Community Tree Risk Management: Program Planning and Design

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Introduction

Most of us have witnessed the destruction a tree can cause when it falls and strikes a physical structure. We have all heard about cases of personal injury and death caused by a falling tree or branch. Without question, trees can become hazardous over time and come to pose significant risks to personal safety and property. A key issue facing communities is how to manage the urban forest, both from an ecological standpoint of promoting resource health, and from a public safety standpoint of ensuring reasonable care is being taken to manage the public safety risks associated with hazardous trees. The best way for a community to confront this issue is to develop a tree risk management program. The program should focus on the prevention and correction of hazardous tree defects, and provide a written, systematic procedure for inspecting and evaluating potentially hazardous trees. Tree risk management programs should be designed to complement a community's overall street and park tree management program goals, and should be fully integrated with the planting, tree care maintenance, and emergency response programs (Fig 2.1).

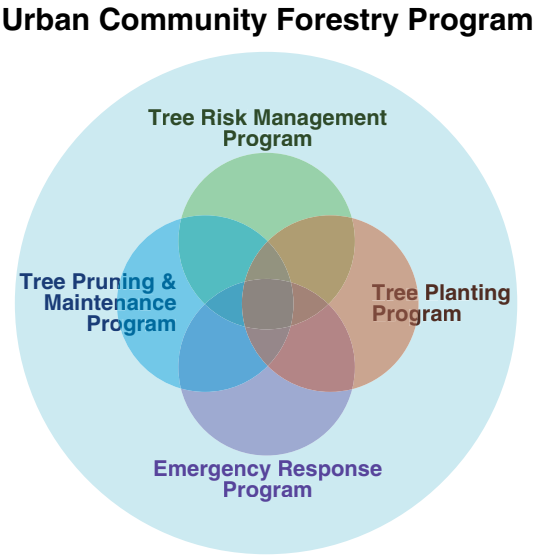

Figure 2.1 - *Tree risk management should be fully integrated with the tree planting, tree pruning and maintenance, and emergency response programs.*

Historical Perspective

Gaining an historical perspective of how and when trees fail can provide key insights into the successful design of a tree risk management program. History documents that most trees fail during storm events, and every year countless storms rage through the United States. These storms and associated tree failures cause deaths and billions of dollars in property damage annually. Severe storms can also cripple community public service and emergency response systems. As destructive as these storms are, valuable lessons can be learned from them. Post-storm surveys of damaged trees provide forensic evidence about tree failure patterns and structural defects that are commonly associated with tree failures. By knowing more about how and when trees fail, we can more accurately assess the degree of risk associated with specific tree defects, and make well founded tree risk management decisions.

Post-storm surveys strongly demonstrate the value of investing community resources to prevent the formation of structural defects through proper tree planting and pruning

Figure 2.2 - *Planting trees too deeply is a primary cause of lower stem decay and subsequent failure. Note there is no root collar flare visible at the base of the trunk. Properly planting this tree so the root collar was level with the soil surface could have prevented this stem failure.*

Figure 2.3 - *Weak branch unions and the presence of included bark (darkened stem tissue where the old branch union existed) are leading causes of branch failures. Early formative pruning could have prevented this branch failure.*

practices, and to inspect trees on a regular basis to detect, assess, and correct hazardous tree defects before they cause tree failures. Aerial and ground examination of trees damaged by Hurricane Andrew (Florida 1992) revealed that inappropriate species composition and improper planting and maintenance practices in urban and suburban areas resulted in extensive and unnecessary tree losses and associated property damage (Dempsey 1994). Field observations following the January 1998 ice storms that struck northern New England, New York, and eastern Canada noted that branch breakage and overall tree damage was much less on trees that were well pruned and well maintained. Johnson and co-workers (1999) found that 84 percent of the trees damaged during high wind storm events had pre-existing defects that resulted in tree and branch failures. They found that most of the pre-existing defects that contributed to tree or branch failure could have been prevented through proper tree planting (Fig 2.2) and pruning practices (Fig 2.3), and could have been detected and corrected if the trees had been inspected for the presence of hazardous defects (Fig 2.4).

Figure 2.4 - *Regularly scheduled tree risk inspections are a valuable tool to detect, assess, and correct hazardous defects, before the tree fails.*

Although storms are commonplace, and the risks trees pose to public safety are often high, many communities operate under a mode of crisis management when it comes to tree care maintenance and correcting/removing trees with hazardous defects. Information from many U.S. cities shows that the cost per unit of maintenance is generally twice as high with crisis

management than it is when maintenance is performed on a scheduled or programmed basis (World Forestry Center 1993). Few communities are adequately prepared to deal with the prospects of removing and storing tons of tree debris, surveying remaining trees for hazardous defects, and implementing corrective tree care treatments. In addition to higher maintenance costs, relying on crisis management may lead to injuries or deaths caused by falling hazardous trees or branches, and result in huge litigation costs.

Figure 2.5 - *This vehicle was injured by the fallen tree in the background. Note the presence of included bark on the tree's stem (darkened stem tissue where the old branch union existed) that led to the branch failure.*

Lessons Learned

History teaches us that properly maintained trees develop fewer hazardous defects and pose less risk to public safety. Communities can avoid crisis management and establish tree risk management plans that are designed to prevent and correct structural tree defects, before they become hazardous. This management approach requires community leaders and residents to recognize that tree risk management is an issue critical to public safety, and similar in importance to other essential public services such as traffic light maintenance, roadway construction and repairs, sewage disposal, and clean and abundant drinking water. It requires communities to view tree risk management as an investment that can literally save lives (Fig 2.5), and reduce the catastrophic impacts of future storms on community budgets (Fig 2.6) and the health of the urban forest (Fig 2.7).

Figure 2.6 - *After major storm events, many trees must be removed, replacement trees planted, and extensive sidewalk reconstruction is often necessary.*

Figure 2.7 - *Major stem or limb failures cause large wounds that result in poor tree architecture and predispose trees to wood decay.*

Most street and park tree management plans or master street plans state the need to remove high-risk or hazardous trees (standing dead or nearly dead trees) as a top priority, but fail to identify a process to systematically detect, assess, and correct hazardous defects in trees. A tree risk management program fills this information gap and provides the community with a systematic approach to accurately identify moderate to high-risk trees, and initiate the timely removal or corrective treatment of hazardous trees. A tree risk management plan integrating sound tree planting and tree care maintenance practices, regularly scheduled tree inspections, and the timely implementation of corrective maintenance actions will prevent or correct many structural defects, before the trees become hazardous to public safety.

A tree risk management plan fills this information gap and provides the community with a systematic approach to accurately identify moderate to high-risk trees, and initiate the timely removal or corrective treatment of hazardous trees

A tree risk management program should complement a community's emergency response plan by increasing the community's level of storm preparedness and its ability to respond rapidly to a natural disaster. Most communities have some sort of plan for responding to emergencies and for taking immediate action to address life-threatening situations and to clear away debris and downed trees that block emergency access routes and medical facilities. However, few communities are prepared to conduct post-storm surveys to assess the extent of damage to the remaining tree population, and to effectively manage the public safety risks associated with highly hazardous trees in need of immediate removal or corrective pruning. Post-storm tree damage surveys should be a top priority after a major storm, and should be conducted by staff or contractors trained in tree damage assessment and risk evaluation methods. Authors of various crisis management texts stress the paramount importance of having emergency response teams in place and trained before a crisis hits. If a tree risk management program exists, the community will have a tree risk evaluation system in place, and a ready source of trained staff or contractors to conduct post-storm tree damage and risk surveys.

