Addendum to Targeted Arboricultural Assessment McPherson Precinct (PSP 1055) 75 McCormacks Rd Elm Tree

Prepared for: Metropolitan Planning Authority

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Consultant arborist

Tree Logic Ref: 14_6068

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Tree management for the urban forest

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Contents.

Ref: 75 Mc Cormacks Rd Elm Tree

Front cover Images
Left: View looking east towards subject tree
Top right: View of root zone with superficial impact wounds to surface roots apparent.
Bottom right: View looking north towards subject tree.

File No.	Version		Author	Issue date	Issued by.
14_6068	1	75 Mc Cormacks Rd Elm Tree	Bruce Callander	1/07/15	BC

Reason for Assessment:

Inspection of one tree located within 75 McCormacks Road, Clyde North.

- Determine the type and current health of the tree;
- Determine the tree's ability to survive in an urban environment within an urban park;
- Identify specific management implications associated with the retention and long-term health of the tree by spatial analysis (i.e. drip zones, root zones etc.);
- Management options in respect of potential new targets in the parkland setting.
- Prepare an addendum to the Targeted Arboricultural Report for the McPherson Precinct (PSP 1055) (TreeLogic, 19 January 2015) that outlines the findings and recommendations of the assessment. (See Appendix 1 of this Addendum for location of all sites assessed in McPherson Precinct)

General Overview:

The subject tree is a mature English Elm (*Ulmus procera*) located in open pasture at 75 McCormacks Road, Clyde North (Site 5 in Appendix 1 of this Addendum). The site is adjacent to the historic St Germains homestead and garden of Alexander Patterson, one of the early settlers of the area, located at 95 McCormacks Road. Tree controls apply to some large veteran trees in the historic gardens and it is likely that the subject tree is associated with the period when the subject site was part of the larger land holding of St Germains.

Tree assessment

Site inspection was undertaken during overcast conditions on Thursday June 4th, 2015.
The tree was inspected from the ground and observations were made of the growing environment and surrounding area. The tree was not climbed and no samples of the tree or site soil were taken.

Observations were made of the tree to determine age and condition, with measurements taken to establish tree height (measured with a height meter), crown width (paced) and trunk diameter (measured at 1.4m above grade unless otherwise stated). Definitions of arboricultural descriptors can be seen in Appendix 2 of this Addendum.

The location of the tree was plotted using a GPS assisted field computer using high resolution aerial imagery and GIS mapping software. The subject tree is indicated on the aerial image in Plate 1 and the site plan in Appendix 1 of this Addendum. 'St Germains' is also indicated located to the east.

Plate 1. Aerial image showing the relative location of the trees within the site.

Documents reviewed include;

- Planning property reports and City of Casey Council planning zones and overlays. The site is in the Urban Growth Zone (UGZ).

Tree assessment details.

Botanic name (Common Name)	*Ulmus procera* (English Elm)
Origin	Exotic Deciduous
Trunk diameter (DBH)	99 (cm measured at 1.4m) (Basal diameter 124cm)
Height x Width (m)	17 metres x 22 metres (12 m North, 7 m East, 10 m South, 11 m West)
Age	Mature.
Health	Good. Tree in deciduous state. Healthy bud development evident to all branch tips.
Structure	Fair. Over-extended limb developing to north. Minor trunk and surface root wounds & past branch failures.
Lower canopy height	Between 1 to 2 metres above ground
General form	Symmetric with over-extend limb to North
Comment	Past branch failure to 30cm diameter at proximal end. Superficial wounding to large surface roots, incipient decay & necrotic tissue. Over-extended limb to north-west. Occluding limb wounds. Acute forks. Pocket of decay in trunk below main fork with 40mm opening to small hollow (possible nesting site).
Arboricultural Rating	High
Useful Life Expectancy	Could be retained in open space for minimum 20-30 years.
Recommendation	Crown Maintenance. Prune to remove deadwood, stubs and weight reduce northern limb. Treat via soil injection to control Elm-leaf Beetle every 3 years. Due to be re-treated August 2015.
Tree Protection Zone (TPZ)	11.9 metres radius from centre of trunk.
Reduced TPZ	TPZ could be reduced to 8.3 metres on one side only if TPZ enlarged in other directions.
Structural Root Zone (SRZ)	3.6 metres radius. No Go Zone.
Likelihood of tree part failure	Possible. Northern over-extended limb.
Size of part likely to fail	>35cm at the proximal end
Target	Open space
Risk rating	Low

View looking west showing the relative size, condition and location of the subject tree.

