TREES & CONSTRUCTION

A GUIDE TO PRESERVATION

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INTRODUCTION

Many people are initially drawn to a piece of property by the existence of large, mature trees. In addition to their beauty, trees can save up to 50 percent of air-conditioning costs, can moderate noise, and can also cleanse the air. There are other benefits as well—some estimates indicate that mature trees can add $5,000 to $10,000 of value to a single-family lot. But saving trees during development does not just happen. It takes effort to adequately plan for tree survival and to use proper construction techniques.

Since 1982, the City of Redding has been recognized by the National Arbor Day Foundation as a "Tree City U.S.A." This designation underscores the City's efforts to plant and maintain trees throughout the community. In 1990, the City Council further recognized the value of trees by enacting Redding's Tree Preservation Ordinance (Chapter 18.45 of the Municipal Code). The tree preservation and planting requirements it contains will serve to ensure that trees become an integral part of development planning in the City.

This guide has been prepared to assist the development community in understanding the basic concepts of designing with and working around existing trees. It is not intended to replace the advice that can only be obtained from a specialist in the field, but does provide a basic framework from which to look at trees and the development process. Part 1 outlines the basic steps in formulating a tree protection plan which can be adapted to many types of projects. Part 2 highlights recognized methods which have proven effective by minimizing damage to trees during project construction.

The bulk of the information that follows addresses the specific needs of some of our most noteworthy local native tree species, including the blue oak, interior live oak, and valley oak. The tolerance level of these trees to disturbance is relatively low and oftentimes special techniques are necessary when working near them. You will find, however, that most of the principles are basic and surprisingly logical.

It is hoped that you will find this guide a useful tool. Should you have any questions, please direct them to the City of Redding, Development Services Department, 777 Cypress Avenue, Redding, CA 96001.

PART 1 — DEVELOPING A TREE PROTECTION PLAN

Listed below are some basic steps that can help to successfully incorporate trees into the development process. They are only guidelines in the realization that no two sites or projects are identical. They do, however, represent a logical design progression that can be modified as dictated by a particular project.

STEP 1 — PRELIMINARY TREE DELINEATION

Planning for tree protection must start at the conceptual stage of a project. Basic information should be plotted on a site plan, including the general location of trees or stands of trees and the location of streams, ponds, or other wetland areas. Topographic information is also invaluable in determining site constraints due to slope and in making an initial assessment of potential development impacts to trees. Depending on the size and location of the project, a good initial source of tree location information may be aerial photographs. Remember, the goal at this stage is to get a feeling for a site, delineating those items which may ultimately determine the preferred locations of roads, buildings, parking lots, etc.

STEP 2 — IDENTIFY TREES TO BE SAVED

The question at this stage is, Will the design of a project dictate which trees will be saved or will the existence of trees dictate project design? In reality, compromise will generally be required. There are, however, certain considerations which may help solve this dilemma.

- Are there trees which are unhealthy or structurally unsound? If so, they likely are not worth attempting to save.
- Are the types of trees suitable for the proposed land use? For instance, if native oak trees will be retained in an area planned for law, it is unlikely that the trees will live for long given that they are prone to the development of oak root fungus when watered during the summer months. This is not to say that the use of "natural" landscape should not be strongly considered.
- Are the trees tolerant to manmade changes in their living environment? The information in Part 2 of this guide, along with the recommendations of a certified arborist or other professional in the field, will help you in determining whether it will be physically possible to successfully build around the trees.
- Would setting aside a natural area which contains trees provide a buffer between adjacent land uses and relief from an otherwise urbanized setting?

