APPENDIX 22 - Guidelines on Tree Preservation during Development

Guidelines on Tree Preservation during Development

Greening, Landscape and Tree Management Section
Development Bureau
The Government of the Hong Kong Special Administrative Region

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1. Introduction

1.1 Trees are important elements in the city landscape and valuable assets in the community. They are dynamic living components of the urban ecosystem and their growth and structural stability change over time and environmental conditions. Infrastructure development both in reforming and modifying the cityscape is common. Trees are thus often subject to potential impact of new development and renovation of existing roads, utilities, facilities and other structures.

1.2 Tree preservation is necessary because trees play an important role environmentally and culturally. It is an integral part of a development project and requires careful planning in all stages from planning, design, construction to post-construction. Preserving the right trees and protecting them from damage can maintain greenery and minimise subsequent costs for the rehabilitation of a tree or its ultimate removal.

1.3 The 'Guidelines on Tree Preservation during Development' (the Guidelines) provides general reference for preserving trees which are subject to construction activities. It offers guidelines on proper practice for managing trees throughout different stages of the development. The objectives of the Guidelines are to identify the suitable trees for preservation, suggest appropriate tree preservation measures and integrate tree management with development activities in a sustainable manner. The Guidelines are relevant to those who are involved in the planning, design, management and supervision in different aspects of a project sharing the common concern on tree preservation.

1.4 The Guidelines should be read in conjunction with the prevailing circular(s) and relevant document(s), e.g. 'Tree Preservation' (Development Bureau Technical Circular (Works) No. 10/2013)[1], Contract Provisions for Preservation of Existing Trees (with or without Old and Valuable Trees)[2] Guidelines on Tree Transplanting[3] and other tree protection practices during construction promulgated by the Greening, Landscape and Tree Management

[1] Source: http://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/327/1/C-2013-10-0-1.pdf
[2] Source: http://devb.host.ccgo.hksarg/en/tree_preservation/PPET_Content_Frame.html and http://devb.host.ccgo.hksarg/en/tree_preservation/PPETwOVT_Content_Frame.html
[3] Source: http://www.trees.gov.hk/filemanager/content/attachments/Guidelines_on_Tree_Transplanting.pdf

Section of the Development Bureau which are available from the trees website at www.trees.gov.hk.

2. Background and guiding principles of tree preservation

2.1. The goal of tree preservation in a development project is to identify and preserve trees with good health, structure and form, while felling trees which are of poor health or structure, or unable to survive effects of construction and have major conflict with the designated use of the site.

2.2. Development activities can affect the health, growth and stability of trees. If the extent of change is too great, trees become weakened and may die. Likewise, their ability to acclimate to new site conditions and tolerate environmental stress declines with age/health condition. Young and healthy trees are in general more resilient to changes whereas old and mature trees or individual trees of poor health are more sensitive to stress. It is for this reason that retention of old trees during development requires special attention and a programme of long term care.

2.3. For a tree to be preserved and protected on site, due consideration should be given to provide adequate space for the function and growth of its root and canopy.

2.4. All parts of a tree can be damaged by construction. A tree that has taken many years to reach maturity can be damaged or killed by unwitting or negligent actions. Trees damaged during construction may take years to exhibit symptoms and eventually need to be treated or removed, often at great expense.

2.5. Successful tree preservation occurs when the goals of the project are achieved with minimal impact to trees designated for preservation (Matheny and Clark, 1998) and should adhere to several important principles.

2.5.1. Successful tree preservation requires the commitment and involvement of all parties involved in the project in different phases; and effective communication on tree preservation among team members is essential.

2.5.2. Members of the project team should be familiar with the rudimentary aspects of tree growth and development and understand the relationships between tree survival and construction practices. Tree specialists/arborists should be involved early to give advice on survey and tree assessment, preservation measures and on site monitoring etc.

2.5.3. Trees preservation begins in early planning stage and develops through design, construction and maintenance phases. A decision to preserve and remove specific trees should be discussed and determined at the same time when site layout and grading etc. are considered.

2.5.4. Trees differ in their ability to tolerate changes which are often constrained by the species, age, structure and vigor, both on the basis of their intrinsic characteristics and their response to potential construction impacts. Tree preservation[4] is a thoughtful process of selecting suitable trees for protection and felling trees that cannot, or should not, be preserved. Evaluation of suitability of individual trees for preservation is an important task. Trees that are to be preserved must be carefully selected in order to make sure that they will survive the construction impacts, adapt to a new environment and perform well in the new landscape. Trees that are poor in health or structure or unable to survive construction impacts are not suitable for preservation.

