TREE CITY USA®
BULLETIN
No. 35
Dr. James R. Fazio, Editor • $3.00

How to Protect Trees During Underground Work

Damage to roots can cause the sudden, tragic fall of a tree during even a light wind. More commonly, however, root damage leads to the slow, insidious decline of otherwise healthy trees. In either case, this unnecessary risk to life and property and loss of trees can be prevented by using proper procedures during underground work.

Courtesy of Ditch Witch®

Modern equipment is able to tunnel safely beneath the roots of a tree. It is widely available and used increasingly by utilities and construction companies.

"I get no respect," said the comedian. But it is no joke that all too often the same thing can be said of tree roots.

Hidden away beneath the soil, roots quietly — almost mysteriously — go about doing their job. They anchor immense trees firmly against the wind, serve up vital water, and pry loose essential elements from the soil. Unfortunately, when they grow in cities and towns, they also must share limited underground space with a plethora of underground utilities. There, in those crowded conditions, they live under the constant threat of disturbance from utility installation or repairs, new lawn sprinkler systems, construction of foundations or sidewalks, and any other activity that requires digging.

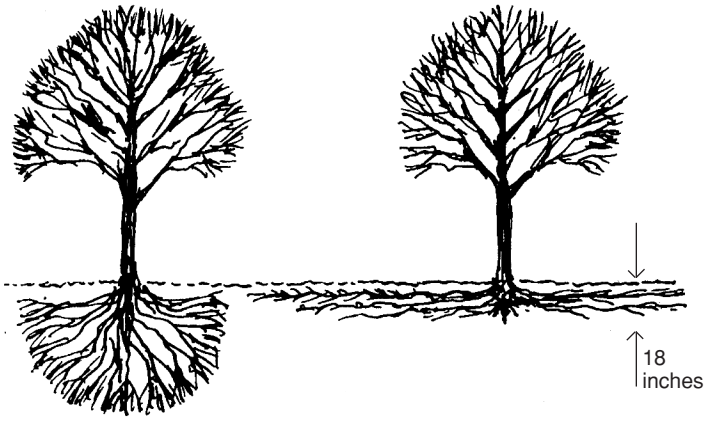
Today, modern technology has provided tunneling methods to install or replace most utilities with virtually no damage to roots. But even when digging a trench is necessary, there are ways to do it with minimal damage to nearby trees.

Published by
Arbor Day Foundation®
100 Arbor Avenue • Nebraska City, NE 68410

Trees and the Underworld

The underworld of ancient mythology or modern gangsters is a sinister place. But to a tree, the underworld is as much a part of its environment as the sky above. Roots are a tree's life support system, and the first rule of tree care is to understand root zones. Here are four facts of biology that will help you understand the part of a tree we rarely see — and why the trenching and tunneling techniques in the following pages are so important.

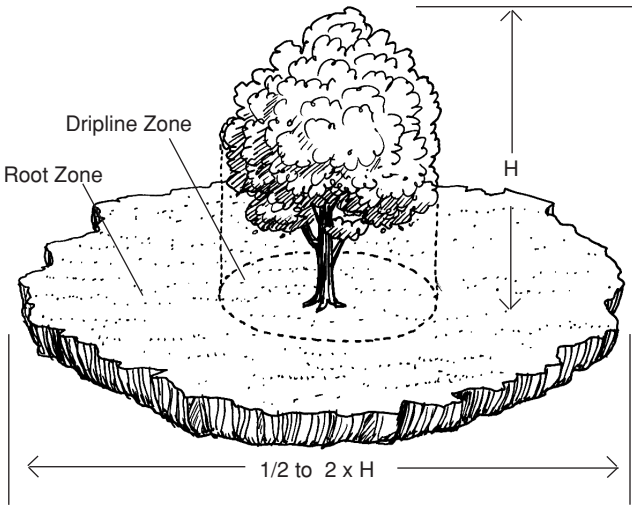
1. Tree roots are not an underground reflection of the crown.



NOT TRUE: This artist's concept regrettably shows how many people envision a tree's root system. Most species do not even have a tap root, and only under rare circumstances would roots appear like this.

