London Hydro Inc.

Review of Vegetation Management

Issued: September 2017

Prepared By:

Allan Van Damme, P.Eng., CPA, CMA
Director of Operations

Reviewed By:

William Milroy, P.Eng.
Vice President of Engineering and Operations

Acknowledgements

I would like to recognize the valuable contributions to this report made by Tom Arnos, Aathishaan Kubendran, Peter Mills, Paul Lawrence, Mohammed Moalin and Greg Sheil. All contributed their knowledge, experience and time to the production of this report.

EXECUTIVE SUMMARY

One of London Hydro's most significant operational risks involves the impact of damaged trees on the overhead high voltage distribution circuits. Damage to the trees can occur during significant severe weather events such as those experienced in Toronto during the 2013 ice storm. One of the most effective ways that an LDC can reduce this risk is through an efficient vegetation management program.

A review of London Hydro's existing vegetation management was performed leveraging various data sets and London Hydro's Geographic Information System (GIS). It included a situational analysis of the tree and overhead circuit densities and areas prone to tree related outages. It then considered the increasing operational risk of tree contacts with overhead lines caused by severe weather such as: ice storms, high winds, early snowfalls and lightning storms. The analysis was focused on improving the reliability and safety of the overhead distribution grid.

The areas identified for improvement include: working with the City to implement new tree planting guidelines to obtain adequate clearances, implementation of a new GIS based mobile inspection tool to accurately record where trimming is required and where it has been completed, modification to the existing annual trim areas and cycles to focus trimming resources on the highest risk areas, and an increase of $175,000 in contract services to the existing $910,000 operating budget. The budget modification is necessary in order to address specific areas with higher than desired tree growth which is presenting a risk to the performance of the overhead lines.

It is recognized that the threat of severe weather is increasing and as a result the risk to the performance of the overhead grid is growing. Through the implementation of the above improvements London Hydro will continue to demonstrate a diligent path forward as it maintains the safety and reliability of its overhead circuits.

TABLE OF CONTENTS

List of Figures

List of Tables

1.0 INTRODUCTION

The City of London has been known as “the Forest City” since 1855 as it was described literally as the city built in the middle of a forest. For over 100 years, overhead distribution lines have been installed side by side with the trees. The ongoing challenge is to plant the trees and install the lines in a manner that promotes a healthy urban forest and safe and reliable distribution network.

London Hydro has conducted several customer surveys and found that customers value reliable electricity at an affordable price. Effective vegetation management is critical to both of these deliverables. This report will summarize the vegetation situation within London and the associated operational risks to the power distribution grid. It will then leverage London Hydro’s Geographic Information System along with various data sets to analyze the current situation and make recommendations on possible areas of improvement.

2.0 FACTORS AFFECTING TREE GROWTH

Several key factors contribute towards tree growth including rainfall, soil nutrients, temperature, and atmospheric carbon dioxide levels. Different species of trees have certain optimal conditions which allow them to thrive. Several ecological factors also influence tree growth including the level of competition and presence of invasive species. Finally, environmental stressors such as heavy storms and the presence of disease-causing pathogens like fungi and insects also affect tree growth.

2.1 Precipitation Levels

The average annual rainfall for London area is higher than the majority of Ontario as shown in Figure 1. The abundance of rainfall contributes towards healthy tree growth in the London area.

A study by a Western University team stated that “climate modelling suggests that the city of London can expect to experience more frequent severe precipitation events in

the future as a consequence of climate change". Severe precipitation events present an increased risk to the performance of the overhead grid due to the associated winds. The study also stated that "a region must adapt its policies and procedures to consider climate change and mitigate risks to municipal infrastructure".[1]

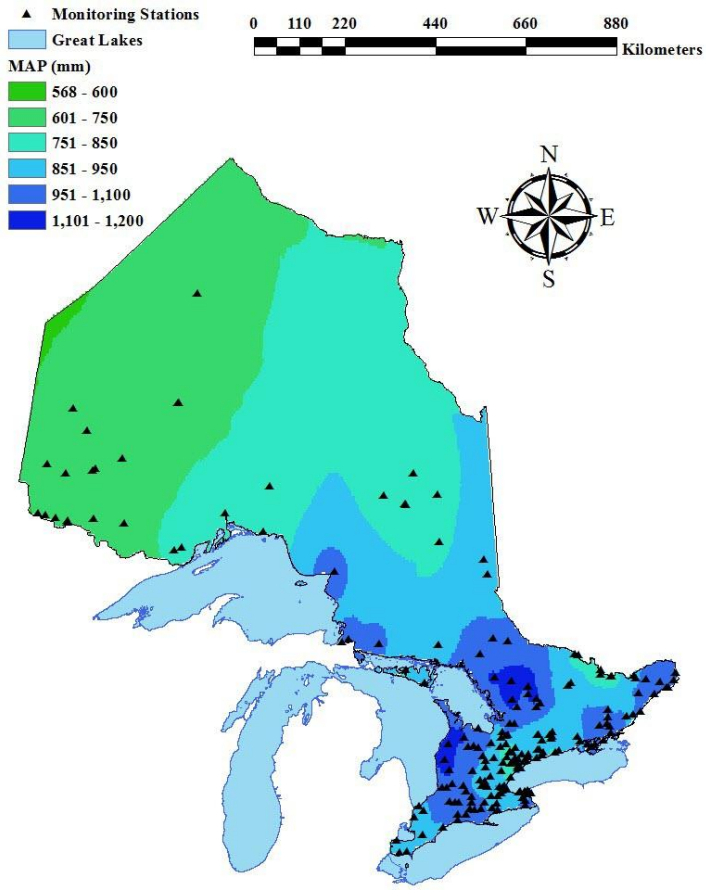


Figure 1 - Mean Annual Precipitation Distribution Within a Year[2]

The Environment Canada map below illustrates that southern Ontario historically receives more heavy rain events then other areas of Ontario (shown in Figure 2). This

[1] The City of London: Vulnerability of Infrastructure to Climate Change – University of Western Ontario, April 2011

[2] Computational Hydraulics International - https://www.chijournal.org/C420

further indicates that the London area receives more precipitation in a severe manner. This presents an increased risk of the overhead powerlines.

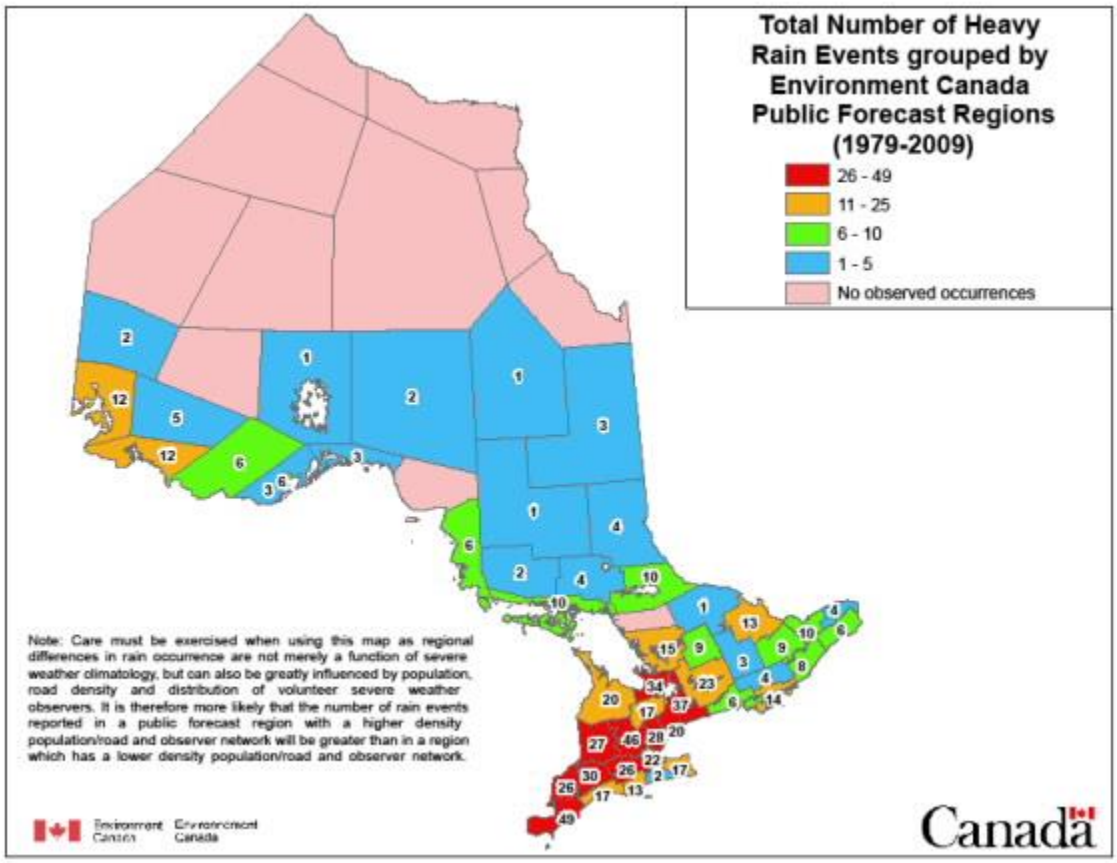


Figure 2 - Total Number of Heavy Rain Events in Ontario (Environment Canada)

2.2 Temperature

The International Panel on Climate Change (IPCC) has predicted that it is “very likely” that the earth will experience more hot days and “likely” more heat waves over nearly all land areas in the years to come. Depending on the model, temperature rises could be between 2°C and 6°C by 2100. The rise in temperature along with adequate moisture can result in an increased growing season with increased growth rates for trees.[3]

[3] Fifth Assessment Report (AR5) Intergovernmental Panel on Climate Change – www.ipcc.ch

2.3 Soil Types London

When glaciers retreated from the London area, they left behind some very fertile agricultural lands. While soil may differ from one pocket of the city to another, the most common makeup holds high calcium, with pH levels that hover around 7.0 – 8.3[4]. Soil texture varies depending upon location. In general the soils in London are sufficient to support large tree species that can affect the performance of the overhead powerlines.

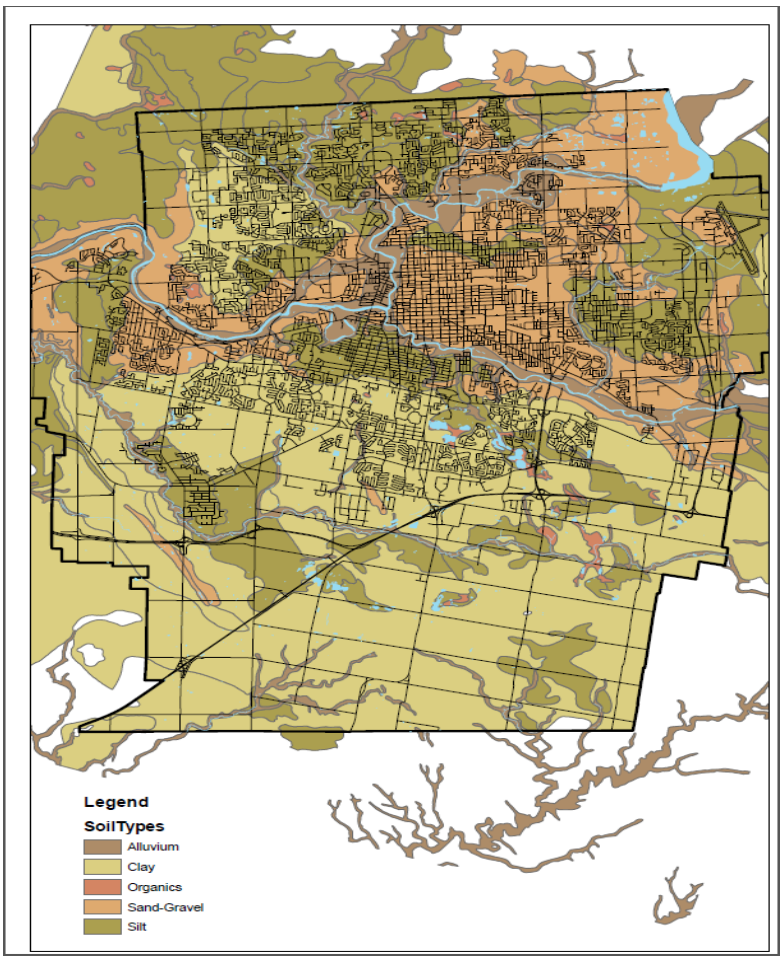


Figure 3 - Soil Types found in London, Ontario

[4] http://clctreeservices.com/trees-planting-london/

2.4 CO2 Levels

There are several reports available that have demonstrated that tree growth is positively influenced by rising levels of CO2.[5] [6] These reports indicate that tree growth is accelerated by long term exposure to higher CO2 levels as long as there are no other limiting growth factors such as moisture, nutrients, and heat.

[5] Elizabeth A. Ainsworth and Stephen P. Long – "What have we learned from 15 years of free-air CO2 enrichment (FACE)? A meta-analytic review of the responses of photosynthesis, canopy properties and plant production to rising CO2"

[6] Sean M. McMahona, Geoffrey G. Parkera, and Dawn R. Millera – "Evidence for a recent increase in forest growth"

3.0 SITUATIONAL ANALYSIS – TREES AND OVERHEAD LINES

3.1 London Tree Demographics (Size)

The City of London has provided London Hydro with information relating to the species, year installed and trunk diameter (Table 1). Although the data set from the City is not complete, it is representative as it covers the dense tree areas of the city. London Hydro is concerned with all trees that are over 7.5 m in height as they have the potential to encroach on the overhead high voltage wires and affect performance. It is estimated that trees with a diameter of 15 cm or more could be 7.5 m in height. The table provided below provides an estimate of the proportion of trees with various truck diameters in the City's database. This is not say that trees with trunk diameters less than 15 cm will not eventually grow larger and cause performance issues in the future.

Diameter Range (cm)	Number of Trees	Frequency
1-10.8	83366	39%
10.8-20.6	35983	16.80%
20.6-30.4	33442	15.60%
30.4-40.2	23664	11.10%
40.2-50	15065	7.00%
50-59.8	7585	3.50%
59.8-69.6	5516	2.60%
69.6-79.4	3710	1.70%
79.4-89.2	2498	1.20%
89.2-99	1470	0.70%
> 100	1637	0.80%

Table 1 - City of London Data on Tree Trunk Diameter

3.2 Tree Density of London's Large Trees

London Hydro is mainly concerned with taller trees that present a risk of contact with the high voltage powerlines. The City of London has mapped the majority of the trees with a focus on trees in the densely populated central part of the city. The City mapping generally excludes trees on private property (including backyards) and the outer portion of the city. In an effort to obtain a more complete inventory of trees, London Hydro performed a high level mapping of the peripheral parts of the city and larger backyard areas using Google Earth. The results are shown in Figure 4. The green dots represent trees from the City data and the purple dots represent trees from London Hydro's Google Earth mapping effort. The map below illustrates that the central portion of the city highlighted in areas 1, 2 and 3 have a higher density of large trees in close proximity to London Hydro high voltage lines. There is a much lower density near the outer areas of the city represented by areas 4, 5, 6 and 7. As a result, the risk of tree contact with a high voltage line is higher in the central portion of the city.

.

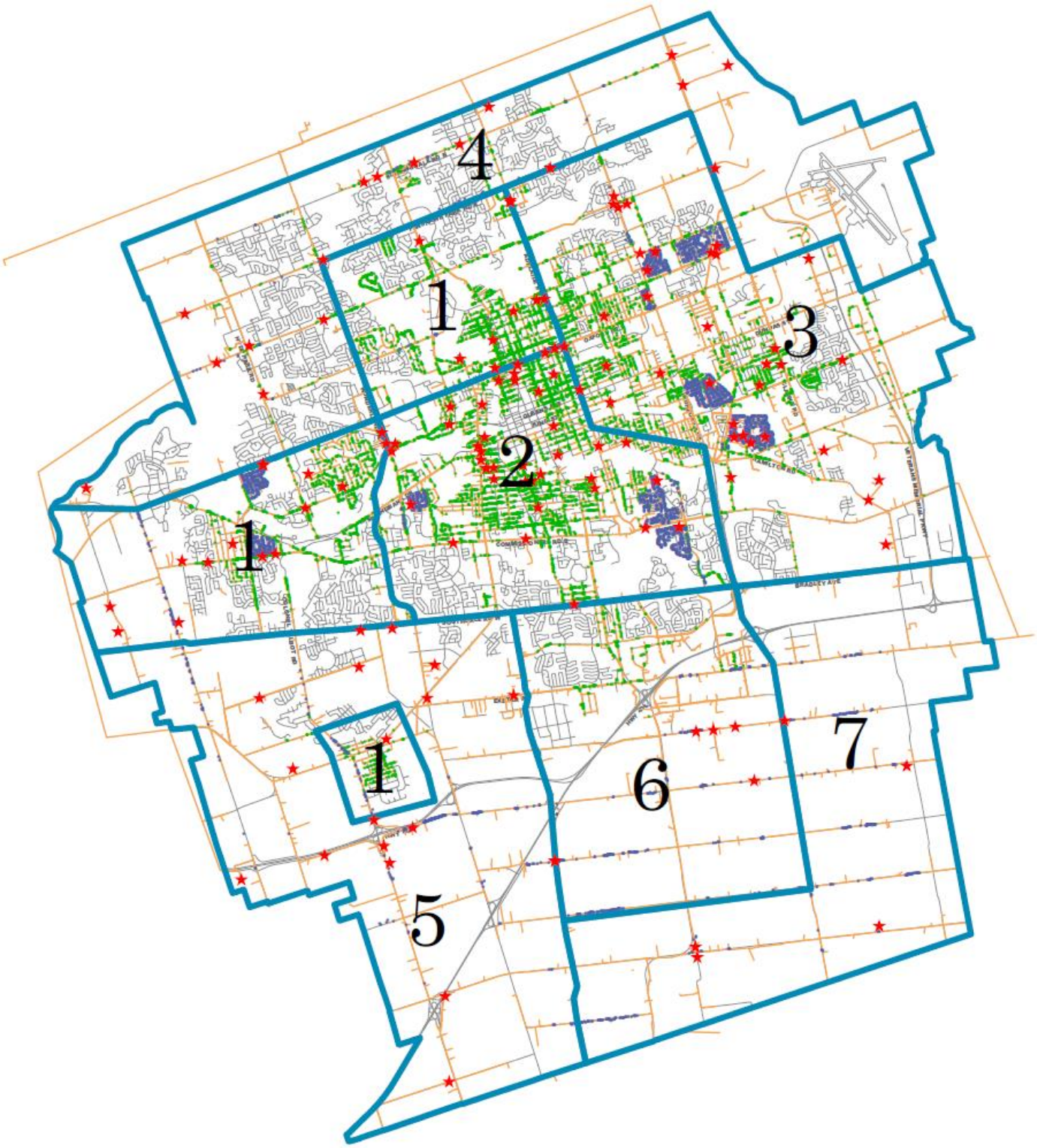


Figure 4 - Tree Distribution

3.3 Tree Species and Growth Rates

The species of tree is relevant to the analysis as each species of tree has a different growth rate and characteristic. From the City's data in Table 2 we observed that Maples are the most prevalent species of large tree with the Norway Maple being the most common of all maples.

Composition of Species of Large Trees Near Polelines

Species	Frequency
Norway Maple	26.00%
Silver Maple	10.40%
Sugar Maple	5.70%
Norway Schwendler Maple	4.70%
Norway Spruce	4.70%
Honey Locust	3.60%
Little Leaf Linden	3.80%
Colorado Blue Spruce	3.30%
Other	37.8%

Table 2 - Composition of Secies of Large Trees Near Polelines

The Norway Maple is invasive in North America and has many advantages which allow it to out-compete native tree species. The roots grow very shallow thereby starving other plants of water. The dense canopy of Norway Maples also blocks sunlight from other nearby species thus inhibiting their growth. Other factors contributing to its invasiveness include its high germination rate and the fact that it puts out leaves earlier in the spring and holds them longer in autumn. This gives Norway maples a longer growing season than most native species. Since Norway maples are not in their native range, they live a much shorter life in North America. Especially on streets, the roots do not have enough space and often wrap around themselves causing the tree to die. It grows fast and vigorously but the wood is not strong therefore making it vulnerable to breakage during storms. These broken limbs can then cause tree-contact outages in London Hydro's distribution grid.

Figure 5 - Norway Maple

The following table describes the characteristics of the most common type of tree species in London. The table further illustrates some of the risks associated with Maples.

Tree Species	Relevant Properties	ESA Zone Type	Status
Norway Maple	Wood is not strong making branches vulnerable to breaking during storms, medium growth rate	Tall	Invasive
Silver Maple	Massive trunk and prone to splitting/ limb breakage, fast growth rate	Tall	Native
Sugar Maple	Dense crown and should not be planted in confined spaces, slow growth rate	Tall	Native
Honey Locust	Spreading canopy, fast growth rate, prone to splitting, weak crotches lead to breaking off when larger	Tall	Native
Little Leaf Linden	Dense canopy, medium growth rate	Tall	Non-native
Norway Spruce	Fastest growing of the spruces, grows in pyramidal shape, medium growth rate	Tall	Non-native
Colorado Blue Spruce	Long-lived and grows in pyramidal shape, medium growth rate	Tall	Non-native
Norway Schwendler Maple	Spreading canopy with rounded crown, medium growth rate, wood is not strong	Tall	Invasive

Table 3 - Relevant Properties of Common Species

Table 4 categorizes tree species by rate of growth. Shorter trim cycles and greater cut back distances are required on faster growing species. It is noted that favourable growing conditions (eg. warm temperatures, adequate precipitation, and available soil nutrients) also leads to faster growth rates.

Ontario Tree Species and Rate of Growth				
Extra Fast	**Fast**	**Medium**		**Slow**
Carolina Poplar	Willow	Tulip	Ash	Sugar Maple
Cottonwood	Locust	Bl. Cherry	Larch	Horse Chestnut
Lombardy Poplar	Silver Maple	Aspen	Norway Spruce	Hickory
Chinese Elm	Manitoba Maple	Elm	Red Pine	White Oak
		Red Maple	White Pine	Beech
		Norway Maple	Scotch Pine	Balsam Fir
		Sycamore	Jack Pine	White Spruce
		Birch	Basswood	Black Spruce
		Red Oak	Walnut	Hemlock
		Hackberry	Larch	White Cedar
			Butternut	Apple
				Hawthorn
				Hemlock

Table 4 - Growth Rates of Common Species

3.4 Density of Overhead Lines (by Voltage)

London Hydro's customers are supplied through more than fifty 27.6 kV feeder circuits. London Hydro also has distribution at 13.8 kV, 8.32 kV and 4.16 kV. Both the 13.8 kV and 4.16 kV are being actively converted to 27.6 kV. The 8.32 kV is also being

converted to 27.6 kV in order to obtain increased capacity for new developments in the peripheral areas of the city.

Although the 27.6 kV has many advantages over the lower voltages, it is more prone to outages due the required increased clearances to trees. The graph below shows the higher number of customers affected due to contacts with the 27.6 kV feeders. It is also noted that a typical 27.6 kV feeder supplies a larger number of customers than lower voltage feeder circuits and therefore a contact impacts more customers. London experienced a higher than average number of tree related outages in 2011 due to a severe thunderstorm.

London Hydro is leading the industry in its strategies to reduce the risk of high voltage line contacts. These strategies include the use of insulated spaced aerial wire and insulated transformer bushings. Another innovation is the extensive use of automatic line reclosers in an urban environment.

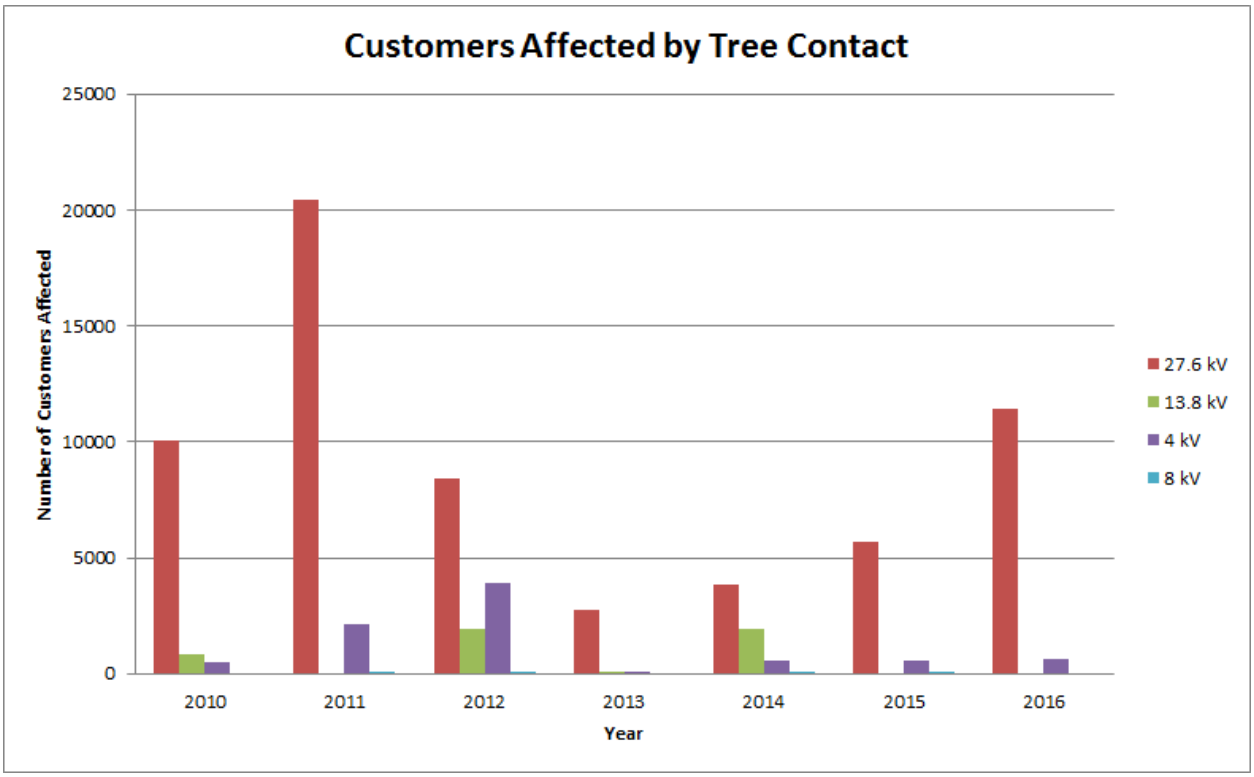


Figure 6 - Customer Outages by Voltage

The map below shown in Figure 7 illustrates the high correlation of tree related outages to the locations of dense overhead 27.6 kV circuits. The red lines represent 27.6 kV circuits and the coloured dots represent outages. It is noted that the circuit density is much higher in the older central urban areas of the city.

