From: zoila vega
Sent: Monday, April 22, 2019 3:20 AM
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Subject: Please, deny HTO variance 37 inch tree 2111 Rio Grande, c-8

Commissioners,
We support the Environmental Commission resolution and request that you deny the heritage tree variance for the 37 inch pecan (#19726) for 2111 Rio Grande because the applicant has NOT provided sufficient supporting material to demonstrate that the conditions of the heritage tree ordinance (HTO) have been met. Staff states that the applicant has NOT provided sufficient information to demonstrate that this tree is an imminent hazard, or prevents a reasonable use of property, or prevents a reasonable access to the property, as the applicant claims.

Regarding the 34 inch pecan, we support the 300% mitigation recommended by the Environmental Commission since the applicant has not met the HTO requirements. The Environmental Commission granted that variance based on the tree's poor condition per staff's recommendation. However, we strongly recommend that all applicants be required to demonstrate that they have met the HTO requirements and have provided sufficient information to staff prior to the being scheduled for public hearings.

This case should NOT be going to the Planning Commissions at this point. This is a case of an applicant blatantly disregarding the HTO requirements, the tree pre-development process, and staff's requests. Instead of working with staff, the applicant is prematurely elevating an incomplete case to the public process to get variances by pressuring the commissioners, because Council can't decide on heritage tree variances.

The applicant should:

- work with staff and provide the information that they requested regarding alternative designs and variances from other requirements that could preserve the 37 inch pecan,
- consider incorporating the 37 inch pecan into the design of the building since the tree is located near the sidewalk,

- estimate the economic impact of preserving the tree with alternate designs, so that the Planning Commission can decide, based on that estimate, whether or not the tree prevents a reasonable use of property,
- consider transplanting the 37 inch pecan, to be relocated close to the preserved historical house or elsewhere. Transplanting a 16 inch red oak, like the applicant proposes, is much cheaper but not as environmentally valuable because red oaks grow faster but are weaker and have shorter live spans than pecans.

During the Environmental Commission hearing, a certified arborist from Davey Tree, hired by the applicant, verbally changed the tree assessment of the 37 inch pecan from “an imminent hazard” or “High-Extreme risk” as was described in the Davey Tree report included in your backup, to the “tree is in poor condition” and therefore “prevents a reasonable use of property” and also “prevents a reasonable access to the property”:

- Davey Tree said during that hearing that after the tomography scans they did a resistance drilling test at the base that showed that the tree main stem is solid (i.e., there is no decay), and thus the tree is NOT an imminent hazard. Davey Tree further stated that the tree is in “poor condition” and “won’t survive code compliance construction because the stems have few leaves”.

- However, this new information completely contradicts the Davey Tree report and letter in the backup. This new tree assessment was provided verbally during the Environmental Commission hearing last Wednesday, but the outdated tree report and letter are still included in your backup as of 04.21.19.
- Prior to this new information, Davey Tree claimed in their report dated August 2018 that the Level 3 Risk Assessment tomography scans showed extensive decay at the base of the main stem.
- In addition, Davey Tree claimed, in the letter dated February 2019 attached to the report, that since the tomography scans showed that the tree had extensive decay at the base, the Level 2 International Society of Arboriculture (ISA) Risk assessment performed yielded that the tree posed a High-Extreme risk within 3 years, and therefore needed to be removed.
- The applicant even included a letter from his lawyer stating that the tree posed a liability and needed to be removed immediately.

“Prevents a reasonable use of property”:

- Staff needs more information, such as site design and alternative designs, to assess if the 37 inch pecan prevents “a reasonable use of property”. A full set of site plans is not needed, as concepts are typically discussed at the tree pre-development meeting. This applicant however, claimed that the 2 trees were imminent hazards at the pre-development meeting in August 2018 and refused to provide additional information to staff, asking instead for administrative variances based on the applicant claiming that both trees were imminent hazards.

- It's not until last week that the applicant changed from "imminent hazard" to "poor condition and therefore prevents a use of property" for the 37 inch pecan. These are attempts to avoid having to abide by the HTO, namely having to show designs and alternative designs, and application for other variances.

- It's NOT sufficient for the applicant to state that the 37 inch pecan is in "poor condition". The applicant needs to show their full Level 2 Tree Risk Assessment form and discuss this with staff since they disagree with their assessment.
- In addition, this tree can recuperate if given compost, mulch and water, as was the case for the Dreyfus tree at 1901 North Lamar. In 2012, the new owner of that property wanted to remove that live oak because of their assessed "poor condition", but opted to work with the City Arborist. They reduced the risk by pruning, and improved the health by watering and applying compost and mulch. That tree has been thriving since then and is an asset to the property.
- This tree could survive code compliant construction, which means that only ½ of the critical root zone (CRZ) would be protected because:
    1. pecan trees have deep tap roots and don't depend so much on lateral roots like other tree species, so preserving only ½ of the CRZ would be sufficient,
    2. by City code, the City Arborist can stipulate that more of the CRZ be protected, as much as staff deems necessary for the tree to survive.

"Prevents access to the property":

- The applicant needs to demonstrate that the applicant applied to other City variances that could preserve the tree, such as driveway requirements, and was denied those variances.

The HTO should be applied equally to all developer to have a fair process. Most other HTO variance cases (with the exception of last years' 2 HTO variances at Block 36, 701 E 3rd St.) had to demonstrate the tree health, and if tree was in fair to excellent condition either transplanted the trees successfully (Bowie St., 34 inch pecan 2011) or notched the buildings to accommodate the trees in the design (ex-Green plant, grandfathered case, heritage trees preserved voluntarily, 2x38 inch live oaks in W Cesar Chavez, and a 32 and a 29 in San Antonio St., 2012).

Please, respect the requirements of the HTO. Variances to remove heritage trees shouldn't be granted because of high density, 175 ft. height, UNO, the affordable housing for students, or even the mitigation. The HTO was approved in 2010 purposely as a preservation ordinance, not a mitigation one. Austin is an excellent example to the nation because of this ordinance and has received the designation of Top 10 Tree City by the Arbor Day Foundation. In addition, the goal of UNO was to preserve trees, mainly the older ones. Unfortunately, many older larger trees have been removed in that area.

Furthermore, the HTO was deliberately approved to apply to all areas in Austin, including high density areas because the community and City officials recognized the need to preserve older heritage trees due to the many benefits they provide. Benefits include environmental benefits (heat island reduction, lower energy consumption, etc.) and health and mental benefits. Older larger trees provide much larger benefits. Young trees don't provide significant benefits until 30 years after planting, and have a 30-50%mortality rate in urban areas. Please, see attached list of quantified tree benefits ("Tree Benefits at state level").

