Trees & Construction Series

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Conserving Trees During Site Development

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Trees are valuable to sites where people live, work, shop, and recreate. Tree-generated values impact psychological, social, ecological, and biological aspects of daily life. Planting, cultivation, and conservation of trees on sites where land-use or structural changes occur are important to people.

Modifying the human environment through building, renovating, or removal of physical structures or landscape features is a part of development. Significant changes in a tree's soil, water, energy and biological resources can occur in this process. Understanding site and tree constraints, and the various forms of problems on sites, can help preserve tree values.

Tree quality concerns can be grouped into three distinct time periods:

A) pre-development planning and site evaluation -- Pre-development concerns revolve around site selection, project planning, and tree and forest attributes;

B) construction activities -- Construction concerns concentrate on site-layout, tree protection zones and site-damage control; and,

C) post-development mitigation and monitoring – Post-development concerns concentrate on restoration of tree functions and values.

Within each time period, are a number of site conservation issues which affect tree and soil quality. Each issue can have a number of assessment processes which can be used to better control development activities around trees and soils. Development site assessments are provided in an associated publication. Here will be examined five major components of conserving trees during a site development process.

COMPONENT #1: Tree-Literate Design

Tree quality management around development sites must begin early in the planning stage as part of a site-team effort. Tree and site attributes, and their relationship with the design process and construction methods, determine post-development survival, continued tree success, and any requirement for therapeutic treatments.

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The first step in tree management is getting tree-literate professionals involved in the planning process. There are times when biological components of a design process may be ignored or given low priority. This action leads to poor tree quality and diminished value production. A tree health care provider must be involved with all the concepts within site development and planning in order to accentuate, or at least maintain, tree values.

Protection of tree and site quality are key aspects in developing a site. To assure whole tree quality, all tree parts must be protected from acute and chronic damage while short and long-term resource degradation is minimized. Tree quality must be interwoven early in the design process, and continually with construction methodologies. Tree quality must be a part of client perceptions and expectations, and translate clearly into planning and design activities. Tree health care professionals must be part of site planning!

COMPONENT #2: Pre-Development Site Evaluation

Systematic site and tree evaluation are essential for maintaining tree values and managing risks on construction sites. There are many great assessment tools for use in both the office with computer generated plans, and in the field covering both pre-, during, and post-construction. These assessments are key to minimizing tree and soil damage and for maintaining project-to-project and site-to-site management success memory.

Begin a pre-development evaluation process at least one growing season in advance of site development activities, if possible. There are many tree and site features to examine -- some of the more important are discussed below.

Numbers. How many trees are present on-site affects many aspects of development. As a rule, the more trees on a site, the more a forest-like atmosphere is generated (up to a point). Over-abundance can be a problem. Sites with too many trees can be as limiting and unresponsive to development as sites with too few trees. Building in dense, overstocked stands can result in decline and death of many trees. Remaining trees are prone to windthrow, pest, storm and ice damage.

The biological occupancy level of trees on a site can be easily determined. Any site, depending upon its inherent productivity, can only hold a given amount of leaf surface area. This leaf surface area can be concentrated onto a few large trees or onto many small trees. Figure 1. For example, 600 five-inch trees, 150 ten-inch trees, 65 fifteen-inch trees, or 40 twenty-inch trees all carry similar total crown volumes per acre. There is a trade-off between the numbers of trees and their sizes for similar site occupancy.

Basal Area. One way to estimate site occupancy or tree density is by measuring basal area (BA). Basal area is a forestry measure that determines the cross-sectional area (in square feet) of all the trees on an acre at 4 ½ feet above the ground (called DBH). This measure can be easily estimated using an angle gauge or prism (or a US 5 cent coin) at a number of random points in an area. Basal area is a direct estimation of crown area or site occupancy.

Using basal area can help quickly establish site occupancy, and expectations of how a site will respond to development. A wooded site would be considered overstocked and unresponsive if basal areas are greater than 70 square feet per acre. A wooded site is under-stocked if basal areas are less than 35 square feet per acre. Tree parks or savannah sites would carry 21-40 square feet of basal area.