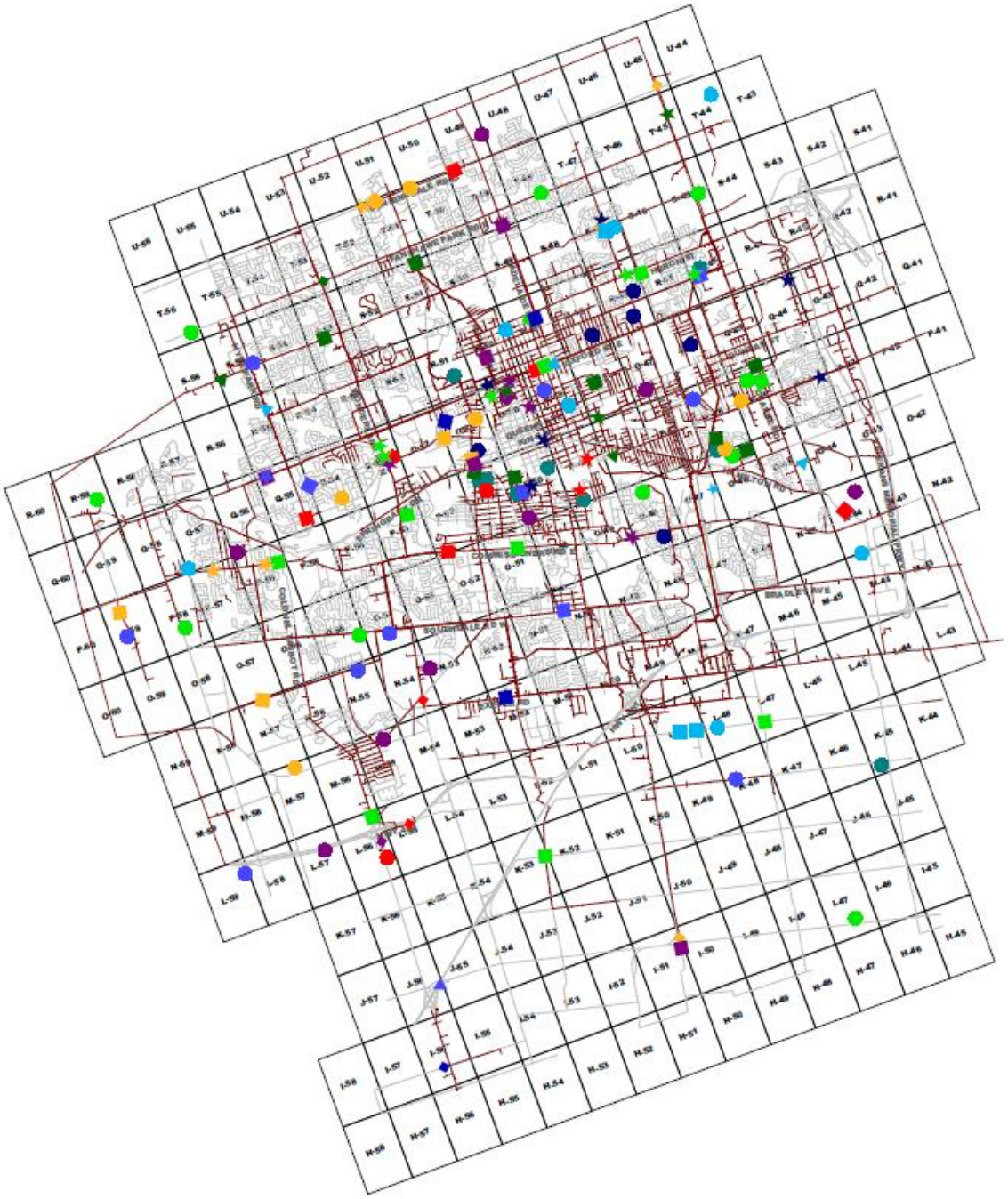


Figure 7 - 27.6 kV Overhead Poleline and Tree Related Outages

4.0 RELIABILITY BENCHMARKING

London Hydro has historically performed marginally better than its peers in controlling tree related outages. The graph shown in Figure 8 below excludes all major event days.

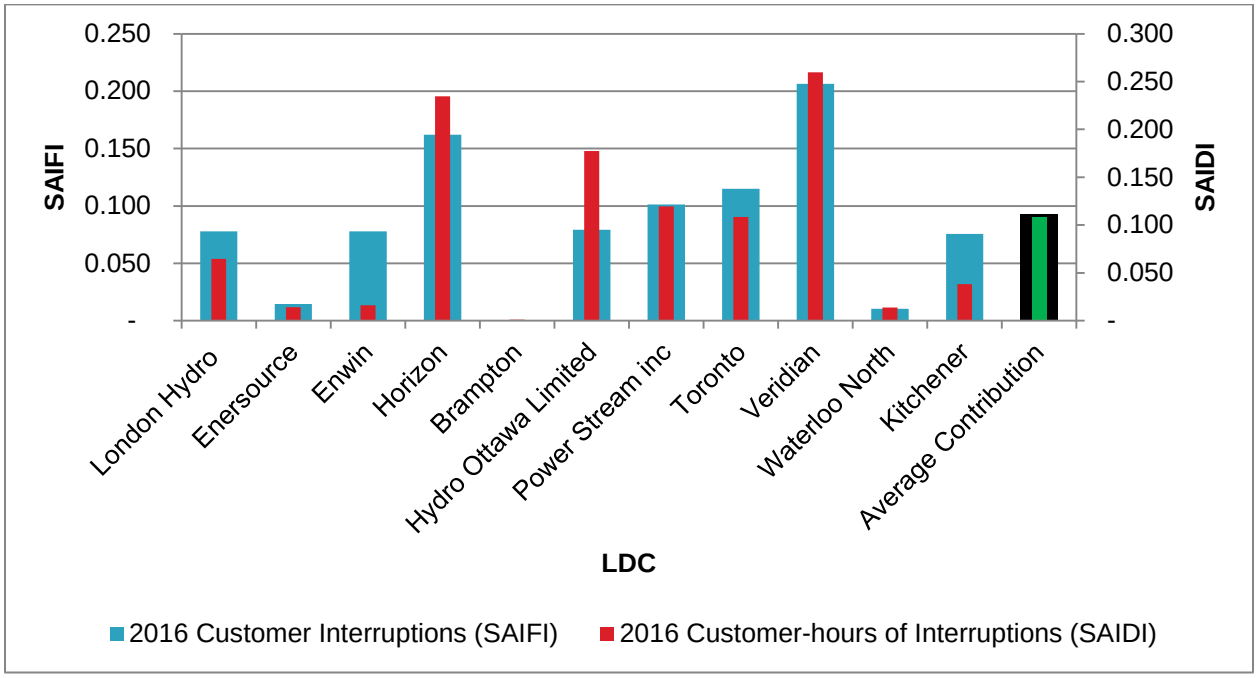


Figure 8 - Benchmarking of Tree Related Outages

Tree related outages in London typically represent a small component of all of the outage causes in London (approximately one tenth). The historical tree related SAIDI and SAIFI is shown in Figure 9. However, the risk of a major ice storm or wind storm can change the number of tree related outages dramatically. These events are described in section 4.1

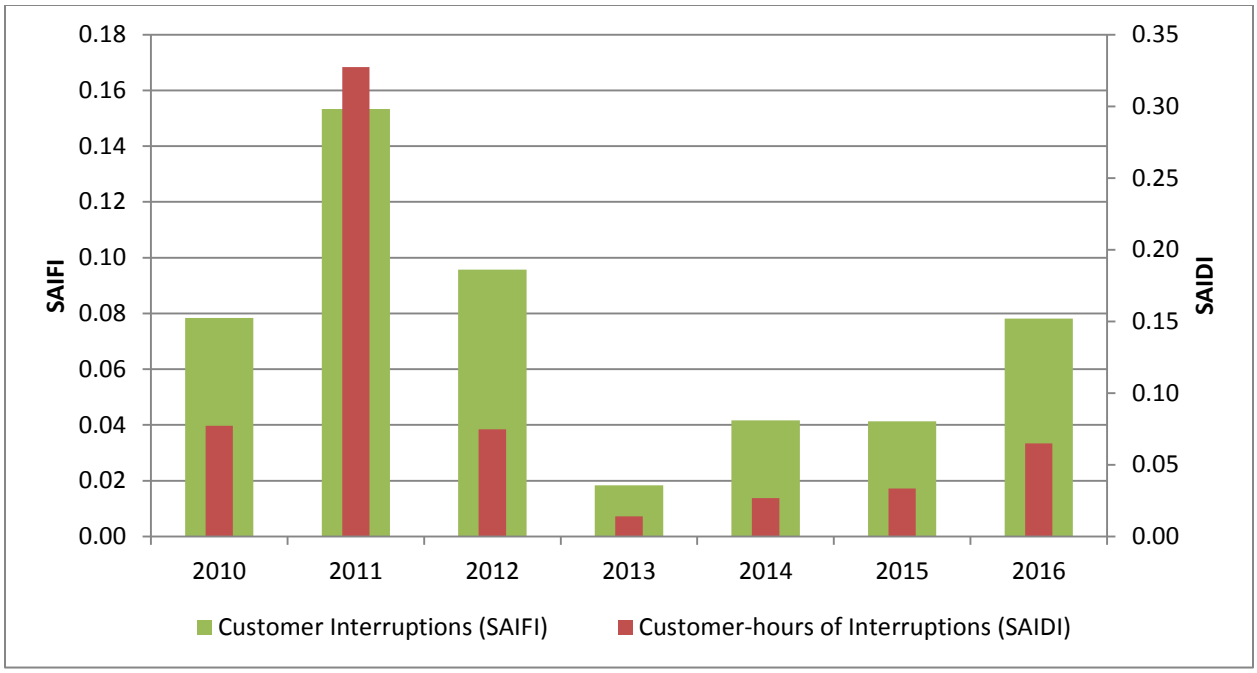


Figure 9 - London Hydro Historical Tree Related SAIDI and SAIFI

4.1 Major Event Days

A Major Event is defined as an event that is beyond the control of the distributor and is:

a) unforeseeable;

b) unpredictable;

c) unpreventable; or

d) unavoidable.

"Beyond the control of the distributor" means events that include, but are not limited to, force majeure events and Loss of Supply events.

Such events disrupt normal business operations and occur so infrequently that it would be uneconomical to take them into account when designing and operating the distribution system. Such events cause exceptional and/or extensive damage to assets, they take significantly longer than usual to restore, and they affect a substantial number of customers.

MEDs Experienced by the city of London:

Since 2010, the city of London has experienced several Major Event Days that caused thousands of customers to be without power for prolonged durations. For example, in 2011, a severe thunderstorm and high winds resulted in 8 outages related to tree contacts. Tree Contacts inflicted damage on multiple overhead circuits resulting in extended outages affecting several thousand customers. Also, in 2013, another severe thunderstorm combined with high winds rolled through the city in the late afternoon of September 11th resulting in a large number and duration of interruptions as a result of trees coming down and peak winds of 85 km/h. In total, that single day registered over 1.5 million customer-minutes and caused power interruptions to over 22,500 customers. Moreover, in 2017, on March 8th, the city of London experienced an extreme wind event resulting in a high frequency and duration of interruptions. In total, this single day registered 2.18 million customer-minutes of interruption and caused power interruptions to over 18,800 customers.

It is noted that although a utility's reliability may appear to be performing well, a significant weather event such as a wind storm or ice storm can quickly expose the areas that require vegetation management.

5.0 OPERATIONAL RISKS

5.1 Severe Weather

Severe weather is one of the most serious risks to the reliability of London Hydro's overhead distribution grid. The main weather events that present the greatest risk to the overhead distribution plant related to trees are: ice/snow storms, wind storms and lightning storms.

It has been observed that the occurrence of severe weather events and their associated damage is increasing.[7] This is reflected in the value of insurance claims resulting from catastrophic weather related occurences in Canada. London Hydro's overhead system can be impacted by these types of catastrophic weather events.

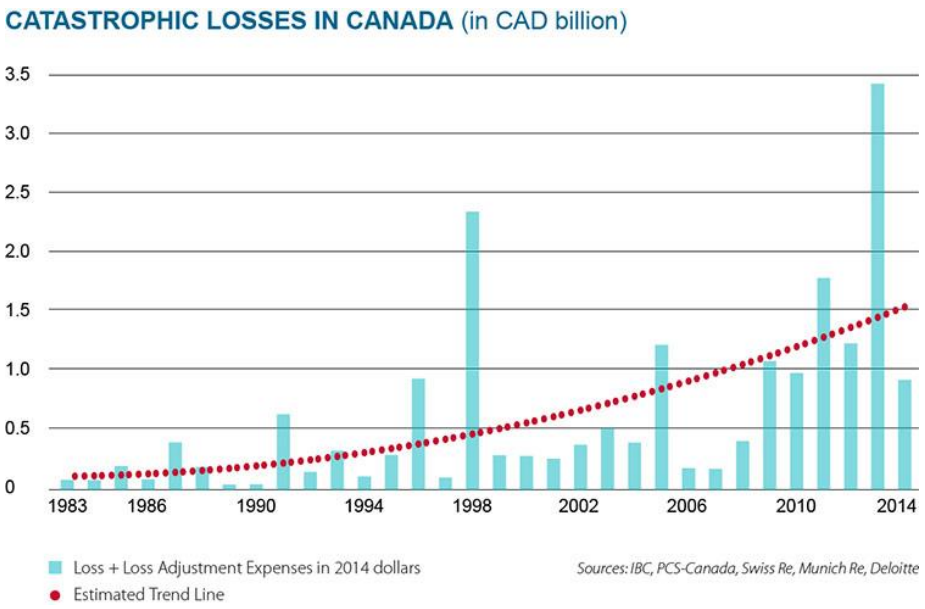


Figure 10 - Catastrophic Losses in Canada[8]

5.1.1 Ice/Snow Storms

An ice storm is an example of a major severe weather event that can cause vegetation-related power outages. Ice accumulation on tree limbs adds extra load which can lead to them breaking and falling on overhead distribution lines. Although historical trends

[7] Government of Canada – "Facts on Climate Change" - https://www.canada.ca/en/environment-climate-change/services/climate-change/facts.html

[8] Insurance is Evolving – "Climate – The Weather is Changing", http://www.insuranceisevolving.com/en/climate-ontario.html

show that most ice storms pass to the south of London (as shown in Figure 11), this could change. In 2004, Environment Canada stated that if tracks shifted northward under the influence of climate change, the frequency of ice storms in southern Ontario could increase. If ice storms in London increase then so will the occurrence of tree contact outages in London Hydro's distribution grid, especially since the majority of trees near overhead lines are Norway maples which are structurally weak.

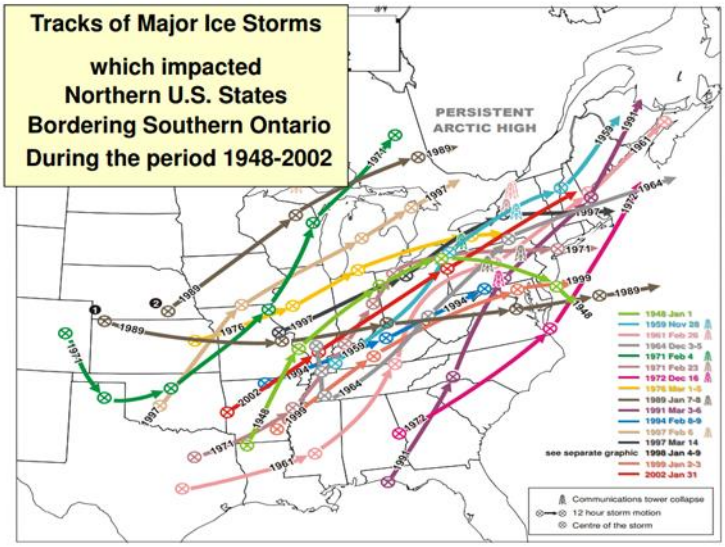


Figure 11 - Tracks of Major Ice Storms[9]

The Toronto ice storm of December 2013 and the Quebec ice storm of 1998 highlighted just how vulnerable overhead distribution systems are to ice accumulation. Toronto Hydro engaged Aecom to study the risks associated with climate change in 2015.[10] A portion of the report focused on freezing rain and ice storms. The report identified there was a high risk for 15 mm and 25 mm of freezing rain on overhead feeder systems based on probability of occurrence. The preliminary forensic analysis of outages from

[9] Environment Canada – "Severe Ice Storm Risks in Ontario" - https://www.iclr.org/images/2004_Nov_ICLR_Final_ICE_STORMS.pdf

[10] "Toronto Hydro-Electric System Limited Climate Change Vulnerability Assessment", AECOM, June 2015

the freezing rain in 2013 indicates that 15+ mm of freezing rain is a trigger for the breaking of tree branches and limbs. This quantity of freezing rain resulted in widespread outages in Toronto due to tree contacts. The next threshold is 25 mm of freezing rain, which is the CSA design requirement for overhead electrical systems. Theoretically, overhead feeder systems are supposed to withstand 25 mm of freezing rain (12.5 mm of radial ice). However, such quantities of freezing rain and ice on overhead infrastructure bring them to their structural design limits, which are further exacerbated by breaking tree branches and wind.

The report stated that the current annual probability of occurrence of 15 mm of freezing rain is 0.11 days / year (1 in a 9 year return period), and is projected to increase to 0.16 days / year (1 in a 6 year return period) by the 2050's. The current annual probability of 25 mm of freezing rain is 0.06 days / year (1 in a 17 year return period), and is projected to increase to 0.09 days per / year (1 in an 11 year return period) by the 2050's. As the projected trend for 15 mm and 25 mm freezing rain events is increasing in the future, the interaction of these two climate parameters with overhead feeder systems are at risk.

The previously mentioned report released by Toronto Hydro in 2015 stated that "Toronto Hydro ….is planning to increase its vegetation management activities. This study supports the need for increased tree trimming practices around overhead power lines and use of tree proof conductors in areas where outages due to tree contacts have been frequent."

The direct cost to Toronto Hydro for the 2013 ice storm is reported as being $14 million. There were also questions asked about the LDCs preparedness for the ice storm and its ability to respond. The city of Toronto is reported as requesting $106 million to cover its costs, of which $75 million is clean up and repairing the tree canopy.

According to the Insurance Bureau of Canada[11] "With warming winters and increasing precipitation, eastern Canada, including Ontario, is also projected to have more freezing rain events in the future than was historically experienced during the period 1958 to 2007. The increase in the number of freezing rain events could be progressively greater from south to northeast across eastern Canada. For example, the percentage increase for severe freezing rain events (lasting six (6) hours or longer) is projected to be about 35% in southwestern Ontario and around the lower lakes...". This projection simply highlights the continued need for London Hydro to remain diligent on its tree trimming efforts.

The map in Figure 12[12] illustrates that the city of London historically has experienced a higher than average number of freezing rain hours per year.

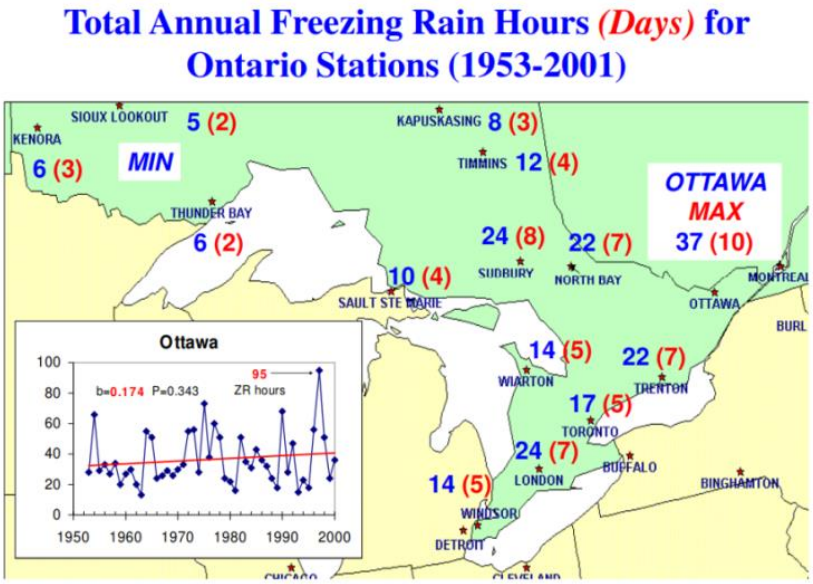


Figure 12 - Historical number of Freezing Rain Hours for Ontario

[11] "Telling the Weather Story, Insurance Bureau of Canada", Prepared by the Institute for Catastrophic Loss Reduction, June 2012.

[12] Environment Canada – "Severe Ice Storm Risks in Ontario" - https://www.iclr.org/images/2004_Nov_ICLR_Final_ICE_STORMS.pdf

5.1.2 Early Snowfall

An early snowfall while the leaves are still on the trees is a concern because the extra surface area of the leaves allows for more loading. The trees may then break and bring down any overhead lines nearby causing an outage. Average annual snowfall in London proves to be higher than other regions in Southwestern Ontario (refer to Table 5) and therefore presents a significant risk for local vegetation and therefore tree contact outages. It should also be noted that the majority of trees near London Hydro's overhead lines are Norway maples which have a longer growing season and hold their leaves longer than other species in autumn, thereby increasing the overall risk.

Southwestern Ontario Average Snowfall Amounts

Place	Centi-metres
Chatham-Kent	79.2
Guelph	155.1
London	194.3
Owen Sound	330.4
Point Pelee National Park	103.8
Sarnia	112.0
Waterloo	159.7
Windsor	129.3

Table 5 - Average Annual Snowfall for Southwestern Cities[13]

[13] Current Results Weather and Science Facts - https://www.currentresults.com/Weather/Canada/Ontario/snowfall-annual-average.php#c

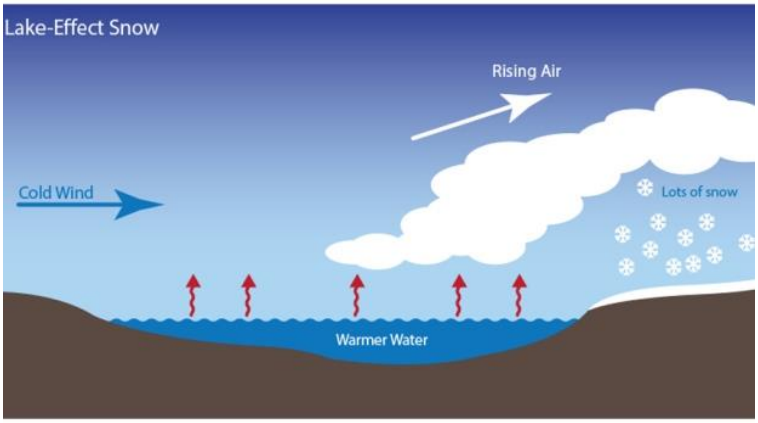


Figure 13 - Lake-Effect Snow

London Ontario is surrounded by water on three sides so many parts of the region get a large part of their winter snow from lake-effect snow. It is produced during cooler atmospheric conditions when a cold air mass moves across warmer lakes, warming the lower layer of air which picks up water vapor from the lake, rises up through the colder air above, freezes and is deposited on the downwind shores as snow. This is a major factor contributing to London's relative heavy snowfall which presents a risk to damage of tree branches.

5.1.3 High Winds

A review of Environment Canada's historical wind data shows that there has been no significant increase in hourly wind speeds or in three to five second gusts since 1953. The IPCC has also indicated that there are no specific indications that wind speeds will increase over historical values.

Tornado

The map provided in Figure 14 shows that London Ontario is positioned in the center of tornado alley (a high concentration of F4 tornadoes). In the event of a storm, London could experience winds speeds of up to 418 kph.

The Fujita scale for tornado speeds is as follows, F0 (64 - 116 kph), F1 (117 – 180 kph), F2 (181-253 kph), F3 (254-331 kph), F4 (332 -418 kph).

Looking closely at the trees near London Hydro's overhead circuits, it was observed that the majority (>25%) of the trees near our overhead wires are Norway maple. These trees are known to have weak wood and shallow roots making them structurally unsound. A Tornado in London is a low probability but high in impact event.