This chapter will outline a process that communities can use to design a comprehensive tree risk management program for trees located on public property. We will discuss how to customize the program to address specific needs and fiscal resources within the community, establish program goals, formulate and implement tree risk management strategies, and evaluate program effectiveness. We will follow the basic format of a planning model suggested by the International Society of Arboriculture (ISA), with proven success in the development of effective urban forest management plans and programs. This planning model poses four core questions and identifies key steps to address the core questions. We modified the model by adding three steps that are specific to the subject area of tree risk management. The modified planning model is as follows:

Tree Risk Management Program Planning and Design: A Ten Step Approach

What Do You Have?

Step 1. Assess the tree resource

Step 2. Review current tree management practices

Step 3. Assess fiscal and human resources available to manage the tree resource

What Do You Want?

Step 4. Identify program goals

How Do You Get What You Want?

Step 5. Formulate a tree risk management strategy

Step 6. Prioritize inspection and corrective action needs

Step 7. Select a tree risk rating system

Step 8. Write a comprehensive tree risk management program policy

Step 9. Implement a tree risk management strategy

Are You Getting What You Want?

Step 10. Evaluate and revise

What Do You Have?

Step 1. Assess the Tree Resource

Recently collected tree resource data is essential for the development of a realistic and useful tree risk management plan. Baseline information on general tree location, species, size class, and condition (percent canopy dieback); maintenance needs; and available planting sites is needed to provide a snapshot of the current condition of the tree population and to identify key public safety issues and tree maintenance needs. This information supplies a framework for developing a successful tree risk management strategy that is tailored to the specific resource needs of the community, and provides a basis for estimating program costs and developing budget requests.

A complete tree inventory provides the most accurate data. However, a complete tree inventory is not necessary to collect the baseline data needed for this step, and the high cost of conducting one can be avoided. A partial inventory that surveys a representative sample of the total tree population can quickly and accurately provide an estimate of the total number of trees, species composition, and size and condition classes of an urban street population (Jaenson et al. 1992). A partial inventory offers communities with limited budgets a practical and cost-effective method to assess tree resources.

Identify tree maintenance needs and costs. Compiling and analyzing tree inventory data provides a mechanism to identify tree maintenance needs such as tree removals, pruning, and replanting, and to determine costs associated with implementing needed tree maintenance practices. Corrective tree maintenance needs

can be estimated from tree inventory data based on the percentage of trees in need of removal or pruning, and the number of available planting sites. The total cost for the community tree population can be projected by establishing an average cost per tree for each maintenance action, and multiplying that cost by the number of trees needing each maintenance action.

Obtaining accurate cost estimates can be difficult because the average unit cost for each maintenance practice can vary significantly within a geographic region, due to local differences in the cost of materials, labor and equipment, staff training, and overhead administrative expenses. Also, individual tree and site characteristics must be factored into the cost of planting, pruning, or removing trees. For example, proximity to electric wires, buildings, and sidewalks; moderate to high traffic volumes that require additional workers; and the presence of major decay within the tree are all factors that make pruning or felling operations more difficult, time consuming, and expensive.

The best way to estimate program costs is to use cost figures that are representative for your specific locality and program. If your community has a tree planting and maintenance program in place, break down program costs into major program areas such as planting, pruning, and removals, and look at the average cost per tree for each maintenance task over an extended period of time. If a community lacks the ability to track tree maintenance costs, does not have a tree planting or maintenance program in place, or is considering the option to subcontract tree maintenance work, the best guide will be to solicit bid prices from at least three local contractors for each maintenance task, and use the median bid price. Contacting nearby communities that have tree care programs and similar population size may also provide valuable information on tree planting and maintenance costs that are representative for your local area.

Identify tree removal and disposal costs. The percentage of total trees surveyed with extensive or total canopy dieback provides an estimate of the number of very high-risk trees that need to be removed (Fig 2.8). Tree removal is typically the most expensive tree maintenance operation on a per tree basis. Costs are based on tree diameter and size, tree density, accessibility factors such as proximity to overhead utility wires, sidewalks, and buildings, and high roadway traffic volume levels. Factor costs associated with stump removal and wood waste disposal into the budget. Explore opportunities to sell the wood to offset removal and clean-up costs. Recent publications provide useful information on successful community wood waste disposal programs (Bratkovich 2001), and guidelines for marketing sawlogs from street tree removal and municipalities (Cesa et al. 1994).

Figure 2.8. *This tree has extensive crown dieback, with decayed and broken major limbs. It is a high-risk tree that should be removed.*

Managers can identify high risk, problematic tree species by reviewing the percentage of total trees surveyed with extensive or total canopy dieback, broken down by tree species and diameter. Identify high-risk problem species within the tree population, and conduct more frequent risk inspections in areas of the community where problem species occur in high densities.

Identify pruning needs and costs. Tree inventory data that includes recommended maintenance actions provide an estimate of the number of trees in need of corrective pruning. Pruning costs are based on tree age and size, tree density, and accessibility factors such as proximity to overhead wires, sidewalks, buildings, and high roadway traffic volume levels. A comprehensive tree risk management plan includes an assessment of pruning needs, including therapeutic pruning to correct existing structural defects and maintenance pruning to prevent the formation of structural defects. Estimated pruning costs can be viewed as a shared cost between a tree risk management program and a tree planting and pruning program.

Identify planting needs and costs. The number and location of trees to be planted within the community can be determined from the tree inventory data, if information on vacant planting sites was collected. Include planting sites that will become available as other trees are removed. The average purchase cost per tree is dependant on species, caliper, and nursery stock type (balled-and-burlapped, bare-root, or container-grown), and on an average planting cost (dependent on materials, equipment and labor costs). When estimating total planting costs, it is common practice to multiply the nursery purchase cost by a factor of three (Petitjean 1997).

Generating quantitative data on tree maintenance needs will lend credibility to budget requests and garner public support. For example, if you know there are 40 trees within the community that are high-risk trees in need of immediate removal, there is compelling evidence that a tree risk management program should be established to increase public safety and potentially save lives. Stressing the public safety aspects of tree risk management can help elevate its importance to the level of other essential public health services such as such as traffic light maintenance, roadway construction and repairs, sewage disposal, and clean and abundant drinking water.

Determine the value of the urban forest resource. Knowing the economic value of the urban forest can be useful as a leveraging tool to obtain funding for programs and departments responsible for community tree care. Municipal forestry programs compete for funding with community services such law enforcement and fire protection, and the development and maintenance of roads, sewers, and street lights. Most communities document the monetary value of these public services, and elected officials are kept aware of what it costs to maintain the value of these services and improvements. In a similar fashion, the forestry department should document the monetary value of the urban forest, and inform the public and elected officials about the costs required to maintain its value and benefits. For example, when tree maintenance costs, including periodic inspections of trees to detect hazardous defects, are shown as a percentage of the monetary value of the urban forest, the cost of tree maintenance will compare favorably with other public safety costs such as maintaining emergency access routes and roadways, traffic lights, and sewage systems. Over time, properly maintained trees grow in value, while most other urban assets decline in value.