Species. Another site feature to examine is the tree species mix. There are many types of trees and associated reactions to site changes. Some will respond well to nearby construction and associated

environmental changes -- others will begin to decline almost immediately. Tree species tolerance to site development activities can be found is an associated publication.

The greater variety of trees on a site, the better the chances for long-term health of all trees. A mix of several different species can insure a healthy diversity of tree cover. Work for at least three species per crown class. If a site has only one species, such as only pine, only hickory, or only cottonwood, the site is at risk for tree problems. Invest in, and manage toward, genetic diversity.

Size. A diversity of tree sizes is also important. There should be a mix of small, medium, and large trees. As a general perception rule for a wooded look and feel to a site, for every existing large tree (11 inches diameter or greater), there should be five medium sized trees. For every medium sized tree (5-10 inches diameter), there should be five small trees. For every small tree (1-4 inches diameter) there should be ten seedlings / saplings. Figure 2.

Crowns. Another valuable evaluation technique is examining tree crowns as an estimate of a tree's potential response to change. Mature trees with a large volume of living crown can react most favorably to development. The proportion of living branches or living crown should ideally comprise 66% of mature tree height. Most trees should at least carry a minimum 35% live crown. If the live crown is less than 20% of total height, problems may develop after construction. Small crowned trees (<10% live crown) would be candidates for removal before construction begins. Figure 3.

Old Damage. Past damage on a site must be recognized and mitigated, or worked around. Site and tree damage may have resulted from past construction, logging, storm, erosion, or land clearing. It is difficult to use machinery between and around trees without damaging tree parts or site resources. Such injuries lead to decline, decay, pests, susceptibility to additional damage, and structural problems. Severe mechanical damage will make it more difficult for trees to adjust to any site changes.

Carefully examine the bottom 20 feet on tree trunks and the basal 10 feet of root area for any scrapings, tears, or wounds. If mechanical injury disrupts more than 1/3 of the trunk's circumference, removal is warranted. The basal portion of the tree withstands the most concentrated structural loads and are most prone to debilitating damage. Survival for trees with severe damage in this basal portion is usually poor over the long-run. Risk assessments should completed and hazardous trees removed before construction begins.

Soil Problems. The soil surface mirrors past site abuse and current health. The soil surface can show soil disruption, heavy equipment use, and compaction. Soil movement across the surface from natural processes or from equipment can lead to tree damage and site productivity losses. Removing soil can severely damage roots. Excessive fill (defined primarily by soil texture and bulk density) around existing trees can suffocate roots and cause tree decline or death.

Erosion from past and present activities can destroy site productivity and tree quality. The presence of many exposed surface roots and lack of natural litter suggest excessive erosion, compaction, and/or drainage problems. Establishing tree protection areas well before construction begins is critical. Physically protect roots and rooting areas with mulch, fences, plywood sheets, and other physical barriers.

COMPONENT #3: Pre-Development Treatments

After pre-development site and tree evaluations have been completed, treatments can be recommended to minimize potential damage and maximize positive tree reactions to change. Preferably one

full growing season in advance of any development activity on the site, and if warranted by tree and site characteristics, treatments could include:

-mark utility and equipment access corridors and assure needed vehicle clearances;
-mark construction danger zones and tree protection zones;
-prune, clean, deadwood, and clear trees;
-mulch tree protection areas;
-set-up tree protection barriers;
-establish irrigation needs and methods;
-fertilize with any essential element showing deficiency in tissue samples except for nitrogen; and,
-make low concentration / slow release / low yield nitrogen applications.

As you are aware, seldom are tree health care professionals allowed the luxury of timely advanced access to sites for evaluations or treatments. Usually tree health care providers are called to fix tree quality concerns after site development activities have commenced and some construction damage has already occurred.