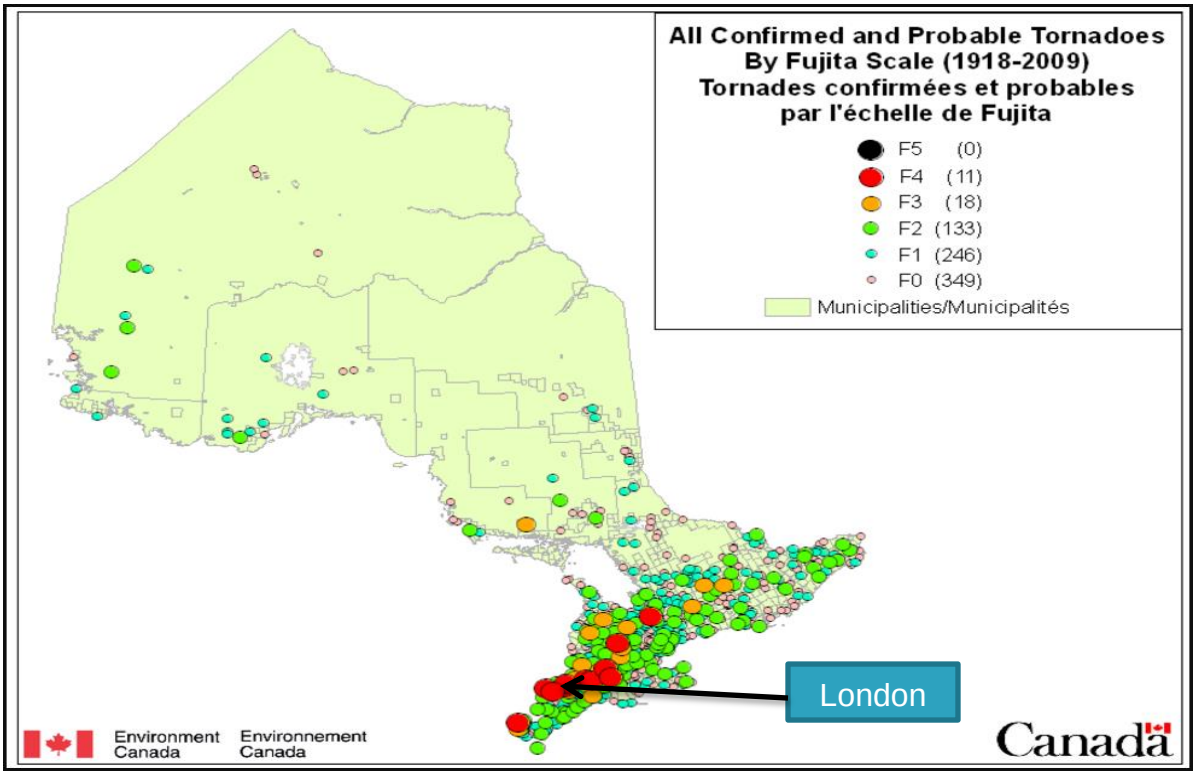


Figure 14 - All Confirmed and Probable Tornadoes in Ontario (1918 to 2009)[14]

[14] Ontario Tornado Data - Association for Canadian Educational Resources - http://www.acer-acre.ca/publications-and-research/research/tornado

5.1.4 Thunderstorms/Lightning

London is affected by thunderstorms more than other Ontario cities (as shown in Table 6) due to hot and humid summer weather, as well as the convergence of breezes originating from Lake Huron and Lake Erie. The rapid upward movement of warm, moist air forms clouds which produce thunder and lightning. Thunderstorms can cause severe damage to trees including limb breakage and splitting of trunks which can then lead to outages when they fall on distribution lines. Species of trees most commonly struck by lightning include mature, tall trees such as Maples. These species make up the majority of large trees located near London Hydro's overhead lines and therefore present a risk for lightning damage resulting in tree outages.

Average number of days annually with thunderstorms (1971 – 2000)	
City	**Days a Year**
Windsor, Ontario	33.2
London, Ontario	30.9
Kitchener - Waterloo, Ontario	29.3
Brantford, Ontario	29.3
Guelph, Ontario	29.2
Oshawa, Ontario	29.1
Toronto, Ontario	28.0
Hamilton, Ontario	27.7
Calgary, Alberta	27.4
Barrie, Ontario	27.0

Table 6 - Average Number of Days per Year with Thunderstorms[15]

[15] Average Number of Days per Year with Thunderstorms – Current Results Weather and Science Facts - https://www.currentresults.com/Weather-Extremes/Canada/stormiest-cities.php

5.1.5 Severe Weather Summary

The following Table is a summary of the weather elements which are projected to be impacted by climate change.

Climatic Change	Observed Change	Projected Change
Temperature	Canada has seen an increase in annual temperature of 1.3°C during the last half of the last sixty years (1948-2006).[16]	The annual average temperature of Great Lakes Basin will increase 2.3 to 7.9^{o}C in the 2011—2100 period when compared to 1971-2000 baseline (varying due to different greenhouse gas concentrations).[17]
Rainfall	A 12% increase occurred in the last 50 years.[18]	Annual precipitation is projected to increase by 72.5 to 123 mm in the 2011—2100 period for Great Lakes Basin when compared to 1971-2000 baseline.[17]

[16] Warren, F.J. and Egginton, P.A. (2008). Background Information; in From Impacts to Adaptation: Canada in a Changing Climate, 2007, edited by D.S. Lemmen, F.J. Warren, J. Lacroix and E.Bush; Government of Canada, Ottawa, ON, p.27-56

[17] Climate change projections for Ontario: An updated synthesis for policymakers and planners (2015), pg. 21, Jenni McDermid, Shannon Fera and Adam Hogg

[18] http://www.oakville.ca/assets/general%20-%20environment/projectedobserved.pdf

High Wind	From 1980-2009 an average 12 tornadoes are reported to Environment Canada each year in Ontario and 62 nationally.[19]	Part of southern Ontario between the Great Lakes from roughly Windsor to Barrie is one of the most active tornado corridors in Canada. *Probability of an F2 – F5 tornado is estimated to exceed $10^{-5}/km^2/year$.*[19]
Thunderstorms	30 or more thunderstorms occurred each year from 1971 to 2000.[18]	Warmer temperatures and a rise in atmospheric water vapour will cause an increase in thunderstorm activity.[18]
Early Snowfall	Average annual snowfall in London was 194 cm between 1981-2010, second highest in southwestern Ontario.[20]	While snowfall days are generally expected to decrease with a warming climate, they will continue to occur annually through to the 2050's.[21]
Freezing Rain	22 Ontario ice storms during 1948-2002 period.[22]	The percentage increase for severe freezing rain events is projected to be about 35% in southwestern Ontario and around the lower Great Lakes.[11]

Table 7 - Summary of Weather Elements Impacted by Climate Change

[19] https://www.theweathernetwork.com/news/articles/tornadoes-in-canada-everything-you-need-to-know/25876/1/1

[20] https://www.currentresults.com/Weather/Canada/Ontario/snowfall-annual-average.php#c

[21] http://www.cleanairpartnership.org/wp-content/uploads/2016/06/THESL-Climate-Change-Vulnerability-Assessment.pdf

[22] London Hydro: TECHN ICAL RISK ASSESSMENT-Overhead and Underground Strategy (2014) Rowan Jones

5.2 Common Pests and Diseases in Southwestern Ontario

As shown in the chart below there are many common pathogens which exist in Southwestern Ontario that can harm the structural integrity of the trees found in London. Certain insects can create holes in their trunks and branches and some fungi can harm their foliage. These pathogens not only weaken these trees but also leave them vulnerable to other invaders such as bacterial agents causing serious damage and even death. These physically weakened trees are then more prone to limb breakage thereby causing tree-contact outages when they fall on distribution lines.

Pest/Disease	Description	Symptoms	Tree Species Affected
Emerald Ash Borer	Beetle from Asia that attacks and kills by feeding off inner bark and disrupting flow of nutrients and water.	Cracking bark, small holes, loss of density	All species of Ash
Dutch Elm Disease	Fungal pathogen that attacks and blocks water-conducting systems	Shriveling leaves which turn yellow and wilt	All Elm except Siberian, Chinese, Japanese
Asian Long-horned Beetle	Larvae tunnel through leading to fungal growth, weakness, death	>20mm holes	Birch, elm, hackberry, maple, polar, aspen, willow
Beech Bark Disease	Scale infestation and fungal invasion kills bark	Brown slime from dead bark, weak leaves	All beech
European Gypsy Moth	Larvae eat leaves and weaken trees for other disease and	Lost leaves	Oak, birch, poplar, willow, maple,
Tar Spot	Fungal pathogen that attacks leaves	Raised black spots	Red, Norway and Silver Maple, willow, tulip
Magnolia Scale	Large insects kill branches by feeding on sap through vascular system	Sticky dew, stunted growth, branch decline	Star and Saucer Magnolia and tulip
Tent Caterpillars	Larvae of several moth species work in large groups to defoliate trees	Webs/tents	Cherry, apple, maple, aspen, oak, hawthorn, crab apple

Table 8 - Tree Pest/Disease for Ontario Trees[23]

[23] How To Identify Common Tree Diseases in Southwestern Ontario – Olympic - http://olympictreecare.ca/how-to-identify-common-tree-diseases-southwestern-ontario/

6.0 OPERATIONAL RISK IDENTIFIED

6.1 Tree Planting

The most effective manner to prevent new occurrences of tree related outages is through elimination of the root cause of having large or medium sized trees too close to high voltage polelines. The Electrical Safety Authority of Ontario has issued a guideline that outlines restrictions on planting trees in or around powerlines. This guideline is targeted on ensuring worker and public safety with a focus on preventing tree related contacts with powerlines. It specifies the distances that various sizes of tree must be away from powerlines in order to ensure safe and reliable operation of the grid. This guideline is provided in Appendix A. London Hydro has recently been meeting with the City of London Trees and Forestry Advisory Committee to insist that this guideline is considered in the planting of all new trees.

6.2 Tree Trimming

6.2.1 Tree Trimming Inspection – Existing Method

London Hydro presently uses hard copy grid maps to inspect the overhead system. The supervisor highlights portions of circuits that require trimming. The highlighted maps are then assigned to forestry crews. It has been observed that the manual nature of the inspection process is susceptible to error due to the magnitude of the locations being inspected which increases the chance of missing areas. The method of gathering data must be reviewed.

After completing the work, the crews then record the work that is complete on hard copy forms (see Appendix B) which are stored in the forestry department. These forms record information such as address/location of the trees that were trimmed and whether they were encroaching on high voltage wires, low voltage wires or both. Unfortunately, this information is not in a searchable format.

6.2.2 Tree Trimming Standards Practices

Once the tree is in place there is no choice but to trim it in accordance with best practices. The following is a guideline that provides direction in accordance with ANSI standards. London Hydro has adapted pruning practices consistent with ANSI A300 and Dr. Alex Shigo's field pocket guide entitled "Pruning Trees near Electric Utility Lines". Copies of London Hydro trimming guideines and the above two documents are included in Appendix C and Appendix D.

6.2.3 Tree Trimming Clearances

London Hydro trims all trees and brush to meet the following clearances:

Growth Rate	Clearance of Branch Tips from Primary voltage Lines after Trimming		
	Top	Side	Overhang
Extra Fast	3.5 metres	2.5 metres	3.0 metres
Fast	3.0 metres	2.5 metres	3.0 metres
Medium	2.5 metres	2.5 metres	3.0 metres
Slow	2.0 metres	2.5 metres	2.0 metres

Table 9 - Required Trimming Clearances

Clearances for trunks and large limbs may need to be less than shown above to avoid tree mutilation.

London Hydro does not trim trees to provide clearances around secondary service drops. London Hydro only trims around the main secondary bus.

6.2.4 Existing Tree Trimming Cycle

Presently, London Hydro has divided the city into three geographic areas as depicted in Figure 15. Each area is intended to be trimmed on a three year cycle. It has been observed that the number of trees that require trimming in each area is not equal. This can often result in crews working in one area longer than in other areas in order to complete the required trimming.

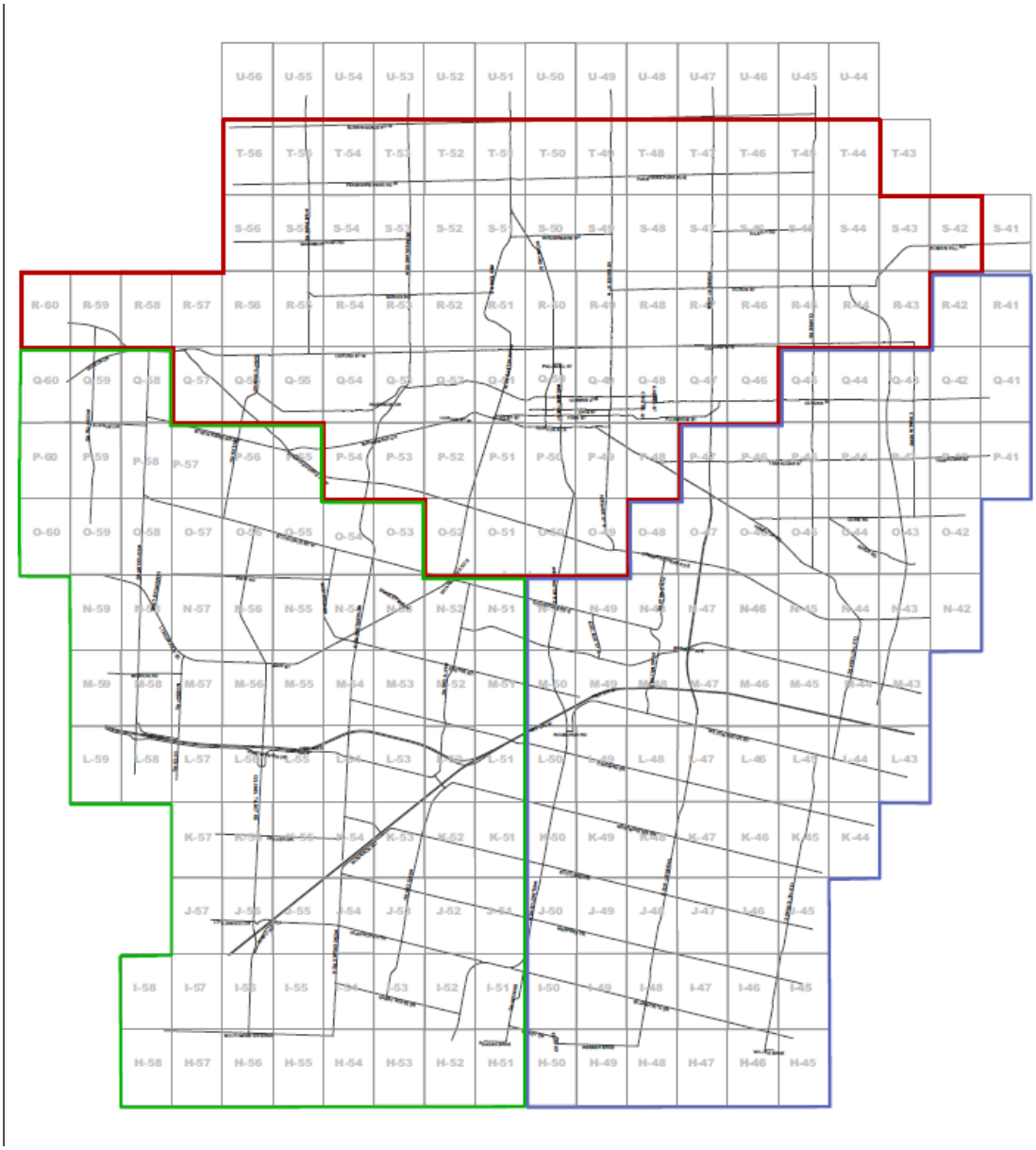


Figure 15 - Tree Trimming Areas

In 2014, London Hydro changed from a five year trimming cycle to the current three year trimming cycle. This was done in an effort to mitigate the risk of tree related outages through more frequent visits. It was also noted that a five year trimming cycle was longer than the cycle used by other LDCs.

A poll of trimming cycles for other LDCs was conducted. It was noted that many LDCs vary the trimming cycle depending on the area of the city and the rate of growth of the trees. The results of the survey are provided below.

LDC	Trimming Cycle (Years)	Reason
Hydro Ottawa	2	Downtown area
	3	Fixed
Enersource Hydro	3	Fast growing trees
	4	Slow growing trees
Power Stream	3	Urban areas
	2	Specific Spots (old trees)
	4	Rural areas
Toronto Hydro	3	Density
	4	Fast growing trees
	5	Slow growing trees
Newmarket-Tay Hydro	3	Fixed
BC Hydro	4	Fixed
Hydro One	6	Fixed + On spot
Saint John Energy	5	Fixed
Horizon	3	Fixed

Table 10 - Trimming Cycles used by Other LDCs

At the time of the transition from 5 to 3 years, the resources allocated to trimming did not increase. It has been observed that existing resources have been unable to adequately trim the entire area which they are assigned for each year. Some areas are beginning to become overgrown and encroach on the conductors. Some examples of these areas include: The Parkway, Frontenac Road, Kingsway Ave, Harrison Ave, Devonshire Ave and others. These outstanding areas need to be addressed.

6.3 Engineered Construction – Spaced Aerial Wire

As London Hydro continues to convert its lower voltage distribution systems to 27.6 kV it has also employed the use of insulated spaced aerial wire in an attempt to mitigate the risk of brush contacts with branches. London Hydro has been a leader in the use of this type of wire in Ontario. It has proven to be effective on limiting outages, but does decrease operating flexibility due to the close proximity of the grounded messenger cable to the energized 27.6 kV insulated wires. While insulated conductor improves outage statistics by preventing contacts caused by small branches during wind storms it may not be able to prevent outages caused by large branches that come down during severe events such as ice or early snow storms.

7.0 CONCLUSIONS

Severe weather events are projected to increase due to climate change. This presents a continued risk to overhead distribution grids. London Hydro must remain diligent on its vegetation management practices in an effort to mitigate the impact of these severe weather events.

Large trees are being planted too close to London Hydro's high voltage circuits. This is negatively impacting the safety and reliability of London Hydro's grid. The City of London's tree approval process does not have specific guidelines on planting trees near overhead lines. This can be rectified by implementing effective tree planting guidelines.

It is not possible to effectively track trimming details using the manual process for inspecting tree trimming areas. This process makes it difficult to verify that all areas are identified and have been trimmed sufficiently. This has led to some areas requiring additional trimming in the short term.

The trimming areas are not presently optimized based on tree density, circuit density, number of tree related outages and annual required work effort.

8.0 RECOMMENDATIONS FOR IMPROVEMENT ON EXISTING PRACTICES

8.1 Planting Guidelines

Continue to work with the City of London Trees and Forestry Advisory Committee (TFAC) with a focus on having the ESA's provincial planting guide incorporated into the City's tree planting approval process.

8.2 Implement GIS Based Inspection Tool – MobileLink

London Hydro has an extensive Geographic Information System (GIS) model which enables an effective inspection tool through the use of an add-on module called Mobile Link (by Hexagon/Intergraph) which can be deployed on a tablet for mobile computing. It has been observed that the tree information supplied by the City of London is incomplete and in some cases it is inaccurate. By implementing Mobile Link for Line/Tree inspections and the recording of completed work, London Hydro will be better positioned to identify locations that require increased attention. This will facilitate further optimization of resources through accurate reporting.

8.3 Modification of Trimming Areas and Cycles

The GIS system was used to spatially analyze the tree related outages and their relationship to the various tree and circuit densities throughout the city. It was observed

that London Hydro would be better positioned to proactively address tree related outages if it realigned its trim areas and cycles.

Figure 16 illustrates an adjusted trimming schedule that would allow London Hydro to focus its resources in the urban high risk areas. Areas 1, 2 and 3 have high overhead line density, high large tree density and a higher resultant occurrence of tree related outages. The remaining outlying areas 4, 5, 6 and 7 have fewer tree related outages due to lower line density and lower tree density. By maintaining a trimming cycle of 3 years in dense urban areas and increasing the trimming cycle to four years in outlying areas of 4, 5, 6 and 7 it is anticipated that the reliability will improve. This schedule is intended to allow London Hydro to fully complete the required trimming in each given year due to an even amount of work in each area. In order to proactively address the areas which have higher than desired growth it is recommended that external forestry services be engaged, in the short term to address these areas.

The following chart illustrates how the trimming cycle would work.

Area			
Year 1	Year 2	Year 3	Year 4
1, 4	2, 5	3, 6	1, 7
2, 4	3, 5	1, 6	2, 7
3, 4	1, 5	2, 6	3, 7

Table 11 - Illustrative Trimming Rotation

It acknowledged that individual pockets of high growth vegetation will need to be monitored through increased inspection and may be trimmed on a more frequent cycle than indicated in Figure 16.

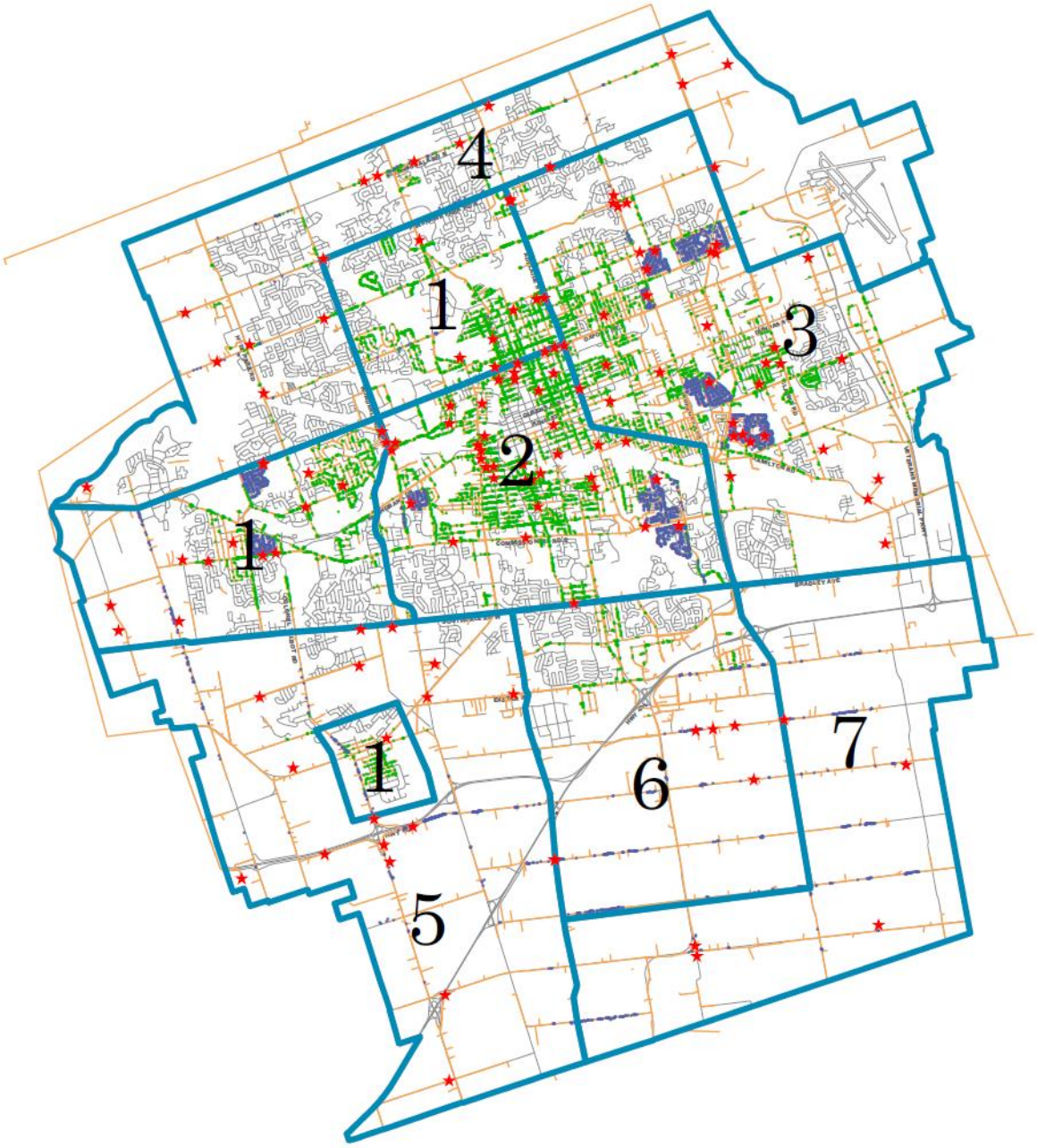


Figure 16 - Proposed Trim Areas

Table 12 below considers the large trees that present a risk to London Hydro overhead distribution circuits. It then provides information that was used to balance the trimming areas. Factors such as: number of outages per area, number of trees and density of Line were used to select the area boundaries.

Zone	1	2	3	4	5	6	7
Area (km2)	56.2	40.6	72.7	75	75.3	45.2	58
Outages	24	38	37	17	18	4	5
Outages/km2	0.43	0.94	0.51	0.23	0.24	0.09	0.09
Trees	4621	5159	4741	494	331	724	342
Length of OH Line (km)	249.1	258.6	353.7	136.7	125.1	136	64.4
Km of OH Line/Area	4.43	6.37	4.87	1.82	1.66	3.01	1.11
Trees/Km of Line	18.55	19.95	13.40	3.61	2.65	5.32	5.31

Table 12 - Proposed Trim Area Statistics

**Trees greater than 15 cm in diameter and located within 7m of OH Lines*

The goal was to balance the number of trees that are near London Hydro powerlines in areas 1 to 3 and areas 4 to 7 in order to create balanced workloads from year to year. It is noted that the quantities of trees provided in above table are based on the information available at the time of this report. The data will improve in accuracy as future inspections are completed and recorded.

8.4 Adjustment to Operating and Maintenance Budget

The existing tree trimming resources have been unable to complete all of the required tree trimming on a 3 year cycle. This has left some areas of the city with a back log of trimming which needs to be addressed. In order to address the areas that have higher than desired growth it is recommended that London Hydro increase the annual budget from the existing level of approximately $910,000 by an additional $175,000 in contract services. London Hydro's present budget for contract forestry services is approximately $75,000. It is estimated that this will provide for a two person forestry crew for an additional 30 weeks. The level of progress will continue to be monitored and future budgets will be adjusted accordingly.

Appendices

APPENDIX A – ESA – PLANTING UNDER OR AROUND POWERLINES & ELECTRICAL EQUIPMENT

Planting Under or Around Powerlines & Electrical Equipment

Electrical Safety Authority

TABLE OF CONTENTS

LEGAL DISCLAIMER

This document contains AWARENESS ONLY material to assist members of the Public and Industry Professionals to select the correct tree and location to avoid conflicts with the overhead and/or underground powerlines.

This document does not have the force of the law. Where there is a conflict between this document and any Municipal, Regional and/or Township by-laws, legislation or regulation which may apply, the relevant law prevails.

Contact the local Municipality, Regional and/or Township offices to determine if permits are required to plant trees.

Contact your *Local Distribution Company* (*LDC)* to determine their requirements to plant trees and/or shrubs under or around powerlines and electrical equipment.

