Planting and After Care of Community Trees

PENNSTATE
College of Agricultural Sciences
Agricultural Research and Cooperative Extension

This publication is for people who plant trees in public landscapes, such as streets and parks. Much of the advice is also useful to those who plant trees around homes and businesses. To properly plant trees, you should understand the characteristics of planting sites, the tolerances and growth characteristics of tree species, and the benefits you want to receive from the trees.

Start planning 6 to 12 months before planting and allow time to conduct a thorough site analysis, find and obtain quality trees, and arrange for supplies, equipment, and workers. Trees should be selected that are well adapted to the planting site and strategically located so their roots, trunks, and branches have adequate room to grow. Trees need adequate space above and below the ground to remain healthy, safe, attractive, and to grow to a mature size.

Understanding the Planting Site

Trees differ in their requirements for growth. Selecting trees that will become established and thrive in the biological and physical conditions of the planting site requires observation and thought. A thorough planting site analysis will identify important site conditions that can affect the survival and growth of the trees to be planted. Experienced tree commission members or arborists are best qualified for analyzing tree planting sites, but even a novice can do a site analysis reasonably well using good information and common sense.

Essentials for Evaluating Planting Sites

Climate and Weather

- Temperature extremes
- Moisture
- Light
- Wind

Soil

- Structure
- Compaction
- Drainage
- Texture
- Depth to hardpan or rock
- pH (acid or alkaline)
- Fertility
- Salinity
- Contamination and pollution

Growing Space

- Volume of soil for roots
- Space available for trunk and crown growth
- Placement of utilities
- Constraints of sidewalks, curbs, streets, and buildings
- Conflicts with pedestrian and vehicular traffic

Functional Benefits of Trees

- Design themes, sense of place
- Complement existing flora
- Climate modification
- Noise reduction
- Screen or enhancement of views
- Pedestrian and vehicular traffic considerations
- Erosion control
- Wildlife food and cover

- Visit or meet with people in the neighborhood to inform them, listen to their concerns, and seek their assistance in planning planting projects. People can help care for trees or they can ignore or vandalize them, so the attitudes of people living where street and park trees are to be planted are important.
- Assure them that all legal requirements will be met. Many municipalities have ordinances describing who may plant trees, what trees may be planted, and where.
- Consider landscape design. Trees are used for various design purposes, such as creating a sense of place, security, and comfort. They may complement important views and architectural features. Tree plantings can be formal and uniform or informal and diverse. Narrow trees can accent or frame significant features; broad trees or groups can soften or screen harsh features. Their flowers, fruit, foliage, and bark can stimulate the senses with fragrance, texture, and color.
- The trees selected for planting must be able to withstand the coldest temperature that can be expected in the area. Determine the hardiness zone of your tree planting site by checking a hardiness map based on low temperature extremes. These maps

are available at your local library or county extension office, in many nursery catalogs, or in *Street Tree Factsheets* (Gerhold et al. 1993).

- Safety is important. Consider how clearance for pedestrians, vehicles, lighting, signs, and utilities will be maintained. Visibility at street intersections is reduced as trunks grow in diameter.

- Space is often limited in urban areas. Look up, look down, look all around! The planting space above and below the ground should be large enough for the selected trees to reach their mature height, branch spread, trunk diameter, and root extension without interfering with surrounding objects and the activities of people. Roots can extend well beyond the spread of branches. Identify objects such as buildings, roads, sidewalks, signs, and underground and above-ground utilities that could restrict or conflict with the growth of roots and canopy. If enough space exists for a tree to grow to its mature size, damage to sidewalks and curbs will be reduced or eliminated, and severe pruning will not be required later.

Fig. 1. Large-growing trees such as red oak and Norway maple should not be planted under power lines.

- An adequate amount of fertile soil is crucial for tree growth. Tree roots need sufficient amounts of water, oxygen, and nutrients supplied from soil to grow. Investigate critical soil factors such as depth, texture, structure, amount of rocks and other debris, compaction, drainage, pH (acidity or alkalinity), and fertility levels by digging one or more test holes. Soil compaction restricts root growth. Poor drainage and standing water can cause a tree to be unhealthy, limit its growth, or kill it. If compaction or drainage is a concern, pour a gallon of water into a 12-inch-wide, 24-inch-deep test hole. If the water does not drain from the hole in 8 hours, consider planting the tree in another location that has better drainage. Replacing the soil in a planting area may or may not help drainage problems caused by surface or subsurface soil compaction; suggestions for managing compacted soils are provided later in this publication. Some species of trees such as red maple, red oak, pin oak, and sweetgum cannot tolerate alkaline soil (pH above 7.0). If concerned about the fertility or pH of a soil, ask for advice about completing a soil test from your county extension office.

Fig. 2. Planting large trees in confined areas causes sidewalk and other damage.

Fig. 3. There is not enough room above or below the ground to plant trees here.

- The condition of nearby trees and other plants can indicate whether health problems can be expected and what tree species may or may not do well. Browning and scorching of leaves during summer, premature fall coloration, and yellow or chlorotic leaves can indicate sites that are hot, droughty, compacted, or that have a high pH or road salt problems. Some species tolerate certain adverse conditions better than others do. Also, the condition of neighboring trees can indicate insect or disease problems such as plant bug, verticillium wilt, or fire blight that can cause problems to susceptible tree species.

- Investigate the sun and shade patterns of the site. Some trees need full sun, others will tolerate partial shade, and a few prefer shade. Trees can be planted strategically around buildings to provide summer cooling and decrease winter shade, which reduces energy expenditures for air conditioning and heating. Plant trees on the west and east sides of buildings to shade during summer. To decrease the shading of buildings during the winter, keep trees away from the south side of buildings a distance that is at least twice the mature height of the tree. Thicker rows of evergreen trees can be planted on the north side of buildings to shield against winter winds.

Keep in mind that trees can have a long life span if properly selected, planted, and maintained. If trees will not receive inadequate pruning, watering, and other care, trees should be selected that tolerate a low level of care. It is also important to consider the future health of trees by thinking about how the site conditions might change and recognizing the size and form that a mature tree will have both above and below the ground.

Selecting the Right Tree

The tree variety chosen for a planting site should be tolerant of the site conditions determined during site analysis, compatible with the landscape design, and capable of providing the desired benefits. Important characteristics to consider when deciding what tree to plant include cold hardiness, mature size, shape, branch structure and strength, flowers and fruit, growth rate, longevity, rooting characteristics, and resistance to common insect and disease problems. Also consider the tree's tolerance to soil compaction, heat, drought, sun or shade, and to pollutants such as road salt.

You should consider the ornamental benefits of trees such as fall color, showy flowers, fruit, and bark. Trees can be used to control pedestrian and vehicular traffic, hide unsightly buildings and views, and increase human comfort by screening the wind and shading buildings, sidewalks, and parking lots. They can be used to provide cover and food for birds. Trees can also provide feelings of security and comfort. Also consider possible maintenance problems. Some trees require excessive pruning, while others drop messy fruits and flowers.

Selecting the wrong type of tree that is not well adapted to a planting site can lead to low survival, sickly or unattractive growth, and premature death. Planting the wrong type of tree also can lead to unattractive streets, increased sidewalk and curb damage, and interference with utilities and signs. Desirability of tree fruits by birds and wildlife are additional considerations in species selection since bird droppings can be a nuisance in parking lots and other public places. All of these add to long-term maintenance costs.

Besides the many tree species that are available, nurserymen and horticulturists have developed numerous cultivars. Cultivars originate when an individual tree is selected for its superior qualities such as form, fall color, size, or disease resistance. Cultivars are asexually propagated by budding onto ordinary seedlings, by rooting of cuttings, or by tissue culture. All the trees of a cultivar are uniform in appearance and their disease tolerance, growth, fall color, flowering, and fruiting are predictable.

Fig. 4. Trees grow in many different shapes and sizes, from broadly spreading to upright.

To find information on tree species and cultivars consult a cooperative extension specialist or a publication such as *Street Tree Factsheets* (Gerhold et al. 1993).

Buying Quality Nursery Stock

To improve the chances for success in tree planting, it is important to begin with healthy plants with good structural form that have been properly grown, dug, and transported.

A good tree for planting has:

- a strong, straight trunk
- bark that is not cut or damaged
- branches that are evenly spaced along and around the trunk
- branches that are not split or broken
- dense, dark green foliage
- no diseases or harmful insects
- a firm root ball that is securely wrapped with fresh, nonsynthetic burlap
- no roots growing out of the bottom of the container
- no roots circling the inside or top of the container
- no weeds growing in the container or from the root ball
- moist soil in the root ball
- been freshly dug, briefly stored with moist packing material (for bare-root stock)
- the specifications listed in the *American Standard for Nursery Stock*

Trees are available in three nursery types: balled and burlapped, bare-root, and containerized. Each type has advantages and disadvantages. Balled-and-burlapped (B&B) trees are the most common type available from local nurseries and the most reliable for good survival and growth because many fine roots are intact in the root ball and ready to proliferate. However, B&B trees are heavy and much of their root system is severed and left behind at the nursery when the trees are dug.

Containerized stock is much lighter and has intact root systems but can have problems with circling and girdling roots if it remains in the container too long. Containerized trees can be transplanted during the summer, outside the usual spring and fall planting seasons. They do need to be watered more frequently than B&B trees until they are established.

Bare-root stock is less expensive, smaller, and easier to handle. It can only be harvested and planted when dormant, so it's only available in early spring and late fall. It is more likely to suffer from drying and requires greater care in handling and faster planting after digging. The roots of bare-root trees must be kept moist during shipping, storage, and planting. Roots can be dipped in water to moisten them, but they should not be immersed in water for long periods because roots need to "breathe."

Genetic adaptation to site conditions is just as important as the physical quality of trees. Trees such as red maple and sweetgum, which are native to Pennsylvania, are not necessarily winter hardy if they are grown from seed collected in southern regions. To avoid this possibility, buy cultivars that are known to be hardy or obtain plants that have been grown several years in Pennsylvania nurseries or other states with similar climates.

Many important characteristics to consider when purchasing nursery stock, such as height-diameter relations and root ball sizes, can be found in the *American Standard for Nursery Stock* (American Landscape and Nursery Association, 1997). In general, the following are important in obtaining a high-quality tree:

- To improve chances of obtaining the type and size of trees you desire, order them 6 to 12 months ahead of the planting date and check prices of several nurseries. Nurseries often sell out of the most popular trees.
- Obtaining the best price for trees should be a secondary consideration to quality. Low-price trees that perform poorly or die are no bargain.
- Many nurseries allow customers to inspect and tag trees for future delivery. This helps ensure that you will receive the quality of trees that you want.
- Look for reasonably straight, single trunks with healthy, well-spaced branches, reasonable crown symmetry, and trunks and limbs free of scrapes or other damage.
- The most common sizes used for street trees are from 1½ to 2½ inches in caliper. Caliper is the diameter of the trunk measured 6 inches from the ground on trees that are 4 inches or smaller, and 12 inches above the ground on larger trees. Trees larger than 2 inches in caliper are most suitable for areas where vandalism is likely or pedestrian traffic or children's play is frequent. Larger trees can be used if a prominent landscape effect is desired immediately.

