ARBOR ANALYTICS AUSTRALIA
ASSESSMENT RATIONALE, METHODOLOGY & GLOSSARY

RISK ASSESSMENT MATRIX - RATIONALE

AGE	
Young	20% of life expectancy
Mature	20-80% of life expectancy
Over Mature	Over 80% of life expectancy
HEALTH STATUS	
Good	Typical vigor and vitality for the species judged on shoot elongation, colour and density of foliage, incremental growth of would-wood etc.
Fair	Just below average vigor and vitality
Poor	Obvious signs of decline in tree health, well below average vigor and vitality.
Dead	Tree shows no indication of life.
RETENTION VALUE: *Preservation is focused on high quality trees with good tolerance for impact during construction. The goal of tree preservation is to have trees remain assets to the site for years to come. The following tree characteristics are sought after when evaluation a tree with a high retention value:*	
Tree Health	Trees displaying good health and high vigor are better able to withstand the impact and stresses associated with construction e.g. Root injury, pruning, changes to soil density and moisture levels.
Tree Structure	Trees with poor structure (co-dominant stems, poorly attached limbs, poor taper, decay/cavity etc.) are inherently predisposed to failure. Only trees with good structure or redeemable structural defects should be considered for retention near high target areas such as dwellings.
Species	Species characteristics such as tolerance to disturbance, origin, rarity and propensity to become weeks are important components on any decision regarding retention.
Age/Potential Longevity	The goal of tree preservation is to have trees remain assets to the site for years to come. Short lived species or over-mature trees at the end of their mature life span, do not make good candidates for retention.
Landscape Impact	Is the tree a major asset and contributing to the aesthetic of the surrounding area?
Location Onsite	A critical factor especially on small residential developments.
Structural Condition	
Good	No obvious defects which would indicate predicable failure points. Species is of value, tree location is good
Fair	Moderate levels of defects in structure noted. These defects would be able to be managed through pruning, bracing etc. Species is of some value, tree is in a fair position.
Poor	Severe structural defects noted. Generally trees rates as having poor structures have unmanageable defects and may need to be removed or have their target areas modified, tree may also be a poor species choice for the area or weed species.

RISK ASSESSMENT MATRIX – RISK RATING

Evaluation of risk was calculated using the "Bartlett Method" (Smiley, ET, Fraedrich, BR, Hendrickson, N (2002) Tree Risk Management, Charlotte NC, Bartlett Tree Research Laboratories) – a recognized published method. Each tree receives a score out of 15 as the result of multiple site and tree factors being assessed. The risk rating method is basic and capable of being sued in large-scale tree data-capture situations. The arborist makes an estimate of tree failure potential and the consequences of failure, including the frequency of occupation of a site based on their experience. Limitation are that the method is not based on quantitative data and is very simple -as such, it should be used as a guide only.

Total Risk Score is derived by the addition of two criteria:

FAILURE POTENTIAL/DEFECT SEVERITY (F)	
Critical Risk – Failure imminent	10
High Risk – Failure likely especially in storms	7
Moderate Risk – Failure possible especially in severe storms	4
Low Risk – Failure unlikely	1
CONSEQUENCE OF FAILURE (C) – *considers potential for injury/loss should a failure occur based on such factors as size of defective part, target value and frequency of use*	
Severe Consequence	5
Moderate Consequence	3
Low Consequence	1
TOTAL RISK RATING (= F + C)	
Critical Risk: Failure imminent; personal injury and/or property damage inevitable (lower end of scale indicates lower potential for injury)	13-15
High Risk: Failure likely especially during storms; personal injury and/or property damage likely (lower end of scale indicates lower potential for injury/property damage)	10-12
Moderate Risk: Failure unlikely, and/or high risk of failure but low risk of property damage/personal injury	7-9
Low Risk: Failure unlikely and low risk of property damage/personal injury	<7