Introduction

The "Planting Under or Around Powerlines and Electrical Equipment" Guideline responds to the number of reports of powerline contact incidents associated with the trimming or removal of trees, shrubs and vines. This is one of two guidelines produced by the Electrical Safety Authority with the support of Ontario's *Local Distribution Companies (LDC)* and Corban and Goode Landscape Architecture and Urbanism to reduce electrical contact incidents and other electrical hazards when:

- ☐ Planting Under or Around Powerlines and Electrical Equipment
- ☐ Trimming Trees Around Powerlines

These guidelines provides information and insights to support landscape and arborist trades workers, maintenance workers, and homeowners. The guidelines share important information on potential electrical risks, how to avoid these risks, provincial standards, and best practices that, if followed, can decrease electrical incidents.

This guideline includes sections on:

- ☐ Electrical Issues and Hazards
- ☐ Avoiding Potential Hazards
  - Planning
  - Planting

A companion guideline has been created that focuses on avoiding electrical issues and hazards when trimming or removing of trees and/or shrubs under or around overhead powerlines.

We would like to acknowledge the insights and contributions of Corban and Goode Landscape Architecture and Urbanism. Through sharing their insights we have worked to produce easy to use Guidelines for audiences engaging in landscape planning.

ELECTRICAL ISSUES AND HAZARDS - PLANTING UNDER OR AROUND POWERLINES & ELECTRICAL EQUIPMENT

Individuals engaged in planning and/or planting under or around powerlines and electrical equipment, such as Landscape Architects, Landscapers, Municipalities or the public need to be aware of the electrical hazards associated with planting in the vicinity of powerlines or electrical equipment.

TREES

Some species grow at a rapid rate and at a height which directly interferes with overhead powerlines. Planting the wrong tree under or around overhead powerlines create hazards to members of the public and workers. These include:

- **Potential Hazard or Electrocution from:**
  - **direct contact** - when playing in or working around trees where powerlines are hidden by foliage.
  - **energized objects** - branches and limbs caught in the powerlines may unexpectedly become conductive.
  - **contact with powerlines** - during tree maintenance, trimming or removal, including direct contact by unqualified individuals and contact through tree trimming tools.
  - **downed powerlines –** when energized powerlines are pulled down to the ground by broken branches and limbs.
- **Potential Fires** - branches and limbs in close proximity to powerlines can lead to electrical arcing that can create fires.
- **Power interruptions –** resulting when branches and limbs that break damaging powerlines during storms or from disease.

When selecting trees for planting, it is important to consider location of overhead powerlines, the growth rate for specific varieties based on the environment and placement.

Qualified ***Utility arborists*** should do maintenance on trees near overhead powerlines. Any other Landscaper, Arborist, or homeowner should contact the *LDC* to arrange for power to be disconnected prior to starting work.

SHRUBS

Planting shrubs and other plant material near electrical equipment can:

- cause an obstruction for powerline maintenance workers;
- disguise potential hazards;
- cause damage to underground powerlines;
- contact energized components through the roots possibly becoming energized.

Obstruction around a transformer

VINES

Planting vines at the base of a powerline pole or guy wire will eventually creep and come into contact with energized overhead powerlines or electrical equipment. Vines in contact with powerlines can become energized and be a hazard to the public, cause power interruptions, or fires.

Pole growth contacting electrical equipment & powerlines

Guy-wire growth contacting electrical equipment & powerlines

GETTING STARTED - PLANNING & PLANTING TO AVOID POTENTIAL ELECTRICAL HAZARDS

Trees, shrubs and plant materials help homeowners and business owners create a property that they can enjoy and benefit from. Before starting, it is important to locate overhead and underground powerlines, and to understand the impact of landscape plans on the electrical infrastructure and electrical equipment. Up-front consideration of electrical powerlines and equipment can avoid potential electrical hazards that can occur from contact between trees, shrubs and roots, and electrical powerlines and equipment.

BEFORE YOU START ANY LANDSCAPE PLANNING, CHECK FOR:

- ☑ MUNICIPAL, REGIONAL OR TOWNSHIP BY-LAWS that specify preferred tree species and locations for planting.
- ☑ *LDC* REQUIREMENTS regarding planting under or around the overhead powerlines or around underground equipment including underground powerlines.
- ☑ *EASEMENTS* THAT MAY BE ON THE PROPERTY. *Easements* may contain underground and/or overhead powerlines and electrical equipment which allows the *LDC* the legal right to access properties to install and maintain electrical services to the property and/or neighbourhood. A land title search will identify if there are existing *easements*.

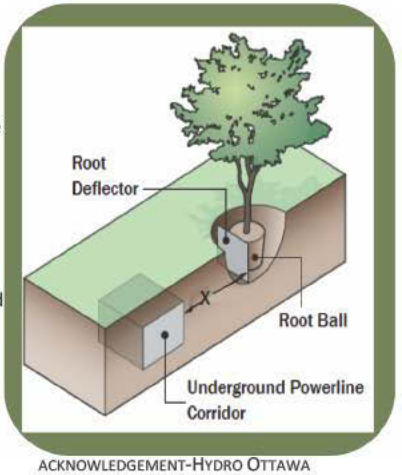
UNDERGROUND POWERLINES

- ☑ Underground powerlines exist in rural, urban and industrial environments and can be compromised when excavating if these powerlines have not been located prior to excavating. The *LDC* can provide a '*locate*' to identify the location of **their** powerline assets. If powerlines are privately owned, the property owner, and/or excavator or landscaper, will need to make special arrangements to locate underground powerlines. Also, contact other utilities, such as natural gas, water, cable, and telephone, to ensure you are aware of their underground equipment and clearance requirements.

  NOTE: driving stakes in the ground for tree support also requires *locates* also to be done.

  For locate request, call ahead and allow a minimum of 2 weeks to receive all *locates*. All *locates* must be received prior to excavation.

- Powerlines may be directly buried, or in conduit, and can be located at different depths depending on grade changes that may have occurred. When planting in the vicinity of underground powerlines, the minimum clearance required from the edge of the root ball to the edge of the underground powerline corridor is 1.0m (3 ft). The *LDC* can provide their clearance requirements from the underground powerlines to the root ball. If the determined distance cannot be achieved, the *LDC* may require the installation of a *root deflector* against the root ball.



ACKNOWLEDGEMENT-HYDRO OTTAWA

ELECTRICAL EQUIPMENT - ABOVE GROUND MOUNTED OR UNDERGROUND CHAMBER

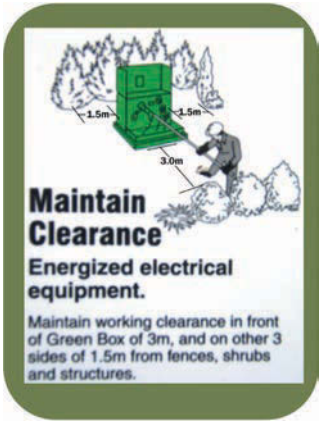
Depending on the *LDC,* electrical equipment such as a transformer or switchgear, may be above ground mounted on a concrete pad foundation (*pad mounted*) or in an underground chamber. *Pad mounted* electrical equipment, are typically green in color. Obstructions such as structures, fences, trees, shrubs or other vegetation should **not** be placed near the equipment. Clearance is required around the *pad mounted equipment* and underground cables for your safety and the safety of Utility workers who require access at all times.

Pad mounted transformer

Pad mounted switchgear

Underground Chamber

- Typically the *LDC* requires a minimum of 3.0 m (10 ft) in front of the pad mounted transformer door(s) and 1.5 m (4.9 ft) around the sides and back. The door(s) can be identified by the padlock. Pad mounted switchgears however requires a minimum of 3.0m (10 ft) in the front and at the back doors of the unit and 1.5 m (4.9 ft) at the sides.
- You should also be aware of the presence of a buried 'ground loop' that is installed approximately 1.0 m (3ft) around the perimeter of the foundation and the minimum of 2 ground rods located at the outside corners of this 'ground loop'. The 'ground loop' protects the public and workers from potential hazards associated with ***step and touch potential*** that can exist from fault conditions.



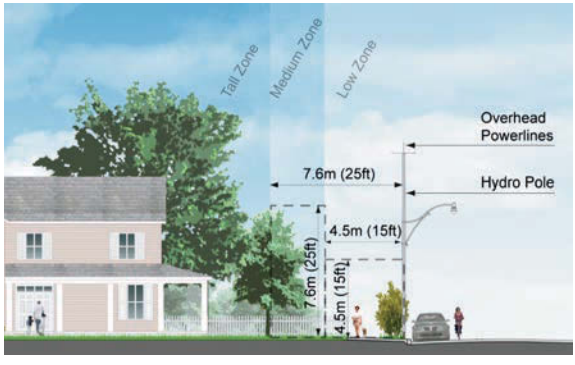
OVERHEAD POWERLINES

- ☑ Considering overhead powerlines is critical in the planning and planting of large trees and shrubs. The *LDC* can assist in identifying the type of powerline:
  - Primary distribution and transmission powerlines – these are typically non-insulated **bare** conductors and carry high voltage power.
  - Secondary distribution powerlines – these may be insulated and carry low voltage power.

- ☑ Planting under or around powerlines requires caution to ensure:
  - Delivery of Plant Materials - trees that are being planted should not be delivered under or around the powerlines. Delivery equipment such as a boom truck can come into contact with the overhead wires. The same for digging with equipment such as a high hoe, the equipment can also come into contact with the overhead wires.
  - Trees do not come in contact with overhead powerlines when unloading.

- ☑ A careful review of the tree planting zone in which your landscape project is in will assist in determining the type of trees that can be considered. Tree planting is categorized in 3 different zones; Low, Medium and Tall. Factoring these zones into landscape plans will ensure that the tree at full maturity doesn't come into contact with the overhead powerlines, and will not compromise powerlines if branches and limbs are broken during extreme weather.

☑ To ensure accuracy determining the height and width at maturity, it is important to consider the *Plant Hardiness Index* accompanied with the *Plant Hardiness Geographical Map (*Appendix A). This will confirm where you can plant the specie of tree in proximity to overhead powerlines.

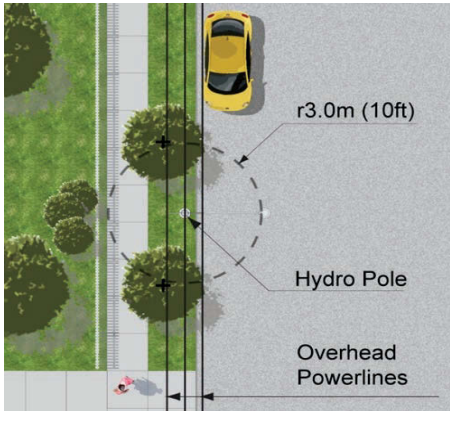


Low Zone - is the area under the power lines and extends to 4.5 m (15 ft) on either side. Trees and/or shrubs planted in this zone should have a maximum mature height and spread of 4.5 m (15 ft).

Medium Zone- extends from the edge of the outer edge of the Low Zone to a distance of 7.6 m (25 ft) on either side of the power line. The maximum mature height and spread of trees planted in this zone should be 7.6 m (25 ft).

Tall Zone – extends from the outer edge of the Medium Zone extending greater than 7.6 m (25 ft) from the power lines. Any strong and healthy tree may be planted in this zone.

Base Zone near the Hydro Pole - Trees and/or shrubs should not be placed closer than 3.0 m (10 ft) from the base of a hydro pole.



APPENDIX A: PLANT HARDINESS INDEX

Geographical Area														LOW ZONE – SMALL TREES		
														Latin Name **Common Name**	**SPREAD**	**HEIGHT**
0a	*0b*	*1a*	*1b*	*2a*	*2b*	*3a*	*3b*	*4a*	*4b*	*5a*	*5b*	*6a*	*6b*		*(m)*	*(m)*
				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	*Acer ginnala*, Amur Maple	*4.5*	*4.5*
								✓	✓	✓	✓	✓	✓	*Amelanchier laevis* Allegheny Serviceberry, Tree Form	*4.0*	*4.5*
								✓	✓	✓	✓	✓	✓	*Cornus kousa*, Chinese Flowering Dogwood Tree Form	*3.5*	*4.5*
										✓	✓	✓	✓	*Cornus florida 'Rubra'*, Pink Flowering Dogwood Tree Form	*4.5*	*4.5*
								✓	✓	✓	✓	✓	✓	*Magnolia Stellata*, Star Magnolia Tree Form	*4.0*	*3.0*
								✓	✓	✓	✓	✓	✓	*Malus cultivars*, Crab Apple varieties	*2.5 - 4.0*	*4.5*
				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	*Prunus virginiana 'Schubert'*, Schubert Chokecherry Tree Form	*4.0*	*4.5*

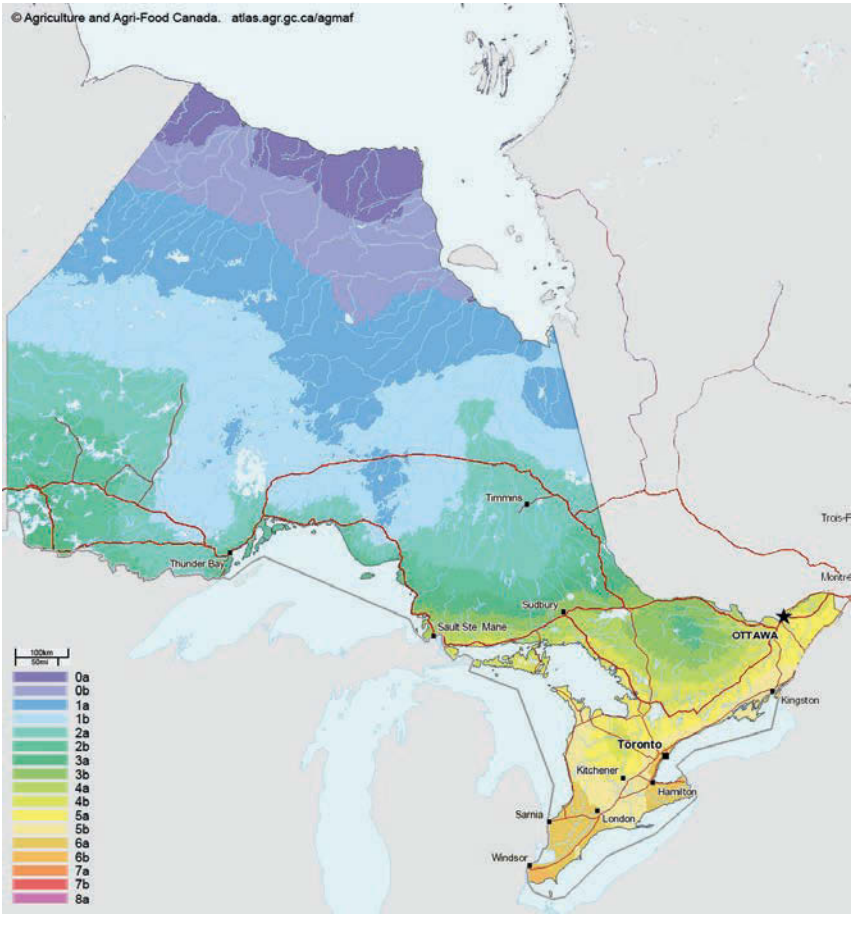
Geographical Area														MEDIUM ZONE – MEDIUM TREES		
														Latin Name **Common Name**	**SPREAD**	**HEIGHT**
0a	*0b*	*1a*	*1b*	*2a*	*2b*	*3a*	*3b*	*4a*	*4b*	*5a*	*5b*	*6a*	*6b*		*(m)*	*(m)*
				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	*Acer ginnala*, Amur Maple 'Flame'	*7.0*	*7.0*
						✓	✓	✓	✓	✓	✓	✓	✓	*Aesculus glabra*, Ohio Buckeye	*7.0*	*7.5*
								✓	✓	✓	✓	✓	✓	*Amelanchier canadensis*, Shadblow Serviceberry/Juneberry, Tree Form	*3.0*	*7.5*
								✓	✓	✓	✓	✓	✓	*Amelanchier x grandiflora 'Autumn Brilliance' (PP5717)*, Tree Form	*5.0*	*7.5*
										✓	✓	✓	✓	*Cercis Canadensis*, Eastern Redbud Tree Form	*7.0*	*7.5*
						✓	✓	✓	✓	✓	✓	✓	✓	*Crataegus phaenopyrum, Washington Hawthorn Tree Form*	*7.0*	*7.5*
												✓	✓	*Koelreauteria paniculata*, Golden Rain Tree	*7.0*	*7.5*
								✓	✓	✓	✓	✓	✓	*Malus cultivars*, Crab Apple varieties	*5.0 - 7.0*	*7.0*
								✓	✓	✓	✓	✓	✓	*Malus 'Robinson'*, Robinson Crab Apple	*7.5*	*7.5*
								✓	✓	✓	✓	✓	✓	*Malus 'Selkirk'*, Selkirk Crab Apple	*7.5*	*7.5*
								✓	✓	✓	✓	✓	✓	*Malus 'Winter Gold'*, Winter Gold Crab Apple	*6.0*	*7.5*
								✓	✓	✓	✓	✓	✓	*Prunus sargentii 'Rancho'*, Columnar Sargent Cherry	*3.0*	*7.5*
										✓	✓	✓	✓	*Prunus serrulata 'Kwanzan'*, Kwanzan Oriental Cherry	*5.0*	*7.0*
										✓	✓	✓	✓	*Pyrus calleryana 'Aristocrat' (PP3193)*, Aristocrat Callery Pear	*7.0*	*7.5*
				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	*Syringa reticulatata 'Ivory Silk'*, Ivory Silk Tree Lilac	*5.0*	*7.5*
				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	*Viburnum lentago*, Nannyberry Tree Form	*7.5*	*7.5*

* Malus cultivars come in a variety of species. Select the specie's maximum height for the specific planting zone

APPENDIX A: PLANT HARDINESS INDEX-CONT'D

TALL ZONE – TALL TREES															
Geographical Area													Latin Name Common Name	SPREAD	HEIGHT
0a	0b	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b		(m)	(m)
										✓	✓	✓	✓	*Acer campestre*, Hedge Maple	10.0	10.0
						✓	✓	✓	✓	✓	✓	✓	✓	*Acer x freemanii 'Armstrong'*, Armstrong Maple	8.0	15.0
								✓	✓	✓	✓	✓	✓	*Acer x freemanii 'Jeffersred' (PP4864)*, Autumn Blaze Maple	13.0	16.0
								✓	✓	✓	✓	✓	✓	*Acer x freemanii 'Celzam' (PP7279)*, Celebration Maple	8.0	15.0
								✓	✓	✓	✓	✓	✓	*Acer x freemanii 'Scarsen'*, Scarlet Sentinel Maple	8.0	15.0
				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	*Acer negundo*, Manitoba Maple [f]	15.0	13.0
								✓	✓	✓	✓	✓	✓	*Acer nigrum*, Black Sugar Maple	12.0	15.0
										✓	✓	✓	✓	*Acer platanoides*, Norway Maple	10.0	13.0
											✓	✓	✓	*Acer pseudoplatanus*, Sycamore Maple	8.0	13.0
						✓	✓	✓	✓	✓	✓	✓	✓	*Acer rubrum*, Red Maple	15.0	16.0
								✓	✓	✓	✓	✓	✓	*Acer rubrum 'Karppick'*, Karpick Red Maple	7.0	12.0
					✓	✓	✓	✓	✓	✓	✓	✓	✓	*Acer saccharinum*, Silver Maple	15.0	18.0
										✓	✓	✓	✓	*Aesculus hippocastanum*, Common Horse Chestnut	16.0	18.0
										✓	✓	✓	✓	*Carpinus betulus*, European Hornbeam	13.0	20.0
										✓	✓	✓	✓	*Carpinus betulus 'Fastigiata'*, Pyramidal European Hornbeam	4.0	12.0
								✓	✓	✓	✓	✓	✓	*Catalpa speciosa*, Northern Catalpa	6.0	12.0
										✓	✓	✓	✓	*Cladrastis lutea*, Yellowwood	10.0	12.0
								✓	✓	✓	✓	✓	✓	*Crataegus crus-galli var. inermis*, Thornless Cockspur Hawthorn Tree Form	10.0	10.0
				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	*Celtis occidentalis*, Common Hackberry	18.0	20.0
										✓	✓	✓	✓	*Celtis occidentalis 'Prairie Pride'*, Prairie Pride Hackberry	12.0	12.0
								✓	✓	✓	✓	✓	✓	*Cercidiphyllum japonicum*, Katsura Tree	7.0	15.0
										✓	✓	✓	✓	*Corylus columa*, Turkish Hazel	8.0	15.0
								✓	✓	✓	✓	✓	✓	*Fagus grandifolia*, American Beech	20.0	30.0
								✓	✓	✓	✓	✓	✓	*Fagus sylvatica*, European Beech	12.0	15.0
								✓	✓	✓	✓	✓	✓	*Ginkgo biloba*, Maidenhair Tree	11.0	17.0
								✓	✓	✓	✓	✓	✓	*Ginkgo biloba 'Autumn Gold'*, Autumn Gold Maidenhair Tree	10.0	10.0
								✓	✓	✓	✓	✓	✓	*Ginkgo biloba 'JFS-UGAZ'*, Golden Colannade™ Maidenhair Tree	8.0	15.0
								✓	✓	✓	✓	✓	✓	*Ginkgo biloba 'Princeton Sentry'*, Princeton Sentry Maidenhair Tree	5.0	13.0
								✓	✓	✓	✓	✓	✓	*Gleditsia triacanthos var. inermis*, Common Thornless Honeylocust	13.0	17.0
								✓	✓	✓	✓	✓	✓	*Gleditsia triacanthos var. inermis "Impcole'*, Imperial Honeylocust	10.0	10.0
								✓	✓	✓	✓	✓	✓	*Gymnocladus dioicus*, Kentucky Coffee Tree	13.0	17.0
										✓	✓	✓	✓	*Liquidambar styraciflua*, Sweetgum	12.0	15.0
										✓	✓	✓	✓	*Liriodendron tulipifera*, Tulip Tree	15.0	25.0
										✓	✓	✓	✓	*Liriodendron tulipifera 'Fastigiatum'*, Columnar Tulip Tree	5.0	15.0
								✓	✓	✓	✓	✓	✓	*Magnolia x galaxy*, Galaxy Magnolia Tree Form	6.0	12.0
								✓	✓	✓	✓	✓	✓	*Magnolia x loebneri 'Merrill'*, Merrill Magnolia Tree Form	10.0	13.0
						✓	✓	✓	✓	✓	✓	✓	✓	*Nyssa sylvantica*, Black-Gum	10.0	16.0
								✓	✓	✓	✓	✓	✓	*Phellodendron amurense*, Amur Cork Tree	9.0	13.0
										✓	✓	✓	✓	*Platanus x acerfolia 'Bloodgood'*, London Plane Tree	13.0	16.0
										✓	✓	✓	✓	*Pyrus calleryana 'Bradford'*, Bradford Callery Pear	7.0	13.0
										✓	✓	✓	✓	*Pyrus calleryana 'Capital'*, Capital Callery Pear	4.0	11.0
						✓	✓	✓	✓	✓	✓	✓	✓	*Quercus macrocarpa*, Burr Oak	13.0	18.0
								✓	✓	✓	✓	✓	✓	*Quercus palustris*, Pin Oak	13.0	25.0
										✓	✓	✓	✓	*Quercus robur*, English Oak	13.0	18.0
								✓	✓	✓	✓	✓	✓	*Quercus rubra*, Red Oak	15.0	16.0
						✓	✓	✓	✓	✓	✓	✓	✓	*Robina pseudoacacia 'Bessoniana'*, Bessoniana Black Locust	6.0	10.0
								✓	✓	✓	✓	✓	✓	*Robina pseudoacacia 'Frisia'*, Frisia Black Locust	8.0	13.0
						✓	✓	✓	✓	✓	✓	✓	✓	*Tilia americana*, Basswood	13.0	25.0
								✓	✓	✓	✓	✓	✓	*Tilia americana 'Redmond'*, American Linden	10.0	20.0
						✓	✓	✓	✓	✓	✓	✓	✓	*Tilia cordata 'Greenspire'*, Greenspire Littleleaf Linden	12.0	16.0
								✓	✓	✓	✓	✓	✓	*Tilia tomentosa*, Silver Linden	15.0	23.0
						✓	✓	✓	✓	✓	✓	✓	✓	*Ulmus Americana 'Princeton'*, Princeton Hybrid Elm	16.0	23.0
										✓	✓	✓	✓	*Ulmus 'Frontier'*, Frontier Hybrid Elm	10.0	13.0
										✓	✓	✓	✓	*Ulmus parvifolia*, Chinese Elm or Lacebark	10.0	13.0
								✓	✓	✓	✓	✓	✓	*Ulmus x 'Pioneer'*, Pioneer Hybrid Elm	15.0	25.0
										✓	✓	✓	✓	*Zelcova serrata*, 'Musashino' Zelkova	5.0	15.0
										✓	✓	✓	✓	*Zelcova serrata*, Green Vase Zelkova (PP5080)	13.0	16.0

APPENDIX A: PLANT HARDINESS GEOGRAPHICAL MAP



DEFINITIONS

Easement - a right granted to a *LDC* on property owned by others to use their property to support the distribution of electricity. Easements may contain underground and/or overhead powerlines and electrical equipment which requires the *LDC* to have legal access to property for maintenance and installation of electrical services.

Limits of Approach - specifies the required distance between workers and equipment to energized overhead electrical lines and conductors with a nominal phase-to-phase voltage rating set. The *LDC* should be contacted to define the voltage rating for overhead powerlines where work is being done.

Local Distribution Company (LDC) – A Distributor who is licensed under the Ontario Energy Board (OEB) responsible for transmitting electricity to municipal infrastructure including general public and public area.

Locates- Requesting of information from a facility owner identifying all their underground facilities by the use of surface markings such as coloured spray paint or flag identifiers, maps or drawings.

Pad mounted Equipment- Electrical equipment approved to be installed above ground on a concrete foundation.