Table 1. Typical sizes and weights of deciduous B&B trees

Caliper (inches)	Ball Diameter (inches)	Approximate Weight (lbs)	Typical Height (feet)
1½ to 1¾	20	225	10 to 12
1¾ to 2	22	260	11 to 13
2 to 2½	24	300	12 to 14
2½ to 3	28	600	13 to 15
3 to 3½	32	750	14 to 16

Fig. 5. Even after years in the ground, plastic burlap will not decay, eventually resulting in root and tree death. It must be completely removed at planting.

Fig. 6. This tree has poor branching structure and should not have been purchased or planted.

- The proper root ball size of a B&B tree is determined by its caliper. See Table 1 for sizes and weights of root balls for trees of different caliper. Tree trunks should be centered in the root balls.
- Root balls should be moist, tightly wrapped, and free of cracks. The trunk should not move loosely in the root ball.
- Be cautious with trees whose root balls are wrapped in plastic burlap (Figure 5) or if fresh burlap has been placed over old burlap. Plastic burlap and twine must be completely removed after a tree has been placed in the planting hole. To determine if you are working with plastic burlap, try burning the burlap. Plastic will melt; natural burlap will turn to ash and blow away.
- Some nurseries will guarantee the replacement of trees that die within a year at an added cost.

It is important to inspect trees both in the nursery and when delivered. Consider rejecting trees if any of the following are present:

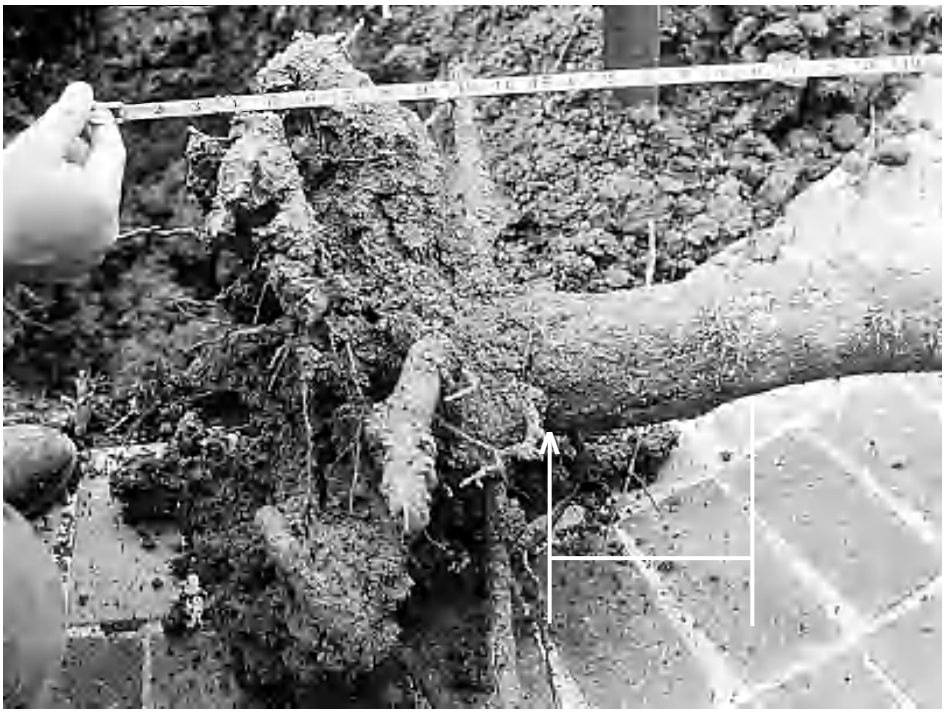
- Two main trunks or double leaders (Figure 6). This is especially important for street trees. If planting ornamental trees in a lawn, you may plant certain trees that have double leaders or multiple trunks.
- Fungal cankers on branches or trunk. Look and feel for discolored, sunken, or swollen areas in the bark.
- Signs of drying, such as dead buds, brittle twigs, or parched root balls.
- Scrapes or other damage to the bark that exceed one-quarter of the trunk circumference.
- Cracked or loosened root balls.

Fig. 7. An example of a good B&B root ball: large enough, firmly wrapped and caged, and roots covered with fresh burlap.

Fig. 8. An example of a poor B&B root ball: too small, loosely wrapped and caged, and roots exposed.

Fig. 9. Encircled and kinked roots can be a problem with containerized trees. Trees with these root problems should not be purchased or planted.

Fig. 10. This tree was planted too deep at the nursery, resulting in a small root mass when the tree was balled. No soil should be placed above the arrow when a tree is balled or planted.



- Unhealthy, circling, or kinked roots. Containerized stock, especially if left in a container too long, can have circling roots that can eventually kill a tree or slow its development.
- A root crown that is too deep in the root ball. Trees that were planted too deep in the nursery or that have been covered with soil by mechanical cultivation are too deep in the root ball.

If a large number of B&B trees have been ordered, remove the burlap from the top of the root ball of a few trees and determine how much soil is covering the roots. If there is more than 6 inches of soil, additional trees in the order should be inspected. Trees with more than 6 inches of soil covering roots should be rejected. Entire root balls of containerized plants can be inspected. Trees with heavily kinked or encircled roots should be rejected.

Shipping and Handling

After trees have been selected and purchased, it is important to ensure proper shipping and handling, especially if inexperienced municipal employees or volunteer crews are being used to move and plant trees. Below are some tips for shipping and handling trees.

- When transporting trees in an open vehicle, even for short distances, cover trees with a tarp to prevent them from drying out and being damaged by the wind.
- The protective covering around the trunk should remain in place until the tree has been planted to protect against damage from equipment or shovels. Then the covering should be removed.
- Always try to unload the tree as close to the planting site as possible and gently lower the tree into the planting hole. Never drop trees off a truck since this can cause cracks in the root ball and serious root damage.
- Remember that B&B trees are very heavy. Use a front-end loader or backhoe to unload them. Make sure that enough people are helping when lifting and lowering a root ball. Be careful not to drop a tree onto the legs or feet of people standing in a planting hole.
- Always lift a tree by its root ball. Never drag or lift a tree by the trunk because the root system can separate from the soil and break roots. Do not wrap chain or rope around a tree's trunk to lift it. Alternatives for lifting and moving trees include using a tree sling, hand truck, or front-end loader. If hooking a chain into the wire basket on a tree, always hook to at least two wires. If hooked to just one, the wire can break and injure people.

Storage

Trees can be stored temporarily, but they should be planted as soon as possible after delivery. Tips for proper tree storage are as follows.

- The roots of bare-root trees must be kept moist at all times. It is best to plant bare-root trees within one week. If trees are to be stored longer, they should be kept at a low temperature (around 35°F) and high humidity. Keep wrapping materials on bare-root trees until you are ready to plant them. Keep trees out of the sun and their roots cool and moist by covering them with a damp cloth or moist packing material.
- B&B trees can be stored longer by using these procedures: (1) stand the trees upright together in a group close to the shaded north side of a building; (2) cover the containers or balls with mulch; (3) water trees enough to keep the root balls moist. Avoid temperature extremes when storing trees and do not let the root balls become dry or overwatered. If B&B trees have been stored for a long period, handle them carefully as the burlap and twine may have begun to rot. If the burlap has rotted, wrap the root balls in fresh burlap before handling them.
- Containerized trees can be stored in any open, flat area. They should not be stored with B&B plants because they require more frequent irrigation, especially after bud break. Since they are well drained, containerized trees may have to be watered every day.

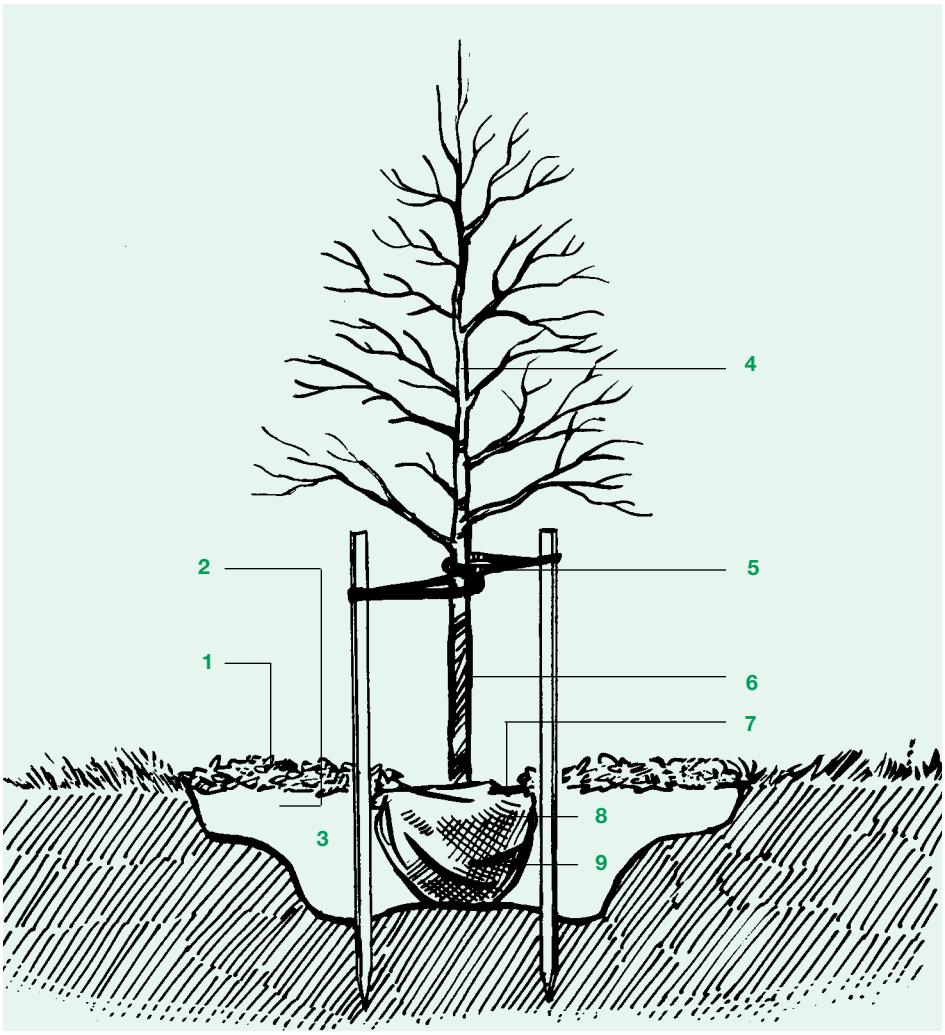
Fig. 11. These trees are stored incorrectly; they should be in a shady area and covered with damp mulch.