Please, see attached HTO process flowchart, drawn by Environmental Commissioner Perales, 2015 ("Heritage Tree Ordinance Process Flow Chart"). This is the process that the commissions must follow to abide by the HTO wording in City code. Mitigation can only be discussed after the variance is granted, not as part of the variance.

To qualify for a variance from the HTO, the tree must meet the following conditions:

1) Meets at least one of the following requirements:
    a. Tree is **dead**,
    b. Tree is **diseased and can't be restored (restoration applies only to disease not structure),**
    c. Tree is an **imminent hazard to life or property, and the hazard cannot reasonably be mitigated without removing the tree**.
    d. Tree **prevents access to the property**
    e. Tree **prevents a reasonable use of property**
2) The applicant has applied for and been denied a **variance, waiver, exemption, modification, or alternative compliance from another City Code provision which would eliminate the need to remove the heritage tree**.
3) **And** the applicant has presented **alternative designs** to make sure that removal of the heritage tree is not based on a condition caused by the method chosen by the applicant to develop the property, unless removal of the heritage tree will result in a design that will allow for the maximum provision of ecological service, historic, and cultural value of the trees on the site.

37 INCH PECAN:
Staff, formed of a large group of experienced certified arborists, has determined that the tree is NOT dead, diseased or an imminent hazard, in spite of the claims from the applicant. Staff further states that the applicant has not provided information, in spite of repeated requests, to assess that applicant applied for a variance from other city requirements that would allow preserving the tree, and that applicant has not provided alternative designs.

In fact, staff states that from the very beginning at the pre-development meeting where issues like what trees to preserve are typically discussed, this applicant had a site plan that didn't include these 2 heritage trees and a report from their private certified arborist, Davey Tree, stating that both heritage trees pose high-extreme risk of tree failure within the next 3 years, and the only way to mitigate for the hazard is to remove the trees.

Like staff, we disagree with the applicant's conclusions. While the 37 inch pecan tree is not structurally perfect or a pretty heritage tree because of previous pruning, it is NOT an imminent hazard. Even Davey Tree stated that the risk of failure is within 3 years, not imminent.

Many 150 years old tree like this have visible open cavities at the base, or where large branches were cut. Actually, it is impressive that this tree does not. Tomography scans were taken at 5 locations that were suspect of decay, and yet 4 showed solid wood.

Trees are very resilient, and a tree like this will thrive with compost, mulch and water. We have seen that with many heritage trees.

The determination of this tree being a hazard is extremely exaggerated:

- The tomography scans do NOT show that the heritage pecan is in poor condition. Actually, the scans show that this tree is in fair-good condition since the main stem is solid wood except for **<u>potential minor incipient decay</u> at the base**.

- Tomography scans are not actual cross sectional pictures, like ultrasounds, x-rays or MRIs. They are a software approximation of solid wood estimated from the velocity of sound waves through the wood between sensors placed around the tree circumference. These scans can be 30-50% inaccurate because of several reasons: the number of sensors put around the tree, the shape of the tree since the software calculates the results as if the tree was perfectly round, whether there is a crack or not in that cross section because cracks exaggerate and distort the estimated potential decay, etc.). <u>Please, see attached paper ("decay detection tomography vs drilling, 2008")</u>.

- Tomography scans are only the initial analysis:

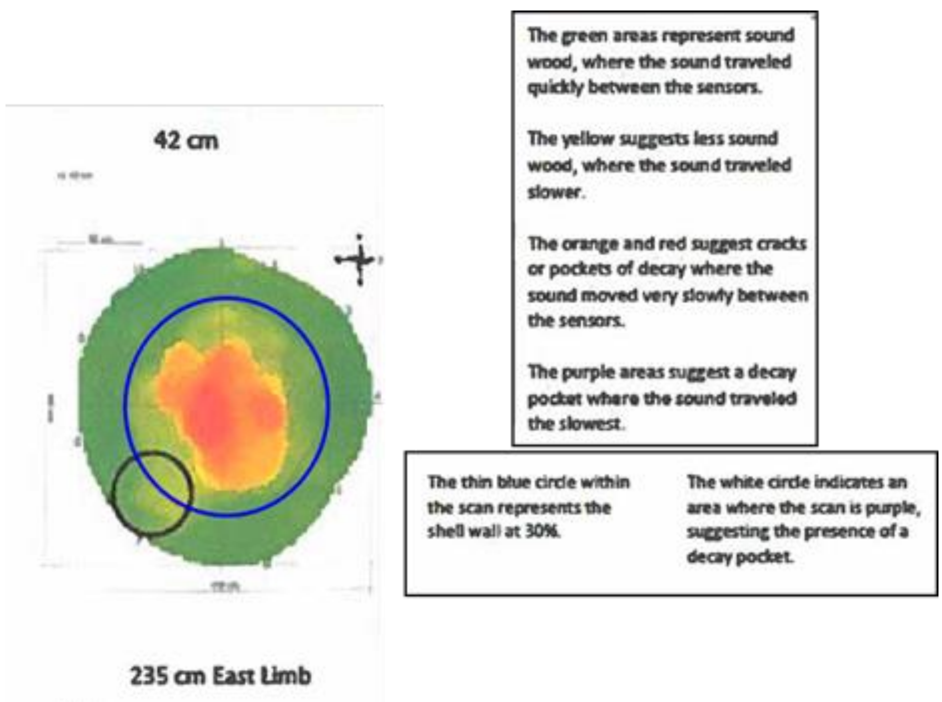
    1) It's standard industry practice to verify the results from these scans with resistance drilling of the sections to determine the decay (resistogram with a tiny drill bit that minimizes damage to the tree). Cost and time delays are minimum. These additional tests cost $500-1000 and can be done in an hour.
    2) If decay is confirmed with the resistogram, then the arborist should proceed to do a root excavation to determine if the decay can be mitigated by improving the soil with compost and mulch. Sometimes main stem decay comes from open cavities a bit higher than the base that allowed water in causing rot, but this is not the case.

- The interpretation of the tomography scan at the base is incorrect. Traditionally, certified arborists have considered a tree structurally sound until decay exceeds 70% of the cross sectional area (has a minimum 30% wall). The standard when reading a tomography scan a is that the red area represents potential decay, the green potential solid wood and the yellow potential incipient decay. I**ncipient decay is defined as "wood in the early stages of infection or invasion by a wood decay fungus, so that the wood is not yet evidently softened".**

- The Davey Tree report states in the discussion section that "there is an area near the center s**<u>uggesting</u>** less sound wood that reaches the shell wall at 30%", but in the report's conclusions this is elevated to "the base of this tree **<u>does have</u>** less sound wood present at the shell wall at 30%". But the area being referred to shows as faint yellow, not red. Faint yellow indicates potential incipient decay, not potential decay. The rest of the cross section is solid, as are the other 4 scans. This tree is solid.

