other species sprout vigorously resulting in the need to re-prune.

Branch removal is straightforward – the branch is removed back to the parent branch or trunk which is larger in diameter than the removed branch. Reducing the length of branches is more complicated and is a key component of pruning trees. The location of the first reduction cut is toward the end of the branch in question. Beginning at the trunk and moving outward, the largest portion of the branch is visually followed at each fork until the arborist finds a place to make a reduction cut of the specified diameter. Any subsequent cuts are made on the largest lateral branches back toward the trunk (working from the branch end) until the specified number of reduction cuts are made. *(Note to specifier: The last three sentences of this paragraph are important and may be poorly understood by contractors. These can be included in specifications to clarify the desired pruning strategy.*

Why Specifications?

Written specifications are essential for communicating what is to be accomplished by pruning. They establish tree owner objectives and describe how to meet them. Specifications guide and protect both the tree owner and the contractor by ensuring that everyone clearly understands objectives and scope of the work. Municipalities, utilities, commercial arborists, and tree owners all benefit from writing and using specifications. The language and practices contained in national standards should be used when writing pruning specifications. The United States has national standards for tree pruning that establish uniform language and practices. This document uses the American National Standards Institute (ANSI) A300, Part 1 Pruning Standard language.

Specification Overview

Pruning is complicated; therefore, specifications should be prepared by professional arborists with proven and demonstrated knowledge in drafting and implementing clearly written and accountable pruning specifications. These entities may not be easy to find. Personnel preparing specifications should comply with the language and practices contained in the latest ANSI A300 Part 1 pruning standards, and apply practices in the latest International Society of Arboriculture (ISA) Best Management Practices document. The books "Structural Pruning: A Guide to the Green Industry" and "Illustrated Guide to Pruning: Third edition" may also be referenced when writing specifications. Said arborists should also be able to show others how to conduct pruning. In cases where the FDOT will not prepare the pruning specifications, the DOT should have arborists on staff with proven knowledge of drafting pruning specifications so they are qualified to review specifications drafted by contractors. Ideally, FDOT would prepare specifications that contractors would implement. Specifications need to be clear and detailed enough so that contractors implement pruning in the same manner envisioned by the personnel preparing the specifications. FDOT and contracting arborists should receive detailed and documented training on how to draft and implement specifications from entities with experience in writing specifications. International Society of Arboriculture Certified Arborists (CAs) may or may not have the experience needed to write pruning specifications.

Individuals drafting specifications should have a working knowledge of - and experience with – modern arboricultural pruning. This includes familiarity with the applicable safety (ANSI Z133) standards, and recent advancements (research), texts, and on-the-ground hands-on experience. The most important qualification of a specification writer is an understanding of what should be accomplished with pruning (objectives) and how to describe it. This requires practice to master. Inexperienced individuals lacking knowledge of the applicable standards, and lacking experience in structural pruning might include unreasonable expectations of contractors; skip important steps or objectives; misapply terminology; recommend substandard practices; and other activities that can compromise the tree owner and the trees.

Specifications should include the location and general (or specific) description of the trees, pruning system(s), objective(s), pruning cut types(s), amount to remove, type of part to remove, and location of branches in the tree (Table 1). Specifications should also include the timeframe for completion, the plan for disposal or repurposing of debris, and a recommendation for re-inspection or re-pruning (sometimes referred to as the pruning interval or pruning cycle). The sample specifications in this document include many ways of expressing these parameters; there may be other ways to express them. However, standard language included in Z133 and A300 should be adhered to in order to avoid confusion. The language used in this document meets that in the cited Standards at the time of publication.

Table 1. A pruning specification should include the following information.

1-Trees to prune (plant name(s) - common and/or scientific)

2-Location in the landscape (street address and position in the landscape e.g., all trees lining the roadway)
3-Pruning system to be applied (e.g., natural, pollard, topiary or hedge shape); the **natural pruning system** is by far the most common and will be the only system described in this document.
4-Purpose or reason for pruning: (e.g. improve sight lines, preservation of trees, provide clearance, improve a view, prevent trees and tree parts from falling on roadway, reduce risk, increase light penetration to ground)
5-Pruning objective(s) (e.g. improve branch architecture, raise crown, reduce length or dimensions, reduce crown density, reduce risk of branches falling)
6-Type of parts to remove (e.g., live branches, dead branches, dead fronds, fruit, mistletoe)
7-Size range of branches to remove (e.g., diameter range, maximum or minimum diameter, length)
8-Location within the crown of the parts to remove (e.g., largest diameter primary branches, outer edge of entire crown, top half of the crown, over roadway, largest aspect ratio branches, branches on the travel lane side of tree, over the building,)
9-Type of pruning cuts to utilize (e.g., branch removal cut, reduction cut, heading cut)
10-Amount to remove (e.g., all dead branches over 2 inches in diameter; number of pruning cuts [of a certain diameter]; 5 to 7 feet of length; a percentage of length or height; a percentage of foliage [e.g., 25 percent of live foliage])
11-Limitations (e.g., less than 70% of cuts shall be branch removal cuts)
12-Plan for disposal of debris (e.g., remove all debris, chip brush, leave wood chips, leave firewood)
13-Time frame for completion of the work (e.g., certain date, over the winter, July)
14-Re-inspection or pruning interval (e.g., 3 years, annual, monthly during the growing season)
Additional information as needed (e.g., topiary shape, clearance distances, desired view)
(Note to specifier: For simplicity of presentation, items 6 through 10 can be combined into a "branches to be pruned" item as shown in many of the example specifications.)

Although all of the following are addressed in either the Z133 or A300 Part 1 Pruning Standards, additional emphasis can be placed on certain work practices by including them in the specification. Some examples of important statements to include are:

- All pruning cuts shall be made in accordance with the ANSI A300 Part 1 Pruning Standard.
- Work practices shall be consistent with the current ANSI A300 Part 1 Pruning Standard and the ANSI Z133 Safety Standard.
- All work shall be performed under the supervision of an ISA Board-Certified Master Arborist (BCMA). *(Note to specifier: Although there are presently (2019) no qualifications for tree pruners, the ISA's BCMA credential may be the best substitute for a trained pruning specification writer.)*
- Trees should be inspected in three *(Note to specifier: or choose an appropriate number)* years to consider re-pruning.
- Trees shall not be lion tailed or topped.

Developing Specifications

There are two ways to use this document to help develop specifications. The specifier can 1) review the list of specifications (Table 2) and illustrations (Appendix 2) to quickly locate an appropriate specification and detail(s), or 2) peruse the many specifications by reading them and then matching the appropriate specification for the trees in question. The specifier should also have a copy of the five relevant documents recommended above (also listed in the Suggested Reading section) which will help the specifier to use standard arboriculture language and understand standard practices. The specifier might want to consider including language in the specification that recommends contractors also have a copy of each on site.

Specifications Included within this Appendix

Table 2. List of example specifications included in this Appendix.

Specification example number and title.			
Example 1	Incomplete specification.	Example 18	Clearance from sidewalk, street and buildings downtown.
Example 2	Pruning specification for single tree.	Example 19	Residential street trees (young trees).
Example 3	Pruning specification for highway rest stop.	Example 20	Residential street trees (medium-aged/mature trees).
Example 4	Pruning trees at planting.	Example 21	Parking lot large-maturing young trees.
Example 5	Pruning young trees planted in the last 5 years.	Example 22	Parking lot large-maturing medium-aged trees.
Example 6	Pruning young trees.	Example 23	Parking lot small-maturing trees.
Example 7	Pruning medium-aged trees.	Example 24	Single tree.
Example 8	Pruning mature trees.	Example 25	Single tree.
Example 9a, 9b	Palms without crownshaft.	Example 26	Small grouping of trees.
Example 10	Palms with crownshaft.	Example 27	Residential shrubs and hedge.
Example 11	Pine trees.	Example 28	Reduction on a single mature tree.
Example 12	Interchange slope (shrubs).	Example 29	Reduce section of crown.
Example 13	Young trees along turnpike and interstate entrance/exit ramp. (Interchange)	Example 30	Reduce crown density on small-maturing trees.
Example 14	Medium-aged and mature trees along turnpike and interstate entrance/exit ramp.	Example 31	Reduce crown density on large mature trees
Example 15	Forest edge strip for many miles. Hedging.	Example 32	Raise crown of young large-maturing tree.
Example 16	Divided highway median.	Example 33	Raise crown of medium-aged large-maturing tree.
Example 17	Raise crown at Interstate/turnpike interchange.	Example 34	Raising crown of large mature tree.

The specifications should be based on tree owner objectives, tree species, tree condition, tree location, and size of the trees to be pruned. Sizes, lengths, fractions, percentages, number of branches, phrases and other statements are shown in this document as examples; these should be modified by the specifier to meet the objectives and the situation. These parameters should be adjusted according to the pruning cycle, tree owner's tolerance to voids in the crown, proximity to pedestrians and structures, and severity of any defects. Details (illustrations with captions, Appendix 2) should be incorporated as needed and are typically essential to communicate what is to be performed. More than one detail may be referenced and included in any specification.

Single tree specifications can be very specific detailing what is to be done on the tree; specifications written for a large grouping or population of trees have to be less specific and broader in language to reflect the

variation among trees in the population to be pruned. Broader language would include items such as specifying ranges in pruning cut sizes (e.g. 2.5 to 3.5 inch diameter) instead of a specific diameter, ranges in the number of cuts (e.g. 3 to 5 reduction cuts) instead of a specific number, and expanded ranges in branch length reduction (e.g. 6 to 12 feet) instead of a specific length or tighter range (6 to 7 feet).

It is impractical to evaluate each tree where there are many trees to be pruned. A subset of the population can be evaluated by size and species and specifications can be drawn from this subset. For example, if there were a total of 500 trees (oak and mahogany) to be pruned a 5 percent (25 trees) or 10 percent (50 trees) subset could be evaluated – the remaining trees would not be evaluated. The specifications drafted from the subset would then be applied to all 500 trees. More specifically, if an average of ten 3.5 to 4 inch diameter reduction cuts were required to meet objectives on the subset, then an average of ten 3.5 to 4 inch diameter reduction cuts would be applied to all 500 trees.

One method of calibrating a specifier is to develop a written specification on paper and go to the field and apply it to several real trees. As the arborist prunes the trees according to the specification, the specifier may realize that it requires adjustment in order to meet objectives. The specifier will become better at preparing clear specifications after some practice sessions on a variety of tree species, situations, and sizes. Items that may need adjusting include the ratio of reduction to branch removal cuts, the diameter of pruning cuts, the diameter or aspect ratio of primary branches to be pruned, the number of pruning cuts to apply to primary branches, and the location of pruning cuts.

Example Specifications: Comparing Complete and Incomplete Specifications

Short, concise, simple specifications are simple to write and allow the contractor great flexibility and leeway in executing the work. This may or may not be advisable depending on the situation. An experienced skilled contractor with a history of meeting objectives and providing quality service to your organization may execute the work exactly as you wish; whereas, a contractor new to your organization may require more detail. Detailed specifications are more time consuming and challenging to write because they describe what is to be performed to meet objectives. In the end, a detailed specification provides a more accountable system of operating and is the best way to ensure work is being performed in a manner which meets the needs of you and your customers and preserves tree health. Examples of both are discussed below.

The "*Note to specifier*" - purposely written in red throughout this instructional document - will assist the specification preparer in understanding the reasons for including certain items in a specification, and how to modify the statement for your particular application. The text in red will be removed by the specifier prior to publishing your specification.

The two examples (Example 1 and 2) below serve as models for items to include in a pruning specification. Although there are instances where these specifications could be used as is, most situations will require adjustments in the text that follows the headings in bold. The categories listed in bold should, in most cases, be included in a specification.

Example 1. Sample pruning specification for single tree. (*Note to specifier*: *This is a more complete approach to writing a specification compared to Example 3; compare the two to see if you can determine why Example 3 is deficient.*)
Tree to prune: Large oak (*Quercus*) in the front yard.
Pruning system: Natural.
Purpose: Preserve tree structure and health.
Objectives: Reduce the risk of live and dead branch failure; increase light penetration to the ground.
Branches to prune:

1) Remove dead, dying, detached, and broken branches greater than 1 inch in diameter at the point of attachment at a healthy branch (a branch with foliage) or trunk.

2) Reduce the live branch on the north side (~8-inch diameter) with a crack and dead twigs using two 3-inch reduction cuts.

3) Reduce the five largest live upright-growing primary branches using two 2.5- to 3-inch diameter reduction cuts on each branch for a total of ten reduction cuts.

Limitations: No branch removal cuts should be used to remove live branches.

Completion date: Early spring of this year.

Re-inspection: 2 years.

Example 1 detail:
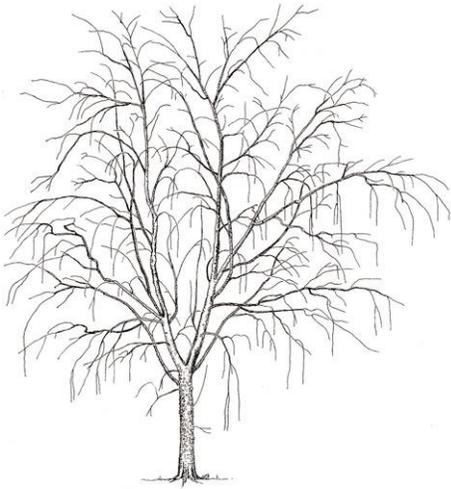
Before pruning (above): The diameter of two branches have become nearly as large as the trunk measured directly above the union.
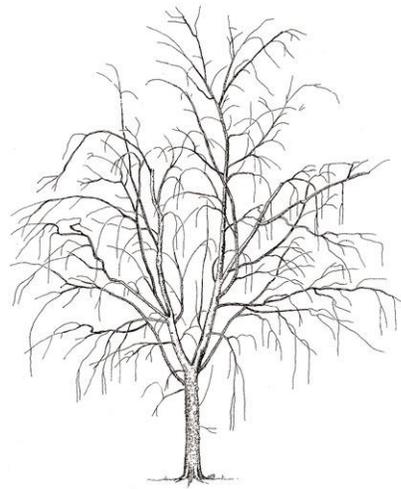
After pruning (above): Reducing the largest primary branches (growing from trunk on lower left and middle right) using reduction cuts.
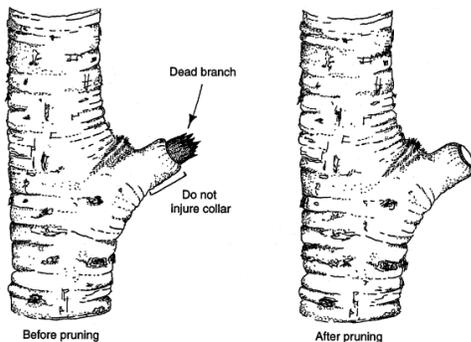
Removing dead branches (left): Remove only the dead portion of the branch; leave the live collar intact.

Example 2. Sample pruning specification for highway rest stop. (*Note to specifier*: *This is a more complete approach to writing the specification shown in Example 3.)*

Location: Highway rest stop.

Trees to prune:

1) 115 large-maturing planted trees of various species 12 to 15 inch DBH along truck rest stop roadways, and parking lot;

2) 47 large-maturing planted trees of various species 12 to 15 inch DBH along automobile rest stop roadways, and parking lot;

3) 16 oaks 15 to 30 inches DBH located in the open lawn and landscape 40 feet or more from sidewalks and roadways.

Pruning system: Natural.

Purpose: The purpose of pruning trees at the rest stop is to minimize current and future interference with truck and other vehicle traffic; provide visible site lines across the landscape; and reduce likelihood of future tree failure.