Planting Trees in Spacious Places

Techniques for planting B&B, container-grown, and bare-root trees do not differ greatly when there is ample space. The following guidelines can be used for planting trees in parks, lawns, large lawns along streets, or other spacious areas.

- Arrangements for workers, volunteers, and equipment should be made months in advance.
- To avoid hitting underground utilities while digging, contact the One-Call System a few weeks before the planting date. This system will schedule someone to identify the location of underground utilities. Check with the public works department in your municipality to locate the One-Call System.
- The ideal time for planting in the temperate zone is spring, as soon as the ground has thawed and excess moisture has drained from the soil. Fall plantings should be done soon after deciduous trees have dropped their leaves and before the ground has frozen but can be started in early September. Some trees such as oaks and ornamental pears are not recommended for planting in the fall because of the potential for excessive mortality.
- Digging proper planting holes by hand can be extremely time consuming and labor intensive, especially for youth and other volunteers. Try to obtain a backhoe and operator from the municipality, borrow one from a construction firm, or rent one. A backhoe not only makes it easier to plant trees, but it also helps in the correct digging of wide planting holes. Communicate with the backhoe operator to make sure the operator understands the size of tree planting holes that you want, or you will be filling in holes that are too deep, which can cause trees to settle, tilt, or be planted too deep.
- If possible, mark out a planting area that is three to five times the diameter of the root ball; the wider the hole, the better. Loosen the soil in the entire planting area to the depth of the root ball. At a minimum, the planting hole would be 2½ times the diameter of the root ball and soil loosened to 12 inches as far around the planting hole as possible.

Fig. 12. Diagram for planting a tree in a spacious place.



1. 3" to 4" mulch of bark or wood chips
2. Wider hole if soil is compacted
3. Good native soil or topsoil
4. Single straight trunk
5. Slack rubber hose or strap
6. 1½" to 2½" caliper
7. Keep mulch away from root collar
8. Remove burlap or fold down burlap and wire basket
9. Root ball on undisturbed soil

- In the center of the loosened soil, dig a hole that is twice the diameter and exactly as deep as the root ball. To prevent the root ball from being planted too deeply, it should sit on solid, undisturbed ground rather than on loose soil. To plant the tree at the proper depth, make sure the upper surface of the root ball is level with the existing grade of the area. Because of cultivation in the nursery, B&B stock may have soil piled on top of the root collar (where the tree trunk flares out to the roots), causing trees to be planted too deeply. Pull this excess soil away to determine the proper depth of the planting hole.
- Before placing the tree upright in the planting hole, carefully remove any twine that may be holding branches together.
- Once the tree is properly situated in the planting hole, cut and remove any twine holding burlap in place. Remove burlap from at least the upper third of the root ball; cut it off or shove it down into the planting hole. All artificial burlap must be removed from the planting hole. If a tree has come in a wire basket, cut at least the top one-third or two tiers of wire and remove it. Before backfilling, check from two sides and be sure the trunk is vertical.
- Hold the tree upright while backfilling around the root ball. Gently pack the soil to prevent any major air pockets; water occasionally to help settle the soil. When the root ball has been covered with soil, rake the soil evenly over the entire planting area and cover the area with 3 to 4 inches of composted mulch. Keep mulch a few inches away from the tree trunk because mulch piled around the trunk may keep it too moist and lead to fungal problems. Deeply water the entire excavated area.

Fig. 13. For good establishment and growth, trees must be planted at the right depth as shown here, with the top of the root ball level with the existing grade. Note that the root collar is exposed.

Fig. 14. This tree was planted about 7 inches too deep, which can cause death or long-term decline.

Fig. 15. This tree was planted slightly too high and the twine and burlap should have been removed. The suckers growing from the base should have been removed.

- Mounding the soil at the outer edge of the root ball to form a water-holding berm can help hold a larger quantity of water, but it may also encourage root growth to remain close to the tree. If you decide to use a watering berm, the berm should be made slightly beyond the root ball to promote root extension into the surrounding soil. Cover the berm with mulch, but keep mulch away from the tree trunk.
- The roots of bare-root trees should be supported by a mound of soil within the planting hole so they will be evenly distributed within the planting hole. Do not kink the roots of bare-root trees to force them into a planting hole that is too small. Their root collar should be positioned level with the existing grade.

Fig. 16. The twine, burlap, and metal cage should be removed from at least the top third of a B&B root ball to avoid poor root growth and root girdling.

Fig. 17. Trees must be watered at planting and for the first 2 years during periods of hot, dry weather.

A new system for planting bare-root trees

The Urban Horticulture Institute at Cornell University has developed a system for transplanting large bare-root nursery trees that can be used to replace B&B trees in plantings. Instead of shipping trees balled and burlapped, bare-root trees are dipped in a slurry of hydrogel and placed in large, pleated plastic bags. Trees are treated at the nursery and loaded into an enclosed truck or an open bed covered with a tarp. Store the trees in a cool, shady spot and plant as soon as possible but within a week.

Larger bare-root trees should be planted in a shallow hole no more than 12 to 18 inches deep and wider than the spread-out root system. Fill the planting hole with loosened, fertile soil and mulch the planting area correctly. Because there is no added weight from a root ball, bare-root trees need to be staked. It is important to keep bare-root trees well watered during warm weather in the first few growing seasons.

Trees should be planted when they are dormant in late fall or early spring, and only deciduous trees can be planted using this method. Trees that have responded well to this new method of planting include hybrid freeman maple, hedge maple, shadblow, crabapple, Japanese tree lilac, shantung maple, Norway maple, sycamore maple, black alder, ash, ginkgo, honeylocust, Kentucky coffee tree, sweetgum, scholar tree, linden, and Japanese zelkova.

Planting in Sidewalks and Other Harsh Environments

The size that a tree can attain depends mainly on the volume and quality of soil accessible to its roots. Providing an adequate amount of soil volume will increase the amount of moisture and nutrients available to a tree, leading to larger, healthier, and long-lived trees. Various techniques can be used to modify harsh or confined planting areas, but these usually are expensive; some should be designed with the assistance of an engineer or landscape architect. It is important to properly water and maintain trees that are planted in harsh environments. There is no sense in designing and constructing special planting areas only to have trees perish because they are not watered. Before trying extraordinary site modification techniques, consider whether tree planting sites can be relocated to nearby yards or other more favorable areas.

Planting pits in concrete

Planting cutouts in sidewalks, patios, or parking lots should be a minimum of 4 feet long, 4 feet wide, and as deep as the root ball. If removing polluted or inferior soil, the depth of the cut-outs can be deeper than the root ball. The volume of soil provided in a pit this size can sustain a stress-tolerant tree that remains small. A minimum of 200 cubic feet (5 by 10 by 4 feet) of fertile soil is required for large trees such as oak. To provide more soil to the tree, enlarge the cut-out by increasing its length and width rather than its depth. Loosen all soil within the planting pit and plant the tree as described for spacious areas. (See Figure 12.) If the excavated soil is poor or full of debris, do not amend with sand or organic material; instead, replace with a fertile topsoil. (See Figure 20B.) If the drainage of the area is poor, consider moving the planting location or using the subse-

quent recommendations for managing compacted soils.

Limestone gravel and cement associated with streets, sidewalks, or patios increase soil alkalinity, so only plant trees in these areas that are tolerant of alkaline soils. Do not plant red oak, pin oak, sweetgum, or red maple in these areas. In places with heavy pedestrian traffic, use stakes or iron guards to protect trees from damage and vandalism. Sidewalk planting pits should be located so that trees will not interfere with business or traffic signs or sight visibility at intersections or be hit by car doors and bumpers. Alternatives for using pavers and other surface materials are discussed later. Sidewalk, patio, or parking lot cut-outs can be improved by using shared space for trees, continuous planters, or raised planters, especially when major repair or sidewalk construction is being planned.

Fig. 18. Cutouts measuring 4 by 4 by 4 feet (64 cubic feet of fertile soil) are the minimum size for planting trees in sidewalks, patios, or parking lots. Pits measuring 5 by 10 by 4 feet are used in Philadelphia and other cities to plant large trees such as oak and sycamore.

Fig. 19. Limestone gravel, cement, and asphalt will raise the soil pH in planting sites. Pin oak, red oak, red maple, and other trees intolerant of alkaline soils should not be planted in these areas.

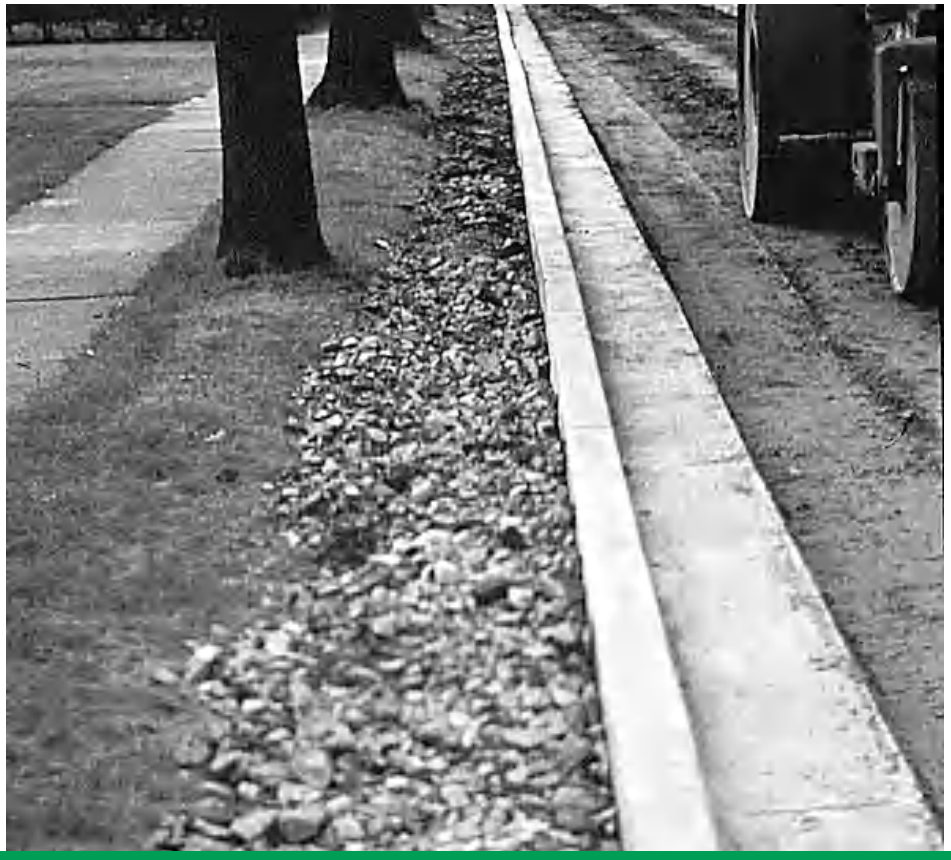


Fig. 20A. Example of an aeration system that can be constructed from PVC piping for use in sidewalks and other plantings. The system can also be used to promote deep watering.

