Pointe West Community

Tree Infrastructure Impact Assessment

Arrow indicates tree root lifting and separating a valley gutter in the Pointe West community.

by

Chuck Lippi
ISA Board Certified Master Arborist #FL-0501B
ASCA Registered Consulting Arborist #443

and

Danny Lippi
ISA Board Certified Master Arborist #FL-6145B
Tree Risk Assessment Qualification (TRAQ)

Summary

We were asked by Rick Kimes, Pointe West Community Manager for Elliott Merrill Community Management, to perform an evaluation of approximately 750 street trees within the Pointe West community in order to assess the interactions between the street trees and nearby sidewalk, street, and valley gutter infrastructure. Many trees have begun causing infrastructure damage to sidewalks and valley gutters. Pointe West has already undertaken grinding and/or replacement of previously lifted sidewalks that have become a trip hazard. Newly replaced sidewalk slabs, as well as the previously ground slabs have begun to lift again and a more permanent solution is desired. We were asked to provide recommendations and guidance to deal with the bourgeoning infrastructure issue before it becomes a more dangerous and costly problem. The vast majority of street trees are live oaks (*Quercus virginiana*). It was agreed upon that, a representative sample of 750 trees, selected at random throughout the community, would provide sufficient information about the community street trees with regard to infrastructure conflicts. We discovered that over half of those 750 trees evaluated have caused or were actively causing infrastructure damage and would require some form of mitigation ranging from continued slab grinding to tree removal. We also observed that the larger trees were causing more damage and increasingly significant damage.

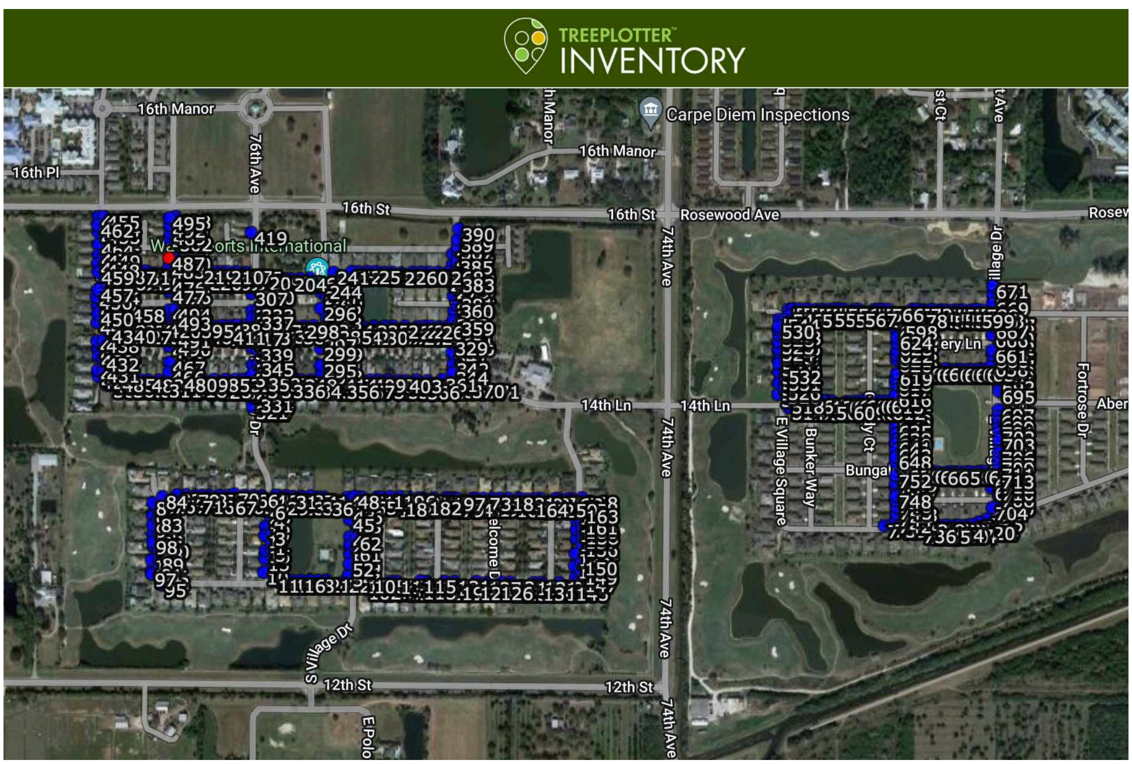

Image 1. A map view of all assessed trees as collected with TreePlotter cloud based tree inventory software.

