

## CITY OF ARLINGTON FORESTRY AND BEAUTIFICATION

### TREE DESIGN CRITERIA & GENERAL GUIDELINES

These guidelines are intended to assist planning and design of public improvements in the City of Arlington regarding tree health and longevity of City assets. The information in this document may be consulted regarding designs on private property; however, the City of Arlington makes no warranty express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or use of any information, apparatus, product, or process disclosed. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the City of Arlington. Always defer to applicable Ordinances or Standards regarding design and installation of landscaping.

## **I. TREE INSTALLATION**

### **A. DESIGN PRINCIPLES**

#### **1. Maintenance**

Any proposed tree planting for the City of Arlington should fully consider the enduring maintenance requirements of the proposed design. Typically, maintenance is provided by the Parks and Recreation Department which utilizes staff and outside contractors for maintenance. The Parks and Recreation Department does not readily have the capability to perform the following: road closures, vehicle parking exclusion, pedestrian walkway closures, elevated work above 10 feet, lifting of greater than 80 pounds, work requiring heavy equipment, or work that requires special tools not readily available. Feasibility of daily, weekly, or monthly maintenance needs should be fully considered in the proposed design. For example, tree and landscape beds located adjacent to single lane roadways must allow for parking of maintenance crew vehicles without fully blocking traffic. Vehicles should be provided with adequate space at a reasonable distance on the shoulder, on the sidewalk, or adjacent city property. As another example, tree pit coverings should allow for collection of trash without removal and removal for other maintenance should be feasible for two workers without specialized equipment. For maintenance questions concerning a design please contact the Parks and Recreation Department.

#### **2. Conflicts**

Tree installation design should always consider future conflict from growth of the tree. This includes growth of the canopy and trunk as well as growth of the roots. Expected crown width and height should be considered and reasonable clearance from structures should be determined from fully mature trees, not

the specified size at time of planting. Tree roots should be expected and allowed to grow to the mature canopy width at a minimum. Longevity of planted trees is dependent on limited competition of roots and canopies when trees are fully mature. Although planting design should strive to reduce conflicts, this is not always feasible and potential issues should be noted. Designs that could require “thinning” or intentional removal of trees due to conflict should be noted. Specified clearances are detailed below ([I.D SPACING AND CROWN CLEARANCE](#)).

## B. TREE PITS

### 1. Dimensions

Tree pits should have a minimum of 20 square feet open to rainfall infiltration. Tree pit area includes only open soil covered by metal grates, mulch, or decomposed granite. Soil under permanent paving materials are not considered tree pit area and include concrete, asphalt, pavers, bricks, porous asphalt, or any other paved surface.

Tree pits must have a minimum width of 3 feet regardless of tree size or other factors. Tree pits must be designed to accommodate the specified tree size. Root balls shall not be cut or reduced in any way to fit into a tree pit (see Table 1). The root ball shall not be wider than the tree pit or covered by any paving material. Fixed tree pit coverings (e.g. metal or plastic grates) must be placed with a minimum of 4 inches from the trunk of the tree at installation. Further details on tree pit cover are covered in [I.B.3 Coverings](#).

Drainage systems are required in all tree pits to prevent damage to the root systems from ponding and oversaturation. See section [I.B.2 Recessed Pits](#).

Appropriate pit dimensions for shade tree species are generally 6' x 5' or 7' x 4'. Comparably sized ornamental tree species (i.e. similar container size, but smaller canopy) may be allowed a smaller tree pit, such as 5' x 5' or 6' x 4'.

Table 1. Minimum tree pit dimensions and tree size.

| APPROXIMATE TREE SIZE    | ROOTBALL DIAMETER | MINIMUM PIT WIDTH | SUGGESTED PIT SIZE |
|--------------------------|-------------------|-------------------|--------------------|
| 15 Gallon / 1.5" Caliper | 18"               | 36"               | 5' X 4'            |
| 30 Gallon / 2" Caliper   | 24"               | 36"               | 6' X 4'            |
| 45 Gallon / 2.5" Caliper | 28"               | 36"               | 6' X 4'            |
| 60 Gallon / 3.5" Caliper | 32"               | 40"               | 7' X 4'            |
| 100 Gallon / 4" Caliper  | 38"               | 48"               | 6' X 5'            |
| 150 Gallon / 5" Caliper  | 44"               | 55"               | 6' X 5'            |
| 200 Gallon / 6" Caliper  | 50"               | 62"               | 6' X 6'            |
| 300 Gallon / 8" Caliper  | 60"               | 72"               | 8' X 6'            |

## 2. Recessed Pits

A recessed tree pit, broadly known as a bioretention, bioswale, or rain garden, allows accumulation and infiltration of rainfall and sediment which would otherwise run off site. The use of recessed tree pits is encouraged when suitable for the site.

The minimum depth of a recessed tree pit is 2 inches, which is measured from pavement surface to any ground covering. Select tree pit covering materials and suggested depths are listed below. The list is not meant to be inclusive and other tree pit cover materials are also acceptable.

