MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #652

Tree Preservation During Construction

Outline:

In tree preservation, take steps to prevent construction damage, as little can be done to correct it!

This CMG GardenNotes was written as an overview of tree preservation issues in a construction site. For additional information refer to:

- ***Trees and Development, A technical Guide to Preservation of Trees During Landscape Development*** by Nelda P Matheny and James R Clark. International Society of Arboriculture. 1998. ISBN: 1-881956-20-2
- ***Up By Roots: Healthy Soils and Tree in the Build Environment*** by James Urban. International Society of Arboriculture. 2008. ISBN: 1-881956-65-2

Guiding Principles of Tree Preservation

1. Goals in tree preservation include both *construction* AND *tree preservation.*

- Both goals have to be valued.
- Both sides have to make compromises.
- Polarizations of attitudes include 1) that it is cheaper, easier and faster to remove all trees at the start and 2) that all trees need to be saved. For tree preservation, comprise must be found in the middle.
- The goal is not to preserve trees just until occupancy occurs, but rather for twenty plus years.

2. Preservation requires commitment of all parties, as a team effort.

- Owners
- Engineers
- Architects and landscape architects
- Grading and demolition crews
- Construction and landscape crews
- Government agencies
- Arborists, who's role includes
    - Technical resources and tree knowledge
    - Familiar with local regulations and regulatory staff
    - Familiar with local growing conditions

3. Tree preservation cannot wait until construction or afterwards.

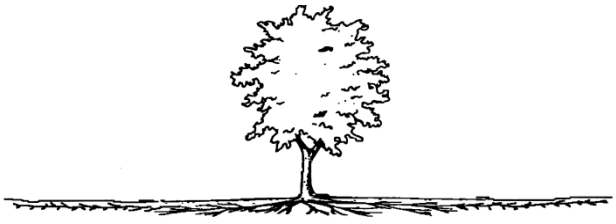
- Tree preservation takes place in the planning phase.
- Construction crews then follow the plans.

4. All trees cannot and should not be preserved.

- Trees require that space be protected for their roots.
- Trees in poor health simply will not tolerate construction stress.
- Trees with poor structure have limited value.

5. Tree preservation patterns must respect patterns of tree growth.

- All players in design and construction must respect the ***Tree Protection Zone, TPZ.*** .



Trees have a root plate system, shallow and wide spreading.

6. Tree preservation requires above and below ground space.

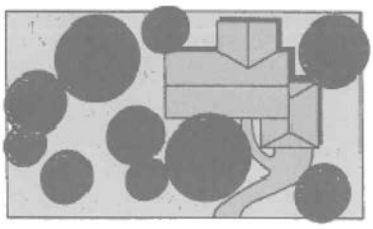
- Inside TPZ there is NO grading, trenching, parking, stock piling of building materials or dumping of waste products.

7. **Preservation focuses on preventing injury to trees, as little can be done to correct injury.**

8. **Construction impacts to trees are cumulative.** Small impacts add together for stress and tree decline.

9. **Tree preservation requires accurate site information.**

- Location of buildings, utilities and hardscape features
- Location of trees
- Species identification and tolerances to construction stress
- Evaluation of tree health and potential for preservation



10. **Arborists and design/construction professionals must communicate.**

- Talk in technical terms.
- Both sides must be willing to compromise.

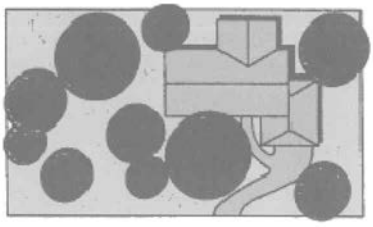
11. **Community attitudes and practices must support both tree preservation and development.**

- A compromise must be found between the polarizations of 1) aggressive tree preservation ordinances and practices that prohibit construction and 2) ignoring tree preservation in favor of construction.
- The same standards should apply to both private and public sector development.

Development Sequence

1. **Site design including *tree report***

- Requires communication and compromise between all parties.
- This is the most important step in tree preservation.