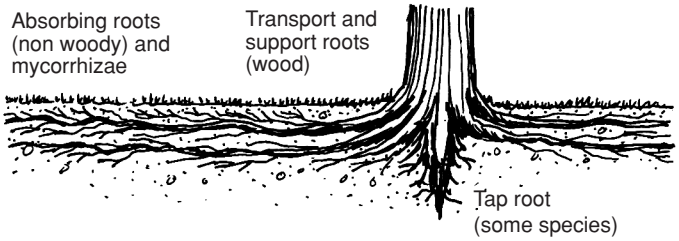
MORE LIKELY: Roots spread where soil conditions allow access to soil nutrients, moisture and sufficient air. This results in about 85 percent of a tree's roots being in the top 18 inches of soil.

2. Roots spread far and wide!



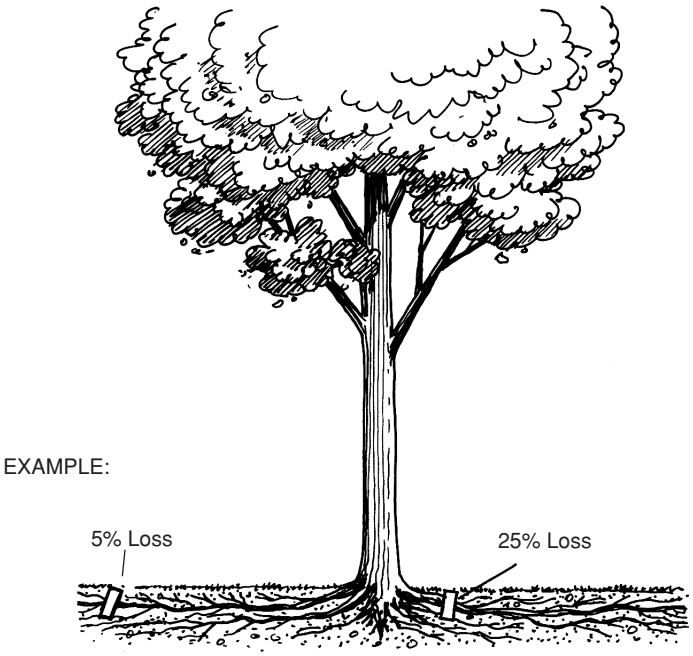
Roots spread amazingly far from the trunk. They typically spread up to 2 times the height of the tree — and sometimes farther! However, the essential mass of roots is usually found within the "dripline," the area underneath the tree's branches.

3. Roots form a complex underground network — and all parts are important.



Roots that are easiest to see are usually the larger, woody portions necessary for supporting the tree and transporting water and nutrients. These, however, taper out to nearly-invisible, non-woody threads that do the essential work of absorption. These tiny root structures are aided by beneficial fungi called mycorrhizae. Importantly, this active network is usually located within inches of the surface.

4. Root damage is proportional to how far a cut is made from the trunk of a tree.

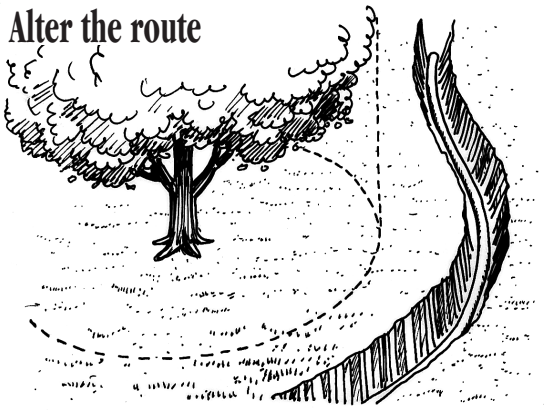


A single root that is severed close to the trunk will shut off the work of a large network of vital roots.

Preventing Damage from Trenches

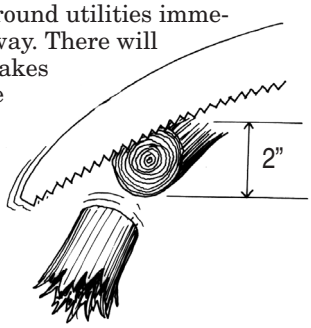
Trenches and trees don't mix! But when a trench—or ditch—is inevitable, here are some ways to minimize damage to roots.