Plant Hardiness Index- is a geographically defined area in which a specific category of plant life is capable of growing, as defined by climatic conditions, including its ability to withstand the minimum temperatures of the geographical area.

Root Deflector- Is a mechanical barrier placed between the tree roots and the electrical cables to prevent damage to the cables. A root deflector can be made from 6.5 mm (1/4") rigid plastic, fibreglass or non-degradable material.

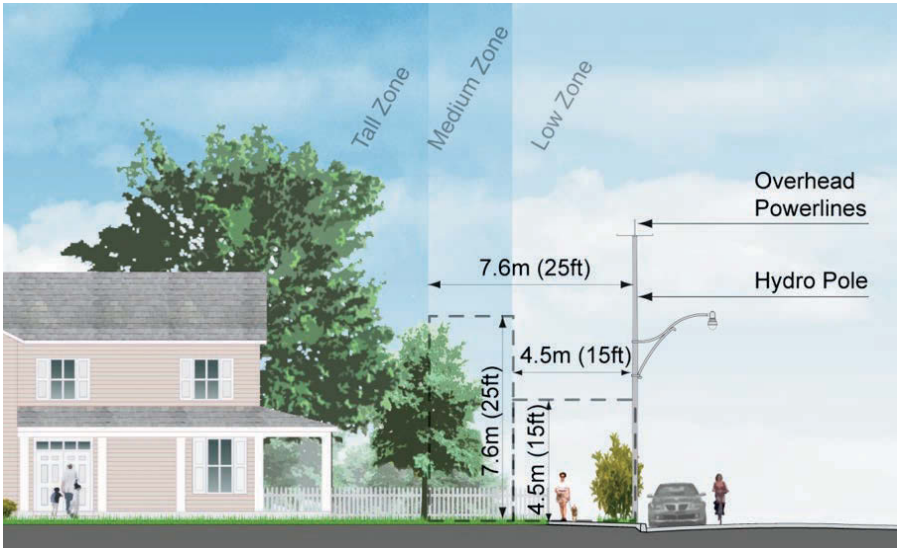
Step Potential- Is the voltage entering a person from one foot through the body and exiting the other foot standing near an energized ground object.

Touch Potential- Is the voltage entering a person and exiting the body through the feet while contacting an energized object.

Utility Arborist - HAVE COMPLETED THE UTILITY ARBORIST APPRENTICESHIP PROGRAM UNDER THE MINISTRY OF TRAINING COLLEGES AND UNIVERSITIES 444B CERTIFICATE OF QUALIFICATION - AND ARE AUTHORIZED TO PRUNE, CLEAR VEGETATION, FELL OR REMOVE TREES WITHIN THE ONTARIO OCCUPATIONAL HEALTH & SAFETY ACT (ONT. OH&S ACT) DEFINED '***LIMITS OF APPROACH***'.

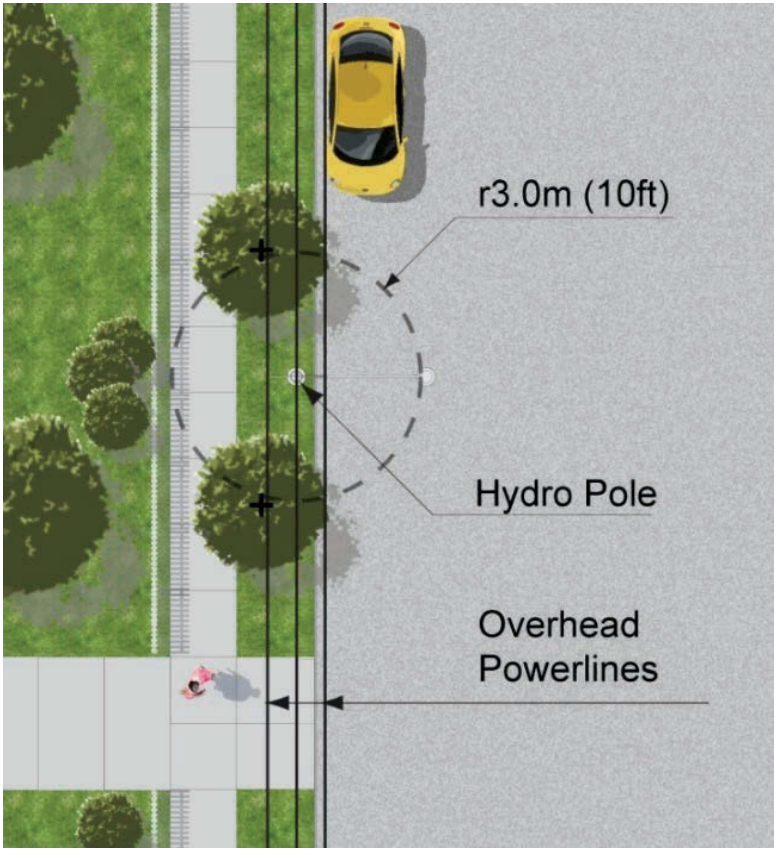
REFERENCE CHART A: TREE PLANTING ZONES

TREE PLANTING ZONES



REFERENCE CHART B: BASE ZONE NEAR HYDRO POLES

BASE ZONE NEAR HYDRO POLES



QUICK REFERENCE GUIDE: LANDSCAPE & ARBORIST TRADES

'LOOK UP! LOOK OUT!' TO AVOID POTENTIAL ELECTRICAL HAZARDS

☑ **LOCATE OVERHEAD POWERLINES AND FOLLOW ONT. OH&S ACT'S LIMITS OF APPROACH**

☑ **LOCATE ALL UNDERGROUND SERVICES PRIOR TO EXCAVATING**

Allow a minimum of 2 weeks to receive all *locates*. All *locates* must be received prior to excavation.

☑ **CHECK MUNICIPAL, REGIONAL AND TOWNSHIP BY-LAWS FOR SPECIFICATIONS**

☑ **CHECK WITH THE *LDC* FOR THEIR PLANTING REQUIREMENTS UNDER OR AROUND POWERLINES AND ELECTRICAL EQUIPMENT INCLUDING UNDERGROUND POWERLINES**

☑ **SELECT LANDSCAPE MATERIALS AND DESIGNS THAT MEET CLEARANCE REQUIREMENTS UNDER OR AROUND POWERLINES AND ELECTRICAL EQUIPMENT, SPECIFICALLY:**

⇨ **UNDERGROUND POWERLINES** - THE MINIMUM CLEARANCE REQUIRED FROM THE EDGE OF THE ROOT BALL TO THE EDGE OF THE UNDERGROUND POWERLINE CORRIDOR IS 1.0 M (3FT.)

⇨ **ELECTRICAL EQUIPMENT** - WHEN PLANTING NEAR *PAD MOUNTED EQUIPMENT*:

- **TRANSFORMERS** - 3.0 M (10 FT.) IS REQUIRED IN FRONT OF THE DOOR(S) AND 1.5M (4.9 FT.) ON THE SIDES AND BACK
- **SWITCHGEAR** - 3.0 M (10 FT.) IS REQUIRED IN THE FRONT AND BACK DOORS AND 1.5M (4.9 FT.) ON THE SIDES

⇨ **OVERHEAD POWERLINES** – 'LOOK UP! LOOK OUT!'

1. **CONSIDER REQUIRED DISTANCES BETWEEN POWERLINES AND TREES OR SHRUBS WHEN SELECTING SPECIES.**

   ⇨ LOW ZONE - IS THE AREA UNDER THE POWER LINES AND EXTENDS TO 4.5 M (15 FT) ON EITHER SIDE. TREES AND/OR SHRUBS PLANTED IN THIS ZONE SHOULD HAVE A MAXIMUM MATURE HEIGHT AND SPREAD OF 4.5 M (15 FT).

   ⇨ MEDIUM ZONE - EXTENDS FROM THE OUTER EDGE OF THE LOW ZONE TO A DISTANCE OF 7.6 M (25 FT) ON EITHER SIDE OF THE POWER LINE. THE MAXIMUM MATURE HEIGHT AND SPREAD OF TREES PLANTED IN THIS ZONE SHOULD BE 7.6 M (25 FT).

   ⇨ TALL ZONE – EXTENDS FROM THE OUTER EDGE OF THE MEDIUM ZONE EXTENDING GREATER THAN 7.6 M (25 FT) FROM THE POWER LINES. ANY STRONG AND HEALTHY TREE MAY BE PLANTED IN THIS ZONE.

   ⇨ BASE ZONE NEAR HYDRO POLES - TREES AND/OR SHRUBS SHOULD NOT BE PLACED CLOSER THAN 3.0 M (10 FT) FROM THE BASE OF A HYDRO POLE.

2. **DELIVERY OF PLANT MATERIALS** - UNLOADING OF THE TREE(S) **IS NOT** TO BE DONE UNDER OR AROUND THE OVERHEAD POWERLINES. DELIVERY EQUIPMENT SUCH AS A BOOM TRUCK CAN COME INTO CONTACT WITH THE OVERHEAD WIRES. THE SAME FOR DIGGING WITH EQUIPMENT SUCH AS A HIGH HOE, THE EQUIPMENT CAN ALSO COME INTO CONTACT WITH THE OVERHEAD WIRES.

APPENDIX B – RECORD OF COMPLETED TRIMMING

LONDON HYDRO LINE CLEARING REPORT

Date: SEPT 18/17 Crew: CARTER/KEITCH Hrs. Worked: 8

Equipment #: LANDREI

Vehicle #: 179

General Overhead Line Trimming

	Planned	Capital	Reactive	Address	Nature of Work	Secondary	Primary	# of Trees	# of Hours	Check if NOT Accessible with Bucket
1	✓			St James + Talbot	Remove 20 Man Maple		✓	20		
2	✓			Bike path	Remove 15 B Locust		✓	15		
3	✓				Remove 10 Mulberry		✓	10		
4	✓				Remove 22 Man Maple		✓	22		
5	✓				Remove 4 Hackberry		✓	4		
6	✓				Remove 8 Elm		✓	8		
7	✓				Remove 1 Poplar		✓	1		
8	✓				Remove 6 Ash		✓	6		
9	✓				Remove 3 Buck Horne		✓	3		
10										
11										
12										
13										
14										
15										
16										
17										
18										

Tree Removal Section

	Planned	Capital	Reactive	Address	Nature of Work	Stump Removal	Wood Pick-Up	Size Less than 6"	Size 6"-12"	Size 12"-18"	Size 18"-24"
1											
2											
3											
4											
5											
6											
7											

APPENDIX C – ANSI A300 PART 1 – TREE, SHRUB AND OTHER WOODY PLANT MAINTENACE – STANDARD PRACTICES (PRUNING)

American National Standard

for Tree Care Operations — Tree, Shrub, and Other Woody Plant Maintenance — Standard Practices (Pruning)

ANSI A300 (Part 1)-2001 Pruning
Revision of ANSI A300-1995

Approved American National Standard

ANSI

ANSI®
A300 (Part 1)-2001
Revision of
ANSI A300-1995

American National Standard
for Tree Care Operations –

Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices *(Pruning)*

Secretariat

National Arborist Association, Inc.

Approved May 22, 2001

American National Standards Institute, Inc.
Headquarters:
1819 L Street, NW
Sixth Floor
Washington, DC 20036
New York Office:
25 West 43rd Street
Fourth Floor
New York, NY 10036

American National Standard

Approval of an American National Standard requires review by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgement of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made towards their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Published by

National Arborist Association, Inc., 3 Perimeter Rd. Unit 1, Manchester, NH 03103
Phone: (800) 733-2622 or (603) 314-5380 Fax: (603) 314-5386
E-mail: naa@natlarb.com www.natlarb.com

Printed in the United States of America

Contents

Forward (This foreword is not part of American National Standard A300 Part 1-2001.)

An industry-consensus standard must have the input of the industry that it is intended to affect. The Accredited Standards Committee A300 was approved June 28, 1991. The committee includes representatives from the residential and commercial tree care industry, the utility, municipal, and federal sectors, the landscape and nursery industries, and other interested organizations. Representatives from varied geographic areas with broad knowledge and technical expertise contributed.

The A300 standard can be best placed in proper context if one reads its *Scope*, *Purpose*, and *Application*. This document presents performance standards for the care and maintenance of trees, shrubs, and other woody plants. It is intended as a guide in the drafting of maintenance specifications for federal, state, municipal, and private authorities including property owners, property managers, and utilities.

The A300 standard stipulates that specifications for tree work should be written and administered by a professional possessing the technical competence to provide for, or supervise, the management of woody landscape plants. Users of this standard must first interpret its wording, then apply their knowledge of growth habits of certain plant species in a given environment. In this manner, the user ultimately develops their own specifications for plant maintenance.

ANSI A300 Part 1 – *Pruning,* should be used in conjunction with the rest of the A300 standard when writing specifications for tree care operations.

Suggestions for improvement of this standard should be forwarded to: NAA300 Secretary, c/o National Arborist Association, 3 Perimeter Rd. - Unit 1, Manchester, NH 03103, USA or Email: naa@natlarb.com.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee on Tree, Shrub, and Other Woody Plant Maintenance Operations – *Standard Practices,* A300. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the A300 committee had the following members:

Tim Johnson, Chair (Artistic Arborist, Inc.)

Bob Rouse, Secretary (National Arborist Association, Inc.)

Organizations Represented	*Name of Representative*
American Forests	Staff (Observer)
American Nursery and Landscape Association	Craig J. Regelbrugge
American Society of Consulting Arborists	Andrew Graham
	Donald Blair (Adviser)
	Beth Palys (Adviser)
American Society of Landscape Architects	Ron Leighton
Asplundh Tree Expert Company	Geoff Kempter
Associated Landscape Contractors of America	Preston Leyshon
	Jeff Bourne (Alt.)
The Davey Tree Expert Company	Joseph Tommasi
	Dick Jones (Alt.)
	Richard Rathjens (Adviser)
The F.A. Bartlett Tree Expert Company	Peter Becker
	Dr. Thomas Smiley (Alt.)
International Society of Arboriculture	Ed Brennan
	Sharon Lilly (Alt.)
National Arborist Association	Ronald Rubin
	Tom Mugridge (Alt.)
National Park Service	Robert DeFeo
Professional Grounds Management Society	Kevin O'Donnell
Society of Municipal Arborists	Andrew Hillman
U.S. Forest Service	Ed Macie
	Mike Galvin (Alt.)
	Philip D. Rodbell (Alt.)

Organizations Represented	*Name of Representative*
Utility Arborist Association	Jeffery Smith
	Matt Simons (Alt.)

American National Standard for Tree Care Operations –

Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices *(Pruning)*

1 ANSI A300 standards

1.1 Scope

ANSI A300 standards present performance standards for the care and maintenance of trees, shrubs, and other woody plants.

1.2 Purpose

ANSI A300 standards are intended as guides for federal, state, municipal and private authorities including property owners, property managers, and utilities in the drafting of their maintenance specifications.

1.3 Application

ANSI A300 standards shall apply to any person or entity engaged in the business, trade, or performance of repairing, maintaining, or preserving trees, shrubs, or other woody plants.

1.4 Implementation

Specifications for tree maintenance should be written and administered by an arborist.

2 Part 1 – Pruning standards

2.1 Purpose

The purpose of this document is to provide standards for developing specifications for tree pruning.

2.2 Reasons for pruning

The reasons for tree pruning may include, but are not limited to, reducing risk, maintaining or improving tree health and structure, improving aesthetics, or satisfying a specific need. Pruning practices for agricultural, horticultural production, or silvicultural purposes are exempt from this standard.

2.3 Safety

2.3.1 Tree maintenance shall be performed only by arborists or arborist trainees who, through related training or on-the-job experience, or both, are familiar with the practices and hazards of arboriculture and the equipment used in such operations.

2.3.2 This standard shall not take precedence over arboricultural safe work practices.

2.3.3 Operations shall comply with applicable Occupational Safety and Health Administration (OSHA) standards, ANSI Z133.1, as well as state and local regulations.

3 Normative references

The following standards contain provisions, which, through reference in the text, constitute provisions of this American National Standard. All standards are subject to revision, and parties to agreements based on this American National Standard shall apply the most recent edition of the standards indicated below.

ANSI Z60.1, *Nursery stock*

ANSI Z133.1, *Tree care operations - Pruning, trimming, repairing, maintaining, and removing trees, and cutting brush - Safety requirements*

29 CFR 1910, General industry [1)]

29 CFR 1910.268, Telecommunications [1)]

29 CFR 1910.269, Electric power generation, transmission, and distribution [1)]

29 CFR 1910.331 - 335, Electrical safety-related work practices [1)]

4 Definitions

4.1 **anvil-type pruning tool:** A pruning tool that

has a sharp straight blade that cuts against a flat metal cutting surface, in contrast to a *hook-and-blade-type pruning tool* (4.21).

4.2 **apical dominance:** Inhibition of growth of lateral buds by the terminal bud.

4.3 **arboriculture:** The art, science, technology, and business of commercial, public, and utility tree care.

4.4 **arborist:** An individual engaged in the profession of arboriculture who, through experience, education, and related training, possesses the competence to provide for or supervise the management of trees and other woody plants.

4.5 **arborist trainee:** An individual undergoing on-the-job training to obtain the experience and the competence required to provide for or supervise the management of trees and other woody plants. Such trainees shall be under the direct supervision of an arborist.

4.6 **branch bark ridge:** The raised area of bark in the branch crotch that marks where the branch and parent meet.

4.7 **branch collar:** The swollen area at the base of a branch.

4.8 **callus:** Undifferentiated tissue formed by the cambium around a wound.

4.9 **cambium:** The dividing layer of cells that forms sapwood (xylem) to the inside and inner bark (phloem) to the outside.

4.10 **cleaning:** Selective pruning to remove one or more of the following parts: dead, diseased, and/or broken branches (5.6.1).

4.11 **climbing spurs:** Sharp, pointed devices affixed to a climber's boot used to assist in climbing trees. (syn.: gaffs, hooks, spurs, spikes, climbers)

4.12 **closure:** The process of woundwood covering a cut or other tree injury.

4.13 **crown:** The leaves and branches of a tree measured from the lowest branch on the trunk to the top of the tree.

4.14 **decay:** The degradation of woody tissue caused by microorganisms.

4.15 **espalier:** The combination of pruning, supporting, and training branches to orient a plant in one plane (5.7.2).

4.16 **establishment:** The point after planting when a tree's root system has grown sufficiently into the surrounding soil to support shoot growth and anchor the tree.

4.17 **facility:** A structure or equipment used to deliver or provide protection for the delivery of an essential service, such as electricity or communications.

4.18 **final cut:** A cut that completes the removal or reduction of a branch or stub.

4.19 **frond:** A leaf of a palm.

4.20 **heading:** 1. Cutting a currently growing, or a 1-year-old shoot, back to a bud. 2. Cutting an older branch or stem back to a stub in order to meet a defined structural objective. 3. Cutting an older branch or stem back to a lateral branch not large enough to assume apical dominance in order to meet a defined structural objective. Heading may or may not be an acceptable pruning practice, depending on the application.

4.21 **hook-and-blade-type pruning tool:** A pruning tool that has a sharp curved blade that overlaps a supporting hook; in contrast to an *anvil-type pruning tool* (4.1). (syn.: by-pass pruner)

4.22 **interfering branches:** Crossing, rubbing, or upright branches that have the potential to damage tree structure and/or health.

4.23 **internodal cut:** A cut located between lateral branches or buds.

4.24 **lateral branch:** A shoot or stem growing from a parent branch or stem.

4.25 **leader:** A dominant or co-dominant, upright stem.

4.26 **limb:** A large, prominent branch.

4.27 **lion's tailing:** The removal of an excessive number of inner, lateral branches from parent

branches. Lion's tailing is not an acceptable pruning practice (5.5.7).

4.28 mechanical pruning: A utility pruning technique where large-scale power equipment is used to cut back branches (5.9.2.2).

4.29 parent branch or stem: A tree trunk, limb, or prominent branch from which shoots or stems grow.

4.30 peeling: *For palms:* The removal of only the dead frond bases at the point they make contact with the trunk without damaging living trunk tissue. (syn.: shaving)

4.31 petiole: A stalk of a leaf or frond.

4.32 phloem: Inner bark conducting tissues that transport organic substances, primarily carbohydrates, from leaves and stems to other parts of the plant.

4.33 pollarding: The maintenance of a tree by making internodal cuts to reduce the size of a young tree, followed by the annual removal of shoot growth at its point of origin (5.7.3).

4.34 pruning: The selective removal of plant parts to meet specific goals and objectives.

4.35 qualified line-clearance arborist: An individual who, through related training and on-the-job experience, is familiar with the equipment and hazards in line clearance and has demonstrated the ability to perform the special techniques involved. This individual may or may not be currently employed by a line-clearance contractor.

4.36 qualified line-clearance arborist trainee: An individual undergoing line-clearance training and who, in the course of such training, is familiar with the hazards and equipment involved in line clearance and has demonstrated ability in the performance of the special techniques involved. This individual shall be under the direct supervision of a qualified line-clearance arborist.

4.37 raising: Selective pruning to provide vertical clearance (5.6.3).

4.38 reduction: Selective pruning to decrease height and/or spread (5.6.4).

4.39 remote/rural areas: Locations associated with very little human activity, land improvement, or development.

4.40 restoration: Selective pruning to improve the structure, form, and appearance of trees that have been severely headed, vandalized, or damaged (5.7.4).

4.41 shall: As used in this standard, denotes a mandatory requirement.

4.42 should: As used in this standard, denotes an advisory recommendation.

4.43 stub: An undesirable short length of a branch remaining after a break or incorrect pruning cut is made.

4.44 thinning: Selective pruning to reduce density of live branches (5.6.2).

4.45 throwline: A small, lightweight line with a weighted end used to position a climber's rope in a tree.

4.46 topping: The reduction of a tree's size using heading cuts that shorten limbs or branches back to a predetermined crown limit. Topping is not an acceptable pruning practice (5.5.7).

4.47 tracing: The removal of loose, damaged tissue from in and around the wound.

4.48 urban/residential areas: Locations, such as populated areas including public and private property, that are normally associated with human activity.

4.49 utility: An entity that delivers a public service, such as electricity or communications.

4.50 utility space: The physical area occupied by a utility's facilities and the additional space required to ensure its operation.

4.51 vista pruning: Selective pruning to allow a specific view (5.7.5).

4.52 watersprouts: New stems originating from epicormic buds. (syn.: epicormic shoots)

4.53 wound: An opening that is created when the bark of a live branch or stem is penetrated, cut, or removed.

4.54 woundwood: Partially differentiated tissue responsible for closing wounds. Woundwood develops from callus associated with wounds.

4.55 xylem: Wood tissue. Active xylem is sapwood; inactive xylem is heartwood.

4.56 young tree: A tree young in age or a newly transplanted tree.

5 Pruning practices

5.1 Tree inspection

5.1.1 An arborist or arborist trainee shall visually inspect each tree before beginning work.

5.1.2 If a condition is observed requiring attention beyond the original scope of the work, the condition should be reported to an immediate supervisor, the owner, or the person responsible for authorizing the work.

5.2 Tools and equipment

5.2.1 Equipment and work practices that damage living tissue and bark beyond the scope of the work should be avoided.

5.2.2 Climbing spurs shall not be used when climbing and pruning trees.

Exceptions:
- when limbs are more than throwline distance apart and there is no other means of climbing the tree;
- when the bark is thick enough to prevent damage to the cambium;
- in remote or rural utility rights-of-way.

5.3 Pruning cuts

5.3.1 Pruning tools used in making pruning cuts shall be sharp.

5.3.2 A pruning cut that removes a branch at its point of origin shall be made close to the trunk or parent limb, without cutting into the branch bark ridge or collar, or leaving a stub (see Figure 5.3.2).

5.3.3 A pruning cut that reduces the length of a branch or parent stem should bisect the angle between its branch bark ridge and an imaginary line perpendicular to the branch or stem (see Figure 5.3.3).

5.3.4 The final cut shall result in a flat surface with adjacent bark firmly attached.

5.3.5 When removing a dead branch, the final cut shall be made just outside the collar of living tissue.

5.3.6 Tree branches shall be removed in such a manner so as not to cause damage to other parts of the tree or to other plants or property. Branches too large to support with one hand shall be precut to avoid splitting of the wood or tearing of the bark (see Figure 5.3.2). Where necessary, ropes or other equipment shall be used to lower large branches or portions of branches to the ground.

5.3.7 A final cut that removes a branch with a narrow angle of attachment should be made from the outside of the branch to prevent damage to the parent limb (see Figure 5.3.7).

5.3.8 Severed limbs shall be removed from the crown upon completion of the pruning, at times when the tree would be left unattended, or at the end of the workday.

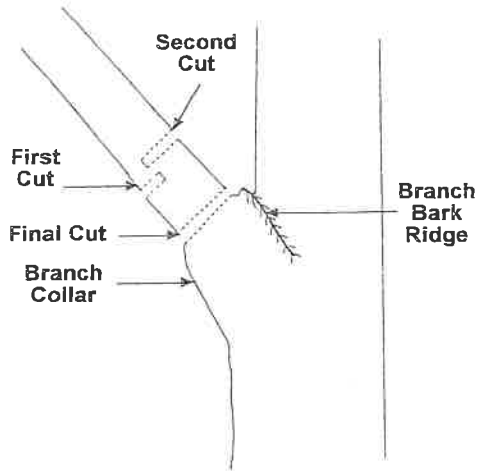


Figure 5.3.2. – A pruning cut that removes a branch at its point of origin shall be made close to the trunk or parent limb, without cutting into the branch bark ridge or collar, or leaving a stub. Branches too large to support with one hand shall be precut to avoid splitting of the wood or tearing of the bark.

