Processes of Planning for Maximizing Tree Retention During Land-Development Constructions

Presented by Rick Thomas | ArborCulture Pte Ltd | Consulting Arborists | Singapore
Role of Consulting Arborist :-

• Condition survey the tree resource
• Involve in master planning to represent the interest of trees
• Input base tree information's to plan drawings
• Overlay buildings & infrastructure to plan/ identify potentials for tree harm (Risk Analysis)
• Continue dialogue with design team to eliminate, avert or minimize impacts of identifiable harm.
• Specify conservation parameters through instructional design
• Provide supervision and managements at the necessary times
Tree Conservation Planning: Tree Risk Analysis Construction

- Identify potential impacts upon trees arising from constructions
- Develop methods to impact mitigate or eliminate agents of harm
- Integrate communication protocols by way of instructional design

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Tree Conservation Strategy:
Tree Risk Analysis Construction

- Construction threat & mitigation method identified
- Mitigation method included in contract specification
- Tree Protection Methods & Devices Implemented
- Common Tree Maintenance/ Stress Minimization Methods Implemented
- Communications Protocol Incorporated
- Regular Monitoring and Conditions Recording Implemented

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Tree Conservation Components: Identifying Tree Conservation Parameters

1) **CRR (ZRT)**
2) **RPZ**
3) **PCA (TPZ)**

a) ZRT = Zone of Rapid Taper
b) CRR = Critical Root Radius
c) RPZ = Root Protection Zone
d) PCA = Projected Crown Area
e) TPZ = Tree Protection Zone
To deliver affective rules of protection, it is necessary to set parameters of conserved soil areas deemed to be the minimum requirement for sustainability of tree(s).

Tree roots may well extend beyond the tree crown width extent; often occupying soil areas in greater mass where conditions are most conducive to root function.
Tree Conservation Components: Calculating the Root Protection Zone (RPZ)

\[ B = \text{RPZ} \]
\[ \text{RPZ} = 1\text{mR} : 12\text{cmDBH} \]

Calculating the \text{RPZ}

Example: A moderately tolerant tree of intermediate age [est. 45% of expected longevity] with trunk DBH of 0.6m is attributed 5m radial protection in every direction

(Based on Matheny & Clark 2004)

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Tree Conservation Strategy: Calculating the Critical Root Radius (CRR)

Formula [Using preferred radius ] = DBH x 0.5 x 5
Example: DBH = 1m x 0.5 x 5 = CRR 2.5mR

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Tree Conservation Strategy:
Plotting Tree Conservation Parameters/ information on Plan

1) Tree ID & location plotted

2) Calculate and plot Root Protection Zone (RPZ)

3) Draw the Projected Crown Area (PCA) as extracted from tree survey
Result:

- Produces the image on plan indicating where the impacts upon trees lay.

- Prompts for the continuing dialogue between Architects, Structural / M & E Engineers & other design team members in seeking to avoid conflict with trees.
Tree Conservation Strategy: Process of review…’in a nut-shell’

Arch
- Building Layout
- Material use & design components

Engnr
- Substructure design
- Method / equip application
- Site-utilizations

Arbor
- Promote/ support design innovation
- Advise & endorse sustainable solutions

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Example for mitigating conflict through Archi/layout design

Nudge buildings where-ever able; so as not to affect any trees or; minimize the quantity of trees affected or; minimize impact quantity overall.
Examples for mitigating conflict through structural design

Suspension (eg: cantilever) of structure over rooted soils is an excellent design measure for the conservation of tree roots.
Example for mitigating conflict through structural design

a) Columns located within RPZ are usually acceptable under controlled construction conditions.

b) To allow for design/construction flexibility; design with lateral movement of column to max tolerance = 1x column diameter.
Examples for mitigating conflict through structural design

‘Bridging’ off *strip foundations* or bridging off *columns* is a desirable tree-root conservation method of suspended design.

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Temporary ground protection during constructions

Temporary construction access in close proximity to conserved trees...
...this method can be extended/ modified to become permanent (low load bearing applications)
Example for mitigating conflict through structural design (Temporary Structure)

Non-permeable hard-surfaces may be acceptable...

...provided they are temporary & constructed upon grade; under controlled conditions

More permanent hard-surfaces may be acceptable...

...provided +/- <30% RPZ affected; constructed upon grade; provision of root passages beneath; under controlled conditions
Examples for mitigating conflict through design (Temporary Structure)

Suspending low load bearing structure can be as simple as laying hard-surfaces upon grade; provided the appropriate materials are applied; under controlled conditions.
Examples for mitigating conflict through design

Trafficable, permeable hard-surfaces are available...

