Structural Assessment Report: Red oak (Quercus rubra)

Location: *29 Blackamore Ave*
Cranston, RI 02910

Assessment Date: *May 30, 2025*

---

1. Overview

A large, mature red oak (Quercus rubra) located in an urban residential setting has experienced a significant structural failure. A major scaffold limb, approximately 60 feet (18 meters) long, failed and fell into a neighboring property, damaging a fence and the roof of a shed. Thankfully no one was harmed. Full assessment of the property damage is pending removal of the failed leader.

A visual inspection and advanced diagnostic testing using sonic tomography were performed to assess the internal condition and structural integrity of the trunk. Additionally, wind load calculations were conducted to determine mechanical stability under wind stress.

Based on our assessment, with details outlined below, the overall risk rating of this tree is moderate.

---

2. Visual Assessment

During the ground-level and aerial, drone-assisted inspections, the red oak was observed to be a large, mature, broad-spreading tree with an expansive canopy that dominates the residential landscape. The tree displays a classic open-grown form, with a very wide and rounded crown. The trunk is robust with a noticeable flare at the base, indicating a well-developed root system that anchors the tree. The tree has several massive, lateral scaffold limbs, extending in multiple directions. These leaders overhang houses, sheds, fences and driveways.

View of red oak from North

To provide a more comprehensive view of the tree's form and structure, a 3D model was created using photogrammetry with data captured during the drone flight. The model allows rotation and zooming for a full spatial analysis and can be accessed with the links below.

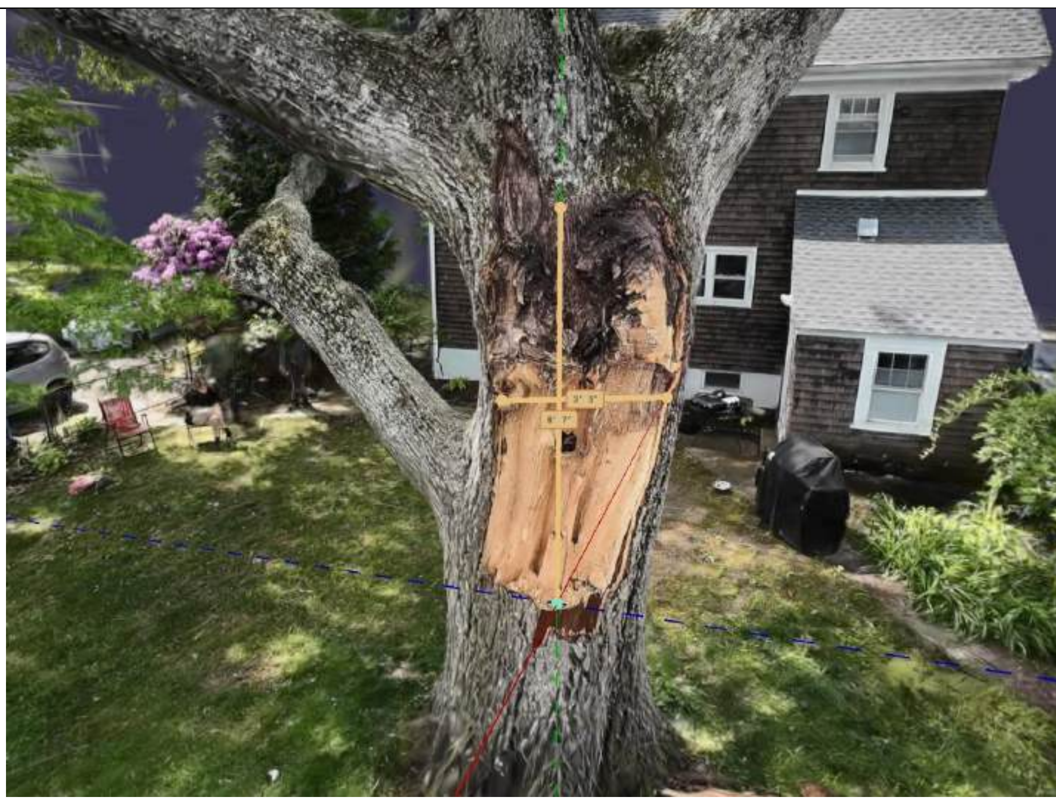
Red oak inspection - 3D Model

Red oak inspection - Isolated 3D Model

Some ascending secondary branches form upward-reaching “elbows,” while many lower branches extend horizontally, contributing to the tree’s broad profile. There is a dense leaf layer in the upper crown, with heavier foliage concentrations near the periphery. This strong leaf production suggests the tree has good vigor and a healthy photosynthetic capacity.

