British Standards Institute publication

**Trees in relation to construction – Recommendations** [BS5837:2005]

and the British Standards Institute (BSI) (BS) publication

**Guide for Trees in Relation to Construction**
[BS 5837:1991]


Terms used are different for the ISA and BS but essentially the planning and arboricultural processes are the same.
Arboriculture

The culture and management of trees as groups and individuals, primarily for amenity and other non-forestry purposes

David Lonsdale, 1999
Root crown

Trunk or Primary trunk(s)

Secondary trunk(s)

Primary branch(es)*

Root crown

*Primary branch(es) often called ‘Scaffold branches’
Depth in feet

- Absorbing Roots: 45 cm / 18 inches Depth
- Root System Depth: 0 - 91 cm / 0 - 3 feet
- Structural Roots
- Lateral Roots
- Sinker Roots
Overview: Primary aim of tree preservation

long-term survival and stability of the trees(s).

The International Society of Arboriculture (ISA) identifies three main principles:

1. Tree preservation programs must respect pattern of tree growth and development

2. Preservation must focus on preventing injury to trees

3. Tree preservation requires space
1. Tree preservation programs must respect pattern of tree growth and development

- Decisions about trees must be based on accurate information
- Also be based on information gained through scientific literature
- Decisions must also be based on accumulated professional experience
2. Preservation must focus on preventing injury to trees

- Arboricultural or forest practices cannot repair construction damage
- Degradation of trees' environment cannot be reversed
- Arborist's have limited ability to rectify specific injuries or generalised stress caused by construction activities
- Tree will either adapt to damage or environmental changes or will die
3. Tree preservation requires space

• Trees occupy large volumes of space above and below ground
• Tree preservation must plan for undisturbed space to retain healthy root system and crown
• Sufficient space must be provided both below and above ground to allow for an increase in size that will occur over time.

ISA, Harris, Clark and Matheny (2003)
Tree preservation can include single trees or groups

Forested area tree’s should be retained in remnant groups

For ‘resource conservation’ single tree retention is not generally* thought of as effective - this requires a larger area and number of trees i.e. wildlife corridors

*During the field portion of workshop I will discuss practical measures to provide wildlife habitat
Overview: The process

In order to preserve existing trees consideration for the trees needs to be applied at each phase
Arboricultural processes are divided into 9 elements

1. Perform a **tree stand delineation**

2. **Tree survey** within development area

3. **Identify trees suitable for preservation**

4. Access the **potential impacts to trees**

5. Suggest **modifications to development plans**

6. Identify **tree work** required prior to clearing and grading or predevelopment works

7. Prepare **specification for tree preservation**

8. **Monitor** trees during construction

9. Prepare a **post-construction maintenance plan**
Tree retention is successful where a logical sequence of processes is implemented.

Pre-planning that includes an arborist is recommended. The following flow diagram illustrates this process.

It is important to note that not all of the process may apply to every development.
Surveys
There are two main forms of survey used in this field of arboriculture as it relates to trees and construction.

Land Surveys

Tree Surveys
Tree stand delineation

Tree Constraints Plan (TCP)
Syn: ISA- Total Tree Survey, and Tree Stand Delineation;
former is more frequently used
Plan prepared by an arboriculturalist for the purposes of layout design

1. Showing the Root Protection Area (RPA)
2. Representing the effect that the mature height and spread of retained trees will have on layouts through shade, dominance, and so on
2. **Tree survey** within development area

3. **Identify trees suitable for preservation**
5. Suggest *modifications to development plans*

6. Identify *tree work* required prior to clearing and grading or predevelopment works
The schedule should list all the trees or groups of trees. Information required may consist of the following:

- Reference number (recorded on tree survey plan);
- Species (common/scientific);
- Height (m / ft);
- Stem diameter in millimetres (mm) / inches (in) at 1.5 m / 4.5 feet above adjacent ground level (on sloping ground to be taken on the upslope side of the tree base) or immediately above the root flare for multi-stemmed trees;
- Branch spread in meters taken at the four cardinal points to derive an accurate representation of the crown (to be recorded on the tree survey plan);
- Height in meters of crown clearance above adjacent ground level (to inform on ground clearance, crown stem ratio and shading);
- Age class (young, mature, over-mature, veteran);
- Physiological condition (good, fair, poor, dead);
- Structural condition, e.g. collapsing, the presence of any decay and physical defect;
- Preliminary tree management recommendations, including further investigation of defects or decay requiring more detailed assessment;
- Estimated remaining contribution in years (e.g. less than 10, 10-20, 20-40, more than 40);
- R or A to C or condition rating 1 to 5 category grading (see next table) to be recorded on tree survey plan
<table>
<thead>
<tr>
<th>Condition Rating</th>
<th>Overall Vigor</th>
<th>Canopy Density</th>
<th>Amount of Deadwood</th>
<th>History of Failure</th>
<th>Pests</th>
<th>Extent of Decay</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Severe Decline</td>
<td>&lt;20%</td>
<td>Large; major scaffold branches/primary</td>
<td>More than one scaffold/primary</td>
<td>Infested</td>
<td>Major - conks and cavaties</td>
</tr>
<tr>
<td>2</td>
<td>Declining</td>
<td>20-60%</td>
<td>Twig and branch dieback/tertiary and primary</td>
<td>Scaffold branches/primary</td>
<td>Infestation of significant pests</td>
<td>One to a few conks; small cavaties</td>
</tr>
<tr>
<td>3</td>
<td>Low/Moderate</td>
<td>60-90%</td>
<td>Small twigs/tertiary</td>
<td>Small branches/secondary</td>
<td>Minor</td>
<td>Present at pruning wounds</td>
</tr>
<tr>
<td>4</td>
<td>Good</td>
<td>90-100%</td>
<td>Little or none</td>
<td>None</td>
<td>Minor</td>
<td>Present at pruning wounds</td>
</tr>
<tr>
<td>5</td>
<td>Excellent</td>
<td>100%</td>
<td>None</td>
<td>None</td>
<td>None or insignificant</td>
<td>Absent</td>
</tr>
<tr>
<td>Foliage, Leaf / Needle</td>
<td>Colour</td>
<td>Size</td>
<td>Density</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------</td>
<td>------</td>
<td>---------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Seed / Cone Production</th>
<th>Size</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deadwood</th>
<th>Size</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Identify trees suitable for preservation

