

COMMUNITY & URBAN FORESTRY PROGRAM

CUFLINK 2007

Protecting Trees During Construction

Building with nature requires careful planning

Indiana woodlots raise property values and provide a myriad of natural resource activities. The value of a small woodlot extends far beyond economics.

Woodlots:

- Provide wildlife habitat, mental comfort, relaxation, and viewing pleasure to passersby.
- Clean the air by collecting particulate matter from the air and sequestering carbon.
- Provide oxygen, and through various ways, help clean our water supply.

Woodlots benefit the local community and the state. They need to be cared for if they are to maintain their value. Any activities that may impact woodlot health-such as construction need to be carefully considered and planned. Woodlots and trees can be damaged beyond repair when they are put under construction stress.

To alleviate this, there are steps that need to be taken prior to any saws, hammers, diggers, mechanical equipment, and vehicles entering this valuable natural resource asset.



Define woodlot goals

Goals for the woodlot might include:

- Avoiding the damage; not the construction. Protect the trees, soil, and other vegetation by altering building foot-prints and set-backs, relocate

hard scapes and utility trenches.

- Building in concert with nature, not against it.
- Being sure that you comply with any conservation easements or covenants.
- Maintaining the aesthetics, property value, and integrity of the woodlot.
- Increasing or conserving habitat for specific species of wildlife.

Inventory and assess

It is difficult to manage a resource if the components that make up that resource are unknown. That is why it is important to do a woodlot inventory. The inventory will determine species, size, condition, health, and vigor of the trees. For lots of less than two acres, it is important to inventory all the trees that are two inches or more in diameter. A partial or complete inventory can be done for woodlots larger than two acres. The inventory will help determine which trees can withstand the stresses of construction activities. Whichever type of inventory you decide on, you will want the help of a woodlot forestry consultant. A Small Woodlot Owner Consultant Directory is available from the Indiana DNR, Division of Forestry.

Decide which trees need to be protected

The next step is to decide which trees need to be protected and marking the construction boundaries of the project. Be sure to mark the total footprint of the entire project. Consider the walkways, utilities, all structures and future structures, where construction equipment will sit and drive, where tools will be stored, and where the debris area will be. Use a measuring tape, stakes, and flagging to mark the entire site.

Then look at it. Where are the trees? What ones should be protected? How are they rated in the inventory? Are they candidates for protection or removal according to the inventory? Can they be protected with little damage to the root system? If not, then the footprint of the project will need to change or a determination on removals will have to be made.

According to the inventory, are the trees in the area healthy enough to withstand the rigors of living in a construction zone for a few months? Some tree species do better than others in construction situations. (see Appendix A)

Some things to look for when determining what trees to save include:

- Trees in reserved or easement areas.
- Trees that are native and suitable for the site
- Trees that provide the most benefits and fill multiple functions such as shade, wildlife habitat, winter and spring interest, buffers etc.
- Trees that are connected to other groups of trees on the property and on neighboring property. This provides connectivity and wildlife corridors.
- Trees that are young, vigorous, and will have a higher tolerance to the stresses of construction.
- Trees that are in groups with a mix of species, size, and age class; This will help the area maintain that woodsy feel and, should a tree die due to the construction process, then the void it leaves, will not be so obvious.
- Avoid saving trees that are likely to fail and possibly damage new structures and utilities. Decayed and/or diseased trees are not worth saving.

Protect the trees you plan to save

When the decision has been made on what trees to save, it is time to surround them with a zone of protection called the Protected Root Zone (PRZ). This is the space needed for a tree or group of trees to remain healthy and vigorous.