Introduction

Assignment

Our assignment was to:

1. Assess the current condition of the street trees with regard to infrastructure impacts
2. Determine whether or not the observed street infrastructure impact condition warrants mitigation
3. Recommend an appropriate course of action for maintenance
4. Provide a reactive and preventive management plan to deal with current and future infrastructure conflicts where possible
5. Provide general guidance with regard to pruning requirements based on the existing canopy

Purpose and Use of the Report

This report is prepared for the Pointe West HOA Board of Directors and community.

Important Note*: *The terminology used in the tree database associated with this report to describe tree defects observed and maintenance recommended is designed to communicate tree conditions to ISA Certified Arborists who are trained in Risk Assessment protocol and ANSI A-300 Standards. Property owners concerned about their trees' health and structural condition may find the terminology used in the database confusing. Likewise, tree service workers who are not trained in Risk Assessment protocol and ANSI A-300 Pruning Standards may also find the terminology confusing, in which case they should not be hired to perform the maintenance work recommended. Hopefully, this accompanying written report will explain some of these matters more clearly.

Assumptions

A field examination of the site was performed over five days from November 5, 2023 to November 28, 2023. Our observations and conclusions are as of that period. Information on sidewalk slab removal and replacement processes was provided to us verbally by Pointe West management staff and contractors.

Testing and Analysis

We performed a **Level 2 Basic Assessment**, which is a detailed visual inspection of a tree and its surrounding site. The Level 2 Assessment includes a 360-degree visual inspection from ground level on each tree and sound testing of the lower trunk and root flares with a rubber mallet to listen for tonal variations that may indicate internal hollows or decay. The Risk Assessment is done in accordance with ***ANSI A300 Standards on Tree Risk Assessment*** [1] and the companion publication ***Best Management Practices, Tree Risk Assessment***.[2]

No **Level 3 Advanced Tree Risk Assessment** tests were required, in our opinion, or performed. In general, tree health was not at issue. Most of the trees were young healthy, and growing vigorously.

Limits of the Assignment

We visually inspected each tree for the tree assessment.

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

Data Collection

Both empirical data as well as subjective data were gathered on each tree. Data were collected on TreePlotter, a cloud based tree inventory data collection database and georeferencing application used on our handheld iPads and accessed online as well as downloaded to a MS Excel spreadsheet.

Empirical data included:
1. Tree plot point map locations on Google Maps
2. Tree species
3. Tree diameter at breast height (DBH)

The subjective data included:
1. Health condition (excellent, good, fair, poor)
2. Structural condition (excellent, good, fair, poor)
3. Maintenance recommendations such as sidewalk slab lifting, driveway paver lifting, curb/valley gutter damage.
4. Structural issues such as low hanging branches impacting traffic.

Observations

The Trees

Live Oak (*Quercus virginiana*) Because the Southern live oak is the dominant street tree on the site, it is worth noting some of its attributes. The Southern live oak is a native tree, which is considered to be one of the premier tree species in the Southeastern United States. According to Dr. Ed Gilman, Professor Emeritus of Environmental Horticulture at the University of Florida, when mature the live oak is “a large, sprawling, picturesque tree, usually graced with Spanish moss and strongly reminiscent of the Old South. Live oak is one of the broadest-spreading of the oaks, providing large areas of deep, inviting shade. An amazingly durable American native, it can measure its lifetime in centuries if properly located and cared for in the landscape.”[3] He also says of live oak, “give it plenty of room since the trunk can grow to more than six feet in diameter.”[4]

Dr. Mary Duryea, Associate Dean for Research and Forestry Professor at the Institute of Food and Agricultural Sciences of the University of Florida, has been studying hurricane damage on the trees for the past 20 years. Dr. Duryea has made lists of the trees she has found to have the lowest wind resistance and the highest wind resistance. The live oak is on her list of the trees with the highest wind resistance. The wind-resistance list has subsequently been incorporated in several University of Florida Extension Service publications.[5, 6]

Image 2. Live oak tree planted and growing in a 4 foot wide curb strip.