- Stating that this tree has decay that has reached the 30% shell wall has 3 issues:

    1) The 30% rule should be calculated based on the cross sectional area, not the linear diameter. It's erroneous to show a black circle on the section in question to indicate a 30% linear dimension, instead of calculating a cross sectional area.
    2) Newer standards challenge the 30% rule and state that a tree could be structurally sound up to 10% depending on wind loads.
    3) The tomography scan of the base only shows a faint yellow small area reaching the 30% wall. Since this may be potential incipient decay, this scan is too uncertain and not sufficient to declare the tree hazardous.
    4) Davey Tree has not confirmed the potential decay with simple resistograms tests, and has not done the root evaluation needed to determine the health of this tree.



The applicant's lawyer even states, to further pressure staff, that the applicant's duty is to remove these trees because they are *"eminent (sic Imminent), High Extreme hazards".* **These**

trees are NOT imminent hazards since Davey Tree stated that the risk of failure is within 3 years.

Staff disagrees with Davey Tree's assessment of this tree. The tree does NOT pose an extreme risk and is NOT an imminent hazard.

The report is extremely exaggerated because:

1) It is based only on the tomography scan that shows at most potential incipient decay at the base, typical of old trees. There's not even an open cavity to justify the extreme concern with decay.
2) Davey Tree doesn't show the ISA (International Society of Arboriculture) Tree Risk Assessment form that led him to this ratings, like to one I'm attaching ("ISA Basic Risk Assessment Form"). This form is standard practice, but was NOT provided to staff or the commissioners. Instead, Davey Tree describes the ratings with the following words, in the letter attached to the report:

   Davey Tree states that there is **a probable-imminent likelihood of failure in 3 years with a medium-high likelihood of impacting the target** (pedestrians, structures, etc.) **with the potential of causing severe damage**. Therefore, he concludes a **high to extreme risk**.

   These words come from the 2 matrices below. The two failure likelihoods of probable-imminent and the 2 target likelihood of medium-high rated by Davey Tree are shown with red rectangles. The combination of these produce a risk with 3 levels: **Anywhere from Moderate, to High, to Extreme**. Not just High to Extreme as claimed by Davey Tree.

Matrix 1. Likelihood matrix

Likelihood of Failure	Likelihood of Impacting Target			
	Very low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

Matrix 2. Risk rating matrix

Likelihood of Failure & Impact	Consequences of Failure			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

Moder
No

ISA's definitions (attached, "Tree Risk Assessment and Drones") for likelihood of failure are:

Probable = failure expected under normal weather conditions within specified time frame.
Imminent = failure has started or is most likely to occur in the near future, regardless of weather.

and the definitions for likelihood of impact are:

Medium = may or may not impact the target, with nearly equal likelihood.
High = will most likely impact the target.

And the consequences of failure are:

Moderate = moderate property damage, small disruptions of traffic or utility, or very minor injury.
High = high value property damage, considerable disruption, or personal injury.
Extreme = serious personal injury or death, high-value damage, or disruption of important activities.

It's a wide range: Davey Tree's report states that this tree has a **likelihood of failure from "expected under normal weather conditions within 3 years" to "failure has started or is most likely to occur in the near future regardless of weather",**

and that the **probability of impacting the target varies from the failing tree "may or may not impact the target" to "will most likely impact the target".**

Thus, the **risk** (consequences of failure) varies from **"moderate property damage, small disruption, or very minor injury" to "serious personal injury"**. **It is NOT just an "extreme risk causing serious injury"** as stated in the report. The report omitted the "moderate" possibility.

In addition, failure has NOT started and is NOT most likely to occur in the near future regardless of weather, so by definition **this tree does NOT pose a likelihood of imminent failure**. And this tree is NOT expected to fail under normal weather conditions within 3 years, so by definition **this tree does NOT pose a likelihood of probable failure**.

Alternative designs and their economic impact have not been provided. To the contrary, the applicant had a completed site plan showing the trees removed from the very beginning, at the predevelopment meeting with staff. The 37 inch tree is very close to the preserved historic house and the sidewalk. It could survive code compliant construction (1/2 CRZ) since it's a pecan with a deep tap root.

Notching the building and making up the space lost somewhere else, or with a parking variance, could provide a beautiful relaxing area for the students. Changing the design of the tower to allow preserving more of the tree canopy and CRZ would additionally improve the esthetic of the development, more in agreement with UNO. Affordable housing does not have to be ugly rectangular 175 ft. towers. *Can only wealthy persons have heritage trees by their buildings?*

34 INCH PECAN:
This tree does show decay because of the large red area shown in the tomography scan AND because of the visible cavity at that point WITH visible rot. It is not just because of the tomography scan.

Unfortunately, a large branch of this tree was cut which allow water on the exposed wood. Trees don't heal like humans, but form a scab over the wound, isolating it (compartmentalize, CODIT). However, it takes years for that scab to form, and water rots the wood that is exposed and not covered by outer skin.

However, this tree is NOT an imminent hazard, dead or diseased. Even Davey Tree stated that it is has a high-extreme risk of failure "**within 3 years under severe weather conditions". That means not imminent**.

We strongly agree with the Environmental Commission resolution that mitigation should be 300% for this 34 inch pecan since the applicant did not comply with the HTO requirements before presenting this case to the commissioners. The applicant has not presented information on variances that could save the tree or alternative designs. However, staff considers the tree in poor condition and thus not worth preserving, that it qualifies under "prevents a reasonable use of property".

PREVENTS A RESONABLE USE OF PROPERTY? WON'T SURVIVE CODE COMPLIANT CONSTRUCTION?

The HTO doesn't specifically address heritage trees that are in poor condition. Staff allows administrative variances (for heritage trees in the administrative realm, under 30 inch in diameter) based on the tree preventing a reasonable use of property because it is not worth subjecting the developer to preserve the tree if it is in poor condition and has a short life. This exemption however was never discussed or agreed to with the community, commissions or council.

Staff has also states that trees in poor condition won't survive code compliance construction. However, code authorizes staff to ask for protection beyond code if needed to preserve the tree.

In fact, often staff asks for additional conditions beyond code to preserve leaning trees, such as preserving a larger critical root zone on the leaning side to not damage critical roots. Staff often includes a tree preservation plan that includes mulching and watering for a year. And staff even asks for mitigation in advance and puts in an escrow for a year to make sure that developers preserve the trees they showed as preserved in site plans.