STEP 3 — PREPARE A TREE SURVEY

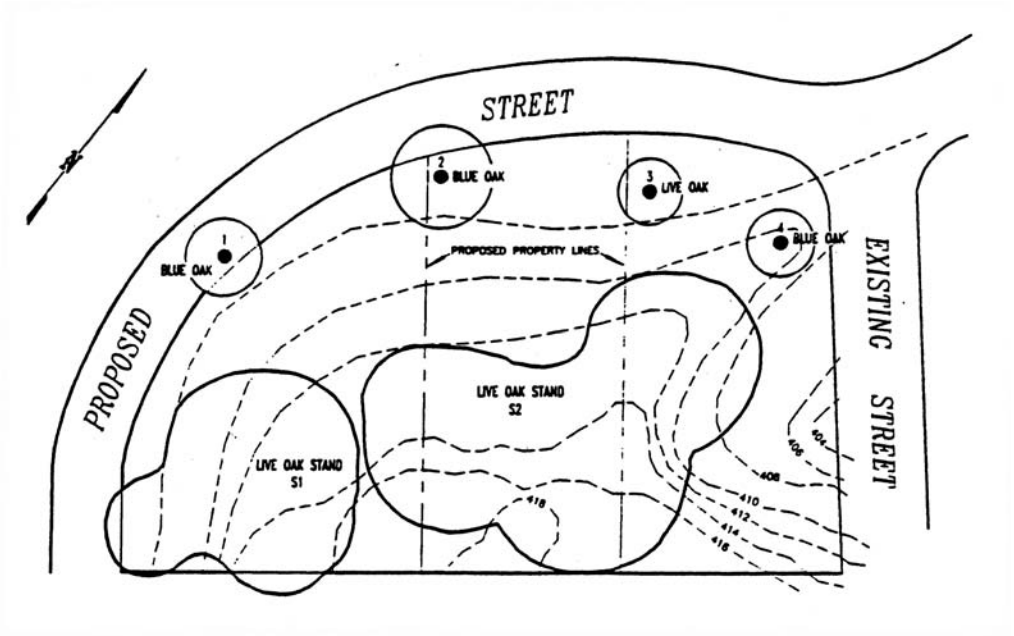
On most sites, it is advised that a tree survey be undertaken prior to formulating the final development plan. The survey is particularly valuable on sites that will require significant grading, since cut and fill operations can have severe impacts on trees. Common sense will dictate if a survey should be done and, if so, how extensive it should be. For instance, in subdivisions where grading will be limited to street rights-of-way, a survey of all trees on the site is usually not warranted.

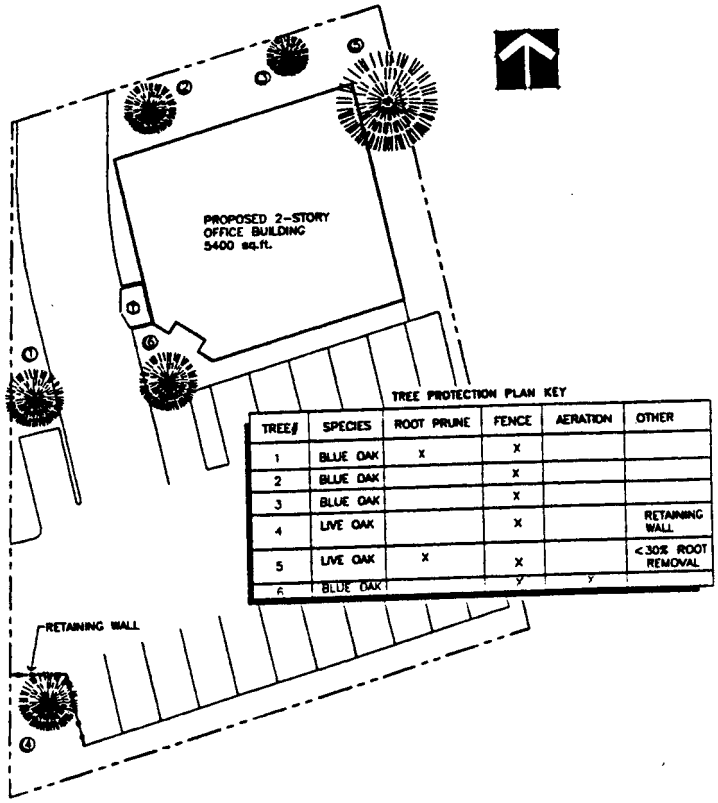
A tree survey provides very specific information which can prove critical in successfully saving trees. A typical survey would include the following information:

- The precise location of trees on the site that exceed 6 inches in diameter at 4.5 feet above the ground.
- The area under the foliage of the tree (drip line).
- The base elevation of each tree shown.
- A chart or table which keys the following information to each tree surveyed:
  - Species
  - Diameter
  - Condition/health
  - Recommendations on saving or removal
  - Any special considerations