The Site

All of the street trees we assessed are growing in curb strips that run parallel to the streets. These curb strips range in width from four feet to seven feet (image 2).

The majority of the curb strips we encountered were five to six feet wide. The planting area within the curb strips consists of urban composite soils with limited space for roots between sidewalks, street and driveway infrastructure. Generally, urban composite soils have low organic carbon, low soil nutrition, and have varying degrees of compaction from urban activity. Because none of the trees presented stress symptoms consistent with soil quality issues, a formal laboratory soil analysis was not performed.

Infrastructure Conflicts

The older, larger street trees were installed at the time of development which was took place in 1999, according to the Pointe West Country Club website. The trunk size at the time of installation in 1999 is unknown. However, the trees that have been replanted in areas where mature trees were removed due to infrastructure damage are approximately two to three inches in trunk diameter.

It is important to understand that the root systems of most trees, including live oaks, are shallow and wide. Roots need oxygen for respiration which means they must stay close to the soil surface, generally within 12 to 20 inches deep with many roots occurring at the soil surface. The smaller fibrous roots which occur toward the edge of the canopy driplines and beyond, exist inches from the soil surface, within the carbon rich top O horizon. Roots generally do not exist deeper than the described depths due to reduced soil oxygen levels and stressful anaerobic conditions. For these reasons, roots of the live oaks will persist at the soil surfaces. Any built floating surface, such as a sidewalk or driveway near a tree must be engineered to accommodate or prevent eventual root/infrastructure interactions.

DBH	Total trees	Total causing damage	% causing damage
2	19	0	0%
3	53	0	0%
4	43	0	0%
5	22	1	5%
6	44	5	11%
7	32	7	22%
8	38	18	47%
9	34	16	47%
10	58	36	62%
11	64	49	77%
12	46	36	78%
13	57	47	82%
14	59	52	88%
15	56	48	86%
16	37	34	92%
17	36	35	97%
18	21	19	90%
19	12	11	92%
20	10	9	90%
21	5	5	100%
22	5	5	100%
23	1	1	100%

Table 1. This table shows the breakdown of trees by trunk diameter size in inches (DBH - diameter at breast height), and how many of those trees are causing infrastructure damage. The last column shows the total as a percent.

Of the 752 trees assessed, 434 trees have caused some form of infrastructure damage (Table 1). The majority of observed infrastructure damage is lifting sidewalk slab, many of which have been mitigated by concrete grinding. A further breakdown of the data shows that 418 trees are causing or have caused some degree of sidewalk lifting (Table 3). One hundred and thirty nine trees are causing valley gutter and/or street damage (Table 3).

Concrete Sidewalk Slab Lifting

The most immediate and numerous infrastructure conflict observed is sidewalk slab lifting. Sidewalk repair is a large expense that will become larger each year as cut tree roots regrow under replaced sidewalk slabs and as sidewalk slabs that have previously been ground continue to be lifted by existing roots under the sidewalk. This ongoing sidewalk problem is being caused by tree roots growing and expanding under the floating sidewalks at the sidewalk/soil surface interface. The production and expansion of radial growth rings will continue to impact and likely raise any unreinforced surfaces which are encountered. And roots cut during a sidewalk slab replacement will grow back usually, in our experience, within three years after they have been cut.