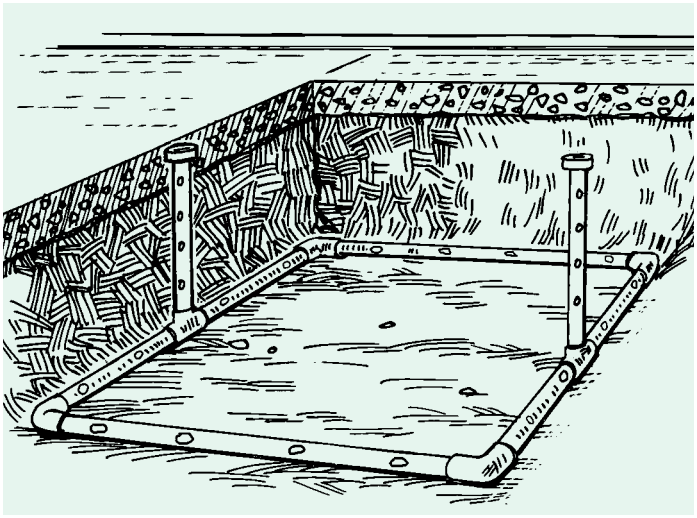
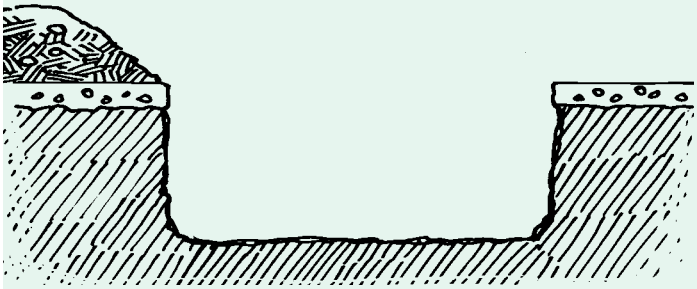
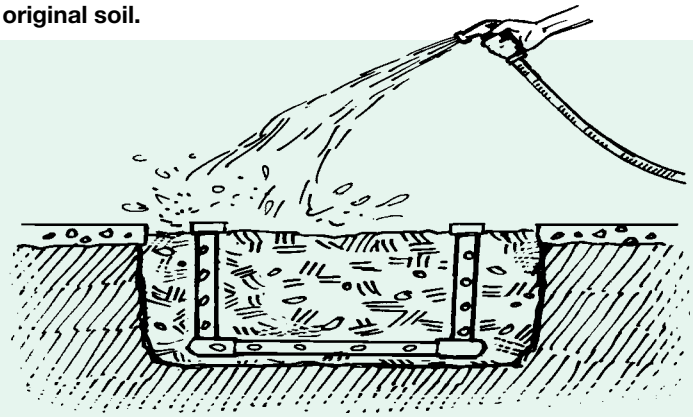


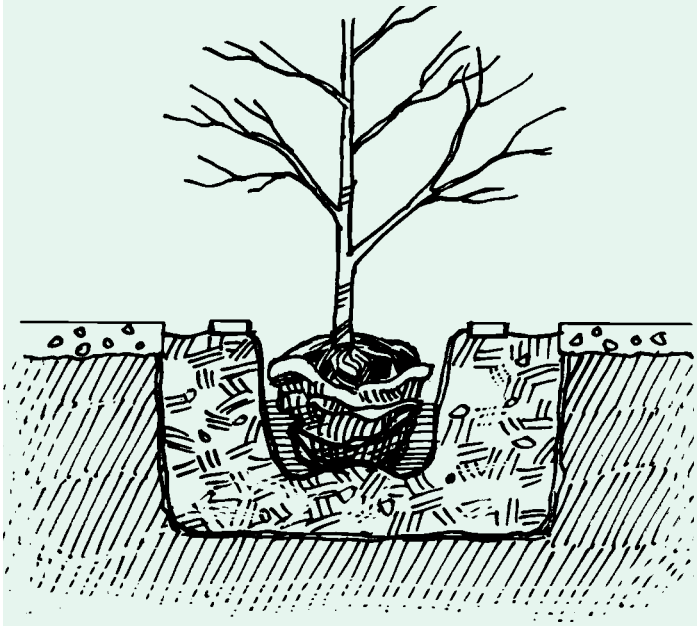
Fig. 20B. Diagram for planting a tree in a sidewalk after removing original soil.



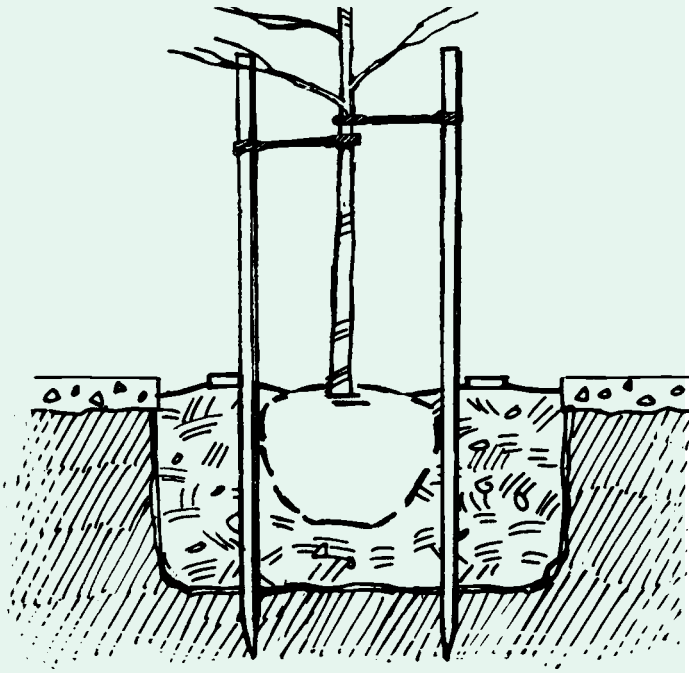
Remove all nonfertile soil in minimum 4' x 4' x 4' pit.



Construct aeration system per Fig. 20A and fill with fertile topsoil. New soil should be “watered in” to settle and slightly compact.



Dig planting hole in the new soil and plant tree per specifications in Fig.12 (see page 9). Soil under root ball should be lightly compacted to prevent settling of root ball.



Stake to protect street trees.

Shared spaces and cluster plantings

Groups of trees can share larger soil spaces, which improve the growing conditions for all of the trees. Shared spaces promote a mutually beneficial environment that provides cool shade, higher humidity, and organic material to improve soil structure and fertility. Larger planting areas can be designed in sidewalks, patios, and parking lots to support groups of trees and other plants instead of the traditional single cutouts in concrete without necessarily increasing costs or taking up more space.

In shared planting areas, it is beneficial to loosen all soil in the planter to the depth of the root balls being planted, and then plant trees as described in the section on planting in spacious areas. Keep the bottom of shared planters open and cultivate new soil into old soil to provide for better root growth.

Continuous planting spaces

In wide sidewalks, a continuous tree planting space can be constructed by cutting a minimum 4-foot-wide strip parallel to the curb and trenching to break soil compaction, or by removing and replacing poor or contaminated soil. The planting space should be as deep as the root balls being planted, have an open bottom, and be filled with good topsoil. A cantilevered cement top, brick, or other porous paving material can cover the planting space. This type of planting space can promote root growth parallel to the curb and provide trees with larger, shared rooting volumes in sidewalks or other paved areas.

Fig. 21. Shared planters can be used to provide more soil nutrients, moisture, and shade to tree roots. Keep the bottom of shared planters open to provide more soil volume.

Fig. 22. Continuous planters provide good soil volume and can be covered with brick or cantilevered cement panels.

Fig. 23A. Elevation view of a continuous planter. Where needed, the aeration system can be connected to a storm drain to provide drainage. Where drainage is not needed, the system can be used to deeply water the trees.