2.5.5. The focus of tree preservation during development is on prevention of damage as there are few remedial treatments and the ability of a tree to recover from all construction injuries is generally limited. Injury should be avoided during all stages of development in particular as construction impacts are cumulative.

[4] Factors to be considered on tree assessment for tree preservation, transplanting and felling can be referred to the Development Bureau Technical Circular (Works) No. 10/2013 'Tree Preservation' vide
http://www.devb.gov.hk/filemanager/technicalcirculars/en/upload/327/1/C-2013-10-0-1.pdf

2.5.6. Information from the field survey is crucial to determine the construction plans and activities and to facilitate a decision on the siting of the development with its likely impacts on trees. Information therefore should be accurate for the successful tree preservation.

2.5.7. Trees require sufficient space for the growth of canopy and root systems. Adequate space should be allowed to minimise the impacts from construction, and to ensure the healthy growth of a tree over time.

2.6. The major causes of injury, which are by no means exhaustive, are:

- Root cutting or damage – due to excavation or trenching; as over 90% of the roots are located at the top 1m of soil, working around trees can easily cut roots;

- Soil compaction – results in less root growth or reduced aeration with long term implications;

- Grade changes – lowering of level leads to root removal while raising of level leads to root suffocation;

- Mechanical injury to trunk, roots and crown – injury to conductive and protective tissues, i.e. bark, phloem, cambium and xylem, reduces the capacity of trees to transport water, nutrients and carbohydrates. Injury also leads to invasion/infection of pathogens.

3. Process

3.1. During the various stages of construction, the following key points related to tree preservation should be noted.

3.2. Planning

3.2.1. This stage involves the initial site evaluation where the land, tree and building needs are all evaluated and defined. Trees immediately adjacent to the site that will be impacted by the construction or may affect the construction activity should also be included. Information collected is to facilitate a decision to establish the relative importance of the existing trees on a construction site which should be preserved and protected or removed. Due consideration should also be taken to avoid causing damage to trees during the site evaluation work.

3.3. Design

3.3.1. During the design phase, the project team sites the building and supporting infrastructure appropriately. Trees covered in the survey are assessed and determined on how they can be incorporated into the development or to be transplanted or felled.

3.3.2. The trees' location relative to the structures should be considered so that the trees have sufficient space to grow and are adequately protected during construction. It is also important that the project team should incorporate the design considerations on the future use of the areas within and/or the TPZ in relation to the future and proper growth of the preserved trees in the vicinity. Inappropriate design for the future use of the areas may have long term implications on the micro-climate and the growth environment of the trees.

3.3.3. The following should be considered for trees to be preserved.

- Tree protection zone (TPZ)

  TPZ is considered as the minimum area around a tree deemed to contain sufficient roots and rooting volume to maintain the tree's viability, and where the protection of the roots and soil structure is treated as a priority. Methods generally used include

  - the 'Dripline method', i.e. the tree canopy dripline is used to define the boundary of the TPZ and the entire area within the dripline is considered the TPZ;

  - the 'Tree height method', i.e. the circular area with the radius equal to the height of the tree; and

  - the 'Trunk diameter method', i.e. multiply the trunk diameter at 1.4 m by 6 to 18 to determine the radius of the TPZ, etc. (Fite and Smiley, 2008)

  Under general circumstances in Hong Kong, the 'Dripline method' is adopted. However, for narrow canopied trees, the 'Tree height method' would be appropriate. The 'Trunk diameter' method would be suitable for trees which are leaning or of irregular conformation.

  A bigger TPZ is usually preferred. The tolerance level of a tree may depend on tree species, age/size, health/vigor, site conditions etc. and further deliberation on factors on a case by case basis would be necessary.

  There is a need to consider factors such as site conditions, technical issues and cost effectiveness etc. to work out a balanced arrangement. There are situations in which the designation of TPZ at dripline may not be practicable, e.g. a slope with dense vegetation cover, roadside verge or trees grown on the stonewall[5]. The advice from the tree

[5] For details about the protection of stonewall trees during construction, please refer to the Management Guidelines for Stonewall Trees vide http://www.trees.gov.hk/filemanager/content/attachments/Guilelines_for_stone_wall_trees.pdf

specialist/arborist has to be sought on adequate tree protective measures and design.