COMPONENT #4: Managing Construction Impacts

The first and most critical rule in working with tree quality on development sites is to "get there first!" The first approach to a tree and over its soils can be the most damaging and facilitate further damage. Tree quality managers need to be the first people to approach all the trees on a site and make removal, treatment, and preservation decisions.

Locate Trees! Tree quality managers need to insure that every person on a site knows where the trees actually are -- not some general circle on a site plan. Plans should include accurate and precise locations for the trunk, crown, and major soil areas colonized by the roots. Remember construction equipment and development activities do not damage tree quality and site resources -- individuals accomplish these actions. Use on-site education, daily monitoring, and/or a strong series of fines, penalties, and rewards to help people remember that trees are important.

Once a site plan is available, determine where tree quality and site resource damage are most likely to be concentrated. When trees are not accurately recorded on site plans, go onto the site and outline on the ground with string where various planned structures and areas will occur.

Define Zones. If a tree is within thirty feet of the string, it is in the "construction danger zone" and should normally be removed to facilitate good construction. Trees within this zone are easily and consistently damaged during construction. These trees decline and die due to damage, or eventually become a hazard to structures and people in the area. Figure 4.

High quality trees between zero and sixty feet from any structure can be individually protected with barriers and stem, branch and root paddings or wraps, if the tree value is warranted. The area between zero and sixty feet from structures is the "tree protection zone." Trees already in poor condition should be removed. Tree protection barriers should be installed before construction begins anywhere on the site. Barriers will not prevent all damage but will remind people working on the site that trees are important and barriers should be respected.

Provide Space. Protect as much open soil surface as possible below the tree's crown. Trees require physical space and soil volume to colonize and control. Valuable soil features include:

-- physical space for support and pore volume;
-- open surface area for oxygen and water movement; and,
-- an adequate and sustainable supply of essential soil resources.

To summarize this point, trees with large areas to grow in have the best chance of being healthy, long-lived, and developing few problems. A tree quality manager assists a tree to colonize and effectively utilize a site.

There are a number of ways to determine how much space is minimally needed for tree survival and growth. One effective means of determining a protection distance is using a site-occupancy measure. The expected diameter (DBH) of a tree 10-15 years in the future is estimated. The expected diameter in inches is then multiplied by 2.5 to yield the number of feet in diameter of a tree protection area (critical rooting area). Many times with mature trees, only the current critical rooting area is determined, not providing for any future growth.

Eliminate Potential Problems. Always limit construction machine access, material storage, chemical or cement rinsing, vehicle parking and site-office locations to non-tree areas. Do not let construction equipment near trunks or main rooting areas. Construction activities should not occur beyond 60 feet from site development hardscape, building footprint, or site construction access routes.

Soil level changes over the site can disrupt and destroy roots and negatively modify the soil environment. Fills and cuts, leveling, and surface cultivation or tilling all can damage or kill trees. An often overlooked but critical soil component is water availability and water movement. Soil changes or movement on a site can completely change water flow patterns, ponding, and soil aeration patterns. Soil cuts can drop water tables and available water away from established tree root systems.

Soil Compaction. Construction activities destroy soil resources, functions and values. Soil bulk density or compaction changes can be the most constraining and damaging, while remaining hidden to most site users and planners. Compacted sites do not support vigorous tree growth. Construction sites can easily have 50% greater bulk density than native soils. Increasing bulk density by one-third can be expected to cost a tree one-half of its root and shoot growth.

Soil compaction constrains root growth by acting as a physical barrier to root growth and by blocking oxygen movement to the root surface. Tree roots have difficulty physically penetrating soils with bulk densities greater than 1.7 g/cc, and as the proportion of air pore space (macro-pores) in a soil drops below 15%. Soil compaction is measured as a combination of bulk density of the soil and soil texture. Both components must be known to determine the full extent of tree damaging compaction.

