DEVELOPMENT IN HARMONY WITH

LIVE OAKS & MARITIME FORESTS

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Development in Harmony with Live Oaks & Maritime Forests

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Properly preserving live oak trees during development takes time, good design, communication and money. However, the results are worth the effort. Preserving trees has been shown to have positive effects on the image and attractiveness of developments and enhances developers' reputations and profits. Trees increase a project's appearance, monetary value and marketability by providing aesthetic and functional values. Lots where trees are preserved can be sold more quickly and at higher prices. Commercial areas with trees have been shown to attract more businesses and customers who are willing to pay a higher price for goods. Research has shown that mature trees can increase the worth of a property up to 12 percent.

Developers who understand these values realize that it is in their best interest to encourage the preservation of trees and green spaces, but where do you begin to learn the best methods to preserve trees? This publication briefly touches on steps you need to take to protect maritime forest species, including the live oak (the city tree of Virginia Beach). It highlights best practices along the way, from pre-construction tree inventories, to protection of trees during construction and care after construction. More detailed information can be found at A Guide to Protecting Maritime Forests Through Planning and Design from the NC Department of Environmental, Health and Natural Resources and the Maritime Forest brochure from the Currituck County Planning Department. Both have specific information about working in this unique ecosystem.

If you would like more detailed information about protection during any of the phases of construction, the City of Leesburg and Penn State Extension and others have on-line publications that go into great technical detail on preserving trees. These are listed in the resources section at the end of the publication.

Tree preservation starts with a basic understanding of the health of trees and the soils that support trees. Trees are alive - and like most living things they need access to water, air, sunlight, and nutrients to maintain good health. Trees also need structural stability and relatively intact wood in order to support themselves and to prevent breaking limbs or the entire tree falling over. They respond to what is done to them and to the environment that they occupy. To stay healthy and vigorous, trees need a pollution-free and compaction-free soil that allows unhampered movement of water and air. Trees also need protection from insects, disease and physical damage. Trees have roots, bark, a trunk, branches, and foliage, and they will thrive only if these parts remain healthy and undamaged.

Tree Parts

Roots are essential to tree health. They support the weight of the tree, store food, and take up water and nutrients from the soil. Tree roots need to be well anchored into soil to hold the tree safely erect. Although the large, woody roots that support the weight of a tree and resist strong winds may reach deep into the soil, most roots that absorb water and nutrients can be found in the upper 12 to 18 inches of the soil. In general, oaks are considered to have some of the more

sensitive root systems, so damaging live oak roots can wreak havoc on the tree. A significant portion of live oak roots exists in that upper 12 inches of the soil. This is crucial for the tree's access to the oxygen that is vital for respiration. This is why we tend to see live oak roots emerging from the ground with offshoots or suckers more than in any other species. Roots are not confined to the area beneath a tree canopy in fact, some roots can grow to more than three times the spread of the tree's branches.

Bark serves as a living barrier to insects, disease and water loss, and as a transport system. Water and soil nutrients move upward in the wood, while manufactured food (carbohydrate or sugar) and growth substances (such as hormones) move downward and outward. Wounds that penetrate through the bark into the wood enable insects and fungi that cause decay or diseases to pass through the outer defenses of the tree.

A tree ***trunk*** provides height to the canopy of the tree, space for storing food materials and support for the branches and leaves.

Tree limbs, branches and twigs support leaves, where most of a tree's food is produced. Through the process of respiration, living cells in buds, leaves, roots, and other structures consume oxygen and convert the carbohydrates into other chemicals and energy the tree can use for growth, reproduction and defense against decay. Injury to a tree can affect the production or use of energy in that tree by increasing the rate of respiration and the usage of stored carbohydrates. Repeated depletion of stored carbohydrates because of injury threatens the tree's health at the time of injury and into the future.

Soil for Healthy Trees

Soil is the medium in which trees grow. It supports tree establishment, growth and reproduction. To remain healthy, trees need soil for water, nutrients and structural support.