Objectives:

1) Provide 18 feet clearance from ground to bottom of lowest branches at the point where the branch enters the ROW of 12 to 15 inch trees over rest stop truck roadways and parking lots. *(Note to specifier: Clearance height can be adjusted to meet site requirements and tree form. Change the height in the "Branches to prune" section below to match.)*

2) Provide 14 feet clearance from ground to bottom of lowest branches at the point where the branch enters the ROW of 12 to 15 inch trees over rest stop automobile roadways and parking lots. *(Note to specifier: Clearance height can be adjusted to meet site requirements and tree form. Change the height in the "Branches to prune" section below to match.)*

3) Provide 14 feet clearance from ground to bottom of lowest branches at the point where the branch enters the ROW under the 15 to 30 inch DBH trees located more than 40 feet from roadways. *(Note to specifier: Clearance height can be adjusted to meet site requirements and tree form. Change the height in the "Branches to prune" section below to match.)*

4) Reduce likelihood of tree failure in storm events on all 178 trees. *(Note to specifier: This statement was included because it is advisable to include structural pruning when clearance (crown raise) is the main objective. Implementing clearance pruning - without structural pruning - forces trees to grow taller which can accentuate and make worse existing defects in the middle and upper crown. Defects can cause trees to break.)*

Branches to prune: *(Note to specifier: Be sure each objective is met when writing this section.)*

12- to 15-inch DBH oaks (and other large-maturing) trees in truck parking area:

1) Where the trunk divides into two equal or nearly equal parts in the lower 10 feet, remove the one toward the parking area or roadway. Remove all primary branches – regardless of diameter or **orientation**- originating on the lower 10 feet of trunk (*Note to specifier: This distance could be as low as 8 feet depending on the upward angle of the branch segments close to the trunk. The goal is to create 18 feet of clearance between ground and the lowest branch over the pavement of the roadway and parking lots.)* so there is only one trunk vertically to 10 feet *(Note to specifier: Compared to removing only secondary branches from primary branches to create clearance – referred to as lion tailing - this approach reduces likelihood of branches and foliage growing back and blocking visibility in the future. Large pruning wounds on the trunk might be required on certain trees, but this is a good trade-off for these young trees.)* Remove secondary branches growing downward into the clearance zone from low primary branches.

On individuals where more than 50% of the foliage on the tree *(Note to specifier: Estimating the percentage of foliage removed is difficult and people often do not agree. This is a judgement call by the specifier and the contractor. Because all parties may not agree on the percentage of foliage remaining on the tree after pruning, the specifier and contractor should come to agreement by pruning three or four trees together prior to beginning the work. Other locations may have different species and branch architecture so this exercise may have to be performed in multiple locations. While this approach minimizes trunk decay from larger pruning cuts, reduced branches are likely to sprout resulting in the need for clearance again in the near future). This percentage can be adjusted downward.)* would be removed following this specification, adjust the procedure to only remove those primary branches that are less than one-half the trunk diameter originating on the lower 10 feet of trunk, and reduce those that have a larger aspect ratio. This is accomplished by using 3-to 4-inch diameter reduction cuts to a) shorten (reduce) the longest and the most upright branches and b) removing those drooping downward. About half the foliage should be removed on each reduced primary branch; do not execute step #2 below. *(Note to specifier: Specify the number of cuts to perform per branch such as 3 to 4; this section of "Branches to prune" relates to objectives 1 and 2.)*

2) Reduce length of the three largest diameter branches on the trunk originating above 10 feet trunk height with two 3-to 3.5-inch diameter *(Note to specifier: Number and diameter of cuts can be adjusted.)* reduction cuts on each. *(Note to specifier: This section of "Branches to prune" relates to objective 4.)*
3) Reduce length by 30 percent on branches with bark inclusions or cracks.

<u>12- to 15-inch DBH oaks (and other large-maturing) trees in automobile parking area:</u>
(Note to specifier: Insert text from the section above substituting 14 feet for 18 feet.)

<u>15- to 30-inch DBH trees:</u>
1) Reduce length of primary branches and stems originating from the trunk in the lower half of total tree height with aspect ratio greater than one-half using an average of three (range 2 to 4) 3 to 4 inch diameter reduction cuts on each branch *(Note to specifier: The number and size of cuts can be adjusted to suit the site and the condition and size of trees. For example, the number of cuts per branch could be adjusted upward for larger branches and trees.). (Note to specifier: This section of "branches to prune" relates to objective 3 and 4.)*
2) Remove or reduce secondary branches growing downward from primary branches in the lower half of total tree height.
3) Remove all branches on lower 8 feet of trunk except branches larger than 6 inches *(Note to specifier: This number can be adjusted to suit the conditions, structure and size of trees and the site knowing that the larger the pruning cut on the trunk the greater the potential trunk decay. This can also be expressed as in the above section specifying aspect ratio instead of diameter. Aspect ratio is a more generic specification which can carry over to the larger number of situations.). (Note to specifier: This section of "Branches to prune" relates to objective 3.)*
 4) Reduce length by 30 percent on branches with bark inclusions or cracks.

Limitations:
1) No heading or shearing cuts shall be made without authorization.
2) No more than one-half of the foliage shall be removed from an individual tree without authorization. *(Note to specifier: This number should be adjusted to accommodate the age and condition of trees and the site attributes. Adjust the number downward for older trees in poor health. Younger trees could tolerate a larger percentage provided trees were in a high state of vitality.)*
3) Less than 70% of cuts on live branches shall be branch removal cuts. *(Note to specifier: Including this statement in the specification ensures that the contractor uses some reduction cuts to prune the trees. Reduction cuts are necessary in order to perform the objectives in this specification. Adjust the percentage according to the site, location, age, and form of the trees. The percentage should be adjusted to suit conditions.)*
4) Make no removal cuts on the trunk larger than 6 inches diameter *(Note to specifier: This number should be adjusted to accommodate the age and condition of trees and the site attributes. Adjust the number downward for older trees in poor health. The diameter of the cuts should be adjusted to suit conditions.)*
5) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the most common sub-standard pruning practices in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*
6) Wounds left by reduction and removal cuts shall not be coated with wound dressing or pruning paint of any kind. *(Note to specifier: Except for a small number of diseases such as oak wilt, there is no evidence that wound dressings help trees following pruning. This can be included in the Limitation section of every pruning specification if needed)*
General requirements: *(Note to specifier: The following five items should be included in every pruning specification because they are considered standard practice; in order to conserve space in this document, they will not be included in subsequent example specifications in this document.)*
1) All pruning cuts shall be made in accordance with the current ANSI A300 Part 1 Pruning Standard.

2) Work practices shall be consistent with the current ANSI A300 Part 1 Pruning Standard and the ANSI Z133 Standard.

3) Trees shall not be lion tailed or topped.

4) All work shall be performed under the supervision of an ISA Board-Certified Master Arborist. (*Note to specifier: Most states including Florida do not license arborists; some states e.g. Louisiana, New Jersey, Connecticut, and others license arborists*).

No tree shall be ascended using climbing spurs or spikes unless it is to rescue an injured worker or in cases of tree removal.

Debris removal: All debris will be removed from the work area daily.

Completion date: Fall of this year.

Re-inspection: Trees will be re-inspected and considered for pruning 3 years after completion of the current pruning project (*Note to specifier: choose your own number appropriate for the circumstances.*).

Contractor requirements: All potential contractors shall be present Monday morning 8 am to watch three trees pruned according to the specifications contained herein. (*Note to specifier: This is designed to demonstrate to contractors the pruning to be performed on the subject trees. Contractors may not be familiar with this approach to pruning and therefore might not be capable of - or they may resist - performing the specified work. The specifier should hire a contractor that understands the pruning required in the specification and this is a great way to expose contractors as to what is expected. Before choosing a contractor to perform the work, consider requiring them to demonstrate the pruning to the specifier. The specifier should be prepared to review work the day it starts and then several times weekly until contractor demonstrates that they are capable of performing the work as specified.*)

(*Note to specifier: The Contractor requirements statement should be considered for inclusion in every pruning specification; in order to conserve space in this document, the Contractor requirements section will not be included in subsequent specification examples in this document.*)

Example 2 detail:
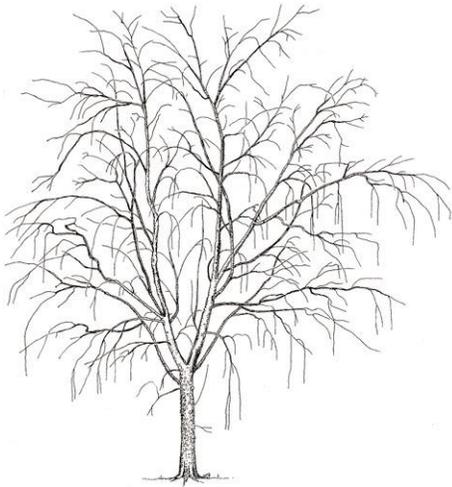
Before pruning: The diameter of two branches have become nearly as large as the trunk measured directly above the union. Low branches are blocking pedestrians and drivers view of traffic signs.
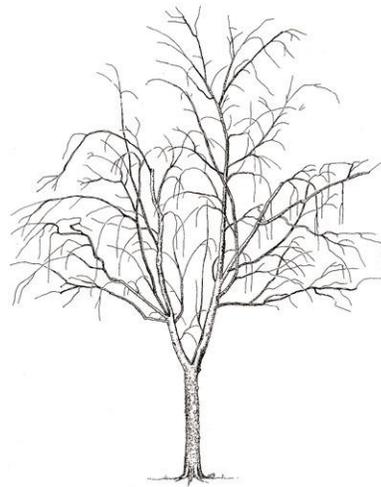
After pruning: 1) Reducing the largest two branches (growing from trunk on lower left and middle right) with reduction cuts to improve branch architecture. 2) Removing lower secondary branches with removal cuts to raise the crown.

<u>Example 3. Sample incomplete specification.</u> *(Note to specifier: This incomplete specification is not recommended and serves only as an example to compare with the recommended detailed specifications presented above and in the remaining portion of the document. As you read through this sample, ask yourself what might be missing from this specification before reading the critique below.)*

Location: Highway rest stop.

Trees to prune:

1) 115 large-maturing planted trees of various species 12- to 15-inch trunk diameter measured 4.5 feet from the ground (DBH) along truck rest stop roadways, parking lot and sidewalks;

2) 47 large-maturing planted trees of various species 12- to 15-inch DBH along automobile rest stop roadways, parking lot and sidewalks;

3) 16 oaks 15 to 30 inches DBH located in the open landscape 40 feet or more from sidewalks and roadways.

Objectives:

1) Provide 18 feet of clearance over rest stop truck roadways, parking lots, and sidewalks.

2) Provide 14 feet clearance over rest stop automobile roadways, parking lots, and parking lots

3) Provide 14 feet clearance under the 16 oaks 15- to 30-inch DBH located more than 40 feet from roadways.

Debris removal: All debris will be removed from the work area daily.

Completion date: February 14 of the current year.

Critique of Example 3 specification. The incomplete specification above is missing some sections that can result in inconsistent and/or substandard work without meeting objectives. The following is a discussion of the implications of not including certain items.

Pruning system is missing. Including this makes it clear to the contractors that trees will retain their natural shape without topping, shearing, or lion tailing.

Purpose is missing. Including a purpose of pruning allows the contractor to perform the work to meet objectives as they relate to long term goals at the site.

Objectives: As written, the only objective is to provide clearance. While complete in this regard, it is often easy to achieve multiple objectives when pruning a tree. For example, pruning to reduce the likelihood of failure in storms would add very little to the overall expenditures required per tree because so much effort is made simply for crews to reach the tree. It is important to reduce likelihood of failure in planted trees at a rest stop and other locations where pedestrians, vehicles, or other potential targets are present.

Branches to prune: Writing this section is the most difficult (and important), requiring knowledge of tree biology, structure, and tree response to pruning. Including this section details how the work is to be accomplished including pruning cut size and pruning cut types to use, amount to remove, and where in the trees to prune. It is recommended that the type of information included in the detailed specification shown below is incorporated into the specification. Without this detail, the contractor may not provide the service in a manner that meets objectives while minimizing the negative impacts on tree health. For example, contractor could remove all branches back to the trunk on the roadside of the tree and meet the clearance objective in the specification. The specifier may have envisioned a different approach such as removing only drooping secondary branches and shortening but retaining all primary large branches low on the trunk; without specifying the detail shown below, there is no guidance on this issue.

Limitations: This section details the practices the specifier does and/or does not want performed on the trees. It is a powerful way to communicate work practices which may or may not be used on the trees.

Re-inspection: There is no designated pruning cycle or recommended return time when the tree should be pruned again. Including a pruning cycle in the specification allows the specifier and contractor to place the

pruning into a better context. More material (e.g. more cuts or larger cuts) should be removed where the pruning cycle is long (e.g. 10 years) than when the pruning cycle is shorter (e.g. 3 years).

Example Specifications: Large Maturing Trees (Trees Maturing at more than 35 Feet Tall)

The following five examples (4 through 8) form the base specifications for pruning medium- and large-maturing trees (such as oaks, mahogany, black olive, tabebuia, sweetgum, maples, and many other large-maturing trees) of different sizes or ages. They can be applied to trees in many different locations. The specifications that follow these five examples are more situational based. Phrases and sentences can be added or deleted to conform to tree owner objectives.

Most trees that require crown raising for under-tree visibility and clearance also benefit from structural pruning; the reader will notice that most examples include "improve crown structure" or "reduce likelihood of branch failure" as an objective. Also, sentences and phrases in the "branches to prune" section of any example specification can be used for other situations depending on tree structure, size, species and location.

Example 4. Pruning trees at planting. *(Note to specifier: The crown structure on most newly or recently planted trees can be improved significantly with structural pruning at planting or within the first year or two after planting. This specification could be applied to new trees with good vitality planted in any location. Pruning can be conducted to improve branch architecture without negative effects on the tree. The goal is to create one dominant leader toward the center of the crown by reducing the growth rate of the largest competing branches; this approach makes subsequent clearance under the crown easier. Growth suppression on these largest branches is accomplished by substantially reducing their length, or by removing them, or by a combination of reduction and removal. Making a reduction cut back to a lateral branch pointed away from the trunk is the best method of slowing growth on these branches that are competing with the one leader.)*

Trees to prune: 275 trees (a mix of medium- and large-maturing tree species) that are 3.5- to 6-inch **caliper**.

Pruning system: Natural.

Purpose: Create strong branch architecture; limit the need for major branch removal at maturity. *(Note to specifier: Removing large branches later can negatively impact tree health and stability and the type of pruning described below is the best method of avoiding this.)*

Objectives:

1) Improve crown structure (also known as branch architecture) by a combination of reducing and removing stems, branches, and leaders with an aspect ratio larger than one-half. Encourage growth in one dominant leader. *(Note to specifier: Aspect ratio is calculated as the diameter of the branch divided by (compared to) the diameter of the trunk measured directly above the branch union. Two-thirds can be adjusted to one-half (recommended ratio) for a more aggressive long-lasting pruning application.)*

Branches to prune:

1) Reduce length by two-thirds of all stems and branches with an aspect ratio larger than one-half by cutting back to a lateral branch that is larger (where possible) than one-third the diameter of the pruning cut (referred to as a reduction cut); make no pruning cuts on the stem retained as the leader.

Limitations:

1) No heading or shearing cuts shall be made without authorization.

2) Less than 20% of cuts on live branches shall be branch removal cuts. *(Note to specifier: Including this statement in the specification requires the contractor to use mostly reduction cuts to prune the trees. Reduction cuts are necessary in order to perform the work according to this specification. Adjust this percentage according to the site, location, age, and form of the trees.)*

3) Sprouts on the lower 5 feet of trunk shall not be removed unless larger than one-inch diameter.

4) No more than 50% of the foliage shall be removed from an individual tree without authorization.

5) All severed branches shall be removed by the end of the workday.
Debris disposal: All debris will be removed from the work area and recycled as mulch or disposed of at the City green waste recycling center.
Completion date: March 18.