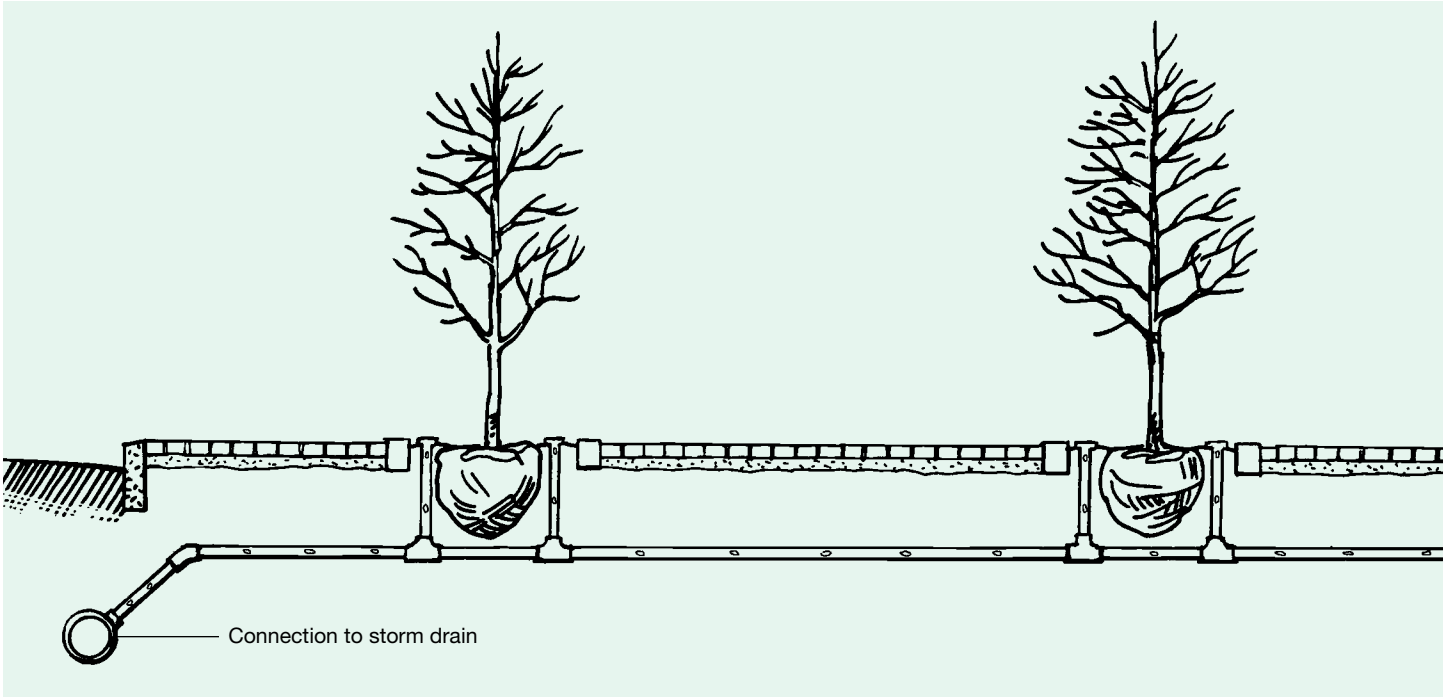
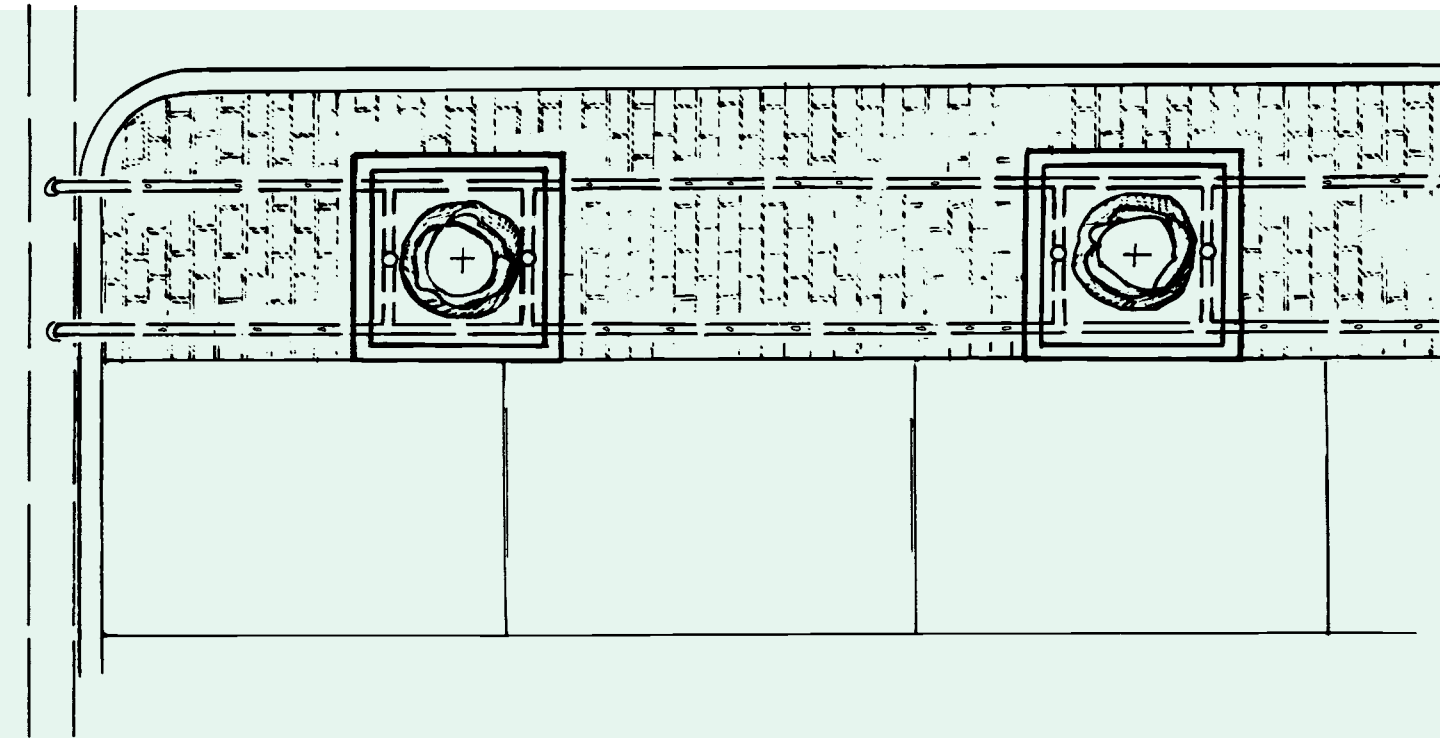


Fig. 23B. Plan view of a continuous planter. Again, note connected aeration system.



Raised planters

Elevating planting spaces above sidewalks or parking lots is a good way to provide positive drainage, avoid salty runoff, and discourage compaction due to pedestrian traffic. With heights up to 36 inches, the planter lip can provide seating. Raised planters should be filled with good topsoil and be a minimum of 4 feet wide and 2 feet high. They can also be quite large and blend into the natural grade of an area. Keeping the bottom of the bed open and cultivating planting soil into the original soil will encourage roots to escape from the bed into surrounding soil. French drains or other channels or sinks filled with gravel can be incorporated into the design to improve drainage.

Designing aeration systems for confined areas

Tree roots are opportunistic, tending to grow in soil where the air-water balance is most favorable. Therefore, aeration systems may encourage deeper rooting of trees by increasing oxygen and water at greater depths than would normally occur under sidewalks, parking lots, and other confined areas. Promoting deeper root growth will improve the health and longevity of trees and result in less damage to sidewalks and curbs from surface rooting. Constructing parking lots and sidewalks with permeable materials can also be used to improve soil moisture and aeration.

Fig. 24. Raised planters can be used to provide more soil volume, avoid road salt and other runoff, and provide shady seats. The bottoms of raised planters should be kept open.

It has been proposed that aeration systems can be built into concrete cutouts, continuous planters, or containers to improve the root environment and encourage root growth. The system depicted in Figures 18, 20, 23, and 23B has two main purposes: to help increase aeration and provide a means of watering and fertilizing the tree. The extent to which embedded pipes may improve root growth has not been well documented, but they certainly do offer a practical means of irrigation that may promote deeper root growth if drainage is sufficient.

An aeration system is best designed and installed by an expert when major sidewalk or parking lot work is being completed. To prevent tree roots from clogging the system, the pipe should be wrapped with geotextile. The tops of vertical pipes should be covered with slotted caps to allow free air exchange, but keep out litter. The pipe system can be attached to a storm drain or other channel of moving air to help increase aeration and move excess water away from tree pits. In more complicated systems, a check valve should be installed at the connection to the storm drain to prevent water backflow.

Preventing root interference with sidewalks

The majority of tree roots can be found within the top 2 feet of soil. When a tree root encounters an obstruction such as a sidewalk, it may extend underneath and raise the concrete as it grows in diameter every year. The likelihood of this occurring increases with compacted soils that limit the depth of root growth, especially when larger trees are planted in small spaces. Preventing root damage to sidewalks and curbs requires selecting species to match the planting site, altering sidewalk construction, installing root barriers, and providing good maintenance such as slow, deep waterings. It is not advisable to plant trees in areas where planting strips are less than 2 feet wide. In strips 2 to 4 feet wide, plant trees with a mature height less than 30 feet. In strips 4 to 6 feet wide, plant trees with a mature height of less than 45 feet. Trees that grow taller than 45 feet can be planted in planting areas over 6 feet wide.

Tree roots are less apt to raise sidewalk blocks if the cement blocks are thick and heavy enough and properly engineered. Sidewalk design can be altered by using more expansion joints near trees, curving or bowing sidewalks around trees, or reducing sidewalk width to 3 feet while expanding the size of a planting cutout. Using root barriers between planted trees, sidewalks, and curbs can reduce damage, but the use of root barriers should be coupled with good tree selection, planting area and sidewalk design, proper planting, and proper maintenance. Root barriers that are commercially available include polypropylene plastic and geotextile fiber impregnated with herbicides. Six-mil plastic film also has been suggested as a root barrier. Barriers should be installed in trenches along the sidewalk or curb to a depth of 12 inches and extend 3 to 4 feet in each direction from the tree trunk. Water recently planted trees slowly and thoroughly, no more than once a week. Frequent shallow irrigation may encourage the development of a shallow root system.

Using a structural soil mix

A structural soil mix developed at Cornell University can be used in sidewalks, patios, and other confined planting areas. Use of this mix is believed to reduce sidewalk and curb damage and increase tree vigor and life span. The structural soil mix provides both a penetrable rooting volume and a load-bearing surface for asphalt and concrete. The three components of the mix are an angular crushed stone (to provide a skeleton to hold weight), a clay soil (to provide for nutrient and water-holding capacity), and a small amount of hydrogel (to bind soil and stone together). A ratio of 80 percent stone, 20 percent soil, and a small amount of hydrogel is recommended. Limestone gravel should not be used if planting trees, such as pin oak, red oak, and red maple, that are not tolerant of high-pH soils.

Fig. 25. Although soil is used in the planting pit, structural soils can be used under sidewalks to expand the soil volume available for root growth.

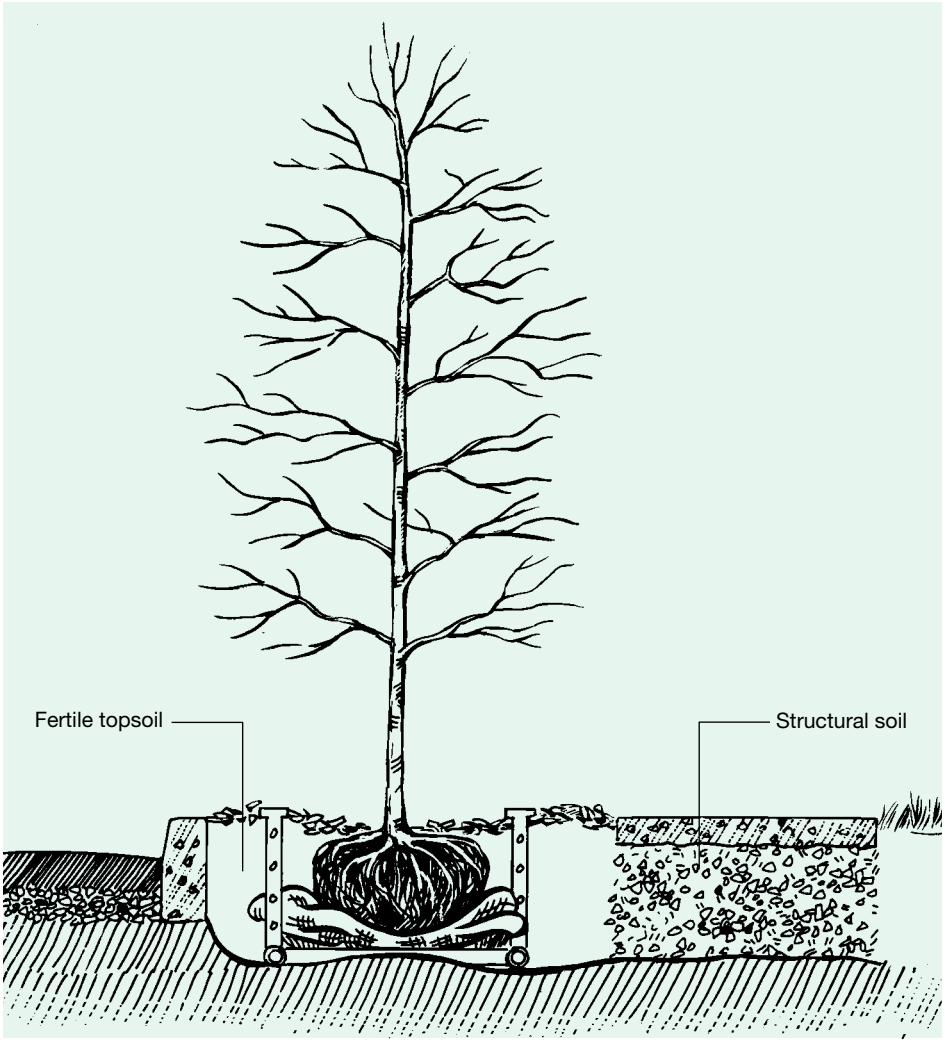


Fig. 26. Root barriers used along with proper site preparation, species selection, planting, and watering can decrease damage to curbs and sidewalks.