A TPZ will ensure that a tree is protected during development, has enough space for root and branch growth, and will receive adequate supplies of soil nutrients, air and water. It is also a specified area around, above and below ground and at a given distance from the trunk set aside for the protection of the root system and the crown of a tree at where it is potentially subject to damage by development.

The TPZ should be protected from construction disturbances. No grading, excavation or construction activity is to be allowed save with special consideration and approval given. Where appropriate, a cross-section showing the proposed architectural and engineering features around trees proposed to be retained should be provided to show that sufficient vertical and horizontal space can be reserved for TPZs.

- Tree protection fences

TPZ must be surrounded by strong fences sturdy enough to withstand impacts from the construction activities including vehicles and machinery at the beginning of contract including site investigation works before the construction on site. The fences should be rigid and complete and its foundation should avoid contact with the structural roots. Weak fencing such as nylon netting is not appropriate for protecting trees.

At where the erection of protective fencing is not practicable or the preserved tree grows on a retaining structure, alternative tree protective measures such as temporary protective plank armouring should be considered. If necessary, coverings should be laid on top of the temporary protective mulching to provide additional protection from soil compaction due to passage of vehicles, equipment or machinery.

Warning signs and notices are to be installed at the fences denoting the 'tree protection zone' to prohibit the entry of equipment or construction activities.

Photo 1

A tree should be protected by strong protective fence at the TPZ wherein construction activities are not allowed

Photo 2

A tree without protective fence will be vulnerable to damage caused by construction activities

- Tree preservation plan (TPP)

  Information on TPZ and the location, size and conditions of trees from the tree survey reports should be clearly shown and included in a TPP as part of the contract documents.

  The TPZ should be superimposed on a layout plan showing the spatial relationships between trees and the development. The TPZ should not be interfered by uses such as storage, parking area or vehicular/pedestrian access. The TPP should clearly indicate the location of protective fence to be erected around the preserved trees. The extent and type of ground protection or other measures to protect the roots from compaction should also be indicated.

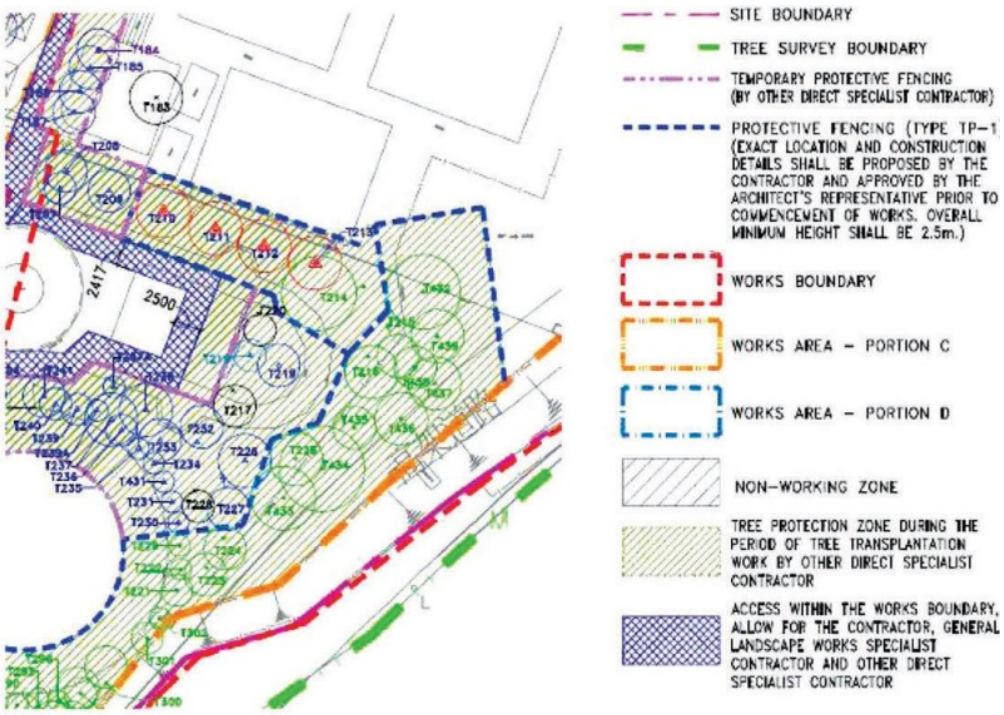

Figure 1
Tree Preservation Plan (TPP) is a part of the contract drawings: with levels, TPZ, protective fence, circulation routes indicated[6].