Each soil type has unique characteristics of texture and structure. Soil texture is the proportion of the individual particles of sand, silt and clay found within a soil. Construction activity will not change soil texture unless new soil or debris is brought to the site, but it can change soil structure.

There are many types of soils. Soil structure is determined by the way in which individual particles of sand, silt, and clay are combined into aggregates over time. Structure is important because the fine spaces between soil particles hold water and air, which support tree growth, while the larger pore spaces between aggregates allow for the infiltration of rainfall and air. Healthy trees need healthy roots and healthy roots need good soil structure.

In addition to inorganic particles of sand, silt, and clay, decaying matter shed by plants (leaves, bark, branches, and decaying roots) forms a loose organic layer on the soil surface, which is gradually incorporated into the soil. This layer promotes the infiltration and retention of water, supports populations of beneficial soil organisms, reduces the risk of erosion, increases the development of soil structure and provides a slow release of nutrients.

The ideal soil for tree growth is a mixture of clay, sand and silt (called a "loam") that is well drained and aerated, contains 1 to 5 percent organic matter, has a covering of leaves and other organic material, and has an established population of living organisms such as fungi, bacteria and earthworms.

The goal of preserving trees during development is to protect adequate space and good soil for trees with the best health, structure and appearance, while removing hazardous trees, lower quality trees, and others that are in the way of construction. Above all else, preserved trees need adequate space for root and canopy function and growth. The first preconstruction action is to complete a tree inventory.

Pre-Construction Tree Inventory

The first step in conducting a tree inventory is to do an initial walk-through of the property with a qualified arborist, forester or landscape architect. It is important to use qualified people who understand the relationship between trees and construction and also have knowledge about species characteristics, tree health and tree structure. During the walk-through, decisions are made about which trees should be tagged and inventoried. This tree inventory provides information used to make decisions on which trees can be preserved and what measures are needed to protect them. In an inventory, a form is used to gather information on tree species, trunk diameter, height, crown size, condition, suitability for preservation and maintenance needs. An accurate inventory should ideally be completed before lot lines, paved areas and building footprints are laid out on an undeveloped piece of property. They should also be done whenever there are additions or changes to existing parcels that have trees present. Accurate information is important for preserving trees. Variations as small as several feet between actual and mapped tree locations can drastically affect the amount of root and canopy pruning needed to fit construction.

In some municipalities, tree preservation ordinances dictate the type and sizes of trees that must be inventoried. In others, the developer can decide freely how the inventory will be conducted. You can find tree ordinances for Virginia and Virginia Beach on the internet.

Tree condition should also be assessed at this time. Condition is a combination of tree health and tree structure and is a major factor in determining suitability for preservation and tree removal priorities. Tree health is evaluated by observing crown density, foliage color and size, insect and disease problems, injuries and amount of deadwood.

Evaluating tree condition is complicated, so a qualified arborist should be consulted, especially about older and larger trees that will be close to people, buildings, play areas, paved areas and cars.

Detailed information on how to conduct this inventory and assess the condition of trees, along with a sample form can be found in the Penn State Extension publication.

After the inventory is complete, a tree preservation plan needs to be made. This plan identifies places where limited space needs to be carefully managed when developers are trying to accommodate both trees and construction - buildings, paved areas and underground and overhead utilities. This type of plan may lead to changes during the early stages of development that will preserve important trees and help developers avoid costly mistakes and delays. The best plans provide adequate tree protection zones that separate buildings, infrastructure, and construction activities from worthy trees. Refer to the guidelines in the Penn State Extension publication to help you develop a tree preservation plan. Keep in mind that aging live oaks will tend to develop spreading low branches. Be sure you have allowed enough space for this natural process on this plan. Another alternative is to keep the tree well trained throughout its life. Always prune branches before they reach 1/3 the diameter of the stem (where branch is attached) to minimize decay and discoloration, and maximize effective growth over the pruning wound.