Material selection and combinations may assist design intentions

Installing ‘Grass-rings’ material upon geo-fabric & sand bed

Smooth installed material, black into river-stones ‘Grass-rings’

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Examples for mitigating conflict through structural design

Suspended structure during temporary works; the structure may be acceptable as permanent; subject to design & installation conditions.
Some common conflicts between trees & construction

Cutting or filling of soils within RPZ may only occur under highly controlled/pre-planned conditions and; Arborist supervisions are often needed.
Some common conflicts between tree crowns & constructions

Encroachment of buildings into tree crown areas (PCA)

Vertical constructions/equipment operations

Preparations & constructions of RC walls, scaffolding, glazing, roof-truss installations, etc

Bore-piling, concrete-pore/pumping & crane/hoisting rigs; other vertical or lateral equipment operations.
Examples for mitigating conflict through documentation

RFA & RFI; Communication Protocol (Installed & constantly enforced)

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<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Trees Not Affected</td>
<td>Trees identified as not affected by construction / land-development activities.</td>
</tr>
<tr>
<td>2) Trees Affected; Retained in Structure</td>
<td>Trees identified as affected by construction; yet able to be retained successfully within or close to structure</td>
</tr>
<tr>
<td>3) Trees Affected; Unable to be successfully retained</td>
<td>Trees identified affected and unable to be retained successfully at location due to excessive impacts imposed</td>
</tr>
</tbody>
</table>
## Trees Affected: Outcome of process performed....

1) **Trees Not Affected**  
   (unaffected)  
   - Implement protection measures to separate trees from construction so as to maintain the **unaffected** status.

2) **Trees Affected; Retained in Structure**  
   - Implement protections measures to minimize impacts of construction, conduct regular monitoring of tree condition & apply maintenance where necessary

3) **Trees Affected; Unable to be successfully retained**  
   - Trees remove or;  
   - Endeavour to save trees (Transplant option available).
## Mitigation outcomes: Pro’s & cons.....

<table>
<thead>
<tr>
<th>Available mitigating option</th>
<th>Potential Positive attributes</th>
<th>Potential Negative attributes</th>
<th>Outcome (**Rated)</th>
</tr>
</thead>
</table>
| 1. Adjustment/ movement to buildings foot-print and / or; fixed structure locations | a. Study completes in a relatively short time.  
   b. Confirms submittal of the remaining affected trees to either option 2 or 3 | a. Potential affects may be contrary to initial architectural layout architectural intents and/or affects the facility operators requirements. | 1 |
| 2. Accommodating trees through sub-structure, architectural & mechanical design. | a. Prompts high-end innovative design  
   b. Demands higher quality contractors (good if available) | a. Additional time to design  
   b. Probable higher construction cost  
   c. Demands higher quality contractors (not so good if unavailable) | 2 |
| 3. Transplanting of excessively affected trees; being those trees remaining & unable to mitigate via option 1 or 2 above | a. Option remains available/ do-able if and as necessary | a. Potential of higher cost  
   b. Time associated with design, development & fabrication of specialist equipment's that may be needed.  
   c. Time consuming operationally/ program disruption potential exists  
   d. Extensive maintenance programs commonly apply (+/-2yrs) | 3 |

**Ratings:-**  
1 = Most preferred; 2 = less preferred; 3 = least preferred
Tree Transplanting: Commonly applied process; albeit variable subject to conditions

- Phase 1: Planning and assessments
- Phase 2: Tree preparation (root-system etc)
- Phase 3: Pre-transplant maintenance period
- Phase 4: Transplant tree
- Phase 5: Post transplant maintenance period
Tree Transplanting: Process Method Example: Tree preparation

1. Determine the Root-ball parameters; commence careful manual excavations severing select roots and retaining selected roots; as & where conditions dictate.

2. Wrap & pack against severed root ends.

3. Back-fill to level ground; commence phase 3 inclusive of programmed applications of root-stimulants/other additives.
Tree Transplanting: Process

Method Example: Tree preparation

Application of pneumatic tools, root-stimulus natural plant hormones (i.e. auxins/gibberellins) & other additives that may apply.

Soil amendments are not always required, are subject to conditions as found and; the analysis of progressions forward.

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Tree Transplanting: Example - operational methods

Tree Frame Method

Modular system proven as successful for transplanting small size trees and large sizes up to approx 65 tonne (6m x 6m root-ball) and can be adapted to cater for heavier loads/ larger root-ball sizes.
Tree Transplanting:
- Tree Frame Method

Excavate the root ball by hand or machine with care.

Attach the tree frame device and crane rigging.

Crane lift the tree into planting location.
Tree Transplanting:
- Tree Frame Method

Place the tree in the forest; plant above ground so as not to damage tree roots of the surrounding trees

Attach cable guying – in this case, cabling aerially from existing surrounding trees to the transplanted tree(s)

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Tree Transplanting: Example - operational methods

Tree Boxing Method

Custom or modular system proven as successful for transplanting small size trees & large trees 200 tonne or more; sledding or jacking of larger root-ball sizes usually applies.
Transplanting - Bare Root

Using Air-spade® to remove soils from the root-network is an alternative to conventional methods.

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Transplanting - Bare Root

Water the tree heavily a few days in advance to ensure well hydrated.

Carefully remove soil from the roots using pneumatic tool (ie Air-spade®) and crane lift the tree.
Tree Transplanting: Operational Methods…

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500t crane lifting 40 tonne tree to planting area

Transplanted tree 3 years after planting

Root-ball lowered into planter
Tree Transplanting: Operation Example: Tree Transplant

Lift method (in this image crane) and transport to planting location (either direct crane slew or alternative mode)
Processes of Planning for Maximizing Tree Retention During Land-Development Constructions

Thank-you 😊

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