SURVEY RATING CHART

#	SPECIES	DBH	HEALTH	ELEV	RECOMMENDATION
1	BLUE OAK	12"	FAIR	407	REMOVE—WITHIN RIGHT-OF-WAY
2	BLUE OAK	20"	GOOD	408.5	SAVE—ROOT PRUNE NEEDED FOR RIGHT-OF-WAY
3	LIVE OAK	13"	GOOD	408.5	SAVE
4	BLUE OAK	15"	GOOD	411.2	SAVE—POSSIBLE AERATION SYSTEM
S1	LIVE OAK		FAIR		SAVE—SELECTIVE HAND TRIMMING
S2	LIVE OAK		GOOD		SAVE—SELECTIVE HAND TRIMMING





TREE PROTECTION PLAN KEY

TREE#	SPECIES	ROOT PRUNE	FENCE	AERATION	OTHER
1	BLUE OAK	X	X		
2	BLUE OAK		X		
3	BLUE OAK		X		
4	LIVE OAK		X		RETAINING WALL
5	LIVE OAK	X	X		<30% ROOT REMOVAL
6	BLUE OAK		X	X	

STEP 4 — CONSOLIDATE INFORMATION INTO A TREE PROTECTION PLAN

With the tree data described above clearly shown on a base map, a site and grading plan can be developed which is geared to protect those trees identified to be saved. It may not be practical to save all desirable trees; however, with sufficient information, the best candidates for survival can be pinpointed. The plan can also identify special construction techniques that will be required (i.e., root pruning, use of retaining walls) to ensure that construction impacts are minimized.

STEP 5 — CONSTRUCTION SUPERVISION

It is important during the construction process to take steps for the on-site protection and care of those trees selected to be preserved. Part 2 of this manual provides specific information related to potential construction impacts to trees and recommends methods to minimize disturbance. Prior to construction, it is suggested that:

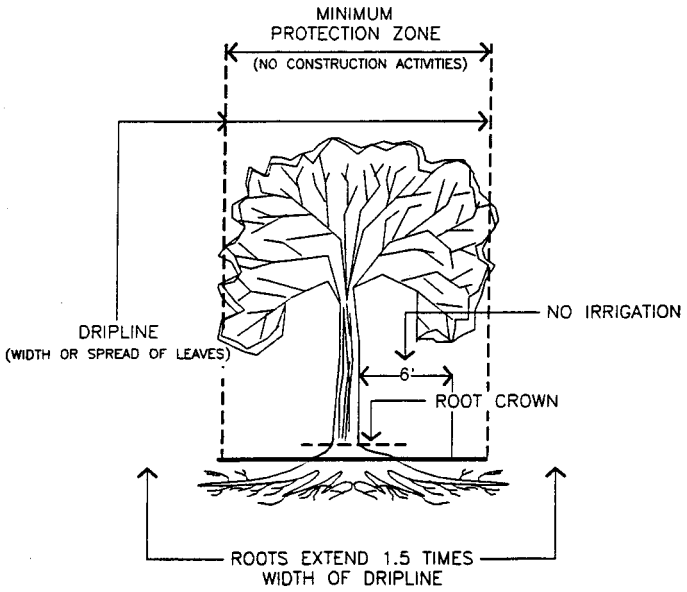
1. A preconstruction meeting be held at the project site with the project developer, contractor, subcontractors, and City Planning and Engineering staff to discuss

which trees are proposed to remain and to highlight potential problem areas.

2. Each tree proposed to remain should be flagged in the field. This is particularly important for those trees near any areas that are proposed to be graded. Ideally, protective fencing would be placed around these tree's drip lines, so that soil within the root zone is protected from disturbance. Fencing significantly reduces the possibility of equipment operator error, resulting in the inadvertent removal of trees or damage to trunks and branches.

3. In areas where machinery traffic will occur within a tree root zone, an 8- to 16-inch-deep mulch layer should be used to prevent soil compaction.

Tree Protection
Roots are the Key



PART 2 — RECOMMENDED CONSTRUCTION PRACTICES

The guidelines that follow are based on proven methods of minimizing the harmful effects that construction activities can have on trees, particularly native oaks. First, however, it is important to understand some basic characteristics of these trees.