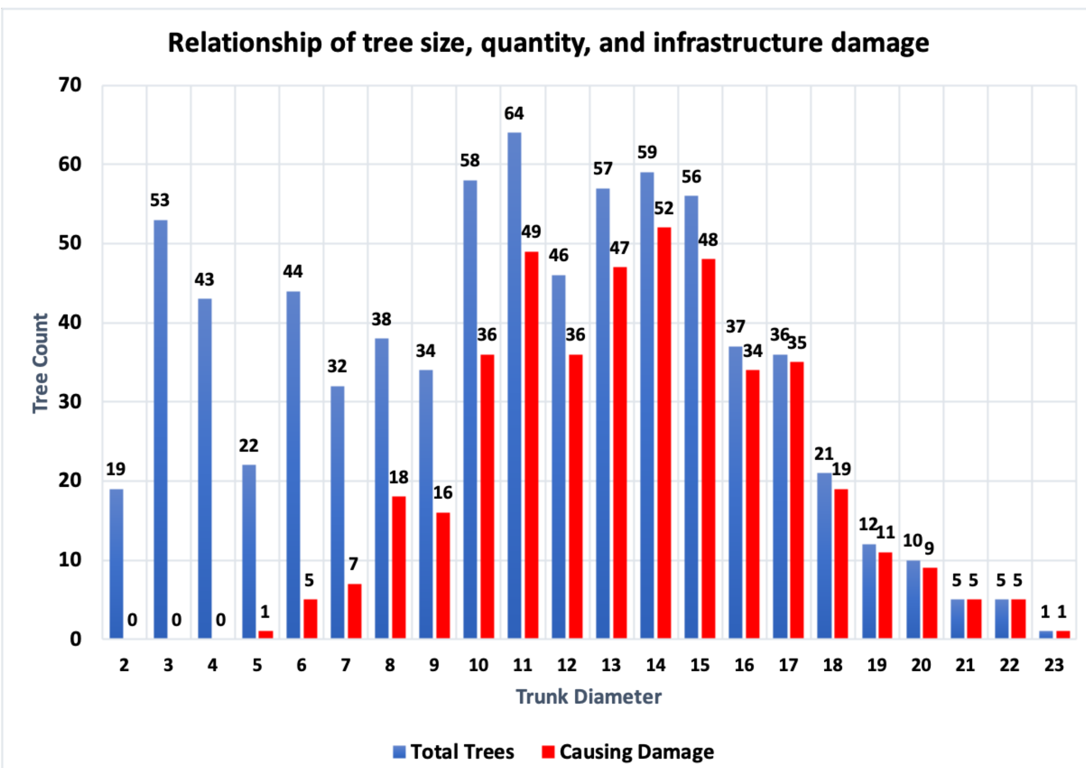

Table 2. A visual representation of the comparison of damaged trees within Table 1.

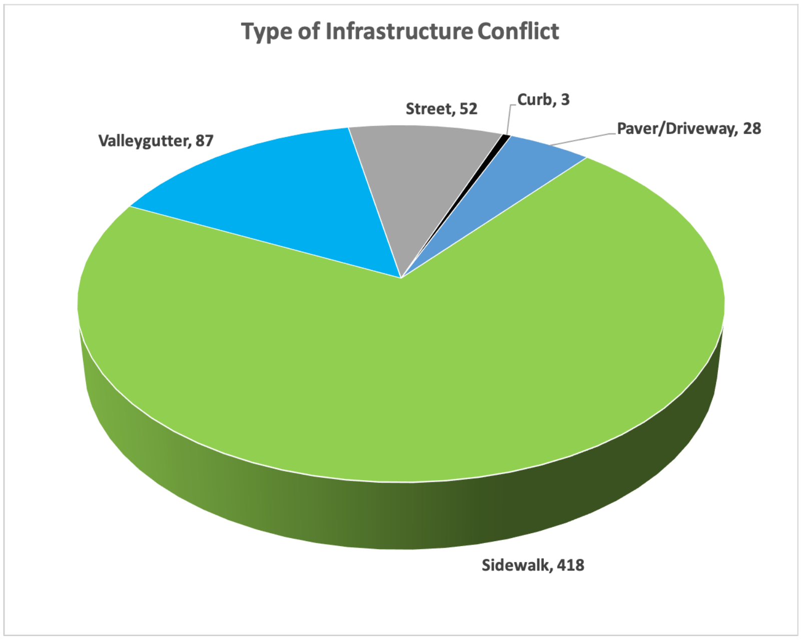

Table 3. Breakdown of the type of infrastructure damage.