Prepping for Construction to Begin

All of the work put into the tree report and the tree preservation plan can be lost through carelessness. It only takes a moment for a piece of heavy equipment or a person with a chain saw to injure or kill a tree that was selected for preservation. Other construction activities, such as the cleaning of cement trucks and paint equipment, can seriously injure or kill a tree. If a tree is damaged by equipment or workers, it can be marred for life or killed. Wounds and pockets of decay do not fill, but are compartmentalized and covered by wound wood. As a result, pockets of decay never disappear, even if they are covered by new wood. Some trees decline slowly over a number of years because of construction injury, while others may die quickly. Construction-impacted oak trees take a long time to die, giving live oak a reputation for being a tough tree. It is usually the last tree to die around a newly constructed building.

Developers, contractors and home builders must take every precaution to ensure that trees designated for preservation are not injured during construction. This requires that trees be protected by fenced tree protection zones and that workers be properly instructed and monitored.

A Tree Protection Zone (TPZ) is designed to minimize access to the area around a tree and to prevent the area from being excavated, used to stockpile material, dump debris, or for equipment access/storage. Clearly define the boundaries of the TPZ by installing a sturdy tall temporary fence around the zone. There are two methods for determining the diameter of this zone:

1) Measure a distance of 1½ times the diameter of the edge of the outermost leaves (also known as the “canopy dripline”). For example, if the diameter of the tree (from outermost leaves on one side to the outermost leaves on the opposite side) is 60 feet, the fence should be placed completely around the tree at 45 feet away from the trunk for a total diameter of 90 feet (1½ x 60 feet), or

2) Measure the diameter (in inches) of a tree trunk at a point 4.5 feet above ground, known as the diameter at breast height (DBH). Define a circle around the tree with a diameter in feet equal to the number of inches of the trunk's DBH. For example, a live oak with a diameter of 10 inches would have a TPZ 10 feet in diameter.

It is commonly thought that trees can withstand the removal of 1/3 to 1/2 of their root system, but structural stability may be compromised after the removal of more than 1/3. Because it is difficult to estimate the full extent of a tree's root system, it is difficult to know when a certain percentage of roots has been affected. Providing an adequate TPZ helps preserve needed tree roots.

The more undisturbed space that can be provided around a tree, the better the tree's chances of survival and subsequent growth. For especially valuable, large, old, historic or landmark trees, the TPZ should extend at least to the dripline, preferably beyond, and should be established by an experienced arborist or horticulturist.

Within the TPZ, you can take extra measures to protect the trunk of the tree by placing a vertical barrier of 2 x 4s around the trees and using a strap to secure them. You can also use black plastic corrugated tubing wrapped around the trunk. What to use will be determined by the equipment being used near the tree and how close the trees are to one another. Prior to construction, pull and tie back limbs that may impede the construction zone. Minimize pruning or removing limbs - even large limbs over 3” in diameter may have the flexibility to be effectively pulled and tied away from the work area.

Developers of larger projects may wish to consider setting aside groves of trees to provide recreation, wildlife habitat and other environmental benefits. Because of these benefits, it is often desirable to incorporate groves of trees into a development's landscape. Live oaks do best in groups or clumps where each tree shades the base and soil of the other trees. In the wild, many oak stands can be related genetically through centuries of sprout development. Like the live oak, trees growing in groups have adapted to each other and to their light, wind and soil conditions. These conditions change when exterior or interior trees in a group are removed. The remaining trees may be subject to windthrow, sunscald, altered soil conditions, and altered water availability.

Cluster development can be used to preserve trees and other natural resources in developments. However, it may conflict with local zoning and subdivision ordinances or with the traditional philosophies of builders. The following practices can help create space for trees and other natural resources:

- Complete a natural resource inventory that identifies important views, riparian areas, paths and other resources.
- Design grading and site plans to meet specific site characteristics.
- Keep front yard setbacks to a minimum.

- Keep areas of turf and grass to a minimum.
- Use step-down or other types of foundations that reduce grading.
- Keep the width of roads to a minimum.
- Locate underground or overhead utilities to minimize tree impacts where possible.
- Delete or rearrange lots to provide more space for trees.
- For live oaks, it is best to avoid circling the entire exterior of the dripline with hard surfaces, as the root system typically expands 2 to 3 times outside of this area. It is common to see sidewalk sections uplifted around a live oak, as roots in search of oxygen rise to the surface.
- Design developments in a clustered format.
- Work with municipal officials to explain the advantages of creative subdivision or site design.