View looking east. The over-extended limb to the north (LHS) is evident.

Arboricultural assessment method.

The health and structural characteristics of the tree was assessed with regard to contemporary arboricultural principles and practices and was attributed an 'Arboricultural Rating'. The arboricultural rating correlates the combination of tree condition factors (health, structure & form) with tree amenity

value. Amenity relates to the trees biological, functional and aesthetic characteristics within a built environment. The arboricultural rating in combination with other factors can assist the project team and planners in nominating trees suitable for retention. The tree was attributed a High arboricultural rating.

The arboricultural descriptors used by Tree Logic are attached as Appendix 2 of this Addendum.

Establishing Tree Protection Zones (TPZ);

To successfully retain suitable trees within or around a development site, consideration must be given to protecting the trunk, crown and roots of each specimen. Tree protection zones (TPZ's) are used to provide adequate space for the preservation of sufficient roots to maintain tree health (particularly important for mature trees) whilst providing a buffer zone between construction activity and the tree trunk and crown.

The method for determining tree protection zones adopted in this report is the 'Australian Standard for Protection of trees on development sites' (AS4970-2009). The TPZ area is based on the trunk diameter measurement measured in metres at 1.4m and multiplied by 12 and is a guide for planning purposes. The centre of the trunk of the tree is used as the start point for the measurement. TPZ measurements are included in the tree assessment data on previous page. The TPZ can be reduced on one side by up to 10% area if a commensurate area is protected in other parts of the TPZ and contiguous with the TPZ.

Additional measurements have been included in the tree assessment data that indicate the Structural Root Zone (SRZ) which is the absolute minimum required to maintain tree stability without consideration to ongoing health. No works are permitted in the SRZ. Details of tree protection zone establishment and management guidelines are outlined in Appendix 3 of this Addendum.

Management of aging trees

It is widely recognised within the arboricultural industry that trees are shedding organisms and that large old trees are likely to be subject to health and structural conditions that may make them more likely to shed a limb than a younger, more dynamic tree.

The most effective treatment is to ensure there are no high value targets within the potential fall zone for any prolonged period in conjunction with addressing the identifiable deficiencies and defects in health, structure and form.

It is therefore recommended that no seating, play equipment or other park furniture or features be located within the canopy drip-line plus one metre. Where pruning is recommended to reduce excessive end-weight the canopy drip-line may be marginally altered.

It is considered that the species is tolerant of minor to moderate alterations to the growing environment and this is clearly apparent in the extensive and prominent avenues of mature Elm trees throughout the many of the older areas of Melbourne and rural Victoria often in confined growing sites.

Pest and disease.

The species English Elm is susceptible to attack by Elm-leaf Beetle (ELB). The Beetle can damage the foliage of the tree through eating shot holes in the leaves or skeletonising the leaves via sap sucking. If left untreated the population of beetle increases each season and progressively weakens the tree which can in turn accelerate decline and premature death.

The Elm-leaf Beetle population can be successfully controlled via chemical treatments applied either via soil injection or via stem injection provided at strategic times of the year. The treatment needs to be repeated on a 2-3 year cycle to keep the population in check. It is understood that the tree has not been treated within the last 5 years. On this basis it is recommended that the tree be treated via soil injection in around August or September of 2015.

The species is also susceptible to Dutch Elm Disease (DED), a fungal pathogen that can rapidly kill affected trees. Currently the pathogen responsible for DED is not present in Australia.

Risk assessment.

The assessment of risk was undertaken using the ISA Basic Tree Risk Assessment Form which assesses four criteria as follows;

a) Likelihood of Failure - Assessment of structural defects & informed by species, habit, condition, size and age. Based on sound arboricultural knowledge.

b) Likelihood of Impacting a Target – Assessment of type and frequency of use of the area within the potential fall zone of the tree.

It is understood that the tree is proposed to be retained in public open space that may be frequently occupied by residents in mild conditions but less likely to be occupied during inclement weather events.

c) Likelihood of failure and impact – Assessment of the likelihood that a potential failure would impact a target.

d) Consequences of Tree Failure - Assessment of the consequences of a potential failure impacting a target.