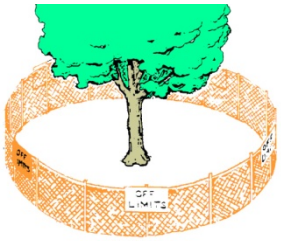


2. **Review and approval by public agency**

- Conditions of approval
- Bonding: appraised value of trees preserved
- Permits

3. **Site work**

    1. **Tree work**



        - Tree work needs to be completed before other activities start.
        - Due to construction schedule, the time frame for tree work may be very short.
        - Tree protection needs to be in place during site work.

    2. Demolition and clearing
    3. Grading
    4. Utilities and roads

4. **Construction and landscaping**

- Tree protection needs to be in place during site work.
- Implement *tree maintenance during construction plan.*

    - How/who will the tree be protected during construction?
    - How/who will the tree be watered and cared for during construction?

5. **Occupancy**

- Implement *post-construction maintenance plan.*
- In tree preservation, it should be expected that the tree lives for twenty plus years, not just until site occupancy.

Tree Report

Step A – Inventory and Evaluation

- Identify trees suitable for preservation.

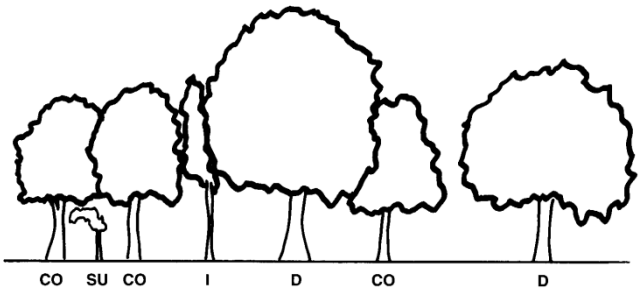
    - Species
    - Size
    - Health and vigor
    - Structural integrity
    - Age – Young trees are more tolerant of construction stress.

    - Species tolerance to construction stress
    - Maintenance requirements

    - Trees suitability to new use

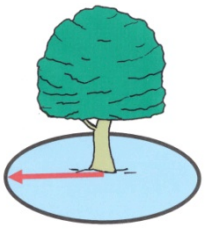
        - Group or specimen trees – Trees are often easier to preserve in a grouping rather than specimen trees.

- **Crown class**



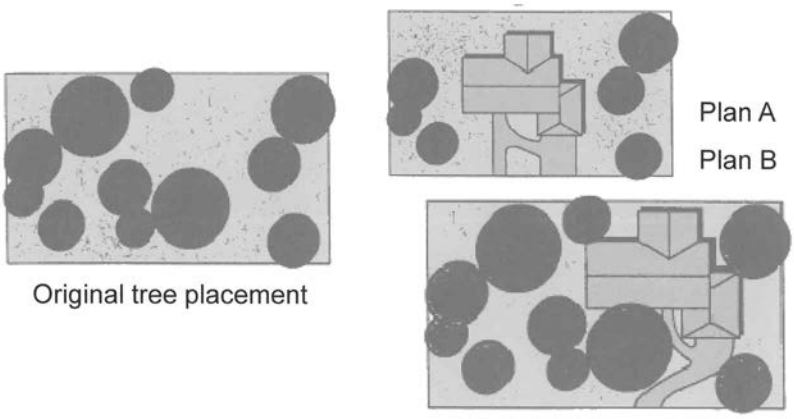
- ✓ ***Dominant trees*** make the best options for preservation.
- ✓ ***Co-dominant trees*** are best preserved in groupings.
- ✓ ***Intermediate trees*** make a poor choice for preservation.
- ✓ ***Subordinate trees*** make a poor choice for preservation due to inferior structure and sudden exposure.

Step B – Assess potential impacts by calculating the *Tree Protection Zones* for each tree.



- Trees under stress and/or decline are less tolerant of construction related stress and do not merit preservation.

Step C – Modify plan to accommodate TPZ and building plans



Step D – Identify tree work

- Work to be done by arborist not construction workers.
- There may be limitations on time of year for work to be done.
- There may have short time frame to complete work before construction begins.