[6] Source: Proper Planting Practice – Design for Tree Protection Zone
http://www.greening.gov.hk/en/preservation/new/designForTreeProtectiveZone_b.jpg

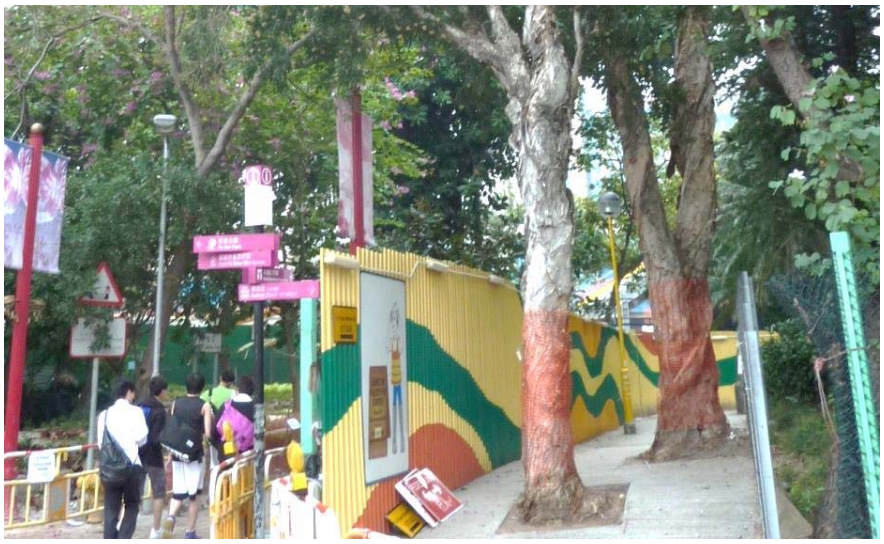

Photo 3
A tree adjacent to the construction area is properly fenced off and protected by strong fences

- Soil compaction controls and storage areas

  Major causes of soil compaction are due to vehicular movements and the storage of heavy machinery/equipment/materials near a preserved tree.

  Soil compaction decreases soil permeability and interferes with essential gas exchange processes and percolation, and impairs drainage. Besides, the fine, absorbing roots concentrated in the upper centimeters of soil can easily be damaged or killed by heavy construction equipment travelling across or grading the site.

Photo 4

Heavy vehicles or equipment stationed in the vicinity of a preserved tree not only cause damage to the tree but also add weight to the soil causing compaction

Mechanical damage of tree trunk or surface roots or spillage of chemicals can cause irreparable damage. It is important to prevent soil compaction by diverting traffic routes and designating storage areas away from trees. Spreading a layer of woodchips on soil surface can also reduce compaction. The designation of TPZ and installation of strong protective fence can effectively prevent damage from compaction and storage.

Photo 5 and Photo 6
Areas in the vicinity of a preserved tree should be free from storage and dumping

- Existing and proposed utilities alignment

  Both existing and new trenches and overhead wires for utilities should be identified and marked on the plan.

  Trenching or excavation near a tree can cause substantial root damage or root loss and should be avoided as far as possible. Depending on the extent, cutting of roots will affect the absorption and anchorage of the tree, which may lead to decline of tree vigor or even tree collapse.

- Grade change

  In term of grade change, consideration on tree preservation should be given either to build "tree island" or "tree well" to encompass an area extending at least to the TPZ[7]. [Figures 2, 3 and 4]

[7] Source: Case Study: Tree Preservation and Level Change vide http://devb.host.ccgo.hksarg/en/tree_preservation/Lesson_Learnt_Sau_Ming_Road_Bombax_change_in_soil_level.pdf