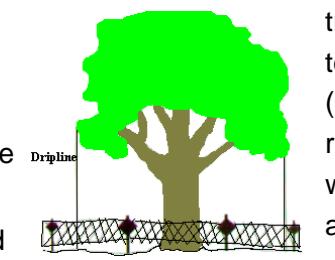
PRZ

1. A common way to measure the PRZ area of protection is to use the drip line method which is the area directly below the outside branches of the tree. This would be the protected area. But, experts agree, using the critical root radius method will go further to saving the tree since the PRZ is expanded. To find the critical root radius, calculate 1.0 to 1.5 feet (preferred) for each inch of diameter at breast height (DBH) (e.g. 1.0 for younger, healthier, more "construction tolerant" trees; 1.5 ft. for older, less healthy and/or more construction sensitive trees). With this method, a

tree that is 12 inches dbh will need a protection zone of 36 feet. The calculation is: (12 inches (DBH)x1.5(ft.) =18 feet of critical root radius). The PRZ for this calculation would be 36 feet (2 x radius). A consulting arborist who specializes in protecting trees during construction can help determine just how far out the PRZ needs to be for a particular species.

2. It is important to give the trees as much space as possible in the PRZ. The intent is to protect the roots system of the trees. The majority of the feeder roots grow in the top 12 to 18 inches of soil and can spread two to three times the height of the tree. That means a 50 foot tree could cover the top 12" of soil in a 150 foot circle around the trunk of the tree!

3. Install bright orange PRZ fencing around the tree or tree groups. Post signs such as ***Tree Protection Zone—off limits*** on each side of the fencing.



Visible barriers that are erected out beyond the drip line are a good way to protect trees during construction.



Tree Protection Zone courtesy of
Vine and Branch

Protect the PRZ area

It is important to anticipate any grading operations and protect the PRZ barriers from soil piles that could build up, get pushed into the PRZ, erode onto the tree roots and suffocate them, etc. It is best to be sure that NO activity takes place within 30 feet of the PRZ barrier.

If the PRZ is on a downward slope, it is important that a silt fence be erected in front of the orange PRZ barrier. This will prevent runoff and sediment entering into the PRZ and into any waterways.

To increase the level of awareness regarding the PRZ areas, develop a map showing where the protected trees are and the route access zone for construction traffic, equipment, and building materials.

Before construction begins

It is advisable to prepare trees for the stress of construction. Their survival rate will increase if they are as healthy and vigorous as possible prior to construction.

- If rainfall is not adequate, then supplement with a regular watering schedule before, during, and after the construction. If realistic, water the entire root zone of each tree so that the top 8-12 inches of soil are moist. Trees are very prone to drought stress during construction.
- If watering is not realistic, then after a good rainfall, prior to construction, place a layer of wood chips or mulch covering the entire PRZ. This will provide a blanket of protection over the root systems and will help retain needed moisture and reduce any soil compaction that may occur. These chips can come from trees that had to be removed for the project. Ask the tree removal



company to chip the tree debris of any trees that will not sell for timber and lay it over the PRZ at a depth of three to four inches.

- Check for nutrient deficiencies and fertilize tree areas if soil tests indicate they are stressed.
 - Prune branches that are dead, diseased, or hazardous.
 - Educate all workers on the site about the PRZ. Explain to them that the orange barrier and nothing inside the orange barrier is to be disturbed. Make sure they know *why* the trees need to be protected citing tree mortality due to root stress, soil compaction etc. Explain the trees importance to the character, integrity, and economic viability of the property.
- If large numbers of trees have been removed, the trees that are left will be shocked to suddenly see sun and experience stronger wind. That is why it is important to try to save groups of trees as opposed to individual trees. The exposure and damage to those left will be less. A site that is heavily wooded that will need large numbers of trees removed should be done in a two to three year time span.
- Soil compaction can kill trees. To prevent this, develop traffic routes away from the PRZ; if this is not feasible, then construct root system bridges suspended over wood beams or spread six inches or more of wood chips or mulch on the soil. Use the chips from the pruning and removals on the property.
- Chemicals can harm or kill trees. Be sure that all debris and waste be hauled away for proper disposal. Make sure the property is not a cleaning site or dump site for any work related disposals; including concrete truck rinsing.

Follow up is critical

After the above steps are taken to ensure that you are conserving parts of this valuable natural resource, things can still go wrong.