Drainage systems are required in all tree pits to prevent extended ponding around trees and plants, and to prevent overflow onto the pavement surface. There are many options for providing adequate drainage in tree pits, which include surface drains, connections allowing flow between tree pits, below ground drainage systems, and other acceptable systems. In recessed tree pits there must be sufficient drainage to prevent water from ponding for extended periods of time. Surface drains in recessed tree pits must be located a minimum of 1" beneath pavement surface and should not necessarily be placed at soil surface. Surface drains in recessed tree pits should allow for excess water to drain without loss of bioretention function. Surface drainage intakes should be located above any cover material and only drain excessive stormwater flow (see Figure 2).

Recessed pits often require site specific modifications that cannot be completely covered in this document. General considerations include expected stormwater flow, slope, tree pit size, location, pedestrian traffic, cover materials, and inclusion of landscape plants. Pits should be designed such that stormwater does not regularly overflow the retention. Slope should be minimized in the pit when surface flows are sufficient to wash away mulch or granite. Landscape plants reduce stormwater flow and prevent loss of surface coverings. Plants also help define walking paths and prevent incursion by pedestrians; therefore, larger pits should include landscape plants or utilize metal coverings.

Possible species when utilizing recessed tree pits include: bald cypress (*Taxodium distichum*), pond cypress (*Taxodium ascendens*), cedar elm (*Ulmus crassifolia*), bur oak (*Quercus macrocarpa*), pecan (*Carya illinoensis*), sycamore (*Platanus occidentalis*), boxelder (*Acer negundo*), yaupon (*Ilex vomitoria*), and vitex (*Vitex agnus-castus*).

Table 2. Examples of tree pit cover materials and applicable design criteria. Planted tree root ball should be at or above the minimum soil level.

| TREE PIT COVER                             | SUGGESTED DEPTH<br>TO TOP OF COVER | APPLIED DEPTH<br>OF COVER LAYER | MINIMUM DEPTH<br>TO SOIL / ROOT BALL |
|--|------------------------------------|---------------------------------|--------------------------------------|
| Fixed Cover (e.g. metal grate)             | 0" / at grade                      | N/A                             | 2"                                   |
| Mulch - no landscape plants                | 3"                                 | 3"                              | 5"                                   |
| Mulch - with landscape plants              | 3"                                 | 2.5-3"                          | 6"                                   |
| Decomposed Granite                         | 2"                                 | 2-2.5"                          | 4"                                   |
| Decorative Gravel<br>(e.g. Canadian small) | 2"                                 | 2.5"                            | 4"                                   |



Figure 1. Recessed street tree planting with landscaping provides rainfall retention.



Figure 2. Example of surface drain installation in recessed tree pits. This unit is raised and screened to prevent sediment and cover material from entering drainage system. Water below the drain is allowed to infiltrate into the soil.



*Figure 3. A major bioretention displaying use of ground cover materials and landscape plants to retain stormwater runoff. Note the raised surface drain which allows temporary pooling of water for sediment retention and increased water infiltration into the soil. Only landscape plants well suited to saturated soils should be used in areas of high water pooling, such as around this large drain.*



*Figure 4. Street side recessed tree planting. Note centrally located drainage raised above soil level and openings to allow stormwater flow into the bioretention. This application should be limited to low traffic areas with low stormwater flow rates.*

### 3. Coverings

Soil in tree pits must be covered by plants and/or materials. Tree pit cover materials consist of fixed covers, such as metal grates or plastic rings, or ground covers, such as mulch, decomposed granite, gravel, or rocks. Landscaping plants

may also be used to supplement cover, add to appearance, and assist bioretention function.

Fixed tree pit coverings (e.g. metal or plastic grates) must be placed with a minimum of 4 inches from the trunk of the tree at installation. Therefore, the diameter of the opening should be the specified tree caliper plus 8 inches. The minimum inside diameter for tree openings is 12 inches. Exceptions include, but are not limited to: flexible, automatically expanding, or biodegradable materials that allow tree expansion. Fixed tree pit covers should accommodate tree growth through expansion features or the cover must allow removal without damage to the pavement or tree.

Permanent obstructions should be limited to the outer perimeter of the tree pit. No permanent object shall be attached to the trunk of the tree without an acceptable method to allow for growth of the tree, including electrical or lighting fixtures. Such objects must be approved by the Urban Forest and Land Manager.

Ground covers are preferred for City of Arlington tree pits. These include but are not limited to mulch, decomposed granite, gravel, rocks, or landscape plants. Turf grass is generally not an acceptable ground cover for tree pits unless trees are in areas with low pedestrian traffic.

Trees and landscape plants should be designed considering final plant size so that tree pits are not “over-planted”.

#### 4. Exclusion Devices

Tree guards and fences are not recommended for City of Arlington tree pits. Low metal fences or railings are subject to damage and do not adequately protect tree pits. We recommended sturdy exclusion devices or using natural design to discourage pedestrian incursion into tree pits. For example, devices may be used if designed as part of low walls or bench seating. Examples of natural exclusion include high landscaping plants, recessed pits, and selectively locating walkways and paths to cross tree pits. Vehicles must be excluded using parking blocks in the case of curbless designs and vehicles should not be allowed to overhang tree pits. Tree must remain partially accessible for maintenance (i.e. should not fully enclose pit or allow for stepping over the exclusion to access the tree). No exclusion device shall be greater than 4 feet tall.