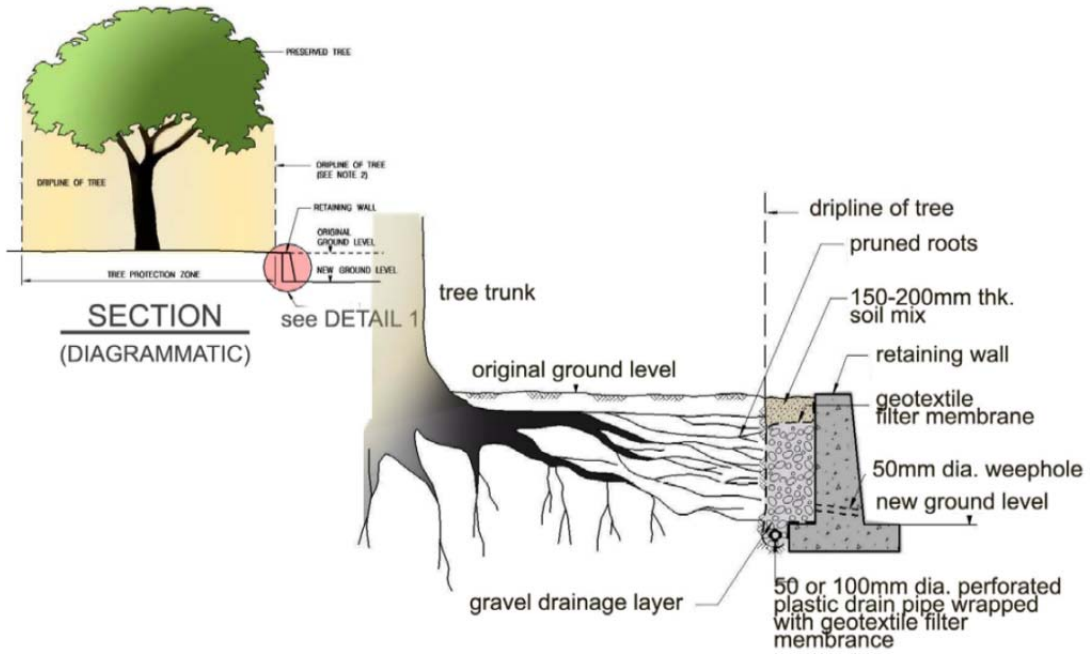

Figure 2

Construction of tree island for lowering of soil level

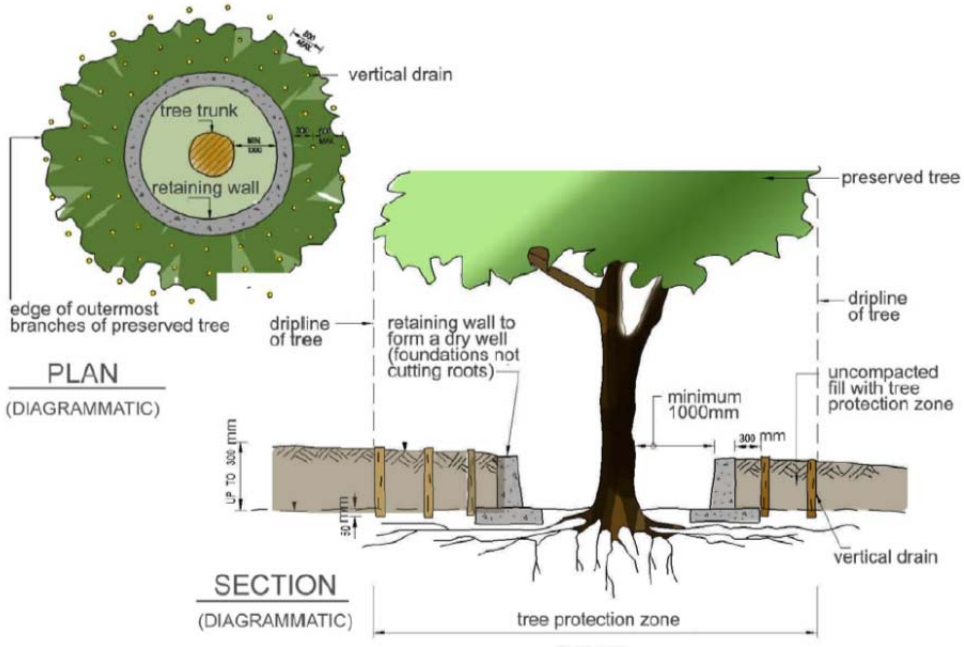

Figure 3

Construction of tree well for increasing soil level (minor to moderate rise up to 300mm)