The most widely used method to assess the value of individual trees is a system developed by the Council of Tree and Landscape Appraisers (CTLA), described in their handbook entitled Guide for Plant Appraisal (CTLA 2000). Copies of this handbook may be obtained by contacting the International Society of Arboriculture, PO Box 3129, Champaign, IL 61826-3129. The CTLA appraisal method involves the establishment of a base value for a landscape tree, as determined by local tree replacement cost figures. The base value is a maximum value and is modified by multiplying by percentage factors for tree species, condition, and location. This system relies on the following formula to compute tree values as follows:

Tree Value = Base Value x Species Classif cation (%) x Condition (%) x Location (%)

This method can be used to establish the value of more than one tree, making it useful for determining the collective value of a community's urban forest. For collective value, the value of the average tree within the community tree population is calculated rather than the value of every individual tree. Based on tree inventory data and the total number trees surveyed, the average size (d.b.h.) replacement tree is determined, and an average rating value for tree species, condition, and location is calculated. These average values are then plugged into the formula above to calculate the average tree value. The value of the average tree is multiplied by the total number of trees inventoried, resulting in a total value for the urban forest (Petijean 1997).

Step 2. Review Current Tree Management Practices

The next step is to review current tree planting, pruning, and removal practices, and any formal documents that affect tree care such as street and park tree management plans, emergency response plans, or tree ordinances. Identify common goals that exist between programs, plans, or ordinances, particularly as they relate to promoting tree health and increasing public safety. Explore ways to integrate efforts, strengthen effectiveness, and leverage community support and funding. Eliminate duplication of efforts between municipal departments, public utilities, and private contractors whenever possible. This coordinated approach to tree risk management can eliminate duplication of efforts between community tree planting and pruning programs. For example, as part of regularly scheduled, systematic tree risk inspections, tree inventory data can be collected along with tree risk data, and the need to conduct separate, periodic tree inventory assessments can be eliminated. A small crew of individuals can be trained to conduct tree risk inspections and collect tree inventory data. Data relating to tree removals, pruning needs, and available planting sites can be shared with the tree planting and pruning programs to direct and schedule the activities of the tree planting and pruning work crews. Empower pruning crews to report the location of all high-risk trees detected in the course of performing their daily work to the tree risk management program. Give these "high-risk tree reports" high priority, and implement corrective actions promptly. This integrated approach to tree risk management provides the community with a way to continuously update tree inventory data, eliminate the need to conduct separate, periodic tree inventory assessments as part of the tree planting or pruning programs, and share tree resource information between the tree planting, pruning, and risk management programs to facilitate more effective scheduling of work crews.

Step 3. Assess Fiscal and Human Resources Available to Manage the Tree Resource

After the tree resource is assessed and corrective tree maintenance costs are estimated, review the community tree care budget to see how these costs compare with the fiscal and human resources currently available to manage the tree resource. Compare the

number of trees that are removed, pruned, and planted annually to the estimated number of trees that need to be removed, pruned, or planted as identified in the tree inventory survey. Determine the difference on an annual basis. Calculate cost projections for the maintenance work needed, but not currently completed, based on the average cost per tree for removal, pruning, and planting as discussed in Step 1. These costs reflect "new" or additional funding that is needed to implement corrective tree maintenance treatments, and should be included in budget requests.

In addition to estimating the cost of implementing corrective tree maintenance treatments, factor in the cost of conducting regularly scheduled tree risk inspections. The amount of time required to conduct tree risk inspections will depend on which tree risk rating system the community selects to implement. Step 7 summarizes information on the amount of time needed to conduct individual tree risk assessments for tree risk rating systems that are designed for use in urban areas and currently published in the United States. A small crew can be trained to conduct tree risk inspections. Many communities opt to cross-train existing tree pruning or tree planting staff, and share costs between programs. This can be a very effective way to reduce program costs and fully utilize the skills of existing staff.

For most communities, limited budgets and personnel will require that the tree risk inspections and maintenance tasks be implemented or phased in over a period of years. Prioritize tree maintenance needs, identifying those that are most critical and those that can be delayed with minimal impact on the public safety and tree health. A process to prioritize tree maintenance needs and develop cyclic tree inspection and implementation schedules is discussed in Step 6.

What Do You Want?

Step 4. Identify Program Goals

Establish a broad-based municipal working group to develop a community tree risk management plan. The working group should be in place and active during the entire program design process. It should bring to the table all groups that are currently involved and those that should be involved with the management of the community's urban forest, public safety, and emergency services. Be inclusive rather than exclusive as you establish the membership list for this working group. A tree risk management working group will typically consist of:

- City Forester or tree warden
- Representatives from municipal departments such as public works, parks and recreation, transportation, fire/police/emergency services, planning and zoning, engineering, and the county attorney's office, county commissioner's office, and the mayor's office
- Tree service providers
- Public utility providers
- Private citizens
- Media contact

Local non-profit organizations, non-governmental organizations, and other public agencies may also be involved, depending on the infrastructure of a particular community.

The working group should define what a tree risk management program will accomplish within their community. Establish program goals that address identified community needs and identify management strategies that will produce measurable results. Program goals are the tangible ends that the management strategy seeks to achieve, and provide the basis for formulating, implementing, and evaluating the management strategy.

There is little point in establishing a goal if there is no practical way of determining whether progress is being made towards achieving that goal. For example, while it is most admirable to seek to "protect the health and welfare of the community" or to "improve the health of the urban forest," such goals are very general and tangible results are difficult to measure. However, establishing the goal of "reducing risk to public safety and personal property by mitigating hazardous tree defects," would address a key public safety need. Tangible actions (e.g., establishing tree inspection guidelines) can be taken, and progress can be measured by documenting the dates when risk inspections are conducted and corrective actions are implemented.

Guiding principles and fundamental goals. Although a community tree risk management program can have many goals, two guiding principles provide the overarching context of most successful programs: Increase public safety by reducing risks associated with trees that possess hazardous defects or visually obstruct traffic signs, intersections, or street lighting, and manage the community tree resource to promote tree health and sustainability

The two guiding principles of tree risk management programs are:
- **Increase public safety**
- **Promote tree health and sustainability**

Both guiding principles can be achieved through a two-tiered program that focuses on the fundamental goals of 1) preventing hazardous tree defects through the implementation of proper arboricultural practices that promote tree health and structurally sound trees, and 2) correcting hazardous tree defects through the use of a systematic process to accurately detect and assess hazardous defects, and implement corrective actions within a reasonable time.

Other possible goals:
Goals and specific management strategies will vary by individual communities. They should address specific needs that exist within the community such as identified tree resource needs, staff and fiscal resources needed to implement a tree risk management program, and the need to educate the public.
Other program goals that might be considered include:

- Hiring a full-time City Forester and/or other tree care staff needed to implement a tree risk management program

- Promoting professional development of tree care staff through continuing education programs

- Developing educational outreach programs and demonstration projects to increase public awareness of the need for and benefits of a community tree risk management program

- Increasing awareness of tree risk management among municipal staff through presentations and training sessions (This is NOT just for forestry staff; everyone needs to be aware of the program.)

- Coordinating with public utilities to promote proper pruning and the selection of smaller stature tree and shrub species for planting under utility lines

- Establishing a comprehensive wood waste utilization management plan that focuses on implementing efficient and ecologically sustainable methods

How Do You Get What You Want?

Step 5. Formulate a Tree Risk Management Strategy

A tree risk management plan enables a community to prevent, detect, assess, and correct structural defects in trees, before they endanger public safety or tree resource health. Just as nothing in life is risk-free, every landscape and tree situation involves risk. The goal of a tree risk management program should not be to strive for zero risk, since this is unattainable. Rather, the goal should be to reduce the risks trees pose to public safety to a level that meets professional standards and demonstrates reasonable care. Management strategies should address program principles and fundamental goals, implement actions that address specific needs, and produce measurable results.