Solutions to compaction problems on development sites include:

A) deep tillage or sub-soiling (if no tree roots are present);
B) mulching and composting to reinvigorate soil health (if moisture and aeration are assured);
C) amending with large, porus, non-compactible solids to create an aerated soil framework;
D) selective use of porus or open structure surfaces as long as compaction is not used to stabilize the units;
F) deep core aerators (12-18" depth);

G) vertical mulching using an auger to drill holes in the soil and backfilling with washed, graded, and non-compact able materials including some soil which leave hole tops open to the atmosphere;

H) radial trenching away from the tree stem base to 16-24 inches of depth and backfilling with washed, graded, and non-compactible materials including some soil with the trench top left open to the atmosphere; and,

I) air gun (knife/spade) which stirs soil and does minimal damage to roots.

Items to maintain tree quality through soil management include: prevent and restore high bulk density soils; avoid, treat, and prevent soil contamination by construction materials; and, improve nutrient cycling, moisture balance, and soil structure by top-dressing with organic matter.

Assign Space. Design and control access corridors for utility installation, both underground and overhead. Depending upon local codes for underground utility corridors, two or three trenches are the most needed for all the various utilities. Unfortunately, seldom do various utility providers cooperate in the installation processes to minimize tree quality loss. Utilities lines should be designated to non-tree areas for access, such as along driveways and sidewalks. Working with utility service providers to generate serpentine corridors and tunneling (soil piercing) under tree rooting areas are essential.

Provide room for trucks and construction equipment to get back and forth to the building site. Two access points are needed because large equipment or delivery trucks can not turnaround without extensive site quality losses. An incoming and outgoing access route should be designated for deliveries. This does require a designated, non-tree area for storage of construction materials and parking spaces for construction related vehicles, including laborers and sub-contractors.

BMP Checklist. There are a number of important tree quality conservation items to note and manage as site development activities occur. These include:

1) Know the site development and building regulations concerning trees in your area.

2) Establish fenced tree protection areas. For trees in harm's way, use tree protection barriers, wraps, and pads, keeping them in good repair.

3) Include contractual penalties in real dollars for tree protection area violations and tree barrier damage. Allow dollars to educate reluctant or tree-illiterate people and companies.

4) Plan a cement wash-out pit and designate a chemical holding area, both away from tree protection areas.

5) Limit site parking and material storage to already damaged areas.

6) Allow no site-offices, equipment, or material storage in tree protection areas.

7) Keep refueling and maintenance areas away from trees and native soils.

8) Control toilet, lunch, break and burn areas, and associated refuse.

9) Control and limit on-site soil storage.

10) Control and minimize grade changes, and prevent significant water and soil flow / accumulation changes on-site across tree protection areas,.

11) Allow only two construction access drives into the site -- one in, one out.

12) Control utility over-head and under-ground corridors.

13) Be careful of fire dangers to site and surrounding woods during construction and afterwards.

COMPONENT #5: Post-Development Treatments

Post-development tree quality management primarily concerns identification of problems and associated treatments that do not accentuate tree quality losses or further destroy site resources. In addition, sorting out the living trees from the dead, and soon to be dead, is required. Severely damaged trees should be quickly removed and replaced with plantings, if warranted.

Cultural treatments on the post-development site can include:

-weekly water management (the most important item!);
-fertilizing with essential elements shown to be deficient in tree tissue tests;
-wait one growing season for minimal nitrogen applications then maintain minimal levels for 3-5 years;
-if in doubt about the structural integrity or survival of a tree, remove it immediately; and,
-watch closely for pests and changes in tree structure -- preventative treatments may be advisable.

CONCLUSION

The quality of life of the tree and the tree owner is dependent upon design and development processes being tree-literate, and timely treatments are prescribed that attempt to affect casual agents of problems. Tree quality can be preserved, maintained and restored around development sites if we give trees a biological and ecological chance.

Figure 1: All sites recieve the same amount of sunlight energy per acre to power all the trees. Managers can divide this energy into a few big trees or many small trees. The leaf area at full stocking will always be the same.