☑ Alter the route



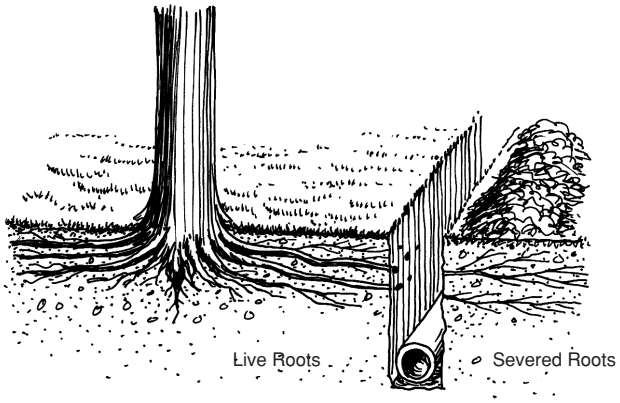
There is nothing sacred about straight lines or the shortest route between two points. When the health of trees are at stake, the small cost of additional material necessary for making a detour is often well worthwhile. Another method is to keep all underground utilities immediately adjacent to the driveway. There will be fewer roots there and it makes future digging less disruptive to vegetation.

☑ When you must cut roots, make sharp cuts



When roots 2 inches or larger must be cut, shovel by hand near the roots and saw the roots. Accidentally broken roots should be sawed a couple inches behind the ragged end. Crushed or torn roots are more likely to allow decay to begin; sharply cut roots produce a flush of new roots, helping the tree to recover from its injury.

☑ Work to the far side of the trench



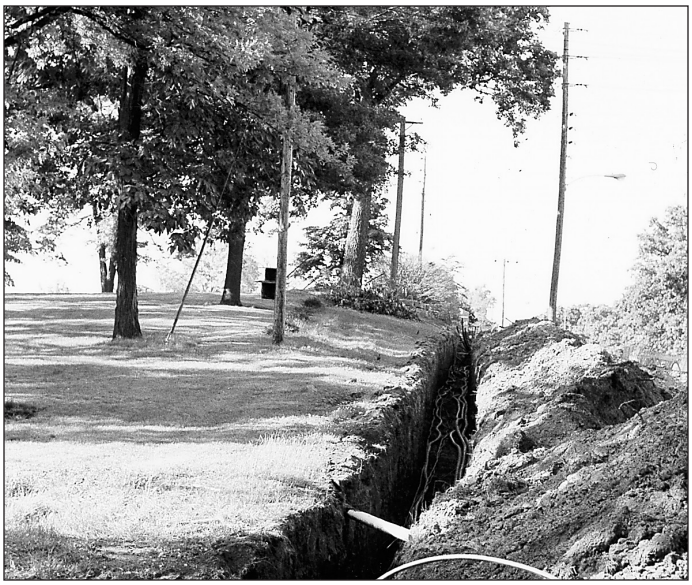
Keep the trench as far away from the trunk as possible, preferably outside the dripline. Then pile soil on the side away from the tree. When this is not possible, place soil on plywood, a tarp, or a thick bed of mulch. This is to help prevent cutting into the soil surface when the backhoe or dozer blade refills the trench.

☑ Keep root ends moist

Refill an open trench quickly. If this is not possible and the weather is hot, dry or windy, take steps to keep the root ends moist. A sprinkler system, mist from a hose, or wet burlap may help. Small roots can dry out and die in 10 - 15 minutes. Larger roots can succumb in an hour or less under unfavorable weather conditions.