Example 5. Pruning young trees planted in the last 5 years. Typical locations would be rest stops, interchanges, street trees, operation centers, and park trees.
Trees to prune: Fourty-three oak (*Quercus*) and mahogany (*Swietenia*) street trees that are 5- to 10-inch DBH and 14 to 30 feet tall.
Pruning system: Natural.
Purpose: Create strong branch architecture; create clearance for pedestrians and vehicles under the crown; prevent large branch removal from the lower trunk later.
Objectives:
1) Improve crown structure (also known as branch architecture) by reducing or removing stems, branches, and leaders with an aspect ratio larger than two-thirds. Encourage growth in one dominant leader. *(Note to specifier: Aspect ratio is calculated as the diameter of the branch divided by (compared to) the diameter of the trunk measured directly above the branch union. Two-thirds can be adjusted to one-half fora more aggressive long-lasting pruning application.)*
2) Provide clearance for adjacent sidewalk and street. *(Note to specifier: Adjust language for the situation; for example, delete reference to sidewalk if there is no sidewalk present.)*
Branches to prune:
1) Reduce length by two-thirds of all stems and branches with an aspect ratio larger than two-thirds by cutting back to a lateral branch that is larger (where possible) than one-third the diameter of the pruning cut (referred to as a reduction cut); make no pruning cuts on the stem retained as the leader.
2) Remove at the trunk all branches that originate from the lower 7 feet of trunk so only one trunk (preferably the larger if there are two or more) remains. Remove additional secondary branches from primary branches to create 8 feet of clearance under the crown. *(Note to specifier: Adjust clearance height for the current and expected form of the species and the situation. You will notice that on slightly older and larger trees in the specification that follows (i.e., example 3) that clearance increases. The amount of clearance is governed by the location of the tree, growth rate, species, crown form, and when trees are expected to be pruned again.)*
3) Remove dead and broken branches greater than one inch in diameter at the point of attachment.
4) Remove branches and sprouts originating on the trunk below 7 feet including those growing from the **root collar**.
Limitations:
1) No heading cuts greater than one-inch diameter or shearing cuts shall be made without authorization. Heading cuts shall only be used to subordinate branches where a reduction cut is impractical because there is no lateral branch nearby.
2) Less than 50% of cuts on live branches shall be branch removal cuts. *(Note to specifier: Including this statement in the specification forces the contractor to use reduction cuts to prune the trees. Reduction cuts are necessary in order to perform this work according to this specification. Adjust this percentage according to the site, location, and form of the trees.)*
3) No more than 40% of the foliage shall be removed from an individual tree without authorization.
4) All severed branches shall be removed by the end of the workday.
Debris disposal: All debris will be removed from the work area and recycled as mulch or disposed of at the City green waste recycling center.
Completion date: March 18.

Example 6. Pruning young trees. Typical location would be rest stop, highway median, interchange, street tree, or other location within about 50 feet of the roadway.

Trees to prune: 640 oak (*Quercus*) and royal Poinciana (*Delonix*) street trees that are 10- to 16-inch DBH and 25 to 40 feet tall.

Pruning system: Natural.

Purpose: Create strong branch architecture; create clearance for pedestrians and vehicles under the crown; prevent large branch removal from the lower trunk later; reduce likelihood of future tree failure.

Objectives:

1) Improve crown structure (also known as branch architecture) by reducing stems, branches, and leaders with an aspect ratio larger than two-thirds. Encourage growth in one dominant leader. *(Note to specifier: Aspect ratio is calculated as the diameter of the branch divided by the diameter of the trunk measured directly above the branch union.)*

2) Provide clearance for adjacent sidewalk and street. *(Note to specifier: Adjust language for the situation; for example delete reference to sidewalk if there is no sidewalk present).*

Branches to prune:

1) Remove at the trunk all branches and sprouts less than four inches in diameter *(Note to specifier: Adjust the diameter of the branch to meet conditions)* that originate from the lower 12 feet of trunk. Reduce all larger branches growing from the lower 16 feet of trunk using 3 to 4 reduction cuts of approximately 3 inches diameter to remove about 50% of foliage on each. Remove additional secondary branches from the lower crown to create 8 feet of clearance under the crown on sidewalk side and 16 feet clearance on street side. *(Note to specifier: Adjust clearance height for the current and expected form of the species and the situation. You will notice that clearance increases on slightly older and larger trees in the specification that follows. This amount of clearance is governed by the location of the tree, growth rate, species crown form, and when trees are expected to be pruned again).*

2) Reduce the three branches with the largest aspect ratio in the upper half of the tree using one 3-inch reduction cut on each.

3) Remove dead, dying, diseased, and broken branches greater than one inch in diameter at the point of attachment. *(Note to specifier: Adjust diameter of branches to remove based on species attributes and site conditions).*

4) Reduce (preferred) or remove (less preferred) branches that touch other branches.

Limitations:

1) No heading or shearing cuts shall be made without authorization.

2) Less than 35% of cuts on live branches shall be branch removal cuts. *(Note to specifier: Including this statement in the specification forces the contractor to use reduction cuts to prune the trees. Reduction cuts are necessary in order to perform this work according to this specification. Adjust this percentage according to the site, location, and form of the trees.)*

3) No more than 40% of the foliage shall be removed from an individual tree without authorization.

4) All severed branches shall be removed by the end of the workday.

5) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations section increases the likelihood that trees will be pruned according to specifications.)*

Debris disposal: All debris will be removed from the work area and recycled as mulch or disposed of at the City green waste recycling center.

Completion date: March 18

Re-inspection: 3 years.

Example 7. Pruning medium-aged trees. Typical situations include street tree, tree growing in turf or ground cover, rest stop, highway median, parking lot island, park, operations facility, or median strip. *(Note to specifier: Medium-aged trees are those approximately 30 to 40 years old and with a DBH of 15 to 30 inches. Adjust clearance height for the current and expected form of the species and the situation).*

Trees to prune: All black olive and mahogany street trees 16 to 25 inches DBH on American Ave.

Pruning system: Natural.

Purpose: Reduce likelihood of future live and dead branch failure; create strong branch architecture; create clearance for pedestrians and vehicles under the crown.

Objectives:

1) Improve crown structure (also known as branch architecture) by reducing stems, branches, and leaders with an aspect ratio larger than two-thirds. *(Note to specifier: Aspect ratio is calculated as the diameter of the branch divided by the diameter of the trunk measured directly above the branch union.)*

2) Reduce likelihood of dead and live branches breaking and dropping from tree.

3) Provide 14 feet clearance from ground to bottom of branches.

Branches to prune:

1) Remove at the trunk all branches less than three inches in diameter that originate from the lower 12 feet of trunk. *(Note to specifier: Adjust the specified height to match objective for the particular site).* Reduce larger primary branches originating on the lower 16 feet of trunk using three or four 3-inch diameter reduction cuts at the ends of branches and three 2-inch diameter branch removal cuts back to primary branches to provide 14 feet of vertical clearance over the pavement. Remove additional secondary branches from the lower crown to create 10 feet of clearance under the crown on sidewalk side. *(Note to specifier: Adjust clearance height for the current and expected form of the species and the situation. You will notice that on slightly older and larger trees clearance increases. This amount of clearance is governed by the location of the tree, growth rate, species crown form, and when trees are expected to be pruned again).*

2) Remove dead, detached, and broken or cracked branches greater than one inch in diameter at the point of attachment. *(Note to specifier: Adjust diameter of branches to remove based on species attributes, location and site conditions. Dead branches on trees in open lawn areas without targets may not need pruning, or the dead branch diameter threshold can be increased to 1.5 inches or even larger).*

3) Reduce length by one-third on remaining primary branches with an aspect ratio larger than two-thirds by cutting back to a lateral branch using one or two 2- to 4-inch diameter reduction cut(s). Make no pruning cuts on the stem retained as the leader. *(Note to specifier: Adjust percentage and diameter of branches to remove based on species attributes, location and site conditions.)*

Limitations:

1) No heading cuts greater than one inch shall be made without authorization.

2) No more than 50% of cuts shall be branch removal cuts.

3) No more than one-third of the foliage shall be removed from an individual tree without authorization.

4) All severed branches shall be removed by the end of the workday.

5) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Completion date: June 7.

Re-inspection: 3 years.

Example 8. Pruning mature trees. Typical location might include street tree, open lawn area, rest stop, or highway interchange.

Trees to prune: 54 trees greater than 30 inches DBH in the lawn area of the Interstate interchange.

Pruning system: Natural.

Purpose: Preservation of mature trees.

Objectives:

1) Improve aesthetics within the tree planting zone.

2) Reduce risk of branch, trunk and whole tree failure.

3) Enhance visibility under tree crowns.

Branches to remove:

1) Remove dead, nearly dead, broken and detached branches 2.5 inches and larger in diameter at the point of attachment. *(Note to specifier: Reduce the diameter [e.g. 1 inch] in locations where pedestrians and/or vehicles will pass under trees.)*

2) Remove branches less than six inches diameter from the lower 10 feet of trunk.

Branches to reduce in length by one-quarter to one-third:

1) Reduce branches that extend outside of the shape of the main crown. Reduction in length shall be accomplished using reduction cuts 3 to 4 inches in diameter. Some trees may not require this depending on crown shape and where no branches extend beyond the rest of the crown.

2) Reduce the largest four branches (4 is an average per tree but could range from one to 6 depending on the tree) measured at the trunk *(Note to specifier: You could write instead "reduce the four largest aspect ratio branches". Specify the number of branches here that make the most sense for the situation considering the compartmentalization ability of the species, the pruning cycle, and condition of the trees.)* that originate 10 feet or more from the ground with four 3 to 4 inch diameter reduction cuts on each for a total of 16 reduction cuts per tree.

3) Reduce length by 30 percent on branches with bark inclusions or visible cracks.

Limitations:

1) No heading or shearing cuts shall be made without authorization.

2) No more than one-fourth *(Note to specifier: Use your own number here; 25% is only a suggestion. More may have to be removed in certain circumstances to meet one or more of the objectives)* of the foliage shall be removed from an individual tree without authorization.

3) All severed branches shall be on the ground by the end of the workday.

4) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Completion date: July 24.

Re-inspection: 3 years.

Example Specifications: Palms

Example 9a. Palms without crownshaft (such as the native *Sabal palmetto*).

Trees to prune: 140 palms 10 to 15 feet behind the guard rail at edge of highway shoulder.

Palms do not need to be pruned. *(Note to specifier: Most landscape palms do not require pruning to remain strong because they naturally grow with one trunk. There is antidotal evidence that pruning live foliage from palms could increase damage in strong storms, such as hurricanes.*

Example 9b. Palms without crownshaft (such as *Sabal* and *Washingtonia*).

Trees to prune: Trees to prune: 16 palms 10 to 15 feet behind guard rail at the edge of highway shoulder.

Pruning System: Natural

Purpose: Improve aesthetics.

Objective: Remove all leaves with more than 50 percent dead (brown) tissue. *(Note to specifier: Adjust the percentage to suit the desired aesthetic.)*

Leaf removal: Remove leaves at the trunk by cutting through the base of the petiole without cutting into live trunk tissue.

Limitations: Remove no leaves that are entirely green; remove no leaves that are mostly chlorotic. *(Note to specifier: Chlorosis on lower foliage indicates a nutrient deficiency; removing these leaves could cause chlorosis on retained green leaves causing a further decline in health. Palms in this condition require fertilizer to promote health; without it the palms may die.)*

Debris disposal: The brush shall be hauled away from the site.

Completion date: May 1.

Example 10. Palms with crownshafts such as foxtail palm (*Wodyetia bifurcate*) and Royal palm (*Roystonia alata*).

Trees to prune: 140 palms 10 to 15 feet behind the guard rail at edge of highway shoulder.

Palms do not need to be pruned.

EXAMPLE SPECIFICATIONS: Conifers and other excurrent trees

Example 11. Pine trees.
Trees to prune: Pines (*Pinus spp.*) on the north edge of the lawn about 20 feet from building.
Pruning System: Natural
Purpose: Reduce likelihood of the whole tree or tree parts striking the building in tropical storms.
Objective: Reduce branch length while maintaining natural crown form.
Branches to prune: Live branches - Reduce the five largest diameter primary branches, plus any other branches with rust disease or other cankers forming depressions or cracks in the wood, using one 2-to 3-inch reduction cut on each. Dead branches – Remove dead branches 2 inches in diameter and larger. *(Note to specifier: Smaller dead branches are not likely to cause damage in a tropical storm)*
Limitations: No branch removal cuts at the main stem shall be used on live branches. No reduction cuts shall be made greater than 4 inches in diameter without approval from the project arborist. Do not reduce tree height.
Debris disposal: The brush is to be chipped and left on site under the trees for mulch.
Completion date: Within the next two weeks to comply with the nesting bird study recommendations.

Example Specifications: Highway/Street/Parking Lot Trees

Example 12. Interchange slope (shrubs).
Shrubs to prune: Approximately 200 Japanese privet (*Ligustrum japonica*) on the four interchange slopes at the base of overpass bridge.
Pruning system: Natural.
Objective: Reduce in size, maintain current shape.
Branches to prune:
1) The longest and tallest five live branches shall be reduced by half their length using reduction cuts. In most cases the pruning cuts will be positioned inside the retained crown edge with a hand pruner as to be hidden from view. This method of reduction leaves a more natural irregular – not smooth – edge to the plants. *(Note to specifier: There is no doubt that reducing back to a specified height [e.g. 6 feet] using engine-powered hedging shears is a more efficient and less expensive method of reducing plant height. The choice of reduction methods is dictated by the location of the plants and the desired outcome.)*
2) Dead branches greater than one-inch diameter shall be removed at the position of a live lateral branch or at the point of origin at ground level.
Limitations:
1) Engine-powered hedging devices shall not be used to reduce size; use hand shears only. *(Note to specifier: Delete this limitation if powered hedging devices will be utilized to reduce plants.)*
Debris disposal: Remove all debris.
Completion date: Spring of this year.
Re-inspection: 3 years.

Example 13. Young trees along turnpike and interstate entrance/exit ramp.
Trees to prune: 110 mix of species including mahogany (*Swietenia*), royal Poinciana (*Delonix*), oak (*Quercus*), and yellow trumpet trees (*Tabebuia*) that are 8- to 14-inch DBH and 20 to 30 feet tall.
Pruning system: Natural.
Purpose: Provide clearance for roadway and mowers; reduce likelihood of future storm damage to trees and potential lane blockage from resulting debris.
Objectives:
1) Reduce tree crown width to provide 35 feet clearance *(Note to specifier: use the distance appropriate for the site)* between roadway edge and the edge of the tree foliage on roadway side of trees. If the tree trunk is within 35 feet

of the roadway edge, then remove the tree by cutting it at the trunk base. *(Note to specifier: Removal of misplaced trees may be controversial but will provide a reduction in maintenance. Once tree crowns are reduced in width to provide clearance, they grow back quickly to their original dimension requiring routine pruning to keep the roadway clear.)*

2) Raise crown to provide 10 feet clearance for mowers.

3) Improve crown structure (also known as branch architecture) by reducing stems, branches, and leaders with an aspect ratio larger than one-half. Encourage growth in one dominant leader.

Branches to prune:

1) Remove at the trunk all branches and sprouts less than three inches in diameter that originate from the lower 10 feet of trunk. Reduce all larger branches growing from the lower 16 feet of trunk using 3 to 4 reduction cuts of approximately 2 to 3 inches diameter to remove 60% of foliage on each. Remove additional secondary branches from the lower crown to create 10 feet of clearance under the crown. *(Note to specifier: Adjust clearance height for the location of the tree, growth rate, species crown form, and when trees are expected to be pruned again).*

2) Remove dead and broken branches greater than 2.5 inches in diameter at the point of attachment. *(Note to specifier: Adjust diameter of branches to remove based on species attributes, potential mower damage from chopping fallen dead branches, and other site conditions.)*

Limitations:

1) No heading or shearing cuts shall be made without authorization.

2) Less than 70% of cuts on live branches shall be branch removal cuts. *(Note to specifier: Including this statement in the specification ensures that the contractor uses reduction cuts to prune the trees. Reduction cuts are necessary in order to perform this work according to this specification. Adjust this percentage according to the site, location, and form of the trees.)*

3) No more than 50% of the foliage shall be removed from an individual tree without authorization.

4) All severed branches shall be removed by the end of the workday.

5) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Debris disposal: All debris will be removed from the work area and recycled as mulch or disposed of at the City green waste recycling center.

Completion date: January 20.