Be attentive to the following details:

- Inspect the trees for direct physical damage such as broken, torn, or split branches, damaged bark and trunk wounds. Seek the help of an arborist to deal with these issues immediately. This will reduce the likelihood of decline.
- Make sure that irrigation is a priority to trees that have been in the PRZ zone.
- Make sure that when underground utilities are installed that the tree roots are not severed by trenching and that tunneling around them is done carefully.
- If tunneling is not possible, non-destructive trenches can be “dug” by specialized supersonic air jets that displace the soil without damaging the root systems.
- Landscaping needs to be installed carefully to avoid raising or lowering the grade of trees. Both practices can be harmful.
- Use caution when doing any earth work around the trees such as roto tilling, installing planting beds, and irrigation systems. These activities can also harm the tree roots.

Monitor the woodlot

Symptoms of stress and decline after construction damage may appear during the next growing season or in two or three years. Look for:

- Dieback in the top of the tree and near the end of branches.

- Yellow or chlorotic looking foliage
 - Smaller leaves
 - Less leaves
 - Wilting of leaves and new leaf growth
 - Premature fall color
 - Internal decay such as cavities in the tree
 - Peeling bark
 - Presence of fungi on trunk, roots, and branches
- If the trees are showing symptoms of stress, consult an arborist or woodlot consultant to determine the best course of action regarding remedial treatments.

Helping a tree stressed by construction

The best treatment for trees stressed by construction is surface mulching. An organic mulch layer is the most effective soil treatment.

Other treatments that may be considered include:

1. Aeration and vertical mulching. The procedure is to drill holes in the ground that are 2-4 inches in diameter, 12 inches deep, and approximately 3 feet on center. The holes are then filled with wood chips, mulch, peat moss, pea gravel, or other materials. This treatment will need to be done every two or three years until the tree or trees recover.
2. Fertilizer. It is generally recommended that low rates of a slow -release form of nitrogen not be applied until one or two years after the damage or stress had occurred. A nitrogen fertilizer applied at the onset of damage could cause the top of the tree to grow at the expense of the roots. When considering fertilization, it is important to determine what the tree is deficient in at the site and to base the fertilizer on that need. This can be determined with a soil analysis. And, only fertilize if a tree is stressed.
3. Pruning and wound repair is an important treatment which must be done carefully and, most usually, by a woodlot consultant, tree care service, or Certified Arborist. Trunk wounds on the bark need to be assessed. Small areas of damage with ripped and torn shards of bark can be cleanly cut off with a sharp knife. Wound dressings and paint are not recommended.



“Everything a tree needs is in mulch.” Dan Herms, PhD, Ohio State University

A multitude of problems can happen to trees *not protected during construction* and put them on a short path to decline and death.

The trees now have many things working against them

- △ Severing and disturbing the roots hinders trees ability to absorb the water and nutrients that are essential for growth.

The tree, in its quest for survival, ends up using the carbohydrates it has stored in the roots which further weakens the tree.

- △ The top layer of the soil is compacted hindering the trees efforts to absorb essential nutrients needed for healthy growth and survival. It also decreases the oxygen in the soil needed by the roots.

- △ A slow death can occur over two to five years, because the stored carbohydrates have been used up, and, the trees are too weak to replace their reserves. Pests and disease move in on the weakened and the large plants slowly die.

- △ In an unprotected site, construction debris ends up as fill on top of the trees which further weakens an already stressed root system starved for oxygen.

- △ Trees that have been thinned and left standing will suffer from exposure to the elements since the community of trees that used to surround and protect each other from the elements are now gone. Removals that are not carefully



Woodlot trees live in a community and protect each other from the elements.

planned exposes the trees that are left to sunlight and wind, which can cause sunscald on the trunks and branches making them more susceptible to ice and wind storm damage.

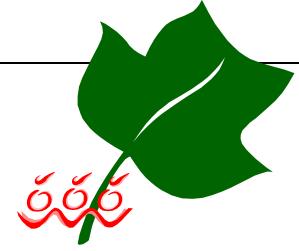
- △ Trees left unprotected with structures built around them can decline and pose a risk to people and buildings in the area. In addition, it is more expensive to remove a dead or dying tree if arborists are hindered by structures that were built too close to the tree.