Consider actions to prevent hazardous defects. Sound arboricultural practices are the best defense against development of hazardous defects. Choose species that are suitable for the available planting sites, and implement proper planting techniques. Chapter 4 (Prevention of Hazardous Defects) discusses criteria for selecting nursery stock, species selection, and proper planting and pruning techniques. Once a tree is planted, a program of early and regular tree pruning will prevent the development of many structural defects, and reduce subsequent pruning, tree removal, and replanting costs.

Consider actions to correct hazardous defects. A tree risk management plan must provide the community with a systematic process to detect, assess, and correct hazardous defects before they cause tree failures. Procedures to correct hazardous defects in trees range from simply pruning out defective branches to the ultimate step of removing the tree. Chapter 5 (Correction of Hazardous Tree Defects) discusses specific corrective actions. Early detection and correction of tree defects will reduce the number of trees that become hazardous and reduce subsequent tree pruning, tree removal, and replanting costs.

Step 6. Prioritize Inspection and Corrective Action Needs

In all likelihood, a community cannot handle 100 percent of its forestry workload each year. Limited budgets and personnel will require that tree inspections and corrective actions be implemented or phased in over a period of years. The community must carefully evaluate the condition of the community forest and visitor usage patterns within public areas, and target the use of limited community resources where they are needed the most — in the areas with the greatest risk to

public safety. Communities should prioritize inspection and corrective action needs, identifying those that require immediate attention and those that may be delayed with minimal impact on public safety and tree health.

Identify specific areas or situations that will be excluded from the program. For example, trees located on private property are often excluded from the jurisdiction of a community tree risk management program. The community must decide to include or exclude borderline trees or trees abutting public property as part of the program. Wooded areas located away from structures or trails, undeveloped green belts or corridors, wetlands, or low use trails might be designated as "natural areas" that will be excluded from the program and will not receive risk inspections. Some tree risk management plans have made it a policy to inspect only trees that are greater than 6 inches in diameter, since most documented tree failures occur in trees greater than 6 inches in diameter.

We will discuss how to prioritize tree inspection and corrective action needs, based on a process that 1) divides the community into tree risk zones, 2) establishes tree risk inspection methods and schedules, according to tree risk zones, and 3) implements corrective actions in a reasonable and timely manner. Both large and small communities can effectively implement this process.

Divide the community into tree risk zones. To assist communities as they prioritize inspection and corrective action needs, the community can be divided into tree risk zones, ranging from zones where trees pose a very high level of risk to public safety to zones associated with low public safety risks. Each zone is managed and inspected on a defined schedule, based on the level of risk posed to public safety. For example, high-risk zones are scheduled to receive more frequent, in-depth inspections, and tree maintenance work is performed on an expedited basis. A color-coded map of risk zones, ranging from very high to low risk, can be developed for use as a management tool for forestry staff, and as a visual aid for educating the public about the levels of risk that trees can pose to public safety.

Determine the level of risk posed to public safety based on risk criteria that assess roadway characteristics (type, traffic volume, and congestion patterns); public use and occupancy patterns (high, moderate, and low) within public areas; and tree resource characteristics including tree condition (risk rating, age, and density), and location factors such as branch interference with pedestrian traffic or utility lines, and root interference with sidewalks. For example, high-use parks and playgrounds should always be considered high-risk zones based on high public use patterns and the presence of relatively large tree populations. Inspect these areas frequently and implement corrective actions on an expedited basis. Similarly, consider trees or tree branches that obstruct pedestrian and/or vehicular traffic very high risk, and dispatch maintenance crews immediately to perform clearance pruning as soon as the problem is identified.

Analysis of tree inventory data can be an effective tool in identifying high-risk zones within the community tree population. For example, if high winds caused tree damage within the community, analyzing tree inventory data that includes tree condition and general location variables can identify storm-damaged areas. Designate storm-damaged areas as high-risk zones, and direct maintenance crews to conduct post-storm tree risk inspections as a top priority. Similarly, a neighborhood with a large number of mature or over mature trees might be red-flagged as a high-risk zone

in need of more frequent risk inspections and more extensive corrective pruning. If the community has compiled a list of "problem" tree species (species with the highest rates of tree failures, storm damage, structural decay, repetitive crown dieback, or a short life-span), target neighborhoods or areas that contain a high density of "problem" species to receive more frequent risk inspections.

Identify criteria to define tree risk zones. Below are criteria that can be used to establish and map risk zones within a community.

Criteria to Establish Tree Risk Zones (See Table 2.1)

- **Roadway characteristics:** Prioritize according to key public safety issues such as emergency accessibility, and traffic volume and congestion factors. Top priority areas include:
    - Emergency access routes
    - Congested intersections
    - Major detour routes
    - Roadways or intersections where tree branches obstruct visibility of traffic signs or stop lights, or physically obstruct pedestrian or vehicular traffic
    - Streets that have had major reconstruction or underground utility work
    - Main thoroughfares

- **Public use and occupancy patterns**: Prioritize according to importance to public safety (fulfilling emergency and medical needs) and occupancy patterns. Top priority areas include:
    - Emergency and medical facilities, handicap access areas
    - Extensively used public areas and buildings
    - Neighborhoods with high population densities

- **Tree resource characteristics:** Prioritize by tree condition factors such as high average risk rating, areas with older or dense tree populations; and tree location factors such as branch interference with pedestrian or vehicular traffic, utility lines, or root interference with sidewalks. Top priority areas include:
    - Areas with a high proportion of high to very high tree risk ratings, as determined by the preliminary inventory survey data, tree risk inspections, or "hazard" reports submitted by the public of city staff
    - Areas severely damaged by storms
    - Areas with old growth trees
    - Areas with high a density of "problem" tree species
    - Areas with root injury caused by sidewalk or road construction
    - Areas where tree roots interfere with sidewalks and cause buckling

Table 2.1 provides an example of a color code system and includes examples of roadways, public buildings and use areas, and tree resource characteristics within each tree risk zone category. Very high-risk areas (color coded in red) include emergency access routes, medical and emergency facilities and shelters, school playgrounds, permanent structures, and drive-in campsites within high-use parks. High-risk areas are color coded in orange; moderate risk areas in yellow, and low risk areas in green.

Table 2.1. *Tree risk zone categories; color codes; and examples of roadways, public buildings and use areas, and tree characteristics that pertain to each tree risk zone.*

Hazard Zone Categories	Color Codes	Examples
Very High Hazard	**Red**	1. Emergency access routes 2. Medical and emergency facilities and shelters, handicap access areas 3. School playgrounds 4. In high-use parks/public areas: permanent structures and drive-in campsites 5. Individual trees or neighborhoods with very high-risk tree characteristics such as : • standing dead trees or those with very poor condition class ratings • severely storm-damaged trees • trees that visually obstruct traff c signs, stop lights, or security lights • tree roots causing severe sidewalk buckling
High Hazard	**Orange**	1. Main thoroughfares: congested intersections and visually obstructed traff c signs and stoplights 2. High-use parks, playgrounds, and picnic areas 3. Golf courses 4. Parking lots adjacent to high-use public areas 5. Bus stops along high-use thoroughfares 6. Individual trees or neighborhoods with high-risk tree characteristics such as: • old growth trees • high density of large diameter, mature, or "problem" tree species • root injury caused by sidewalk or road construction • storm-damaged trees
Moderate Hazard	**Yellow**	1. Secondary roadways: congested intersections and visually obstructed traff c signs and stoplights 2. Neighborhoods with a moderate density of large diameter, mature or "problem" tree species 3. Moderate-use parks, playgrounds and picnic areas 4. Parking lots adjacent to moderate-use areas
Low Hazard	**Green**	1. Low-use roads and public areas with dispersed recreation 2. Open areas, woods, riparian zones, and peripheral areas with limited use or access 3. Neighborhoods with a low density of large diameter, mature, or "problem" tree species