Re-inspection: 3 years.

Example 14. Medium-aged and mature trees along turnpike and interstate entrance/exit ramp.

(Note to specifier: Medium-aged and mature trees are those approximately 30 years and older and with a DBH over 16 inches.

Trees to prune: All black olive, oak and mahogany trees more than 16 inches DBH.

Pruning system: Natural.

Purpose: Provide clearance for roadway and mowers; reduce likelihood of future storm damage to trees and potential lane blockage from resulting tree debris.

Objectives:

1) Reduce tree crown width to provide 35 feet clearance *(Note to specifier: use the distance appropriate for the site)* between roadway edge and the edge of the tree foliage on roadway side of trees. If the tree trunk is within 35 feet of the roadway edge, then remove the tree by cutting it at the trunk base. *(Note to specifier: Removal of misplaced trees may be controversial but will provide a reduction in maintenance. Once tree crowns are reduced in width to provide clearance, they grow back quickly to their original dimension requiring routine pruning to keep the roadway clear.)*

2) Raise crown to provide 10 feet clearance for mowers and visibility under trees.

3) Improve crown structure (also known as branch architecture) by reducing stems, branches, and leaders with an aspect ratio larger than two-thirds. Encourage growth in one dominant leader.

Branches to prune:

1) Remove at the trunk all branches and sprouts less than three inches in diameter that originate from the lower 10 feet of trunk. Reduce all larger branches growing from the lower 16 feet of trunk using 3 to 4 reduction cuts of approximately 2.5 to 4 inches diameter to remove 60% of foliage on each. Remove additional secondary branches from the lower crown to create 10 feet of clearance under the crown. *(Note to specifier: Adjust clearance height for the location of the tree, growth rate, species crown form, and when trees are expected to be pruned again).*

2) Reduce length on the four largest remaining primary branches using two 3 to 4 inch diameter reduction cuts which will remove an estimated 50-60% of the foliage from the ends of these branches.

3) Remove dead and broken branches greater than 2.5 inches in diameter at the point of attachment. *(Note to specifier: Adjust diameter of branches to remove based on species attributes, potential mower damage from chopping fallen dead branches, and other site conditions.)*

Limitations:

1) No heading or shearing cuts shall be made without authorization.

2) The stem retained as the dominant leader shall not be pruned.

3) Less than 70% of cuts on live branches shall be branch removal cuts. *(Note to specifier: Including this statement in the specification ensures that the contractor uses reduction cuts to prune the trees. Reduction cuts are necessary in order to perform this work according to this specification. Adjust this percentage according to the site, location, and form of the trees.)*

4) No more than 40% of the foliage shall be removed from an individual tree without authorization.

5) All severed branches shall be removed by the end of the workday.

6) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Debris disposal: All debris will be removed from the work area and recycled as mulch or disposed of at the City green waste recycling center.

Completion date: January 20.

Re-inspection: 3 years.

Example 15 . Forest edge strip for many miles.

Trees to prune: Trees in their natural state (i.e. not planted) along rural interstate, divided highway or two-lane road.

Pruning system: Topiary/natural combination.

Purpose: Reduce likelihood of tree failure; provide clearance.

Objective: Reduce length of branches growing toward travel lanes.

Branches to prune:

1) Branches larger than 4 inches *(Note to specifier: Adjust this diameter for the trees in question)* diameter - measured at the pruning cut - that are growing toward the travel lane should be reduced in length using heading cuts retaining approximately a 4 to 6 foot- long branch section or stub attached to the trunk. Smaller diameter branches can be pruned, but this is not a requirement.

2) The height of trees more than 6 inches dbh *(Note to specifier: Adjust this diameter for the trees in question)* with the bottom 25% of trunk length leaning more than 10 degrees toward the travel lanes should be removed with a final cut at the base of the trunk or reduced in height by 25% using reduction cuts on the longest and tallest stems on the leaning side. *(Note to specifier: Adjust the degrees and percentage according to conditions.)*

Limitations: No branch removal cuts shall be used at the main stem.

Debris disposal: The brush is to be removed from the sight at the end of each week.

Re-inspection: 3 years.

Example 16. Divided highway median.

Tree location: Median in the center of the roadway.

Trees to prune: Large-maturing planted trees of various species 12- to 16-inch DBH.

Pruning system: Natural.

Purpose: Minimize current and future interference with truck and other vehicle traffic; reduce likelihood of future tree failure.

Objectives:

1) Provide 15 feet clearance from ground to bottom of lowest branches over roadway. *(Note to specifier: Clearance height can be adjusted to meet site requirements and tree form. Change the height in the "Branches to prune" section below to match.)*

2) Reduce likelihood of tree failure.

Branches to prune:

1) Remove all primary branches and stems – regardless of diameter or orientation- originating on the lower 10 feet of trunk. (*Note to specifier: This distance could be as low as 8 feet depending on the upward angle of the branch segments close to the trunk. The goal is to create 15 feet of clearance between ground and the lowest branch over the roadway.)* so there is only one trunk vertically to 10 feet. *(Note to specifier: Compared to removing only secondary branches from primary branches to create clearance – referred to as lion tailing - this approach reduces likelihood of branches and foliage growing back and blocking visibility in the future. Large pruning wounds on the trunk might be required on certain trees, but this is a good trade-off for these young trees.)* Remove secondary branches growing downward into the clearance zone from low primary branches.

2) Reduce length of the three largest diameter branches originating above 10 feet trunk height with two 3- to 3.5-inch diameter reduction cuts on each pruned branch. *(Note to specifier: Adjust the number and diameter of cuts so approximately 60% of foliage and buds are removed from each pruned branch.)*

3) Reduce length by 30 percent on branches with bark inclusions or cracks.

Limitations:

1) No heading or shearing cuts shall be made without authorization.

2) No more than one-half of the foliage shall be removed from an individual tree without authorization. *(Note to specifier: This number should be adjusted to accommodate the age and condition of trees and the site attributes. Adjust the number downward for trees in poor health.)*

3) Less than 70% of cuts on live branches shall be branch removal cuts. *(Note to specifier: Including this statement in the specification ensures that the contractor uses reduction cuts to prune the trees. Reduction cuts are necessary in order to perform the work according to this specification. Adjust the percentage according to the site, location, age, and form of the trees. The percentage should be adjusted to suit conditions.)*

4) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Debris removal: All debris will be removed from the work area daily.

Completion date: Fall of this year.

Re-inspection: Trees will be re-inspected and considered for pruning 3 years after completion of the current pruning project. *(Note to specifier: choose your own number appropriate for the circumstances.)*

Example 17. Raise crown at Interstate/turnpike interchange.

Trees to prune: 78 large maturing planted (approximately 30 feet apart) native trees of various species 12 to 16-inch dbh.

Pruning system: Natural.

Purpose: Provide visibility under the tree crowns and clearance for mowers; reduce failure potential in storms

Objectives:

1) Provide 18 feet clearance from ground to bottom of lowest branches. *(Note to specifier: Clearance height can be adjusted to meet site requirements. Change the height in the "Branches to prune" section below to match).*

2) Reduce likelihood of failure in tropical storm events.

Branches to prune:

1) Remove all branches – regardless of diameter - originating on the lower 18 feet of trunk so there is only one stem and no branches from ground vertically to 18 feet. This approach will be dependent on branch architecture of

individual trees. On trees where more than 60% of the foliage would be removed following this specification, remove only the largest diameter branches in the lower 18 feet while retaining approximately 40% of the foliage; do not execute step #2 below.

2) Reduce length of the three largest diameter branches originating above 18 feet trunk height with two 3 inch diameter reduction cuts on each.

Limitations:

1) No more than 60% of foliage shall be removed from any tree.

2) No heading cuts shall be made.

3) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Debris removal: All debris will be removed from the work area daily.

Completion date: Fall of this year.

Re-inspection: 3 years.

Example 18. Clearance from sidewalk, street and buildings downtown.

Trees to prune: 120 street trees 12 to 18 inches dbh on Main Street adjacent to two- and three-story buildings.

Pruning system: Natural.

Purpose: Provide clearance for pedestrians and vehicles; create strong branch architecture; prevent large branch removal later.

Objectives:

1) Provide 8 feet vertical clearance over sidewalk and 14 feet over street.

2) Provide 5 feet of horizontal clearance from buildings.

3) Improve branch architecture by developing or maintaining a dominant trunk.

Branches to prune:

1) Remove all primary branches and sprouts (including suckers from the root collar) less than 4 inches diameter originating on the lower 10 feet of trunk on the sidewalk side and 14 feet on the street side of trees *(Note to specifier: This distance could be as low as 8 feet depending on the upward angle of the branch segments close to the trunk.)* so there is only one vertical trunk to 10 feet *(Note to specifier: Compared to removing only secondary branches from primary branches to create clearance – referred to as lion tailing - this approach reduces likelihood of branches and foliage growing back and blocking visibility in the future. The 4-inch diameter pruning wounds on the trunk might be required on certain trees; this is a good trade-off for these young trees.)* Remove secondary branches growing downward into the clearance zone from other branches. On branches larger than 4 inches diameter in the lower 10 (sidewalk side) or 14 (street side) feet of the trunk, reduce the length of the downward and upward growing portions with a total of four reduction cuts and remove other branches as needed to meet clearance. *(Note to specifier: The following four sentences present an alternative method of specifying work referred to above that is more generic and applicable to a large number of tree species and sizes. Remove primary branches that are less than one-half the trunk diameter originating on the lower 10 feet (sidewalk side) or 14 feet (street side) of trunk, and reduce those that have a larger aspect ratio. This is accomplished by using 3 to 4-inch diameter (specify a number such as 4 reduction cuts) reduction cuts to a) shorten (reduce) the longest and the most upright branches and b) removing those drooping downward. About half the foliage should be removed on each reduced primary branch. Remove secondary branches growing downward into the clearance zone from other branches.)*

2) Reduce length of the three largest diameter branches on the trunk originating above 10 feet (sidewalk side) or 14 feet (street side) trunk height with two 3 to 3.5-inch diameter *(Note to specifier: Number and diameter of cuts can be adjusted.)* reduction cuts on each.

3) Remove dead, dying, diseased, and broken branches one inch or larger in diameter at the point of attachment. Reduction cuts can be used in cases where the retained lateral branch has adequate foliage and no die-back.

4) Reduce all branches that grow toward the buildings using 1 to 2.5-inch diameter reduction cuts resulting in 5 feet of horizontal clearance.

5) Reduce length by 30 percent on branches with bark inclusions or cracks.

Limitations:

1) No heading or shearing cuts shall be made without authorization.

2) No more than one-fourth of the foliage shall be removed from an individual tree without authorization. *(Note to specifier: One-third of the foliage may have to be removed on trees that have not been pruned in some time or on certain trees with many low growing branches.)*

3) All severed branches shall be removed by the end of the workday.

4) Make no removal cuts on the main trunk larger than 4 inches; at least six pruning cuts shall be reduction cuts 3 to 3.5 inches diameter. *(Note to specifier: This can vary with the particular trees being pruned. Adjust as needed to meet objectives.)*

5) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Completion date: June 7.

Re-inspection: 3 years.

Example 19. Residential street trees (young trees).

Trees to prune: 175 8 to 12-inch dbh oak and maples in an urban neighborhood.

Pruning system: natural.

Purpose: Clear branches from street signs (e.g. stop signs, warning signs) and traffic lights; create future clearance by directing growth into one dominant trunk.

Objectives:

1) Create clearance by raising the crown to 12 feet (street side) measured between street and lowest point of foliage or branches and 8 feet on sidewalk side;

2) Improve branch architecture by reducing growth rate of (or removing) the largest diameter low branches.

Branches to prune:

1) Remove an average of the largest four (range 3 to 5 per tree) primary branches (diameter measured at the trunk) on the lower 15 feet of trunk. Smaller diameter branches can remain but should be shortened or removed to meet the clearance objective *(Note to specifier: leaving small diameter branches along the lower trunk protects it from mowers, damage from people, and direct sun and may reduce sprouting. Sprouting is not bad for the tree, its simply annoying. Number of large branches can be adjusted depending on objectives and branch architecture.)*; reduce the length of branches with aspect ratios greater than one-half growing from the trunk 15 feet and higher using 2 inch diameter reduction cuts.

2) Reduce length by 30 percent on branches with bark inclusions or cracks.

Limitations:

1) No heading cuts should be used.

2) No more than 70% of pruning cuts will be branch removal cuts. *(Note to specifier: Adjust this percentage to account for tree architecture and number of primary branches along the lower trunk. Where they are few low branches to remove, the percentage of branch removal cuts will be much less and the percentage of reduction cuts will be much higher.)*

3) Remove no more than 50% of foliage.

4) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Completion date: June.

Re-inspection: 4 years.

Example 20. Residential street trees (medium-aged/mature trees).

Trees to prune: 175 20 to 30-inch dbh Jacaranda (*Jacaranda*) and mahogany (*Swietenia*) trees in an urban neighborhood.

Pruning system: natural.

Purpose: Clear branches from street signs (e.g. stop signs, warning signs) and traffic lights; reduce likelihood of branch and whole-tree failure.

Objectives:

1) Create clearance by raising the crown to 14 feet (street side) measured between street and lowest point of foliage or branches and 10 feet on sidewalk side;

2) Improve branch architecture by reducing growth rate of the largest diameter branches and those with defects.

Branches to prune:

1) Remove (removal cuts) secondary branches toward the edge of the crown and reduce primary branches (reduction cuts) with cuts 4 inches or less in diameter to create clearance under crown. *(Note to specifier: The diameter of cuts can be adjusted to meet the objective.)*

2) Reduce all primary branches larger than one-half the trunk diameter (diameter measured at the trunk) on the lower 25 feet of trunk using four reduction cuts 3 to 3.5 inches in diameter on each branch. Where the trunk divides into two or more stems or branches, reduce all but one located in (or nearest to) the center of the crown using four 3 to 3.5 inch diameter reduction cuts on each. Smaller diameter branches growing from the trunk can remain but should be shortened or removed to meet the clearance objective *(Note to specifier: The number of cuts and diameter of cuts can be adjusted to meet the objective of slowing their growth rate. Where there are equal sized stems, more cuts and/or larger cuts may be needed.)*

3) Reduce length by 30 percent on branches with bark inclusions or cracks.

Limitations:

1) No heading cuts should be used.

2) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

3) No more than 50% of pruning cuts will be branch removal cuts. One of the objectives is to reduce likelihood of failure and that is best accomplished using reduction cuts, not removal cuts. *(Note to specifier: Adjust this percentage to account for tree architecture and number of primary branches along the lower trunk. Where they are few low branches to remove, the percentage of branch removal cuts will be much less and the percentage of reduction cuts will be much higher.)*

4) Remove no more than 50% of foliage.

5) No removal cuts shall exceed 4 inches diameter.

6) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Completion date: June.

Re-inspection: 3 years.

Example 21. Parking lot large-maturing young trees.

Trees to prune: 54 8 to 14-inch dbh shade trees in parking lot islands and buffer strips.

Pruning system: Natural.

Purpose: Clear branches from security lights, store signage, and traffic signs; create current and future clearance by directing growth into one dominant trunk.

Objectives:

1) Create under-clearance by removing and reducing length of branches in the lower 10 feet of the crown;

2) Reduce the appropriate side of the crown to provide 6 feet clearance back from security lights;

3) Improve branch architecture by reducing growth rate of (or removing) the largest diameter low branches and directing future growth away from security lights.

4) Remove dead branches.