*Figure 5. Use of benches next to tree pit restricts walking across tree pits with ground cover. Concrete bench and wall combinations may also provide exclusion from tree pits. Note that vehicles are blocked from entering the tree pit.*

## C. SOIL

### 1. Minimum Volume

Root spread must not be restricted to the tree pit (i.e. pits fully enclosed on all sides) without the tree pit containing the minimum soil volume. Each shade tree is required to have approximately 1,000 cubic feet of viable soil. Trees in planting strips or connected tree pits (i.e. root growth permitted from pit to pit through soil under permeable pavement or similar designs) may have less than 1,000 cubic feet per tree. Each ornamental tree is required to have at least 250 cubic feet of viable soil. Due to space limitations, above-ground tree planters are not required to have a minimum volume, although planters are recommended to have at least 250 and 62.5 cubic feet for shade and ornamental trees, respectively. Maximizing available soil for tree roots is a desirable design characteristic. In addition, utilizing structural soil under surrounding impervious pavement reduces the minimum soil volume requirement by 10% for both shade and ornamental tree designs.

Viable soil is defined as soil open to rainfall within tree pits or the planting strip. Additionally, adjacent soil may be considered toward the minimum soil volume permitted if it is permeable to rainfall and is not separated by more than 10 feet of impervious pavement. For example, a 7' X 4' tree pit contains up to 420 cubic feet of viable soil; therefore, an additional 40 square feet of permeable area is required near the tree if soil depth is not limited. This additional permeable area

can be gained from landscape beds, permeable pavement, or adjacent tree pits as long as there is no impervious pavement wider than 10 feet between the tree and the additional area.



Figure 6. Examples of tree planting design which allow adequate soil volume and connectivity.

2. Depth

All trees shall be planted in soil with a depth of at least 3 feet. For consideration of soil volume, soils less than 3 feet in depth shall not be considered viable soil. Further, soil shall only be considered viable to a depth of 15 feet.

3. Amendments

Trees shall be planted in a viable growth medium for any design; however, growth medium located in tree pits shall require specific modification. Tree pits shall utilize structural soils or modify native soil per the following:

- 1) Soil shall be lifted and placed in the pit such that large soil clods (greater than 6 inches) and “hardpan” layers are broken up. Existing soil in tree pits should be removed and broken up to a depth of at least 3 feet.
- 2) Organic material shall be applied to native soils in the form of compost, potting compost, compost/shale mix, or other fortified soil amendments suitable to site conditions. For example, pH balanced expanded shale and compost mixes (e.g. “Gumbo Buster”) would be suitable for amending high-pH, heavy clay soils typically found in southeast Arlington. Unless otherwise directed by manufacturer, the selected amendment shall be mixed with soil at a rate of 1:20 by volume to a depth of 3 feet. For example, a 7’ X 4’ tree pit shall be treated to 3’ depth (84 cubic feet) with approximately 4 cubic feet of compost. Organic material shall be mixed into soil prior to or as the soil is placed in the tree pit and shall not be applied as top-dressing.

Fertilization is not typically needed for trees and should never be applied at time of planting. The only recommended soil amendments for native soil is organic material and/or water degradable pH modifiers such as sulfur for correction of high pH (greater than 8.0). Calcium based amendments are not permitted due to alkalinity issues common in Arlington soils.

4. Structural Soils

The use of structural soils is recommended in highly developed urban environments. These soils provide support while resisting further compaction from construction and utility work while permitting some root growth beneath pavement. Structural soils should be utilized when landscaping is infrequent between tree pits or permeable space is limited, and a strong base for pavement is required. Structural soils should only be used where necessary for meeting strength requirements, native soil or other planting medium should be utilized within tree pits and unpaved areas. The above guidelines (section [I.C](#)) apply when using structural soils; however, amendments to structural soils should follow manufacturer specifications.

Soil cells and suspended pavement systems are also recommended in select applications. All systems should allow sufficient space for root growth by incorporating openings of at least 4 inches between all structural cells. Ideally, large, continuous openings between each cell should allow uninterrupted outward root growth and up to 6 inches of space for roots to increase in size without becoming constricted by support structures. Suspended pavements generally preclude the need for structural soils, but the two may be used in conjunction. For example, structural soils may be used under road pavement while suspended pavements are utilized for lighter loads such as sidewalks, particularly those located between adjacent tree pits.

Where suspended pavement is used, soil must be saturated or rinsed with water to completely fill voids within the support structure. Failure to account for settling can result in dangerous void space. If not properly placed, soil may settle and shift tree or pavement. Additionally, void space may result in undesirable wildlife habitat. Void space should be filled immediately if settling occurs.



Figure 7. Exemplary suspended pavement support design. Note that large openings for roots are located on all sides and the bottom of the cells. The City of Arlington does not endorse, recommend, or favor any person, or organization, or activities, products, or services related to such person or organization.