Best,
Zoila Vega-Marchena, Ph.D.
Austin Heritage Tree Foundation

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Decay Detection in Red Oak Trees Using a Combination of Visual Inspection, Acoustic Testing, and Resistance Microdrilling

Xiping Wang and R. Bruce Allison

Abstract. Arborists are often challenged to identify internal structural defects hidden from view within tree trunks. This article reports the results of a study using a trunk inspection protocol combining visual observation, single-path stress wave testing, acoustic tomography, and resistance microdrilling to detect internal defects. Two century-old red oak (*Quercus rubra*) trees located in Capitol Park, Madison, Wisconsin, U.S., were visually inspected and then evaluated using a single-path stress wave timer, an acoustic tomography, and a resistance measuring drill. The trees were subsequently felled, and a disk at each test location was obtained and examined. It was found that the visual inspection and single-path stress wave tests correctly identified a general problem but without specificity; the tomograph accurately revealed the general location and magnitude of the defect within the cross-sections tested but required resistance microdrilling to precisely locate defects and differentiate between decay and crack-induced acoustic shadows.

Key Words. Acoustic tomography; crack; decay; hazard tree; resistance microdrilling; Resistograph; risk assessment; stress wave.

The science of tree stability analysis uses both biological and engineering principles in attempting to rate a tree's structural soundness and make reasonable predictions of potential for failure. In such analysis, arborists are often challenged by internal structural defects hidden from view within the trunks and roots. Both public safety and urban forest conservation concerns support strong interest in developing and applying more rapid and precise diagnostic techniques to detect decay and other types of structural defects in trees. Visual inspection has been and continues to be the starting point of tree defect evaluation (Matheny and Clark 1994; Mattheck and Breloer 1994; Hayes 2001; Pokorny 2003; Luley 2005). Methods using nondestructive stress waves and minimally invasive resistance microdrilling are now available to evaluate trunk defects hidden from view.

The use of stress waves (ultrasound or soundwaves) to detect decay in trees has been explored by many researchers (McCracken 1985; Mattheck and Bethge 1993; Yamamoto et al. 1998; Wang et al. 2004). The concept of detecting decay using this method is based on the observation that stress wave propagation is sensitive to the presence of degradation in wood. Stress wave velocity is directly related to the physical and mechanical properties of wood. In general terms, stress waves travel slower in decayed or deteriorated wood than sound wood. They also travel around hollows, increasing the transmission time between two testing points. The first-generation stress wave equipment used for decay detection was two-probe systems that measured the wave transmission time in a single path. The capability of a single-path approach for tree decay detection has proven to be limited because stress wave velocity across tree stems varies substantially even for intact trees, and a standard reference velocity for data interpretation is not readily available (Wang et al. 2005).

In recent years, tomography techniques that were developed for engineering or medical applications have been evaluated for their applicability in standing trees. Investigations on urban trees showed a great success of using tomography techniques to detect internal decay. Nicolotti et al. (2003) applied three different types of tomography methods (electric, ultrasonic, and georadar) to urban trees and found different degrees of success. Of the three technologies evaluated, ultrasonic tomography proved to be the most effective tool for detecting internal decay, locating the position of the anomalies and estimating their sizes, shapes, and characteristics in terms of mechanical properties.

Gilbert and Smiley (2004) evaluated an acoustic tomography tool for its ability to quantify decay in white oak (*Quercus alba*) and hickory (*Carya* spp.). Picus tomography and visual inspection were used to evaluate 27 cross-sections from 13 trees. Gilbert and Smiley (2004) reported a high correlation between the amount of decay detected by the Picus and the amount actually present in the cross-sections ($r^2 = 0.94$) for all cross-sections. The average percentage accuracy for samples in which decay was present was 89%. No cracks were present in the trees they tested.

Both decay and crack are significant structural problems to urban trees, but they have influence on tree stability in different ways. When cracks are present in tested cross-sections, the Picus Q71 operating manual states that tomographs cannot differentiate between decay and crack-induced acoustic shadows (Argus Electronic Gmbh 2006). In those situations, resistance microdrill testing is required to determine the nature of the defect and correctly interpret the tomographs.

Resistance microdrilling measures the relative resistance (drilling torque) of the material as a rotating needle (tip diameter 3 mm [0.12 in], shaft diameter 1.5 mm [0.06 in]) is driven into the wood at a constant speed. Changes in wood resistance are displayed on a graph as changes in amplitude. Areas of prolonged low resistance indicate decay, cavities, or cracks. Because it requires drilling into the tree, this test is considered minimally invasive.

We report the results of using a combination of visual inspection plus single-path stress wave, acoustic tomography, and resistance microdrilling tools to detect internal defects in century-old red oak trees.

MATERIALS AND METHODS

Two red oak (*Quercus rubra*) trees located at the Capitol Park in Madison, Wisconsin, were evaluated for structural stability in autumn 2005 (Allison 2005). The trees in this study were identified as No. 307 and No. 123. To screen for trunk decay and defects, a visual inspection was conducted looking for anomalies such as fungal conks, cavities, cracks, seams, bulges as well as root-related problems.

Further screening for internal trunk defects using single-path stress wave testing was conducted using a Fakopp Microsecond Timer (Fakopp Enterprise, Agfalva, Hungary). The trunks were tested by aligning the two probes on the trunk in a level north–south position for the first test and in a level east–west position for a second test. An electronic caliper was used for accurate measurement of the distance between the probes. It took a single arborist less than 15 min per tree to conduct and record the results of the visual inspection and single-path stress wave screening tests.

Next a Picus Sonic Tomograph tool (Argus Electronic Gmbh, Rostock, Germany) was used to conduct acoustic tomograph measurements on the trees. The Picus Sonic Tomograph measurement system consisted of 12 sensors, which were evenly placed around the trunk in a horizontal plane during testing. Each sensor was magnetically attached to a pin that was tapped into the bark and sapwood. Acoustic wave transmission data were collected by sequentially tapping each pin using the steel hammer. A complete data matrix was obtained through this measurement process at each testing location.

The tomograph measurement was conducted at one elevation of 100 cm (40 in) aboveground level for tree No. 123 and at three elevations of 10, 100, and 200 cm (4, 40, and 80 in) aboveground level for tree No. 307. At each elevation, the circumference and distances between sensors were measured using a tape measure and an electronic caliper. This information was used as an input for the system software to map the approximate geometric form of the cross sections. Because the cross-sections of the oak trees tested were irregular, the “free geometry” feature of the program was selected to reconstruct the geometry of the cross-sections. On completion of acoustic measurements, a tomogram was constructed for each cross-section using the Picus Q70 software.

Using information provided by the tomographs regarding the acoustic characteristics of each trunk cross-section, resistance microdrilling was conducted using a F400S Resistograph (IML, Inc., Kennesaw, GA). The drilling paths were selected to enter the area of trunk cross-section displayed in the tomograph as possible decay. The goal was to determine if the tomograph display represented an area of hollow, decay or was a crack-induced acoustic shadow in an area of solid wood.