By planning ahead to save healthy trees prior to construction, property owners will not be looking at a newly developed site three years later and wondering why their trees don't look healthy. They will, instead, spend time enjoying the fact that they managed to save this important resource, keep it healthy, boost property value, leave a legacy to future generations, and simply be able to enjoy the benefits that healthy trees offer.



5 “If a natural woodland “floor” suddenly becomes a manicured and chemically-maintained lawn, the soil microorganisms that the tree relied on for normal health will be gone, and no chemicals can replace them.”

Protecting Trees During Construction



Checklist

Before construction

- * Decide on woodlot goals.
- * Inventory the trees taking note of waterways, slopes, wildflowers, other forms of vegetation, invasive exotic plants, and wildlife.
- * Mark off the entire proposed construction site checking if there are any trees in the footprint that need to be saved. Include driveways, walkways, possible future structures, irrigation, utility, and landscape plans, equipment sites, drive sites, parking sites etc.
- * Work with the contractor and try to change the footprint if there are tree conflicts.
- * Select trees to be saved within that site looking for groups of trees in varying species, sizes, and age class. Consider removing and transplanting young, healthy trees that are in the way of the construction process.
- * Mark trees slated for removal. Determine with the help of a woodlot consultant if these trees can be sold to timber buyers; or consider having the trees cut, and then hire a portable saw mill operator to come in and saw the removed trees into lumber for use in the project, or crafted into outdoor and indoor furniture.
- * Determine protected root zone (PRZ) areas using the critical root radius method for the best results.
- * Erect barriers around the PRZ; also possibly install silt fencing in sloped areas to reduce sediment from piling up on trees and entering waterways.
- * Erect equipment trails, parking sites, entrance site, possible debris site with barrier to protect soils in the area etc for all construction traffic and workers who will be on site.
- * Prepare the trees for disturbance with irrigation, soil tests for nutrient deficiencies; pruning dead or obstruction branches
- * Contract for tree removal, timber sale if feasible, or portable saw mill operator, and have debris chipped for equipment trails to protect soils.

During construction

- * Communicate with all on the site throughout the project, assess their work to make sure PRZ, trails, debris sites etc. are being respected.
- * Make weekly work site inspections looking for damage such as torn roots and moisture loss. Remedy these issues quickly.

After construction

- * Follow up with inspection and taking care of physical damage, irrigation issues, check for any roots exposed by trenching and tunneling, check to ensure the grade has not been lowered or raised. Correct grade issues.
- * Monitor during the coming year and next growing season looking for dieback, chlorosis, irregular leaf size, and other issues listed in the publication.
- * Consider recommended treatments for trees stressed by construction.

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Tree species and their Tolerance to Construction Stress

A guide for builders, developers, landscapers, urban forestry consultants, urban foresters, and homeowners when determining which trees MAY survive construction stress—if properly protected during construction