The failed leader was a major scaffold, about 60' (18 m) in length, which had formed a significant portion of the north side of the crown. The failure has left a large, open wound on the main trunk of the red oak. The wound extends approximately 8’7” (260 cm) vertically and 3’5” (104 cm) horizontally, exposing both sapwood and heartwood.

	
View from northwest	View from northeast

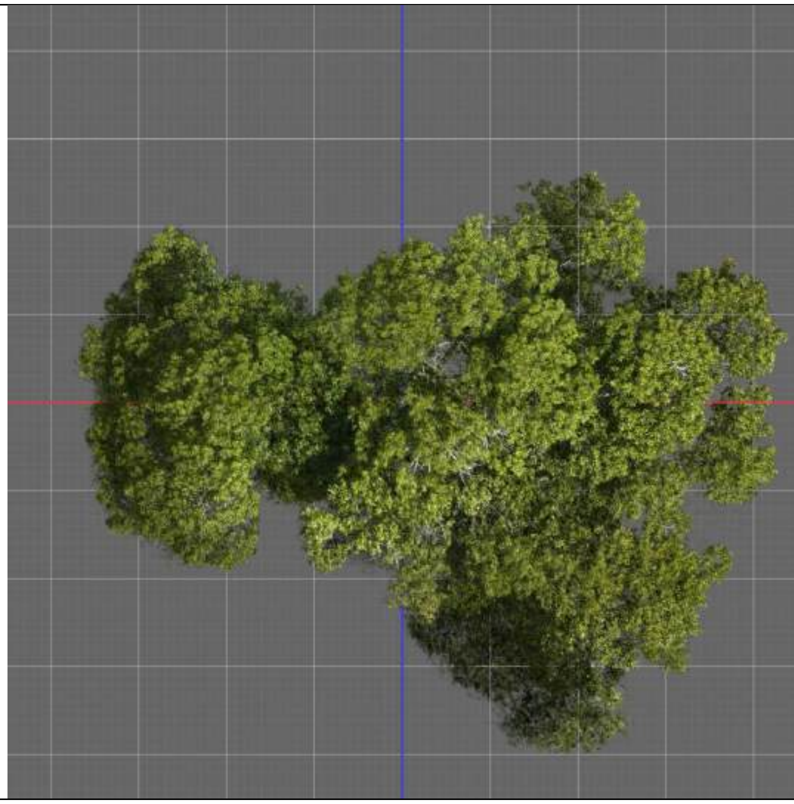


Wound measurements

The oak's broad, heavy crown and large, extending scaffold limbs create significant leverage forces at the unions, particularly at the main stem. Wind exposure risk is high due to the expansive crown and the presence of large surface areas on multiple sides. The proximity of targets (houses, sheds, fences) increases the risk of property damage from future limb failures.