Step E – Outline *Tree Maintenance During Construction Plan*

- Who and how will trees be protected during construction?
- Who and how will the tree be watered and cared for during construction?
- Who and how will the *tree protection plan* be communicated to all workers?
- Who and how will tree protection be monitored during construction?
- What penalties will be in place for individuals and companies who violate the tree protection plan?

Step F – Outline *Post-Construction Maintenance Plan*

- What will be done and who is responsible?
    - Soil management
    - Pruning: Cleaning
    - General care (watering, pest management**)**

Assessing Tree Tolerance

Species

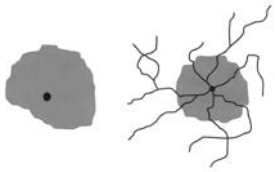
- For comparison, classify species as **good**, **moderate** or **poor** tolerance.
- There is no comprehensive list of species tolerances.
- Ask experts about their experience with specific species.

Age and longevity

- For comparison, classify as **good**, **moderate** or **poor** tolerance.
    - Young trees typically have good tolerance.
    - Medium age trees typically have moderate tolerance.
    - Over-mature and declining trees have poor tolerance and do not merit preservation.

Health and vigor – Trees in poor health will not survive construction related stress.

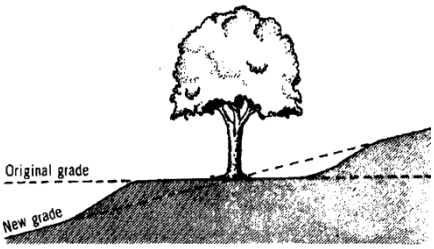
Actual crown and rooting area may not be uniformly distributed.



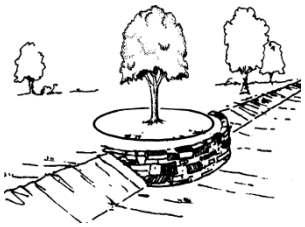
Structural stability – Preservation efforts are not warranted on structurally unsound trees.

Cuts and fills

- **Fills** are more tolerance on flooding tolerant species
- **Cuts** – more tolerance on drought tolerant species



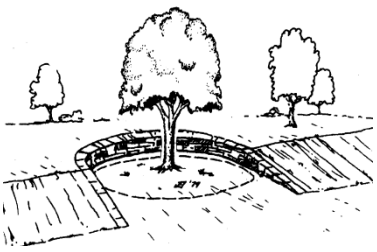
- **<u>Removing soil inside TPZ</u>**
  - On root severance **tolerant** species, may disturb up to **25% of TPZ <u>area</u>** (not diameter).
  - On root severance **sensitive** species, allow **extra space** beyond TPZ.



Root Severance Tolerance

Tolerant	**Intermediate**	**Sensitive**
<u>Up to 25% of TPZ area</u>	<u>TPZ area</u>	<u>Allow extra space in TPZ</u>
Ash: green, white, black	Birch: paper & yellow	Beech
Aspen: quaking & big-tooth	Buckeye: Ohio	Butternut
Birch: river	Catalpa	Ironwood
Boxelder	Cherry: black	Oak: white, northern
Cottonwood: eastern	Kentucky coffee	pin and black
Fir: balsam & white	Hawthorn	Walnut: black
Hackberry	Hickory: Bitternut	
Honeylocust	Maple: sugar	
Locust: black	Spruce: Colorado blue	
Maple: silver & red	Oak: bur & bi-color	
Mt. Ash		
Pine: white, jack, & red		
Spruce: black, white		
Willow		

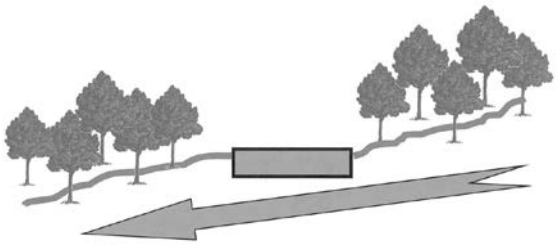
- **<u>Adding soil inside TPZ</u>**
  - If a compaction/flooding **tolerant** species, *may* successfully add **up to 6" *porous* fill**.
  - If a compaction-flooding **sensitive** species, **do NOT change grade**, and TPZ (as calculated with diameter method) may be too small.