In summary;

- The likelihood of failure was considered to be possible.
- The size of the part that had potential to fail was considered to be up to 35cm in diameter at the proximal end and from a relatively localised and low area of the tree.
- The likelihood of impacting a target was 'Moderate'.
- The likelihood of 'Failure and Impact' results as 'Unlikely' and though the consequences of a branch failure could be considered to be 'Significant' the overall risk of the tree is 'Low'.
- The risk is considered to be Low especially if the pruning recommendations are implemented and appropriate tree protection measures are applied.

	Likelihood of Impacting a Target			
Likelihood of Failure	Very Low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

Likelihood of Failure and Impact	Consequences of Tree Failure			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

The risk path for the subject tree is shown in Yellow.

Conclusion

1. The subject English Elm tree is a good specimen of a mature English Elm and has a high retention value, being a significant component of the surrounding landscape. Despite having minor structural deficiencies there is scope to address these through crown maintenance and weight reduction pruning as well allocating appropriate tree protection zones.
2. Based on assessment of the tree in the context of the proposed park setting it is concluded that with appropriate crown maintenance pruning and tree protection measures the trees will present a Low risk.
   2.1. Pruning of the over-extended limb to the north is recommended to reduce the risk of the limb failing and leaving a large wound that could reduce the longevity and suitability of the tree for retention.
3. Adequate space to allow for the TPZ of 11.9 metres radius from the centre of the tree should be allocated and landscape treatments that effectively limit prolonged acess to the area beneath the tree canopy should be implemented including appropriate groundcovers, shrubs and ornamental plantings.
4. Park furniture, paths, play equipment and landscape features must not be located within the potential fall zone (generally canopy drip-line plus one metre) of the retained tree.
5. No excavation for construction or installation of paths or underground services is permitted within the recommended TPZs of the tree.

I am available to answer any questions arising from this report.

Signed Bruce Callander

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References:

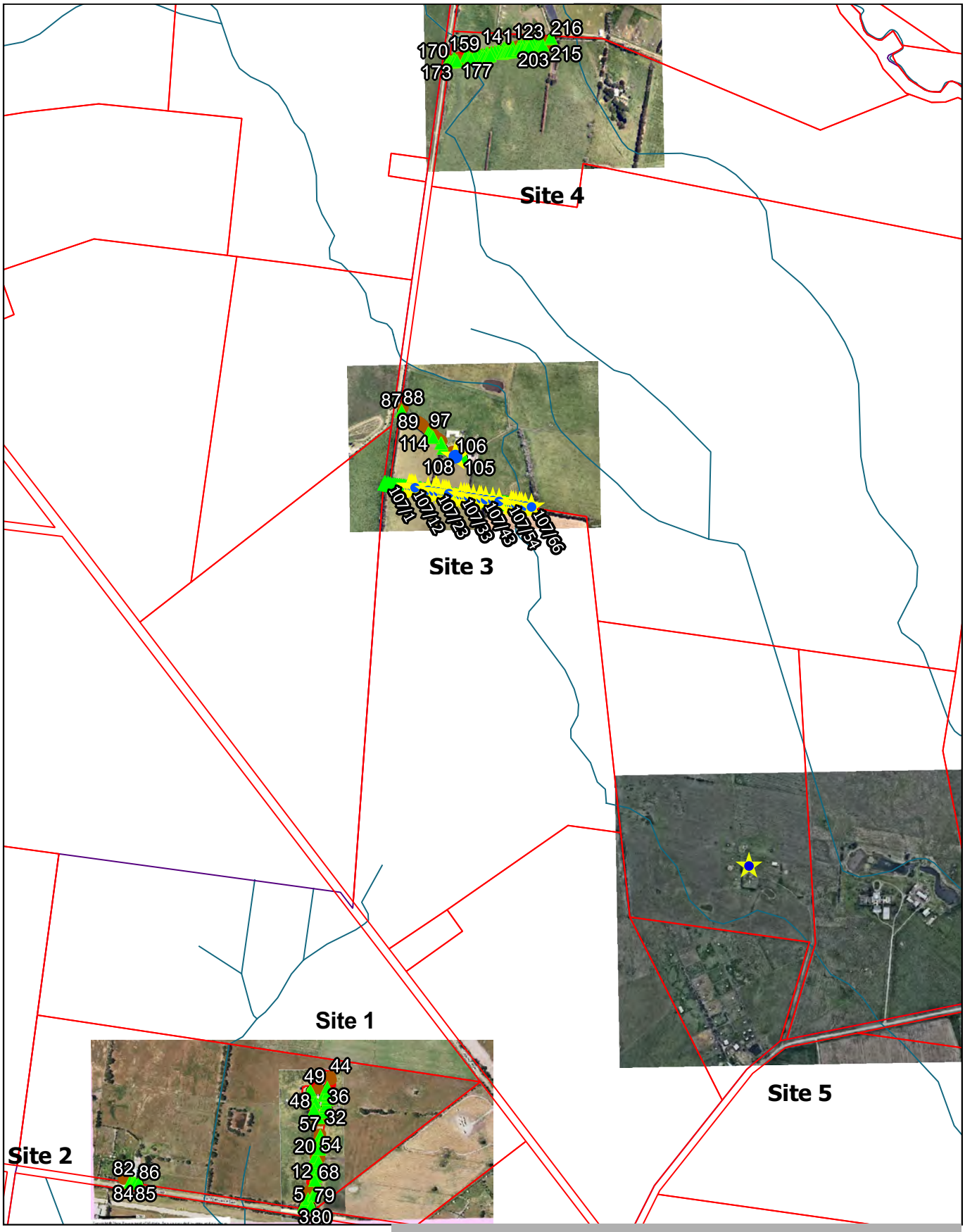
Australian Standard (4970-2009) Protection of Trees on development sites.
Standards Australia, Sydney NSW Australia