The trees were felled and a 10 to 15 cm (4 to 6 in) thick disk was cut from each elevation. All the disks were then transported to the USDA Forest Products Laboratory in Madison, Wisconsin, for physical examination. A digital picture of the cross-section was also taken for each disk.

RESULTS

For red oak No. 307, the visual inspection revealed trunk seams, *Ganoderma applanatum* fungal conks, and lack of root flare. The single-path stress wave tests revealed stress wave transmission times ranging from 1640 to 3248 μs/m (500 to 990 μs/ft). These values were significantly higher than the anticipated transmission times for intact oak of 621 to 724 μs/m (189 to 221 μs/ft) (Wang et al. 2004). The tomographs indicated a large area of defect at all three elevations. The Resistograph drilling revealed that some areas displayed in the tomographs as potential decay or cavity were actually sound wood and that large cracks were creating an acoustic shadow display in the tomograph.

After being cut down, tree No. 307 was found to have heartwood decay at all three elevations. Laboratory examination confirmed the presence of white rot decaying fungus. The decay was less severe in the upper cross-section (200 cm [80 in] elevation), but it increased in size as the elevation dropped.

In addition to decay, major internal cracks were present in the cross-sections of tree No. 307. The combination of extensive decay and large lateral cracks caused the base disk to fall into several pieces during transportation. The photographs of the disks show that lower and middle cross-sections had multiple lateral cracks and the upper cross-section had one large lateral crack.

Figure 1 shows the comparisons of acoustic tomographs and photographs of the cross-sections at three elevations for red oak No. 307. The dark-colored zones (brown if it is in color print) in the tomograms represent solid wood, and the light-colored zones represent potentially decayed wood (if displayed in color, the tomograms use green, violet, and blue to represent increasing degradation by decay). It is clear that the tomographs show a strong correspondence to the images of the disks. Extensive decay and radiating lateral cracks in the lower and middle cross-sections were reflected by large light-color zones in the tomographs. The tomograph of the upper cross-section accurately located the position and orientation of the big lateral crack and heartwood decay.

For red oak No. 123, the visual inspection revealed trunk seams and cracks with cankering on the south side with associated *Ustulina deusta* fungus. The single-path stress wave tests revealed a stress wave transmission time ranging from 1908 to 2320 μs/m (581 to 707 μs/ft). The tomography revealed a large area of defect. The Resistograph drilling revealed a large snake-shaped crack. Figure 2 shows the comparison of the acoustic tomograph and photograph of the cross-section for red oak No. 123.

DISCUSSION

The visual inspection in combination with the single-path stress wave testing provided a quick screening to justify the need for more advanced testing. The acoustic tomographs obtained using the Picus Sonic Tomography provided strong evidence of structural defect in both trees. The defect areas identified by the tomographs showed strong correspondence to true physical conditions of the cross-sections. Most decay pockets in the cross-sections were well reflected in the tomographs. However, the light-colored potential decay zones shown in the tomographs

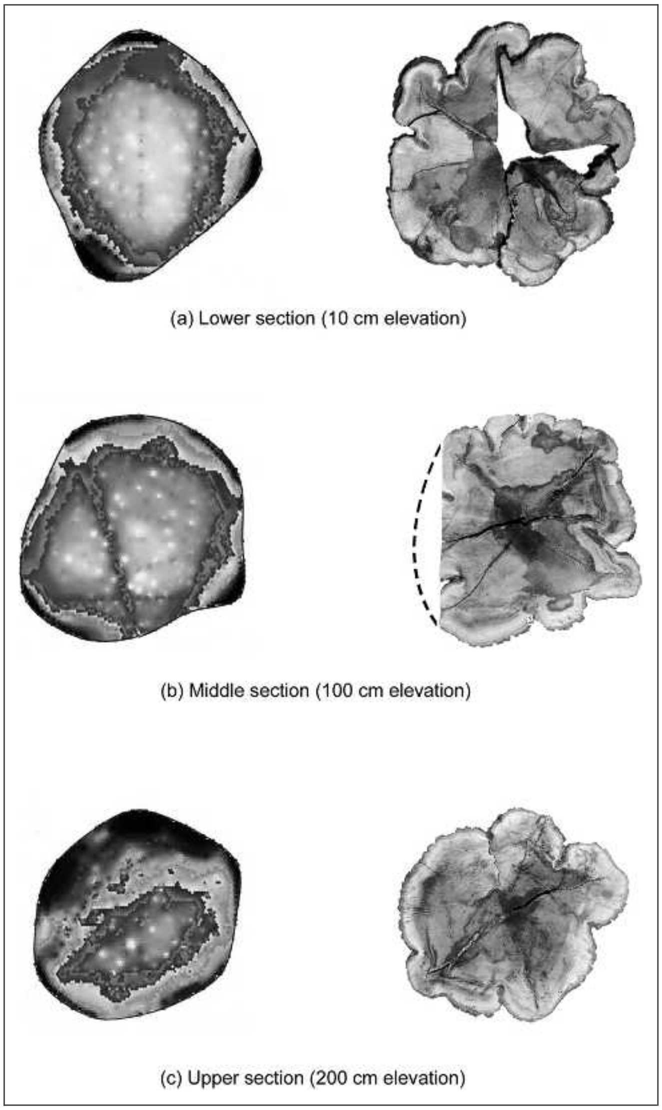

Figure 1. Comparison of acoustic tomographs and photographs of corresponding cross-sections for red oak tree No. 307.

were larger than the true decay areas present in the cross-sections. Examination of the cross-sections revealed that internal cracks ("star" crack, "snake" crack, lateral crack, and so on) were also the dominating defects in these two red oak trees. These cracks, mostly present in the radial direction and extended up and down in vertical planes within the trunk, effectively cut off linear propagation of the acoustic waves diverting them to a much longer travel path. The direct result of this was that, even without decay present, the software produced a wide light-colored zone in the tomographs that resembled the influence of extensive heartwood decay. This observation was consistent with the warning provided in the operating manual (Argus Electronic Gmbh 2006). Tomographs generated using the Picus software were the composite effects of both decay and cracks. Only through carefully directed resistance microdrilling can the tomography displays be interpreted as representing decay versus crack-induced acoustic shadows.

This study of two mature red oaks demonstrates the effectiveness of a trunk decay detection protocol using a combination of visual inspection and single-path stress wave testing to screen for defect followed by acoustic tomography to identify the location and approximate magnitude of defects. Because the tomography only reflects the acoustic properties of the cross-section tested and is not an actual representation of the internal condition, carefully placed resistance microdrilling tests guided by information provided by the tomographs are needed to differentiate between decayed wood and crack-induced acoustic shadows. Laboratory examination of the tested trees confirmed that the screening tests correctly identified a general problem but without specificity, the tomography accurately revealed the general location and magnitude of the defects, but microresistance drilling was required to locate the defects and differentiate between decayed wood and crack-induced acoustic shadows.