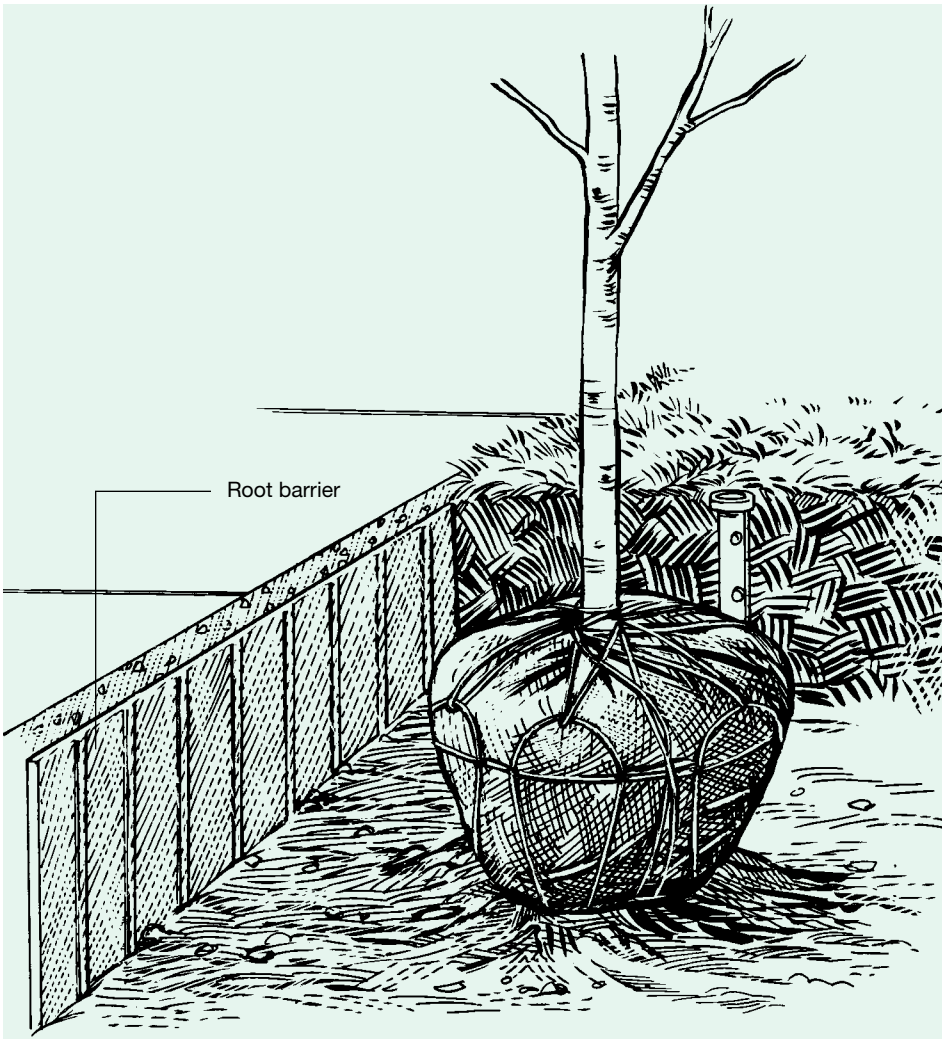


Fig. 27. Structural soils in continuous planters, under sidewalks, and under asphalt allow tree roots to grow while supporting the weight of cement and asphalt. The actual planting pit is filled with fertile soil.

Fig. 28. Operating heavy equipment has ruined this soil. Soil structure must be protected to plant or preserve trees.

Managing Soil Problems

Because of grading and construction requirements, soils under pavements and around buildings are mixed and compacted. Even parks that have been graded can have severely compacted soils. Soil compaction can also be caused or worsened by pedestrian and vehicular traffic.

Compacted soils have less oxygen available to tree roots and slower infiltration of water and physically restrict root growth. Suggestions for managing compacted soils before tree planting are as follows.

- Select trees such as sycamore, honeylocust, flowering pear, and thornless hawthorn that are more tolerant of compacted conditions. Do not plant trees that require good aeration such as flowering cherry, magnolia, serviceberry, or sugar maple in compacted soils.
- Adding peat moss, sand, or leaf mold to individual planting holes is usually unnecessary and may be counterproductive. Usually, compacted topsoil should just be broken and loosened, not amended. Some believe that moss acts as a sponge does and may hold excessive water in the planting hole, especially in heavy clay soils.

- The best way to improve both droughty, sandy soils and compacted, poorly aerated/drained clay soils in large planting areas is to incorporate composted organic material into them. Composted organic material will improve the water-holding capacity of sandy soils and the drainage and aeration of heavy clay soils (Figure 29). Composted organic material should be incorporated at 25–50 percent of the total soil volume in the rooting area. Composted sewage sludge is satisfactory (maximum amount 25 percent of soil volume), but composted yard wastes (leaves, grass clippings, and wood chips) are preferred. A mix of composted sewage sludge and composted yard waste is acceptable.

- When using composted organic material, thoroughly mix the native soil and amendment together throughout the planting area. *Amending or replacing soil in individual planting holes is not recommended.* Abrupt transitions and dramatic differences in soil texture and fertility at the edge of a planting hole can actually inhibit the growth and spread of roots. When amending or replacing soil, it is best to loosen and amend or replace as much soil area as possible, not just soil in the planting hole. When replacing soil, a soil similar in texture and structure or coarser than the original should be used. Whenever amending or replacing soils, it is important to blend the replacement soils together with the existing soil so that a sharp soil interface is not created. Soil interfaces do not allow free movement of air, water, or roots.

Fig. 29. Organic material should be incorporated/cultivated into large planting areas, not just planting holes.

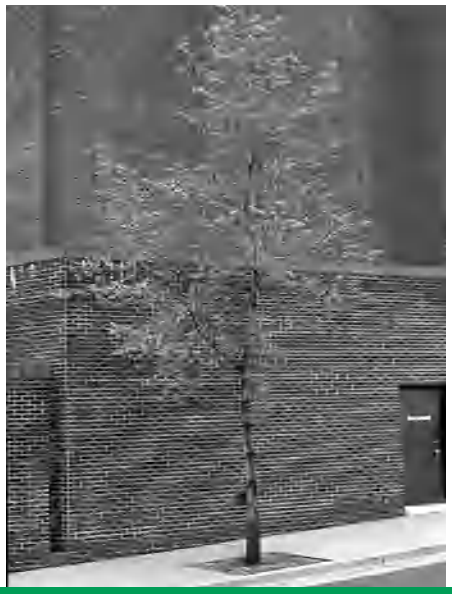
Fig. 30. Larger holes should be dug when planting trees near schools, parks, and other areas with compacted soil.

Fig. 31. Along with larger planting holes, trenches can be dug leading away from the root ball to allow for expanded root growth in compacted soils. Trenches should be as deep as the root ball.

Fig. 32. Placing a thin amount of soil over compacted gravel or clay does not allow for good plant growth. The parking lot planter should be well drained and filled with a minimum of 4 feet of fertile topsoil.

Fig. 33A. Planted at the same time in a shared space that provided more soil volume, these two trees grew much faster and larger than the sidewalk tree (below).

Fig. 33B. Sidewalk tree



- If individual trees must be planted in compacted soil, such as in a park or schoolyard, mark out a planting area that is five times the diameter of the root ball. Loosen and mix the soil in the entire planting area to the same depth as the root ball. If the soil is extremely heavy clay, consider replacing it with a good quality topsoil. French drains or gravel-filled sinks may be required where impermeable barriers exist below the planting area.
- Another alternative for planting in compacted soils is to dig a planting hole that is 12 to 24 inches wider than the root ball and then digging three to five trenches as deep as the root ball extending 5 to 10 feet radially out from the planting hole. The trenches will look like spokes from a wheel hub. The soil in the trenches should be broken up or replaced with topsoil. Roots from the tree can then grow into the loosened soil.
- In sites that have mainly dirty fill, building rubble, or other impermeable barriers to root growth, consider replacing the soil in a continuous planter to a depth of 3 to 4 feet. To prevent settling of trees, moderately pack the replaced soil under the root ball and plant trees so that the root crown is slightly above the existing grade. Recommendations for amending rather than replacing soils can be complicated and depend on location, use, and existing soils. Contact your county cooperative extension office for assistance when concerned about soil amendment.

Staking

Before staking a tree, you should consider if it is necessary. Most B&B trees are so heavy they do not require staking to hold them upright. Staking is recommended only if a tree needs support or protection. Staking should be used to protect trees from car doors and vandalism when planted near curbs, sidewalks, or playgrounds.

Staking should keep a tree in an upright position, but allow for trunk movement. Trunk movement caused by the wind promotes taper in the trunk and increases trunk diameter and strength. There are various techniques for staking or guying. A simple method that will meet most planting situations is shown in Figure 12. Common staking problems can be avoided by following these guidelines:

- Ties can be made in various ways. A loosely fitted figure-8 tie of rubber garden hose or webbed strap is easy to install, provides good support, and cushions the tree from rubbing. Do not use wire ties.
- Regardless of the tree size or the tie used, always allow enough slack to let the tree sway. This movement is necessary for building the strength of the trunk.
- Avoid driving stakes through the root ball or damaging tree roots when staking.
- Remove stakes and ties within one year, before ties girdle the trunk. If a tree will not stand on its own after one year of staking, consider removing the tree and replanting.