Map tree risk zones. The next step is to develop a color-coded map of the community that highlights designated tree risk zone categories. This map will serve as a handy visual reference of tree risk zones within the community, and will be useful in establishing inspection schedules and tree risk assessment methods. Start by constructing a map of the community that contains the roadway system, public buildings, and public use areas. Many city departments have developed computerized data layer or Geographic Information System (GIS) files that contain the information needed to map tree risk zones within the community. For example, the transportation or public works department often has maps or

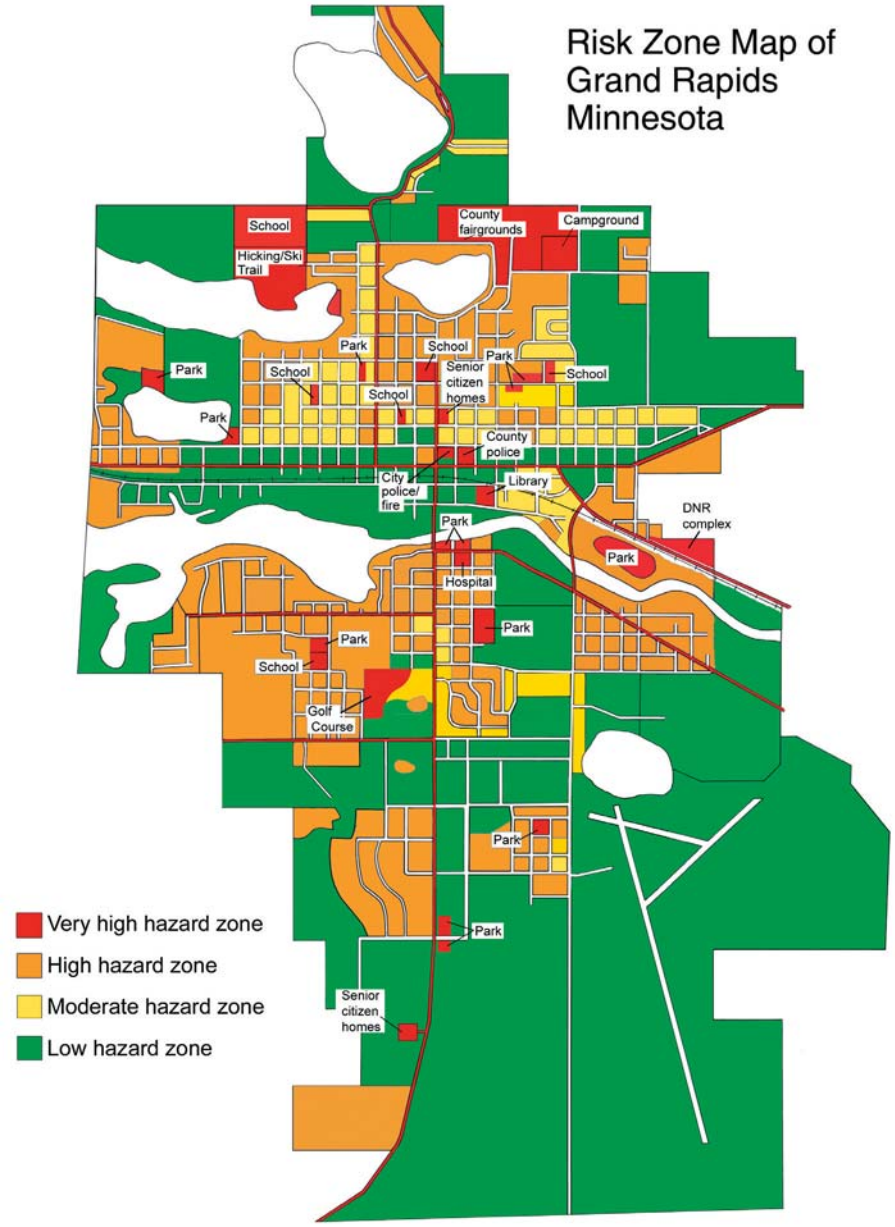

Figure 2.9. *Color-coded risk zone map of Grand Rapids, Minnesota. Very high-risk areas (color coded red), and high-risk areas (color coded orange) represent areas that should receive frequent risk inspections, using in-depth inspection methods, and where corrective actions should be implemented on an expedited basis.*

data layer files of the roadway system and traffic volume and congestion levels. The department in charge of planning and zoning will have information on the location of public buildings such as hospitals, fire, police, and other emergency medical facilities; schools; libraries; city administration buildings and community centers; and public use areas such as golf courses, city parks, and swimming areas. The parks and recreation department will have information on the location and usage patterns of public parks and other recreational areas. If computerized data files are not available to construct a community map, work from a standard city map of the roadways, manually identify public buildings and high use public use areas, and color-code these features on the map, using a different color for each tree risk zone. Using stick pins of various colors to mark the map works well and allows the map to be updated easily to reflect changes in risk levels. Figure 2.9 is a manually generated map that illustrates tree risk zones, using the above mentioned color-code system, for the city of Grand Rapids, Minnesota.

Update the community tree risk zone map to reflect significant changes within the tree population, roadway traffic patterns, or public use patterns. Keep up to date on the incidence of very high-risk trees. Mark very high-risk trees that are identified during ongoing tree risk inspections or post-storm damage surveys, or that are reported by tree planting or pruning crews with red pins on manually produced maps or color code these areas red on computer generated maps. Remove the red pins or color coding when corrective actions are completed. Delineate neighborhoods that have a large number of storm-damaged trees on the map until corrective actions are completed. Some communities red-code neighborhoods with large, mature trees that have undergone sidewalk reconstruction projects because severe root severing has occurred and the risk of tree failure is very high. Roadway repair or construction projects that result in serious congestion traffic patterns problems should also be tracked and coded appropriately.

Establish tree risk inspection methods, according to tree risk zone categories. Tree risk assessments estimate the degree of risk associated with a given tree to fail and potentially injure persons or damage property, and should be capable of measuring risk levels ranging from low to very high. Within a tree risk management program, implementation of more than one inspection method may be useful. In-depth inspection methods that examine the full range of tree defects and site conditions present are most useful when conducting risk assessments to determine the likelihood of a tree to fail and strike a target. Less intensive methods can be effective tools for identifying very high-risk trees and pinpointing high-risk zones within the community, and for conducting post-storm tree damage surveys. We will describe two basic methods: 1) walk-by (individual tree) inspections and 2) drive-by (windshield) inspections, and discuss the appropriate use of each of these methods within the context of a tree risk management program. See Table 2.2

Walk-by (individual tree) inspections. This method requires inspectors to walk through an area and rate individual trees for their potential to fail, based on the presence of defects, evaluation of targets, and other site conditions. All trees located within striking distance of a target receive a 360-degree visual inspection. Diagnostic tests are performed as needed.

Strengths of walk-by inspections. Walk-by tree inspections represent an in-depth evaluation method that provides the level of information necessary to make cumulative decisions about tree defects, site conditions, and the level of risk associated with a given tree to fail and strike a target. To accurately assess the potential risk that a tree will fail, it is important to thoroughly examine the tree and determine the full range of defects and site conditions that are present and could contribute to tree failure. Tree risk assessments should be capable of measuring a variety of risk levels, ranging from low to very high, and should include examination of all sides of the tree including the rooting zone, root collar, main stem, branches, and branch unions. A 360-degree inspection method is especially critical when defects occur on only one side of the tree and might be missed using the drive-by/windshield inspection method. It is not uncommon to find a tree that displays a full, green canopy and/or no major defects when viewed from only one side (Fig 2.10). The same tree, when viewed from the other side, may reveal a serious wound with extensive decay that causes the tree to be at a very high level of risk for failure (Fig 2.11).