SAFE & USEFUL LIFE EXPECTANCY (SULE) RATINGS

Rating	Sub-Rating	Description
1	**LONG SULE -Retainable for more than 40 years with an acceptable level of risk**	
	A	Structurally sound trees which are located in positions that can accommodate future growth
	B	Storm damaged or defective trees which could be made suitable for retention in the long term by remedial surgery
	C	Trees of special significance for historical, commemorative or rarity reasons which would warrant extraordinary efforts to secure long term retention
2	**MEDIUM SULE – Retainable for 15-40 years with an acceptable level of risk**	
	A	Trees which may only live between 15-40 more years
	B	Trees which may live for more than 40 years but would be removed during the course of normal management for safety or nuisance reasons
	C	Trees which may live for more than 40 years but would be removed to allow the safe development of more suitable individuals
	D	Storm damaged or defective trees which can be made suitable for retention in the medium term by remedial work
3	**SHORT SULE – Trees that appeared to be retainable at the time of assessment for 5-15 years with an acceptable level of risk**	
	A	Trees which may only live between 5-15 years
	B	Trees which may only live for more than 15 years but would be removed during the course of normal management for safety or nuisance reasons
	C	Trees which may live for more than 15 years but would be removed to allow the safe development of more suitable individuals
	D	Storm damaged or defective trees which require substantial remedial work to make safe and are only suitable for retention in the short term
4	**REMOVE – Trees that should be removed within the next 5 years**	
	A	Dead trees
	B	Dying or suppressed or declining trees through disease or inhospitable conditions
	C	Dangerous trees through instability or recent loss of adjacent trees
	D	Dangerous trees with defects including cavities, decay, included bark, wounds or poor form
	E	Damaged trees which are considered unsafe to retain
	F	Trees which will become dangerous after removal of other trees for the reasons in (A) to (E)
	G	Weed Trees
	H	Trees causing or about to cause damage to structures
5	**YOUNG OR SMALL TREES**	
	A	Trees which are less than 5 metres in height
	B	Trees which are over 5 metres in height but less than 15 years old
	C	Trees which have been regularly pruned to artificially control growth
	D	Trees or Palms that can be transplanted easily

TREE PROTECTION ZONES

Introduction

In order to sustain trees on a development site, consideration must be given to the establishment of tree protection zones. The physical dimensions of tree protection zones can sometimes be difficult to define. The projection of a tree's crown can provide a guide but is by no means the definitive measure. The unpredictable nature of roots and their growth, differences between species and their tolerances, observable and hidden changes to the trees growing environment as a result of development, are variables that must be considered. Most vigorous, broad canopied trees survive well if the area within the drip-line of the canopy is protected. Fine root density is usually greater beneath the canopy than beyond. If few to no roots over 3cm in diameter are encountered and severed during excavation the tree will probably tolerate the impact and root loss. A healthy tree can sustain a loss of between 30% and 50% of absorbing roots (Harris, Clark, Matheny, 1999), however encroachment into the structural root system of a tree may be problematic.
The structural root system of a tree is responsible for ensuring the stability of the entire tree structure in the ground. A tree could not sustain loss of the structural root system and be expected to survive let alone stand up to average annual wind loss upon the crown.

Allocation of tree protection zone (TPZ)

The most important consideration for the successful retention of trees is to allow appropriate above and below ground space for the trees to continue to grow. This requires the allocation of tree protection zones for retained trees. The method of allocating a TPZ to a particular tree will be influenced by site factors, the tree species, its age and developed form. Once it has been established, through an arboriculture assessment, which trees and tree groups are to be retained, the next step will require careful management through the development process to minimize any impacts on the designated trees. The successful retention of trees on any particular site will require the commitment and understanding of all parties involved in the development process. The most important activity, after determining the trees that will be retained is the implementation of a TPZ.

The intention of tree protection zones is to:

- Mitigate tree hazards;
- Provide adequate root space to sustain the health and aesthetics of the tree into the future;
- Minimize changes to the trees growing environment, which is particularly important for mature specimens;
- Minimize physical damage to the root system, canopy and trunk; and
- Define the physical alignment of the tree protection fencing.

The Australian Standard AS 4970-2009 Protection of trees on development sites has been used as a guide in the allocation of TPZs for the assessment of trees. The TPZ for individual trees is calculated based on trunk (stem) diameter (DBH), measured at 1.4 meters up from ground level. The radius of the TPZ is calculated by multiplying the trees DBH by 12. The method provides a TPZ that addresses both the stability and growing requirements of a tree. TPZ distances are measured as a radius from the centre of the trunk at (or near) ground level. The minimum TPZ should be no less than 2m and the maximum no more than 15m radius. The TPZ of palms should be no less than 1.0m outside the crown projection.