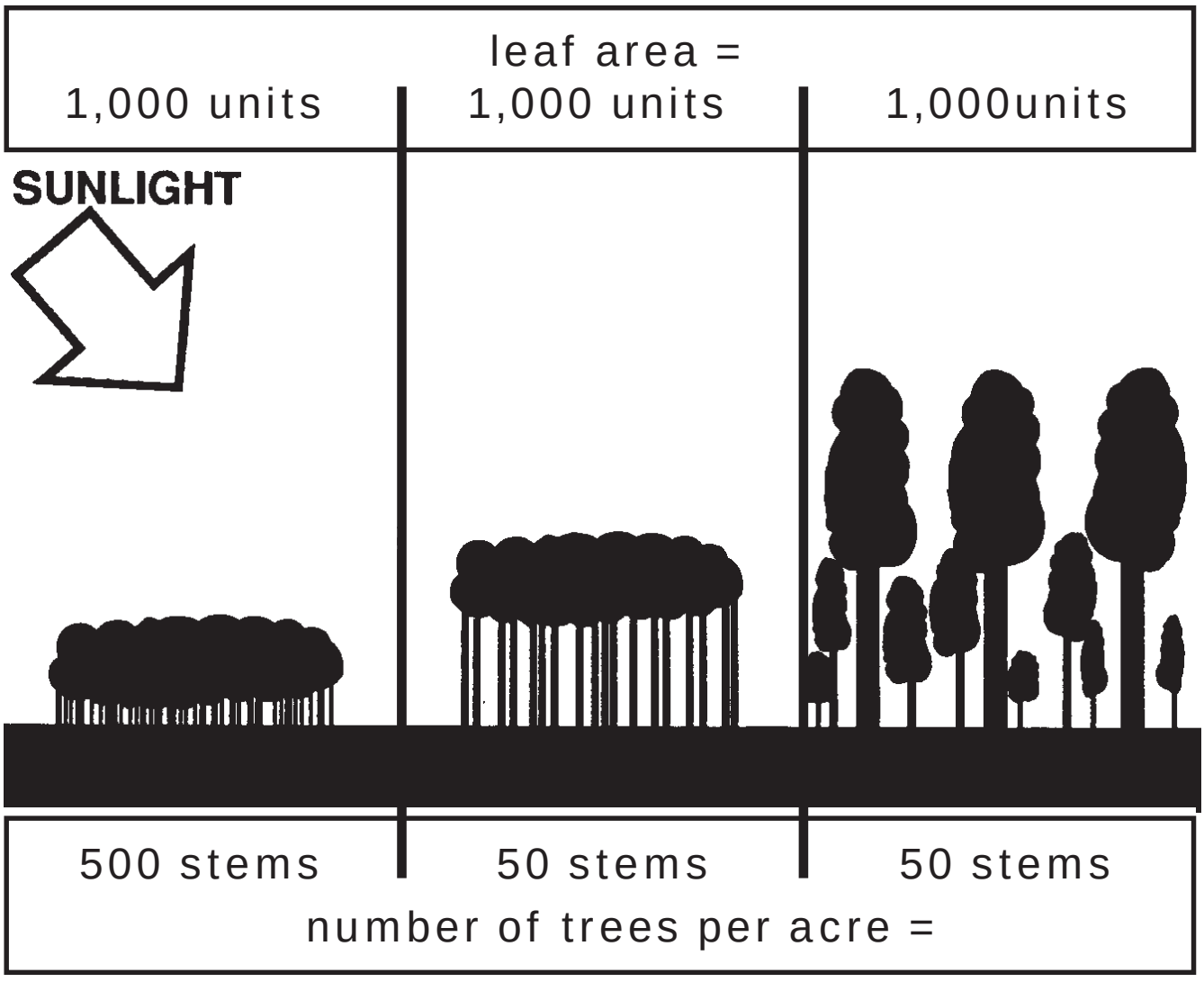

Figure 2: An ideal size distribution for a wooded appearance on a developemnt site.