Above: South view *Below: North view*

Above: East view *Below: West view*



Above: Top axis *Below: West view*

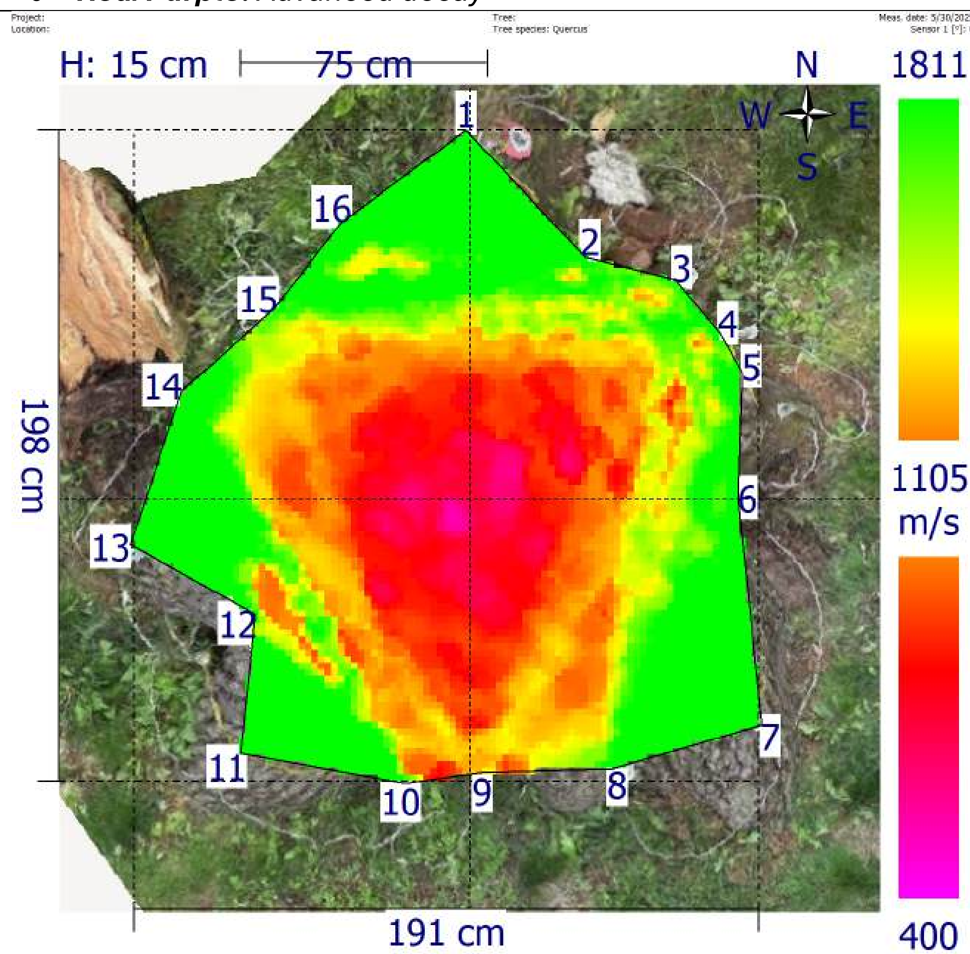
3. Sonic Tomography Assessment

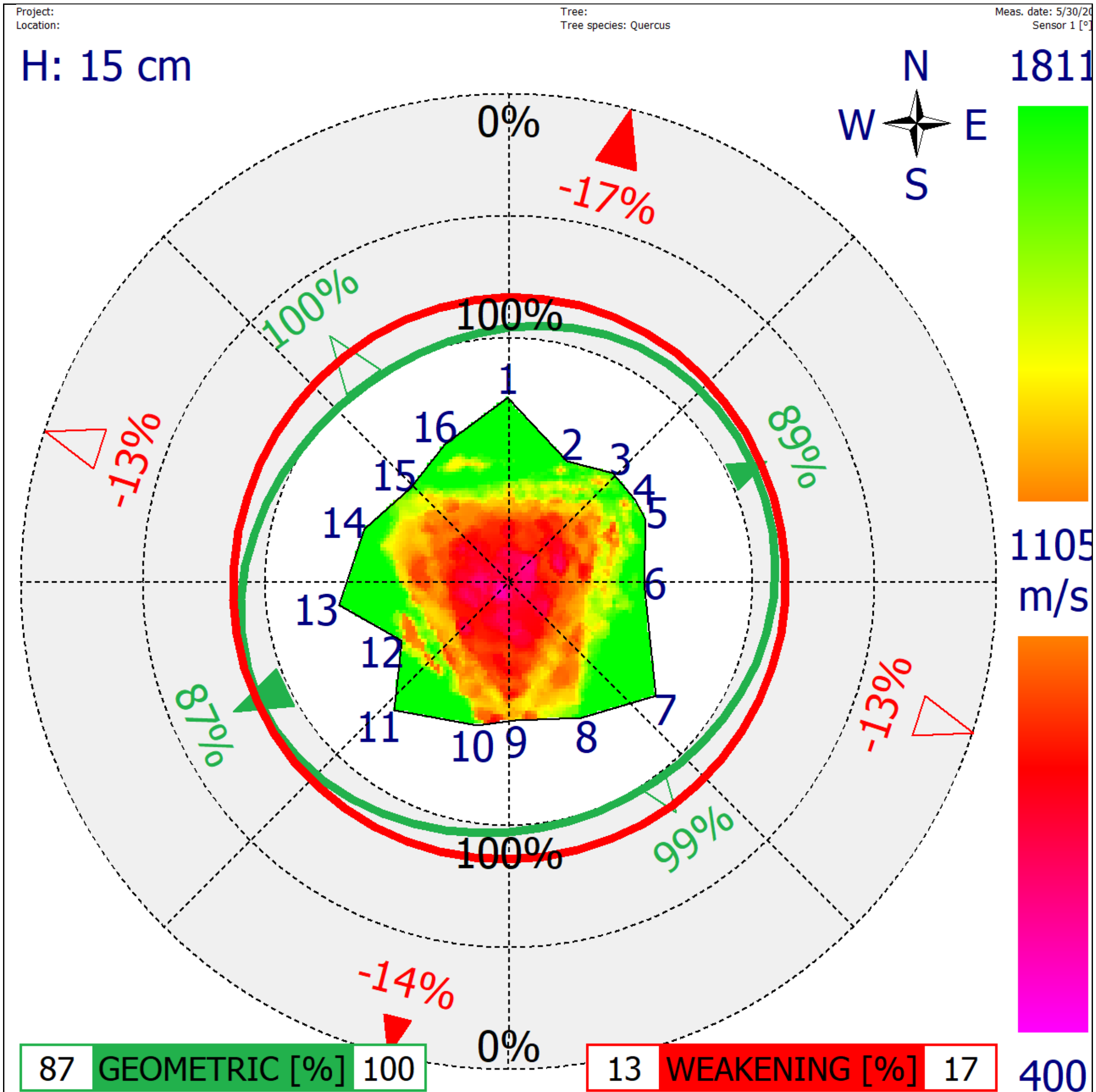
Sonic tomography is a non-invasive tool used to assess the internal condition of a tree, detecting contrasts in wood density and detecting hidden defects such as decay, cavities, or cracks. Sensors around the trunk and sending sound waves through the wood, it maps variations in sound speed—slower in decayed or hollow areas, faster in solid wood. The data is used to generate a cross-sectional image showing internal decay or defects, helping evaluate structural integrity and support informed management decisions.