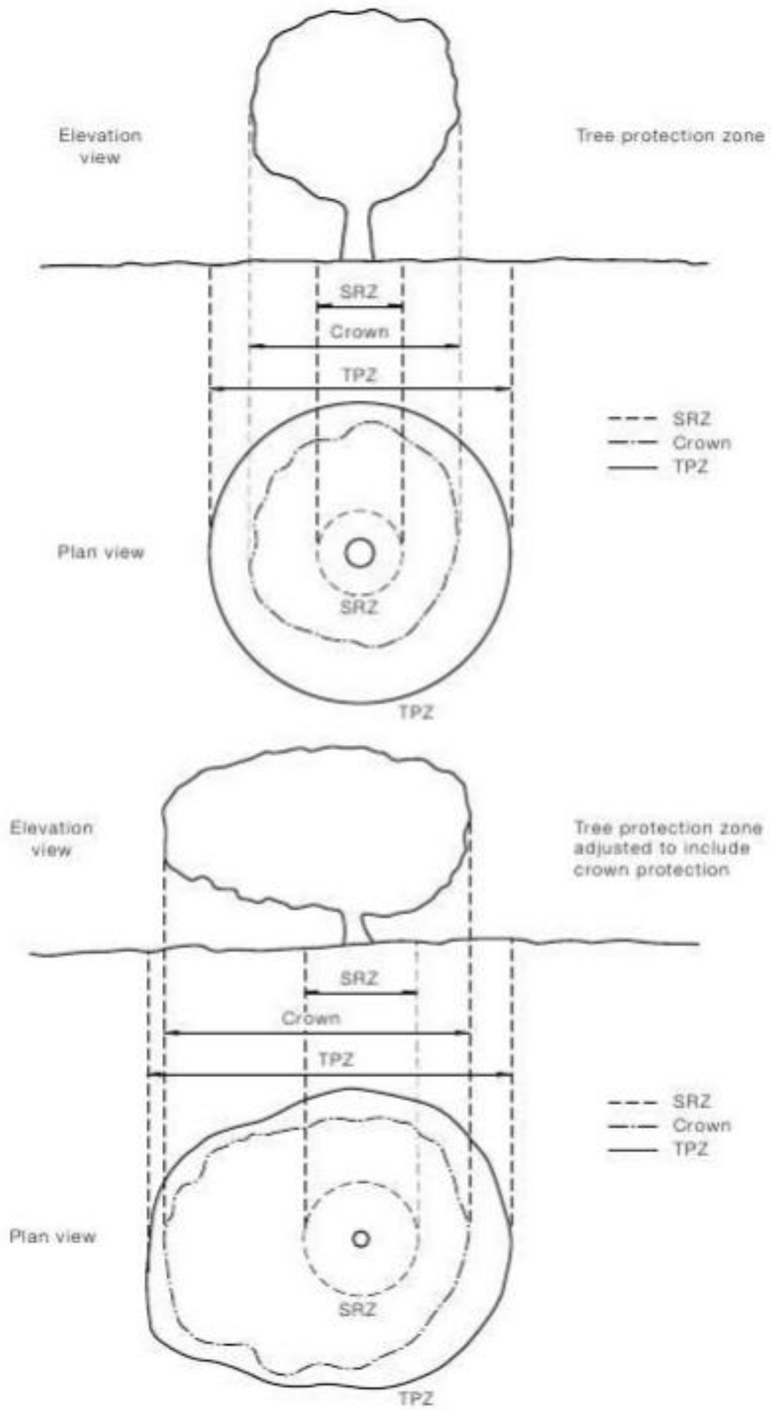


Diagram 1: Indicative Tree Protection Zone

Encroachment into the TPZ is permissible under certain circumstances though is dependent on both site conditions and tree characteristics. Minor encroachment, up to 10% of the TPZ, is generally permissible provided encroachment is compensated for by recruitment of an equal area contiguous with the TPZ. Examples are provided in Diagram 2. Encroachment greater than 10% is considered major encroachment under AS4970-2009 and is only permissible if it can be demonstrated that after such encroachment the tree would remain viable.