Protecting Trees During Construction

Contractors, equipment operators and workers need to be informed of the importance of protecting trees that have been selected for preservation. Fencing should be checked periodically and people involved in a project informed that moving a fence is not acceptable.

The importance of protecting trees can be reinforced by establishing penalties that must be paid if trees are injured or killed during construction. Penalties should be large enough to emphasize that large trees can be worth thousands of dollars and even small trees can cost hundreds of dollars to replace. The value of injured or killed trees can be appraised by qualified arborists using the International Society of Arboriculture's *Guide for Plant Appraisal*. In addition, lot owners or home builders can have tree preservation terms written into their contracts with developers and contractors.

Do not use a bulldozer to selectively remove trees. Trees designated to be saved can be easily damaged by bulldozers during the removal of adjacent trees. When a bulldozer is used to remove a tree, the entire tree falls at once and its canopy can damage the branches and bark of adjacent trees meant to be preserved. Bulldozers also compact soils and destroy soil structure. Trained arborists can selectively remove trees without harming adjacent trees.

During construction, trees can be injured or killed due to soil compaction or pollution, disruption of mycorrhizae and other beneficial soil organisms, changes in soil level, the severing of roots and damage to trunk, branches and/or leaves. Here are some recommendations of how to prevent and mitigate these problems, in order to maintain the health of the trees during construction.

Soil compaction - Soil drainage is one of the most important features of sustaining good live oak growth. Heavy equipment, storage of supplies and materials and work activities within or near a

tree's dripline can cause the soil within the root zone to compress. Soil compaction is greatly increased following an event such as rain or irrigation, when wet or moist soil is compressed by equipment or foot traffic. Compacted soil is extremely difficult to remedy and can lead to the decline and/or death of a tree. Care must be taken during construction to protect the structure of soil. Compacting soils harms trees by decreasing the ability of their roots to take up water, oxygen and nutrients. Compacting soil with heavy equipment or stored materials destroys good structure of the soil by crushing and closing the pore spaces. Even foot traffic beneath trees in parks and around buildings can compact soils enough to be detrimental to tree health. Soil compaction slows or stops rainwater from infiltrating and also increases runoff, which reduces the amount of water available for tree growth. Compaction also interferes with the aeration of the soil, which lowers oxygen levels and raises carbon dioxide levels around tree roots. In areas where trees are to be preserved, soil should be protected from compaction by using a TPZ. Use construction designs that minimize soil compaction for streets, parking lots, driveways and patios. Streets and parking lots cannot support their own weight, so soil compaction is a requirement for standard asphalt or concrete construction. Self-supporting or permeable asphalt or concrete sections for streets and parking lots can be engineered and constructed around trees of high value. Another inexpensive and recyclable way of protecting soil structure under temporary roads and storage areas is to use a layer of heavyweight geotextile covered with about 4 inches of wood chips. This system will support the weight of a loaded cement truck and can be used on all construction sites for temporary roadways and materials storage areas. Geotextiles can also be used for driveways and patios. Wood decks are excellent alternatives to hard-surface patios in areas where trees have been preserved. No removal or compaction of the soil is needed and decks have the added advantages of allowing water and air to reach covered tree roots.

Soil Pollution - Do not pollute the soil. Arrange for proper disposal of construction waste. Soils may be polluted by the on-site disposal of construction residues, petroleum products or other chemicals. Lime-based products such as cement and plaster can dramatically raise the alkaline level of the soil. Many trees cannot tolerate high pH or alkaline soils. Burying rocks and other debris near trees can damage and inhibit their root growth. The pollution of soils must be prevented if they are to support root growth.

Designate specific sites for equipment cleaning or disposal of construction debris. Do not bury construction debris to avoid the cost of hauling and disposal. Only sites that are well away from tree preservation or planting areas should be designated for equipment cleaning and temporary disposal of debris.