Most insurance companies designate a lifted sidewalk as a trip hazard once a slab has been lifted 1/4 of an inch at which time it should be mitigated. This is based on Federal ADA guidelines. While grinding will remove the immediate trip hazard, it is only a temporary fix. A ground slab will usually rise back to the minimum 1/4 inch height limit for a legal trip hazard within three years, sooner if the trees are healthy and vigorous such as those within Pointe West. We do not recommend grinding a slab more than twice because it weakens the structural integrity of the concrete. This means that after a second cycle of grinding occurs, more permanent infrastructure mitigation techniques will need to be considered. These options are discussed later in this section. In Table 4, special attention should be given to the "Yes - previously ground" designation. This indicates that the first mitigation grinding

Image 3. Tree #461. Supportive lateral roots were cut to install a new sidewalk slab. This temporary fix, which has failed allowing the new roots to lift the replacement sidewalk, has also destabilized the tree.

effort has failed and the trip hazard has recurred. This also indicates that a decision must be made for future maintenance after the second and final slab grinding has failed. Trees categorized as "yes" indicates a first phase of grinding should take place. "Not feasible" means that grinding is no longer a viable option due to the current extent of damage and other, more involved root mitigation options must now be employed. "No-not recommended" means that there is either no lifting taking place or the lifted slab has not reached 1/4 inch in vertical height at the time of analysis.

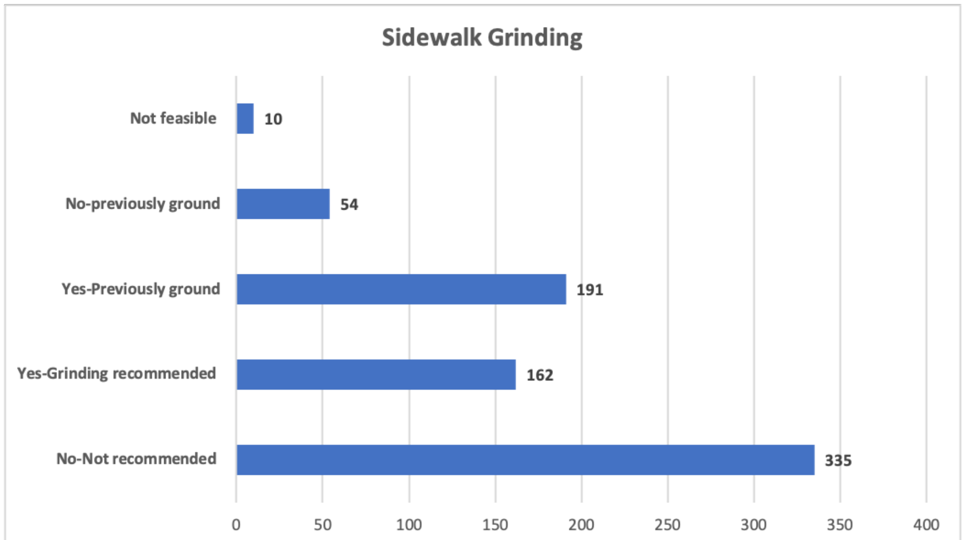

Table 4. This table represents the analysis of past present and future sidewalk maintenance.

Root Cutting

Simply removing the lifted sidewalk slab and cutting the roots before pouring a new slab will not last long. In our experience, in Florida, new roots from the same tree will grow back under the new sidewalk and again the lift slab in about three years. Cutting and removing roots also destabilizes trees and makes them more prone to failing during high winds events. Tree #461 (Image 3) appears to have had a new slab installed which is now lifting. In the process, all of the large lateral roots on the sidewalk side of the tree are removed. Trees are more prone to failure due to lack of root support during the years it takes to replace those roots (image 4) .

Image 4. Lack of well developed lateral support root makes trees more susceptible to failure during high wind events. This can be a result of either cutting roots or not providing enough rooting space. Often, both go hand in hand.

Tree Mitigation or Repair

We will use two general methods: **tree-based sidewalk repair** and **infrastructure-based sidewalk repair**. The tree-based sidewalk repair methods tend to work around roots using infrastructure that accommodates roots. The infrastructure-based sidewalk repair methods tend to prune roots and create barriers to prevent root growth beneath the sidewalk. Neither method is permanent because live oaks will continue to grow and eventually reach a girth that inevitably causes infrastructure damage. The goal here is to greatly increase the interval required between sidewalk repair sessions. Twenty years is a realistic time frame.