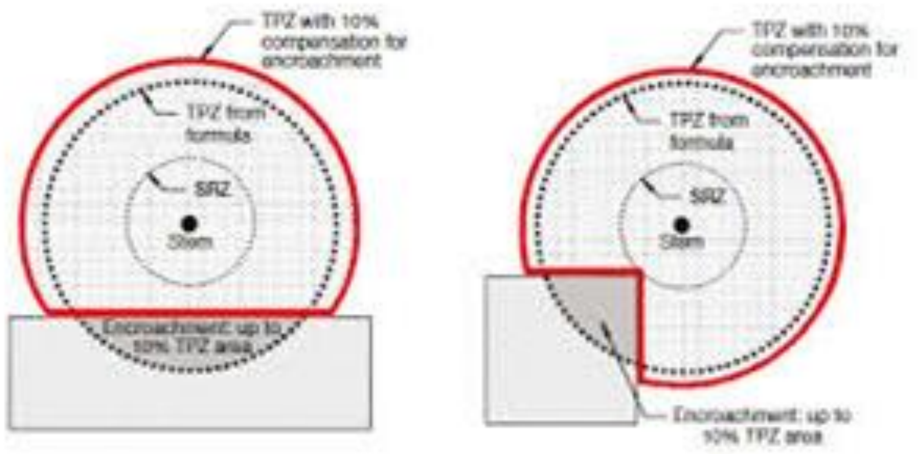


Diagram 2: Examples of minor encroachment into a TPZ (Extract from AS4970-2209 Appendix D p30)

The 10% encroachment on one side equates to approximately 1/3 radial distance. Tree root growth is opportunistic and occurs where the essentials to life (primarily air and water) are present. Heterogeneous soil conditions, existing barriers, hard surfaces and buildings may have inhibited the development of a symmetrically radiating root system.

Existing infrastructure around some trees may be within the TPZ or root plate radius. The roots of some trees may have grown in response to the site conditions and therefore if existing hard surfaces and building alignments are utilised in new designs the impacts of the trees should be minimal. The most reliable way to estimate root disturbance is to find out where the roots are in relation to the demolition, excavation or construction works that will take place (Matheny & Clark, 1998). Exploratory excavation prior to commencement of construction can help establish the extent of the root system and where it may be appropriate to excavate or build. The TPZ should also give consideration to the canopy and overall form of the tree. If the canopy requires severe pruning in order to accommodate a building or other works and in the process the form of the tree is diminished it may be worthwhile considering altering the design or removing the tree.

General tree protection guidelines

The most important factors are:

- Prior to construction works the trees nominated for tree works should be pruned to remover lager dead wood. Pruning works may also identify other tree hazards that require remedial works.
- Installation of tree protection fencing. Once the tree protection zones have been determined the next step is to mulch the zone with woodchip and erect tree protection fencing. This must be completed prior to any materials being brought on-site, erection of temporary site facilities or demolition/earth works. The protection fencing must be sturdy.
- Appropriate signage is to be fixed to the fencing to alert people as to the importance of the tree protection zone.
- The importance of tree preservation must be communicated to all relevant parties involved with the site.
- Inspection of trees during excavation works.

Exploratory excavation

The most reliable way to estimate root disturbance is to find out where the roots are in relation to the demolition, excavation or construction works that will take place (Matheny & Clark, 1998).

Exploratory excavation prior to commencement of construction can help establish the extent of the root system and where it may be appropriate to excavate or build. This also allows management decisions to be made and allows time for resign works if required.

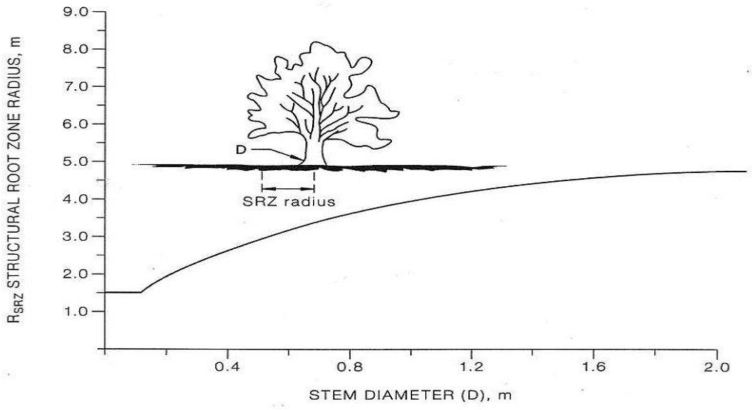
Any exploratory excavation within the allocated TPZ is to be undertaken with due care of the roots. Minor exploration is possible with hand tools. More extensive exploration may require the use of high-pressure water or air excavation techniques. Either hydraulic or pneumatic excavation techniques will safely expose tree roots; both have specific benefits dependent on the situation and soil type. An arborist is to be consulted on which system is best suited for the site conditions.

