ARBORLOGIX

PREPARED FOR

THI MY CAO

125 HORSLEY RD, PANANIA

4 DECEMBER 2023

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1. Contents

2. Report summary

2.1. Scope of works

2.1.1. Arborlogix Pty Ltd has been contracted by the client to undertake an arboricultural impact assessment report and provide a tree protection plan for a proposed new development at 125 Horsley Road, Panania. The site is located on a flat block with Horsley Road on the northern side and neighbouring properties on the other 3 sides. The site is currently occupied by a single storey clad residence located slightly forward of central in the block with a driveway running along the western boundary, a small garden at the front and a larger garden at the rear.

2.1.2. The proposed development is for demolition of the current residence and the construction of a duplex residence located centrally in the block with a shared central access driveway at the front and separate gardens at the rear.

2.1.3. Arborlogix Pty Ltd has been asked to assess the trees within this site, and on any neighbouring properties or council land, that have their TPZs (Tree Protection Zones) within 5m of the proposed development footprint or in areas that could be used as access points to the site for construction vehicles and materials. This arboricultural impact assessment report is only concerned with trees that are large enough to be covered by the local DCP (Development Control Plan) and Tree Management Policy for Canterbury Bankstown Council which includes any trees over 5m in height. Therefore this report includes 10 trees, 8 of these are within the site, 1 of them is within the neighbouring property on western side and 1 is out front on the council nature strip.

2.1.4. This report will assess these 10 trees for health, vitality, structural defects, form, pests and diseases, life expectancy, significance and retention value. An assessment will also be made of the likely impacts the proposed development will have on these trees. This will be used to aid with determining whether any of these trees would need to be removed for safety reasons or to accommodate the new development, or whether they should be retained and protected.

2.1.5. If the trees are to be retained this report will provide recommendations to any design modifications, construction techniques and the necessary protection measures that will need to be implemented prior, during and post development to ensure the health, vigour and longevity of these trees. Details of these protection measures will be based on local government regulations and protection measures outlined in AS-4970-2009 (Protection of Trees on Development Sites). Any pruning works that may be required to accommodate this development or improve the health and stability of these trees will also be outlined and detailed as part of the recommendations of this report.

3. SUMMARY OF RECOMMENDATIONS

This arboricultural impact assessment of the proposed development site made the following recommendations.

3.1. Retention and Protection of Trees 8 and 10 according to AS-4970-2009 (Protection Trees on Development Sites). No roots are to be pruned greater than 40mm diameter within any TPZ and no roots at all within any SRZ without the authorisation of the project arborist. Details of any TPZ encroachment and tree protection required are found in sections 8.1, 8.2 and 8.4 (Tree Protection Plan).

3.2. Removal and replacement of Trees 1-7 and 9 due to their low retention values, conflicts with the proposed development design or already approved for removal by council. More details can be found in section 8.1 and 8.3.

3.3. Generally all activities involving soil level changes, excavation, storage, cleaning and refueling are prohibited (a full list is found in section 4.2 AS-4970) within the TPZ. Installation of any underground services including stormwater infrastructure will need to be done in accordance with the conditions listed in 10.4.2. Some activities may be authorized if required but only by the project arborist. Any additional mulching or irrigation required should be done at the discretion of the project arborist.

3.4. All other tree protection measures required during construction and detailed in section 8.4 (Tree Protection Plan) of this report are to be complied with.

3.5. Any tree removal works and tree protection measures should be carried out by an arborist with a minimum qualification of AQF level 3 and certified by the project arborist. The project arborist should have a minimum qualification of AQF level 5 or equivalent.

3.6. All works on-site should be carried out according to Workcover Authority NSW 2007, *Code of Practice Amenity Tree Industry,* NSW.

3.7. All works should be carried out according to AS-4373-2007 (Pruning of Amenity Trees) and AS-4970-2009 (Protection trees on development sites).

4. Disclaimer and limitations of report

4.1. This document is only valid in its entirety and is for the exclusive use of the client and Arborlogix Pty Ltd only. Arborlogix Pty Ltd will not be held liable for any use or interpretations from any other person or third party. This report remains the intellectual property of Arborlogix Pty Ltd and any individual or company must have written consent prior to its use for any other purpose. Alterations of this report invalidate the entire report

4.2. All inspections and assessments were carried out using Visual Tree Assessment methods (VTA)[1] from ground level only and do not include the use of diagnostic devices. Although great care is taken to accurately diagnose the condition of the tree, using accepted industry practices; the arborist is limited in determining the exact structural integrity of the tree by interpreting mainly exterior features. There are multiple factors both physical and environmental such as extreme climatic events and conditions that could lead to possible structural failures in trees which would not have been possible to predict or identify from VTA methods and assessments.