Fig. 34. Wire ties should not be used when staking because of girdling and other wounds. Ties should be removed after the first season.

Fig. 35. Only soft materials, such as rubber hose or straps, should be used to attach trees to stakes.

Watering

Inadequate or excessive water reduces the chance that a tree will become established and grow. Trees become established when their root systems adequately support root and branch growth. Trees and other plants must be watered when planted and periodically thereafter until well established. The amount of water needed and when to apply it depends mainly on inadequate rainfall but also on the moisture-holding capacity of a soil, drainage, and the type of mulch used.

Rapid water loss on hot summer days can cause the death of young or newly planted trees. During hot, dry periods it is advisable to water trees every week during the first few growing seasons. A 2-or 2½-inch caliper tree should receive 20 to 40 gallons of water each time it is watered. The need for watering will gradually fade in successive years as trees become established, but it will still be beneficial during extended droughts. Water should be applied slowly and uniformly over the planting area until it penetrates the bottom of the root ball. This can be done by using perforated containers called TREEGATORS® or by using a 5-gallon plastic bucket with several small holes made in the sides, close to the bottom. Excessive watering combined with inadequate drainage deprives roots of oxygen and can kill them. *The symptoms of overwatering are the same as those for drought: wilting, loss of leaves, and poor growth.*

Fertilizing

Trees grown in good soils in a nursery, with proper weed control, and that are irrigated and fertilized regularly develop a "growth momentum." This momentum allows trees to reestablish both a dense, healthy canopy and root system after planting. The momentum is a result of high levels of carbohydrates (energy reserves) and nutrients (mineral elements) that accumulate in the trunk, limbs, and roots while growing under optimum nursery conditions.

Following the first flush of growth, some nutrients need to be replenished in a tree. Nitrogen is always needed, but it should be applied in relatively small amounts, compared to phosphorus or potassium. The amount of fertilizer to apply should be based on the results of a soil test.

Trees planted in newly developed areas, sidewalk cutouts, and other harsh urban sites without soil amendment or replacement may benefit from fertilization at planting. Since soils in developed areas vary greatly from one site to another, and it is impractical to test the soil at each planting site, a general-purpose, complete fertilizer can be applied.

Newly emerging roots are sensitive to high salt levels in soils, so only fertilizers with low-salt indexes should be used. Fertilizers high in nitrogen can encourage heavy foliage growth, which may place a high demand for water on roots and increase problems with fire blight or other diseases or insects. Use a slow-release fertilizer that has a low proportion of nitrogen, such as a 10-20-20.

Recommendations for the amount of fertilizer are based on the number of cubic yards (for newly planted trees) or per 1,000 square feet of canopy for larger trees.

Mulch and Other Surface Materials

Mulching newly planted trees is one of the easiest and most effective ways to protect them and encourage rapid establishment. Mulch conserves soil moisture, stabilizes soil temperatures, reduces competition from grasses and weeds, provides nutrient-rich organic material to a soil, lessens lawn mower and weed trimmer damage, and prevents soil compaction by pedestrians. Composted, coarse-shredded mulch should be used for street plantings because it is less likely to be blown away. However, mulch should not be applied too thick and never placed against a tree trunk. Apply 3 to 4 inches of mulch over the rooting area of a tree. Because noncomposted mulch may take nitrogen from the soil, composted mulch is preferable. Leaf mulch is another option, but it will decompose more quickly and will have to be replenished more frequently. Maintaining the mulch layer each year will improve tree health substantially and can improve the structure of compacted soils.

Other materials can be used in sidewalk cutouts and areas where mulch may be impractical. Although expensive, iron tree grates are long lasting and require little maintenance. Every few years the sections that interfere with the enlargement of the tree trunk must be cut out. Grates should have small openings that will not cause pedestrians to trip and won't collect debris. Bricks or paving stones set in sand are sometimes used, but these tend to settle and must be reset periodically. Special paving bricks that support one another can avert this problem. A mulch or gravel surface is practical only if it can be contained within an edging barrier. Paving materials that permit little water to infiltrate and deprive trees of moisture essential to their health should be avoided.

Fig. 36. If TREEGATORS® are not available, five-gallon buckets with small holes in the sides near the bottom can be used to water trees slowly and deeply.

Fig. 37. Mulch improves soil and protects a tree from lawn mower and weed trimmer damage. Only 3 to 4 inches of mulch are needed and should be kept away from the tree trunk.

Fig. 38. Decay damage done by adding too much mulch and placing mulch against the tree trunk (below).

Controlling Disease, Insects, and Calamitous Damage

The best way to manage tree problems is to select and plant trees that are resistant to insect and disease problems and tolerant of existing site conditions. To reduce calamitous damage within the community forest from severe storms and unanticipated diseases such as Dutch elm disease, use a planting strategy that creates a diversity in age and species composition. Judicious pruning throughout the life of a tree and removing hazardous trees and limbs will also prevent many problems.

Training Young Trees

Responsibility for the care of newly planted trees should be designated even before they have been placed in the ground. Proper maintenance includes not only mulching and irrigation but pruning as well. The purpose of pruning is to develop a balanced and well-spaced structure of branches while maintaining the typical form of a tree. Pruning trees while they are young is easier and causes smaller cut surfaces that heal faster and provide smaller entry ways for infection. Pruning to promote a strong framework during the first 10 years of a tree's life is a sound investment, which will decrease maintenance problems, efforts, and costs later.

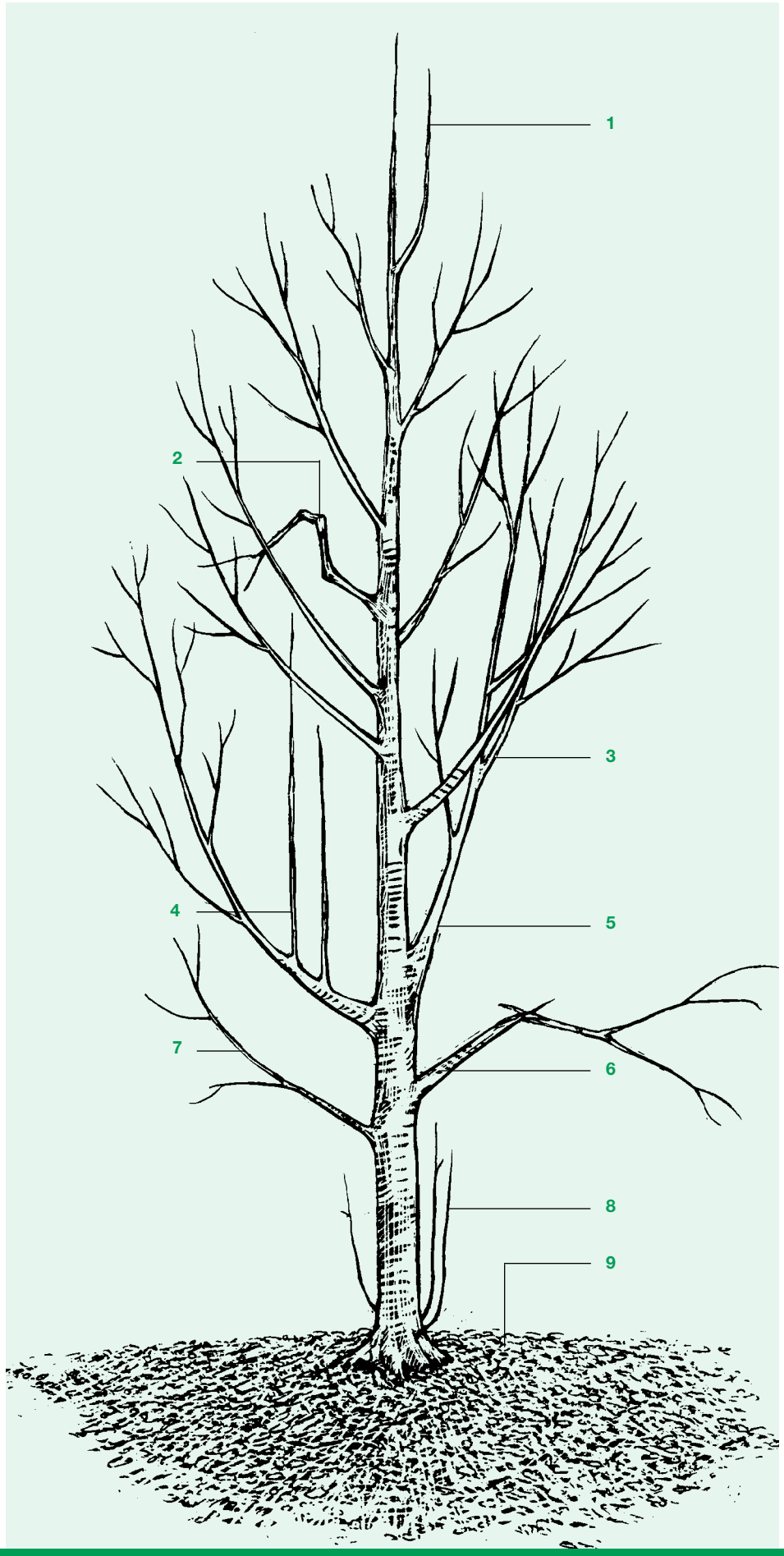
Properly trained trees fulfill their intended functions sooner and should require less corrective pruning as they mature and branches become larger. Young trees should be trained so that they have a sturdy, tapered trunk with well-spaced branches. Remember that trees grow from the tips and top, not from the bottom. If not pruned, a branch that is at a height of 4 feet on a young tree will be at the same height on a mature tree. The training guidelines provided below apply primarily to large-growing trees such as maple, ash, and oak.

With proper training and supervision, volunteers can prune young trees. It is important to show volunteers how and what to prune and supervise their work. Before you start pruning a tree, look at the tree from all sides and decide which branches should be removed.