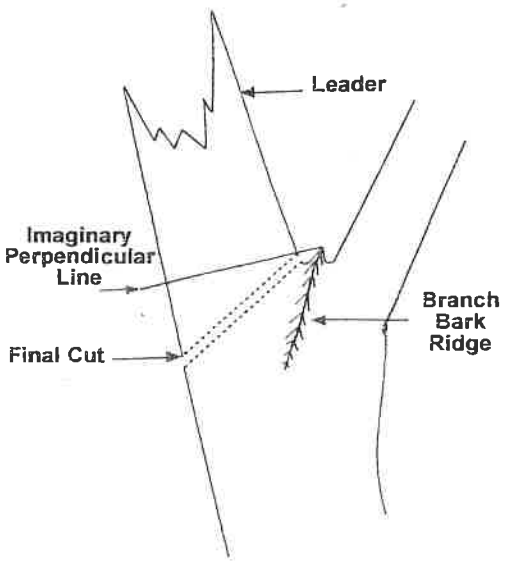


Figure 5.3.3. – A pruning cut that reduces the length of a branch or parent stem should bisect the angle between its branch bark ridge and an imaginary line perpendicular to the branch or stem.

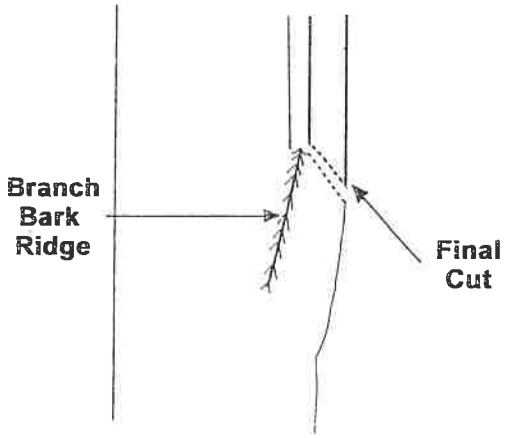


Figure 5.3.7. – A final cut that removes a branch with a narrow angle of attachment should be made from the outside of the branch to prevent damage to the parent limb.

5.4 Wound treatment

5.4.1 Wound treatments should not be used to cover wounds or pruning cuts, except when recommended for disease, insect, mistletoe, or sprout control, or for cosmetic reasons.

5.4.2 Wound treatments that are damaging to tree tissues shall not be used.

5.4.3 When tracing wounds, only loose, damaged tissue should be removed.

5.5 Pruning objectives

5.5.1 Pruning objectives shall be established prior to beginning any pruning operation.

5.5.2 To obtain the defined objective, the growth cycles and structure of individual species and the type of pruning to be performed should be considered.

5.5.3 Not more than 25 percent of the foliage should be removed within an annual growing season. The percentage and distribution of foliage to be removed shall be adjusted according to the plant's species, age, health, and site.

5.5.4 Not more than 25 percent of the foliage of a branch or limb should be removed when it is cut back to a lateral. That lateral should be large enough to assume apical dominance.

5.5.5 Pruning cuts should be made in accordance with 5.3 *Pruning cuts.*

5.5.6 Heading should be considered an acceptable practice for shrub or specialty pruning when needed to reach a defined objective.

5.5.7 Topping and lion's tailing shall be considered unacceptable pruning practices for trees.

5.6 Pruning types

Specifications for pruning should consist of, but are not limited to, one or more of the following types:

5.6.1 Clean: Cleaning shall consist of selective pruning to remove one or more of the following parts: dead, diseased, and/or broken branches.

5.6.1.1 Location of parts to be removed shall be specified.

5.6.1.2 Size range of parts to be removed shall be specified.

5.6.2 Thin: Thinning shall consist of selective pruning to reduce density of live branches.

5.6.2.1 Thinning should result in an even distribution of branches on individual limbs and throughout the crown.

5.6.2.2 Not more than 25 percent of the crown should be removed within an annual growing season.

5.6.2.3 Location of parts to be removed shall be specified.

5.6.2.4 Percentage of foliage and size range of parts to be removed shall be specified.

5.6.3 Raise: Raising shall consist of selective pruning to provide vertical clearance.

5.6.3.1 Vertical clearance should be specified.

5.6.3.2 Location and size range of parts to be removed should be specified.

5.6.4 Reduce: Reduction shall consist of selective pruning to decrease height and/or spread.

5.6.4.1 Consideration shall be given to the ability of a species to tolerate this type of pruning.

5.6.4.2 Location of parts to be removed and clearance should be specified.

5.6.4.3 Size range of parts should be specified.

5.7 Specialty pruning

Consideration shall be given to the ability of a species to tolerate specialty pruning, using one or more pruning types (5.6).

5.7.1 Young trees

5.7.1.1 The reasons for young tree pruning may include, but are not limited to, reducing risk, maintaining or improving tree health and structure, improving aesthetics, or satisfying a specific need.

5.7.1.2 Young trees that will not tolerate repetitive pruning and have the potential to outgrow their space should be considered for relocation or removal.

5.7.1.3 At planting

5.7.1.3.1 Pruning should be limited to cleaning (5.6.1).

5.7.1.3.2 Branches should be retained on the lower trunk.

5.7.1.4 Once established

5.7.1.4.1 Cleaning should be performed (5.6.1).

5.7.1.4.2 Rubbing and poorly attached branches should be removed.

5.7.1.4.3 A central leader or leader(s) as appropriate should be developed.

5.7.1.4.4 A strong, properly spaced scaffold branch structure should be selected and maintained.

5.7.1.4.5 Interfering branches should be reduced or removed.

5.7.2 Espalier

5.7.2.1 Branches that extend outside the desired plane of growth shall be pruned or tied back.

5.7.2.2 Ties should be replaced as needed to prevent girdling the branches at the attachment site.

5.7.3 Pollarding

5.7.3.1 Consideration shall be given to the ability of the individual tree to respond to pollarding.

5.7.3.2 Management plans shall be made prior to the start of the pollarding process for routine removal of watersprouts.

5.7.3.3 Internodal cuts shall be made at specific locations to start the pollarding process. After the initial cuts are made, no additional internodal cut shall be made.

5.7.3.4 Watersprouts growing from the cut ends of branches (knuckles) should be removed annually during the dormant season.

5.7.4 Restoration

5.7.4.1 Restoration shall consist of selective pruning to improve the structure, form, and appearance of trees that have been severely headed, vandalized, or damaged.

5.7.4.2 Location in tree, size range of parts, and percentage of watersprouts to be removed should be specified.

5.7.5 Vista pruning

5.7.5.1 Vista pruning shall consist of selective pruning to allow a specific view.

5.7.5.2 Size range of parts, location in tree, and percentage of foliage to be removed should be specified.

5.8 Palm pruning

5.8.1 Palm pruning should be performed when fronds, fruit, or loose petioles may create a dangerous condition.

5.8.2 Live healthy fronds, initiating at an angle of 45 degrees or greater from horizontal, with frond tips at or below horizontal, should not be removed.

5.8.3 Fronds removed should be severed close to the petiole base without damaging living trunk tissue.

5.8.4 Palm peeling (shaving) should consist of the removal of only the dead frond bases at the point they make contact with the trunk without damaging living trunk tissue.

5.9 Utility pruning

5.9.1 General

5.9.1.1 The purpose of utility pruning is to prevent the loss of service, comply with mandated clearance laws, prevent damage to equipment, avoid access impairment, and uphold the intended usage of the facility/utility space.

5.9.1.2 Only a qualified line clearance arborist or line clearance arborist trainee shall be assigned to line clearance work in accordance with ANSI Z133.1, 29 CFR 1910.331 – 335, 29 CFR 1910.268 or 29 CFR 1910.269.

5.9.1.3 Utility pruning operations are exempt from requirements in 5.1 Tree Inspection:

5.1.1 *An arborist or arborist trainee shall visually inspect each tree before beginning work.*

5.1.2 *If a condition is observed requiring attention beyond the original scope of the work, the condition should be reported to an immediate supervisor, the owner, or the person responsible for authorizing the work.*

5.9.1.4 Safety inspections of the work area are required as outlined in ANSI Z133.1 4.1.3, *job briefing.*

5.9.2 Utility crown reduction pruning

5.9.2.1 Urban/residential environment

5.9.2.1.1 Pruning cuts should be made in accordance with 5.3, Pruning cuts. The following requirements and recommendations of 5.9.2.1.1 are repeated from 5.3 Pruning cuts.

5.9.2.1.1.1 A pruning cut that removes a branch at its point of origin shall be made close to the trunk or parent limb, without cutting into the branch bark ridge or collar, or leaving a stub (see Figure 5.3.2).

5.9.2.1.1.2 A pruning cut that reduces the length of a branch or parent stem should bisect the angle between its branch bark ridge and an imaginary line perpendicular to the branch or stem (see Figure 5.3.3).

5.9.2.1.1.3 The final cut shall result in a flat surface with adjacent bark firmly attached.

5.9.2.1.1.4 When removing a dead branch, the final cut shall be made just outside the collar of living tissue.

5.9.2.1.1.5 Tree branches shall be removed in such a manner so as not to cause damage to other parts of the tree or to other plants or property. Branches too large to support with one hand shall be precut to avoid splitting of the wood or tearing of the bark (see Figure 5.3.2). Where necessary, ropes or other equipment shall be used to lower large branches or portions of branches to the ground.

5.9.2.1.1.6 A final cut that removes a branch

with a narrow angle of attachment should be made from the bottom of the branch to prevent damage to the parent limb (see Figure 5.3.7).

5.9.2.1.2 A minimum number of pruning cuts should be made to accomplish the purpose of facility/utility pruning. The natural structure of the tree should be considered.

5.9.2.1.3 Trees directly under and growing into facility/utility spaces should be removed or pruned. Such pruning should be done by removing entire branches or by removing branches that have laterals growing into (or once pruned, will grow into) the facility/utility space.

5.9.2.1.4 Trees growing next to, and into or toward facility/utility spaces should be pruned by reducing branches to laterals (5.3.3) to direct growth away from the utility space or by removing entire branches. Branches that, when cut, will produce watersprouts that would grow into facilities and/or utility space should be removed.

5.9.2.1.5 Branches should be cut to laterals or the parent branch and not at a pre-established clearing limit. If clearance limits are established, pruning cuts should be made at laterals or parent branches outside the specified clearance zone.

5.9.2.2 Rural/remote locations – mechanical pruning

Cuts should be made close to the main stem, outside of the branch bark ridge and branch collar. Precautions should be taken to avoid stripping or tearing of bark or excessive wounding.

5.9.3 Emergency service restoration

During a utility-declared emergency, service must be restored as quickly as possible in accordance with ANSI Z133.1, 29 CFR 1910.331 – 335, 29 CFR 1910.268, or 29 CFR 1910.269. At such times it may be necessary, because of safety and the urgency of service restoration, to deviate from the use of proper pruning techniques as defined in this standard. Following the emergency, corrective pruning should be done as necessary.

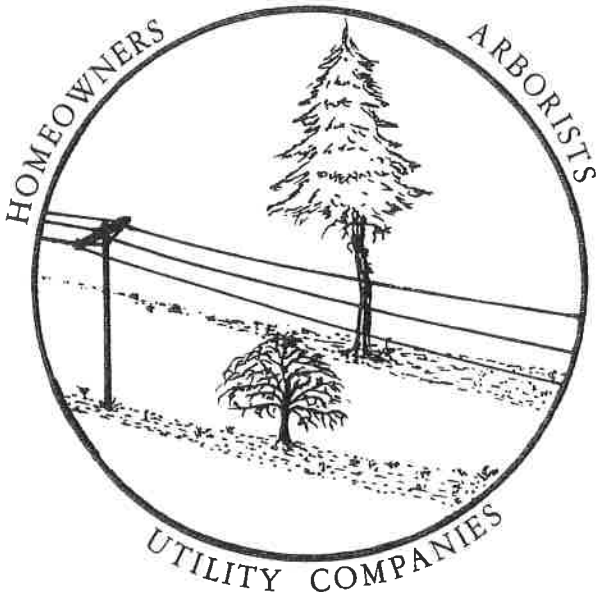
Annex A
(informative)

Reference publications

International Society of Arboriculture (ISA). 1995. *Tree Pruning Guidelines*. Savoy, IL: International Society of Arboriculture (ISA).

APPENDIX D – PRUNING NEAR UTLITY LINES – DR. ALEX L. SHIGO

TREES AND ELECTRIC UTILITY LINES
CAN EXIST TOGETHER

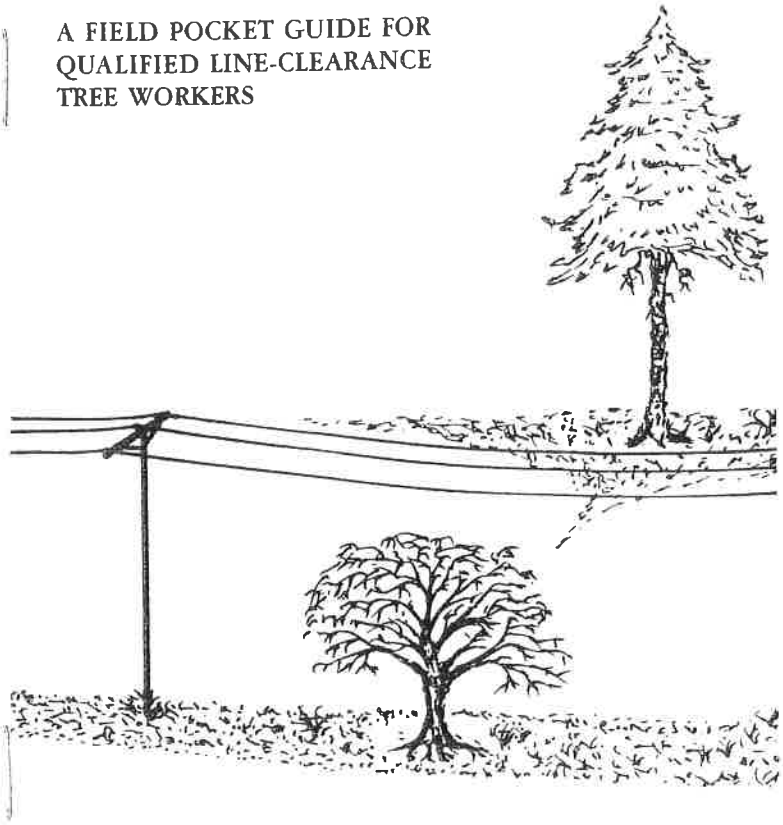


IF WE ALL WORK TOGETHER

PRUNING TREES

NEAR ELECTRIC UTILITY LINES

A FIELD POCKET GUIDE FOR
QUALIFIED LINE-CLEARANCE
TREE WORKERS



DR. ALEX L. SHIGO

PRUNING TREES NEAR ELECTRIC UTILITY LINES

by
Dr. Alex L. Shigo
Former chief scientist and
Pioneering Project Leader, U.S. Forest Service

PLEASE NOTE

This guide is only for qualified line-clearance workers. It is not for homeowners or others who have not been trained properly to work near electric utility lines. However, all people who care about trees should read this guide to learn what pruning practices are best for trees near these lines.

The guidelines are for high-value trees in cities, residential areas, parks, campgrounds, scenic areas and highways, and other places where tree health, beauty, and safety are important.

ACKNOWLEDGEMENTS

I thank the people who gave valuable comments for the improvement of this guide:

Dan Baluss, W. B. Cormack, Claude Desjardins, John Goodfellow, S. T. Griffiths, Keith Jones, L. Brian Morris, Eric Rey-Lescure, R. Neil Thiessen, Eric S. Ulrich, Michael R. Watson, Richard Wells, and James Young.

Shigo and Trees, Associates
4 Denbow Road, Durham, NH 03824-3105
(603) 868-7459 • Fax: (603) 868-1045

PLEAS FOR TREES

It would be better for trees, electric lines, and customers if trees were not planted near electric lines. This would be a permanent solution. Or, if trees are wanted, only low-growing, compact-form varieties should be planted. When large-maturing trees are planted under the lines, pruning is the only alternative to assure a safe and reliable supply of electric power to all customers.

The aim of this guide is to give information that will help the tree worker to make the best pruning decisions on each tree.

This is a guide, not a rule book full of absolutes.

PLAN BEFORE YOU PLANT

PLANT THE RIGHT TREE IN THE RIGHT PLACE

Homeowners should check with their utility company before they plant trees in areas where utility lines are underground.

Consult tree care professionals — **arborists** — before you plant.

DON'T BREAK THE LAW!

All persons pruning trees near electric utility lines must be qualified by training that includes pruning techniques, and an understanding of safety and line clearing requirements given by OSHA and ANSI Z 133.1-1988. If you do not know or understand these requirements, have them explained to you by your supervisor before you go near an energized line. **You must comply with these requirements.**

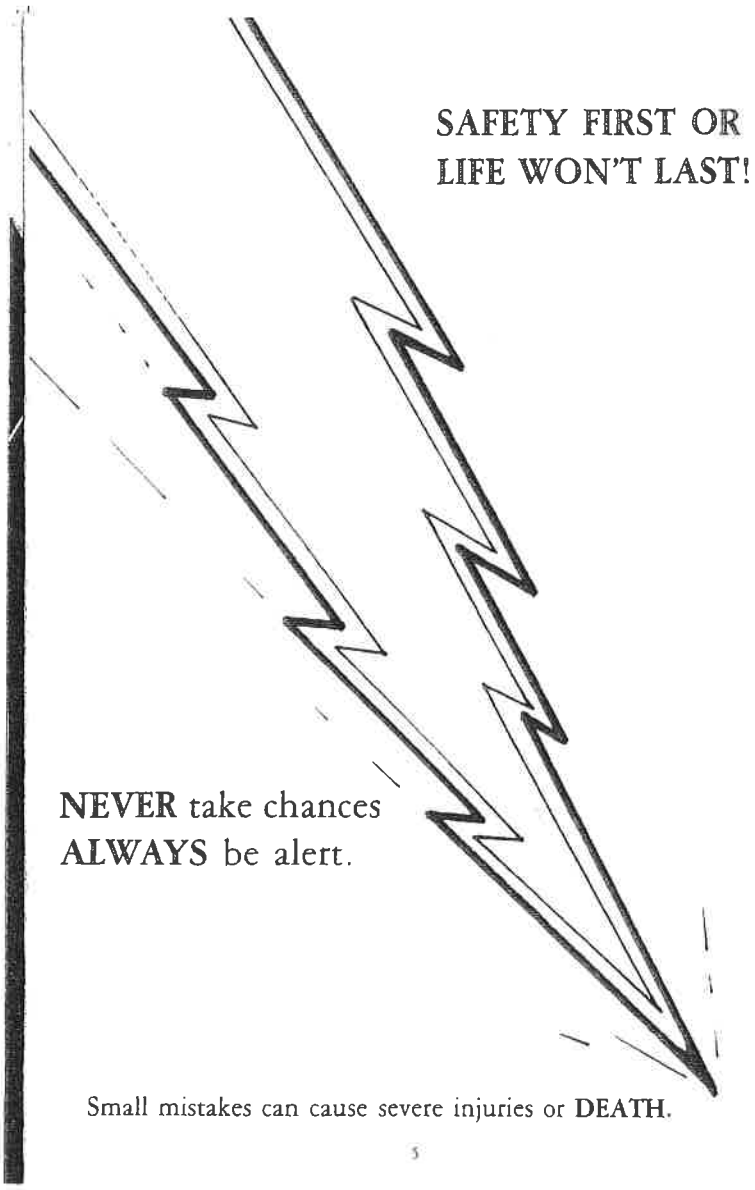
Breaking the law is bad enough.
Breaking your body is worse.

The requirements are for your safety.
Know and practice them.

DON'T BURN YOUR BODY

Reminder:
This is not a pruning guide for homeowners. They should never prune trees near electric lines.

ELECTRICITY CAN KILL!

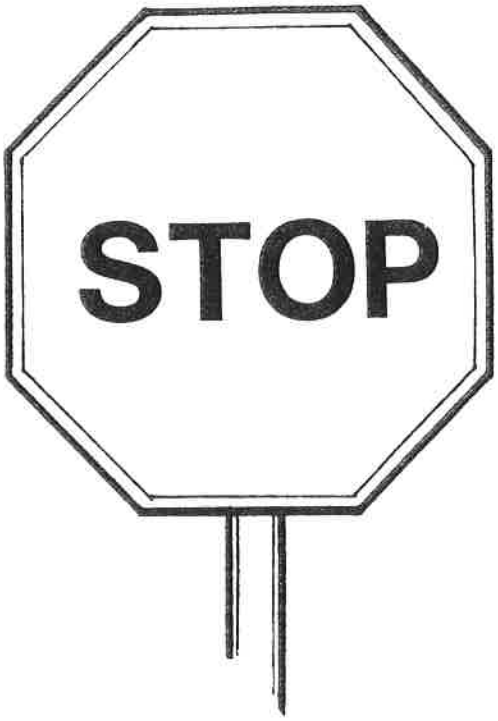


SAFETY FIRST OR LIFE WON'T LAST!

NEVER take chances
ALWAYS be alert.

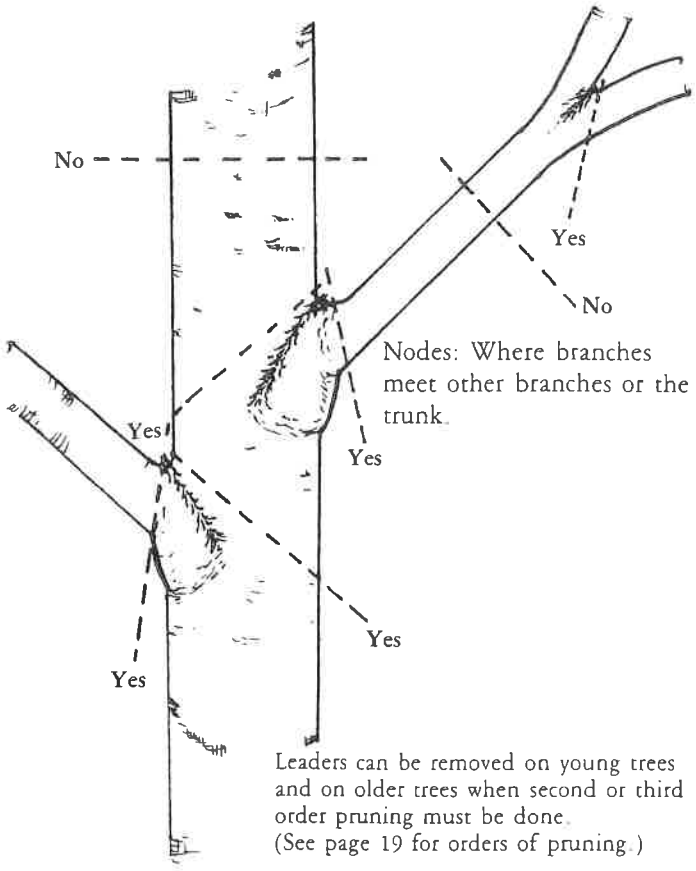
Small mistakes can cause severe injuries or **DEATH.**

1. Seeking permanent solutions.
   Do not plant trees near lines, or plant only low-growing, compact-form varieties.
2. Pruning small trees near lines during regular pruning cycles.
3. Removing branches only at nodes.



1. Topping and Tipping.
2. Removing branch collars or leaving long stubs.
3. Painting cuts.
   (Wound dressings do not stop rot.)

CUT AT NODES

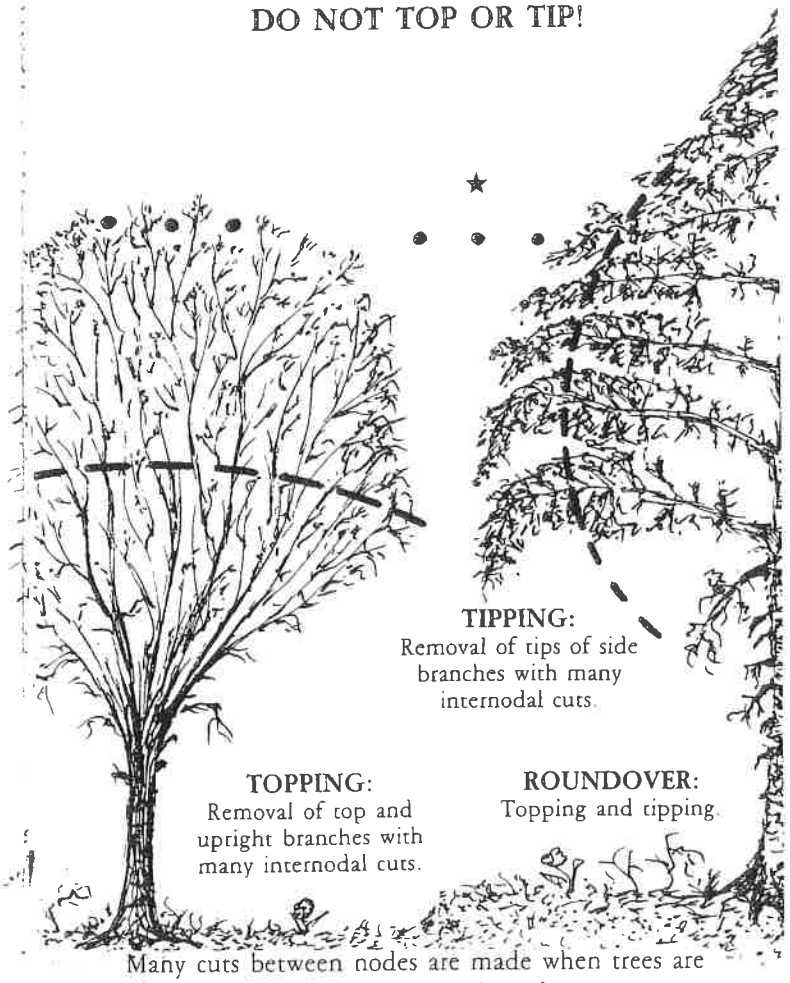


Nodes: Where branches meet other branches or the trunk.

Leaders can be removed on young trees and on older trees when second or third order pruning must be done. (See page 19 for orders of pruning.)

Making cuts between nodes leads to excessive sprouting, and to cracks and rot. Cracks and rot are major causes of branch and trunk failure.

DO NOT TOP OR TIP!



TIPPING:
Removal of tips of side branches with many internodal cuts.