Branches to prune:

1) Remove the largest two (range 1 to 3 per tree) primary branches (diameter measured at the trunk) on the lower 10 feet of trunk. *(Note to specifier: An alternative is to reduce these two largest low branches 75% with a reduction cut or two, and plan on removing them next time. This approach results in a smaller void in the crown.)* Smaller diameter branches can remain but can be shortened to meet the clearance objective *(Note to specifier: Leaving small diameter branches along the lower trunk protects it from mowers, damage from people, and direct sun and may reduce sprouting. Sprouting is not bad for the tree, it's simply annoying. Number of large branches can be adjusted depending on objectives and branch architecture.)*
2) Reduce branches growing toward security lights using reduction cuts to meet clearance objective.
3) Reduce the length of branches with aspect ratios greater than one-half growing from the trunk 10 feet and higher using two 2-inch diameter reduction cuts on each. *(Note to specifier: Adjust number of cuts according to tree size and aspect ratio with more and/or larger cuts on larger trees and larger aspect ratios.)*
4) Remove dead branches 1 inch and larger.
5) Reduce length by 30 percent on branches with bark inclusions or cracks.
Limitations:
1) No heading cuts should be used.
2) No more than 20% of pruning cuts on live branches will be branch removal cuts. *(Note to specifier: Adjust this percentage to account for tree architecture and number of primary branches along the lower trunk. Where there are few low branches to remove, the percentage of branch removal cuts will be less and the percentage of reduction cuts will be much higher.)*
3) Remove no more than 50% of foliage. If more than 50% will be removed, perform work in "Branches to prune" section in order; i.e., perform #1 first, then 2, then 3 until about 50% is reached.
4) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*
Completion date: January.
Re-inspection: 4 years.

Example 22. Parking lot large-maturing medium-aged trees.
Trees to prune: 17 15 inch and larger dbh shade trees in parking lot islands and buffer strips.
Pruning system: Natural.
Purpose: Clear branches from security lights, store signage, and traffic signs; create current and future clearance by directing growth into one dominant trunk.
Objectives:
1) Create under-clearance by removing and reducing length of branches in the lower 10 feet of the crown;
2) Reduce the appropriate side of the crown to provide 6 feet clearance back from security lights and direct future growth in the other direction;
3) Improve branch architecture by reducing growth rate of (or removing) the largest diameter low branches and directing future growth away from security lights.
4) Reduce branches with defects.
5) Remove dead branches.
Branches to prune:
1) Remove the largest primary branch (diameter measured at the trunk) on the lower 10 feet of trunk. *(Note to specifier: An alternative is to reduce this low branch 60 to 75% with a reduction cut or two allowing some view under the tree. This approach results in a smaller void in the crown and no pruning wound on the trunk.)* Smaller diameter branches can remain but can be shortened to meet the clearance objective *(Note to specifier: Leaving small diameter branches along the lower trunk protects it from mowers, damage from people, and direct sun and may reduce sprouting. Sprouting is not bad for the tree, it's simply annoying. Number of large branches can be adjusted depending on objectives and branch architecture.)*

2) Reduce branches growing toward security lights using reduction cuts to meet clearance objective.

3) Reduce the length of branches with aspect ratios greater than one-half growing from the trunk 10 feet and higher using three to five 2 to 3 inch diameter reduction cuts on each. *(Note to specifier: Adjust number and size of cuts according to tree size and aspect ratio with more and/or larger cuts on larger trees and larger aspect ratios.)*

4) Remove dead branches 1 inch and larger.

5) Reduce length by 30 percent on branches with bark inclusions or cracks.

Limitations:

1) No heading cuts should be used.

2) No more than 20% of pruning cuts on live branches will be branch removal cuts. *(Note to specifier: Adjust this percentage to account for tree architecture and number of primary branches along the lower trunk. Where there are few low branches to remove, the percentage of branch removal cuts will be less and the percentage of reduction cuts will be much higher.)*

3) Remove no more than 50% of foliage. If more than 50% will be removed, perform work in "Branches to prune" section in order; i.e., perform #1 first, then 2, then 3 until about 50% is reached.

4) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the biggest problems in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Completion date: February 24.

Re-inspection: 4 years.

Example 23. Parking lot small-maturing trees.

Trees to prune: Tree-form yaupon holly, ligustrum, crapemyrtle, lilac and others in parking lot islands and buffer strips.

Pruning system: Natural.

Purpose: Clear branches for under-crown visibility, mower operation, and access to vehicles.

Objectives:

1) Create clearance under the crown by removing and reducing length of branches in the lower 8 feet of the crown; multiple stems will be clearly visible following pruning. *(Note to specifier: Adjust the distance to account for tree size.)*

2) Remove dead branches.

Branches to prune:

1) Remove and reduce live branches in the lower 8 feet of the tree removing approximately 30% of foliage.
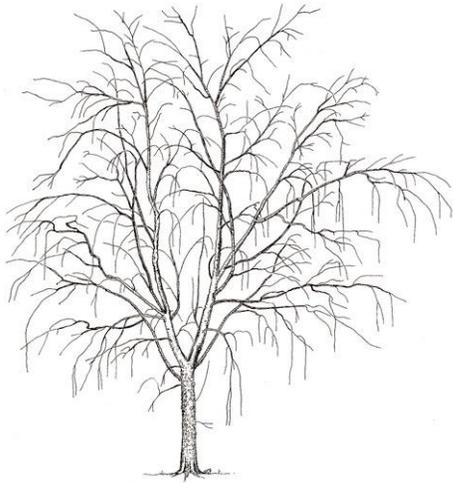
2) Remove dead branches 1/2 inch and larger.

Limitations:

1) No heading cuts should be used.
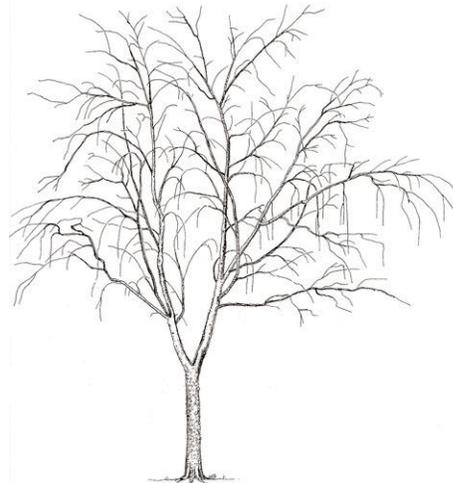
2) Remove no more than 35% of foliage.

Completion date: March 12.

Re-inspection: 2 years.

Example 23 detail:

Before pruning: Lower branches are blocking sight lines to signs.

After pruning: Lower branches are removed using branch removal cuts to create the desired clearance.

Example Specifications: Office Building/Residential Trees

Example 24. Specification for a single tree with an upright crown form.
Tree to prune: Large oak (*Quercus*) in the front yard.
Pruning system: Natural.
Objective: Reduce the risk of live and dead branch failure.
Branches to prune:
1) Remove dead, dying, and broken branches greater than 1 inch in diameter at the point of attachment to a healthy branch.
2) Reduce the branch on the north side (~8-inch diameter) with a crack and dead twigs using a 3-inch reduction cut.
3) Reduce the five largest upright-growing branches using two 2.5- to 3-inch diameter reduction cuts on each branch for total of ten reduction cuts.
Limitations:
1) No heading cuts should be used.
2) Remove no more than 35% of foliage.
Completion date: Early spring of this year.
Re-inspection: 2 years

Example 25. Single conifer tree residential.
Trees to prune: Two pines (*Pinus spp.*) in the northeast corner of the property.
Pruning System: Natural
Objective: Maintain their natural form by reducing and raising the outer crown to provide clearance for construction of the proposed building.
Branches to prune: Reduce branches on the north side of the tree by 8 to 10 feet and reduce lower branches on the west side to a height of 35 feet.
Limitations: No branch removal cuts at the main stem shall be used on live branches. No reduction cuts shall be made greater than 4 inches in diameter without approval from the project arborist. Do not reduce tree height.
Debris disposal: The brush is to be chipped and left on site under the trees for mulch.
Completion date: Within the next two weeks to comply with the nesting bird study recommendations.

Re-inspection: 2 years.

Example 26. Small grouping of trees.

Trees to prune:	Diameter:	Location:
One Sycamore (*Platanus* occidentalis*)*	18-inch	rear of house
Three Baldcypress (*Taxodium distichum*)	18 to 24-inch	right rear of yard
Two Live oaks (*Quercus virginiana*)	16 to 18-inch	rear yard

Pruning system: Natural.

Objectives:

1) Reduce likelihood of failure in wind events.

2) Provide 6 to 8 feet of clearance from house.

3) Raise crown of baldcypress to 9 feet to allow a view of the pond

Branches to prune:

1) Remove dead branches, greater than 2 inches in diameter, extending over yard.

2) On live oak, reduce one 10-inch diameter live branch over house by 10 to 12 feet using three 3 inch diameter reduction cuts. *(Note to specifier: Change the number and diameter of cuts to meet objectives)*

3) Reduce branches with aspect ratio larger than half using 2 reduction cuts 3 inches diameter on each branch.

Limitations: No heading cuts shall be made.

Debris removal: All debris will be removed from the work area.

Completion date: Fall of this year.

Re-inspection: 2 years.

Example 27. Residential shrubs and hedge.

Shrubs to prune: Five Japanese privet (*Ligustrum japonica*) in front of house.

Pruning system: Topiary. *(Note to specifier: Specify shape where applicable)*

Objective: Reduce height and width of the plant 20% while maintaining shape. *(Note to specifier: Change the percentage to meet size objectives)*

Branches to remove: Dead, dying, diseased, and broken branches.

Shear: New growth that is outside the desired shape of the crown. Do not cut to expose interior branches that do not have live leaves.

Debris disposal: Remove all debris.

Completion Date: Spring of this year.

Re-inspection: 3 months.

Example 28. Reduction on two mature trees.

Tree to prune: Large poplar (*Populus*) and sweetgum (*Liquidambar*) in the lawn.

Pruning system: Natural.

Purpose: Reduce likelihood of the 90 feet tall tree, live branches, and dead branches from striking three adjacent homes in storms.

Objective:

1) Reduce height of the tree 10 to 15 feet.

2) Remove dead branches.

Branches to prune:

1) The five largest aspect ratio primary branches and stems shall receive three 2.5 to 3.5-inch reduction cuts each, for a total of 15 reduction cuts. Heading cuts not to exceed 3.5 inches diameter may be used where reduction cuts are not practical because there are no nearby lateral branches. *(Note to specifier: Choose the pruning cut number and diameter appropriate for the situation.)*

2) Remove dead branches 1 inch and larger back to live branches.

Limitations: No heading cuts shall be used except on a branch or two where the reduction cut would exceed 3.5 inches diameter.

Completion date: Late spring of this year.
Re-inspection: 2 years. *(Note to specifier: When crown reduction is specified, consideration should be given to maintaining the crown in a reduced state in perpetuity.)*

Example 28 detail:
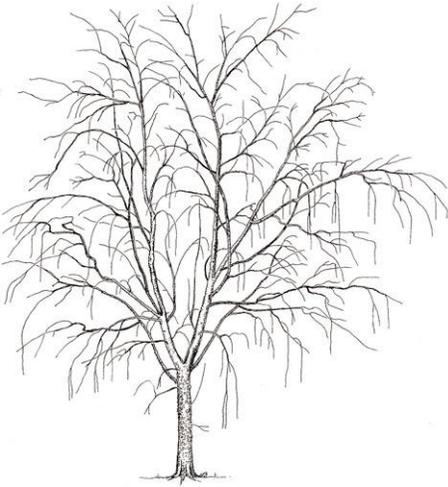
Before pruning (above): Tree crown is larger than desired.
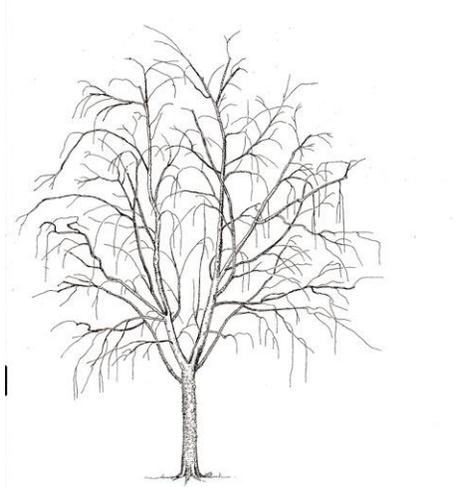
After pruning (above): Reduce size of the crown using fifteen 2.5 to 3.5-inch diameter reduction cuts.
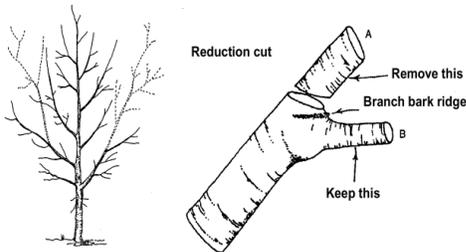
Reduction cut (left): Reduction cut removes the larger of components at a union retaining the smaller.

Example 29. Reduce section of crown.
Tree to prune: Trumpet tree (*Tabebuia*) in the side yard ten feet from the building.
Purpose: Clear tree branches from the building.
Pruning system: Natural.
Objective: Reduce crown by approximately 8 feet on the building side to create 4 to 6 feet horizontal clearance.
Branches to prune: Reduce the two largest branches growing toward the building using two or three 2.5 to 3 inch diameter reduction cuts, for a total of 4 to 6 reduction cuts. One or two heading cuts can be substituted where a reduction cut is not practical such as in cases where a suitable lateral branch is absent.
Limitations: Heading cuts, if needed, may not exceed 3.5 inches diameter.
Completion date: Spring of this year.
Re-inspection: 2 years.

Example 30. Reduce crown density on small-maturing trees.
Tree to prune: Japanese maple with 7-inch diameter trunk in front yard.
Pruning system: Natural.

Objective: Reduce crown density to allow more sunlight to reach under the crown to stimulate turfgrass growth.
(Note to specifier: One of the best methods of crown thinning is structural pruning. This approach accomplishes the stated objective in addition to reducing the likelihood of branch breakage. Structural pruning makes reduction cuts on the ends of the longest – and typically largest diameter – primary branches. Reduction and removal cuts can be used in combination to thin the edge of the crown).
Branches to prune:
1) Shorten the largest six primary branches using 3 to 4 reduction cuts 1/4 to ¾ inch diameter cuts on each.
2) Remove 20 to 30 branches about ¼ to ½ inch diameter from the edge of the crown to thin and visually balance the tree to achieve a uniform but not smooth crown outline. *(Note to specifier: Use your own number and diameter of pruning cuts as appropriate for the situation.)*
3) Reduce (preferred) or remove branches that touch other branches that are in more desirable positions.
4) Remove dead branches ¼ inch and larger.
Limitations:
1) No pruning cuts on live branches should be made within 3 feet of the trunk. *(Note to specifier: Use your own distance as appropriate for the situation.)*
2) No heading cuts shall be used on live branches.
Completion date: Spring of this year.
Re-inspection: 2 years.

Example 31. Reduce crown density on large mature trees.
Trees to prune: 18 mature maples along Happy Park Entrance Road.
Pruning system: Natural.
Purpose: Encourage turfgrass growth under the tree crown by increasing light penetration to the ground.
Objectives:
1) Reduce crown density to allow more sunlight to reach under the crown. *(Note to specifier: One of the best methods to reduce crown density is structural pruning. Structural pruning makes reduction cuts on the ends of the longest – and typically largest diameter - branches. Both reduction and removal cuts can be used to thin the crown).*
2) Create a uniform (but not smooth) crown outline
3) Remove dead branches greater than 1-inch diameter where they occur
Branches to prune at the periphery (outer surface) of the crown:
On each tree, 35 reduction cuts and 25 branch removal cuts should be made on the largest diameter and longest primary branches and dense branch clusters in the crown. Pruning cuts shall be 1 to 1.5 inches diameter. (Note to specifier: substitute the appropriate pruning cut number and diameter for the situation.)
Limitation: No live branches shall be removed from the trunk.
Completion date: Spring of this year.
Re-inspection: 5 years.

EXAMPLE SPECIFICATIONS: general

Example 32. Raising the crown on a young large-maturing tree.
Location: Back yard by swing
Tree to prune: 10-inch DBH linden.
Pruning system: Natural.
Purpose: Raise the bottom of the entire crown to provide 8-foot clearance under the tree and reduce likelihood of tree and branch failure.
Objectives:
1) Provide 8 feet clearance from ground to bottom of lowest branches. *(Note to specifier: Clearance height can be adjusted to meet site requirements and tree form. Change the height in the "Branches to prune" section below to match.)*

2) Improve branch architecture. *(Note to specifier: Although the customer may not have requested this service, this objective can be added – with their authorization - to provide more value.)*
3) Remove dead branches.