The environmental tolerances of mature oaks are permanently set and changes can weaken or kill them. This is true for both young and mature trees. For instance, irrigating under an oak tree for the summer watering of a lawn or garden can stimulate the growth of fungi on the roots of the tree. This often sets in motion the weakening and death of the tree.

The most valuable parts of a native tree are the root zone (area of roots) and the root crown (base of the trunk). The oak's root system is generally very shallow with roots extending well beyond the tree's foliage. Typically, the zone extends for a distance of 1.5 times the diameter of the drip line. Nearly all the feeder roots are located within the top 1.5 feet of soil. Rarely do these roots penetrate the hardpan layer common to many soils in this area.

The amount of soil disturbance that can occur within the root zone without serious damage occurring to the tree varies with the individual tree. Age, size, species, location, health, and other factors all work to determine the tree's ability to withstand changes which can occur during construction. The best policy, of course, is to leave the root zone area undisturbed. Unfortunately, this is not often possible.

The following construction activities are those which have the greatest potential to damage or kill trees. Basic techniques that can be used to limit tree damage are also noted.

PROBLEM—SOIL COMPACTION

Operating heavy equipment and storing materials under trees can result in soil compaction. Compacted soil prohibits the natural exchange of gases between the feeder roots and the atmosphere and also restricts water percolation to the roots. Inadequate soil aeration can lead to the stunting and/or death of roots.

Remedy. Restrict to the extent possible the use of equipment and/or the storage of materials under trees. Where this is not feasible, the tree's root zone should be covered with wood-chip mulch, 8 to 16 inches deep.

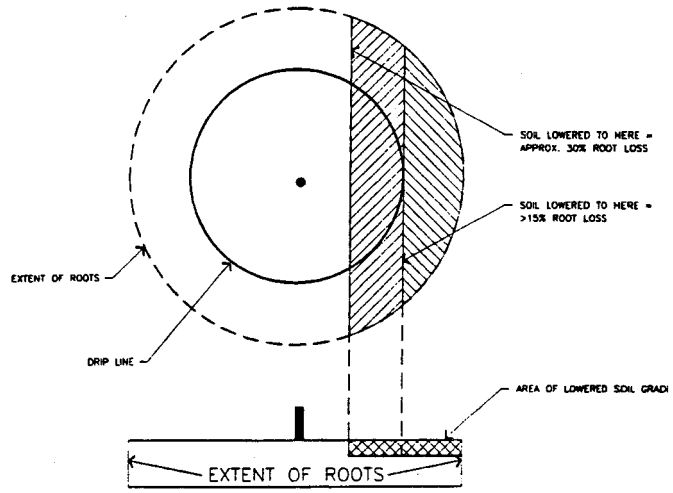


Figure 1 - This plan sketch of a tree illustrates that lowering the soil grade back to the drip line on one side would cut less than 15 percent of the roots; lowering the grade halfway from the drip line to the trunk would eliminate about 30 percent of the feeder roots.

PROBLEM—EXCAVATION

Excavation (cuts) of soils can destroy a substantial number of roots, killing the tree or impairing its stability. By way of example, lowering the soil on one side of the

tree to a point halfway from the drip line to the trunk will eliminate about 30 percent of the shallow roots as illustrated in Figure 1. This is significant root loss. Further root destruction increases the likelihood that the tree will not survive these impacts.