## D. SPACING AND CROWN CLEARANCE

### 1. General Guidelines

No tree planting shall have a distance between trees of less than 10 feet between any trees and no two shade trees shall be placed less than 15 feet apart.

Shade or canopy trees should be planted on a spacing approximately 75-115% of the mature canopy width for the species to provide maximum tree cover without undue stress on the health of the trees. The fully-grown canopy width varies from 30-60 feet for most shade trees species to be planted in Arlington. Recommended standard spacing is 25 feet for most shade tree species. Large canopy tree species include most oaks (*Quercus* spp.), ashes (*Fraxinus* spp.), and American elm (*Ulmus americana*), and should be planted on a wider spacing of 30 feet whenever feasible for the project.

Ornamental or understory species may be planted more closely to each other, nevertheless a spacing of at least 10 feet is necessary unless an exception is granted. Exceptions to minimum spacing requirements are based on the site, layout, selected species, and rationale. Recommended minimum spacing for ornamental tree species is 15 feet. Ornamental trees may be planted between shade trees and under the projected canopy only if they are tolerant of shade. Shade tolerant ornamental species include dogwoods (*Cornus* spp.), redbuds (*Cercis* spp.), maples (*Acer* spp.), Mexican buckeye (*Ungnadia speciosa*), and Eve's necklace (*Styphnolobium affine*).

2. Buildings

No tree planting shall have new trees installed within 5' of a building or large permanent structure. Shade trees shall be planted at least 10' from the furthest protrusion of the building (e.g. roof overhang, wall mounted accessories). In the case of multi-story buildings, shade trees shall not be placed within 15' of the furthest protrusion.

It is recommended that tree planting near buildings follow the spacing to be used between trees as guideline. The distance to the building should be at least half the tree spacing and is recommended to go up to the whole tree spacing distance. For example, shade trees planted on a 30' spacing should not be planted within 15' of the building and it would be recommended to plant trees approximately 30' from the building.

3. Walking Paths

Trees shall not be planted within 2' of a sidewalk or paved trail. Appropriate distance from pedestrian areas should be based on site and species selected. Shade tree species are recommended when planting will occur directly adjacent pedestrian areas. Ornamental species are generally unable to reach adequate height to safely overhang walkways and therefore require space for the full mature canopy width without impeding pedestrian traffic.

4. Roadways

Trees adjacent to roadways shall not be planted less than 2' from the back of curb. Ornamental trees are not recommended for planting along street frontage and should allow space for the full mature canopy width. Any tree with a mature height of less than 25' or with a mature canopy lower than 15' (i.e. ornamental species) shall not be planted less than 4' from roadways to allow for natural canopy growth that does not interfere with traffic or visibility.

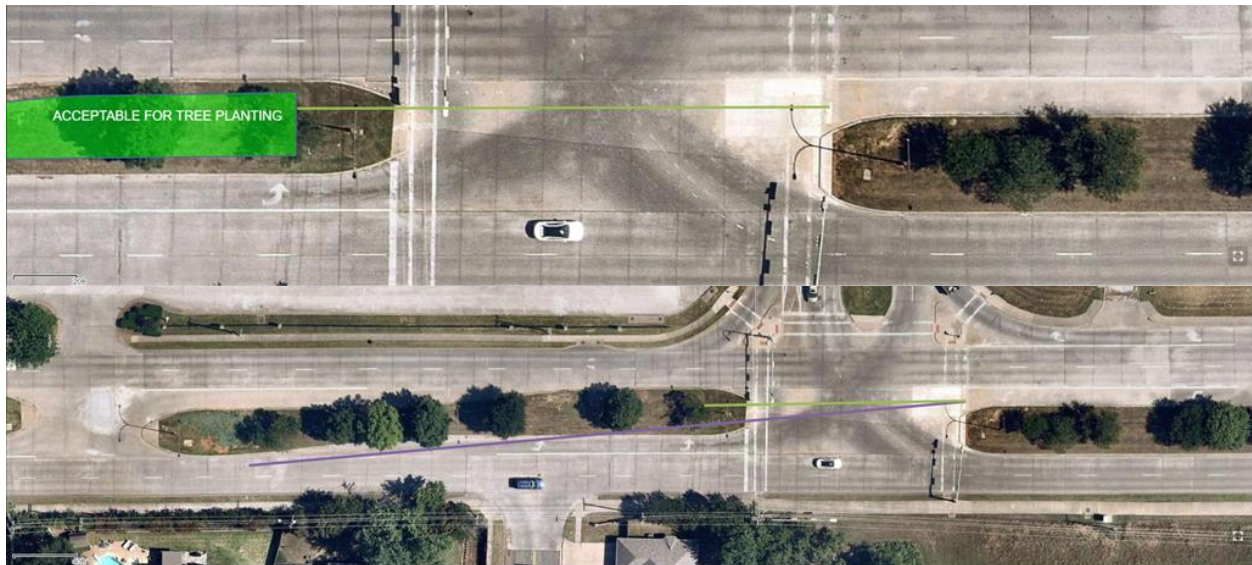
City street trees, for the purposes of this document, are those located in the right-of-way or on a median. Examples include streetscape beautification or corridor beautification projects, or major street rebuild projects. A minimum clearance of 30' is required for street lighting which is located above the mature canopy (e.g. light poles greater than 25' in height), major road signage (e.g. multiple supports, width exceeding 5'), and other structures greater than 15' tall. A clearance of 10' is recommended for other objects in the planting area (e.g. local traffic signs, signal control boxes).