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>DF</td>
<td>30.9</td>
<td>Fair - good condition. Noted weak growth rate and a crown affected by the prevailing winds. Trunk has good degree of trunk taper with the main trunk leaning to the north at a measured angle of 6 degrees (Silva compass/clinometer). The upper crown has a bow that is typical of wind affected trees. The main concern and reason for this tree falling within a ‘fair - good’ category is the weak growth. Tree is co-dependent on Tree No1-2.</td>
</tr>
</tbody>
</table>
Bigleaf maple  
*Acer macrophyllum*  
**Poor - Good**  
Relative species tolerance  
Select species with good crown structure. Tolerant of root pruning. Intolerant of fill (grading).

Red alder  
*Alnus rubra*  
**Poor - Moderate**  
Relative species tolerance  
Retain only in groups or as individuals with strong taper and structure. Relatively short lived. Intolerant of root injury / disturbance.

Black cottonwood  
*Populus trichocarpa*  
**Poor**  
Relative species tolerance  
Mature trees prone to windthrow and trunk failure. Also prone to extensive crown failures.

Douglas fir  
*Pseudotsuga menziesii*  
**Poor - Good**  
Relative species tolerance  
Tolerant of fill if limited to one-quarter of root zone. Declines slowly following addition of fill. Tolerates root pruning. Intolerant of poor drainage. Susceptible to bark beetles following injury.

Western red cedar  
*Thuja plicata*  
**Poor - Moderate**  
Relative species tolerance  
Response is very site dependant and probably related to soil moisture. Tolerant of root pruning. Intolerant of fill (grading).
When assigning trees to any of the categories, the presence of any serious disease or tree related hazards should be taken into account.

If disease is fatal and/or irremediable or likely to require sanitation for the protection of other trees, the trees concerned may need to be categorised as 4 or 5, even if they otherwise have considerable value.

If mechanical (structural) defects present an unacceptable risk to people or property, the extent to which the defects are remediable, including the effect that this might have on the tree’s remaining value, should indicate whether the tree should still be assigned to the category that it would otherwise merit.

- investigate and then categorise
### Assessment of relative condition of trees in individual tree survey

<table>
<thead>
<tr>
<th>Condition Rating</th>
<th>Overall Vigor</th>
<th>Canopy Density</th>
<th>Amount of Deadwood</th>
<th>History of Failure</th>
<th>Pests</th>
<th>Extent of Decay</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Severe Decline</td>
<td>&lt;20%</td>
<td>Large; major scaffold/primary branches/primary</td>
<td>More than one scaffold/primary</td>
<td>Infested</td>
<td>Major - conks and cavities</td>
</tr>
<tr>
<td>2</td>
<td>Declining</td>
<td>20-60%</td>
<td>Twig and branch dieback/tertiary and primary</td>
<td>Scaffold branches/primary</td>
<td>Infestation of significant pests</td>
<td>One to a few conks; small cavities</td>
</tr>
<tr>
<td>3</td>
<td>Low/Moderate</td>
<td>60-90%</td>
<td>Small twigs/tertiary</td>
<td>Small branches/secondary</td>
<td>Minor</td>
<td>Present at pruning wounds</td>
</tr>
<tr>
<td>4</td>
<td>Good</td>
<td>90-100%</td>
<td>Little or none</td>
<td>None</td>
<td>Minor</td>
<td>Present at pruning wounds</td>
</tr>
<tr>
<td>5</td>
<td>Excellent</td>
<td>100%</td>
<td>None</td>
<td>None</td>
<td>None or insignificant</td>
<td>Absent</td>
</tr>
</tbody>
</table>
NOTE: If a layout design places category 4-5 trees in an inaccessible location such that concerns over public safety are reduced to an acceptable level, it may be preferable or possible to defer the recommendation/decision to remove.
It is sometimes possible to relocate mature trees.

However, as this is a costly operation that can also be extremely complex and that may have a variable chance of success it is generally considered only a viable option in exceptional circumstances.
Tree Survey: Post-Planning

This is where an arboricultural assessment is not obtained until after a preliminary site layout has been prepared.