Disruption of mycorrhizae and other beneficial soil organisms - Do not remove the natural leaf mulch or organic litter from beneath trees. This protects soil from erosion, moderates soil temperature and adds carbon and nutrients to the soil. In addition, it is teeming with mycorrhizae and other beneficial soil organisms. The threads of the mycorrhizae absorb nutrients and translocate them back to the host tree. As a result, there is an increase in the absorption surface area of the roots. Not only do the fungal threads help to bring water and nutrition into the tree,

but they also can store them for use when rainfall is sparse and temperatures are high. The mycorrhizae, various bacteria and decomposers help in other ways such as suppressing disease, improving soil structure and helping trees to better deal with environmental stressors. Disruption or removal of these organisms can lead to a decline in a tree's overall health and may lead to death.

Changing the soil level - Do not raise or lower the natural soil level within a (TPZ). Filling or cutting soil within a TPZ can severely injure or kill a tree. Raising the grade by adding or "filling" soil reduces water infiltration and air exchange in the soil around the roots. Lowering the grade or "cutting" soil removes both soil and tree roots and also damages the roots that remain.

If soil excavation is within a TPZ adjacent to an aged tree, try to clear around larger roots by hand and leave as many of them as intact as possible. If roots must be exposed to the air, they should be kept moist by installing and using a temporary irrigation or mist system or covering them with wet burlap while site construction is underway and until the exposed roots can be recovered with soil.

While it is best not to alter the soil grade within a tree's dripline, it is sometimes necessary for construction. If necessary, keep the depth of changes to a maximum of 3 inches. Significant changes in soil grade can affect the fine root system that exists within the top 6-12 inches below grade. Added soil can inhibit roots from "breathing" by smothering them and essentially suffocating the root system.

Severing of roots - Construction projects may require the installation or the rehabilitation of footings, foundations, paved areas, walkways, roads, irrigation lines, drainage systems, utilities, etc. When such construction occurs adjacent to trees, roots are often severed to facilitate the work. When roots, especially those over 2 inches in diameter, are severed during construction, trees can become less stable, absorb less water and nutrients and lose stored nutrition, all of which can lead to decline and/or death. Severing roots should only be done by a certified arborist who can prune them properly.

Do not excavate utility trenches through a TPZ as the root systems of trees can be severely injured. Relocate utility trenches or use tunneling or boring equipment when installing underground utilities through a TPZ. Trenching with backhoes and other equipment can destroy entire root systems, while tunneling or boring under the roots has little effect.

Trunk wounds - Gashes and cuts in tree trunks can occur from accidental vehicle and equipment hits, strikes from materials such as lumber or steel beams, hand and power tools, etc. Such impacts open wounds by breaching the tree's protective layer of bark and exposing it to damaging insects and tree diseases. The physical damage that is caused can also disrupt the effective flow of water and nutrients through the trunk and limbs to other parts of the tree. Depending on the severity of the impact and the damage caused, trunk and limb injury can cause tree decline and possible death.

Branch wounds/leaf injury - Trucks and other large equipment that strike tree limbs can cause breakage. The loss of limbs through breakage results in two principle impacts to trees: (1) reduced capacity to capture sunlight for photosynthesis through lost foliage, and (2) the opening of branch wounds that expose the tree to damaging insects and diseases. While the loss of smaller limbs and branches may only cause a minimal set-back in the health and vitality of a tree, breakage and/or loss of particularly large limbs can result in tree decline and death. To prevent this, tie back or prune branches that may be in the way of construction vehicles or activities. Pruning should be based on the tree preservation plan and be performed by a qualified arborist before construction begins. Construction workers untrained in pruning or other arboricultural practices often unintentionally damage trees by leaving branch stubs, tearing the bark or remove more branches than necessary. Properly prune branches or roots that are broken and/or damaged during construction. Any limbs or roots that are damaged during the work should be removed with a clean saw cut at an adjoining limb or branch using proper pruning techniques.