James R. Fazio

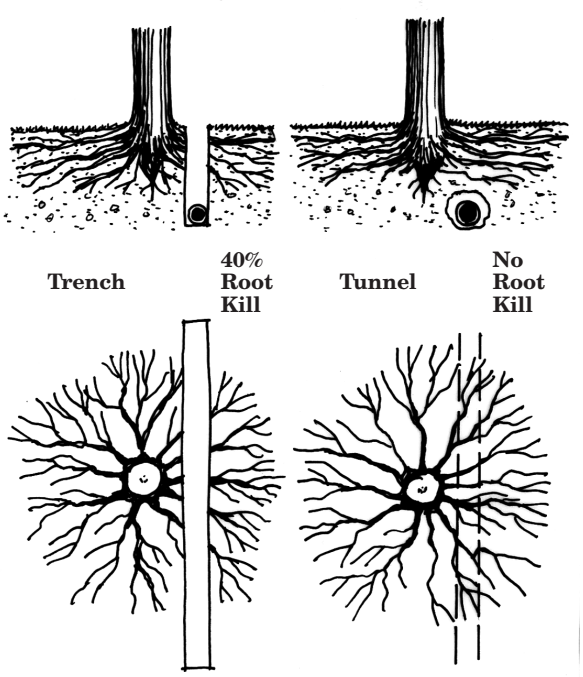
Whether a gaping hole for utilities, or a small slit for a sprinkler system, roots are severed just the same. When work is done near trees, insist that methods are used to minimize damage.



The Beauty of Tunneling

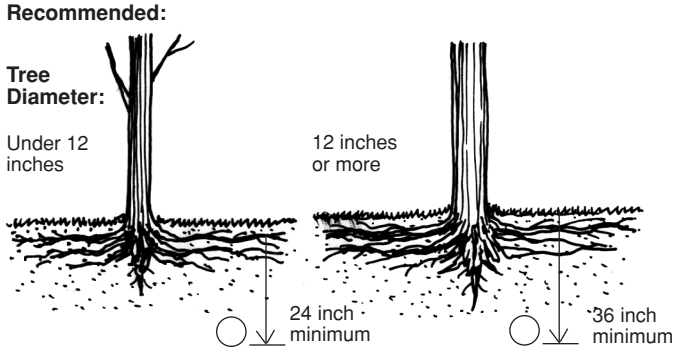
When pipes or cables must be placed — or replaced — within the root zone of a tree, there is no better way to do it than with tunneling. Once this was impractical. Today, tunneling equipment is more common and it has been developed to an astonishingly high level of performance. Homeowners benefit by having vegetation, fences, and other landscape features completely undisturbed. Utility companies can also benefit — by saving time, reducing restoration expenses, and eliminating customer complaints. Rather than being more expensive than open trenches, according to the Gas Research Institute in Chicago, tunneling now sometimes costs 15 to 50 percent less. Tunneling is truly a "win-win" solution in many cases where trees and underground work must mix.

Why tunneling saves trees



Trenching near a tree can kill as much as 40 to 50 percent of the tree's roots. This will almost certainly lead to stress, poor health, lack of firmness against wind, or outright death. A tunnel in the same place will do virtually no damage to the tree.

How deep should it be?



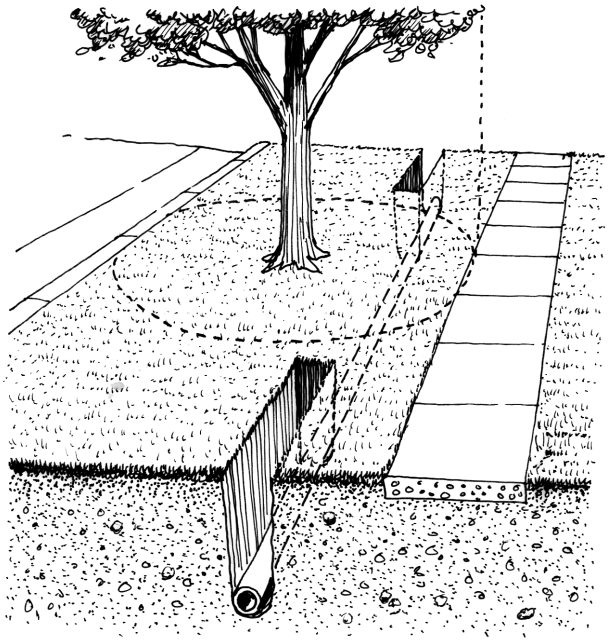
Since most roots live in the top 18 inches of the soil, a tunnel 24 inches deep will usually do little damage. However, root patterns vary depending on species, tree size, and soil conditions. If it is apparent from trenching in the vicinity that roots are deeper than expected, boring should also be deeper.