Clark, J.R. & Matheny, N.P (1998), Trees and Development: A technical guide to preservation of trees during land development. ISA , Champaign, Illinois.

Standards Australia (2007), Australian Standard (4373-2007) - Pruning of Amenity trees, Standards Australia, Homebush, NSW

Appendix 1: English Elm tree located at 75 McCormacks Road, Clyde North.

McPherson Precinct (PSP1055)
Key Map - Clyde North



200 0 200 400 m

Legend

- Tree_High Arb. Value
- Tree_Moderate Arb. Value
- Tree_Low Arb. Value
- Tree_No Arb. Value
- TPZ
- SRZ

Appendix 2: Arboricultural Descriptors

(©Tree Logic October 2014)

Tree Condition

The assessment of tree condition evaluates factors of health and structure. The descriptors of health and structure attributed to a tree evaluate the individual specimen to what could be considered typical for that species growing in its location. For example, some species can display inherently poor branching architecture, such as multiple acute branch attachments with included bark. Whilst these structural defects may technically be considered arboriculturally poor, they are typical for the species and may not constitute an increased risk of failure. These trees may be assigned a structural rating of fair-poor (rather than poor) at the discretion of the author.

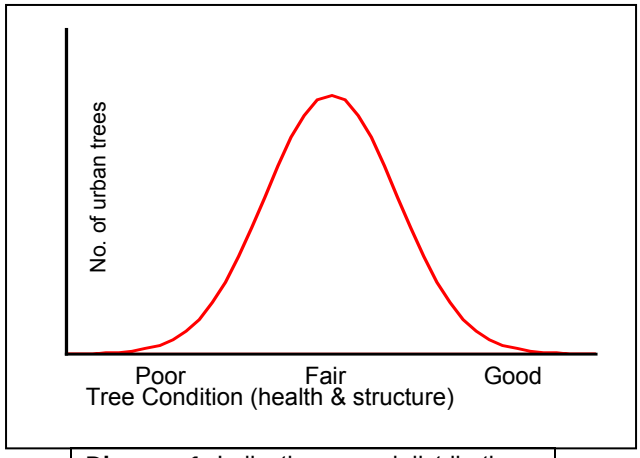


Diagram 1: Indicative normal distribution curve for tree condition

Diagram 1, provides an indicative distribution curve for tree condition to illustrate that within a normal tree population the majority of specimens are centrally located within the condition range (normal distribution curve). Furthermore, that those individual trees with an assessed condition approaching the outer ends of the spectrum occur less often.

Tree Name

Provides botanical name, (genus, species, variety and cultivar) according to accepted international code of taxonomic classification, and common name.

Tree Type

Describes the general geographic origin of the species and its type e.g. deciduous or evergreen.