Figure 2.10. *This tree, when viewed from one side, displays no serious defects.*

Walk-by inspections represent an inspection method that provides communities with the level of cumulative information needed to conduct tree risk assessments within all tree risk zones. They are the suggested inspection method for conducting tree risk assessments in very high, high, and moderate risk areas.

Defects can occur anywhere on a tree, an inspection method that examines all sides of a tree will provide the most complete information to determine the potential risk for that tree to fail

Weaknesses of walk-by inspections. Walk-by inspections are more labor intensive and costly to conduct than less intensive methods such as drive-by surveys. Because of the higher cost of implementing walk-by inspections, it may be necessary to limit their use to areas with the highest degree of risk such as very high, high, and moderate risk zones. This could be an effective way

Figure 2.11. *The same tree, viewed from the opposite side, displays serious defects: a large stem cavity with extensive decay. These defects and the tree's close proximity to a target make it a very high-risk tree.*

to streamline program costs and focus limited community resources to areas of greatest risk.

Drive-by (windshield) surveys. This method involves inspectors visually scanning trees for the presence of hazardous defects while traveling at slow vehicle speeds. It is recommended that a follow-up individual tree inspection be conducted on all trees noted by the drive-by survey to have hazardous defects present. Two people should be present in the vehicle: one to drive and one to assess trees and record data.

Strengths of drive-by inspections. Drive-by surveys are quick and easily implemented, and can be a cost effective planning tool to provide preliminary data on very high-risk trees and to pinpoint high-risk zones within the community tree population. They can detect overt hazards such as standing dead trees, trees with significant numbers of dead branches, or major tree architectural problems visible from the road. They could be used as a scoping tool to conduct a preliminary survey of the community's tree resource and provide an estimate of the number of highly hazardous trees. This information can be very valuable in building community support and documenting the need to establish a tree risk management program. As a supplemental survey tool, drive-by surveys can be used to augment efforts to divide the community into tree risk zones, and assist communities to focus the use of limited resources to the areas of highest risk. Drive-by surveys could also provide a quick and timely response after storms to identify areas where damage to trees occurred and where corrective actions are likely to be needed. This is possible since many storm-damaged trees will have defects in their crowns such as broken branches or cracked branch unions that are visible from the road.

Under situations of limited community resources, it may be feasible to use drive-by surveys to conduct tree risk inspections in low hazard zones and as a supplemental survey method in moderate hazard zones during "off-years" when individual tree inspections are not scheduled. Under conditions of extremely limited community resources, some communities have made a short-term decision to exclude low risk areas from the tree risk inspection program. In this case, tree risk inspections would not be conducted within low risk areas, but rather informal tree risk observations would be made as part of the ongoing tree maintenance program.

Weaknesses of drive-by inspections. Although drive-by surveys are an effective method for conducting preliminary surveys or post-storm tree damage surveys, their usefulness for conducting individual tree risk assessments is very limited. Drive-by surveys collect incomplete data on tree defects, site conditions, and potential targets because they rely on information inspectors collect during a visual scan, while traveling in a moving vehicle, viewing only one side of the tree. Many trees with hazardous defects will go undetected using this method of survey. For example, drive-by surveys will not detect defects (overt or subtle) that occur on the side of the tree facing away from the road. Additionally, more subtle defects such as narrow cracks or girdling roots, even if they occur on the side facing the road, may go undetected simply because they cannot be readily seen from the road. Clearly, defects present in a tree, but not able to be observed with a drive-by survey, can cause a tree to have a high risk for tree failure (Figs 2.12 and 2.13). The data collected with drive-by surveys is limited to what an

inspector can readily see from the road, and restricts the usefulness of this method to the detection of very high-risk trees that have hazardous defects visible from the road. Within the context of a tree risk management program, drive-by surveys are best used a preliminary or supplemental survey tool, not as a stand-alone tree risk assessment method.

Establish tree risk inspection schedules based on tree risk zone categories. Frequent inspections are essential for a successful tree risk management program. Tree structure and vigor necessarily change over time since trees are living organisms. Systematic inspections detect and monitor potentially deleterious changes. If tree inspections are not conducted on an ongoing and regular basis, many hazardous defects and situations will go undetected, and the fundamental goal of reducing risk to public safety cannot be met.

Figure 2.12. *This tree, when viewed from one side, displays no serious defects.*

In addition to improving public safety, frequent tree risk inspections provide a continuous source of tree resource data, and can eliminate the need to conduct separate, periodic tree inventory assessments as part of the tree planting or pruning programs. This integrated approach establishes a foundation for making informed management decisions, validating budget requests, and documenting program success.

Tree risk inspection schedules, like tree risk inspection methods, can be established according to identified tree risk zones as discussed in Step 6. High-risk zones should be inspected frequently, using in-depth tree inspection methods. Lower risk areas can be inspected less frequently and may employ the use of walk-by/individual tree inspections as well as less intensive drive-by surveys. This approach allows the community to target the use of limited fiscal resources to the areas of greatest risk. Inspections can be conducted at any time of the year, leaf-on or leaf-off, with the exception of times when snow cover prevents the examination of root conditions.

Figure 2.13. *The same tree, viewed from the opposite side, displays serious defects: a large stem cavity with extensive decay. These defects and the tree's close proximity to a target make it a very high-risk tree.*

Table 2.2 outlines suggested minimum guidelines for inspection methods and inspection schedules within a community tree risk management program. The suggestions contained in this table present a range of inspection options within most

Table 2.2. *Suggested minimum guidelines for inspection methods and inspection schedules within a community tree risk management program.*

Hazard Categories	Color Codes	Timing of Inspections	Suggested Inspection Method	Comments
Very High	Red	Annual	Walk-by/ Individual Tree Inspections	
High	Orange	1-2 years	Walk-by/ Individual Tree Inspections	
Moderate	Yellow	3-5 years	Walk-by/ Individual Tree Inspections	Consider conducting a drive-by/windshield survey on an "off-year" when individual tree inspections are not scheduled.
Low	Green	5-7 years	Walk-by/ Individual Tree Inspections or Drive-by/ Windshield Surveys	
All Rated Zones	NA	After Severe Storms	Drive-by/ Windshield Surveys	If potentially hazardous trees are detected, follow-up with individual tree inspections

The information contained in this table is offered as suggested guidelines and presents a range of inspection options within most risk zone categories. Individual communities must assess their tree resource needs and community resources, and adopt program guidelines that address their specific situation. Communities should always seek professional legal advice when drafting specific language governing inspection methodology and frequency.

risk zone categories. Individual communities must assess their tree resource needs and community resources, and adopt program guidelines that address their specific situations. It is critical to remember that the community is ultimately responsible for maintaining the publicly owned tree resource and shouldering the liability that may result from improperly caring for it. Not having funds to maintain the resource does not absolve a community of this responsibility or accountability in lawsuits arising from personal injury and property damage claims resulting from a fallen tree or tree branch. Moreover, the cost of a judgment against the community or the defense costs in a lawsuit could conceivably pay for a tree risk management program for many years (Tate 1985). Communities should always seek professional legal advice when drafting specific language governing inspection methodology and frequency to ensure that professional standards are met and reasonable care is demonstrated.