Our sonic tomography was conducted on the red oak at 15 cm above ground, with a trunk diameter of approximately 194 cm (76 inches). The tomography identifies a central heart-shaped area of decay that is approximately 50-60% of the cross-sectional area studied.

Velocity Map: *Internal Transmission Speed (506–1636 m/s)*
Color Spectrum Interpretation:

- ***Green:*** *Sound wood*
- ***Yellow/Orange:*** *Early stages of internal degradation*
- ***Red/Purple:*** *Advanced decay*





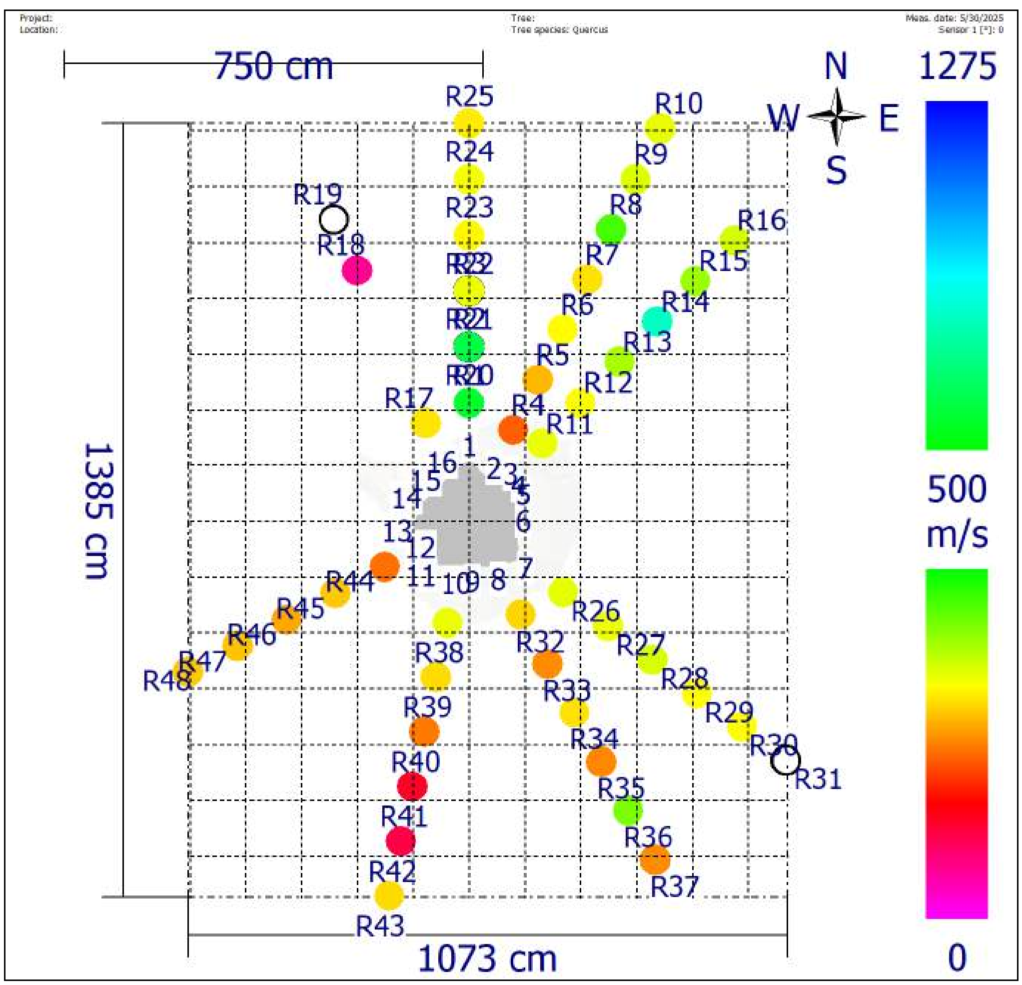
- ***Green curve (Geometric %):*** *Indicates the relative thickness of sound wood around the circumference.*
- ***Red curve (Weakening %):*** *Highlights areas where decay reduces the mechanical strength.*
- ***Red arrows (%):*** *Quantify the* ***percentage weakening*** *in specific sectors relative to a full, healthy cross-section.*
- *The* ***color map (background):*** *Depicts sound velocity (m/s), where* ***red zones = low velocity/decay****, and* ***green zones = high velocity/intact wood****.*