Note: By placing the tunnel 1 or 2 feet on either side of the tree trunk, tap roots can be avoided.

Where to start tunneling

Modern tunneling equipment makes it possible for accurate runs of up to thousands of feet. When long, continuous runs are not needed or possible, trenching can be used between trees. When the trench approaches a tree's root zone, tunneling should resume.

There is no sure way to determine the safest minimum distance between a tree trunk and a trench or tunnel access pit. However, here are some guidelines:



- Stay out of the dripline.
- Stop trenching when roots of 2 inches or larger are encountered.
- Use the following chart developed by the Municipal Foresters of Northeast Illinois:

If a tree's diameter is:	The distance of tunneling from any side of the tree should be at least:
6 to 9 inches	5 feet
10 to 14 inches	10 feet
15 to 19 inches	12 feet
over 19 inches	15 feet

Note: For trees under 6 inches in diameter, tunneling should begin at least 5 feet from the tree, or no closer than the root ball if newly planted. Another option for small trees is to use a tree spade to temporarily move the trees out of the way of underground work.

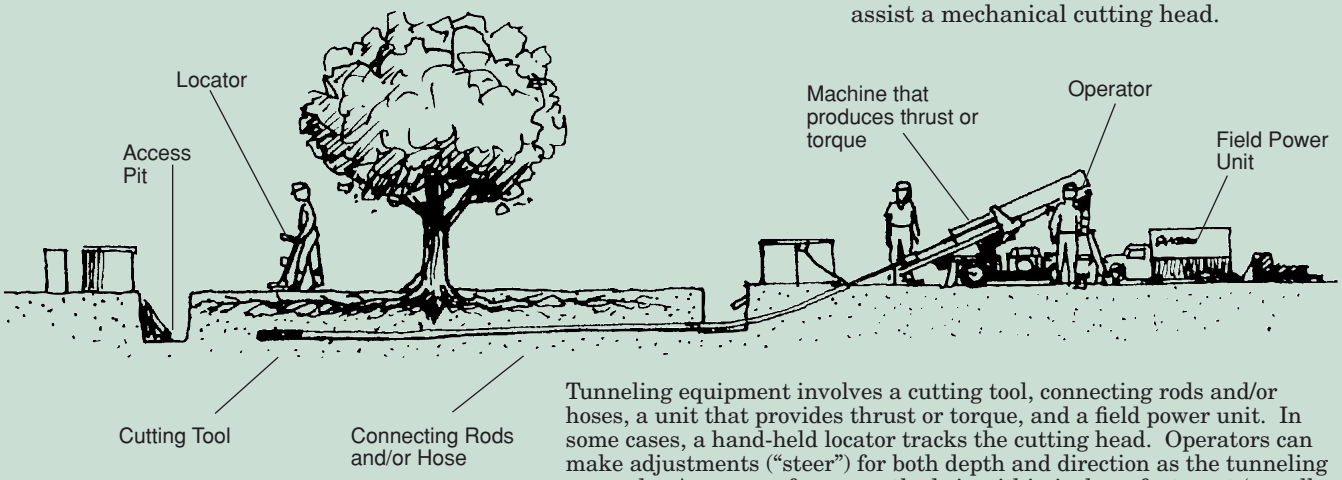
How Tunneling Works

Tunneling is an increasingly common tool used by electric, gas, telephone, cable TV and other industries to install and maintain pipes and transmission lines. The highly mobile equipment can produce hole diameters of 2 to 47 inches. Terminology varies, but boring, moling, and trenchless technology are some of the other names used for tunneling. Regardless of name, the methods used fall into one or a combination of three basic procedures:

Compaction Pneumatic/hydraulic equipment forces a piercing tool through the soil, displacing or squeezing soil to form a void.

Excavation This method has been around for over 30 years. Tools are more sophisticated now, but essentially involve a rotating auger that drills through the soil and pushes spoil material out behind it.

Wet Boring In wet boring methods, water or some other fluid is either used as the cutting agent, or to assist a mechanical cutting head.