Step 7. Select a Tree Risk Rating System

There are many evaluation systems that rate the risk of damage or injury posed by a defective tree or tree part. Some systems define a numerical risk value, while others are categorical and describe the level of risk on a scale ranging from "low" to "very high." The first tree risk rating systems used in the United States were developed for

use in recreational sites and were based on tree failure information collected from federal and state recreation areas within the United States. Some state and federal agencies, including the U.S. Forest Service, the National Park Service, and the Minnesota Department of Natural Resources have developed tree risk rating and management program guidelines for recreation sites to reduce accidents caused by tree failures (Paine 1971, Mills and Russell 1981, Wallis et al. 1980, Johnson 1981, Albers and Hayes 1991). Later, tree risk rating systems were developed for use in urban areas, and many of these "urban" systems were modeled after recreational site systems and guidelines. To date, most published tree risk rating systems are designed for use in recreational areas, but a few are designed for use in urban areas (Bartlett Tree Expert Co. 1991, Matheny and Clark 1994, Colorado Tree Coalition 1999, Hayes 2000).

In Chapter 3 (How to detect and assess hazardous defects in trees), two risk rating systems (Minnesota DNR and U.S. Forest Service) are discussed as examples of systems that have been successfully implemented in urban areas. No single risk rating system is perfect or capable of adapting to all situations, nor is there one model system recommended for all communities. For these reasons, this manual does not recommend a particular tree risk rating system over another. A survey was sent to the authors of tree risk rating systems/manuals, designed for use in urban areas, and published in the United States. The survey consisted of ten questions that addressed assessment methods and rating systems used for conducting tree risk inspections, time required to conduct an assessment, and the level of training needed to prepare field staff to conduct assessments. Survey questions were selected based on their perceived usefulness to community decision-makers in selecting a tree risk rating system suitable for their respective communities. Survey questions, and responses provided by the respondents, are summarized in Appendix 1.

Regardless of the tree risk rating system selected, collect all information on a standard form that summarizes the important aspects of the assessment. Store tree risk assessment information so that data is easy to access, update, and retrieve. Most communities can afford the cost of a computer that is capable of managing their tree resource data. Most communities have chosen to use standard PC workstations that may be connected to a municipal wide area network. There are many software programs on the market that can store and manage tree resource data. Most spreadsheet or database programs can be used for this purpose. Tree inventory software programs are commercially available and can be very useful and cost-effective if they do not need to be customized for your community's needs. Whatever computerized database system the community selects, it must be able to manage tree risk assessment data as well as basic tree inventory data and generate management recommendations. Useful information can often be obtained from communities that have already established a tree inventory system or tree risk management program. It may even be possible to purchase a customized spreadsheet or database program from another community forestry program. Take care to ensure that the software is compatible with databases within other city departments.

Although the up-front hardware and software costs are reasonable, they represent only a portion of the total investment. The time and labor needed to update and maintain a computerized system is substantial, and these costs should be factored into budget requests. Consider the internal and external resources that will be

necessary to automate the system. Internal resources include ongoing clerical support, hardware and software support, and staff training. External resources include program development, program customization, report writing and network administration.

Establish an implementation schedule for corrective actions. Removal or immediate corrective treatment of very high-risk trees must be the top priority within any tree risk management program (Fig 2.14). It is not uncommon for a community to have a large number of high-risk trees, particularly if a tree inventory survey or tree risk inspections have never been conducted or have not been conducted in recent years. For most communities, limited budgets and personnel will require that corrective actions be implemented or phased in over a period of years. In such cases, the question becomes, "Which of the very high-risk trees should receive corrective treatment first?"

Figure 2.14. *The removal or immediate corrective treatment of very high-risk trees must be a top priority within any tree risk management program.*

Be prepared to explain the rationale for assigning treatments to trees identified as hazardous. Clearly outline the methods used to identify high-risk trees, initiate necessary corrective actions, and implement these actions within a reasonable time frame. Numeric tree risk rating systems provide a justifiable way to prioritize corrective treatments. Trees with the highest numeric risk rating are treated first, and other corrective treatments are implemented later, according to decreasing numeric risk ratings. If integrating the tree risk zone approach with a numeric risk rating system, trees with the highest risk ratings within the highest risk zones are treated first, followed by those within the moderate and low risk zones. Such a system allows managers to identify the highest risk trees and implement corrective actions on an expedited basis, and demonstrates an approach to implementing corrective treatments in a reasonable and systematic fashion.

Step 8. Write a Comprehensive Tree Risk Management Program Policy

The community must write, adopt, and enforce a tree risk management policy that specifies program goals, management strategies, and implementation steps identified in Steps 5, 6, and 7. The tree risk management program policy should include provisions that the community is willing and able to enforce. Consult with the city's legal counsel throughout the process of writing, adopting and enforcing a tree risk management program policy. Timely legal advice, based on current laws and professional standards, will help to ensure that reasonable care is being taken to manage the public safety risks associated with hazardous trees. Once a program policy is written and adopted, the community will be held responsible to enforce the stated policy provisions. For this reason, review policy statements often, preferably

on an annual basis, to ensure the provisions provide the level of risk management that is appropriate for the community.

Tree risk management program policy statements should not duplicate or contradict any existing laws. Review copies of other policies, ordinances, codes, rules, or regulations that affect trees in the community, and cross-reference those that are pertinent to the tree risk management program policy. For example: Do the utility department or utility companies have written policies regarding trees and shrubs growing near overhead or underground utility lines? Does the street department have any written policies that require trees to be trimmed to a certain height above streets and sidewalks?

Be aware of industry standards for proper tree pruning techniques, safety requirements for tree care operations, and selecting high quality nursery stock. Implementation of these standards is voluntary, and the community may wish to establish their own set of standards. Whatever tree care standards are selected for implementation, they should be stated or cross-referenced within the tree risk management program policy.

Elected officials, with the designated authority, should sign off on the program policy to officially adopt it as a community tree risk management policy. Once the plan is signed, elected officials should confirm that they will support the personnel who administer the tree risk program and support their assessments of trees and recommendations for corrective treatments. Establish a process to handle conflicts with homeowners, and corrective action appeals presented by affected citizens.

Address the following points in the tree risk management program policy:

- State the community's understanding of its responsibility to maintain the safety of public lands from potentially hazardous trees
- Identify who will administer the tree risk management program and possess the authority to enforce tree risk reduction policies
- Identify the standard (tree risk rating system) to be used to assess the degree of risk associated with a given tree to fail and potentially injure persons or damage property
- Specify inspection methods and schedules to be implemented
- Specify a process by which corrective actions will be implemented
- Identify a process for handling corrective action appeals presented by affected citizens
- Identify a process for handling violations of the tree risk management program policy

An interactive software program (TREEORD) has recently been developed as a tool for communities to draft and write tree ordinances. It contains more than 1,800 examples of text contained in existing ordinances from communities throughout the United States. The example text has application for developing policy statements as well as ordinances. TREEORD is available for purchase from: Tree Trust, 2350 Wycliff Street, Suite 200, St. Paul, MN 55114 (http://www.treetrust@treetrust.org).

Step 9. Implement a Tree Risk Management Strategy

Hire and/or train staff. Trained and able staff must be available to implement a tree risk management program. Staff can be cross-trained and shared between the tree planting, pruning, and tree risk management program areas, and every effort should be made to coordinate activities and share costs among these programs. For smaller communities that do not have a City Forester or forestry staff, it may be more cost effective to contract these services by hiring professional forestry consultants to conduct tree risk inspections or implement corrective actions. Out-sourcing services in this way solves the problem of limited in-house staff size, and eliminates the need to provide ongoing staff training in tree risk assessment and management. Professional consultants should provide evidence of accredited training in tree risk management, arborist certification, and extensive field experience in the detection, assessment, and correction of tree defects. Sharing a City Forester position between several communities may also be a feasible approach to administering a tree risk management program within smaller communities.