- Use sharp, clean tools in a safe manner. Common sense, a hand pruner, and a curved, narrow-pointed saw are all the tools needed for pruning young trees.
- Do not perform compensatory pruning on young trees in an attempt to bring a tree's canopy and root system into equilibrium. Trees bring themselves into balance. The less efficient leaves, twigs, and branches will naturally die out as a tree grows. Only prune broken, damaged, poorly attached, malformed, parallel, or crossing branches from newly planted trees.
- To encourage the growth of young trees, it is important to leave the lower, temporary branches below the lowest permanent branch. When temporary branches grow to about 1 to 2 inches in diameter, they should be removed so that wounds will be small and heal quickly. The height of the lowest permanent branch will depend on the function and location of the tree. Ornamental trees such as bronze beech are meant to have low, drooping branches and should be planted in areas that allow this. In parks and yards, retain small branches for 1 to 5 years to increase trunk size and taper. Gradually remove lower branches over several years, not in one pruning. Depending on their height, street trees should have been pruned up to 4 to 6 feet at the nursery. If additional branches need to be pruned, remove them gradually through multiple prunings over several years to provide clearance for pedestrians (8 feet) and vehicle traffic (15 feet). If needed, temporary branches can be shortened by pruning back to a side branch to provide clearance.
- For most trees, maintain a single, straight trunk or central leader. After the first year's growth, removing or pruning back other competing leaders can encourage a single leader. Overly crowded branches need to be thinned. Retain permanent branches that will provide a strong structure and grow into a shape that is natural for the species. Permanent branches should be well spaced vertically and radially. If any need to be shortened, they can be pruned back to a side branch. See Figure 39a for examples of branches that should be pruned. If two major limbs are growing so close together that they will grow into each other, one should be removed.
- Pruning back to a side branch or bud can retard the growth of a branch or leader. By pruning in this manner, the growth of the unpruned branch or leader can be accentuated over another.
- The angle of branch attachment and the relative size of a branch in relation to the trunk of a tree are important for the strength of branch attachment. Permanent branches should be one-half or less the diameter of the trunk. Branches with unnaturally sharp angles should be removed to avoid development of included bark and weak branch crotches. Clustering of branches that occur in species like zelkova and ornamental pear should be thinned, resulting in better vertical and radial spacing.
- Wound dressings are unnecessary and can be detrimental.

As a tree grows to maturity, pruning should concentrate on maintaining or improving its structure and removing deadwood and hazardous branches. Thinning tree crowns properly, based on species, tree age, and tree vigor, can increase the tree's health by allowing more light and air into the tree canopy and reducing insect and disease problems. Before pruning mature trees, consult the many specifications that have been developed for safe and proper pruning. Only a trained arborist should climb into large trees. Pruning should accentuate the natural form of a tree; trees should not be topped. By planting the right tree in the right place, the need to reduce the size of any tree can be minimized.

Fig. 39A. Examples of branches that should be pruned from newly planted trees.



1. Remove a competing leader. Cut back the less vigorous branch to prevent the development of two leaders, which could cause the fork to split as the tops grow larger.
2. Remove any malformed branch.
3. Remove any crossing branch. It may rub against and damage another branch.
4. Remove water sprouts.
5. Except for trees that have naturally ascending branches, remove any branch growing at a sharp or unnatural angle. When this branch becomes larger, the bark can separate the trunk and the branch. As the tree grows and the limb gets heavier, the added weight can result in the limb splitting from the trunk.
6. Remove any broken or badly damaged branches.
7. Remove lower branches over time. These branches should be removed during the first two years to provide clearance for vehicles and pedestrians.
8. Remove suckers, which take energy away from desirable growth.
9. Apply 3 to 4 inches of composted mulch at the base of the tree. Mulch should be kept 2 to 3 inches away from the trunk of the tree.

Fig. 39B. Growth of a properly pruned young tree.

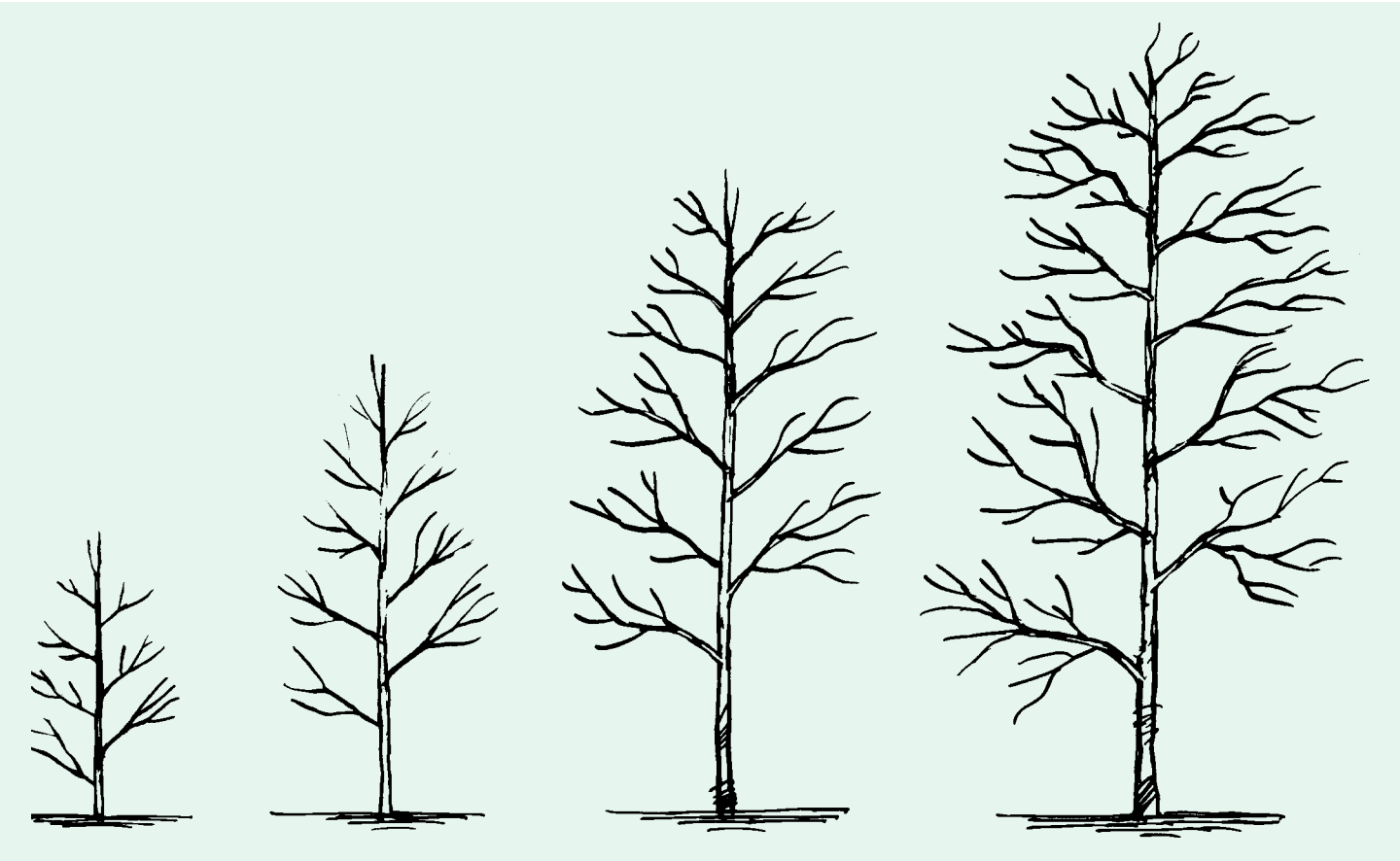
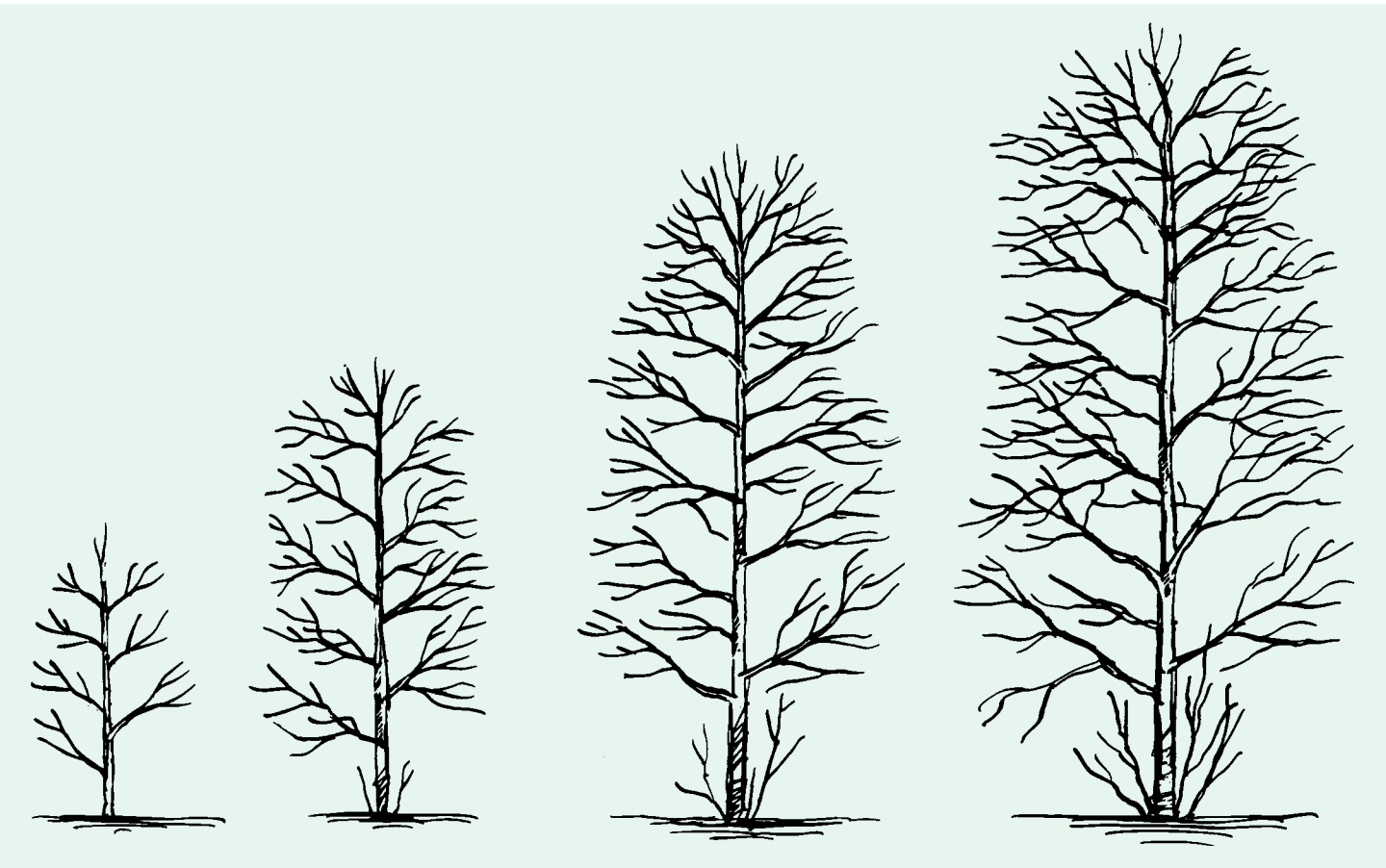


Fig. 39C. Growth of a young tree that has not been pruned.



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Prepared by William Elmendorf, assistant professor of urban and community forestry, Henry Gerhold, professor emeritus of forest genetics, and Larry Kuhns, professor emeritus of ornamental horticulture.

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