Tunneling equipment involves a cutting tool, connecting rods and/or hoses, a unit that provides thrust or torque, and a field power unit. In some cases, a hand-held locator tracks the cutting head. Operators can make adjustments ("steer") for both depth and direction as the tunneling proceeds. Accuracy of some methods is within inches of a target (usually an access pit) at the end of the tunneled span.

Courtesy of Ditch Witch®

Tunneling equipment may be owned by a utility or construction firm, or available — complete with operators — on a contract basis. Equipment can be matched to virtually any soil or site conditions. Left, tunneling equipment that requires no access pit. Right, equipment that begins in an access pit, but that is narrow enough to fit into the end of the trench. Eliminating or minimizing access pits near trees is another way to reduce root damage.

Establishing Rules to Protect Roots

TREE CITY USA®

Tree boards and municipal officials need to be seriously concerned about the protection of root zones in the urban forest. There are tragic cases where street trees have been toppled by wind after their roots were cut by work crews. Less dramatic but equally serious is root damage that leads to poor tree health and mortality long after the crews have departed. The symptoms sometimes don't begin to appear until after the underground work is forgotten. Arborists or residents may spend time and money trying in vain to diagnose the problem and save the declining tree.

Many communities now have provisions in their ordinances that address this issue. While wording varies from place to place, here are examples of provisions most frequently found in a review of ordinances and accompanying standards and specifications from around the country.

To Whom the Ordinance Applies

- *Any underground utility installation that impacts city-owned trees due to underground conflicts with roots are specifically subject to the review and approval of the city arborist before the project starts.*

  (alternate wording)

- *No cutting of any part of city trees, including roots, shall be done without securing a permit from the city arborist.*

Trenching Near Small Trees (trees under 5" DBH)

- *Open trenching in the root zone of a public tree is prohibited except in cases where the trenching falls outside the dripline of the tree involved. Exceptions will be allowed if, in the opinion of the city arborist, the impact of trenching upon the tree will be negligible.*

Tunneling

- *All public trees in excess of 5 inches DBH, where there is insufficient space to bypass the dripline by trenching, must be tunneled. The beginning/ending distance of the tunnel from the face of the tree in any direction is determined by the diameter of the tree as specified by the accompanying table:*

When the tree diameter at 4–1/2 feet is:	*Trenching will be replaced by tunneling at this minimum distance from the face of the tree in any direction:*
6 - 9 inches	*5 feet*
10 - 14 inches	*10 feet*
15 - 19 inches	*12 feet*
over 19 inches	*15 feet*

  (alternate wording, or "Root Ball Method")

- *Guidelines for tunneling are based on A.N.S.I. Z60.1 Nursery Standards which basically state that for each inch of trunk diameter the tree needs a root ball of at least one foot in diameter. (The principle can be applied to non-transplantable trees for the purpose of determining when to start tunneling. As an example, a 30-inch diameter tree would need a "root ball" of 30 feet diameter. Tunneling, then, would begin at least 15 feet from the tree trunk.)*

Depth of Tunneling

Most cities require that utilities be buried at least 24 inches deep. Tunneling at that depth would pose little threat to most roots. Specifying a 36-inch depth is even safer. Another option is this table used in the *Arboricultural Specifications Manual* of the City of Springfield, Illinois:

Tree Diameter	Depth of Tunnel
9 inches or less	2.5 feet
10 - 14 inches	3.0 feet
15 - 19 inches	3.5 feet
20 inches or more	4.0 feet

Other Specifications

Other root protection measures found in ordinances or their accompanying standards and specifications include:

- *Any roots one inch (sometimes two inches) or larger damaged during construction shall be sawed off close to the tree side of the ditch. Clean cuts shall be made at all times. Wound dressing is not necessary or recommended.*
- *All trenches shall be filled to original levels and tamped to original firmness.*
- *Any tree that exhibits signs of deterioration within one year from the time of the underground installation that may be attributed to damage incurred during construction shall be removed and replaced, or treated, by the permittee as required by the city tree care expert.*
- *Snow fencing will be wrapped around all trees in the construction zone to protect them from bark damage caused by construction equipment.*