Branches to prune:

1) Remove all primary branches – regardless of diameter or orientation- originating on the lower 8 feet of trunk so there is only one trunk vertically to 8 feet *(Note to specifier: Compared to removing only secondary branches from primary branches to create clearance – referred to as lion tailing - this approach of removing branches from the trunk or reducing them reduces likelihood of branches and foliage growing back and blocking visibility in the future. Large pruning wounds on the trunk might be required on certain trees, but this is a good trade-off for these young trees. If not removed now, these low branches would continue growing and will require even larger pruning cuts to remove from the trunk later.)* Remove secondary branches growing downward into the clearance zone from low primary branches.

<u>Alternatively:</u> On individuals where more than 50% of the foliage on the tree *(Note to specifier: This percentage can be adjusted downward.)* would be removed following this specification, adjust the procedure to only remove those primary branches that are less than one-half the trunk diameter originating on the lower 8 feet of trunk, and reduce those that have a larger aspect ratio. *(Note to specifier: Estimating the percentage of foliage removed is difficult and people often do not agree. This is a judgement call by the specifier and the contractor. Because all parties may not agree on the percentage of foliage remaining on the tree after pruning, the specifier and contractor should come to agreement prior to beginning the work. While this approach minimizes trunk decay from larger pruning cuts on the trunk, reduced branches are likely to sprout resulting in the need for clearance again in the near future depending on location of the cuts.)* Reducing the largest aspect ratio branches is accomplished by using 2 to 2.5 inch diameter reduction cuts to a) shorten (reduce) the longest and the most upright portion of the branches and b) removing lateral branches drooping downward. About half the foliage should be removed on each reduced primary branch; <u>do not</u> execute step #2 below. *(Note to specifier: Specify the number of cuts to perform per branch such as 3 to 4.)*
2) Remove dead branches greater than 1 inch diameter. *(Note to specifier: Specify diameter appropriate for the situation..)*
One or both of the next two strategies can be performed where less than about 35 percent of foliage was removed in #1 above.
3) Reduce length of the three largest diameter branches on the trunk originating above 8 feet trunk height with two 2 to 2.5 inch diameter *(Note to specifier: Number and diameter of cuts can be adjusted.)* reduction cuts on each.
4) Reduce length by 30 percent on branches with bark inclusions or cracks.

Limitations:

1) No heading or shearing cuts shall be made without authorization.
2) No more than one-half of the foliage shall be removed from an individual tree without authorization. *(Note to specifier: This number should be adjusted to accommodate the age and condition of trees and the site attributes. Adjust the number downward for older trees in poor health.)*
3) Less than 80% of cuts on live branches shall be branch removal cuts. *(Note to specifier: Including this statement in the specification ensures that the contractor uses reduction cuts to prune the trees. Reduction cuts are necessary in order to perform the work according to this specification. Adjust the percentage according to the site, location, age, and form of the trees. The percentage should be adjusted to suit conditions.)*
4) Make no removal cuts on the trunk larger than 5 inches diameter *(Note to specifier: This number should be adjusted to accommodate the age and condition of trees and the site attributes. Adjust the number downward for older trees in poor health.)*
5) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the most common sub-standard pruning practices in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Debris removal: All debris will be removed from the work area daily.

Completion date: Fall of this year.

Re-inspection: Trees will be re-inspected and considered for pruning 3 years after completion of the current pruning project *(Note to specifier: choose your own number appropriate for the circumstances.)*.

Example 33. Raising the crown on a medium-aged large-maturing tree.

Location: Front of property near driveway and street

Tree to prune: 20 inch DBH large-maturing shade tree.

Pruning system: Natural.

Purpose: Raise the bottom of the entire crown to provide 12 foot view clearance under the tree and reduce likelihood of tree and branch failure.

Objectives:

1) Provide 12 feet clearance from ground to bottom of lowest branches. *(Note to specifier: Clearance height can be adjusted to meet site requirements and tree form. Change the height in the "Branches to prune" section below to match.)*

2) Improve branch architecture. (*Note to specifier: Although the customer may not have requested this service, this objective can be added – with their authorization - to provide more value.*)

3) Remove dead branches.

Branches to prune:

1) Remove all primary branches – regardless of diameter or orientation- originating on the lower 12 feet of trunk so there is only one trunk vertically to 12 feet *(Note to specifier: Compared to removing only secondary branches from primary branches to create clearance – referred to as lion tailing - this approach of removing branches from the trunk or reducing them reduces likelihood of branches and foliage growing back and blocking visibility in the future. Large pruning wounds on the trunk might be required on certain trees, but this is a good trade-off for these medium-aged trees. If not removed now, these low branches would continue growing and will require even larger pruning cuts to remove from the trunk later.)* Remove secondary branches growing downward into the clearance zone from low primary branches.

Alternatively: On individuals where one or more removal cuts on the trunk would be 5 inches and larger, *(Note to specifier: This diameter can be adjusted according to conditions.)*, adjust the procedure to only remove those primary branches that are less than 5 inches on the lower 12 feet of trunk, and reduce those that are larger. *(Note to specifier: While this approach minimizes trunk decay from larger pruning cuts on the trunk, reduced branches are likely to sprout resulting in the need for clearance again in the near future depending on location of the cuts.)* Reducing the larger branches is accomplished by a) making 3 inch diameter *(Note to specifier: Specify diameter appropriate for the situation.)* reduction cuts to shorten (reduce) the longest and the most upright portion of the branches and b) removing lateral branches drooping downward. About half the foliage should be removed on each reduced primary branch. *(Note to specifier: Specify the number and type of cuts to perform per branch such as 3 to 4 reduction cuts and 4 to 5 removal cuts.)*

2) Remove dead branches greater than 1 inch diameter. *(Note to specifier: Specify diameter appropriate for the situation.)*

One or both of the next two strategies can be performed where less than about 35 percent of foliage was removed in #1 above.

3) Reduce length of the three largest diameter branches on the trunk originating above 12 feet trunk height with three 2.5 to 3.5 inch diameter *(Note to specifier: Number and diameter of cuts can be adjusted.)* reduction cuts on each.

4) Reduce length by 30 percent on branches with bark inclusions or cracks.

Limitations:

1) No heading or shearing cuts shall be made without authorization.

2) No more than 35 percent of the foliage shall be removed from an individual tree without authorization. *(Note to specifier: This number should be adjusted to accommodate the age and condition of trees and the site attributes. Adjust the number downward for older trees in poor health.)*

3) Less than 80% of cuts on live branches shall be branch removal cuts. *(Note to specifier: Including this statement in the specification ensures that the contractor uses reduction cuts to prune the trees. Reduction cuts are necessary in order to perform the work according to this specification. Adjust the percentage according to the site, location, age, and form of the trees. The percentage should be adjusted to suit conditions.)*

4) Make no removal cuts on the trunk larger than 7 inches diameter *(Note to specifier: This diameter should be adjusted to accommodate the age and condition of trees and the site attributes. Adjust the number downward – reducing branches instead of removing them - for older trees in poor health.)*

5) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the most common sub-standard pruning practices in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Debris removal: All debris will be removed from the work area daily.

Completion date: Fall of this year.

Re-inspection: Trees will be re-inspected and considered for pruning 3 years after completion of the current pruning project. *(Note to specifier: choose your own number appropriate for the circumstances.).*

Example 34. Raising the crown on a large mature tree.

Location: Front of property near driveway and street

Tree to prune: 32 inch DBH large mature shade tree.

Pruning system: Natural.

Purpose: Raise the bottom of the entire crown to provide 14 foot view clearance under the tree and reduce likelihood of tree and branch failure. *(Note to specifier: Clearance height can be adjusted to meet the objectives of the site.)*

Objectives:

1) Provide 14 feet clearance from ground to bottom of lowest branches. *(Note to specifier: Clearance height can be adjusted to meet site requirements and tree form. Change the height in the "Branches to prune" section below to match.)*

2) Improve branch architecture. *(Note to specifier: Although the customer may not have requested this service, this objective can be added – with their authorization - to provide more value.)*

3) Remove dead branches.

Branches to prune:

1) Remove all primary branches originating on the lower 14 feet of trunk so there is only one trunk vertically to 14 feet *(Note to specifier: Compared to removing only secondary branches from primary branches to create clearance – referred to as lion tailing - this approach of removing branches from the trunk or reducing them reduces likelihood of branches and foliage growing back and blocking visibility in the future. Large pruning wounds on the trunk might be required on certain trees, but this is a good trade-off for these medium-aged trees. If not removed now, these low branches would continue growing and will require even larger pruning cuts to remove from the trunk later.)* Remove secondary branches growing downward into the clearance zone from low primary branches.

Alternatively: On individuals where one or more removal cuts on the trunk would be 7 inches and larger, *(Note to specifier: This diameter can be adjusted according to conditions.)*, adjust the procedure to only remove those primary branches that are less than 7 inches on the lower 14 feet of trunk, and reduce those that are larger. *(Note to specifier: While this approach minimizes trunk decay from larger pruning cuts on the trunk, reduced branches are likely to sprout resulting in the need for clearance again in the near future depending on location of the cuts.)* Reducing the larger branches is accomplished by a) making 3 to 4 inch diameter *(Note to specifier: Specify diameter appropriate for the situation.)* reduction cuts to shorten (reduce) the longest portion of the branches and b) removing lateral branches drooping downward. About half the foliage should be removed on each reduced

primary branch. *(Note to specifier: Specify the number and type of cuts to perform per branch such as 3 to 4 reduction cuts and 4 to 5 removal cuts.)*

2) Remove dead branches greater than 1 inch diameter. *(Note to specifier: Specify diameter appropriate for the situation.)*

One or both of the next two strategies can be performed where less than about 15 percent of foliage was removed in #1 above. *(Note to specifier: Specify percentage appropriate for the situation.)*

3) Reduce length of the three largest diameter branches on the trunk originating above 14 feet trunk height with three 2.5 to 3.5 inch diameter *(Note to specifier: Number and diameter of cuts can be adjusted.)* reduction cuts on each.

4) Reduce length by 30 percent on branches with bark inclusions or cracks.

Limitations:

1) No heading or shearing cuts shall be made without authorization.

2) No more than 15 percent of the foliage shall be removed from an individual tree without authorization. *(Note to specifier: This number should be adjusted to accommodate the age and condition of trees and the site attributes. Adjust the number downward for older trees in poor health.)*

3) Less than 80% of cuts on live branches shall be branch removal cuts. *(Note to specifier: Including this statement in the specification ensures that the contractor uses reduction cuts to prune the trees. Reduction cuts are necessary in order to perform the work according to this specification. Adjust the percentage according to the site, location, age, and form of the trees. The percentage should be adjusted to suit conditions.)*

4) Make no removal cuts on the trunk larger than 7 inches diameter *(Note to specifier: This diameter should be adjusted to accommodate the age and condition of trees and the site attributes. Adjust the number downward – reducing branches instead of removing them - for older trees in poor health.)*

5) Trees shall not be lion tailed. *(Note to specifier: Lion tailing is one of the most common sub-standard pruning practices in the tree industry. It can lead to poor tree architecture causing trees to fail prematurely. Including this statement in the limitations increases the likelihood that trees will be pruned according to specifications.)*

Debris removal: All debris will be removed from the work area daily.

Completion date: Fall of this year.

Re-inspection: Trees will be re-inspected and considered for pruning 3 years after completion of the current pruning project *(Note to specifier: choose your own number appropriate for the circumstances.).*

A Plan for Training Planted Shade Trees

Establish a pruning cycle and objectives. Pruning cycle depends on quality of nursery stock, growth rate, climate, and species. A pruning cycle is proposed below. Objectives typically encompass training trees into a strong branch architecture that is also compatible with the long-term uses of the site. Decide on strategies to meet objectives.

Although it is best to begin the proposed program at planting, you may enter at any time.

25 year overview:

1) Establish and maintain a dominant leader by subordinating all but one codominant stem.

2) Space the largest primary branches apart by removing or shortening nearby branches.

3) Anticipate future form and function by training and pruning early to avoid cutting large branches later; removing large branches can initiate decay in the trunk (i.e., instead of allowing a low branch to get large then removing it when it droops, anticipate this by shortening it earlier).

4) Position the lowest main permanent limb high enough so it will not droop and have to be removed later. The lowest permanent branch should typically be positioned no lower than about 15 feet from the ground.

5) Encourage branches to remain less than half the trunk diameter by reducing their length.

Strategies at planting

- If branch architecture is perfect with one dominant leader, do not prune.
- All branches will eventually be removed on trees that are less than 4 inches caliper.
- Do not remove more than about 35 percent of live foliage.
- Shorten or remove leaders and branches competing with the main leader.
- If there is no dominant leader, create one by cutting back all stems and branches with aspect ratio larger than 1/2 except one that will become the leader.

Strategies two or three years after planting

- All branches will eventually be removed on trees less than 4 inches caliper.
- Do not remove more than 35 percent of live foliage.
- Shorten or remove all stems and branches with aspect ratio greater than ½.
- Shorten or remove large, low branches to improve clearance.

Strategies five years after planting

- Most branches are still temporary and will eventually be removed from the tree so keep them small by reducing their length.
- Do not remove more than 35 percent of live foliage.
- Shorten or remove all stems and branches with aspect ratio greater than ½.
- Shorten or remove large, low branches to improve clearance.
- Shorten aggressive branches growing from the bottom half of the canopy that have reached into the top third of the tree.
- There should be only one large branch per node (no clustered branches); shorten those nearby so only one is present.

Strategies ten years after planting

- Shorten or remove all stems and branches with aspect ratio greater than ½.
- Do not remove more than 25 to 35 percent of foliage.
- Determine the best position of the lowest permanent branch and shorten all aggressive branches lower than this limb.
- Shorten branches - by half - within 12 to 18 inches of largest diameter branches (there should be only one large branch per node (no clustered branches).
- Shorten aggressive branches growing from the bottom half of the canopy that have reached into the top third of the tree.
- Shorten low branches that will have to be removed later.

Strategies fifteen years after planting

- Shorten or remove all stems and branches with aspect ratio greater than ½.
- Identify several permanent branches spaced several feet apart and shorten nearby (within 18 to 36 inches) competing aggressive branches.
- There should be only one large branch per node (no clustered branches).
- Shorten or remove large branches lower (on the trunk) than the first permanent branches.
- Shorten aggressive branches growing from the bottom half of the crown that have reached into the top third of the tree.

Strategies twenty years after planting

- Shorten or remove all stems and branches with aspect ratio greater than ½.
- Identify five to ten permanent scaffold limbs and shorten others that compete.
- Shorten or remove large branches lower (on the trunk) than the first permanent branch.

- Shorten aggressive branches growing from the bottom half of the canopy that have reached into the top third of the tree.
- Shorten low branches that will have to be removed later.

Strategies twenty-five years after planting
- Shorten or remove all stems and branches with aspect ratio greater than ½.
- Continue to space apart permanent branches.
- Shorten branches within 36 inches of permanent branches.
- Shorten or remove large branches lower (on the trunk) than the first permanent branch.
- Shorten aggressive branches growing from the bottom half of the crown that have reached into the top third of the tree.
- Shorten low branches that will have to be removed later.

With seven prunings in the first twenty-five years after planting, a strong branch architecture develops that can place the tree on the path to becoming a permanent fixture in the landscape. Less-frequent pruning may be needed if good-quality nursery trees were planted with a dominant leader, and trees were irrigated appropriately until established.