Appendix A

Pamela C. Louks, Coordinator
Community & Urban Forestry

Scientific Name	Common Name	Relative Tolerance	Comments
<i>Acer negundo</i>	Box-elder	Good	Tolerant, but these plants are a poor choice to save.
<i>Acer rubrum</i>	Red maple	Fair	Intolerant of wounding; requires acid to neutral soils.
<i>Acer saccharinum</i>	Silver maple	Good	More tolerant of wounding than red maple; tolerant to additional fill.
<i>Acer saccharum</i>	Sugar maple	Low	Intolerant of fill, of increased light, and of restricted root space.
<i>Aesculus glabra</i>	Ohio-buckeye	Fair	Can adapt to light or shade; sensitive to wounding; will tolerate some fill.
<i>Amelanchier arborea</i>	Downy serviceberry	Good	Adapts to high light, urban situations, and restricted root space.
<i>Amelanchier laevis</i>	Allegheny Juneberry	Good	Adapts to compacted soil, restricted root space, and to increased light.
<i>Betula nigra</i>	River birch	Good	Requires acidic soil, tolerant to urban conditions.
<i>Betula papyrifera</i>	Paper birch	Fair	This plant is sensitive to bronze birch borer, will not tolerate increased heat, and light especially in the root zone; needs to be in its natural range to survive construction activity.
<i>Carpinus caroliniana</i>	Hornbeam	Fair	Short lived due to the presence of hornbeam borer in its natural range; cankers infect stressed trees; can persist as a forest under story plant with low disturbance; tolerates slightly alkaline to acidic soil; needs lots of follow up care after construction activity to ensure survival.
<i>Carya cordiformis</i>	Bitternut hickory	Good	Good stable branching pattern; more so than pecan; will tolerate some fill.
<i>Carya glabra</i>	Pignut hickory	Good	Structurally stable branching pattern; tolerates some fill; withstands winds well.

Scientific Name	Common Name	Relative Tolerance	Comments
<i>Carya illinoensis</i>	Pecan	Good	Co dominant leaders in open grown areas can be a problem making tree structurally unstable; will tolerate some fill.
<i>Carya ovata</i>	Shagbark hickory	Good	Excellent branch structure, tolerates fill; growth and wound closure rates are slow; withstands wind well.
<i>Carya tomentosa</i>	Mockernut hickory	Good	Withstands wind well; tolerates some fill.
<i>Catalpa speciosa</i>	Northern catalpa	Good	Tolerant of wounding; very resistant to decay; tolerates disturbance.
<i>Celtis occidentalis</i>	Hackberry	Good	Tough tree tolerant of urban conditions, including restricted root space, alkaline soils; tolerates some fill.
<i>Cercis canadensis</i>	Redbud	Fair	Adapts to high alkaline soils; will not adapt to high or reflected light as a single plant.
<i>Cladrastis kentukea</i>	Yellow-Wood	Low	Tree has thin bark, which gives it a low tolerance to physical injury and root zone disturbance; sensitive to drought, compaction, canker, and <i>Verticillium</i> wilt.
<i>Cornus florida</i>	Flowering dogwood	Low	Forest understory plant that will not do well in sun; intolerant of disturbance.
<i>Crataegus crus-galli</i>	Cockspur- thorn	Good	Adapts to high light; sensitive to wind throw if limbed up; tolerates some disturbance.
<i>Crataegus punctata</i>	Dotted hawthorn	Good	Adapts to high light and urban situations; subject to wind throw; tolerates disturbance.
<i>Diospyros virginiana</i>	Persimmon	Good	Tolerates poor soils and can adapt to low oxygen sites.
<i>Fagus grandifolia</i>	American beech	Low	Maintain a protected root zone (PRZ) about two feet beyond the drip line. Mulch over the root zone following construction may help. Tree is sensitive to increased light; thin bark makes this tree sensitive to wounding and vulnerable to decay.
* <i>Fraxinus</i>	note Threat	<i>Emerald Ash Borer</i>	*Only save if trees are exceptionally healthy, located in a good spot away from proposed construction activity, or have historical or sentimental significance. Low tolerance to moisture change; Sensitive to drought and confined soil spaces; low tolerance to pests unless in a moist area
* <i>Fraxinus americana</i>			