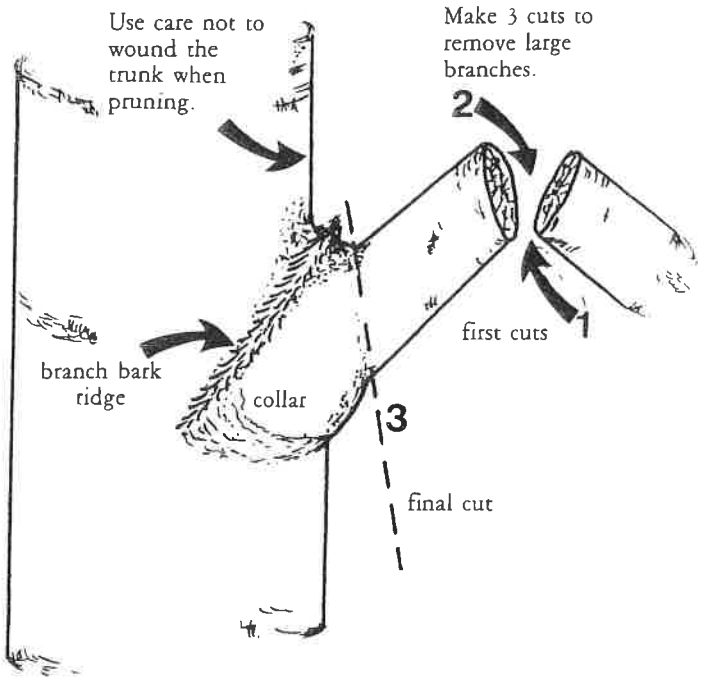
TOPPING:
Removal of top and upright branches with many internodal cuts.

ROUNDOVER:
Topping and tipping.

Many cuts between nodes are made when trees are rounded over or shaped.

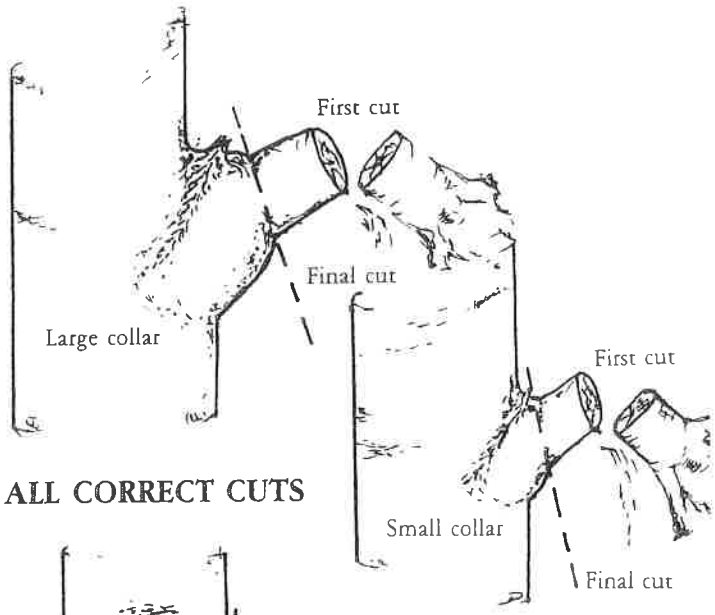
★ • • • indicates energized lines in this booklet.

NATURAL TARGET PRUNING

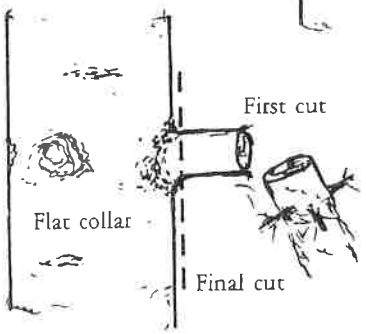


Cut as close as possible to the branch collar. Do not injure or remove the collar. Injury or removal of the collar destroys a major defense system of the tree, and also leads to excessive sprouting. Do not leave stubs. Stubs are entry courts for rot-causing fungi. Do not paint the pruning cuts. Wound dressings do not stop rot.

NO SET ANGLE FOR A CORRECT CUT



ALL CORRECT CUTS



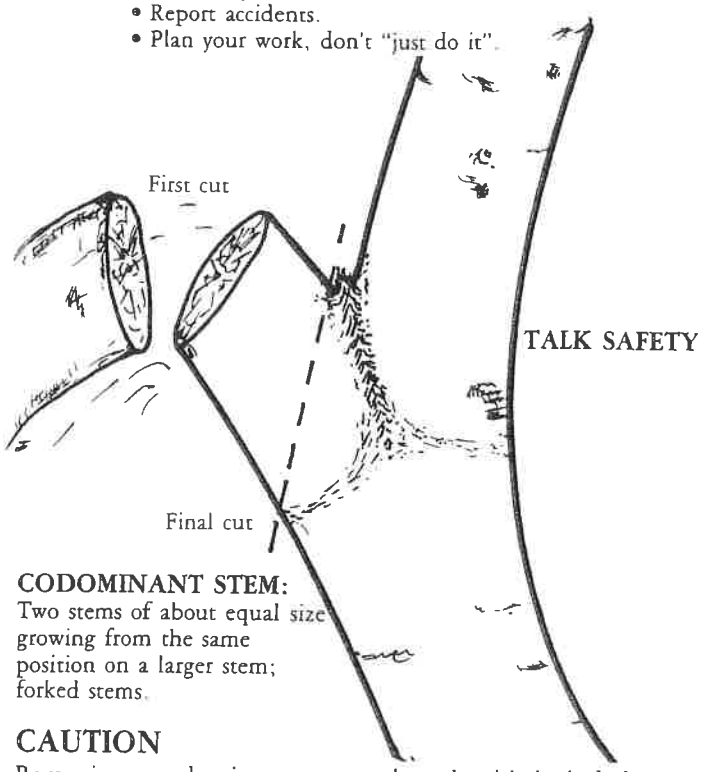
The size and shape of the collar determine the position and angle of the cut.

A ring or "doughnut" of living tissue will form around a correct cut after one growing season. (See page 32.)

CUT WITH CARE

Here are some safety rules professionals know and practice.

- Wear safety gear at all times.
- Know where your partners are at all times.
- Do not work when you are tired or sick.
- Do not ignore cuts and bruises.
- Report accidents.
- Plan your work, don't "just do it".



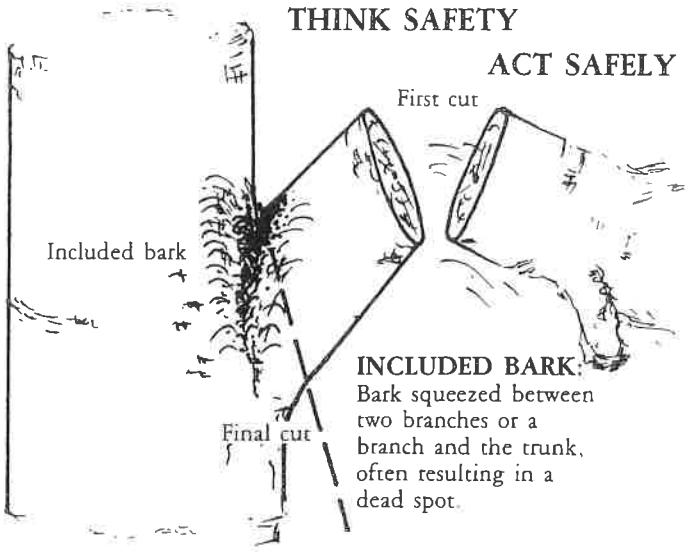
CODOMINANT STEM:
Two stems of about equal size growing from the same position on a larger stem; forked stems.

CAUTION

Removing a codominant stem or branch with included bark may require a final cut on the upstroke. Be alert to avoid kickback and be careful not to cut into the remaining stem.

BE ALERT TO AVOID KICKBACK!

- Respect power tools and use them safely.
- Check tools and equipment before you go into the tree
- Do only what you have been trained to do.
- Concentrate on your job.
- Have regular safety meetings.
- Remove branches with care, using ropes when necessary.
- Treat all conductors as energized.
- Do not force power tools beyond their limits.

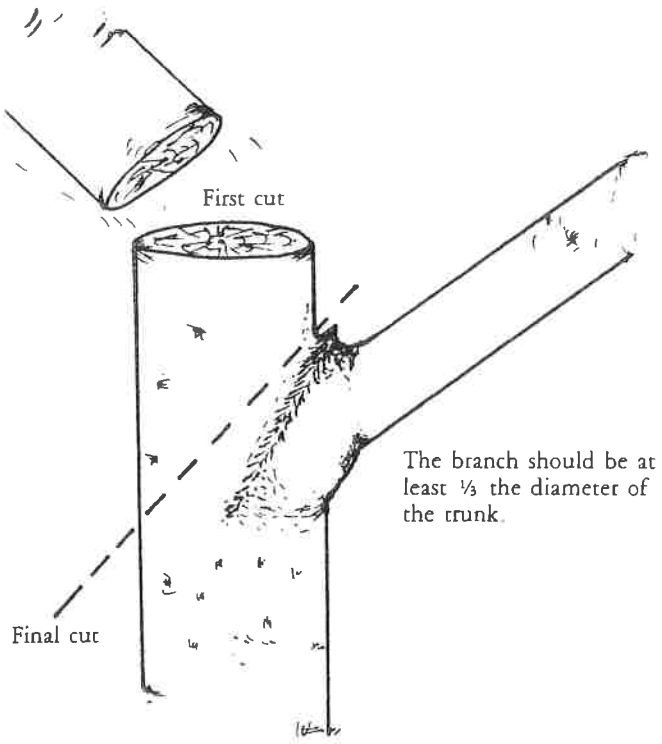


INCLUDED BARK:
Bark squeezed between two branches or a branch and the trunk, often resulting in a dead spot.

Included bark, more than branch angle, leads to weak unions and branch failure. Never put climbing ropes over branches with included bark.

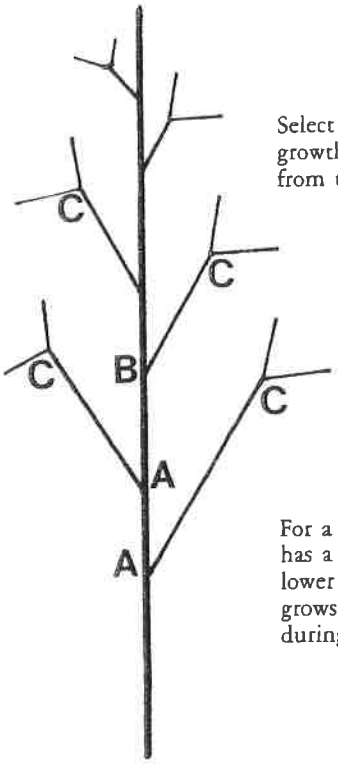
Reminder: This guide is for trained, qualified arborists who know how to operate a chainsaw and other power tools properly and safely.

REMOVING LEADER ON YOUNG TREES



If trees are planted near lines, plant varieties and shapes that can be pruned to remain healthy, safe, and attractive. Learn the growth characteristics of the trees before you plant.

PRUNING YOUNG TREES



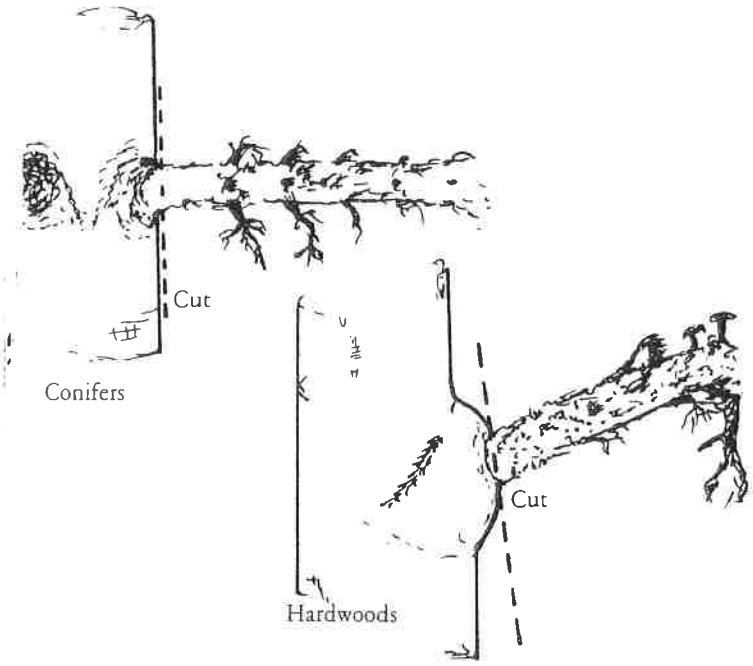
Select branches for future growth that will grow away from the lines.

For a tall tree away from the lines that has a strong central leader, remove lower branches at nodes A. As the tree grows, remove other lower branches during regular pruning cycles.

For a globular low tree, remove leader at B, and upright branches at nodes C. As the tree grows, remove upright branches during regular pruning cycles.

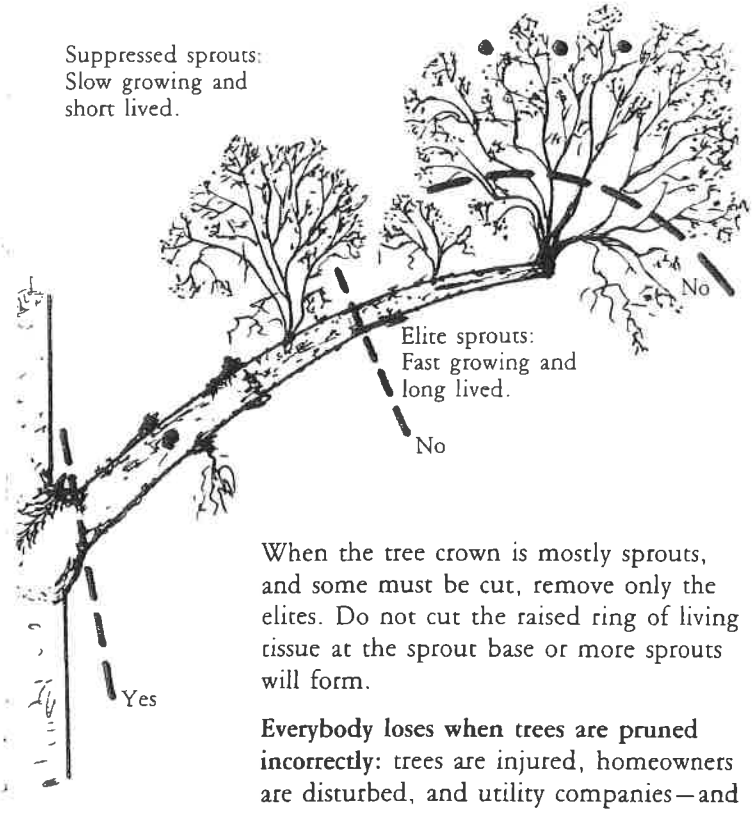
REMOVE DEAD WOOD CORRECTLY NEAR LINES

Removing dead wood is a health treatment for trees because rot-causing fungi use the dead wood as a food source while growing into the tree.



Cut dead branches as close as possible to the ring of living wood around the branch base. Do not injure or remove the ring of living wood. The tree's defense system that blocks rot is in the ring of living wood around the branch base.

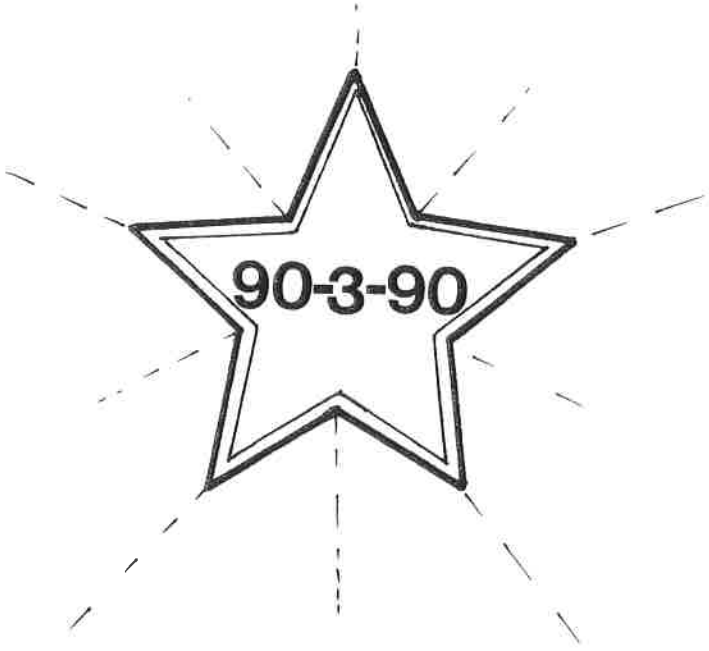
Remove entire branches that are growing toward the lines, and branches that when cut would produce sprouts that would grow toward the lines.



When the tree crown is mostly sprouts, and some must be cut, remove only the elites. Do not cut the raised ring of living tissue at the sprout base or more sprouts will form.

Everybody loses when trees are pruned incorrectly: trees are injured, homeowners are disturbed, and utility companies—and eventually customers—pay more to remove dead branches and sprouts growing toward the lines.

NEW CONCEPT



90% of the time
3 branches can be removed to provide
90% of the clearance.

REMINDER:

The person doing the pruning must weigh many variables before the cuts are made. A great amount of skill is needed to prune trees near electric lines. Some trees may require many cuts before pruning is complete.

NEW GUIDELINES

THREE ORDERS OF PRUNING

IDEAL

FIRST ORDER PRUNING

Start pruning young trees along the lines during regular pruning cycles. Make correct cuts the first time older trees are pruned.

SPECIAL NOTE

There are times and situations when less than ideal pruning must be done to remove a branch or tree that could fall on lines or to remove branches or trees after a storm.

SECOND ORDER PRUNING

The tree receives some internodal cuts. Correct cuts are made on trees that received incorrect cuts the first time. It may be necessary to remove some large branches.

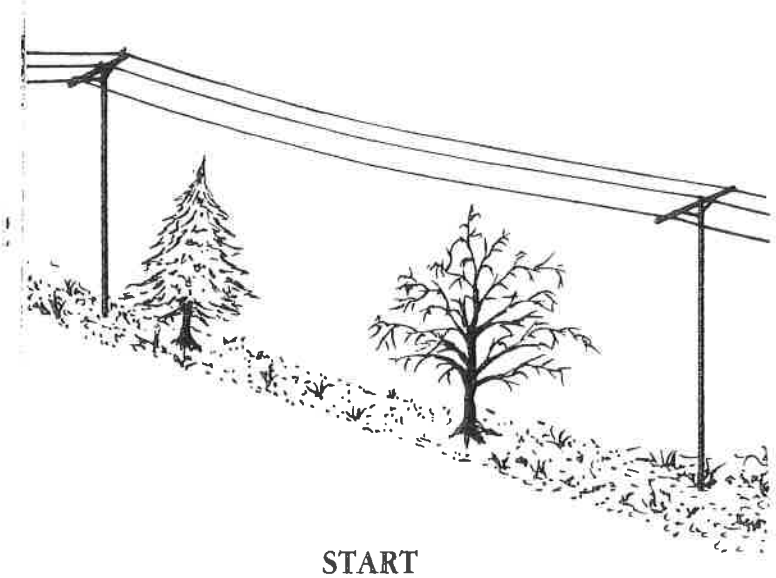
THIRD ORDER PRUNING

The tree receives many internodal cuts. Pruning is done to remove large branches that could fall during mild storms. It may be necessary to remove the entire tree.

FIRST ORDER PRUNING

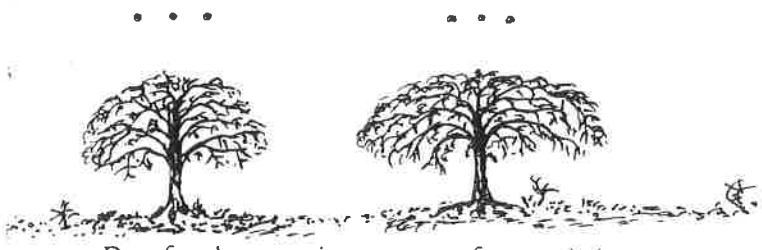
Start pruning young trees near lines during regular pruning cycles. If possible, start before trees are 15 feet (5 meters) high.

Make all cuts at nodes. Cuts between nodes cause serious injuries to trees of all ages.

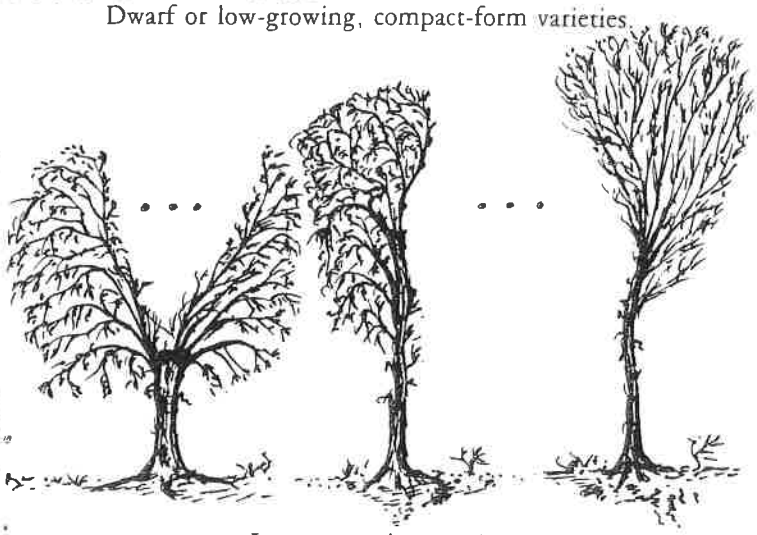


START NOW

Many tree shapes are possible when you start pruning the right species and varieties the correct way early in their lives. The tree can remain healthy and safe for many years.



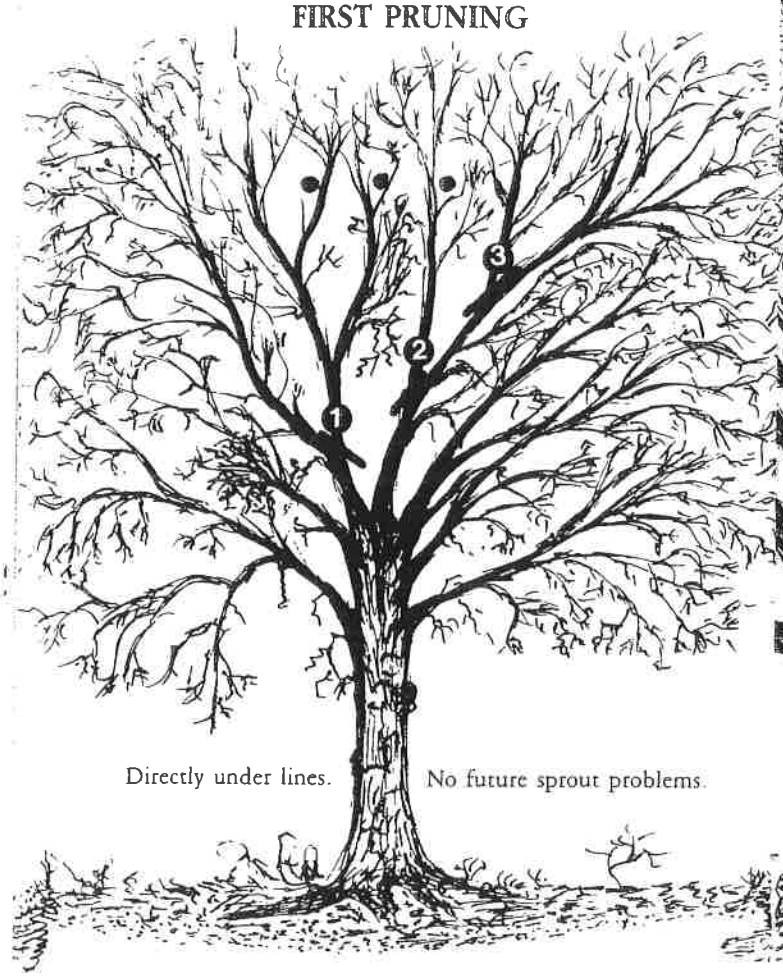
Dwarf or low-growing, compact-form varieties.



Large-maturing species.

THESE FORMS ARE POSSIBLE WITH CORRECT PRUNING.

FIRST PRUNING

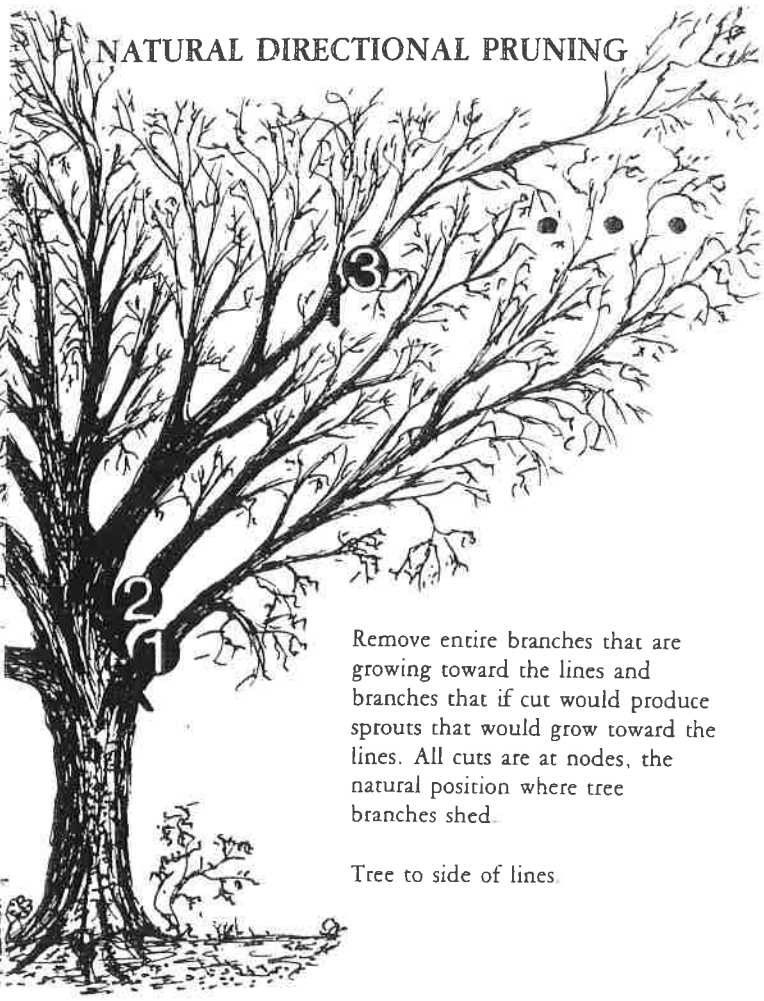


Directly under lines.