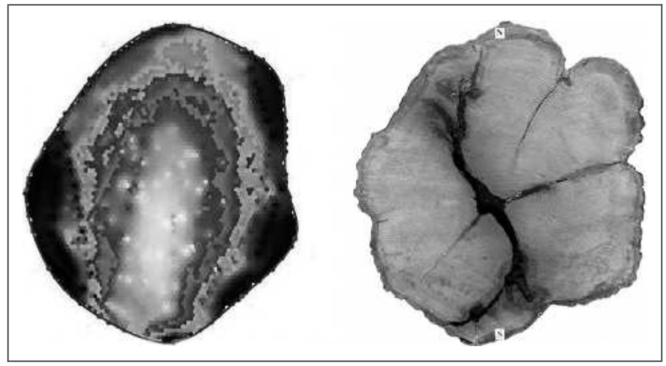

Figure 2. Comparison of acoustic tomograph and photograph of the cross-section for red oak tree No. 123.

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Résumé. Les arboriculteurs sont souvent mis au défi d'identifier les défauts structuraux internes cachés à la vue et qui sont à l'intérieur des troncs. Cet article traite des résultats d'une étude employant un protocole d'inspection du tronc combinant une observation visuelle, un test de stress par onde directe, une tomographie acoustique et une résistance au micro-forage afin de détecter les défauts internes. Deux chênes rouges (*Quercus rubra*) centenaires localisés dans le parc Capitol de Madison au Wisconsin ont été visuellement inspectés puis évalués au moyens des différentes méthodes mentionnées ci haut. Les arbres ont par la suite été abattus et une rondelle a été récoltée de chacune des zones testées au moyen des appareils. On a découvert que l'inspection visuelle ainsi que les tests par onde directe ont correctement identifié un problème général, mais sans pouvoir être spécifique; le tomographe a correctement révélé la localisation exacte ainsi que la magnitude du défaut dans les sections transversales testées, mais cela a requis des tests de résistance par micro-forage pour localiser précisément ces défauts et pour permettre de différencier la carie des fissures qui induisaient des ombres acoustiques.

Zusammenfassung. Baumpfleger erleben oft die Herausforderung, nicht sichtbare, innere Strukturdefekte in Stämmen identifizieren zu müssen. Dieser Bericht stellt die Ergebnisse einer Studie dar, die ein Stamminspektionsprotokoll, visuelle Ansprache, Schallhammer-Untersuchung, akustische Tomographie und Resistograph-Bohrung zur Aufdeckung interner Defekte kombiniert. Im Capitol-Park in Madison, Wisconsin wurden 200jährige Roteichen visuell untersucht, dann mit einem Schallhammer, einem akustischen Tomographen und einem Resistographen untersucht und bewertet. Die Bäume wurden anschließend gefällt und eine Baumscheibe von jedem Testort untersucht. Es kam heraus, dass die visuelle Kontrolle und die Schallhammer-Messung ein generelles Problem korrekt identifizierten ohne es näher zu spezifizieren, während der Tomograph den Defekt akkurat lokalisierte und in der Größe bestimmte, aber es erforderte ein Mikro-Bohren, um den Defekt präzise zu lokalisieren und zwischen Fäule und einem schallverändernden Riss zu unterscheiden.

Resumen. Los arboristas con frecuencia enfrentan el desafío para identificar defectos estructurales internos, escondidos de la vista dentro del tronco de los árboles. Este reporte indica los resultados de un estudio usando el protocolo de inspección al tronco combinado con observación visual, pruebas de ondas de estrés, tomografía acústica y resistencia con micro-taladro para detectar defectos internos. Dos centenarios encinos rojos (*Quercus rubra*) localizados en Capitol Park, Madison, Wisconsin fueron visualmente inspeccionados, luego evaluados usando un medidor de ondas, un tomógrafo acústico y un taladro de resistencia. Después los árboles se derribaron y una rodaja de cada localidad de prueba fue obtenida y examinada. Se encontró que la inspección visual y las pruebas de onda identificaron correctamente un problema general, sin especificarlo; la tomografía reveló la localización y magnitud del defecto dentro de las secciones trasversales pero requirieron las pruebas de resistencia de micro-taladro para precisar los defectos y las diferencias entre la descomposición y las sombras acústicas.

HERITAGE TREE ORDINANCE PROCESS FLOWCHART

By Marisa Perales, Attorney and Environmental Board Member

If applicant seeks to remove a tree that has a trunk measuring 30” or larger, then, no administrative variance is allowed. Application must be approved or denied by Land Use Commission, after a review by the Environmental Board.

The Commission or Board must first make findings that satisfy the requirements in each of these three boxes before application may be approved. If any of the findings has NOT been satisfied, then, variance cannot be approved, and mitigation is not necessary.

(Note: These findings are to be based on the City Arborist's recommendation.)

Commission makes determination based on city arborist recommendation [25-8-642(A)] that one or more of 25-8-624(A) requirements exist:

- tree prevents reasonable access
- tree prevents a reasonable use of property

- tree is imminent hazard that requires removal
- tree is dead
- tree is diseased and restoration not practical or disease threatens other trees

25-8-643(A)(1)

Commission makes determination based on City Arborist recommendation showing that applicant has applied for and been denied a variance, waiver, exemption, modification or alternative compliance from another City Code provision, per 25-8-646, that would eliminate the need to remove the heritage tree

25-8-643(A)(2)

Commission makes determination based on reccomentation of the city arborist that the removal of the heritage tree is not based on a condition caused by the method chosen to develop the property

OR

Commission makes determination based on City arborist recommendation that heritage tree removal will result in a design that will allow for the maximumprovision of ecological service AND historical value of the trees on the site AND cultural value of the trees on the site.

The commision may grant a variance after determining that it is the minimum change necessary.

25-8-643(B)(1)

25-8-643(B)(2) & (3)

Once the Commission has decided to grant the variance, it has to require mitigation as a condition for approval and the variance wil not issue until mitigation conditions are satisfied or fiscal security is posted

BENEFITS FROM TREES

Fiscal And Economical Impact From Trees On The State Of Texas:

- Trees increase property values by up to 23% (Texas Forest Service, 1993). This increases local tax revenue, and decreases the amount of money needed to be sent from the state to support local school districts.
- Trees increase retail sales due to more attractive locations, which increases state sales tax revenue (Wolf, Journal of Arboriculture (29)3 2003).
- Trees improve aesthetics which increases tourism, increasing state sales tax revenue.
- Trees improve aesthetics at a relatively low cost compared to other beautification alternatives.
- Trees increase citizens' physical and mental health.
- Trees should be recognized as capital assets and infrastructure by the state and federal agencies.
- More trees by Texas highways could increase life of shaded asphalt areas, which would result in significant savings on repaving costs.