Scientific Name	Common Name	Relative Tolerance	Comments
* <i>Fraxinus pennsylvanica</i>	Green ash	Good	May require protection from borers during reestablishment period; adapts to low oxygen environments; has a good wound response; tolerates some fill and restricted root zone.
* <i>Fraxinus quadrangulata</i>	Blue ash	Good	Has good wound response.
<i>Ginkgo biloba</i>	Ginkgo	Good	Tolerant of urban conditions; tolerates restricted root space; introduced; not native.
<i>Gleditsia triacanthos</i>	Honey-locust	Good	Will adapt to high light in urban situations; sensitive to wounding when young; somewhat resistant as an older plant; tolerates disturbance; thorns on seedling grown plants an issue.
<i>Gymnocladus dioica</i>	Kentucky coffee-tree	Good	Adapts to high light and urban situations; bark is resistant to mechanical injury; tolerates disturbance.
<i>Juglans nigra</i>	Black walnut	Fair	Requires good soil conditions in order to perform; under poor conditions, this plant is severely stunted; walnuts can be a nuisance; contains juglone, a chemical toxic to many plants.
<i>Juniperus virginiana</i>	Eastern red cedar	Good	Can tolerate poor soils; salt and wound intolerant.
<i>Larix laricina</i>	Tamarack	Fair	Tolerates soil compaction and flooding.
<i>Liquidambar styraciflua</i>	Sweet gum	Good	Adapts to low oxygen, restricted root space, high light, and some fill; reestablishment can be prolonged.
<i>Liriodendron tulipifera</i>	Tulip-tree	Fair	Sensitive to wounding; tolerant of soil compaction; intolerant of sterile soil conditions.
<i>Maclura pomifera</i>	Osage-orange	Good	Tolerant of disturbance, high light, alkaline soil conditions, low oxygen environments, mechanical damage, tolerates some fill.
<i>Magnolia acuminata</i>	Cucumber- tree	Fair	Roots recover slowly from stress and injury; sensitive to drought and poor drainage, and <i>Verticillium</i> wilt.
<i>Malus coronaria</i>	Sweet crab	Good	Adapts to high light; disease prone, tolerant of wounding, tolerates some fill.
<i>Malus ioensis</i>	Prairie crab	Good	Disease prone plant, which adapts to high light, tolerant of wounding.
<i>Morus alba</i>	White mulberry	Good	Tolerant of disturbance, tolerates some fill; introduced to IN; not native.
<i>Morus rubra</i>	Red mulberry	Good	Tolerant of disturbance, of high reflected light, and some fill.

Scientific Name	Common Name	Relative Tolerance	Comments
<i>Nyssa sylvatica</i>	Black-gum	Good	Adapts to urban situations, low oxygen; acid soil requiring plant.
<i>Ostrya virginiana</i>	Hop-hornbeam	Fair	Life expectancy could be short due to hornbeam borer, could survive as a forest understory plant with little disturbance and excellent follow-up care.
<i>Oxydendrum arboreum</i>	Sourwood	Fair	Acid soil requiring plant; adapts to low oxygen sites; holds firm in strong winds.
<i>Paulownia tomentosa</i>	Royal paulownia	Good	Adapts to urban situations readily, tolerates disturbance, and spreads rapidly; introduced; not native.
<i>Picea abies</i>	Norway spruce	Good	Susceptible to wind throw, which is increased with canopy raising; intolerant of excessive root loss; introduced; not native.
<i>Picea pungens</i>	Blue spruce	Good	Susceptible to wind throw which is increased with canopy raising; intolerant of excessive root loss; introduced; not native
<i>Pinus banksiana</i>	Jack-pine	Good	Tolerant of poor soil; tolerates some fill in sandy soils.
<i>Pinus echinata</i>	Shortleaf pine	Good	Acid soil requiring pine; tolerant of wounding, and some fill; introduced; not native.
<i>Pinus nigra</i>	Austrian pine	Good	Tolerate some fill and wounding; introduced; not native.
<i>Pinus resinosa</i>	Red pine	Good	Tolerant of wounding; no tolerance of increased heat; introduced; not native
<i>Pinus strobus</i>	Eastern white pine	Fair	Intolerant of changes in soil moisture; requires moist well-drained soils; intolerant of road salts.
<i>Pinus sylvestris</i>	Scotch pine	Good	Intolerant of moisture level fluctuations; introduced; not native.
<i>Pinus virginiana</i>	Virginia-pine	Good	Intolerant of alkaline soils; tolerant of very sterile soil conditions, wounding, some fill.
<i>Platanus occidentalis</i>	Sycamore	Good	Adapts to low oxygen sites.
<i>Populus deltoides</i>	Cottonwood	Good	Tolerates urban conditions and some fill.
<i>Populus grandidentata</i>	Big-toothed aspen	Low	Tolerant of poor soils.
<i>Prunus serotina</i>	Wild black cherry	Low	Very young plants adaptive to altered environment while older plants often decline over time following any disturbance.
<i>Quercus alba</i>	White oak	Low	Current research indicates that this plant is very intolerant especially if roots are compromised during construction.
<i>Quercus bicolor</i>	Swamp white oak	Fair	Alkaline soil tolerant, adapts to low oxygen sites, tolerates some fill.