Substantial roots are to be exposed and left intact. Once roots are exposed decisions can be made regarding the management of the tree. Decisions will be dependent on the tree species, its condition, its age, its relative tolerance to root loss and the amount of root system exposed and requiring pruning.

Other alternative measures to encroaching the TPZ may include boring or tunnelling.

How to determine the diameter of a substantial root

The size of a substantial root will vary according to the distance of the exposed root to the trunk of the tree. The further away from the trunk of a tree that a root is, the less significant the root is likely to be to the tree's health and stability. The determination of what is a substantial root is often difficult because of the form, depth and spread of roots will vary between species and sites. However, because small roots are connected to larger roots in a framework, there can be no doubt that if larger roots are severed, the smaller roots attached to them will die. Therefore, the larger the root, the more significant it may be. No root or soil disturbance is permitted with the SRZ.



The curve can be expressed by the following formula:
$R_{SRZ} = (D \times 50)^{0.42} \times 0.64$

NOTES:

1 R_{SRZ} is the structural root zone radius.
2 D is the stem diameter measured immediately above root buttress.
3 The SRZ for trees less than 0.15 m diameter is 1.5 m.
4 The SRZ formula and graph do not apply to palms, other monocots, cycads and tree ferns.
5 This does not apply to trees with an asymmetrical root plate.

Diagram 3: Structural Root Zone Radius *(Extract from AS4970-2209 page 13)*

In the area outside the SRZ the tree may tolerate the loss of one or a number of roots. Table 1 below indicates the size of tree roots, outside the SRZ that would be deemed substantial for various tree heights. The assessment of combined root loss within the TPZ would need to be undertaken by an arborist on an individual basis because the location of the tree, its condition and environment would need to be assessed.

Height of Tree	**Diameter of Root**
Less than 5m	≤ 30mm
Between 5m -10m	≤ 50mm
More than 20m	≤ 70mm

Table 1: Estimated significant root sizes outside SRZ

Ground buffering: Where works are required to be undertaken within the tree root zone, surface, ground buffering and trunk and limb protection must be provided to minimize the potential for the soil to become compacted and avoid potential for impact wounds to occur to surface roots, trunk or limbs.