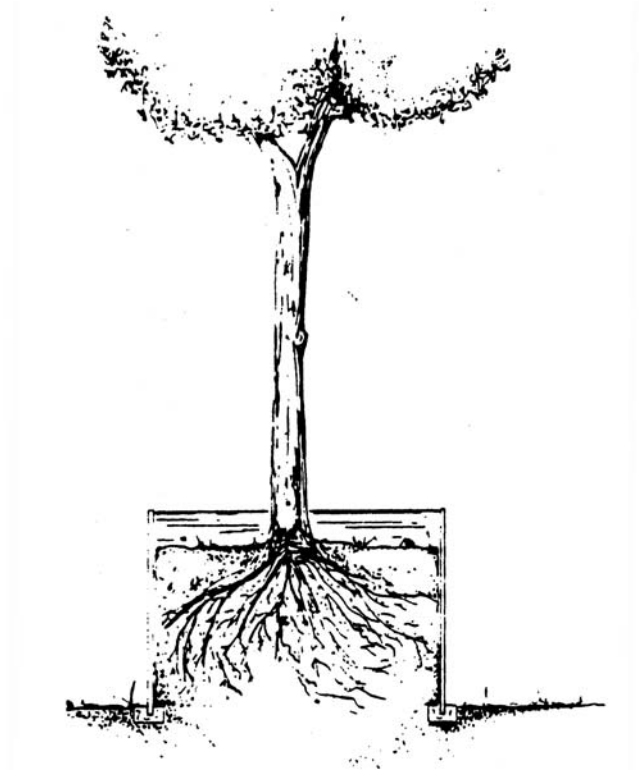


Figure 2 - The use of retaining walls will hold the original root in place and serve as a raised planter. The largest possible area should be left at natural grade.

Remedy. Figure 2 illustrates how the use of retaining walls can limit destruction of the root zone.

PROBLEM — FILLS

Fill materials placed within the root zone present many of the same problems as soil compaction noted above, because fills are often compacted. Compacted fills may also trap excessive moisture in the root zone, causing root and root crown rot. Basically, there is no guarantee that fill can be safely added around trees.

Remedy. If there are no feasible alternatives to the use of fill, it is recommended that the following precautions be taken:

1. Remove grass, leaves, and other material that may form an impervious layer when fill material is added.

2. Build a retaining wall no closer than six feet from the trunk of the tree (preferably not within the drip line). The wall should be several inches higher than the proposed depth of fill (see Figure 3). In addition to being functional, these walls can lend some pleasant diversity to the landscape.

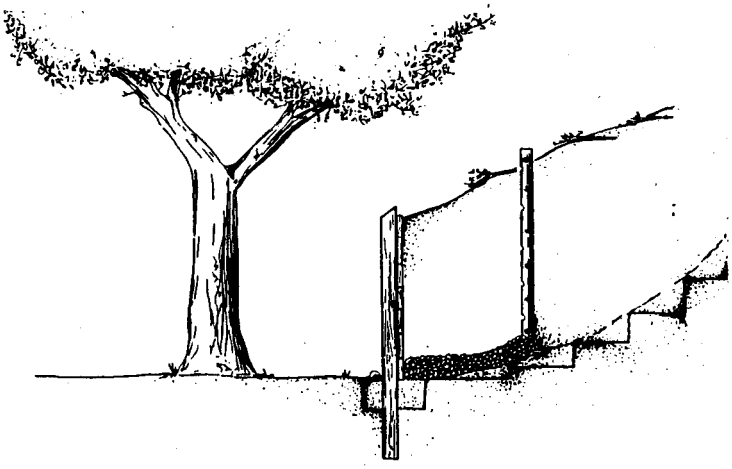


Figure 3 - A retaining wall can shorten the toe of a slope to protect the root zone from encroachment by fill material. A gravel channel and vertical vent pipe provide aeration.

3. Provide an aerating system consisting of gravel aeration spokes or a gravel layer with a system of drain tiles (Figure 4). The spokes allow the vital exchange of gases to occur.

4. Fill soils should be of a texture and structure identical to or coarser than the original soil.

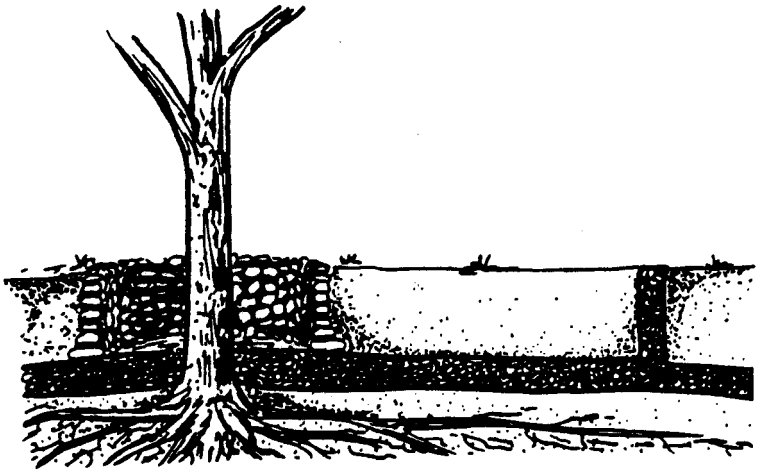


Figure 4 - Gravel aeration spokes (3–5 feet in diameter) provide for the exchange of gasses. Each gravel channel is vented to the surface near the drip line of the tree.