Some larger communities will have a City Forester and a forestry staff in place who can be trained to conduct tree risk inspections and implement a tree risk management program. Proper training is paramount to ensuring staff possess the knowledge needed to conduct tree risk inspections correctly and make accurate and informed management decisions. Staff require thorough training and proper supervision. At a minimum, training should consist of 1-2 days of intensive classroom and field training, with a heavy focus on conducting actual tree risk assessments in the field. The training program should provide for the continuing education of the staff, and offer refresher courses at least every couple of years. Newly trained staff should work under the supervision of a more experienced staff member to become familiar with the program specifications, and the local tree resource characteristics and conditions. There is no substitute for experience in tree risk assessment, so teaming an experienced inspector with a newly trained inspector should be a top priority. In addition, periodic spot-checking of all trained staff should be done as a quality control measure.

Some communities will train and supervise volunteers to assist with implementing a tree risk management program. This is a controversial practice, and many published texts on the topic of tree risk/hazard management unequivocally state that tree risk assessments should be conducted only by tree care professionals who are specifically trained in tree risk assessment techniques. Clearly this approach is thorough and may be the preferred option, but it may be too limited in its perspective. If volunteers are provided the same level of training as community forestry staff, are teamed and supervised with experienced inspectors, and pass quality control checks that demonstrate proficiency in conducting tree risk assessments in the field, it is possible that volunteers could possess the skills needed to conduct tree risk assessments. Proper training, supervision, and quality control checks to demonstrate proficiency are critical to making this approach succeed, however. Clearly, not all volunteers will be suited for this assignment. As a general rule, communities should confer with a city attorney on issues relating to professional standards, practicality, legality, and economics to receive advice and assistance in drafting specific language to be included in a policy statement.

Here are some key points to consider that relate to the use of volunteers within a tree risk management program:

- Volunteers must be indemnified. The city attorney should determine the process that must be followed to ensure volunteers are indemnified against personal liability while assisting in a community tree risk management program.

- Volunteers should receive proper training and supervision. Volunteers should receive 1-2 days of training, with a heavy focus on conducting tree risk assessments in the field. In addition to training, volunteers should always work under the direct supervision of a local professional to become familiar with the program specifications and local tree resource characteristics. The professional should provide backup assistance on any trees that are difficult to rate or pose other problems. Periodic spot-checking of volunteer work should be done as a quality assurance measure, and the proficiency of volunteers in conducting tree assessments must be regularly assessed.

- Volunteers should be qualified. Whenever possible, an effort should be made to work with volunteers who have a background in urban forestry or have received urban forestry training from State Extension Programs and other programs such as Master Gardeners, Tree Care Advisors, Woodland Keepers or Tree Keepers.

- Volunteers should receive training on how to effectively talk with homeowners about the purpose of the tree risk management program and how to address concerns about tree removals.

Implement risk inspections and corrective actions according to established methods and schedules. Risk inspections should be implemented according to the methods and schedules established in Step 6. Establishment of an implementation schedule for corrective actions is discussed in Step 7.

Document tree risk inspections, corrective actions, and tree failures. It is critical to document the inspection process and maintain records of recommended corrective treatments and the dates they are implemented. Whatever tree risk assessment/rating system is used, a standard data collection form should be used to capture this information. The standard form should include the name of the inspector, date of inspection, tree defect and risk rating information, recommended corrective treatments, the date, and who completes corrective treatments. Information contained on the standard form can be manually filed or entered into a computer database file. Digital photography can a very valuable tool to document and supplement inspection reports. Access to tree inspection data will help managers actively manage their tree resource and make sound, objective, and timely management decisions. For example, all high-risk trees recommended for removal can be identified, and work schedules can be coordinated to remove such trees, on an expedited basis.

Documenting the inspection process and tracking corrective actions will help demonstrate that the community is implementing a systematic procedure for inspecting, evaluating, and managing potentially hazardous trees. Tracking corrective treatments as they are completed can be a powerful tool to document the number

Figure 2.15. *All tree failures and significant branch failures should be inspected immediately, documented, and photographed.*

of high-risk trees that have been removed since the inception of the program, and demonstrates that the community has materially reduced risk to public safety through the implementation of the tree risk management program.

Inspect, document, and photograph all tree failures and significant branch failures immediately (Fig 2.15). This information may prove to be extremely valuable in defending the community against negligence lawsuits. Collect information about the details of the tree failure such as the presence and severity of structural defects, wood decay, or injuries; maintenance history; site conditions; the time and date of the tree failure, and prevailing weather conditions. Document the inspector's opinion as to how and why the tree failed, if any significant structural defects were present, and any other extenuating factors that may have contributed to the failure. Collect this information on a standard form, and store it within the tree risk management computer database program, along with tree risk assessment data. Appendix 2 contains an example form for recording tree failures, developed by the California Tree Failure Reporting Program.

Analysis of tree failure data can help to identify patterns of recurring failure of certain tree species, or failures associated with specific structural defects, site conditions, or management practices. This information can be an invaluable tool for the tree risk managers to pinpoint high-risk "problem" tree species in need of more frequent risk inspections or corrective pruning, and more accurately assess the risk potential of certain defects. Identification of high-risk or "problem" tree species can help tree planting programs make better choices of what trees should be planted in the community, and refine their list of recommended tree species for planting.

Are You Getting What You Want?

Step 10. Evaluate Program Effectiveness

There are a myriad of books and other materials in print that provide in-depth analysis of program evaluations, their designs, methods, and techniques. There are at least 35 different types of evaluation including needs assessments, accreditation, cost-benefit analysis, efficiency, formative, summative, goal-based, process, outcomes etc. (McNamara 1998). Outcome-based program evaluations are being used increasingly for non-profit and community-based programs. An outcome-based evaluation can determine if your organization is doing the right program activities to bring about the outcomes you believe or have verified to be needed by your clients. Outcomes are benefits to clients from participation in the program. For a tree risk management program, two expected outcomes would be 1) increased public safety and 2) improved urban forest health and sustainability. Once the major outcomes are identified, observable measures or indicators of success or failure must also be identified. For example, if the annual number of reported cases of personal injury or property damage due to hazardous trees has been reduced since the inception of the program, the tree risk management program can be credited with improving public

safety. An observable indicator of improved urban forest health and sustainability would be a decline in the number of very high-risk trees in need of removal, and fewer trees in need of corrective pruning.

The overall program and all program components should be evaluated to determine how they are performing. For example, the following questions might be addressed:

- Is the risk rating system working?
    - Were most of the trees that failed rated as high-risk trees? If yes, then the tree-risk-rating system is working. If trees with low numeric ratings for failure are failing, then adjustments must be made to the tree-risk-rating system.
    - Review quality control checks to see if the staff are accurately conducting tree assessments. Survey staff to determine what they like or dislike and what they feel is working and not working about the tree-risk-rating system.
    - Has the number of tree "hazard" complaints from the public decreased?
    - Is there a backlog of trees needing removal?
- Is the inspection schedule working?
- Are there any cost reductions as a result of corrective actions taken?
- Is staff training effective?
- Is the use of volunteers effective?
- Are citizens unhappy with corrective actions?
    - Is there a need to have a public review period?

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