Root Covering Tolerance

Tolerant	Intermediate	Sensitive
Add up to 6" porous soil	TPZ area	No change in TPZ
Ash: blue & green	Ash: white	Aspen: quaking & big-tooth
Cedar: northern white	Buckeye: Ohio	Basswood
Birch: river	Butternut	Beech: blue
Boxelder	Cherry: black	Birch: paper & yellow
Fir: balsam	Kentucky Coffee	Cedar: eastern red
Catalpa	Elm: American & slippery	Fir: white
Cottonwood: eastern	Hackberry	Ironwood
Maple: silver & red	Hawthorn	Locust: black
Spruce: Colorado blue & black	Hickory: bitternut	Maple: sugar
Tamarack	Honeylocust	Oak: red, white, black, & northern pin
Oak: bi-color	Mt Ash	Pine: white, jack, red, & scotch
Willow: black	Spruce: white	Plum: wild
	Oak: bur	
	Walnut: black	

Changes in soil hydrology (soil water)

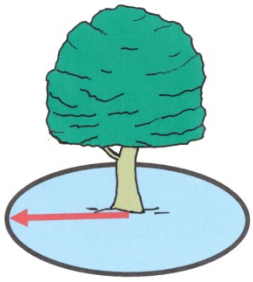


- **Ability to recover from stress factors**
  - Insects and diseases
  - Irrigation changes

Tree Protection Zone, TPZ

Trunk Diameter Method

The trunk diameter is probably the best method for general use on landscape trees. Size of the TPZ is based on the diameter of the trunk, increasing as the tree ages and become less tolerant of stress factors. It may be calculated by measuring the trunk circumference or diameter at DSH (diameter at standard height, 4.5 feet). For trees with a broad canopy in an open lawn, it is approximately 40% larger in area than the dripline method.



Trunk Diameter Method by Circumference

TPZ radius = 1 feet per 2 inches of trunk circumference

1. Measure the tree's circumference at DSH (4.5 feet) in inches.
2. Divide the number of inches by 2.
3. This is the radius, in feet, of the TPZ.

For example
1. Circumference = 24 inches
2. 24 / 2 = 12
3. TPZ radius = 12 feet

Trunk Diameter Method by Diameter

TPZ radius = 1.5 feet per inch of trunk diameter at DSH

1. Measure the tree's diameter at DSH (4.5 feet) in inches.
2. Multiply the diameter (in inches) by 1.5
3. This is the radius, in feet, of the TPZ

For example
1. Diameter = 8 inches
2. 8 x 1.5 = 12
3. TPZ radius = 12 feet

Area of the TPZ

The area of the TPZ can be calculated by the formula:

$$[\text{TPZ radius}]^2 \times \pi$$

For example - 12 foot radius:
12 feet X 12 feet X 3.14 = 452 square feet

Stress Tolerance and Age Method

This method is used in a construction site when compromise must be made to minimize the TPZ, allowing for construction activities.

1. Evaluate species tolerance to construction stress (good, moderate, poor)

- ✓ Transplant response
- ✓ Drought response
- ✓ Rooting pruning response
- ✓ Compartmentalization (decay response)
- ✓ Native range – tolerance to stress outside native ecosystem

2. Identify tree age

- Young = < ¼ life expectancy
- Mature = ¼ - ¾ life expectancy
- Over-mature = > ¾ life expectancy
- Older trees are less tolerant of stress and require larger TPZ

3. From the table, calculate minimum TPZ radius and area

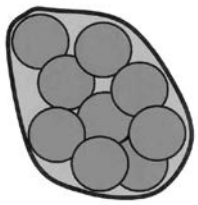
Stress Tolerance	Tree Age	Radius of TPZ* Feet/ inch trunk diameter
Good	Young	0.5
	Mature	0.75
	Over-mature	1.0
Moderate	Young	0.75
	Mature	1.0
	Over-mature	1.25
Poor	Young	1.0
	Mature	1.25
	Over-mature	1.5

- Additional space may be needed on compacted, clayey soils.