The following distances are required to be met for new street tree planting projects. These are minimum distances and should be used as a preliminary check that a landscape plan along a roadway is safe. Specific situations may

require additional considerations for safe visibility as recommended by the National Highway Traffic Safety Administration.

*Table 3. Minimum distances for tree planting on medians and right-of-ways. Distance opposite turning vehicle is clearance needed from the stop bar to the closest tree in front of a turning vehicle (see Figure 8 below). This distance is intended to provide NHTSA recommended sight-lines for left-turning vehicles. This distance may not be suitable in all cases. Distance from median end is minimum distance from intersection to tree if there is no turn lane opposite (see Figure 9 below).*

| SPEED LIMIT (MPH) | NHTSA SAFE VISIBILITY | DISTANCE OPPOSITE TURNING VEHICLE | MINIMUM DISTANCE FROM MEDIAN END |
|-------------------|-----------------------|-----------------------------------|----------------------------------|
| 30                | 335'                  | 123'                              | 15'                              |
| 40                | 445'                  | 163'                              | 40'                              |
| 50                | 555'                  | 203'                              | 130'                             |
| 60                | 665'                  | 245'                              | 200'                             |



*Figure 8. Example of safe distance for tree planting at an intersection with an opposite turn lane. For this 40-mph roadway, distance from the first tree to the opposite stop bar (green line) should be at least 163'. In most cases this will provide the NHTSA recommended visibility (purple line). Please note that light poles or other obstacles may require additional clearance.*



*Figure 9. Example of distance from median end to tree (red line) for cases with no turn lane opposite (red circle). Tree planting is acceptable beyond 40' from median end for this 40-mph roadway. Please note that light poles or other obstacles may require additional clearance.*

## 5. Utilities

Trees shall not be planted directly beneath overhead power lines. Shade tree species and large ornamental species shall be planted a minimum of 10' from existing or planned overhead power lines measured from the closest line or possible point of contact. Ornamental species with a mature height of less than 15' may be planted less than 10' from overhead lines, although 5' offset from the nearest overhead line is recommended.

Trees shall not be placed directly above a known underground utility.

## E. SPECIES SELECTION

### 1. Soil Conditions

#### a) *Soil pH*

Arlington soil ranges from acidic to alkaline, predominately alkaline in southeast Arlington transitioning rapidly through central Arlington (roughly along Cooper St from the south city limits to near Pioneer Parkway and then following Johnson Creek towards Grand Prairie). North and west of this soil boundary Arlington has acidic soil which supports growth of tree species more native to the eastern U.S. Soil pH should always be considered when selecting species as alkaline soil can limit nutrient uptake of species which are not alkaline tolerant.

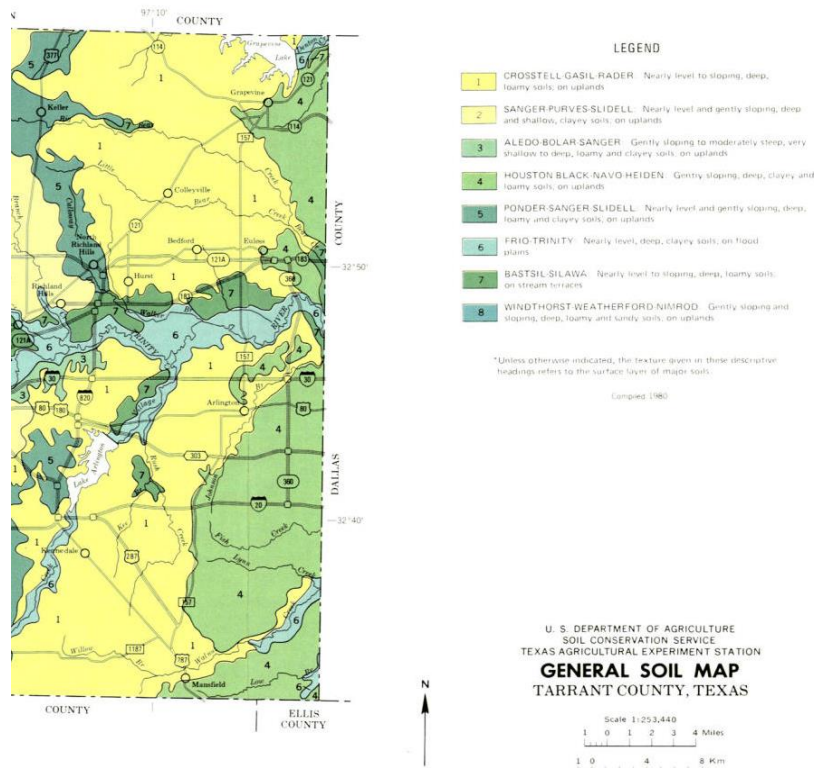


Figure 10. Soil map of Tarrant County, TX showing the general soil boundary through central Arlington. The yellow areas tend to be more acidic and have sandier soil texture while the green is generally more alkaline with more clayey soil texture.