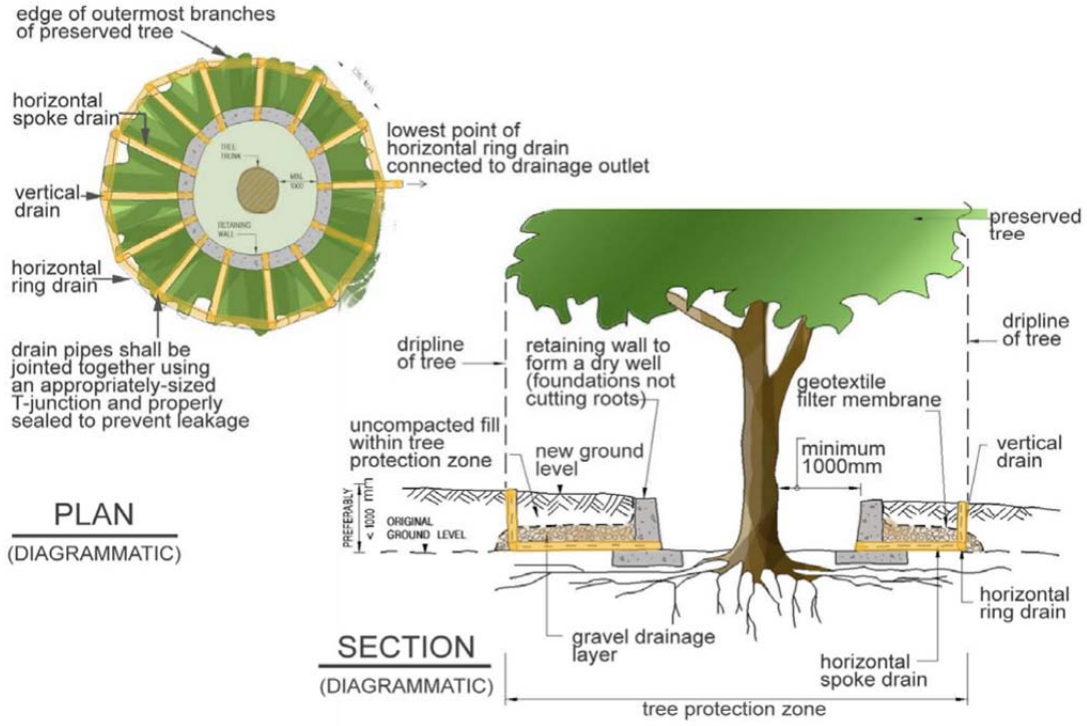

Figure 4
Construction of tree well for increasing soil level (major rise >300mm)

- Other on-site activities

  - Consideration should also be given to properly irrigate the trees and to spray water to remove the accumulated construction dust during dry season in order to lessen the chances of decline and to maintain the vigor of trees.

  - Potential change in local hydrology due to site changes should be considered and prevented as far as possible.

3.4. Construction

3.4.1. The construction phase is when most activities occur on a project site. It starts with site investigation, then site preparation and ends when building and landscaping are finished.

3.4.2. Site inspections are needed to maintain the integrity of the TPZ. The purpose is to verify that all tree protection measures are in place, followed and observed during the construction works.

3.4.3. Trees should be inspected on a regular basis to watch for signs of stresses, such as dieback, leaf loss, or general decline in tree health or appearance and to look for and prevent tree damage with symptoms of construction injury. Photographic records are necessary in order to keep track of the tree condition.

3.4.4. During construction, trees can be damaged by soil compaction, pollution from effluent water, machine petroleum or chemical spillage, grade changes, root crushing and pruning, damage to the bark, improper pruning of branches, incorrect storage of construction machinery/materials, and dumping of construction wastes (Elmendorf, Gerhold, & Kuhns, 2005). Common types and symptoms of construction injury are suggested at Tables 1 and 2[8] below.

Table 1
Types of construction injury

- Soil compaction or pollution
- Root removal and wounds
- Disruption of mycorrhizae and other beneficial soil organisms
- Trunk and butt wounds
- Branch wounds
- Leaf injury
- Unwarranted tree removal

Table 2: Symptoms of construction injury (Soil destruction)

- Reduced canopy density
- Reduced leaf size
- Lighter green colour of the foliage
- Branch/canopy dieback
- Development of early fall colour or leaf drop
- Suckers or epicormic shoots from damaged roots
- Long term decline in health

3.4.5. Landscape installations, e.g. irrigation or lighting installation are a common cause of tree root damage. Monitoring of these activities is essential.