Scientific Name	Common Name	Relative Tolerance	Comments
<i>Quercus coccinea</i>	Scarlet oak	Fair	Has more trouble adapting to a low oxygen environment than other oaks.
<i>Quercus imbricaria</i>	Shingle-oak	Good	Adapts to acid or neutral soils; shorter lived than the white oak group.
<i>Quercus macrocarpa</i>	Bur-oak	Good	Thick bark provides protection from fire and mechanical damage; tolerant of alkaline soil; to low oxygen sites, and some fill.
<i>Quercus muehlenbergii</i>	Chinquapin- oak	Good	Tolerates alkaline soil, and disturbance; tends to have an excellent branching pattern.
<i>Quercus palustris</i>	Pin-oak	Good	Adaptable to low oxygen; requires acid to neutral soils.
<i>Quercus phellos</i>	Willow oak	Good	Requires acid soils, tolerates some fill.
<i>Quercus rubra</i>	Northern red oak	Fair	Shorter lived and less tolerant of disturbance than the white oak group.
<i>Quercus shumardii</i>	Shumard oak	Good	Tolerant and adapts to poor oxygen sites.
<i>Quercus stellata</i>	Post-oak	Good	Tolerant of poor soils, urban conditions, and mechanical injury.
<i>Quercus velutina</i>	Black-oak	Fair	Not tolerant to soil compaction; shorter lived than oaks in the white oak group.
<i>Rhus typhina</i>	Staghorn- sumac	Good	Readily regenerates from root suckers forming large colonies after a disturbance.
<i>Robinia pseudo-acacia</i>	Black locust	Good	Sensitivity to borer damage; tolerates some fill.
<i>Salix babylonica</i>	Weeping willow	Fair	Canker, due to disturbance can cause significant injury and/or death. Will tolerate some fill; introduced; not native.
<i>Salix nigra</i>	Black willow	Good	Tolerant of low oxygen levels; poor wound response can result in hollows in the main stem and structural instability; will tolerate some fill.
<i>Sassafras albidum</i>	Sassafras	Good	Root sucker generated plants can be killed with minimal root disturbance due to the root distribution pattern; tolerant of sterile soils.
<i>Taxodium distichum</i>	Bald cypress	Good	Becomes chlorotic above pH 7.5; tolerates wet and compacted soil; can be susceptible to twig blight, canker, and cypress moth when under stress; intolerant to shade.
<i>Thuja occidentalis</i>	Arborvitae	Good	Tolerates excess moisture if given time to adapt, wounding, and some fill. Often found on rock outcrops where root disturbance can be fatal.
<i>Tilia americana</i>	Basswood	Low	Mulching root zone will help to retain, but will decline over time.
<i>Tsuga canadensis</i>	Eastern hemlock	Low	Intolerant of fill ,moisture extremes ,compaction, and increased soil temperatures.

Scientific Name	Common Name	Relative Tolerance	Comments
<i>Ulmus americana</i>	American elm	Good	Sensitive to Dutch elm disease and phloem necrosis both fatal diseases. Will tolerate some fill, restricted root space, low oxygen sites, and mechanical damage.
<i>Viburnum lentago</i>	Nannyberry	Good	More adaptable in low oxygen situations than <i>Viburnum prunifolium</i> .
<i>Viburnum prunifolium</i>	Black-haw	Good	A forest understory plant, which will adapt readily to higher light situations.

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