Examples of alkaline intolerant species include flowering dogwood, slash pine, Shumard oak, red maple, silver maple, Trident maple, water oak, river birch, and viburnum. Examples of alkaline tolerant species include Arizona cypress, eastern redcedar, cedar elm, bur oak, live oak, chinkapin oak, desert willow, Mexican buckeye, honeylocust, Mexican plum, and Texas persimmon.

Free information regarding soil conditions at project sites can be found on the USDA Natural Resources Conservation Service's Web Soil Survey application: <https://websoilsurvey.nrcs.usda.gov/>

#### *b) Soil Texture*

As with soil pH, soil texture is important regarding suitability of the tree species selected. Arlington soil ranges from clay to loamy fine sand, with a distribution similar to that of soil pH. Southeast Arlington is typically clay to silty clay loam transitioning rapidly through central Arlington (roughly along Cooper St from the south city limits to near Pioneer Parkway and then following Johnson Creek towards Grand Prairie). North and west of this soil boundary Arlington has sandier soil primarily with fine sandy loam texture. Examples of clay and silty clay loam intolerant species include river birch, maple, Shumard oak, chitalpa, and desert willow. Examples of clay tolerant species include mesquite, honeylocust, bur oak, bald cypress, eastern redcedar, Mexican buckeye, and cedar elm.

Other species may be suitable for site conditions, this list is not meant to be comprehensive; for additional information please contact the City Forester.

## 2. Conflicts

#### *a) Visibility*

Conflicts can arise when trees are placed in unsuitable locations for their growth form. One particularly common issue is sight line limitations posed by small species that are unable to grow tall enough to raise canopy for pedestrians or vehicles to safely see beyond the tree (Figure 11). Another issue that may occur is the upward and outward growth of the tree begins to block security cameras or traffic signals. To alleviate these issues, designs should consider the placement criteria listed above and select optimal tree species for situations. For example, conifer species cannot be trimmed back from the top without severe impacts to the tree; therefore, conifers should not be planted without sufficient space above that will not conflict any existing infrastructure. Oak species tend to grow wide without gaining as much height and may be suitable for staying below infrastructure, but the increased canopy width could reach structures and cause damage so planting farther from existing structures may be necessary. Magnolia and similar slow growing species retain lower branches and cannot be "limbed up" to correct major visibility issues; therefore, such low

branching species should be avoided in limited space situations where traffic or pedestrian visibility is a concern. For example, magnolia should not be planted near traffic intersections or along sidewalks where reduced visibility could impact public safety.



Figure 11. Example of 'Little Gem' magnolia planted at the end of a median near a traffic intersection. Visibility for turning vehicles is severely limited by these low branching trees and cannot easily be corrected.

#### *b) Overhead Utilities*

A major conflict for urban trees are overhead power lines. No species should be planted directly under overhead lines. Unless no other planting space is available, power lines should be avoided as specified in section I.D.5 above. Designs should strive to plant small species whenever a potential conflict with overhead utilities may occur. In the case of nearby overhead lines conifers should not be used due to impact of top reduction pruning on those species. Cables and secondary lines do not necessarily preclude tree planting, but to reduce damage to infrastructure trees should not be planted directly under these lines either.

### 3. Forest Longevity

#### *a) Diversity*

An important component of protecting urban trees is the diversity of the urban forest. By decreasing the number of individuals belonging to a single species the urban forest is able to better withstand pest and disease issues that may arise. No tree species shall comprise more than 50% of tree planting in a project. Tree

planting should include a minimum of 4 species for any project of more than 15 trees. For projects planting more than 30 trees a minimum of 5 species are required. Planting designs should strive to plant no more than 20 trees of one species in any project.

*b) Life Expectancy*

Selecting species with long life expectancy reduces the burden on the city for planting and provides the greatest return on investment in terms of environmental benefits. Species selection should also provide a range of life expectancies (i.e. a mix of long- and short-lived species). Designs should consider life expectancy and include some long-lived species. Examples of long-lived species include oaks, American elm, lacebark elm, pecan, bald cypress, and Arizona cypress.

## **II. EXISTING TREE CONSTRUCTION**

### **A. GENERAL CONSIDERATIONS**

#### **1. Tree Root Disturbances**

*a) Distance to Tree*

Distance from the base of the tree is the most predictable relationship to trees surviving root damage and disturbance. However, it is often not possible to fully predict tree survival and root disturbance should occur in as limited of an area as possible and utilize options to reduce the impacts of disturbance (e.g. boring vs trenching, applying mulch to heavy equipment routes). Figure 12 below provides an estimate of root zone distances and safe disturbance. These distances vary depending on the species, the soil conditions, the age of the tree, and treatments applied following disturbance such as irrigation. Typically, the minimum distance a large or significant tree should have roots fully cut from one side is three times the diameter of the tree. For example, a 30-inch oak tree should not have a major cut line within 90 inches of the trunk. Intruding on this root zone increases the potential for the tree to topple during storms for the next few years after the damage occurs.