[8] Source: Elmendorf, Gerhold, & Kuhns, 2005

- Appropriate measures on proper tree care should be in place which include corrective pruning when trees exhibit signs of stresses.

- Temporary trunk or branch protection is sometimes required. Warning signs are also required if branches are spanning across the TPZ to reach the vehicular passage.

Photo 7
Appropriate sign is required to indicate the spanning of tree branches which require special attention

3.4.6. Monitoring and moderating the construction activities is essential for the success of the project. Site meetings and reporting are necessary in order to keep all parties in the construction team informed about tree related activities and to reinforce the importance of tree protection activities. Any foreseeable damage should be reported through the prescribed chain of command and corrected as soon as possible.

Table 3

Do and Don't[9]

● Do install strong protective fencing at the TPZ before construction on site ● Designate specific sites for equipment/disposal of debris ● Do appoint qualified and trained personnel for works and monitoring ● Designate vehicular/foot paths and storage areas away from TPZ ● Do monitor the tree conditions and report on anomalies	● Don't girdle a tree with wire ● Don't nail anything into a tree ● Don't stockpile around a tree ● Don't undertake works within the TPZ ● Don't top a tree ● Don't use trees as anchor ● Don't work with machines near a tree ● Don't cut, trench, excavate/raise soil level within TPZ ● Don't pollute the soil ● Don't allow traffic over root system ● Don't sever main roots near the trunk

3.4.7. Level of compliance and condition of the trees should be well monitored. In the event of damage to fence or trees, the damage should be properly reported and rectified quickly.

[9] Source: Tree Care during Construction at http://www.trees.gov.hk/filemanager/content/attachments/Tree_Care_during_Construction.pdf

3.5. Post-construction

3.5.1. The post-construction phase begins when the construction and landscape installation have finished.

3.5.2. Tree health and structure should be thoroughly evaluated again to determine if any changes have occurred during the construction process. If there is any observed deterioration of tree health and/or structure, remedial treatments should be recommended and implemented. The findings of inspections and evaluations should be included in a management plan for the maintenance party.

3.5.3. Once construction is complete, the TPZ fencing may be removed, but monitoring by the tree specialist/arborist should continue. Monitoring should include managing soil moisture, maintaining mulch, assessing tree damage, and inspecting for insect pests and disease pathogens. Treatments should be prescribed when problems are detected. Trees known to be hazardous should be felled in order to reduce long term management, liability and risk elements.

3.5.4. It is important that all construction materials, such as hoardings, barriers, tree labels, etc., should be removed before a construction project is considered to be satisfactorily completed. Arrangement on handing over of the facilities and the trees between the project proponent department and the department responsible for the subsequent maintenance should be arranged. All defects or irregularities to be followed up after the handing over and during the defect liability period should be properly recorded.

4. Treatment of trees damaged during development

4.1. Despite the best intentions and most stringent tree protection measures, trees may still be injured during construction. Construction damage can be permanent and often irreversible. There are few remedial treatments to improve injured trees.

4.2. Some trees decline slowly over years while others may die instantly. During construction, trees can be damaged by causes such as soil compaction, water/petroleum pollution, grade changes, root crushing and pruning, damage to the bark, improper pruning of branches, incorrect storage of construction machine/equipment/materials, and dumping of construction wastes. The following maintenance care should be taken into consideration.

- Branches that are split, broken, diseased or dead should be removed.

- If branches or tree trunks need additional support, evaluate the benefits of installing cables or other means of supports. Likewise, in case if there are damage of the tree roots and the tree structure is likely to be affected, appropriate means of support is required.

- Adequate but not excessive irrigation can help the trees to recover from stresses. A long, slow soak over the entire root zone is preferred than frequent and shallow watering.

- Mulch covering the root system can enhance root growth, moderate soil temperatures, maintain moisture and reduce competition from weeds and grass.

- Traditional wound dressings, once thought to accelerate wound closure and reduce decay, are not substantiated by research[10]. They are primarily used for cosmetic purposes and are neither required nor recommended in most cases.

[10] There are researches on trial use of biological control agents as wound dressing material for fungal decay control but no conclusive findings have been published as of to date.