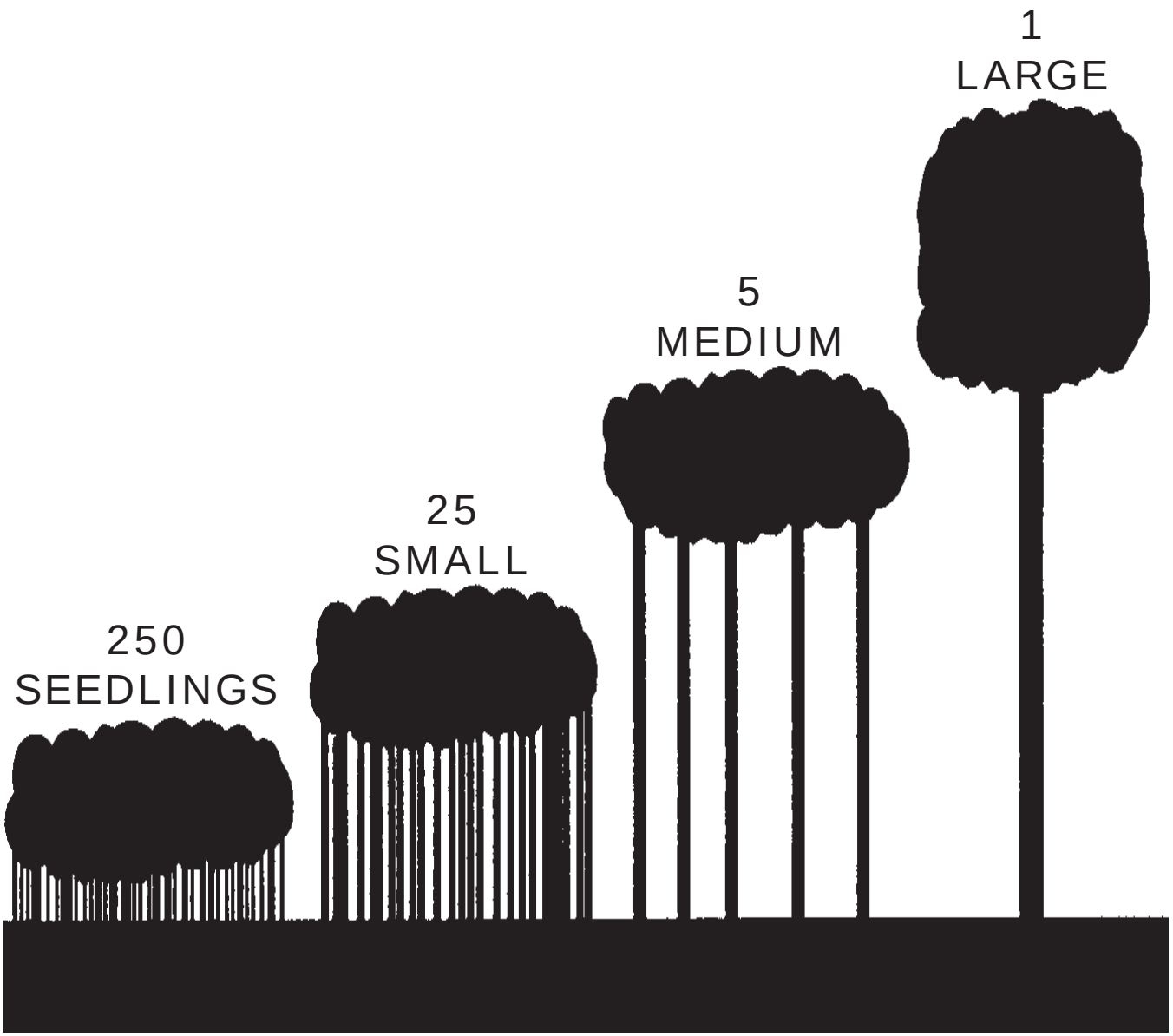

Figure 3: Demonstration of how live crown is masured in a tree. The base of the living crown is determined from where the first main branches grow from the stem, and does not include consideration of incidental sprouts.