Trees Facilitate Meeting State And Federal Regulations:

- Trees ease compliance with federal requirements (ozone level attainment, etc.). This is critical for Camp Bullis, and helped attract the Toyota plant to San Antonio.
- Trees allow meeting federal mandates to protect endangered species.
- Trees allow meeting TCEQ regulations.
- Trees allow meeting Low Impact Development design guidelines from EPA.
- Trees allow municipalities to adopt SMART Growth guidelines.
- Trees allow municipalities to be sustainable.

Trees Improve Water Quality:

- Trees improve stormwater runoff volumes and reduce peak flows, reducing stormwater management costs.
- Trees facilitate stormwater infiltration and treatment.
- Trees increase rainfall interception and filter water impurities.
- By reducing stormwater runoff, trees improve water quality and reduce creek erosion, sediment accumulation and floods.
- Example: Retaining trees in Charlotte, NC saved the city over $1.47 B in storm water management infrastructure (American Forest, Charlotte, 2003).
- Example: San Antonio's urban forest (113K acres of tree canopy citywide) manages 974 million cubic feet of stormwater, valued at **$624 million per year** (American Forest, 2009).

Trees Improve Air Quality:

- Trees increase pollution removal (through phytoremediation).
- Example: **San Antonio's** urban forest removes 12.7 million lbs. of air pollutants annually, valued at **$30.2 million per year** (American Forests, 2009).
- Example: **In Houston and 8 surrounding counties,** the regional urban forest (663 million trees) provides **$295.7 million per year** in air pollutant removal (Houston's Regional Forest report, 2005).

Trees Mitigate Global Warming By Reducing Green House Gases:

- Trees increase carbon dioxide storage and sequestration.
- Trees allow future storage or banking of carbon offsets.
- Example: San Antonio's urban forest stores 4.9 million tons of carbon and sequesters 38,000 tons of carbon annually.

- Example: In **Houston and 8 surrounding counties**, the regional urban forest provides **$700 million per year** in carbon storage and **$29 million per year** in carbon sequestration (Houston's Regional Forest report, 2005).

Trees Increase Energy Savings And Decrease Temperature:

- Trees increase energy savings (shade and windbreaks), up to 35% (Duerksen, Planning Advisory Report, 1993).
- Trees remove demand for peak facilities.
- Trees reduce urban heat island effect.
- Trees reduce asphalt temperatures, resulting in longer life for shaded asphalt areas, saving up to 60% of repaving costs over 30 years (McPherson, Journal of Arboriculture (31)6, 2005)
- Trees reduce emissions from power plants by decreasing demand for air conditioning energy.
- Example: In **Houston and 8 surrounding counties**, the regional urban forest provides **$131.1 million per year** in energy savings (Houston's Regional Forest report, 2005).

Additional Economic Benefits From Trees For Municipalities:

- Trees increase tax revenues by:
  - Increasing property values by up to 23% (TFS 1993).
  - Lowering turnover of rental houses which increases tax revenues.
  - Increasing rents by an average of 7% (Laverne, Journal of Arboriculture (29)5 2003).
  - Increasing attractiveness of retail settings, which increases sales and tax revenues. Businesses with green areas and trees attract customers who pay 11% more for goods (Wolf, Journal of Arboriculture (29)3 2003).
- Trees are capital assets and infrastructure of the cities and counties. For example, the replacement value of the Houston regional forest trees was calculated to be $206 billion in 2005 (Houston's Regional Forest report, 2005).
- Tree mitigation fees defray the cost of purchasing public trees.

Social, Psychological, Community And Historical Benefits From Trees:

- Trees improve aesthetics.
- Trees improve citizens' physical and mental health.
- Trees increase willingness of citizens to participate in outdoor activities, which decrease obesity.
- Trees increase sense of community.
- Heritage trees increase historical value of community.
- Trees improve wildlife habitat.

Tree Risk Assessment – ISA BMP Definitions

Risk- the likelihood for conflict or tree failure occurring and affecting a target, and the severity of the associated consequences—personal injury, property damage, or disruption of activities. Categorized as Low, Moderate, High, Extreme.
Hazard—situation or condition that is likely to cause harm (injury, damage or disruption).
Hazardous tree—a tree identified as a likely source of harm.
Residual risk—risk remaining after mitigation.

Likelihood of Failure –The potential for tree or branch failure within a specified time frame. Based on species, extent of defect, anticipated loads and response growth. Categories based on the time frame established in the report are:

- **Improbable**—failure not likely in normal or severe weather conditions within time frame.
- **Possible**—failure unlikely during normal weather conditions (expected in severe weather).
- **Probable**—failure expected under normal weather conditions within specified time frame.
- **Imminent**—failure has started or is most likely to occur in the near future, regardless of weather.

Likelihood of Impact- The potential of the failed tree or branch impacting a target. Based on target location, occupancy rate, anticipated fall direction, and target protection factors. Categories are:

- **Very low—** chance of impact is remote.
- **Low—**not likely that the failed tree or branch will impact the target.
- **Medium—**may or may not impact the target, with nearly equal likelihood.
- **High —**will most likely impact the target.

Consequences—effects or outcome of an event, including personal injury, property damage, or disruption of activities. Based on target value, tree part size, fall distance, and target protection. Categories are:

- **Negligible -** low-value property damage (replace or repair), and do not involve personal injury.
- **Minor -**moderate property damage, small disruptions of traffic or utility, or very minor injury.
- **Significant -**high value property damage, considerable disruption, or personal injury.
- **Severe -**serious personal injury or death, high-value damage, or disruption of important activities.

Matrix 1. Likelihood matrix.

Likelihood of Failure	Likelihood of Impacting Target			
	Very low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

Matrix 2. Risk rating matrix.

Likelihood of Failure & Impact	Consequences of Failure			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

FAA Drone Requirements

Acquire and maintain an operator certificate.

Maintain in safe operating condition and inspect prior to flight.

Must keep in view, may use visual observer.

May not operate over any persons not directly involved in the operation.

Daylight-only operations only.

Maximum altitude of 400 feet above ground level.

Cannot fly near airport without permission (B4UFly).

Report injury or property damage accidents to FAA.

Additional recommendations

Get insurance coverage.
Define your objectives/mission.
Manage flight, wind <15 mph, maintain program.
Stay close to the tree
Treat the air over private property as property, avoid trespass, "expectation of privacy“.
Noise ordinances
Have a rescue plan.