4.3. Any protection or preservation methods recommended are not a guarantee of tree survival or safety but have been recommended to improve vigour and reduce risk only. Therefore Arborlogix Pty Ltd does not accept any liability for any future tree failure, illness, damage or injury caused by any undetected or unpredicted faults or failures in any tree or part thereof referred to in this document. Arborlogix Pty Ltd also accepts no responsibility for any failure, loss or decline, damage or injury caused by any tree covered in this document due to any meteorological or other unforeseen event.

4.4. It is the client's responsibility to maintain ongoing inspections and assessments of trees covered in this document and obtain the services of a suitably qualified arborist to carry out the work where necessary. All work should be carried out according to AS-4373-2007 Pruning of amenity trees[2] and AS-4970-2009 Protection of trees on development sites[3].

4.5. Tree identification is based on visual characteristics at the time of inspection using the authors knowledge and supporting reference materials. The accuracy of the identification is not guaranteed since key identifying features are not always available.

4.6. All plans and photographs used in this report are for visual aids only and may not be to scale. Arborlogix Pty Ltd also does not guarantee the accuracy of plans and documents provided by others in this report.

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[1] Mattheck, K and Breloer, H (2007). *The Body Language of Trees* – A handbook for failure

[2] Standards Australia (2007). AS4373:*Pruning of Amenity Trees*

[3] Standards Australia (2009). AS4970: *Protection of Trees on Development Sites*.

5. Methodology

Tree Assessments were all carried out using the following information and according to the following methods:

5.1. Tree assessments

- Visual Tree Assessment (VTA) method (Mattheck 2007)) (Appendix 1) was used from ground level to determine tree health, structural integrity and presence of any pests or diseases.
- Sustainable Retention Index Value (SRIV) Version 4 © (IACA 2010) (Appendix 3) is used to provide an index value corresponding to age, vigour and condition.
- The meanings and terminology used to describe and assess each tree are taken from the IACA Dictionary for Managing Trees in Urban Environments (2009). An extract is included as a glossary of terms in Appendix 6 of this report.
- No aerial (climbing) inspections, soil sampling or root excavations were conducted as part of these assessments.
- No additional specialised diagnostics equipment was used to quantitatively determine extent of any decay (i.e. resistographs or non-intrusive tomographic methods such as PICUS)
- All trees were identified using prior knowledge of the species and visual inspection of the subject trees at the time of inspection.
- Trees of the same species, size and age that form a stand or hedge may be grouped together and shown as one tree on plans for simplicity. If this is the case it is always noted in the tree schedule.
- A Lufkin 10m diameter tape was used to obtain the Diameter at Breast Height (DBH) as recommended at 1.4m unless otherwise stated due to variations in tree form (AS-4970-2009). Diameter at Root Crown (DRC) was also measured to enable calculation of Structural Root Zones. If access into a neighbouring property was not possible then measurements were taken from over the fence using a tape measure or estimated.
- Canopy spread was estimated or paced out and the longest span was recorded as the spread.
- Height of each tree was estimated and then cross referenced with photographs.
- Any photographs were taken with an iphone xS (12MP).
- All map data was gathered using www.nearmaps.com.au
- All design work used in this report was completed using Adobe Illustrator and ArborCAD.

5.2. Tree protection zones

This report adopts Australian Standard AS4970-2009 *Protection of trees on development sites* as a point of reference and guide for the recommended minimum setbacks (Appendix 4) from the centre of a tree's trunk to development works. The distances may be increased or decreased by the author in accordance with AS4970 – Section 3.3.4 as a result of other factors providing mitigating circumstances or constraints as indicated by but not restricted to the following:

- Condition of individual trees,
- Tolerance of individual species to disturbance,
- Geology e.g. physical barriers in soil, rock floaters, bedrock to surface
- Topography e.g. slope, drainage,
- Soil e.g. depth, drainage, fertility, structure,
- Microclimate e.g. due to landform, exposure to dominant wind,
- Engineering e.g. techniques to ameliorate impact on trees such as structural soil, gap graded fill, lateral boring,

- Construction e.g. techniques to ameliorate impact on trees such as pier and beam, bridge footings, suspended slabs,
- Root mapping,
- Physical limitations - existing modifications to the environment and any impact to tree/s by development e.g. property boundaries, built structures, houses, swimming pools, road reserves, utility services easements, previous impact by excavation, or construction in other directions, soil
- level changes by cutting or filling, existing landscaping works within close proximity, modified
- drainage patterns,
- Extraneous factors e.g. potential future impacts from development on adjoining land when the tree is located on or near to a property boundary

5.3. Tree significance, sustainability and retention values

Tree landscape significance rating was calculated using IACA Significance of a Tree, Assessment Rating System (STARS) © (IACA 2010) which is shown in Appendix 2. Landscape significance not only takes into account the physical form of the tree but it also assesses other factors such as Heritage, Cultural and Environmental values. These Landscape significance ratings were then combined with the Estimated Life Expectancy values of each specimen to categorise each tree under the Priority Matrix of Retention Values.