TPZ modifications

- Methods above are based on trees in open area with unlimited rooting space.
- Additional space may be needed for shallow rooted trees, like spruce and on compacted clayey soils.
- If low branches will interfere with work, extend the TPZ to include all the dripline area.

Trees in groupings



1. Calculate and plot the TPZ for each tree
2. Plot outer edge of tree group as the TPZ for the grouping

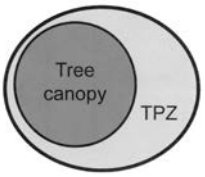
Multiple trunk trees

1. Calculate the trunk area for each trunk at DSH (4.5 feet).
2. Add the areas together.
3. Calculate the diameter of a tree that would have this size area in a single trunk.

   Area = Radius^2 x 3.14
   Radius = $\sqrt{}$area / 3.14

4. Use this as the trunk size to estimate the TPZ

To accommodate site needs, the TPZ area may be



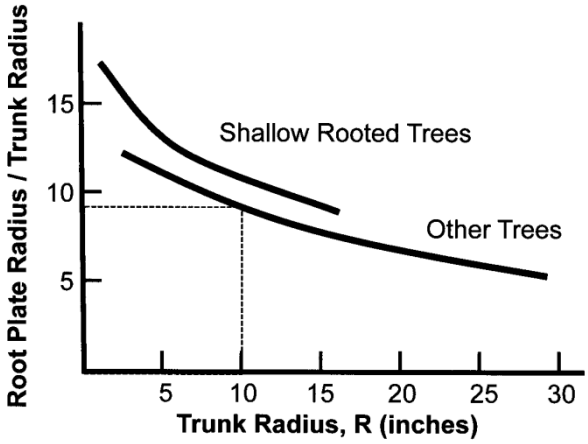
- Offset slightly
- Not necessarily round

Sites with urban hardscape restricting root spread

- Methods, as described above, will need adjustments.
- Need to actually check for root location.
    - Backhoe (A good operator knows when he hits roots and will stop before cutting them.)
    - Hand digging
    - Air spade
- New sidewalks and parking areas are generally OK if they say inside the footprint of the old area without invading the rooting area.
- New buildings are generally OK if they say stay inside the footprint of the old building without invading the rooting area.

Tree Stability

- For wind stability, do not invade the root plate.
    - **General formula**: radius of root plate is 3-6 times DSH (trunk diameter at standard height, 4.5 feet)
    - **Bartlett Tree Lab Model**: radius of root plate is
        - 5 times DSH on one side AND
        - 3 times DSH on other three sides
    - **Mattheck Model**

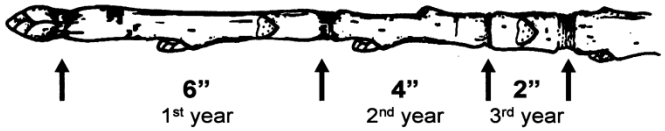


For example, a 10 inch trunk radius needs a root plate/trunk radius coefficient of 9. This would be 90" root plate radius (90"/10" = 9).

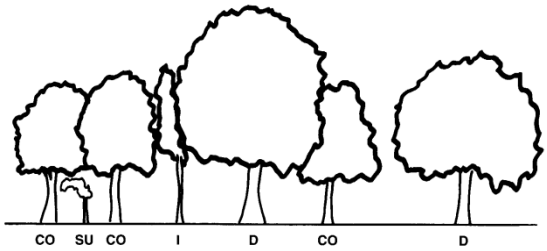
Symptoms of Construction Damage

Symptoms of construction damage include generic symptoms of stress and decline. Trees generally decline due to root decline and death.

- Reduced canopy growth – Compare how annual growth changes from year to year.



- Dieback on upper canopy
- Dieback of upper canopy on side related to root damage
- Small, poorly colored leaves
- Adventitious sprouting along trunk or lower scaffold branches
- Heavy seed set
- Mechanical injury to trunk and limbs
- New Edge" damage – Foliage and bark damage due to increased exposure to sun and wind.



Bottom line: Take steps to prevent construction damage, as little can be done to correct it.

Author: David Whiting, Extension Consumer Horticulture Specialist (retired), Department of Horticulture & LA, Colorado State University Extension.

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