Although this is not the ideal situation, timely and appropriate expert advice can still make valuable contributions to the process of tree retention and protection.

In cases where the arborist is provided a layout, the tree survey should be completed as detailed in the Tree Survey section.

This would then involve providing advice on tree retention, protection, remedial or mitigation works and new landscape design.

It is essential that the trees be assessed objectively and without reference to site layout proposals.

This is covered under the Arboricultural Implications Assessment (AIA) and Design Issues.
Tree Constraints Plan

The influence trees have on the site layout design is plotted on the Tree Constraints Plan (TCP).

- This illustrates both above ground owing to their size and position
- and the underground constraints due to the Root Protection Area (RPA).

The RPA is presented separately as it is a new method of determining the soil and root area to be protected.

It has not yet been adapted by the ISA but is in part based on their formula for calculation of a Tree Protection Zone (TPZ).
The RPA or Tree Protection Zone (TPZ) [ISA] for each tree should be plotted on the Tree Constraints Plan TPC).

The arborist may assess the tree and site, using the following factors, and alter its shape but not reduce the area while protecting the root system / soils.
The likely tolerance of any form of tree to root disturbance or damage. This is based on factors such as species, age and condition and presence of other trees. (For individual open grown trees, it may acceptable to offset the distance by up to 20% in one direction

The morphology and disposition of the roots, when known to be influenced by past or existing site conditions e.g. the presence of roads, structures and underground services

The soil type and structure

Topography and drainage

Where any significant part of the trees’ crown overhangs the provisional position of the tree protection barriers, these parts may sustain damage during the construction period.

In such cases, it may be necessary to increase the extent of tree protection barriers to contain and thereby protect the spread of the crown.

Protection may also be achieved by access facilitation pruning.

The arborist determines all this.
Arboricultural Implications Assessment (AIA) and Design Issues

The tree constraints plan, discussed previously, is utilised in the design layout.

It should however be taken in context as trees are only one factor requiring consideration in this regard.

**Important and sensitive trees may prevent development or dramatically alter its design.**

Retention of unsuitable trees, or too many, should be removed from consideration so as to avoid excessive pressure on trees during development and subsequent demands for their removal.

**NOTE:** Trees are material considerations in the formal planning system, whether or not they are statutorily/legal protected
Tree constraints and design

Trees can, and often do, impinge on many aspects of site development.

All members of the design team throughout the development process should give adequate consideration to the requirements of trees.
# Clearing and grading works

<table>
<thead>
<tr>
<th>Activity</th>
<th>Impact</th>
<th>Methods/treatments to minimise damage</th>
</tr>
</thead>
</table>
| Stripping site of organic surface soil before grading; clearing unwanted vegetation; demolishing existing structure's | Root loss | - Restrict stripping of topsoil around trees  
- Install fences to protect trees from injury  
- Any woody vegetation to be removed adjacent to trees remain should be cut at ground level and not pulled out by equipment  
- Otherwise root injury to remaining trees may result  
- Arborist may be needed for adjacent tree removal if crowns are intertwined |
| Lowering of grade, scarifying, preparing sub-grade for fill and structures | Root loss | - Before grading, root prune tree at edge of excavation to a depth required  
- Spoil beyond cut face can be removed by equipment sitting outside the drip line of the tree  
- Use retaining walls with discontinuous footings to increase the distance that natural grade is maintained from trunk |
Clearing and grading works
Clearing and grading works
Clearing and grading works
Clearing and grading works

Dr. Olaf K. Ribeiro, Ribeiro Tree Evaluations, Inc,
Clearing and grading works

Dr. Olaf K. Ribeiro, Ribeiro Tree Evaluations, Inc,
## Clearing and grading works

<table>
<thead>
<tr>
<th>Activity</th>
<th>Impact</th>
<th>Methods/treatments to minimise damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trenching for utilities, stormwater system,</td>
<td>Root loss</td>
<td>- Avoid open trenching in rooting area</td>
</tr>
<tr>
<td>drains</td>
<td></td>
<td>- Tunnel under roots, if possible. If not, within root area, dig trench by hand, bridging roots within</td>
</tr>
<tr>
<td></td>
<td></td>
<td>root area, dig trench by hand, bridging roots greater than 1 inches / 254 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Consolidate utilities into one trench</td>
</tr>
<tr>
<td>Compacted surface soils</td>
<td>Unfavourable conditions for root growth;</td>
<td>- Fence trees to keep traffic and storage out of root area</td>
</tr>
<tr>
<td></td>
<td>chronic stress from reduced root systems</td>
<td>- Provide a storage area and traffic route/area for construction activity away from trees</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Where traffic cannot be diverted, protect soil surface</td>
</tr>
</tbody>
</table>
## Clearing and grading works

<table>
<thead>
<tr>
<th>Tree diameter</th>
<th>Auger / Trenchless distance from tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-9 inches</td>
<td>5 feet</td>
</tr>
<tr>
<td>10-14 inches</td>
<td>10 feet</td>
</tr>
<tr>
<td>15-19 inches</td>
<td>12 feet</td>
</tr>
<tr>
<td>over 19 inches</td>
<td>15 feet</td>
</tr>
</tbody>
</table>

### Joint National Utility Group

1.0 m / 3.2 feet
Clearing and grading works
Clearing and grading works

Protecting Tree Roots When Installing Utilities

The National Joint Utilities Group, an association of utilities in the United Kingdom, developed guidelines for protecting tree roots when installing utilities (1995).