Tree-based Sidewalk Repair

Excavation beneath root and use of geogrid mat with #57 stone as a base - The key to tree-based sidewalk repair is to accommodate rather than cut roots whenever possible. The process begins by carefully removing lifted slabs (image 6) and then roots are located using an Air Spade excavation tool (image 7). Next the large lateral roots that are encountered are undercut so soil is removed from beneath these roots shown in images 7 and 8. The reason for providing open space beneath each root is to allow room for the root to expand downward as it grows rather than pushing upward. Area around the root is then leveled with #57 stone some of which is allowed to fall beneath the undercut roots (image 9). Next after the area has been leveled, geogrid mat is laid down over the roots and a 3 to 6-inch layer of #57 stone is placed on top of the geogrid (image 10). The greater the thickness of the #57 stone over the geogrid, the greater the resistance to lifting by tree roots. The geogrid stone layer should always be covered with a layer of geotextile cloth to prevent soil and other material placed on top of the mat such as poured concrete from sifting into the layer of aggregate stone and plugging air spaces and reducing air movement. The stones should be large enough so they will not sift through the geogrid mat mesh (image 11). This Geo textile-#57 stone-geogrid layering will provide protection from compaction for the tree roots as well as permit adequate air infiltration into the soil surrounding the roots. It will also help prevent roots from lifting sidewalk slabs by dispersing the upward force of a growing root over a larger area. This 3 to 6-inch gravel base can cause the new sidewalk to be higher than the old sidewalk. Finally, rebar should be incorporated into the new slabs to also help avoid individual slab sections from lifting (image 12).

Image 5. Carefully remove sidewalk slabs that have been lifted by root growth.

Image 6. Use an air excavation tool such as an Air Spade or Air Knife to locate roots and remove soil from roots. Hand digging is also possible but roots can be damaged.

Image 7. Locate the major roots that are lifting the sidewalk.

Image 8. Locate the major roots that are lifting the sidewalk.

Image 9. Level the soil around the excavated root. The resulting sidewalk may be higher than the old sidewalk.

Image 10. Install geogrid mat over the roots and cover the geogrid mat with #57 stone.

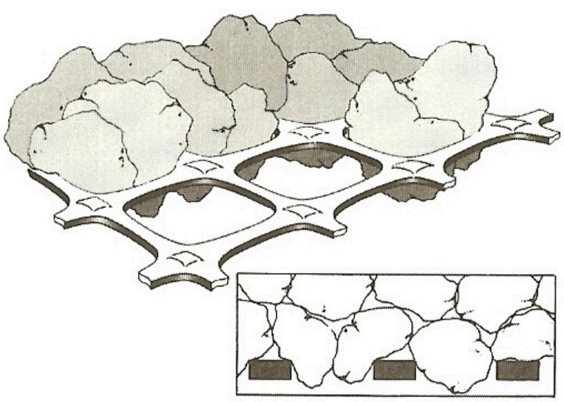

Image 11. The geogrid is Tensar BX1200 (http://www.tensar- international.com). One distributor in Florida is Ferguson Waterworks (http://www.geosyntheticproducts.com). Go to the Ferguson Waterworks website to locate a distributor in your area.

Image 12. Geotextile fabric is then laid over the #57 stone and geogrid mat and rebar reinforcement is then installed over the geotextile fabric.

Image 13. Prior to plate installation, two 4 to 5-inch roots were retained, bruised a bit by the construction crew who did this by hand. Notice smaller roots at the surface were cut.

Image 14. Holding a pasteboard on edge behind each root, draw the upper root contour on the pasteboard. Then take it to a fabricator who can duplicate that contour in scrap diamondplate.

Image 15. Drill through the plate every foot or so, 1/4" to 3/8" holes for lag screws. The diameter of the lags, and length will be appropriate to the root diameter. Pre-drill holes in the roots for the lag screws. Fasten the plates tightly against the top of the roots with the lag screws. Then build the sidewalk.