The remaining sound wood forms an uneven outer shell that appears sufficient to support the tree's structure under current loading. The shell wall varies in thickness from 30–40 cm (12–16 inches) in the strongest sectors, down to 15–20 cm (6–8 inches) in the thinnest sectors, notably on the south side of the trunk.

The area of decay reduces the tree's load-bearing capacity by approximately 13–17%. The greatest loss of strength is observed in the opposing northeast and southwest quadrants.

Additionally, the sonic tomography chart reveals an expansive and well-distributed root system extending radially in all directions from the trunk, with roots detectable up to 13+ meters (45+ feet) in some sectors. The presence of root velocity readings (color-coded dots) across the entire grid indicates that the tree’s root system occupies the full extent of the yard—likely extending beyond property boundaries, though measurements were limited to accessible areas within the lot.

The wide lateral spread of roots is consistent with the species' known growth patterns and suggests the tree has access to a broad soil volume for stability and nutrient uptake.



Higher velocities (500–1275 m/s, green to blue): Indicate healthy, intact root wood, seen in **most radial points** across the north, east, and central quadrants.

Lower velocities (200–500 m/s, yellow to orange): Observed in some isolated points (e.g., R40, R41) near **paved surfaces or compacted areas**—these readings likely reflect **soil conditions, paving, or voids** rather than true root decay.

- Specifically, points like **R40 and R41** were taken above a **paver patio**, where paving likely inhibits root growth or signal transmission, leading to lower measured velocities.

No critical voids or major decay pockets were detected across the measurement grid, supporting a **generally healthy root system**.