Construction activities well outside a TPZ can also have detrimental effects on a tree's health. For example, cuts and fills can affect natural aquifers and drainage patterns. Large manufactured slopes created by cuts uphill from trees can remove their water source or increase erosion. Compacted fills and retaining walls on the downhill side of trees can act like dams, causing water to accumulate. Positive drainage should be provided for preserved trees where needed. Effects of grading on important trees should be evaluated. Meeting stormwater management and drainage requirements may complicate these recommendations, but careful and skillful design can help achieve sound compromise solutions.

Retain a qualified arborist to perform tree maintenance services. An experienced arborist can monitor tree health before and during construction. If necessary, this specialist can then water and/or fertilize the trees - as well as provide treatment for a pest or disease problem.

After Construction

The most common causes of tree injuries are worker carelessness, grade changes, soil compaction, soil pollution and the incorrect removal or trimming of trees. Depending on the extent of the injuries, trees may die shortly after construction is completed or their health may slowly decline over a number of years. Several techniques including repairing soil structure, fertilizing and repairing tree damage are outlined in the Penn State Extension publication. Trees should be inspected for 2 years following construction for declining health. Watch for these things that may signal the tree has been compromised by soil compaction: branch dieback, reduced canopy density, reduced leaf size, lighter green color of the foliage, development of early fall color or leaf drop, suckers of new shoots from damaged roots or epicormic growth of new shoots as a tree’s response to stress or damage from dormant buds that lie beneath the bark of a tree.

Despite the fact that a tree or woodland is preserved and incorporated within a development, some trees are likely to die each year because of the additional landscaping and construction activities of homeowners and inadequate tree care and maintenance. Various activities can injure

a tree. These include grading, trenching, paving, building paved areas, pools, and home additions, lawns, planting beds, and improper tree pruning or topping. Homeowners should provide proper care for preserved trees and should design compatible landscapes and amenities that protect the health of trees. The following practices can help ensure that trees will remain healthy long after construction has been completed:

- Supply homeowners with information such as the Friends of Live Oaks' A Homeowner's Guide brochure. Developers and realtors can supply home buyers with simple information about the value of their trees, how they can be protected and experienced arborists in their area (see resources at the end of this document).
- Keep competing vegetation, especially grasses, as far away from trees as possible. Not only will grass compete with trees for water and nutrients, it also may produce chemicals that inhibit the growth of trees. Consider alternative landscaping. The areas beneath trees should be covered with mulch or planted with native ground covers with low sun requirements. There are many species of native plants that provide a variety of sizes, colors and forms for landscaping beneath preserved trees. A landscape can be created that not only protects trees, but also highlights native plants, conserves water and reduces the need for fertilizers and pesticides. A healthy root system will allow your live oak to respire more efficiently and remain anchored in the landscape, keeping this iconic tree in its place for decades to come.

The safest way to manage the understory is light mulching. Observe the following guidelines when applying mulch:

- The best mulch materials to use are composted leaves, wood chips, bark nuggets or pine needles. Avoid plastic, stone, sawdust, finely shredded bark and grass clippings.
- Mulch should be applied from the dripline to the trunk, but mulch should not be placed against the trunk. The mulch will retain too much moisture if left against the trunk, which may result in disease and decay.
- If it is not practical to mulch from the dripline to the trunk, minimum mulch circles should be 3 feet for small trees, 8 feet for medium trees and 12 feet for large trees.
- Before applying mulch, it is best to kill grass with an approved herbicide. Mulch should be applied directly to the soil surface or on top of the dead grass; plastic barriers should not be used.
- The mulch layer should be 2 to 4 inches deep - do not create mulch mountains.
- To avoid root disturbance, mulch should not be removed. Additional mulch can be added yearly to maintain a 2-4 inch depth.

Improve the aeration and drainage of compacted soils. Aerate compacted soil if the final landscape has already been installed, or if there are large trees on the site that have roots

growing throughout the compacted area. Aeration can be done to shallow depths with standard core aerators or, to deeper depths, by vertical mulching with power drills or augers.