Category	Description
Indigenous	Occurs naturally in the area or region of the subject site
Victorian native	Occurs naturally within some part of the State of Victoria (not exclusively) but is not indigenous
Australian native	Occurs naturally within Australia but is not a Victorian native or indigenous
Exotic deciduous	Occurs outside of Australia and typically sheds its leaves during winter
Exotic evergreen	Occurs outside of Australia and typically holds its leaves all year round
Exotic conifer	Occurs outside of Australia and is classified as a gymnosperm
Native conifer	Occurs naturally within Australia and is classified as a gymnosperm
Native Palm	Occurs naturally within Australia. Woody monocotyledon
Exotic Palm	Occurs outside of Australia. Woody monocotyledon

Height and Width

Indicates height and width of the individual tree; dimensions are expressed in metres. Crown heights are measured with a height meter where possible. Due to the topography of some sites and/or the density of vegetation it may not be possible to do this for every tree. Tree heights may be estimated in line with previous height meter readings in conjunction with author's experience. Crown widths are generally paced (estimated) at the widest axis or can be measured on two axes and averaged. In some instances the crown width can be measured on the four cardinal direction points (North, South, East and West).

Diameter at Breast Height (DBH)

Indicates the trunk diameter (expressed in centimetres) of an individual tree measured at 1.4m above the existing ground level or where otherwise indicated, multiple leaders are measured individually. Plants with multiple leader habit may be measured at the base. The range of methods to suit particular trunk shapes, configurations and site conditions can be seen in Appendix A of Australian Standard AS 4970-2009 Protection of trees on development sites. Measurements undertaken with forestersØ tape or builders tape.

Health

Assesses various attributes to describe the overall health and vigour of the tree.

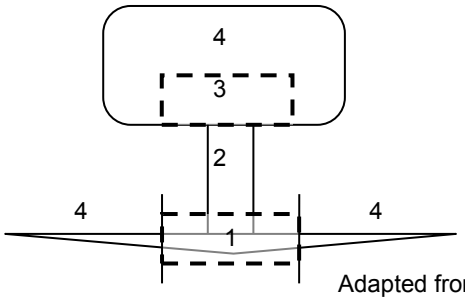
Category	Vigour/Extension growth	Decline symptoms/Deadwood	Foliage density, colour, size, intactness	Pests and or disease
Good	Above typical	None or minimal	Better than typical	None or minimal
Fair	Typical	Typical or expected	Typical	Typical, within damage thresholds
Fair to Poor	Below typical	More than typical	Exhibiting deficiencies	Exceeds damage thresholds
Poor	Minimal	Excessive and large amount/size	Exhibiting severe deficiencies	Extreme and contributing to decline
Dead	N/A	N/A	N/A	N/A

Structure

Assesses principal components of tree structure (Diagram 2).

Descriptor	Zone 1 - Root plate & lower stem	Zone 2 - Trunk	Zone 3 - Primary branch support	Zone 4 - Outer crown and roots
Good	No damage, disease or decay; obvious basal flare / stable in ground	No damage, disease or decay; well tapered	Well formed, attached, spaced and tapered	No damage, disease, decay or structural defect
Fair	Minor damage or decay. Basal flare present.	Minor damage or decay	Typically formed, attached, spaced and tapered	Minor damage, disease or decay; minor branch end-weight or over-extension
Fair to Poor	Moderate damage or decay; minimal basal flare	Moderate damage or decay; approaching recognised thresholds	Weak, decayed or with acute branch attachments; previous branch failure evidence	Moderate damage, disease or decay; moderate branch end-weight or over-extension
Poor	Major damage, disease or decay; fungal fruiting bodies present. Excessive lean placing pressure on root plate	Major damage, disease or decay; exceeds recognised thresholds; fungal fruiting bodies present. Acute lean. Stump resprout	Decayed, cavities or has acute branch attachments with included bark; excessive compression flaring; failure likely	Major damage, disease or decay; fungal fruiting bodies present; major branch end-weight or over-extension
Very Poor	Excessive damage, disease or decay; unstable / loose in ground; altered exposure; failure probable	Excessive damage, disease or decay; cavities. Excessive lean. Stump resprout	Decayed, cavities or branch attachments with active split; failure imminent	Excessive damage, disease or decay; excessive branch end-weight or over-extension

Diagram 2: Tree structure zones
1. Root plate & lower stem
2. Trunk
3. Primary branch support
4. Outer crown & roots



Adapted from Coder (1996)

Trees are assessed and the given a rating for a point in time. Generally, trees with a poor or very poor structure are beyond the benefit of practical arboricultural treatments. The lowest or worst descriptor assigned to the tree in any column could generally be the overall rating assigned to the tree. The assessment for structure is limited to observations of external and above ground tree parts. It does not include any exploratory assessment of underground or internal tree parts unless this is requested as part of the investigation.