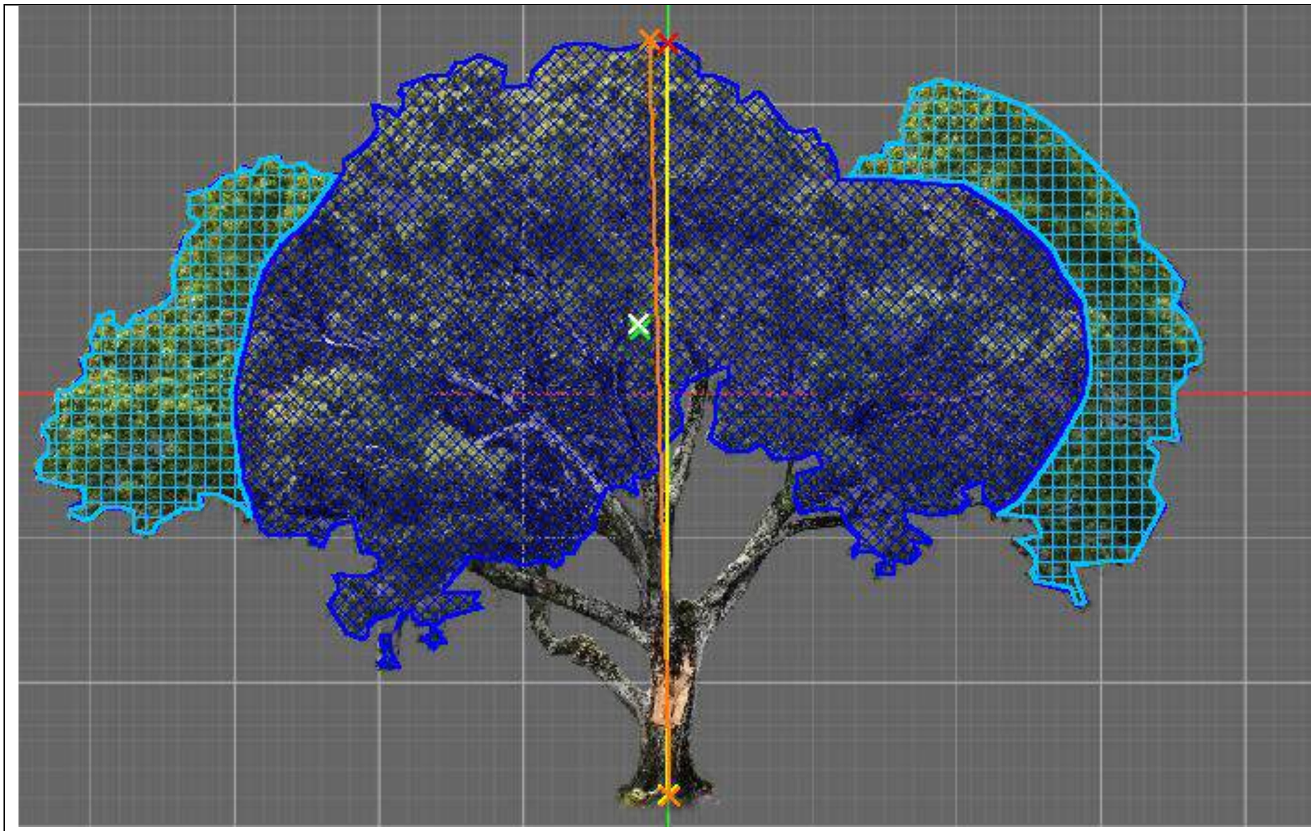
---

4. Wind Load and Risk Assessment

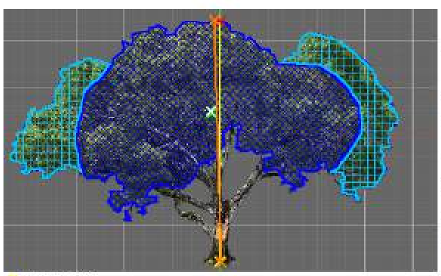
We use specialized wind load software to provide baseline data by estimating the forces a tree may experience under modeled wind conditions. By modeling tree height, crown dimensions, wood density, and local wind conditions, the software calculates wind pressure and resulting bending moments. This offers a framework for assessing structural risk—even though the exact conditions that might cause failure are unknown

By simulating pruning scenarios, the software allows us to determine how pruning impacts wind load reduction, optimizing tree safety while minimizing unnecessary cutting. This makes it a valuable tool for relative risk assessment, long-term monitoring, and informed management decisions.

An image-based analysis was conducted to assess the crown sail area and overall exposure to wind forces. As seen from the north side of the tree, we created a pruning model to help support a management strategy of targeted pruning (approx. 25–30% crown area reduction) to reduce wind load while maintaining overall crown structure and height.