1. Establish a protection zone around each tree that is four times the circumference of the trunk (approximately 0.6m/mm trunk diameter, 1 ft/in. trunk diameter).

   Within that protection area

2. Do not excavate with machinery. Use trenchless techniques where possible. Otherwise dig only by hand.

3. When hand digging, carefully work around roots, retaining as many as possible.

4. Do not cut roots more than 25 mm (1 in.) in diameter unless the council’s tree officer (municipal arborist) agrees beforehand.

5. Prune roots that have to be removed using a sharp tool (e.g., secateurs or a handsaw). Make a clean cut and leave as small a wound as possible.

6. Backfill the trench with an inert granular material and topsoil mix. Compact the backfill with care around the retained roots. On nonhighway sites backfill only with excavated soil.

7. Do not repeatedly move or use heavy mechanical plant equipment except on hard standing.

8. Do not store spoil or building material, including chemicals and fuel.

9. Frost can damage exposed roots. If trenches are to be left open overnight, cover the roots with dry sacking.
MBW Soil Pick

Safely exposes all root structures without causing damage.

Tel. 01204 387784
Fax. 01204 387797
www.soilpick.com
During the design and planning stages the following factors should be taken into account.

- The presence of tree preservation orders or conservation area protection, environmental laws or planning regulations;
- The effect that development proposals may have on the amenity value of trees, both on and near the site;
- The above and below ground constraints i.e. spatial conflict with tree crown, services, grade alteration;
- Whether the design and/or construction of the proposed development can be modified to accommodate retention of trees that would have otherwise be at risk or removed. This includes appropriate tree surgery works that acceptably mitigate adverse effects caused by trees;
- Infrastructure requirements, e.g. easements for underground or above ground services; highway safety and visibility splays; and other infrastructure provisions, such as substations, refuse stores, lighting, signage and CCTV requirements; linking footpaths, stairs, access and egress points to allow for predictable pedestrian movement;
- The end use of the space;
- Whether tree loss resulting from the development proposals can be acceptably mitigated by new tree planting.
NOTE: there is a need to prevent / avoid cumulative damaging effects of incursions into the RPA/TPZ, for example from excavation for services and the laying of permanent hard surfaces.
Particular care is required in the retention of larger and older trees.

Construction and design may enclose within a development or re-development such trees.

These are far less resilient and more likely to die or become potentially unsafe as a result of pressures associated with the development.

Even if the tree(s) survive in the short term, they may die and before the new structure becomes obsolete. Resulting removal may be technically difficult and costly.

If large and older trees are retained it may be effective to incorporate them into open spaces or large gardens, thereby allowing adequate space for their long term physical protection and maintenance.
Proximity of trees to structures

As noted the probable impact and realistic assessment of any proposed development on trees proposed for retention and vice versa should take into account the characteristics of and condition of the tree(s).

This includes an allowance for their future growth and maintenance requirements.
Damage can occur to trees and structures by the continuous whipping of branches.

Branch ends may have to be cut back repeatedly, possibly spoiling the shape of the tree.

Trees should not be retained on the basis that their ultimate branch spread can be significantly controlled by periodic pruning, unless this is a desired management outcome i.e. crown reduction.
Tree Protection Zone / Root Protection Area

TREE PROTECTION PLAN

The Thrapp Residence
1225 Candy Cane Lane

December 1997

Prepared for:
TPT Production Co.

Base map prepared by
Stephen Stover, Architect

Refer to Tree Survey Forms for
descriptions of trees

No scale

TREE PROTECTION ZONE (TPZ)
No grading, trenching or
equipment in this area.
All work to be performed
by hand.
Install 6’ chain link fence
to enclose TPZ before
demolition, grubbing and
grading. Fences shall remain
until all construction is
complete.

No scale

ARBOREA
Root Protection Area (RPA)

Syn: ISA-No equivalent, but similar to Tree Protection Zone (TPZ), which is sometimes termed the Critical Root Zone

*Layout design tool* indicating the area surrounding a tree that contains sufficient rooting volume to ensure the survival of the tree, shown in plan form ft² / m²

Construction exclusion zone (-)

Syn: ISA-Tree Protection Zone (TPZ)

Area based on the RPA (in ft² / m²),
• Identified by an arboriculturalist,
• to be protected during development,
• including demolition and construction work,
• by the use of barriers and/or ground protection fit for the purpose to ensure the successful long-term retention of a tree.