Structure ratings will also take into account general tree architecture which considers aspects of stem taper, live crown ratio, branch distribution or crown bias and position such as a tree being suppressed amongst more dominant trees.

The management of trees in the urban environment requires appropriate arboricultural input and consideration of risk. Risk potential will take into account the combination of likelihood of failure and impact, including the perceived importance of the target(s).

Life Stage

Relates to the physiological stage of the tree's life cycle.

Category	Description
Young	Sapling tree and/or recently planted
Semi-mature	Tree rapidly increasing in size and yet to achieve expected size in situation
Maturing	Specimen approaching expected size in situation, with reduced incremental growth
Over-mature	Tree is senescent and in decline

Arboricultural Rating

Relates to the combination of tree condition factors, including health and structure (arboricultural merit), and also conveys an amenity value. Amenity relates to the trees biological, functional and aesthetic characteristics (Hitchmough 1994) within an urban landscape context.

Category	Description
High	Tree of high quality in good to fair condition. Generally a prominent arboricultural feature. These trees have the potential to be a medium- to long-term component of the landscape if managed appropriately. Retention of these trees is highly desirable.
Moderate	Tree of moderate quality, in fair or better condition. Tree may have a condition, and or structural problem that will respond to arboricultural treatment. These trees have the potential to be a medium- to long-term component of the landscape if managed appropriately. Retention of these trees is generally desirable.
Low	Tree of low quality and/or little amenity value. Tree in poor health and/or with poor structure. Tree is not significant for its size and/or young. These trees are easily replaceable. Tree (species) is functionally inappropriate to specific location and would be expected to be problematic if retained. Retention of such trees may be considered if not requiring a disproportionate expenditure of resources for a tree in its condition and location.
None	Tree has a severe structural defect and/or health problem that cannot be sustained with practical arboricultural techniques and the loss of tree would be expected in the short term. Tree whose retention would not be viable after the removal of adjacent trees (includes trees that have developed in close spaced groups and would not be expected to acclimatise to severe alterations to surrounding environment – removal of adjacent shelter trees). Tree has a detrimental effect on the environment, for example, the tree is a woody weed with potential to spread into waterways or natural areas.

Tree significance

Trees have many values, not all of which are considered when an arboricultural assessment is undertaken. However, individual trees or tree group features may be considered important community resources because of unique or noteworthy characteristics or values other than their age, dimensions, health or structural condition. Recognition of one or more of the following criterion is designed to highlight other considerations that may influence the future management of such trees.

Significance	Description
Horticultural Value/ Rarity	Outstanding horticultural or genetic value; could be an important source of propagating stock, including specimens that are particularly resistant to disease or exposure. Any tree of a species or variety that is rare.
Historic, Aboriginal Cultural or Heritage Value	Tree could have value as a remnant of a particular important historical period or a remnant of a site or activity no longer in action. Tree has a recognised association with historic aboriginal activities, including scar trees. Tree commemorates a particular occasion, including plantings by notable people, or having associations with an important event in local history.
Ecological Value	Tree could have value as habitat for indigenous wildlife, including providing breeding, foraging or roosting habitat, or is a component of a wildlife reserve. Remnant Indigenous vegetation that contribute to biological diversity

Bibliography:

Coder, K D. (1996) Construction damage assessments: trees and sites, University of Georgia, USA

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Pollard, A. H. (1974) Introductory statistics: a service course, Pergamon Press Australia, Australia.

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

Appendix 3: Tree protection zones. Tree logic Pty. Ltd. © 2005

1.0 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, and 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 (Gilman, 1997). 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 structural root system and be expected to survive let alone stand up to average annual wind loads upon the crown.