## A Visual Guide to Tree Root Disturbance

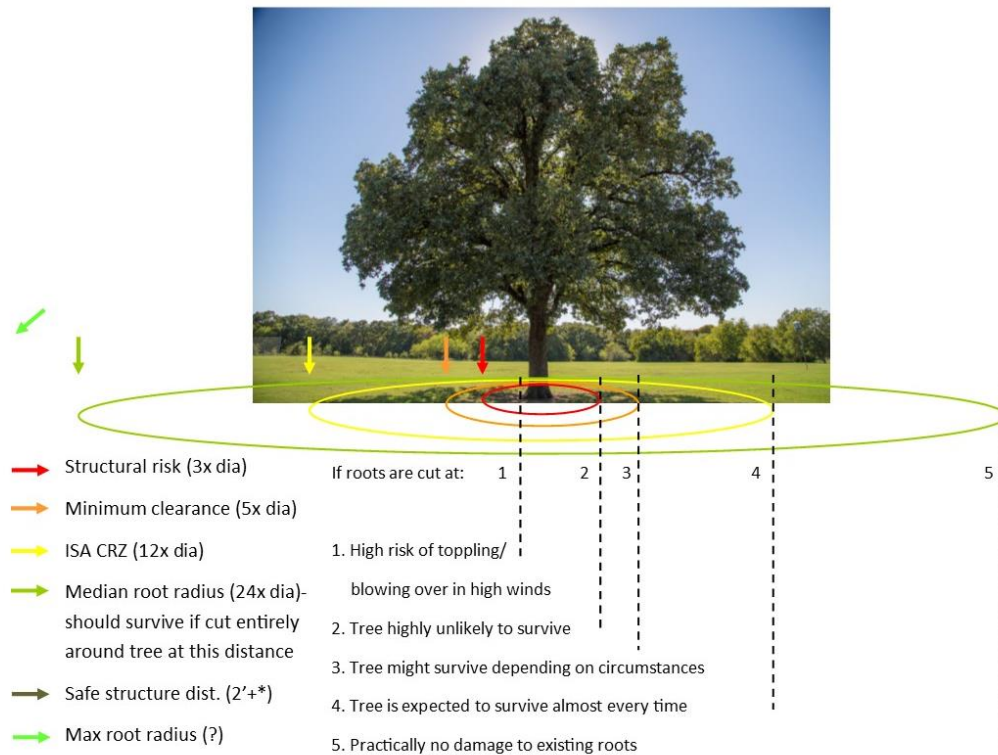


Figure 12. Approximate root disturbance zones based on trunk diameter. The minimum safe distance for a cut removing all roots along one side of the tree is three times the diameter. The ISA recommends a distance of twelve times the diameter to expect recovery. Structures should never be placed within 2 feet of trunk or within three times the diameter. Additional clearance is highly recommended, refer to section I.D.2 above for planting trees near buildings.

Although major roots may not be cut or damaged directly by construction activity, changes to the soil properties may occur from concrete mixing,

chemical contamination of the soil, compaction from heavy equipment, or altering existing soil structure. These indirect changes can impact tree health; therefore, as much of the root zone as possible should be fully excluded from any movement or work, not just direct impacts.

*b) Rooting Depth*

Determining root disturbance requires some consideration of root depth as shallow cuts will not damage roots as severely and may allow some roots to persist on the damaged side of the tree. Almost all root biomass is found within the first 3 feet of soil depth, and roots become more shallow as soils become more harsh, rocky, or clayey. Excavation depths of more than 3 feet should consider all roots removed, although in some cases there may be large roots below such a depth. Cuts less than 1 foot deep can be damaging to the tree, especially within the zone three times the diameter; however, many roots are likely to persist and may reduce the severity of the damage. Cuts to less than 6 inches usually do not impact tree health unless occurring very near the trunk or over a large area.

2. Impact of Specified Activities

*a) Soil Amendments/Modification*

Chemicals applied directly or indirectly to the soil can change properties of the soil including pH, cation exchange capacity, and water and air infiltration. Concrete contains calcium which raises soil pH and can result in chlorosis of trees, whether newly planted or existing. Fluids spilled from construction activities can damage roots or prevent water and air from entering the soil. Mitigation of such contamination is vital for protecting trees from further damage, but in some cases may not be possible or may be too late to save trees. As with disturbance and compaction of the root zone, the further from the tree the less potential impact will occur and tree exclusion zones should not just exclude equipment but also should exclude personnel and should not be used as a storage location for fuel or other materials. See section [I.C.3 above](#).

*b) Mudjacking/Concrete Leveling*

This procedure can be used to level disrupted pavement but should not be utilized within the critical root zone of a tree due to the chemical properties and the potential to “encase” roots and restrict growth. Further, this treatment may not be effective long-term near large trees as further root growth may re-disturb pavement after the leveling is completed. This procedure is not commonly applied in Arlington.