ISA defines this as a radial distance m/ft rather than by area
### ISA - Tree Protection Zone / Root Protection Area

<table>
<thead>
<tr>
<th>Species Tolerance</th>
<th>Tree Age</th>
<th>Distance from trunk feet per inch trunk diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Good</strong></td>
<td>Young (&lt;20% life expectancy)</td>
<td>0.5 feet</td>
</tr>
<tr>
<td></td>
<td>Mature (20-80% life expectancy)</td>
<td>0.75 feet</td>
</tr>
<tr>
<td></td>
<td>Overmature (&gt;80% life expectancy)</td>
<td>1 foot</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>Young</td>
<td>0.75 feet</td>
</tr>
<tr>
<td></td>
<td>Mature</td>
<td>1 foot</td>
</tr>
<tr>
<td></td>
<td>Overmature</td>
<td>1.25 feet</td>
</tr>
<tr>
<td><strong>Poor</strong></td>
<td>Young</td>
<td>1 foot</td>
</tr>
<tr>
<td></td>
<td>Mature</td>
<td>1.25 feet</td>
</tr>
<tr>
<td></td>
<td>Overmature</td>
<td>1.5 feet</td>
</tr>
</tbody>
</table>
BS guideline for Root Protection Area (RPA) can be used in English units

The RPA is capped at 2,320 ft\(^2\)
RPA 49.2 ft\(^2\) radius
RPA as a square 85 ft\(^2\) sides
ISA - Tree Protection Zone / Root Protection Area

Determining the Tree Protection Zone

To calculate the optimum tree protection zone (see Table 11-1):

1. Evaluate the species tolerance of the tree: good, moderate, or poor.
2. Identify tree age: young, mature, overmature.
3. In Table 11-1, find the distance from the trunk that should be protected per unit of trunk diameter.
4. Multiply the distance by the trunk diameter to calculate the optimum radius for the tree protection zone.

Examples:

(Left) A 15-year-old, healthy, 33-cm (13-in.) diameter Raywood ash (*Fraxinus* 'Raywood') (good tolerance, young age):

\[0.06 \text{ m} \times 33 \text{ cm} = 1.98 \text{-m radius tree protection zone}\]
\[0.5 \text{ ft} \times 13 \text{ in.} = 6.5 \text{-ft radius tree protection zone}\]

(Right) A healthy 60-year-old, 76-cm (30-in.) diameter black walnut (*Juglans hindsii*) (poor tolerance, mature age):

\[0.15 \text{ m} \times 76 \text{ cm} = 11.4\text{-m radius tree protection zone}\]
\[1.25 \text{ ft} \times 30 \text{ in.} = 37.5 \text{-ft radius tree protection zone}\]
ISA - Tree Protection Zone / Root Protection Area
ISA - Tree Protection Zone / Root Protection Area
ISA - Tree Protection Zone / Root Protection Area
ISA - Tree Protection Zone / Root Protection Area
Tree Protection Barriers

- must establish a protection zone that covers the trees optimum rooting zone
- should be of substantial construction i.e. plywood, chain-link or sheet metal fence
- fines and penalties for violating the area demarcated by the barrier. This can either be included in the contract or specifications
- location of the barrier is determined by the certified arborist based on species tolerance, condition, and age
- the barrier placement should also account for working space
Arboricultural Method Statements (AMS) and the Tree Protection Plan (TPP)

Once the layout design has been finalised a TPP should be prepared contain the following information.

Trees selected for retention, clearly identified (e.g. by number) and marked on a plan with a continuous outline;

Trees to be removed, also clearly identified (e.g. by number) and marked on a plan with a dashed outline or as determined by the planning authority the precise location for erection of protective barriers and any other relevant physical protection measures including ground protection to protect the RPA and marked as a construction exclusion zone on the plan

NOTE: while the root protection area may be plotted as a circle on the constraints plan, the position of the barrier and any ground protection should be shown on subsequent plans as a polygon representing the actual position of the protection. It is helpful during setting out, and for the purposes of enforcement if the plan is annotated the dimensions of the exclusion zones
1 Standard scaffold poles
2 Uprights to be driven into the ground
3 Panels secured to uprights with wire ties and where necessary standard scaffold clamps
4 Weldmesh wired to the uprights and horizontals

5 Standard clamps
6 Wire twisted and secured on inside face of fencing to avoid easy dismantling
7 Ground level
8 Approx. 0.6 m driven into the ground

0.6 m / 1.9 feet
2.5 m / 7.5 feet
3 m / 9.8 feet
Edge of RPA

Protective fencing

Protected area

Ground undisturbed and protected by geotextile fabric, and side butting scaffold boards on a compressible layer

Platform level at first lift of brickwork

Toeboard

Ground undisturbed and protected by geotextile fabric, and side butting scaffold boards on a compressible layer
Examples of Tree Protection Zone (Additional)

**Figure No.4, General Illustration of Tree Protection Area**

- **A:** Install / maintain a 12 inches/300mm depth of woodchip mulch (absolute minimum)

- **B:** Install / maintain a 12 inches/300mm woodchip mulch from the outer limit of branch spread or specified tree protection area; whichever is furthest.

- **C:** Maintain area at base of trunk free of mulch. As a guide use the following formula to determine the distance:

  \[ \text{Girth} \times 0.5 = \text{distance mulch should be kept away from the trunk} \]

- **D:** Maintain an absolute uniform minimum 12 inches/300mm depth of woodchips. No construction / development equipment, materials, and or spoil within area B described above and illustrated in Figure No.4, General Illustration of Tree Protection Area.