2.0 Allocation of tree protection zone (TPZ)

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 arboricultural assessment, which trees and tree groups are to be retained, the next step will require careful management through the development process to minimise 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;
- minimise changes to the trees growing environment, which is particularly important for mature specimens;
- minimise physical damage to the root system, canopy and trunk; and
- define the physical alignment of the tree protection fencing

Tree protection

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 Australian Standard AS 4970-2009 Protection of trees on development sites has been used as a guide in the allocation of TPZs for the assessed trees. The TPZ for individual trees is calculated based on trunk (stem) diameter (DBH), measured at 1.4 metres 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 not less than 1.0m outside the crown projection.

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 1. 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.

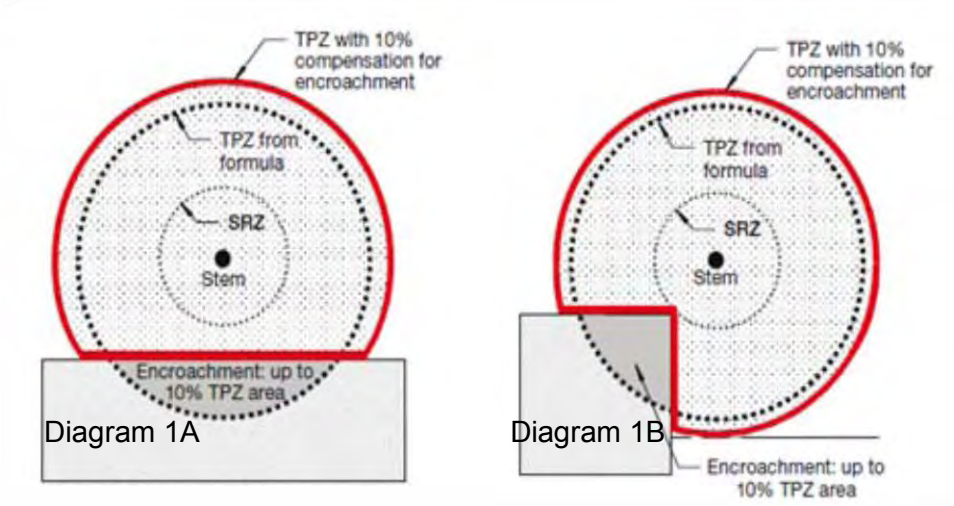

Diagram 1: Examples of minor encroachment into a TPZ. (Extract from: AS4970-2009, Appendix D, p30 of 32)

The 10% encroachment on one side equates to approximately ⅓ 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 on 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 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 remove larger 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 and withstand winds and construction impacts. The protection fence should only be moved with approval of the site supervisor. Other root zone protection methods can be incorporated if the TPZ area needs to be traversed.
- Appropriate signage is to be fixed to the fencing to alert people as to 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 redesign 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 the form, depth and spread of roots will vary between species and sites. However, because smaller 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.

Gilman (1997) suggests that trees may contain 4-11 major lateral roots and that the five largest lateral roots account (act as a conduit) for 75% of the total root system. These large lateral roots quickly taper within a distance to the tree, this distance is identified as the Structural Root Zone (SRZ). Within the SRZ distance, all roots and the soil surrounding the roots are deemed significant.

No root or soil disturbance is permitted within the SRZ.
In the area outside the SRZ the tree may tolerate the loss of one or a number of roots. The table 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.

Table 1: Estimated significant root sizes outside SRZ

Height of tree	Diameter of root
Less than 5m	≥ 30mm
Between 5m - 15m	≥ 50mm
More than 15m	≥ 70mm

Ground buffering

Where works are required to be undertaken within the Tree root zone without penetration of the surface, ground buffering and trunk and limb protection must be provided to minimise the potential for soil to become compacted and avoid potential for impact wounds to occur to surface roots, trunk or limbs. Refer below.