Tree Line USA

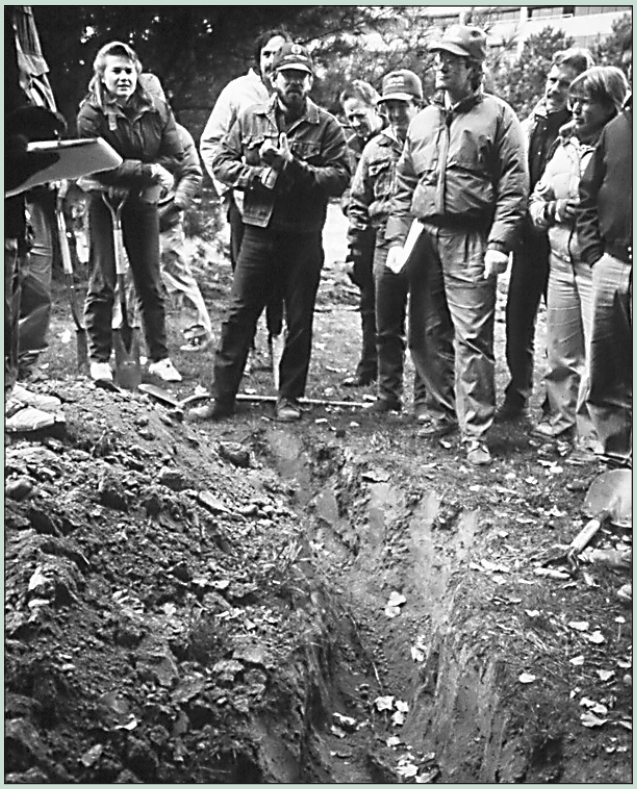
Tree Line USA is a program begun in 1993 to honor private or public utilities that meet tree protection requirements. The program is sponsored by the Arbor Day Foundation in cooperation with the National Association of State Foresters. It was developed with assistance from the Utility Arborist Association and a nationwide committee of advisors.

To qualify for the Tree Line USA Award, a utility must meet five general requirements:

1. Quality Tree Care
2. Annual Worker Training
3. Community Tree Planting and Public Education
4. Tree-based Energy Conservation Program
5. Arbor Day Observance

For more information, please write, call, or email to the Arbor Day Foundation for *Tree City USA Bulletin No. 25, Tree Line USA*, or go online to **arborday.org/treelineUSA**.

Root Appreciation Day!



Participants at a Root Appreciation Day Workshop get a true "hands-on" experience as they excavate roots and learn about the part of trees least seen.

Are you looking for an unusual event that will help people understand how roots grow so they can join you in tree protection efforts? Urban forestry consultant Chris Cowles found a way to teach about roots that people won't soon forget. He called it Root Appreciation Day and tried out the idea on a cold, windy day in a suburb of Washington, DC. It was almost a tongue-in-cheek kind of event, but to his surprise 40 dedicated people showed up.

"There were landscape architects, utility foresters, arborists, and university professors," said Cowles. "I couldn't believe the interest we generated."

The focus of Root Appreciation Day was on understanding the essential but unseen parts of a tree that so often suffer from trenching or excavation. Workshops that followed varied depending on the interests of participants and local site conditions, but the usual procedure was to locate one or more trees scheduled for removal. Armed with Pulaskis and shovels, participants then located roots at the base of the tree and carefully followed them outward, excavating as they'd go. It was "hands-on" learning at its best!

The exposed roots were then spray-painted for high visibility to become visual aids for discussion and demonstration. Some workshop lessons included:

- How root systems vary by species and soil conditions.
- The complexity of roots and the functions served by each part in the system.
- What roots do when they encounter a curb or other roots.
- The results of past excavation damage or other injuries.
- The depth of roots and how far they spread from the tree. (This offers a good opportunity for competition as teams follow different roots!)
- How well beliefs and rules of thumb stand up in light of actual investigation, e.g. the relationship of driplines to entire root zone.

The distance that roots spread is astonishing. Following one with a shovel provides an unforgettable lesson that can result in more careful protection of trees.

The need to tunnel or keep trenches far from trees becomes more apparent when roots are exposed for study.