Tree protection signage; with details of fines and arborist contact details

Examples of tree protection in a streetscape (left) and open sight (right). Note fixed chain-link fence
Design details of the proposed physical means of protection, indicated through drawings and/or descriptive text, including any development facilitation pruning;

All the details listed should be incorporated into subsequent drawings and method statements used for design purposes or issued for use on site, to ensure that all interested parties are fully aware of the areas in which access and works may and may not take place.
Mulch Usage for Mitigation and Treatments

- Moderates soil temperature
- Conserves soil moisture
- Provides organic matter and improves root density
- Reduces compaction and improves soil structure
- Eliminates turf grass competition
Figure No.5 Radial Trenching and Root Re-invigoration / Soil Amendment Treatment

B: Install / maintain a 12 inches/300mm woodchip mulch from the outer limit of branch spread or specified tree protection area; whichever is furthest.

Protection hoarding is required, unless otherwise stated, and should be installed prior to site works; install at point B around the edge of the protection area.

C: Maintain area at base of trunk free of mulch. As a guide use the following formula to determine the distance:

Girth X 0.5 = distance mulch should be kept away from the trunk

D: Maintain an absolute uniform minimum 12 inches/300mm depth of woodchips. No construction / development equipment, materials, and or spoil within area B described above and illustrated in Figure No.4, General Illustration of Tree Protection Area.
In order to avoid disturbance to the physical protection forming the construction exclusion zone once it is installed, it is essential to consider, make allowance for and plan all construction operations which will be undertaken in vicinity of trees, in particular:

- Site construction access;
- The intensity and nature of the construction activity;
- Contractors’ car parking;
- Phasing of construction works;
- The space needed for all foundation excavations and construction works;
- The availability of special construction techniques i.e. micro-piling, trenchless service installation;
The location and space needed for all service runs including foul and surface water drains, land drains, soak-ways, gas, oil, water, electricity, telephone, television or other communications cables;
All changes in ground level, including the location of retaining walls, steps and making adequate allowance for foundations of such walls and backfilling(s);
Space for site huts, temporary latrines (inclusive of drainage) and other temporary structures;
The type and extent of landscape works which will be; needed within the protected areas, and the effects these will have on the root system;
Space for storing (whether temporary or long term) materials, spoil and fuel and the mixing of cement and concrete;
The effects of slope on the movement of potentially harmful liquid spillages towards or into protected areas
Tree Protection

Notes:
A: Install / maintain a 12 inches/300 mm depth of woodchip mulch (absolute minimum)

B: Install / maintain a 12 inches/300 mm woodchip mulch or compost and mulch overlay as specified by ISA certified arborist. From the outer limit of branch spread or specified tree protection area; whichever is furthest. Underlay this with a soaker hose as determined by ISA certified arborist for irrigation.

Protection hoarding is required, unless otherwise stated, and should be installed prior to site works; install at point B around the edge of the protection area. This is illustrated in image F and image I left. This is also detailed in the arborist report dated August 15th.

C: Maintain area at base of trunk free of mulch. As a guide use the following formula to determine the distance:

\[ \text{Girth} \times 0.5 = \text{distance mulch should be kept away from the trunk} \]

D: Maintain an absolute uniform minimum 12 inches / 300 mm depth of woodchips. No construction / development equipment, materials, and or spoil within area B described above and illustrated in image J.

TREATMENT REQUIRED

<table>
<thead>
<tr>
<th>TREE</th>
<th>RECOMMENDATIONS AND TREATMENT REQUIRED</th>
<th>TASKS COMPLETED</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 - 12</td>
<td>Install 2 inches of compost with an over-layer of arborist wood-chip 3-4 inches in depth as per the instructions noted in image J notes above.</td>
<td>TBD</td>
</tr>
<tr>
<td>9 - 12</td>
<td>Perform root re-inivigoration treatment and soils de-compaction, include irrigation in this treatment.</td>
<td>TBD</td>
</tr>
<tr>
<td>9 - 12</td>
<td>Tree protection shall be installed following soils treatment (invigoration and de-compaction). This is detailed in the arborist report dated 15th August 2007. See image I and image F left.</td>
<td>TBD</td>
</tr>
<tr>
<td>9 - 12</td>
<td>The current irrigation lines will need to be lengthened and shall incorporate the soils area treated by root invigoration and de-compaction treatment. The aim it to ensure the treated area is irrigated as discussed on site</td>
<td>TBD</td>
</tr>
</tbody>
</table>
Construction Damage
Symptoms of direct damage to the stem and crown are likely to be broken branches and bark wounds, which should be remedied by pruning out and appropriate treatments
The part of a tree most susceptible to damage is the root system, which, because it is not immediately visible, is frequently ignored.

Damage or death of the root system affects the health, growth, life expectancy and safety of the entire tree.

Trees may take some time to show distress, in certain cases several years. Compounding factors that accumulate over time typically causes damage.
Direct Damage to Roots

This may only be determined from identifying the position of service trenches and the limits of other excavations.

Where roots have been severed the anchorage of the tree may have been seriously reduced.
NOTE: On development sites, reduced water availability for existing trees may be a problem.

Severance of roots may seriously reduce the trees’ ability to absorb sufficient water to meet the demands of foliage.

The uptake of water and mineral nutrients by the root system takes place via the fine roots, typically less than 0.5 mm / 0.19 inches diameter.