*c) Root Pruning*

As a general rule, root pruning to plane or level the surface beneath pavement should not remove more than 40% of bark circumference. Root pruning should

be conducted in a way to minimize damage. Chainsaws may be used only on roots larger than 5 inches as smaller roots will experience bark tearing. Specialty root pruners or spades should be used for in-ground root pruning. Front end loaders, bulldozers, backhoe loaders, and other similar coarse excavation equipment are not permitted for the purpose of root pruning. Such equipment may be used beyond root pruned areas so long as more accurate equipment is used to finalize root pruning cuts.



Figure 13. Example of proper root pruning in preparation of root bridging.

## B. DAMAGE MITIGATION OPTIONS

### 1. Bridging

Pavement bridges are generally metal or wood pier and beam constructed pedestrian walkways that allow separation of the grade and walking surface. This system can be used to provide drainage and allow unrestricted root growth that will not damage pavement. A prime example of design with bridging could be to allow drainage from other landscaping into a recessed pit with a tree species tolerant of saturated soil such as bald cypress, bur oak, or yaupon holly. This system is most commonly applied to remedy tree roots lifting sidewalk sections and is suitable for such use, possibly in conjunction with root pruning. Bridge material must be non-slip and should not create an unprotected ledge higher than 8-12 inches.

### 2. Curb Realignment/Offset

Curb bulbs, jut-outs, curves, or any other realignment can be used in limited instances during design to allow existing trees to remain or as part of an overall

system such as parallel parking protection or traffic calming features. The most common and preferred use of this system is to protect, and provide space, for existing large, long-standing trees (greater than 18 inches and more than 120 years old) with sufficient value to demand the additional design requirements. Trees may be planted near curb realignment as part of design in the systems noted above, but tree growth and visibility are of particular concern in these systems. The above requirements concerning distance from curb should be followed and enlarged if visibility may be an issue due to road curve design. When using curb bulbs or jut-outs, trees should be placed 5-7 feet from the curb, ideally. Alignments should not unnecessarily interfere with traffic or drainage. Other impacts should be considered, such as bicycle and pedestrian safety, likelihood of tree survival, or potential for vehicles to impact tree.

3. Sidewalk Realignment

Similar to curb realignment systems, sidewalks may be realigned or curved to protect existing trees of sufficient value to demand additional design expense. A potential conflict with this design system is the lack of easement space for avoiding trees. The best application of curved sidewalks for protecting existing trees is where the existing sidewalk does not meander and the easement or right-of-way is sufficiently wide. See section [II.A.1](#) for distances needed from trees, considering that sidewalks usually do not significantly impact tree roots unless wider than 10 feet. Meandered or curved sidewalks are recommended in Arlington, although in this case the concern is primarily for existing tree space. New trees should be designed to provide space from sidewalks and room to grow regardless of sidewalk layout.

4. Suspended Pavement

Suspended pavements provide for structural support instead having upper soil levels fully support pavement. As such, these systems can resist lifting while providing more habitable soil for tree roots. These are typically installed for new tree installation, although there may be applicability for providing additional rooting space for existing trees. These systems can be incorporated with structural soils or used as an alternative, for additional information see section [I.C.4 above](#). The major limitation of suspended pavements are the load limits inherent to each design and manufacturer. The best use is for sidewalks adjacent to planting pits with restricted root space.

5. Root Barriers

Roots can be limited with physical or chemical barriers. Physical barriers generally do not kill roots; therefore, roots are generally deflected and will continue to grow in the direction most conducive to roots. Roots may grow beneath or directly against physical barriers which could allow damage from root growth if not properly designed. Physical barriers must extend to a

minimum of 1' depth and should exceed pavement depth by 4-6". Chemical barriers limit root growth and roots are less likely to deflect and continue growth.

The effectiveness of root barriers in preventing sidewalk damage may be enhanced when combined with the use of a modified base layer or structural soil.

6. Modified Base Layer

The use of gravel or other materials to inhibit root growth directly beneath pavement. These modified layers typically involve coarse materials which do not hold water, thereby limiting root growth into the base layer. This modification is best used with young or establishing trees which would be expected to have roots grow underneath pavement. For long term effectiveness, screen or root barrier should be placed along the sides and below the layer to prevent sediment infill and reduce tree roots beneath the pavement. This method does not alter existing large roots and only prevents new root elongation into the base layer. Larger roots beneath the layer will continue to grow in diameter, although the impact of this growth should be absorbed by the base layer.

7. Soil Improvements

The use of soil modifiers or manual techniques to improve soils in planting strips which promote root growth in the treated area and reduce extension of roots into infrastructure. These techniques should be used to decompact soil (ideally below  $1.3 \text{ g cm}^{-1}$ ), correct soil pH (optimal range of 6.5-8 for Arlington tree species), or otherwise improve root growth in the long term. Fertilizers are not recommended for young trees or trees that have had root damage. The following examples are all suitable for improving soil: Addition of compost organic matter into soil at a rate of 5-10% by volume reduces soil compaction and improves water retention. Application of water degradable sulfur reduce soil pH, making nutrients more readily available to trees. Aeration of soil promotes water infiltration and oxygen availability for tree roots and can be accomplished by installing aerated pipe or by using soil aeration probes to create temporary channels.

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<sup>i</sup> Revised May 29, 2020. Author: Jeremy Priest, Forester, City of Arlington.