Photos by Chris Cowles

The Amazing World of Trenchless Technology

An entire industry specializes in putting wires and pipes beneath the surface with virtually no disturbance to surface features or tree roots. The science and engineering behind the technology is advancing every day. Not only can facilities be installed through tunneling, repairs can be made. Moreover, the distances that can be accurately tunneled and the sizes of pipes or conduits that can be used can now meet virtually any need. Most lay people and even many urban foresters are unaware of the capabilities of this equipment and its practical application around trees. Awareness and the will to find better ways to protect trees are the first important steps in making the use of trenchless technology an expected part of urban forestry.

To become acquainted with this industry and its potential for projects in parks or around street trees, a good starting point is to type 'trenchless technology' into your favorite search engine.

For More Information

For sources of additional information about protecting trees underground, please visit **arborday.org/bulletins.**

Walter C. Fazio

Roots are opportunists. They go where conditions are best, always searching for the optimum in air, water and soil to meet their life-sustaining needs. In the case of this cedar, a crevice and even the rock face provide the best (or only!) options. In lawns, the rich soil just under the surface is where most will grow, making them very vulnerable to trenches or other digging.

Tree City USA Bulletin ORDER FORM

Name _____

Organization _____

Address _____

City _____ State___Zip _____

Phone _____

			1 Issue $3.00 ea.
1.	How to Prune Young Shade Trees	1.	$
2.	When a Storm Strikes	2.	
3.	Resolving Tree-Sidewalk Conflicts	3.	
4.	The Right Tree for the Right Place	4.	
5.	Living With Urban Soils	5.	
6.	How to Hire an Arborist	6.	
7.	How to Save Trees During Construction	7.	
8.	Don't Top Trees!	8.	
9.	Writing a Municipal Tree Ordinance	9.	
10.	Plant Trees for America!	10.	
11.	How to Prevent Tree/Sign Conflicts	11.	
12.	What City Foresters Do	12.	
13.	Trees for Wildlife	13.	
14.	How to Kill a Tree	14.	
15.	How to Recognize/Prevent Hazard Trees	15.	
16.	How to Recycle Shade Tree Materials	16.	
17.	How to Landscape to Save Water	17.	
18.	Tree City USA Growth Award	18.	
19.	How to Select and Plant a Tree	19.	
20.	A Systematic Approach to Bldg. w/Trees	20.	
21.	How Trees Can Save Energy	21.	
22.	Tree City USA: Foundation for Better Mgt.	22.	
23.	How to Conduct a Street Tree Inventory	23.	
24.	Trees and Parking Lots	24.	
25.	Tree Line USA	25.	
26.	Understanding Landscape Cultivars	26.	
27.	How to Manage Community Natural Areas	27.	
28.	Placing a Value on Trees	28.	
29.	How to Plan for Management	29.	
30.	Ten Tree Myths to Think About	30.	
31.	Tree Protection Ordinances	31.	
32.	Let's Stop Salt Damage	32.	
33.	How to Interpret Trees	33.	
34.	How to Fund Community Forestry	34.	
35.	How to Protect Trees During Underground Work	35.	
—	Tree City USA Annual Report		
		TOTALS:	**$**

Annual Friends of Tree City USA Membership ..... $15.00 $ _____

Tree City USA Bulletin 3-Ring Binder.....$ 5.00 $ _____

Complete Bulletin Set, in binders..... $99.00 $ _____

TOTAL PAYMENT: $ _____

Order Tree City USA Bulletins online at **arborday.org** or send this form and mail with your payment to:

Arbor Day Foundation, 211 N. 12th St., Lincoln, NE 68508

(Make checks payable to Arbor Day Foundation)

1599 035

50011506

John E. Rosenow, publisher; James R. Fazio, editor; Gerreld L. Pulsipher, information designer; Gene W. Grey, William P. Kruidenier, James J. Nighswonger, technical review committee.

Published for the *Friends of Tree City* USA by

Arbor Day Foundation®

100 Arbor Avenue • Nebraska City, NE 68410

arborday.org

RECYCLED PAPER RECYCLABLE | PRINTED WITH SOY INK