Their survival and functioning – essential – depend on the maintenance of favourable soil conditions. Fine roots noted are short-lived dying and growing with seasonal changes in climate and soil conditions.
Root Growth Requirement: sustaining the root system

- High density soils will reduce root growth
- Limiting root growth will limit tree potential

**Soil Density and Tree Root Growth**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen in soil atmosphere (for root survival)</td>
<td>3% - 21%</td>
</tr>
<tr>
<td>Air pore space in soil (for root growth)</td>
<td>12% - 60%</td>
</tr>
<tr>
<td>Soil bulk density restricting root growth (g/cc)</td>
<td>1.4 clay - 1.8 sand</td>
</tr>
<tr>
<td>Penetration strength (water content dependent)</td>
<td>0.01kPa - 3MPa</td>
</tr>
<tr>
<td>Water content in soil</td>
<td>12% - 40%</td>
</tr>
<tr>
<td>Root initiation (O2% in soil atmosphere)</td>
<td>12% - 21%</td>
</tr>
<tr>
<td>Root growth (O2% in soil atmosphere)</td>
<td>5% - 21%</td>
</tr>
<tr>
<td>Progressive loss of element absorption in roots</td>
<td>10% - 21%</td>
</tr>
<tr>
<td>O2% in soil atmosphere</td>
<td></td>
</tr>
<tr>
<td>Temperature limits to root growth</td>
<td>40°F/4°C - 94°F/34°C</td>
</tr>
<tr>
<td>pH of soil (wet test)</td>
<td>pH3.5 - pH8.2</td>
</tr>
</tbody>
</table>

**Absorbing roots**
- Critical Absorbing roots in top 450 mm of soil

**A Majority root system 0 - 910 mm depth**

A minimum of 1.5 m of well-drained soil depth is required for the growth of a tree to maturity. A tree's root system grows mainly within the top 60 cm of the surface and extends outward 2 to 3 times the dripline dimension. The root system of a tree has three main parts: The large "anchor roots" providing structural support; a framework of "transport roots"; and a complex network of "feeder roots" that grow outward and upward from the transport roots. These non-woody roots branch out to form fans of thousands of slender roots with fine root hairs. These tiny roots provide the major portion of the absorption surface of a tree's root system.
NOTE: The entire root system is typically concentrated within the uppermost 910 mm / 36 inches of the soil:

- although it may be deeper within the dense mass of roots and soil close to the trunk and in sinker roots
- within a short distance the root system branches, forming a network of small diameter woody roots, that typically extend radially for a distance much further than the height of the tree
- this is except where impeded by unfavourable conditions

All parts of this system bear a mass of fine absorbing roots (non-woody / soft tissue).

Absorbing root system within the top 450 mm / 18 inches
NOTE: Older and/or larger trees are more vulnerable than younger or smaller trees to root severance and other impacts noted below but in all cases the effects of root severance is detrimental.

NOTE: Damaged roots or those that have to be pruned should be cut so that the final wound will be as small as possible and free from torn and ragged ends.

If the root forks/bifurcates the final cut should be made to remove the one arm / parts of the fork affected.

Roots can be damaged during the development process, including clearing and demolition activities, or where alterations to drainage and aeration patterns of the soil adversely impact the root systems previously described.

Exposed roots, i.e. trench edge or excavation limits should be covered with indigenous soils or using other temporary methods.
## SITE CONDITIONS

<table>
<thead>
<tr>
<th>TREE</th>
<th>CONDITION/CONCERN</th>
<th>TREATMENT REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 - 15 Tree rooting environment is not covered with compost or arborist wood-chip for nutrient and soil moisture improvement. Image D illustrates the loss of soil moisture and uneven spread of watering with the left excavation showing dry soils and the right with moist soils. (Tape measure is set at 12 inches for scale.)</td>
<td>Application of compost and arborist wood-chip as detailed in the arborist report dated August 15th, 2007. This is illustrated in image J on the next page.</td>
<td></td>
</tr>
<tr>
<td>9 - 10 Roots are exposed where asphalt is removed from the surface. This may lead to desiccation and fine root death. This is illustrated in image C above (Tape measure is set at 12 inches for scale.)</td>
<td>As above.</td>
<td></td>
</tr>
<tr>
<td>12, 15 Roots are exposed where the material used for tree root protection and to ensure root desiccation does not occur in the exposed rooting horizons. This is illustrated in image G on the next page.</td>
<td>Ensure the cover is maintained for the duration of its use on this site. See image E for an illustration for correct maintenance.</td>
<td></td>
</tr>
</tbody>
</table>
Images of typical rooting habit (Morphology)
NOTE: The root system does not generally show the symmetry seen in the branch system.

The development of all roots is influenced by the availability of water nutrients, oxygen and soil penetrability.

As far as these conditions allow, the root system tends to develop sufficient volume and area to provide stability.
NOTE: Removal of roots may require that supplemental watering be prescribed.

This must only be done if it is know that the soil moisture levels are not sufficient.

Irrigation in wet or soils that have sufficient water may cause health problems in the tree by flooding the soil.
NOTE: In addition to the NOTE regarding damaged roots it is important to prevent damage.

Any excavations that encounter roots over 25 mm / 1 inch diameter requires particular care be used to avoid damage; hand excavation is usually prescribed, avoiding damage to the bark.

Other methods of excavation are now available i.e. hydro or pneumatic excavation.