Prevent additional soil compaction. Build wooden decks instead of concrete or stone patios, as they require the removal of soil and the compaction of the base. Use mulches, preferably with a geotextile base, to prevent compaction in heavily used areas or storage areas.

Provide proper maintenance. Trees are often severely damaged by topping and other improper pruning methods. Employ only qualified arborists to prune and perform other maintenance. Newly planted trees should be well cared for. Irrigate newly planted trees during dry periods for the first five years to increase establishment and growth.

Summary

In today's environmentally conscious business world, it is important to be able to say that your business protects and strengthens our local environment as much as possible. This distinction can help set your company apart from your competitors since many do not take proper precautions to protect trees during ongoing construction projects. It really all comes down to doing an accurate tree inventory, designing with the trees in mind, erecting and maintaining a TPZ, minimizing soil compaction and root damage, using alternative construction techniques to protect trees from injury, and continuous monitoring of the trees for health issues - both during and after construction.

With proper planning, creative design and executing of a tree plan, trees - like the magnificent live oak - can be preserved during the construction process. Leaving these trees adds value, beauty and health benefits for the residents of your community, as well as enhancing your reputation and profits.

Other Resources

City of Charlottesville "Best Management Practices for
Tree Preservation, Transplanting, Removal and Replacement":
https://www.charlottesville.gov/DocumentCenter/View/1291/Best-Management-Practices-for--Tree-Preservation-PDF

City of Leesburg "Tree Preservation Planning for Design & Construction**":**
https://www.leesburgva.gov/departments/public-works/urban-forestry/tree-preservation-planning-for-design-construction

Finding an Arborist:
https://www.treesaregood.org/findanarborist/findanarborist

Friends of Live Oaks "A Homeowner's Guide (2024)"
https://friendsofliveoaks.org/2024/12/02/a-homeowners-guide/

How to Protect Trees During Underground Work:
https://www.arborday.org/tree-resources/how-protect-trees-during-underground-work

International Society of Arboriculture "Best Management Practices - Managing Trees During Construction, Third Edition (2023)"
https://wwv.isa-arbor.com/store/product/139/cid/117/

Penn State Extension "A Guide to Preserving Trees in Development Projects":
https://extension.psu.edu/a-guide-to-preserving-trees-in-development-projects

Plant Appraisal:
https://www.isa-arbor.com/Newsroom/determine-the-value-of-trees-with-the-guide-for-plant-appraisal

Soils:
https://www.nrcs.usda.gov/resources/guides-and-instructions/soil-classification

Treatment of Trees Damaged by Construction:
https://www.treesaregood.org/Portals/0/TreesAreGood_Treatment%20of%20Trees%20Damaged%20by%20Construction_0721.pdf

Developing in a Maritime Forest:
"Maritime Forest" brochure. Currituck County North Carolina Planning Department. https://friendsofliveoaks.org/wp-content/uploads/2024/11/currituck-county-maritime-forest-brochure.pdf
"A Guide to Protecting Maritime Forests Through Planning and Design". Division of Coastal Management, North Carolina Dept. of Environment, Health and Natural Resources. Paton/Zucchino & Associates, P.A. 1990
https://www.govinfo.gov/content/pkg/CZIC-ht392-z82-1990/pdf/CZIC-ht392-z82-1990.pdf

Tree salvaging:
https://treesvirginia.org/services/directory
http://www.sawyersite.org

Virginia Beach Tree Planting, Preservation and Replacement Ordinance:
https://library.municode.com/va/virginia_beach/codes/code_of_ordinances?nodeId=CO_APXETRPLPRRE

Virginia Department of Forestry:
https://dof.virginia.gov/urban-community-forestry/urban-forestry-homeowner-assistance/

Virginia Tree Ordinance Database:
https://vtod.frec.vt.edu/results.cfm?Protection=all

1992 Virginia Erosion and Sediment Control Handbook Chapter 3.38 - Tree Preservation and Protection:
https://mostcenter.umd.edu/sites/default/files/2020-02/Virginia_Erosion_and_Sediment_Control_%20Handbook.pdf

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