Image 16. Joe McNeil says, “Nine years later there is no disturbance lifting or fracturing of the sidewalk above the roots. The tree has looked great since, as well.” The sidewalk and curb were elevated about an inch to accommodate the required thickness of the steel plates.

Excavation of root and installation of a steel plate over the offending roots - The second method of Tree-based Sidewalk Repair is to use a steel plate that is bolted over the top of the offending roots (image 15). We have not found a municipality, HOA or a contractor that has performed this technique here in Florida. We learned about it from a colleague Joe McNeil in Pleasantville, California who is an ISA Board Certified Master Arborist and an ASCA Registered Consulting Arborist. His website is: http://www.oakperson.com/ and his company is McNeil Arboriculture Consultants LLC. The descriptions below each photo are Mr. McNeil's as are the photos. The tree in question is a London Plane (*Platanus × acerifolia*) a hybrid of the sycamore tree (*Platanus occidentalis*). According to Joe this installation was done in September, 2009 and the tree, which is located about 12 inches to the right of the sidewalk slab in image 16, is in good condition now and no sidewalk lifting has been observed.

Infrastructure-based Sidewalk Repair

Using an infrastructure-based sidewalk repair, the tree roots are cut. This technique is the one most commonly used yet it is the one method we favor least because it causes both short and longterm damage to a tree. First, cutting roots can damage tree health and tree stability. Trees with roots cut closer to the trunk than a distance equal to three times the trunk diameter can become unstable (image 4). And this instability remains even 20 years or more after the roots have been cut.[7] Cutting large roots also creates an entry point for pathogenic wood decay pathogens such as *Ganoderma spp.* or *Armillaria spp.*. Both are untreatable, naturally occurring pathogens that persist for years slowly degrading the structure and health of a tree.

When roots are cut or when new trees are planted near a sidewalk, it is often advisable to insert a root barrier at the edge of the replacement sidewalk. There are several different root barrier materials on the market — some very flexible with buttons containing a root inhibiting herbicide and other barriers are stiff plastic material that snaps together. We prefer the stiff, snap-together root barrier which must be installed protruding slightly above the soil to prevent roots from growing over the top. Also, the depth of root barriers is important. Our preference is a root barrier such as DeepRoot barrier (http://www.deeproot.com/products/root-barrier.html) that extends at least 24 inches below the soil surface. A 36-inch deep root barrier is better but more expensive than a 24-inch deep root barrier.

In our experience cutting roots with no other techniques to limit or divert root growth, tree roots will grow back beneath the sidewalk within three years following root pruning. So if root pruning is going to be used, additional techniques such as geogrid and gravel (#57 stone) beneath the new sidewalk and a root barrier should be used.

Streets, Valley Gutters (curbs)

Image 17. Valley gutter function is hindered as a result of impacts by tree roots. Arrows indicate lifted valley gutter and pooling water.

Eighty seven trees were documented damaging valley gutters. It should be noted that the techniques described above work well for floating infrastructure such as sidewalks, driveways, and parking lots. These methods do not work for valley gutters.

After sidewalk trip hazards, dealing with valley gutters should be a top priority. A failing drainage system will become very costly because the damage caused by standing water will increase the infrastructure damage. Many trees are observed to be heaving the valley gutters upward which affects the valley gutter flowline, and consequently the roadway drainage. This creates a break in the flowline and disrupts stormwater's path to curb inlets. Stormwater then becomes perched in a newly created depressional area, resulting in stormwater that remains on the roadway for a prolonged duration (image 17). Continued standing water can lead to stormwater seeping into a roadway pavement's base course, reducing the pavement's ability to resist vehicular traffic loads. This ultimately leads to an accelerated deterioration of the pavement and an increase in maintenance costs in the future.

Image 18. A tree root is seen growing between and slowly separating the spaces in the engineered valley gutter.

The street trees in Pointe West are planted too close to the valley gutters in order to recommend cutting of roots. While the trees may survive root cutting, they immediately lose lateral structural root support and become more susceptible to blowing over in a storm or other high loading event (image 4). Due to the highly restricted rooting area, there are no viable mitigation options that do not cause severe loss of health or structural integrity to the trees. For these reasons, we have recommended removal of any tree that is actively lifting a valley gutter. This number will likely increase as the trees grow.