Roots exposed should be surrounded by sharp (washed) sand before replacing soil or other material in the excavation area.
Jim Barborinas, Urban Forestry Services, Inc.
An element of damage that can occur to trees that is often overlooked and not addressed at all stages in the development process is the compaction and/or contamination of the soil.

Other forms include the alteration of soil levels on the development site or changes in the water regime.
Indirect (and Direct) Damage to Roots

Tree roots develop in the soil at a level where oxygen and moisture are available in the appropriate concentrations.

Sudden alteration of the depth of soil over roots as a result of lowering (Direct) or raising the soil level within the branch spread or area designated as critical to the survival of the tree can kill the roots and as a result the tree may die.
NOTE: Lowering the soil level is particularly damaging as this sever roots, especially those on or near the surface.

For this reason the site should not be skimmed of surface soil i.e. to install new paving or hard-court area at the former ground level.

Except for the careful removal of loose organic matter. Preferably the new paving, in this example, should be established above the former ground level, using granular fill.

NOTE: Raising the ground level can be accommodated more easily provided a granular material is used which will not inhibit gaseous diffusion.

However, the response of trees to ground level changes can vary considerably and it depends on the species, age, health and position of the tree and on the nature of the soil.

The fill material must allow for the gaseous diffusion and/or root colonisation of the new soil levels.
NOTE: If excess water is likely to be a problem consideration should be given to the provision of suitable land drainage.

Installation must not compromise the stability of the tree or the tree root system identified as critical for tree retention.
Soil compaction
Root Invigoration

As per previous illustration:

- No treatment within X3 DBH [A]
- Treatment area to include 50% of area [B] within Tree Protection Zone (TPZ)
- Treatment of soil to 15 cm / 6 inches depth
- Incorporation of organic matter and slow release fertiliser
- Mulch treatment within TPZ.
Soil compaction and the above NOTE(s) are also detailed in the following table earlier in the presentation

‘Major construction impact and methods to minimise damage’
Tree Protection Detail

Drawing Notes:
A: Install / maintain a 300mm depth of woodchip mulch (absolute minimum)

B: Install / maintain a 300mm woodchip mulch from the outer limit of branch spread or specified tree protection zone; whichever is furthest.

Protection hoarding is required, unless otherwise stated, and should be installed prior to site works; install at point B around the edge of the protection area.

C: Maintain area at base of trunk free of mulch. As a guide use the following formula to determine the distance:
Girth X 0.5 = distance mulch should be kept away from the trunk

D: maintain an absolute uniform minimum 300mm depth of woodchips. No construction / development equipment, materials, and or spoil within this zone.
A-AA: Preference is to keep all cuts outside the Tree Protection Zone or dripline.

A-B: Optimum minimum distance for root cutting; DBH* X5

A-C: Absolute minimum distance for root cutting; DBH X3

A-C is the closest root cutting distance. Cutting closer creates a high risk of failure. Increase distances if tree(s) are large, leaning, root decay is present and so on.

*Trunk diameter at 1.3m / 4.5 feet height
Use of Minimum Root Cutting Distance: within the Tree Preservation Zone
Risk Rating for Root Loss and or Root Decay

Critical Risk: >50% of roots with significant decay / loss, or if affected roots is uphill or opposite lean
High Risk: >33% of roots with significant decay / loss, or if affected roots is uphill or opposite lean

Moderate Risk: <33% of roots with some decay or cut
Low Risk: no decay or cut roots, not in low or wet site and so on
Typical Symptoms of Tree Stress From Construction Injury

Short seasonal growth elongation
Small leaves [often yellow ]
Thin foliage density
Leaf scorch
Wilting
Early defoliation, sudden leaf loss [that occurs outside normal leaf abscission period]
Epicormic shoots
Heavy seed mast production
Twig and branch dieback

Attack by borers and other stress related pests
Evaluation of Construction Impacts

Must include an assessment on the health and structure of the tree(s); Risk Assessment

In addition the following should also be addressed:

- destruction of the general root system, particularly loss of rooting area
- damage to the root collar and structural roots
- mechanical injury and damage to the stem
- changes in soil structure such as compaction, fill(s), erosion, and loss of organic matter
- changes in wind loading in the crown, which is particularly related to potential for failure

- damage to branches
- decline in overall health
- obstructions
Other Post-Construction Requirements

**Irrigation**

- The amount of water applied must be appropriate to the species requirement
- Light, frequent irrigation’s should be avoided. Irrigation should wet the entire root zone and be allowed to dry before another application
- Excess irrigation from new landscapes should be avoided. Runoff from plantings should be minimised and or directed away from trees
- Wetting the trunk should be avoided

**Pruning**

- Annual inspection of retained trees is required. Prescribed treatments are typically based on the results of inspection
- Pruning to mitigate risk is the priority following construction impacts

**Mulching**

- See section on mulching previously
- Application of 100 – 150 mm / 4 - 6 inches of mulch is recommended to the edge of the drip line or Tree Protection Zone, which ever is greatest
- Mulch should be kept away from the trunk base

**Fertilisation**

- An assessment of the soil nutrient content is preferred prior to any application so that specific nutrient deficiencies can be targeted
- Application of a balanced slow release, low concentration, fertiliser is recommended
Additional recommended reference material for study and general reference

If you have any questions don't hesitate to contact me:

360 733 9799

Email: arborea.consult@mac.com