- If a wound is found on the tree trunk, carefully cut the loose bark to form a clean, smooth surface of healthy wood and bark. Take care not to damage healthy tissue and do not widen the wound more than necessary. Jagged edges can be cut away carefully with a sharp knife, taking care not to cut into the living tissues.

- Fertilization is usually not necessary. It should only be applied after laboratory tests of soil samples to understand the deficiency.

- Applying herbicides/fungicides/insecticides only if it is necessary and appropriate for the purpose.

- Soil compaction and grade increases deplete the oxygen supply to tree roots. To improve soil aeration, vertical mulching[11] and radial trenching[12] are techniques used to improve conditions for root growth. Use of air excavator has proven effective for soil aeration and radial trenching.

Photo 8
Vertical mulching can improve soil aeration and root growth

[11] Vertical mulching involves making holes in the ground with a drill or an air tool and the holes may be filled with organic material such as compost or other materials to improve aeration.

[12] Radial trenching is made in a radial pattern throughout the root zone and should extend at least as far as the dripline. The trenches are backfilled with native soil and compost and sometimes other amendments are added.

- Soil that has been polluted should be removed and replaced, where feasible/appropriate. Polluted soil near trees should be removed carefully as far as practicable with hand tools to avoid further damage to roots. Quality soil mix can be applied to improve nutrient deficiency due to the prolonged period of construction activities.

References

American National Standards Institute (2012). *ANSI A300 (part 5)-2012, for Tree Care Operations – Tree, Shrub, and Other Woody Plant Management – Standard Practices (Management of Trees and Shrubs During Site Planning, Site Development, and Construction)*. Tree Care Industry Association, Inc.

Architectural Services Department (2012). *General Specification for Building.* Architectural Services Department, the Government of the Hong Kong Special Administrative Region.

British Standard Institute (2012). *BS 5837:2012 Trees in relation to design, demolition and construction – Recommendations*. British Standard Institution.

City of Toronto. (2013). *Tree Protection Policy and Specifications for Construction near Trees*. Retrieved 11 May, 2014 from http://www1.toronto.ca/city_of_toronto/parks_forestry__recreation/urban_forestry/files/pdf/TreeProtSpecs.pdf

Civil Engineering and Development Department (2006). *General Specification for Civil Engineering Works – Section 26, Preservation and Protection of Trees.* The Government of the Hong Kong Special Administrative Region

Dennis, C. & Jacobi, W. R. (2014). *Protecting Trees During Construction*. Retrieved 12 May, 2014 from the Colorado State University vide http://www.ext.colostate.edu/pubs/garden/07420.html

Development Bureau. (2010). *Proper Planting Practice – Design for Tree Protection Zone.* The Government of the Hong Kong Special Administrative Region.

Development Bureau. (2013). *Technical Circular (Works) No. 10/2013 – Tree Preservation.* The Government of the Hong Kong Special Administrative Region.

Elmendorf, W., Gerhold, H., & Kuhns, L. (2005). *A Guide to Preserving Trees in*

Development Projects. Retrieved 8 May, 2014 from The Pennsylvania State University vide http://pubs.cas.psu.edu/freepubs/pdfs/uh122.pdf

Fite, K. & Smiley, E.T. (2008). *Best Management Practices – Managing Trees During Construction*. Champaign, IL: International Society of Arboriculture.

Harris, R., Clark, J & Matheny, N. (2004). *Arboriculture – Integrated Management of Landscape Trees, Shrubs, and Vines*. Pearson Education Inc.

Housing Department. (2005). *Landscape Procedural Guide – Tree Preservation.* The Government of the Hong Kong Special Administrative Region.

Lilly, S.J. (2010). *Arborists' Certification Study Guide.* Champaign, IL: International Society of Arboriculture.

Matheny, N. & Clark, J. R. (1998). *Trees and Development – A technical Guide to Preservation of Trees During Land Development*. Champaign, IL: International Society of Arboriculture.

Roberts, J., Jackson, N., & Smith, M. (2006). *Tree Roots in the Built Environment*. London: TSO (The Stationary Office)

Standard Australian (2009). *AS 4970 -009*, *Protection of trees on development sites.* Standards Australia.

Watson, G. W., & Neely, D. (1995). *Trees and Building Sites*. Champaign, IL: International Society of Arboriculture.