Images 19 (left), 20 (right). Tree #256 has suffered significant root loss (arrows) during sidewalk slab removal and replacement. This large tree is currently more susceptible to structural failure during wind events and should be removed.

Removals

A total of 92 trees are recommended for removal. Eighty seven trees are recommended for removal due to impacts to valley gutters. Four trees are recommended for removal because they are located within 20 feet of a fire hydrant. One newly installed tree was recommended for removal due to it's poor health and structural damage.

Tree roots often impact fire hydrants as they are attracted to the presence of water in the underground tubes. As an example from a similar community in Florida, a four inch diameter root can be seen growing toward and around a fire hydrant located approximately fifteen away (images 21, 22).

Other trees recommended for removal are larger trees that have recently suffered serious root damage as a result of recent sidewalk slab removal and replacement. These trees are currently at high risk of structural failure during wind events and should not be retained. Trees #108 and 267 are examples of this dangerous situation.

Image 21. A young live oak tree approximately 15 feet from a fire hydrant and water utility line.

Image 22. A tree root approximately 4 inches in diameter impacting a fire hydrant.

Pruning

While neither canopy assessment nor tree risk assessment were including in the scope of work or the requested by the client, we did note that many of the community street trees require clearance pruning of lower lateral limbs. Federal and Florida Department of Transportation requirements mandate an unobstructed 14 foot vertical clearance over all publicly accessible roadways. Any tree that we observed with branches growing within 14 vertical feet of a roadway footprint is identified in the tree assessment under “Management”.

Summary

The percentage of trees causing infrastructure damage is quite high and according to our analysis, that number is expected to increase substantially as the trees grow (Table 1). As an example, 60% of trees measuring 21 and 22 inches in diameter are causing infrastructure damage severe enough to warrant removal (Table 5).

Our analysis has provided insights into the future of the tree/infrastructure impacts that will affect Pointe West. Infrastructure damage manifests when the trees reach five inches DBH. By nine inches DBH, almost 50% of the trees are damaging infrastructure. By 16 inches DBH, the percentage of trees causing infrastructure damage reaches and stays at or above 90% (Table 1).

DBH	Total Trees	Removal Recommended	% Removal Recommended
8	38	2	5%
9	34	0	0%
10	58	1	2%
11	64	3	5%
12	46	2	4%
13	57	6	11%
14	59	12	20%
15	56	14	25%
16	37	10	27%
17	36	13	36%
18	21	7	33%
19	12	7	58%
20	10	4	40%
21	5	3	60%
22	5	3	60%
23	1	0	0%

Table 5. This table indicates the percentage of trees recommended for removal due to significant infrastructure damage increases substantially with size.

Appendix A

Definitions

Condition – an evaluation of a tree's structure and health
DBH – diameter at breast height, a standard measurement in arboriculture of a tree's diameter usually measured approximately four and one half feet above the ground
Dripline – the outer edge of a tree canopy

Certification of Performance

We, Daniel Lippi and Chuck Lippi, certify that:

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

We further certify that we are members in good standing of the International Society of Arboriculture (ISA), the American Society of Consulting Arborists (ASCA), and the Florida Urban Forestry Council and are ISA Board Certified Master Arborists FL-6145B and FL-0501B. Danny is ISA Tree Risk Assessment Qualified. Chuck is an ASCA Registered Consulting Arborist #443.

BOARD-CERTIFIED MASTER ARBORIST ISA

asca AMERICAN SOCIETY of CONSULTING ARBORISTS

Chuck Lippi and Danny Lippi

ISA Board Certified Master Arborists FL-0501B and FL-6145B

References

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

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

Dr. Ed Gilman, Trees for Urban and Suburban Landscape, Delmar Publisher, New York, 1996, p. 497.[3]

[4] Dr. Ed Gilman, QUERCUS VIRGINIANA: SOUTHERN LIVE OAK, University of Florida - Institute of Food and Agriculture Sciences extension article - ENH-722, 2018.

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

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

[7] Mary Duryea and Eliana Kampf, ***Wind and Trees: Lessons Learned from Hurricanes***, University of Florida, FOR 118, Chapter 5, p. 15.