List of Details (illustrations) for Inclusion in Pruning Specifications0

Chose one or more details listed below to help illustrate specifications.	
Name of illustration	MS Word illustration file name
Branch removal cut	Removal
Branch removal with inclusion	Removalinclusion
Branch removal dead	Removaldead
Reduction cut	Reduction
Double reduction cut	Doublereduction
Heading cut	Heading
Crown raise young tree	Crownraiseyoung
Crown raise and structural 1	Crownraisestructural1
Crown raise and structural 2	Crownraisestructural2
Crown raise and structural 3	Crownraisestructural3
Crown raise mature tree	Maturecrownraise
Structural pruning young	Structuralyoung1
Structural pruning upright branches	Structuralupright
Structural pruning spreading branches	Structuralspreading
Structural pruning mature tree	Maturecrownstructural
Structural pruning process mature tree	Maturestructuralprocess
Reduce crown size	Reducesize
Reduce crown size detail	Reducesizedetail
Reduce crown density	Maturereducedensity
Raise and structural pruning	Matureraiseandstructural
Pruning at planting	Pruneplanting

Available at: https://www.dropbox.com/sh/73gt6ec42gdiij7/AAB08VBHSjLhRR-Z24yRyt1ja?dl=0

Suggested Readings

Suggested publications essential to preparing pruning specifications available from the International Society of Arboriculture, Atlanta, GA.

American National Standards Institute. 2017 (latest edition as of this writing). American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Maintenance—Standards practices. ANSI A300 Part 1, Pruning. New York: American National Standards Institute.

American National Standards Institute. 2017 (latest edition as of this writing). American National Standard for Arboricultural Operations - Safety requirements. ANSI Z133-2017. New York: American National Standards Institute.

Gilman, E.F., B. Kempf, N. Matheny, and J. Clarke. 2013. Structural Pruning: A Guide for the Green Industry. Urban Tree Foundation, Visalia California, 84 pgs.

Gilman, E.F. 2012. An Illustrated Guide to Pruning. 3rd ed. Albany, NY: Delmar Cengage Learning, 476 pgs.

Lilly, S., E.F. Gilman, and T. Smiley. 2019. International Society of Arboriculture Best Management Practices, Pruning. 3rd ed. Atlanta Georgia: International Society of Arboriculture.

Appendix B: Process for Effective Visual Health Assessments

Palm Visual Health Assessments

In our Florida case study, one objective was to determine influential factors of palm health as they related to site conditions and management practices. Using a similar methodology to the one outlined below, visual health assessments were made to 1326 palms recently installed along Florida highways (. The assessor evaluated both quality and live frond ratio in twenty percent scoring classes. From an analysis perspective, the methodology was adapted largely from Bond (2012) where final assigned health ratings are normalized by species. Results were fit to an ordinal logistic regression based on deviations below the normalized health rating for that species. It is recommended to use health score deviations but doing so requires a large sample size or regional knowledge of species characteristics. From a practical standpoint, a blend of Bond (2012) and Hosek and Roloff (2016) provide an efficient framework for palm inventories. The sample protocol outlined in Appendix A will hopefully provide researchers and practitioners confidence to include palm health assessments in their inventory and monitoring studies.

Assessing Palm Quality
1. If there is no live crown, enter 0.
2. Assess fronds in the upper portion of the canopy – paying attention to upright and straight fronds regardless of color.
3. Avoid naturally senescing fronds (i.e., brown or chlorotic fronds in the lower canopy which may have a bent petiole) and completely dead fronds.
4. Determine the overall percentage of upper canopy that is free of discoloration, in steps of 20%.
5. If quality cannot be determined, enter 6 for data filtering purposes.

Assessing Palm Live Frond Ratio
1. If there is no live crown, enter 0.
2. Visualize the center of the circle over the spear leaf base, which is the growth point of the palm (see Figs. 38 and 39).
3. Visualize the edge of the circle extending to the frond tips.
4. Attempt to assess palms from the same distance, if possible.
5. Estimate percent of circle occupied by live fronds, regardless of deficiency or senescence.
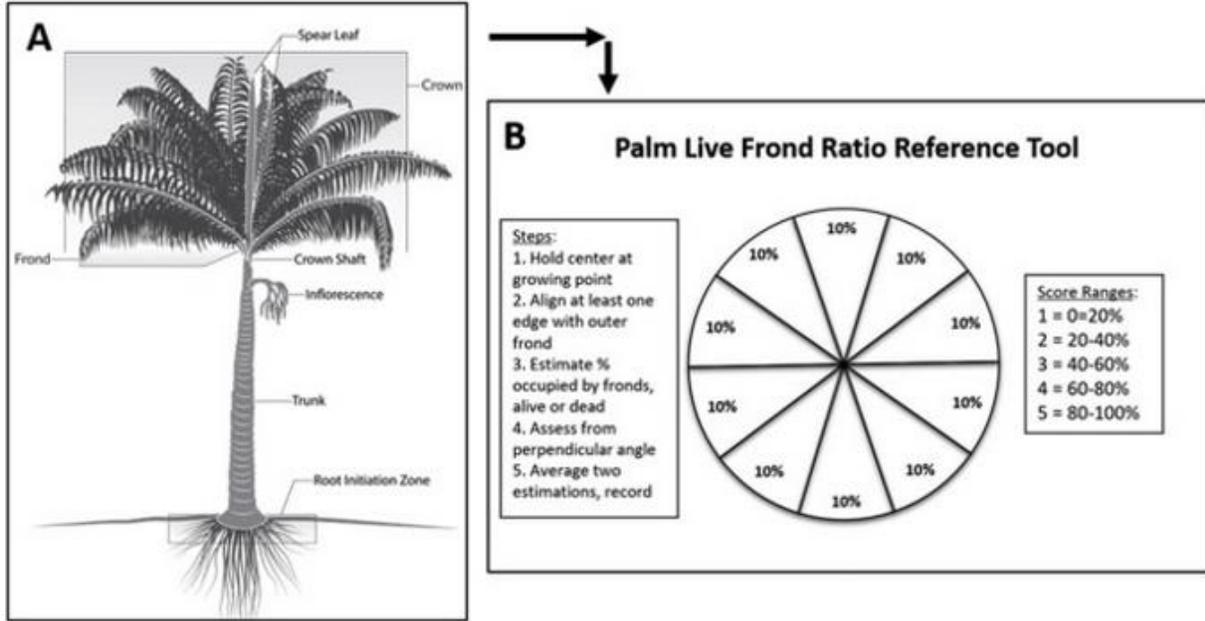6. If quality cannot be determined, enter 6 for data filtering purposes.

FIG 38. ANATOMY OF A PALM (A) AND PALM LIVE FROND REFERENCE TOOL (B)

FIG 40. ASSESSING LIVE FROND RATIO

Table 3. shows a potential means of using these two ratings to produce a final score based on the most limiting rating. Table 2 shows suggested qualitative ratings associated with deviations from the calibrated (mode) normal condition.

| Species: | | | Date: |
| Location: | | | Inspector: |
Score	% free of chlorosis (quality)	% of circle filled with live fronds (live frond ratio)	Final Score (based on lowest of the two categories)
6	n/a	n/a	
5	81-100	80-100	
4	61-80	60-80	
3	41-60	40-60	_____
2	21-40	20-40	
1	0-20	0-20	
0	No live Crown	No live crown	

Quality notes:

Live frond ratio notes:

If clustering, estimate how many trunks of total are represented by this score (i.e., 1/7)[y]:

[x]Crown fullness considers pruning practices because over-pruning can be detrimental to palm health. Therefore, fullness may not be useful on recently transplanted *Sabal palmetto* due to frond cropping at transplant.

[y]Number of trunks in cluster that represent this score. Assessing each trunk individually may be time consuming. However, if electing to remove, it would be counterproductive to remove the entire cluster due to the poor performance of one or a few trunks.

Table 4. Suggested live crown ratio ratings associated with deviations from the calibrated (mode) normal condition (preferred method, especially for working with populations of palms with crownshafts).

Live Frond Ratio Score	Description
6	n/a
5	1 deviation above mode value
4	Mode value
3	1 deviation below mode value
2	2 deviations below mode value
1	3 deviations below mode value
0	No live crown

Other Considerations for Palm Health

Generally, a palm that stands out as unhealthy should warrant further investigation to the tree. Some health issues or presence of pests may have special recommendations attached to them that can impact their final health scores. Below is an example list of some critical problems that should be considered when assessing palm health:

Decay fungi present (i.e. *Ganoderma zonatum)* --→ remove palm

Texas Phoenix Palm Decline or lethal yellowing present ---→ remove palm

Palm weevil --→ remove palm

Trunk borers ---→ remove palm

Major trunk constrictions (caused by past stressors that weaken tree ----------------→ reduce by 1 point

Major trunk damage ---→ reduce by 1 point

Thresholds in Palm Canopy Health

FDOT needs to develop threshold levels for mitigation actions based on their expectations for palm aesthetics and their ability to correct these issues. An example of a thresholds system is: Final Score ≥4 warrants no action, Final Score = 3 warrants corrective action, and a Final Score ≤2 warrants removal.

Tree Visual Health Assessments

The same methodology described above in the palm health assessment section can be applied to shade, ornamental, and conifer trees. Some exceptions from the palm methodology to note are what part of the tree is to be assessed and what parameters are used to assign a health rating.

Leaves to Consider for Assessment

1. The upper half of the canopy (avoids natural shading-out of lower canopy).

Tree Characteristics to Consider for Assessment

1. Vitality – percent of upper ½ canopy free of fine twig dieback
2. Quality – percent of upper ½ canopy free of chlorosis, necrosis, foliar damage
    a. Quality issues often result just before vitality decreases.
3. Ratio – percent of live canopy to total tree height
    a. Not useful for very young/small trees
4. Opacity – percent of light that shines through the upper ½ canopy
    a. Not as useful for conifers because foliage tends to be distributed to branch ends

Appendix C: Chemical Side Trimming

Per Roadside Procedure 850-000-015-j (3.3), "herbicides shall not be used as a seed head suppressant or plant growth regulant without obtaining approval from the Director of the Office of Maintenance." If approval is granted, chemical side trimming applications provide another method of controlling tree growth. By targeting interfering limbs with a controlled amount of herbicide, only the targeted limb will die back to the main trunk. Proper use of this technique can reduce overall maintenance costs and extend growth suppression [47], [48]. Chemical side trimming can be performed as a spot treatment to maintain clearance until the next mechanical **pruning cycle**, or a few years after mechanical trimming to control re-sprouting.

Chemical-side trim applications can be applied throughout the year from the ground, bucket trucks, or truck mounted sprayers. For the purposes of roadside management, helicopters are not a practical means of control due to public perception, necessary height of control, and proximity to impervious surfaces. Desired height of control, generally less than 15 feet in a roadside setting, will help dictate application equipment selection.

There are a few rules that apply to all chemical side-trim applications:

1. Do not chemically treat branches that overhang the roadway. They will eventually fall.
2. Do not apply herbicide over the tops of trees or in upper crown.
3. Do not apply herbicide to more than 1/2 of the crown. This can result in tree injury and/or tree failure.
4. Always comply with the manufacturer's label and MSDS on usage rates, timing, restrictions, and proper mixing. All labels state in some manner that "any use inconsistent with this label is a violation of federal law."
5. All applicators must be licensed in the state of Florida or working under a license in the state of Florida.
6. A daily **Herbicide Application Log (Form No. 850-000-15)** is required for any herbicide application.
7. Follow all other Roadside Procedures 850-000-015-j (3.0 – 3.11) as they relate to herbicide usage.

> **Disclaimer on Herbicide Applications**
>
> Every effort has been given to ensure the accuracy of this section. However, it does not assume priority over any herbicide label, local ordinance, or contractual specifications between FDOT and its agents. Always consult with your local chemical company representatives on choosing the proper mix.

Growing Season Application

Growing season applications may be more applicable to use in the state of Florida due to the lengthy season. The target for coverage will be tree foliage. Amine herbicide formulations are recommended because they are less volatile (susceptible to drift) in high heat and humidity.

Dormant Stem Application

Dormant stem applications can extend the window of control, provide crews with work in slower months, reduce vegetation brownout, and reduce drift potential to crop areas. Applications should be made mid-winter to early spring. Conditions should be dry because oil-based carriers must be used to aid in herbicide penetration and spreading along twigs and buds. The herbicides used must be oil-soluble or emulsifiable concentrates. Lower volume applications are preferred while trees are dormant because satisfactory control will require higher rates per acre of the herbicide formulation. Unlike dormant stem applications on undesirable groundcover, buds and twigs should not be covered to the point of runoff.

Ground-based Application

Ground applications consist of a human applicator pulling a hose from target to target. A handgun sprayer will direct herbicide at undesirable limbs. Reach is typically limited to 25 feet and good coverage may be difficult to achieve. Drift control agents are recommended because the handgun will be pointed in an upward direction. It is important to keep the handgun moving to avoid run-off. The applicator should be positioned parallel with the right-of-way and treating in both directions to limit herbicide making its way into the crown.

Bucket Truck Application

Bucket truck applications work similarly to ground applications but have an increased vertical reach. It is easier to obtain coverage when working from the top down. Drift concern is reduced and it is easier to visualize and avoid damage to the upper crown. However, utilizing buckets can require additional crew worker as safety flaggers. Set up and tear down procedures can become time consuming using this method.

Vehicular-mounted Application

Truck or ATV mounted sprayer applications typically consist of a fixed application rate per acre, calibrated to truck speed and tank pressure. Articulated arms with a spray head can be utilized in areas of difficult to reach vegetation. This method is less selective than ground based applications, but it is more efficient where on large swaths of terrain.

Reducing Public and Environmental Concern

Chemically side-trimmed trees may be aesthetically unappealing to motorists, therefore certain techniques may be employed to reduce complaints. There is seldom controversy in rural areas, but concerns may be reduced by utilizing:

1. Ammonium salt of fossamine (Krenite S). Helps reduce sudden 'brown out' because its mode of action is to inhibit future bud growth.

2. Late summer applications. Mimics "natural" browning of deciduous trees entering the dormant season.

Further information on herbicide recordkeeping, calibration, and regulations has been previously and thoroughly outlined in FDOT's "A Guide for Vegetation Management" [41].

Appendix D: Pest and Disease Outlook

Numerous pests and diseases have been encountered along Florida Highways. Although more exist, it is important to communicate these findings with maintenance managers and provide information about each issue of concern.
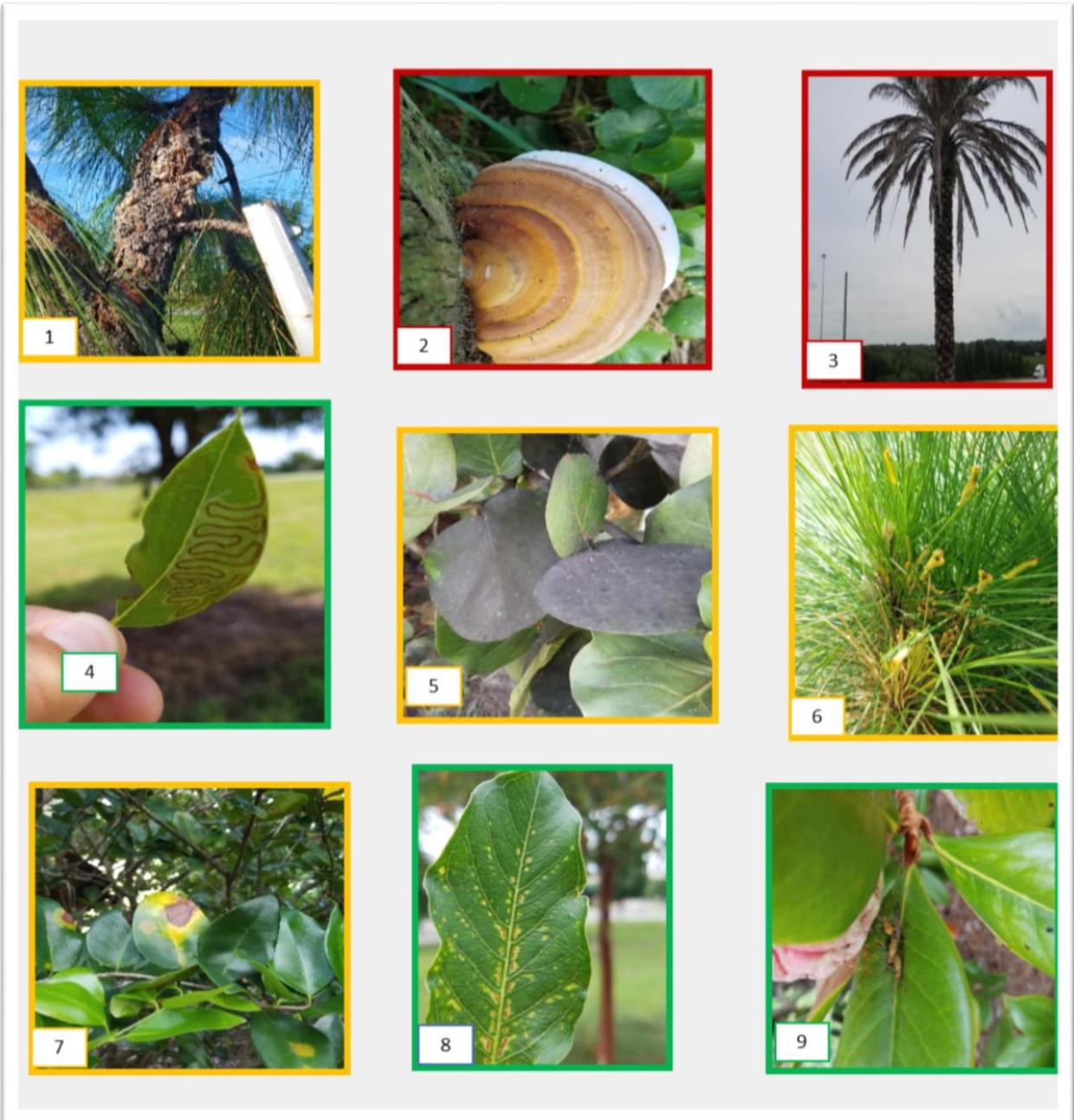

FIG 41. TREE HEALTH CONCERNS NOTED IN FDOT ROADSIDE SURVEY

Pitch Canker (1)

> Location: Lake City, I-75/US41
> Species: *Pinus elliottii*
> Symptom: branch dieback of new growth
> Identification: Flow of pitch on large swelling of tissue (canker)
> Cause: fungus *Fusarium circinatum,* generally during drought conditions or stem wounding
> Treatment: Prune and destroy infected branches
> Notes: Rarely kills a tree, but causes disfiguration of branches. Fertilization (excessive nitrogen) can predispose pines to pitch canker as well as Diplodia Blight.