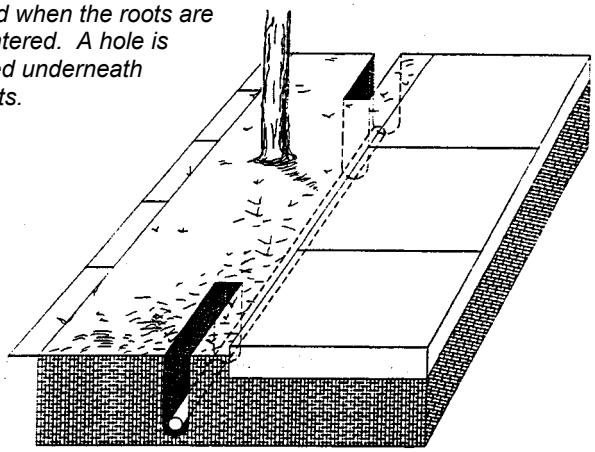
PROBLEM—TRENCHING

Trenching is an often-overlooked cause of tree death. Trenching usually occurs with the installation of underground utilities, often severing major portions of the root zone.

Remedy. Several methods exist to minimize disturbance of the tree due to trenching. Consolidation of underground utilities to a common trench (where permissible under the City's construction standards)

should be considered. Hand digging is a method which also tends to be less destructive to roots than mechanical trenching. The best choice is to use a horizontal bore as illustrated in Figure 5. There are contractors locally available who specialize in horizontal boring.

Figure 5 - Utility trenching can be stopped when the roots are encountered. A hole is tunneled underneath the roots.



PROBLEM—PAVING

Paving can cause many of the same problems that are encountered with soil compaction. Impervious paving, such as asphalt and concrete, prevent water percolation and the exchange of gases between roots, soil, and the atmosphere.

Remedy. There are many kinds of paving which can be compatible with the oak environment. For example, porous brick with sand joints, gravel, and bark wood can be placed under oak trees and still allow adequate percolation and exchange of gases if kept in a shallow layer and dry in summer.

Regardless of the type of covering, nothing should be placed within the critical six-foot radius out from the base of the tree. That inner circle area should always be left natural, uncovered, and dry in summer. When paving is absolutely unavoidable, innovative design can provide some partial solutions.

PROBLEM—DRAINAGE

Changes in drainage patterns can result in water reaching the root zone of trees at times when soils should be maintained in a dry state. This is a particular problem for native oak trees that have adapted to the local dry soil conditions of the summer months. Introduction of water can inhibit the exchange of gases in the root zone and can encourage the growth of root and crown fungus. Examples that can lead to drainage changes include the construction of concrete foundations and footings, streets, and swimming pools downslope of trees, which can act as dams that trap water.

Remedy. In areas where construction of improvements may lead to changes in summertime drainage patterns whether due to nearby springs or irrigation, the use of french drains can be effective in intercepting the flow and routing it away from the tree.

Table 1 highlights the impacts and remedies described above that can be used to minimize damage to trees and can be used as a quick reference guide.

SOURCES OF INFORMATION USED FOR DEVELOPMENT OF THIS GUIDE:

- Harris, Richard W., *Arboriculture Care of Trees, Shrubs, and Vines in the Landscape,* Prentice-Hall, 1983.
- *A Technical Guide to Community and Urban Forestry in Washington, Oregon, and California.* Available from:

  World Forestry Center
  4033 S.W. Canyon Road
  Portland, OR 97221

- *How to Save Trees During Construction.* Available from:

  National Arbor Day Foundation
  100 Arbor Avenue
  Nebraska City, NE 68410

- *A Systematic Approach to Building with Trees.* Available from:

  National Arbor Day Foundation
  100 Arbor Avenue
  Nebraska City, NE 68410

A Mini-Directory of Tree Protection Techniques

IMPACT TO TREE	CONSTRUCTION ACTIVITY	METHODS/TREATMENTS TO MINIMIZE DAMAGE
Branch and trunk damage	Injury from equipment	Fence trees to enclose low branches and protect trunk. Report all damage promptly so arborist can treat appropriately.
	Pruning for vertical clearance for building, traffic, and construction equipment	Prune to minimum height required prior to construction. Consider minimum height requirements of construction equipment and emergency vehicles over roads. All pruning should be performed by an arborist, not by construction personnel.
	Felling trees in construction area	Require that trees being removed be felled away from, rather than into, tree protection zones.
Root damage or loss	Stripping site of organic surface soil	Restrict stripping of topsoil around trees. Any woody vegetation to be removed adjacent to trees should be cut at ground level and not pulled out by equipment, or root injury to remaining trees may result.
	Digging into topsoil layer and killing roots while loading piles of soil, sand, gravel, etc.	Store outside fenced protection zones and away from root zones. Place plastic tarp, straw, plywood, or geotextile material beneath pile.
	Lowering grade, scarifying, preparing subgrade for fills, structures	Use retaining walls with discontinuous footings to maintain natural grade as far as possible from trees. Excavate to finish grade by hand and cut exposed roots with a saw to avoid root wrenching and shattering by equipment, or cut with root pruning equipment. Soil beyond cut face can be removed by equipment sitting outside the drip line of the tree.
	Subgrade preparation for pavement	Use paving materials requiring a minimum amount of excavation (e.g. reinforced concrete instead of asphalt). Design traffic patterns to avoid heavy loads adjacent to trees (heavy load-bearing pavements require thicker base material and subgrade compaction). Specify minimum subgrade compaction under pavement within root zone. Install aeration pipes if necessary.
	Excavation for footings, walls, foundations	Design walls/structures with discontinuous footings and pier foundations. Excavate by hand near major roots. Avoid slab foundations; use post-and-beam footings.
	Trenching for utilities, drainage	Coordinate utility trench locations with installation contractors. Consolidate utility trenches by hand in areas with roots larger than 1-inch diameter. Tunnel under woody roots rather than cutting them. Curve trenches rather than using straight lines.
Unfavorable conditions for root growth; chronic stress from reduced root systems	Compacted soils	Fence trees to keep traffic and storage out of root area. In areas of engineered fills, specify minimum compaction (usually 85%) if fill will not support a structure. Provide a storage yard and traffic areas for construction activity well away from trees. Protect soil surface from traffic compaction with 8 inches to 16 inches of wood-chip mulch. Following construction, mulch compacted areas. Install aeration vents.
	Spills and waste disposal (e.g., paint, oil, fuel)	Post notices on fences prohibiting dumping and disposal of waste around trees. Require immediate cleanup of accidental spills.
	Concrete wash-out and waste dumping	Designate wash-out area. Dig pit and remove after construction, if necessary.
	Soil sterilants (herbicides) applied under pavement	Use herbicides safe for use around existing vegetation and follow directions on the label.
	Impervious surface over soil surface	Utilize pervious paving materials (e.g., interlocking blocks set on sand). Install aeration vents in impervious paving.
Inadequate soil moisture	Rechannelizing stream flow; redirecting runoff; lowering water table; lower grade	In some cases, it may be possible to design systems to allow low flows through normal stream alignments and provide bypass into storm drains for peak flow conditions. Provide supplemental irrigation in similar volumes and seasonal distribution as would normally occur.
Excess soil moisture	Underground flow backup; raising water table	Fills placed across drainage courses must have culverts placed at the bottom of the low flow so that water is not backed up before rising to the elevation of the culvert. Study the geotechnical report for groundwater characteristics to see that walls and fills will not intercept underground flow.
	Lack of surface drainage away from tree	Where surface grades are to be modified, make sure that water will flow away from the trunk, i.e., that the trunk is not at the lowest point. If the tree is placed in a well, drainage must be provided from the bottom of the well.
	Irrigation of exotic landscapes	Some species cannot tolerate frequent irrigation required to maintain lawns, flowers, and other shallow-rooted plants. Use free-form mulch areas or avoid landscaping under those trees, or utilize plants that do not require irrigation.
Increased exposure	Thinning stands, removal of undergrowth	Save groups or clusters of trees when working with species that perform poorly in the open or as single trees. Maintain the natural undergrowth.
	Excessive pruning	Prune sparingly, especially in stands of shade-tolerant species. Remember, leaves manufacture the food needed for root growth and recovery from shock.