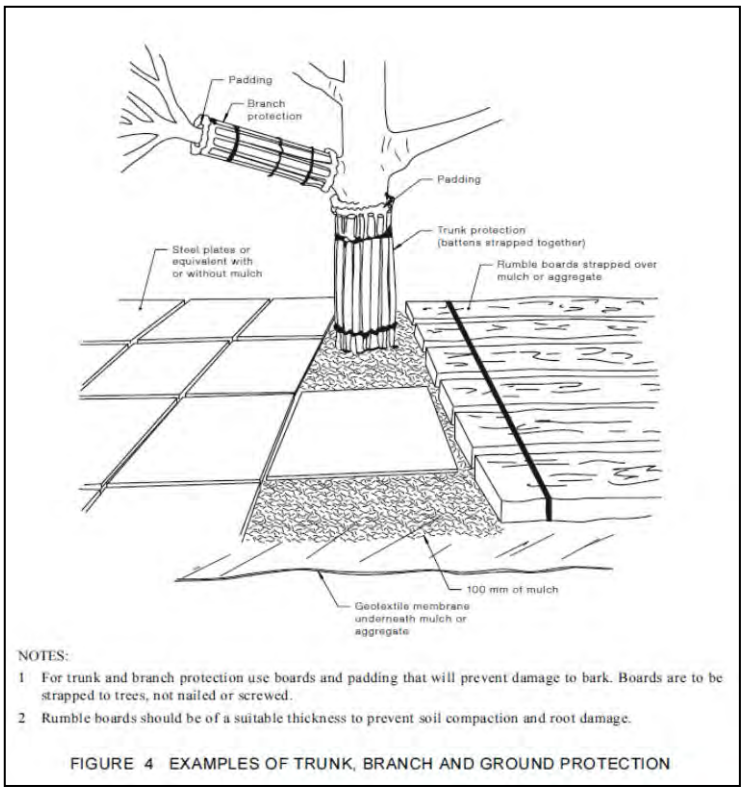

Diagram 2: Examples of ground buffering and trunk and limb protection. (Extract from: AS4970-2009, Appendix D, pg17)

Construction Guidelines

The following are guidelines that must be implemented to minimise the impact of the proposed construction works on the retained trees.

- The Tree Protection Zone (TPZ) is fenced and clearly marked at all times. The actual fence specifications should be a minimum of 1.2 - 1.5 metres of chain mesh or like fence with 1.8 meter posts (e.g. treated pine or star pickets) or like support every 3-4 metres and a top line of high visibility plastic hazard tape. The posts should be strong enough to sustain knocks from on site excavation equipment. This fence will deter the placement of building materials, entry of heavy equipment and vehicles and also the entry of workers and/or the public into the TPZ. Note: There are many different variations on the construction type and material used for TPZ fences, suffice to say that the fence should satisfy the responsible authority.
- Contractors and site workers should receive written and verbal instruction as to the importance of tree protection and preservation within the site. Successful tree preservation occurs when there is a commitment from all relevant parties involved in designing, constructing and managing a development project. Members of the project team need to interact with each other to minimise the impacts to the trees, either through design decisions or construction practices. The importance of tree preservation must be communicated to all relevant parties involved with the site.
- The consultant arborist is on-site to supervise excavation works around the existing trees where the TPZ will be encroached.
- A layer of organic mulch (woodchips) to a depth of no more than 100mm should be placed over the root systems within the TPZ of trees, which are to be retained so as to assist with moisture retention and to reduce the impact of compaction.
- No persons, vehicles or machinery to enter the TPZ without the consent of the consulting arborist or site manager.
- Where machinery is required to operate inside the TPZ it must be a small skid drive machine (i.e Dingo or similar) operating only forwards and backwards in a radial direction facing the tree trunk and not altering direction whilst inside the TPZ to avoid damaging, compacting or scuffing the roots.

- Any underground service installations within the allocated TPZ should be bored and utility authorities should common trench where possible.
- No fuel, oil dumps or chemicals shall be allowed in or stored on the TPZ and the servicing and re-fuelling of equipment and vehicles should be carried out away from the root zones.
- No storage of material, equipment or temporary building should take place over the root zone of any tree.
- Nothing whatsoever should be attached to any tree including temporary services wires, nails, screws or any other fixing device.
- Supplementary watering should be provided to all trees through any dry periods during and after the construction process. Proper watering is the most important maintenance task in terms of successfully retaining the designated trees. The areas under the canopy drip lines should be mulched with woodchip to a depth of no more than 100mm. The mulch will help maintain soil moisture levels. Testing with a soil probe in a number of locations around the tree will help ascertain soil moisture levels and requirements to irrigate. Water needs to be applied slowly to avoid runoff. A daily watering with 5 litres of water for every 30 mm of trunk calliper may provide the most even soil moisture level for roots (Watson & Himelick, 1997), however light frequent irrigations should be avoided. Irrigation should wet the entire root zone and be allowed to dry out prior to another application. Watering should continue from October until April.

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