Ganoderma Butt Rot (2)

> Location: Yulee, I-95/US17 & Tampa, I4/US301
> Species: *Sabal palmetto*
> Symptom: general decline/wilting
> Identification: shelf-like structure on lower trunk
> Cause: *Ganoderma zonatum*
> Treatment: Remove palm and as much of root system as possible, monitor others nearby
> Notes: All palms are susceptible and fungus resides in soil. Replace with non-palm.
> http://edis.ifas.ufl.edu/pp100

Lethal Bronzing (Formerly Texas Phoenix Palm Decline) (3)

> Location: Various
> Species: *Phoenix spp.* and some *Sabal palmetto*
> Symptom: Foliar discoloration/dead spear leaf
> Cause: phytoplasm
> Treatment: Only can prevent using trunk injection with oxytetracycline HCl (OTC) every 3-4 months. Plant non-susceptible species. Remove affected species.
> Notes: In at least 23 Florida Counties
> http://edis.ifas.ufl.edu/pp163

Mahagony Leaf Miner (4)

> Location: Boca Raton, Turnpike/869
> Species: *Swietenia mahagony*
> Symptoms: Lack of leaf vigor with galleries
> Cause: *Phyllocnistis meliacella*
> Treatment: Neem product can prevent, but is not economically justifiable due to negligible damage [49].

Sooty Mold (5)

> Location: Cocoa, I-95/Challenger Memorial Pkwy
> Species: *Coccoloba uvifera*
> Sign: Thick, black substance coating top surface of foliage (fungus)
> Cause: Secretions by sucking insects that grow fungus.
> Treatment: Control insect with insecticidal soap. Sooty mold will eventually fall off due to rains.
> Notes: Unlikely to kill a plant, but consecutive years of heavy infestation can reduce photosynthesis to the point where growth is stunted.

Pine Sawflies (6)

    Location: Deltona, I4/Saxon Blvd.
    Species: *Pinus elliottii*
    Symptom: reddish brown, frayed-like needles
    Cause: Defoliating *Neodiprion* spp.
    Treatment: Insecticides or preservation of natural enemies (birds, small mammals, etc.)
    Notes: Can trigger stress that makes more susceptible to borers
    http://edis.ifas.ufl.edu/in592

Cercospora Leaf Spot (7)

    Location: Okahumpka Service Plaza, Various
    Species: *Ligustrum japonicum*
    Symptoms: Yellow leaf spot with purple margins on upper leaf, raised and brown on underside. Can lead to thinning foliage and premature leaf drop.
    Cause: Fungus. Typical on mature specimens in late summer/fall and prefers wet conditions.
    Treatments: Multiple fungicide applications. Don't overprune, irrigate early, maintain plant health.

Rabbit Tracks (8)

    Location: Pensacola, Alcaniz/Garden St
    Species: *Lagerstroemia spp.*
    Symtpoms: Discolored dashes along mid-vein, when severe leaves may distort
    Cause: Possible micronutrient deficiency, though true cause hasn't been confirmed
    Treatment: Avoid susceptible varieties 'Muskogee' and 'Natchez'
    Notes: Minor disorder

Leaf-footed Bugs (9)

    Location: Moss Head, I-10/285
    Species: *Magnolia grandiflora*
    Cause: *Leptoglossus fulvicornis* that feed on fruits with piercing/sucking mouthparts
    Treatment: Damage is generally negligible

Ambrosia beetle (not pictured)

    Location: Moss Head, I-10/285
    Species: *Sabal palmetto*
    Signs: Frass tubes and holes on trunk
    Cause: Rare but can be found on palms that are in steep decline
    Treatment: Remove and destroy palm
    Note: Ambrosia beetles are a significant concern for pines in Florida. Maintain healthy populations. The palm specimen that hosted Ambrosia beetle in FDOT Roadside Tree Survey was planted too deeply and in poor health.

Bacterial Wetwood (not pictured)

    Location: Boca Raton, Turnpike/869
    Symptom: Strong odor, slime oozing from trunk, discoloration of wood
    Species: *Delonix regia*
    Cause: Bacterial activity creates gas and moisture that causes the oozing. The bacteria likely results from root wounds when young.
    Treatment: Maintain tree health as a preventative measure.

Glossary

All glossary terms follow the International Society of Arboriculture *Glossary of Arboricultural Terms* (2010)

acclimation - physiological adaptation process of plants and other living organisms to a climate or environment different from their native environment or where originally grown.

apical dominance - condition in which the terminal bud inhibits the growth and development of the lateral buds on the same stem formed during the same season.

aspect ratio - diameter of the branch relative to the diameter of the trunk, both measured immediately above the union.

branches - shoots or stems arising from a larger and older stem; a subdominant or subordinate stem; the pith in true branches is not contiguous with pith of the parent stem.

branch angle - the angle, typically less than 90 degrees, formed in the union between stem and branch.

branch architecture - Orientation and distribution of primary branches on the trunk.

branch bark ridge - raised strip of bark at the top of a branch union, where the growth and expansion of the trunk or parent stem and adjoining branch push the bark into a ridge.

branch collar - area where a branch joins another branch or trunk that is created by the overlapping vascular tissues from both the branch and the trunk. Typically enlarged at the base of the branch.

branch protection zone - chemically and physically modified tissue within the trunk or parent branch at the base of a smaller, subordinate branch that retards the spread of discoloration and decay.

caliper - trunk diameter on recently planted (last few months) trees measured 6 to 12 inches above soil line.

clear zone - area adjacent to roadway that must be kept free of vegetation at all times.

clearance - amount of open space between a tree or tree part and another object, the ground, or pedestrian or vehicle traffic on the ground.

codominant stems - forked branches nearly the same size in diameter, arising from a common junction and lacking a normal branch union.

compartmentalization - natural defense process in tree by which chemical and physical boundaries are created that act to limit the spread of disease and decay organisms.

crown cleaning - in pruning, the selective removal of dead, dying, diseased, and broken branches from the tree crown

crown raising - in pruning, the selective removal of lower limbs from a tree crown to provide clearance.

crown reduction - method of reducing the height and/or spread of a tree crown by making appropriate pruning cuts.

crown restoration - method of restoring the natural growth habit of a tree that has been topped or damaged in any other way.

crown thinning - in pruning, the selective removal of live branches to reduce crown density.

crownshaft – on certain palms, the section between the woody trunk and open fronds, which is a collection of frond bases wrapped tightly around each other. Often distinguished from the trunk by a change in color and texture.

DBH - acronym for tree diameter at breast height. Measured at 1.4 meters (4.5 feet) above ground in the United States.

decay - (1) (noun) an area of wood that is undergoing decomposition. (2) (verb) decomposition of organic tissues by fungi or bacteria.

decurrent - rounded or spreading growth habit of the tree crown. Contrast with excurrent.

directional pruning – providing clearance by pruning branches that could significantly affect the integrity of utility facilities or other structures, and leaving in place branches that could have little or no effect.

dominant leader - The one stem that grows much larger than all other stems and branches; at least one-third larger than lateral branches located nearby.

double reduction cut - A type of reduction cut whereby the retained lateral branch also receives a reduction cut.

emergency response - predetermined set of procedures by which emergency situations are assessed and handled.

excurrent - tree growth habit characterized by a central leader and a pyramidal crown. Contrast with decurrent.

flail-type cutters - in utility arboriculture, mowing machines designed to cut vegetation with a moving blade, chain, or other cutting device.

flush cut - pruning cut through and/or removing the branch collar, causing unnecessary injury to the trunk or parent stem.

girdling root - root that encircles all or part of the trunk of a tree or other roots and constricts the vascular tissue and inhibits secondary growth and the movement of water and photosynthates.

GIS - computer application using longitude and latitude coordinates to place objects or specified locations on maps for reference and/or analysis.

heading cut - cutting a shoot back to a bud or cutting branches back to buds, stubs, or lateral branches not large enough to assume apical dominance. Cutting an older branch or stem back to a stub in order to meet a structural objective.

included bark - bark that becomes embedded in a crotch (union) between branch and trunk or between codominant stems. Causes a weak structure.

inflorescence - cluster of flowers.

infructescence – fruiting structure with more than a single fruit.

internodal cut - cut made between the nodes on a stem.

lateral branch - secondary or subordinate branch or root.

leader - primary terminal shoot or trunk of a tree. Large, usually upright stem. A stem that dominates a portion of the crown by suppressing lateral branches.

lion-tailed - The improper practice of removing all or most secondary and smaller branches from the interior portion of the crown leaving most live foliage at the edge of the canopy.

live crown ratio - ratio of the height of the crown containing live foliage to the overall height of the tree.

maintenance Rating Program - monitoring program for evaluation of maintenance in landscape areas and other Florida Department of Transportation assets.

mitigation - in tree risk management, reducing, alleviating, or minimizing risk of harm (damage or injury)

natural pruning system - Pruning that maintains the characteristic and strong branch architecture for the species.

organic matter - material derived from the growth (and death) of living organisms. The organic components of soil.

orientation - The upward, downward or lateral angle of departure.

parent branch - larger branch or stem from which a smaller, lateral branch arises.

permanent branch - in structural pruning of young trees, branches that will be left in place, often forming the initial scaffold framework of a tree.

personal protective equipment - personal safety gear such as hard hat, safety glasses, hearing protection, and leg protection, including chaps.

pH - unit of measure that describes the alkalinity or acidity of a solution. Negative log of the hydrogen ion concentration. Measured on a scale from 0 to 14. Greater than 7 is alkaline, less than 7 is acid, and 7 is neutral (pure water).

pollarding - specialty pruning technique in which a tree with a large-maturing form is kept relatively short. Starting on a young tree, internodal cuts are made at a chosen height, resulting in the development of callus knobs at the cut height. Requires regular (usually annual) removal of the sprouts arising from the cuts.

pore space - air or water-filled spaces between soil particles. Consists of macropores (air holding) and micropores (water holding).

primary branch - A branch attached directly to the trunk extending to the tip following the largest stem at each fork.

pruning cycle - n utility and municipal arboriculture, the time scheduled between pruning events that is established as a guideline for providing reasonable clearance between trees and conductors.

reduce length - Reduce the length of a branch using one or more reduction cut(s)

reduction cut - pruning cut that reduces the length of a branch or stem back to a lateral branch large enough to assume apical dominance

removal cut - cut that removes a branch at its point of origin. Collar cut.

right-of-way - defined area of land, usually a linear strip, reserved for the passage of traffic (paths and roadways) or the construction, maintenance, and operation of various above-ground or underground utilities.

risk - likelihood or probability that something will happen, usually associated with negative consequences. In tree management, the likelihood of a tree failure and severity of associated loss, personal injury, property damage or disruption of human activities.

risk management - systematic application of management policies, procedures, and practices for identifying, evaluating, treating, monitoring, and communicating risk.

root ball - soil containing all (e.g., containerized) or a portion (e.g., B&B) of the roots that are moved with a plant when it is planted or transplanted.

root bound - condition in which plant roots are overcrowded in a container or site and root growth is restricted.

root collar - Base of the trunk where roots and trunk merge that becomes swollen as most trees grow; also referred to as root crown, root flare, and trunk flare.

root initiation zone - region at the base of a palm stem where lateral roots emerge.

root:shoot ratio - relative proportion of root mass to crown mass.

rotary cutting head - single-blade or multiple-blade arrangement that rotates to cut or shred vegetation.

sanitation - cultural practice of removing dead, infested, or diseased plant parts to reduce the spread of insects or disease.

scaffold branch - permanent or structural branches that form the scaffold architecture or structure of a tree.

secondary branch - A branch growing from a primary branch.

senescence - process of aging. Process preceding leaf drop in deciduous plants.

soil compaction - compression of the soil, often as a result of vehicle or heavy-equipment traffic, that breaks down soil aggregates and reduces soil volume and total pore space, especially macropore space

soil horizon - layer or zone of the soil profile with physical, chemical, and biological characteristics that differ from adjacent layers.

soil particle - smallest grains of soil categorized by size into clay, silt, or sand

soil probe - any one of a number of instruments used to take soil cores or samples. Usually some variation of a metal tube with a sharpened or serrated point and a T-shaped handle

soil salinity - a measure of the soluble salts in a soil

soil structure - arrangement of soil particles into aggregates.

soil texture - relative fineness or coarseness of a soil due to particle size (sand, silt, and clay)

specifications - detailed plans, requirements, and statements of particular procedures and/or standards used to define and guide work.

stem - A woody structure bearing foliage and buds that gives rise to other stems and branches.

structural defect - feature, condition, or deformity of a tree that indicates a weak structure or instability that could contribute to tree failure.

structural pruning - pruning to establish a strong arrangement or system of scaffold branches.

stub cut - improper pruning cuts made too far outside the branch bark ridge or branch collar that leave branch tissue attached to the stem

subordinate - prune to reduce the size and ensuing growth of a branch in relation to other branches or leaders.

taper - change in diameter over the length of trunks, branches, and roots.. A desirable characteristic of strong branch and tree structure.

temporary branch - in structural pruning of young trees, branches (generally the lower branches) that are left in place or subordinated but will be removed later in forming the permanent scaffold framework of a tree.

three-cut method - in pruning, using an under-cut, top-cut, and final cut to successfully remove larger diameter branches without tearing bark tissue.

topping - inappropriate pruning technique to reduce tree size. Cutting back a tree to a predetermined crown limit, often at internodes

tree inventory - record of trees within a designated area that provides specified identification and condition information to be used for management decisions and actions.

trunk - The stem that arises from the ground following the largest stem at forks.

trunk flare – area of transition between the root system and the trunk.

Vitality - The state of health.

watersprouts - upright, epicormic shoot arising from the trunk or branches of a plant above the root graft or soil line. Incorrectly called a sucker.

wound dressing – compounds or substances applied to tree wounds or pruning cuts.