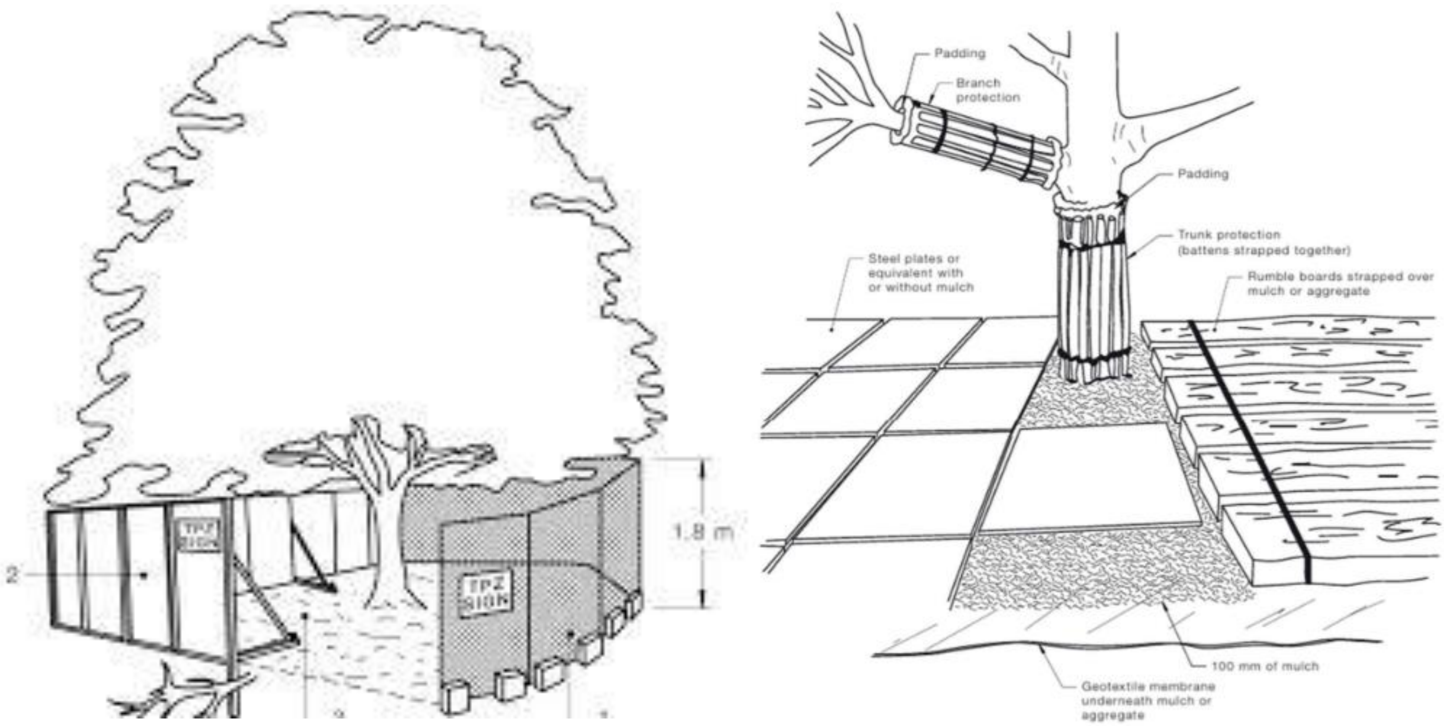


Diagram 3: Buffering: Examples of ground and trunk and limb protection (Extract from AS4970-2009 Appendix D, page 17)

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QUALIFICATIONS

- **Cert III Climbing Arborist AHC30816**
- **Cert V Diploma of Arboriculture AHC50510**
- **Cert V Diploma of Arboriculture AHC50516**

GLOSSARY

Branch attachment	The structural linkage between branch and stem
Branch collar	The area of raised tissue around a branch
Dead wood	Limbs or parts of limbs that are dying or dead, large enough to cause injury or damage to infrastructure or property when they fall, either over 25mm diameter and 900mm long or weighing in excess of 250grams
Decay	The process of degradation of woody tissues by fungi and bacteria through the decomposition of cellulose and lignin
DBH	Diameter at Breast Height. This is a standard industry measurement term
Eucalyptus .sp	The genus Eucalyptus is large and diverse with over 900 species. Eucalypts exhibit a great range of adaptations growth habits and characteristics to different environments. There have been many attempts to introduce different species as amenity trees throughout Australia with varying degrees of success. As such it is sometimes becomes difficult to accurately identify the various species. For the purpose of this report species that are difficult to identify will be classified as “Eucalyptus sp”
Epicormic shoot	A shoot that arises from latent or adventitious buds that occur on stems, branches or the bases of trees
Hazard	A hazard is anything with the potential to harm health, life or property
Inclusion	Where the bark grows inward at a branch attachment and there is a high likelihood of decay or poor strength to hold the branch in place
Infrastructure	Permanent manmade installations that could consist of footpaths, buildings, underground pipes or services
Lean	Departure of trunk from the vertical or near vertical position
Reaction wood	Specialized secondar xylem that develops in response to prolonged structural stresses
Risk	In the likelihood or probability that a hazard will cause damage to health, life or property
Target area	The area below a tree, usually within the drip zone
TPZ	Tree Protection Zone: combination of the root area and the crown area requiring protection – 12 x DBH + any need for crown protection
Vigor	Overall health; capacity to grow and resist physiological stress
VTA	Visual Tree Assessment: where a qualified Arborist will complete a detailed assessment of the tree
Windthrow	The forces of wind pushing a tree followed by upheaval of the root plate