Arboricultural use of drones:

Current

Tree inspection
- Insects and Diseases
- Defect – cavity opening, cankers, weak unions, dead branches, etc
- Infrared camera for stress detection
- Before/after photos for conservation areas or other documentation

Setting throw lines/climbing lines
Assisting with crane operations

Future

Predatory insect releases
Treatment applications

BALTIMORE TCI EXPO 2016
November 10 - 12
Pre-conference Nov. 9

Basic Tree Risk Assessment Form

Client ______________________ Date ____________ Time ____________
Address/Tree location ______________________ Tree no. ________ Sheet ____ of ____
Tree species ______________________ dbh ________ Height ________ Crown spread dia. ________
Assessor(s) ______________________ Tools used ______________________ **Time frame** ________

Target Assessment

Target number	Target description	Target protection	Target zone: Target within drip line	Target zone: Target within 1 x Ht.	Target zone: Target within 1.5 x Ht.	Occupancy rate 1 – rare 2 – occasional 3 – frequent 4 – constant	Practical to move target?	Restriction practical?
1								
2								
3								
4								

Site Factors

History of failures ______________________ **Topography** Flat ☐ Slope ☐ ______% **Aspect** ______
Site changes None ☐ Grade change ☐ Site clearing ☐ Changed soil hydrology ☐ Root cuts ☐ Describe ______________________
Soil conditions Limited volume ☐ Saturated ☐ Shallow ☐ Compacted ☐ Pavement over roots ☐ ______% Describe ______________________
Prevailing wind direction ______ **Common weather** Strong winds ☐ Ice ☐ Snow ☐ Heavy rain ☐ Describe ______________________

Tree Health and Species Profile

Vigor Low ☐ Normal ☐ High ☐ **Foliage** None (seasonal) ☐ None (dead) ☐ Normal ______% Chlorotic ______% Necrotic ______%
Pests/Biotic ______________________ **Abiotic** ______________________
Species failure profile Branches ☐ Trunk ☐ Roots ☐ Describe ______________________

Load Factors

Wind exposure Protected ☐ Partial ☐ Full ☐ Wind funneling ☐ ______________ **Relative crown size** Small ☐ Medium ☐ Large ☐
Crown density Sparse ☐ Normal ☐ Dense ☐ **Interior branches** Few ☐ Normal ☐ Dense ☐ **Vines/Mistletoe/Moss** ☐ ______________
Recent or expected change in load factors ______________________

Tree Defects and Conditions Affecting the Likelihood of Failure

— Crown and Branches —

Unbalanced crown ☐ LCR ______%
Dead twigs/branches ☐ ______% overall Max. dia. ________
Broken/Hangers Number ________ Max. dia. ________
Over-extended branches ☐

Pruning history
Crown cleaned ☐ Thinned ☐ Raised ☐
Reduced ☐ Topped ☐ Lion-tailed ☐
Flush cuts ☐ Other ______________

Cracks ☐ ______________ Lightning damage ☐
Codominant ☐ ______________ Included bark ☐
Weak attachments ☐ ______________ Cavity/Nest hole ____% circ.
Previous branch failures ☐ ______________ Similar branches present ☐
Dead/Missing bark ☐ Cankers/Galls/Burls ☐ Sapwood damage/decay ☐
Conks ☐ Heartwood decay ☐ ______________
Response growth ______________

______________ Condition(s) of concern ______________

Part Size ______________ Fall Distance ______________
Load on defect N/A ☐ Minor ☐ Moderate ☐ Significant ☐
Likelihood of failure Improbable ☐ Possible ☐ Probable ☐ Imminent ☐

Part Size ______________ Fall Distance ______________
Load on defect N/A ☐ Minor ☐ Moderate ☐ Significant ☐
Likelihood of failure Improbable ☐ Possible ☐ Probable ☐ Imminent ☐

— Trunk —

Dead/Missing bark ☐ Abnormal bark texture/color ☐
Codominant stems ☐ Included bark ☐ Cracks ☐
Sapwood damage/decay ☐ Cankers/Galls/Burls ☐ Sap ooze ☐
Lightning damage ☐ Heartwood decay ☐ Conks/Mushrooms ☐
Cavity/Nest hole ______% circ. Depth ________ Poor taper ☐
Lean ______° Corrected? ______________
Response growth ______________
Condition(s) of concern ______________
Part Size ______________ Fall Distance ______________
Load on defect N/A ☐ Minor ☐ Moderate ☐ Significant ☐
Likelihood of failure Improbable ☐ Possible ☐ Probable ☐ Imminent ☐

— Roots and Root Collar —

Collar buried/Not visible ☐ Depth ________ Stem girdling ☐
Dead ☐ Decay ☐ Conks/Mushrooms ☐
Ooze ☐ Cavity ☐ ______% circ.
Cracks ☐ Cut/Damaged roots ☐ Distance from trunk ________
Root plate lifting ☐ Soil weakness ☐
Response growth ______________
Condition(s) of concern ______________
Part Size ______________ Fall Distance ______________
Load on defect N/A ☐ Minor ☐ Moderate ☐ Significant ☐
Likelihood of failure Improbable ☐ Possible ☐ Probable ☐ Imminent ☐

Risk Categorization

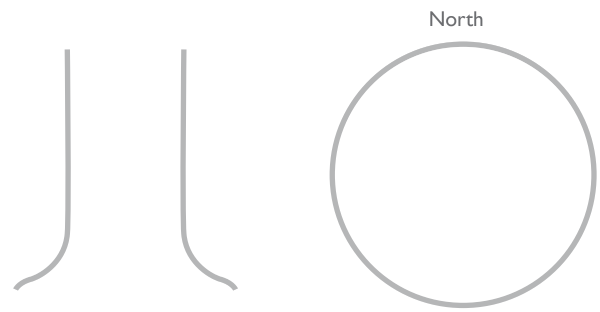
Target (Target number or description)	Tree part	Condition(s) of concern	Likelihood: Failure – Improbable	Possible	Probable	Imminent	Impact – Very low	Low	Medium	High	Failure & Impact (from Matrix 1) – Unlikely	Somewhat	Likely	Very likely	Consequences – Negligible	Minor	Significant	Severe	Risk rating (from Matrix 2)

Matrix 1. Likelihood matrix.

Likelihood of Failure	Likelihood of Impact: Very low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

Matrix 2. Risk rating matrix.

Likelihood of Failure & Impact	Consequences of Failure: Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low



Notes, explanations, descriptions

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____

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Mitigation options

1. ____ **Residual risk** ________
2. ____ **Residual risk** ________
3. ____ **Residual risk** ________
4. ____ **Residual risk** ________

Overall tree risk rating Low ☐ Moderate ☐ High ☐ Extreme ☐

Overall residual risk None ☐ Low ☐ Moderate ☐ High ☐ Extreme ☐ **Recommended inspection interval** ______________

Data ☐Final ☐ Preliminary **Advanced assessment needed** ☐No ☐Yes-Type/Reason ______________________

Inspection limitations ☐None ☐Visibility ☐Access ☐Vines ☐Root collar buried Describe ______________________