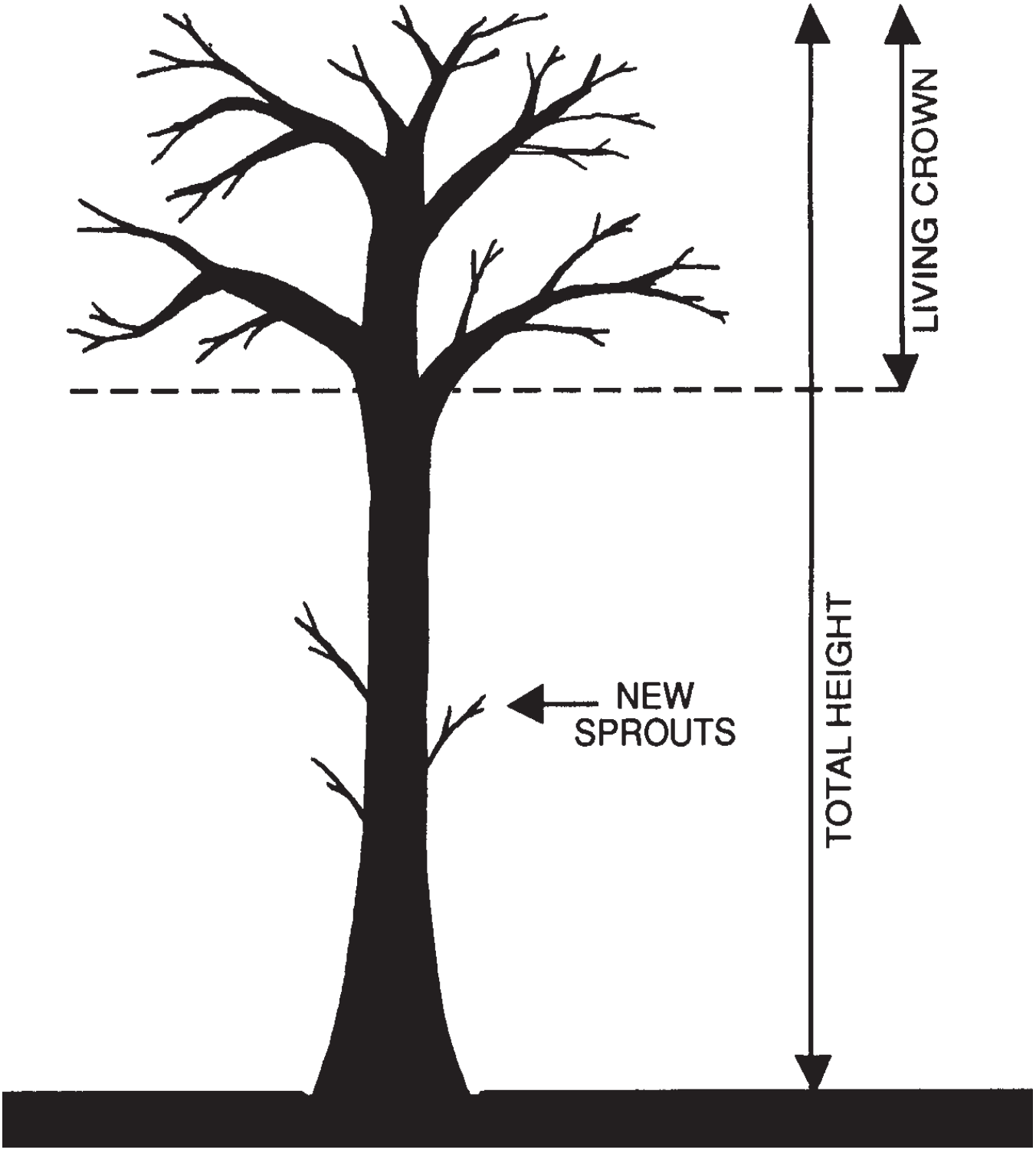

Figure 4: Diagram of a construction danger zone (CDZ) and a tree protection zone (TPZ) around a house foot print. Note two access routes onto the site are not shown.