Wilkerson red oak 1



X Base point
X Tree height
X Crown area center point
X Crown force center point
| Torsion center line
X Reference length

Variant 1

Wind speed Vref	23	[m/s]
≈83km/h (51mph) ≈9 Bft [≙ 23m/s @ H=24m]		
Reference height Zref	10	[m]
Terrain exponent Z^	30 Suburb, Parks	[%]
Drag coefficient Cw	30	[%]
Air density d	1250	[g/m³]
Gust factor gf (²)	150	[%]
Resonance factor rf	100	[%]

Tree height = 24 [m]

Crown area		447	[m²]
Height of crown area center	X	15	[m]
Height of crown force center	X	15	[m]
Wind force on crown		76	[kN]
Stembase bending moment		1136	[kNm]
Torsion moment		73	[kNm]

Area	CA	HAC	HFC	WF	BM	TM	TH
Crown	447	14.8	15.0	76	1136	73	23.9
Selected	333	14.9	15.0	58	876	71	23.9
[X] 1	385	14.7	14.9	67	989	197	23.9
[X] 2	396	14.9	15.1	68	1025	-52	23.9

Variant 2

Wind speed Vref	36	[m/s]
≈130km/h (81mph) ≈12 Bft [≙ 36m/s @ H=24m]		
Reference height Zref	20	[m]
Terrain exponent Z^	30 Suburb, Parks	[%]
Drag coefficient Cw	30	[%]
Air density d	1250	[g/m³]
Gust factor gf (²)	100	[%]
Resonance factor rf	100	[%]

Tree height = 24 [m]

Crown area		333	[m²]	-26%
Height of crown area center	X	15	[m]	0%
Height of crown force center	X	16	[m]	+4%
Wind force on crown		53	[kN]	-30%
Stembase bending moment		827	[kNm]	-27%
Torsion moment		62	[kNm]	-16%

Area	CA	HAC	HFC	WF	BM	TM	TH
Crown	447	14.8	15.5	69	1071	57	23.9
Selected	333	14.9	15.6	53	827	62	23.9
[X] 1	385	14.7	15.4	60	928	170	23.9
[X] 2	396	14.9	15.7	62	972	-50	23.9

	Variant 1 (23 m/s)	Variant 2 (36 m/s)	Change (%)
Crown Area (CA)	447 m^2	333 m^2	-26% (crown reduction)
Height of Crown Area Center (HAC)	14.8 m	14.9 m	~0%
Height of Crown Force Center (HFC)	15.0 m	15.6 m	4%
Wind Force on Crown (WF)	76 kN	53 kN	-30%
Stembase Bending Moment (BM)	1136 kNm	827 kNm	-27%
Torsion Moment (TM)	73 kNm	62 kNm	-16%

Crown Area Reduction (–26%):
Simulates **selective pruning**, reducing the overall wind sail area.

Wind Force Reduction (–30%):
Pruning reduces the **wind drag forces** acting on the canopy, lowering the overall forces transmitted to the trunk and roots.

Stembase Bending Moment Reduction (–27%):
Indicates a **significant decrease in structural stress** at the base, lowering the risk of mechanical failure during wind events.

Torsion Moment Reduction (–16%):
Suggests **slightly decreased twisting forces** on the trunk, possibly due to a more balanced distribution of mass after pruning.

Center Heights Stable:
The **heights of the crown area and force centers remain stable**, suggesting that the crown shape is retained with less bulk.

---

5. Conclusion and Recommendations

The red oak exhibits a large, spreading canopy typical of mature, open-grown oaks. Given the recent failure, the presence of internal decay, and large canopy, the tree presents a moderate safety risk.

Despite the large area of decay detected through sonic tomography, our modelling suggests that this oak retains 83% of its load carrying capacity at its base. The tree displays dense, healthy foliage throughout the remaining crown, indicating good overall vigor. This suggests that the tree is heathy enough to tolerate pruning to help mitigate the risks it poses to surrounding property.

Our suggested pruning scenario could significantly reduce wind loads across the canopy. This level of pruning would also help alleviate weight and leverage at scaffold limb unions at the trunk, further reducing the potential of subsequent structural failure.

These findings indicate that, with appropriate management, the tree can remain a viable feature in the landscape, provided structural risks are mitigated.

Recommendations:

- Prune the canopy selectively, targeting a 25–30% reduction in crown area in accordance with ANSI A300 Pruning Standards. Pruning should prioritize maintaining structural symmetry to minimize torsional stresses and ensure balanced load distribution.

- Conduct annual visual inspections to monitor canopy regrowth, structural integrity, and potential hazards. Pay particular attention to the root flare for signs of decay or structural changes. Ongoing monitoring of the large trunk wound from the recent limb failure is critical to detect any progression of decay.

- Perform sonic tomography every 18–24 months to evaluate the condition of the remaining sound shell wall and track any internal decay progression.

Prepared by: Tom Langan
Casey Tree Specialists
RI Certified Arborist #1125