No future sprout problems.

Placement and number of pruning cuts shown in the drawings are examples only. The tree worker must make the final decision based on many variables.

NATURAL DIRECTIONAL PRUNING

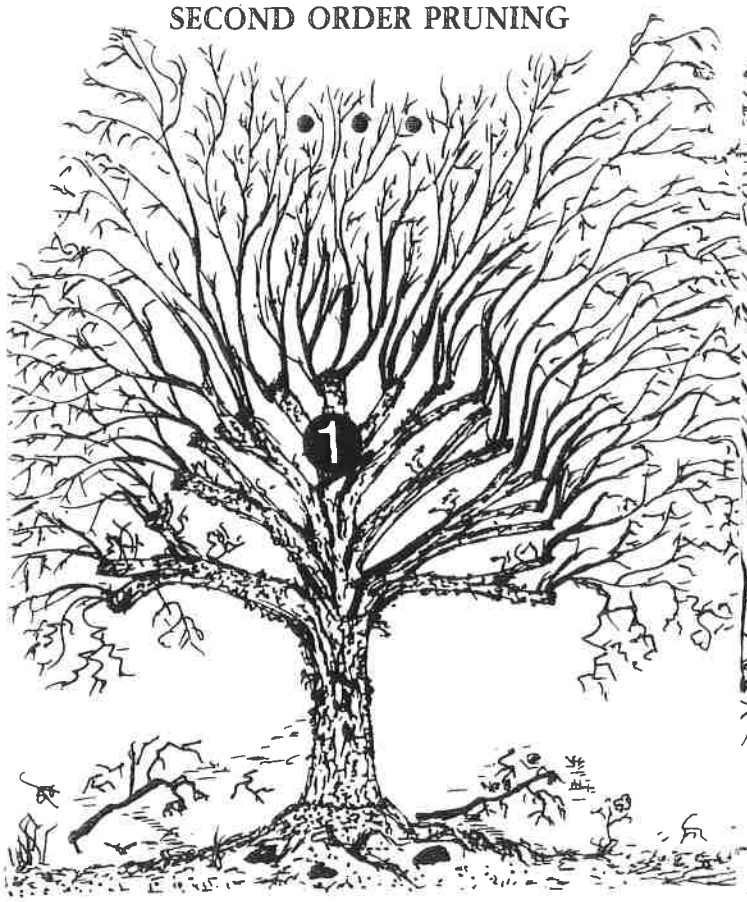


Remove entire branches that are growing toward the lines and branches that if cut would produce sprouts that would grow toward the lines. All cuts are at nodes, the natural position where tree branches shed.

Tree to side of lines.

Do not remove terminal buds on branches that are growing away from the lines. Do not roundover, shape, or "buzz" the tips of branches that are growing away from the lines.

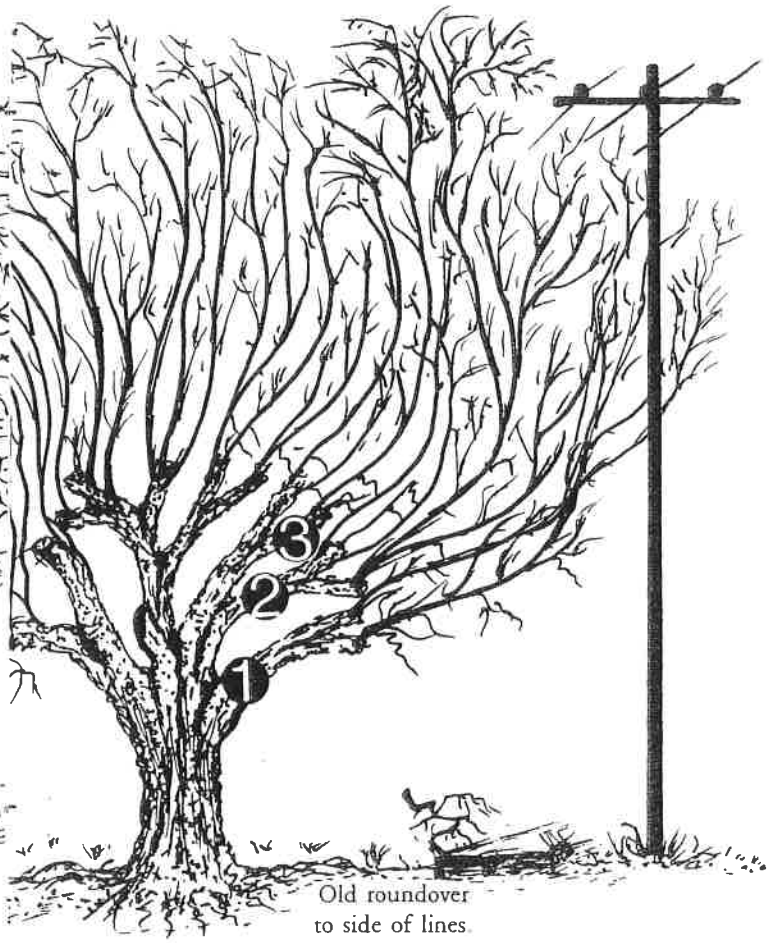
SECOND ORDER PRUNING



Old roundover
directly under lines.

Remove entire branches that have sprouts growing into lines from old topping cuts.

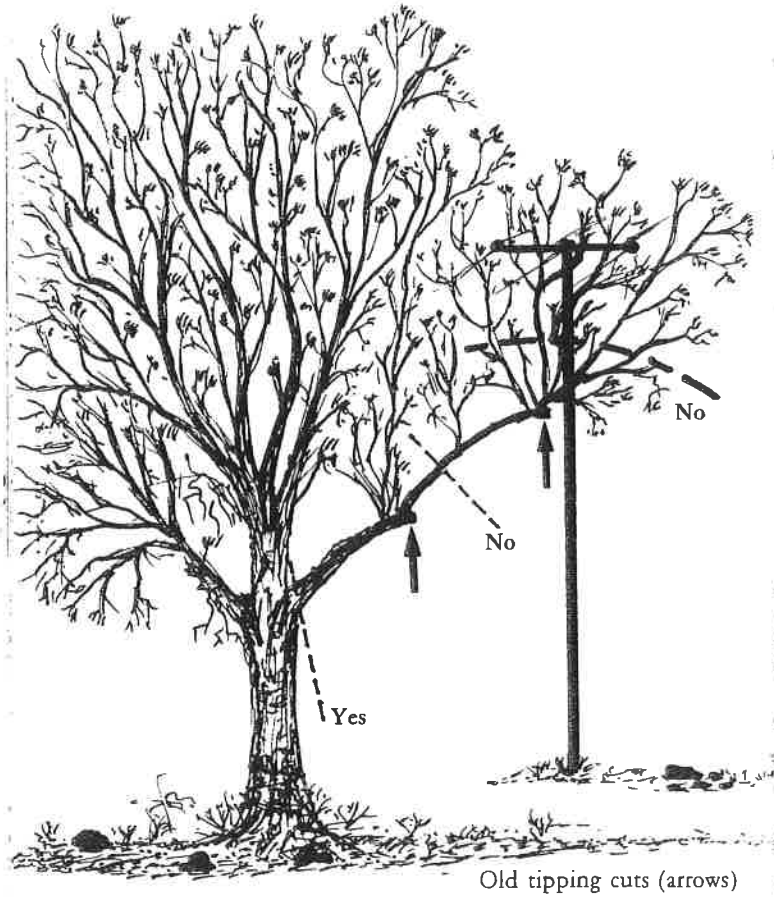
OLD ROUNDOVER



Old roundover
to side of lines.

Many trees incorrectly pruned in the past can be helped for health and safety by correct pruning.

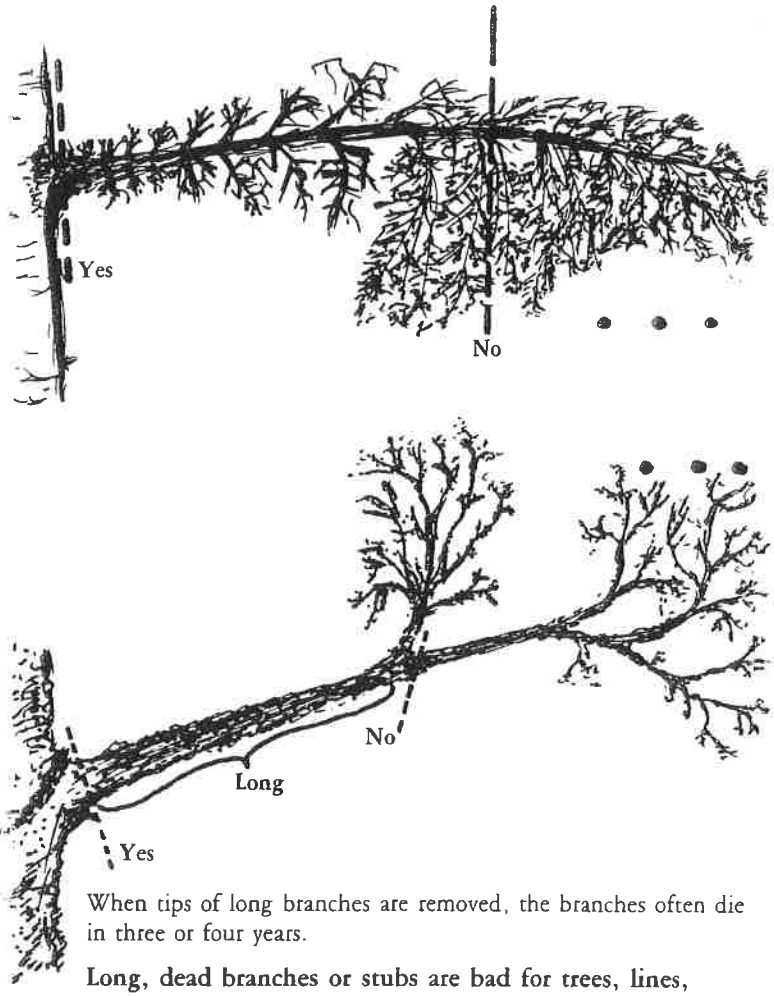
Remove entire branch that has sprouts growing into lines from old tipping cuts.



Tipping cuts are between nodes on lateral branches. Don't do it!

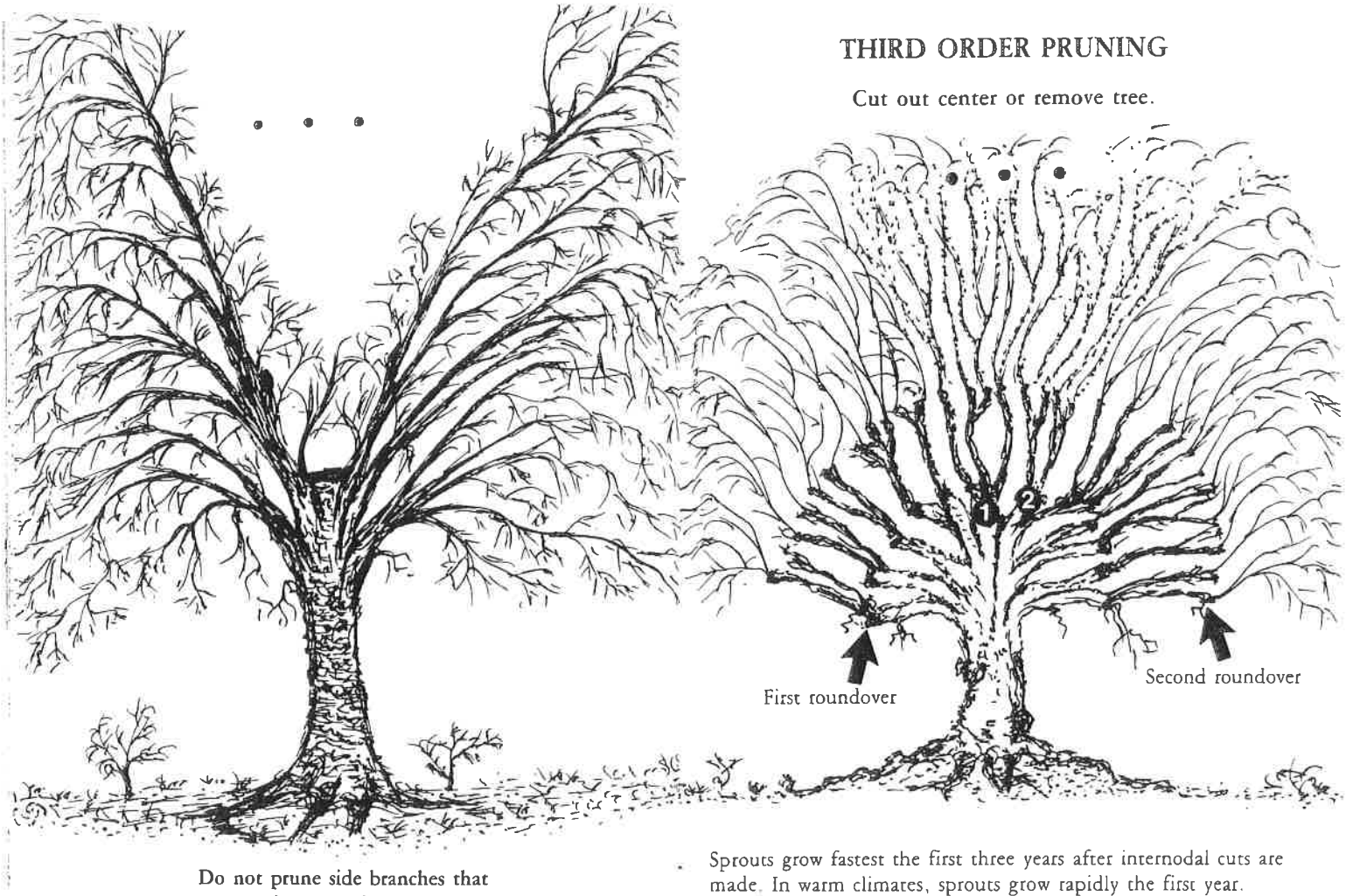
Tipping stimulates sprouting.

PRUNING LONG BRANCHES



When tips of long branches are removed, the branches often die in three or four years.

Long, dead branches or stubs are bad for trees, lines, and people!



THIRD ORDER PRUNING

Cut out center or remove tree.

1 2

First roundover

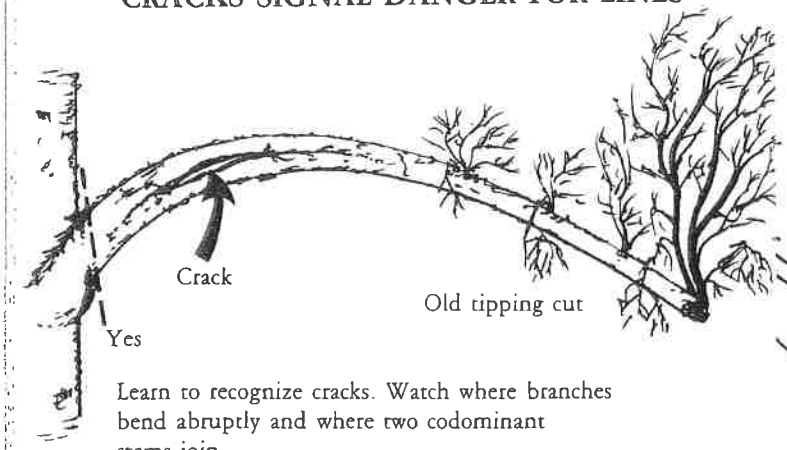
Second roundover

Do not prune side branches that are growing away from the lines.

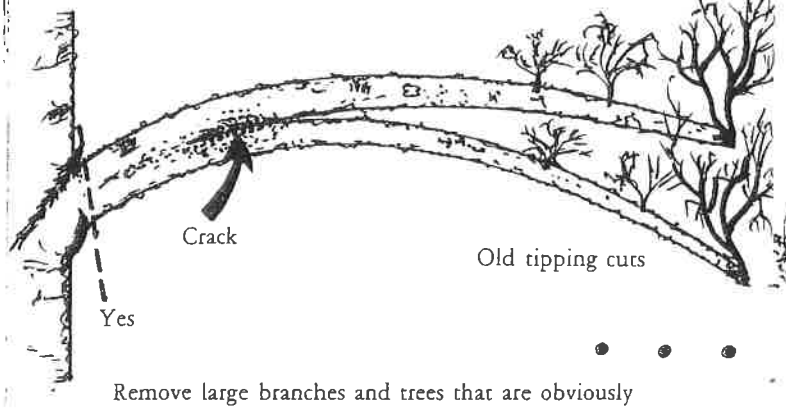
Side branches provide energy, and suppress sprouting by shading the center of the tree.

Sprouts grow fastest the first three years after internodal cuts are made. In warm climates, sprouts grow rapidly the first year. Topping and tipping every three years leads to the greatest number of sprouts. When trees are stressed by over pruning, many sprouts grow from dormant buds.

CRACKS SIGNAL DANGER FOR LINES



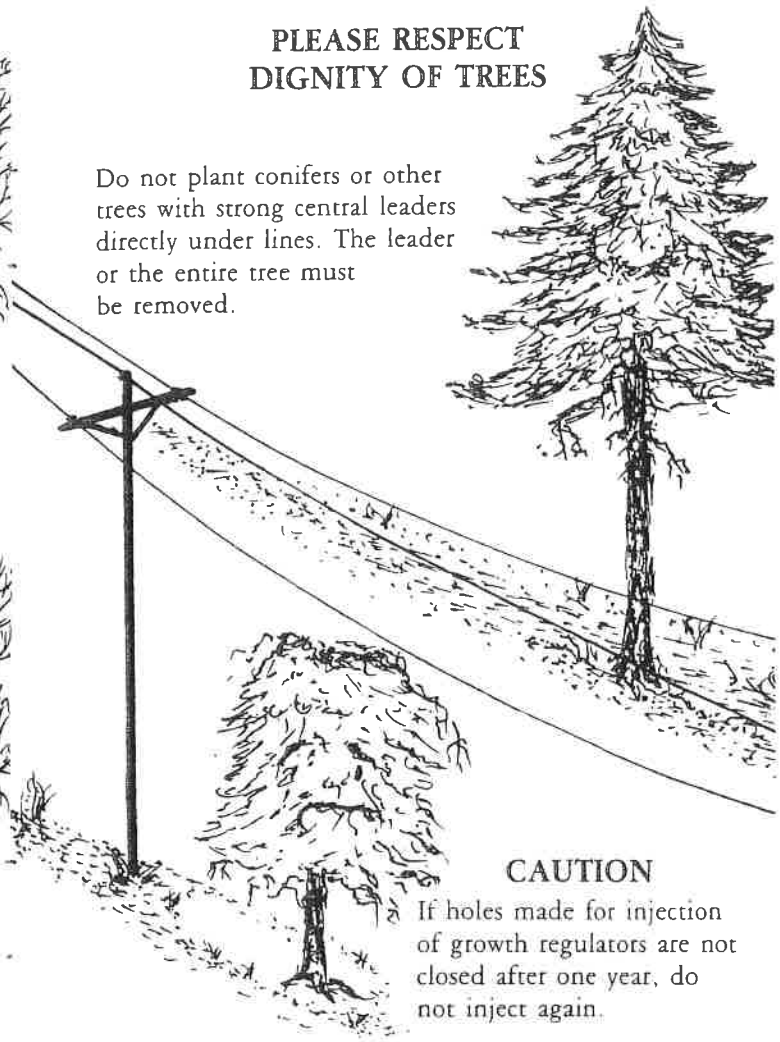
Learn to recognize cracks. Watch where branches bend abruptly and where two codominant stems join.



Remove large branches and trees that are obviously dangerous. Be on the alert for dangerous trees after storms.

PLEASE RESPECT DIGNITY OF TREES

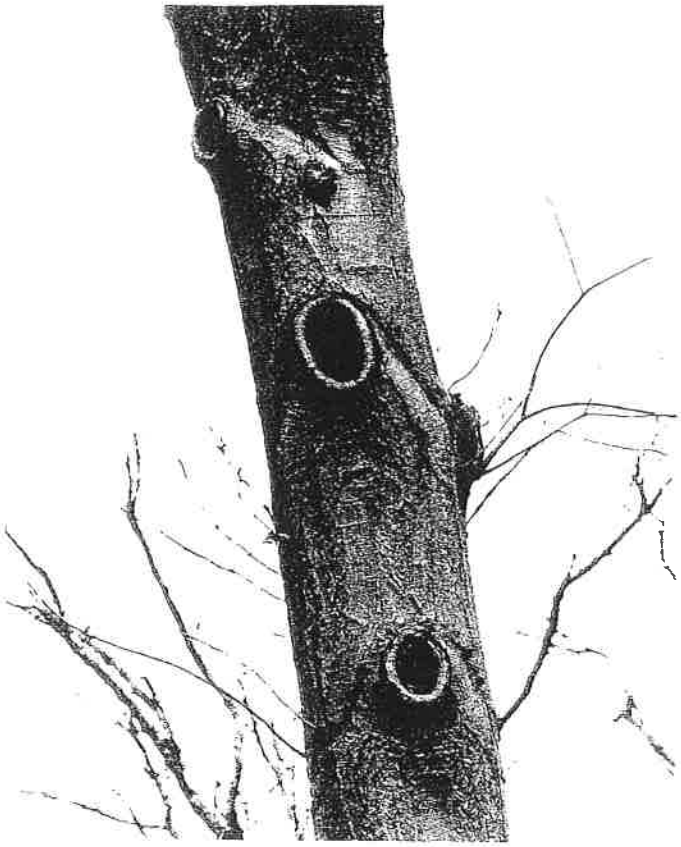
Do not plant conifers or other trees with strong central leaders directly under lines. The leader or the entire tree must be removed.



CAUTION

If holes made for injection of growth regulators are not closed after one year, do not inject again.

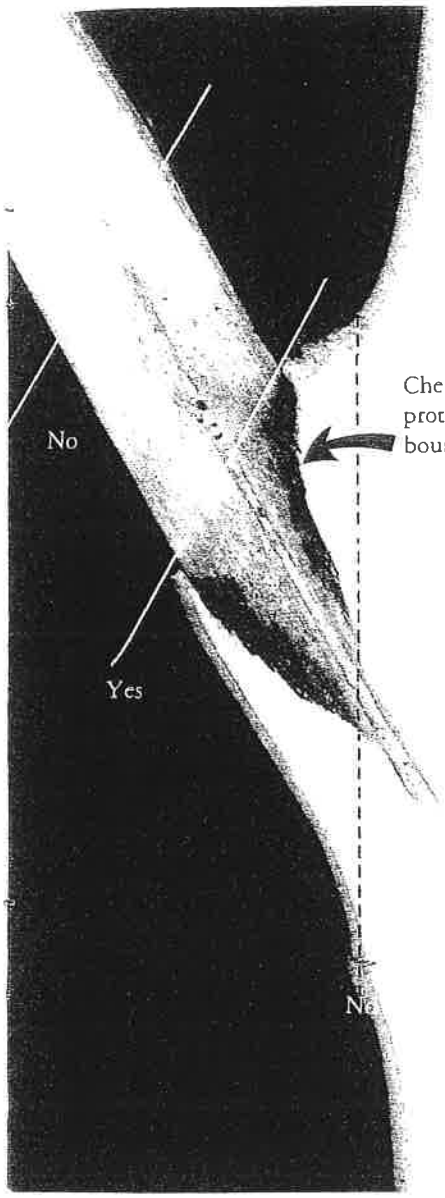
Do not use climbing spikes when pruning.



AIM FOR THE TARGETS

When branches are pruned correctly, rings or "doughnuts" of living tissue will form around the cuts after one year. Be a sharp pruner!

HIT THE TARGETS!



NATURAL TARGET PRUNING RESPECTS THE TREE'S NATURAL DEFENSE SYSTEM.

A collar cut does not remove the branch protection boundary within the branch collar.

WE MUST WORK TOGETHER

The guidelines given here aim to reduce sprouting, reduce the working time in a tree for the tree worker, increase the time between pruning cycles, and help the trees planted near lines to be as healthy, safe, and attractive as possible.

It is better for the trees, lines, and customers to remove fewer but larger branches at nodes. Nodes are where branches shed naturally.

It will take time to make all the adjustments given here. But, if we all work together, the adjustments will come. And the trees, the tree workers, the electric power companies, and the electric power users will all benefit.

For more details on pruning
see
TREE PRUNING
A Worldwide Photo Guide
by
Dr. Alex L. Shigo

For other books on trees by Dr. Shigo:
A NEW TREE BIOLOGY
A NEW TREE BIOLOGY DICTIONARY
TREE BIOLOGY AND TREE CARE

contact
Shigo and Trees, Associates
4 Denbow Road, Durham, NH 03824-3105

SUMMARY

1. Safety first or life won't last!
2. Know and practice OSHA and ANSI requirements.
3. Seek permanent solutions. Do not plant trees near electric lines; or plant only low-growing, compact-form varieties.
4. Start pruning young trees during regular pruning cycles.
5. Remove entire branches that are growing toward the lines; or branches that when cut would produce sprouts that would grow toward the lines.
6. Make cuts at nodes.
7. Cut branches as close as possible to the collar.
8. Do not paint cuts. Wound dressings do not stop rot.
9. Remove branches that have cracks and rot.
10. Remember 90-3-90, and that this is a guide, not a rule book full of absolutes.