This is used in combination with the value obtained from the Sustainable Retention Index Value (SRIV) Version 4 © (IACA 2010) (Appendix 3) to determine whether the tree should be removed for safety and sustainability reasons or whether it should be retained and what remedial works may be required. Tree Sustainability is an important factor since it takes into account not only the life expectancy but also the effect of other economical, social and environmental factors that need to be addressed as part of a tree management plan.

5.4. Local government documentation reviewed for assessment.

In order to ensure all legal requirements are met when determining which trees can be retained or removed on this development site a number of Local Government Area (LGA) Policies and documents were reviewed:

- Significant Tree Register and/or – Heritage Tree Register -– No listings for this site were found.
- Threatened/Endangered species or communities onsite – No listings for this site were found.
- Local Government Area (LGA) Tree Preservation Order – Canterbury Bankstown Council

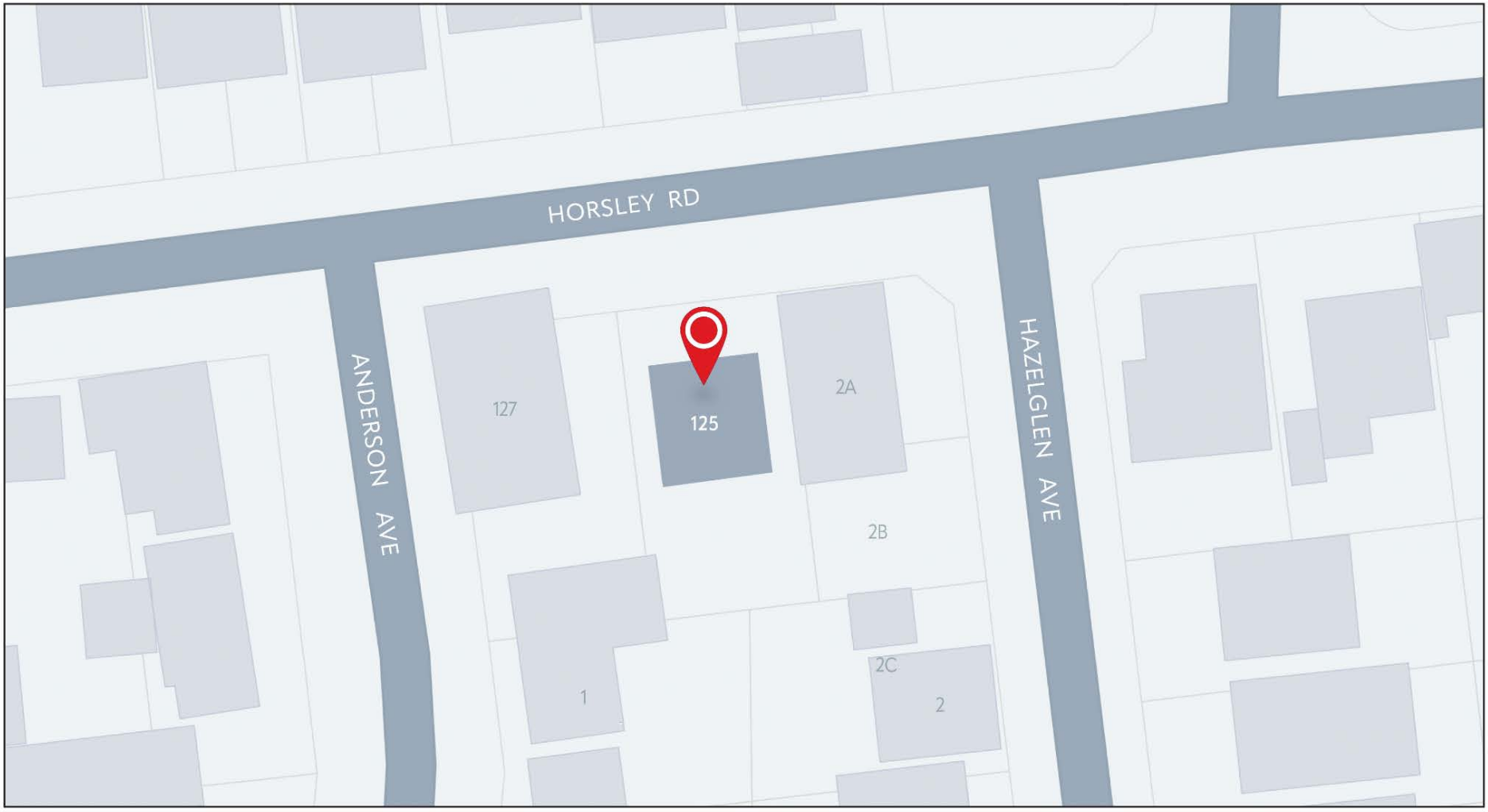
5.5. Documentation provided for this report

The following documentation was provided to assist in preparing this report:

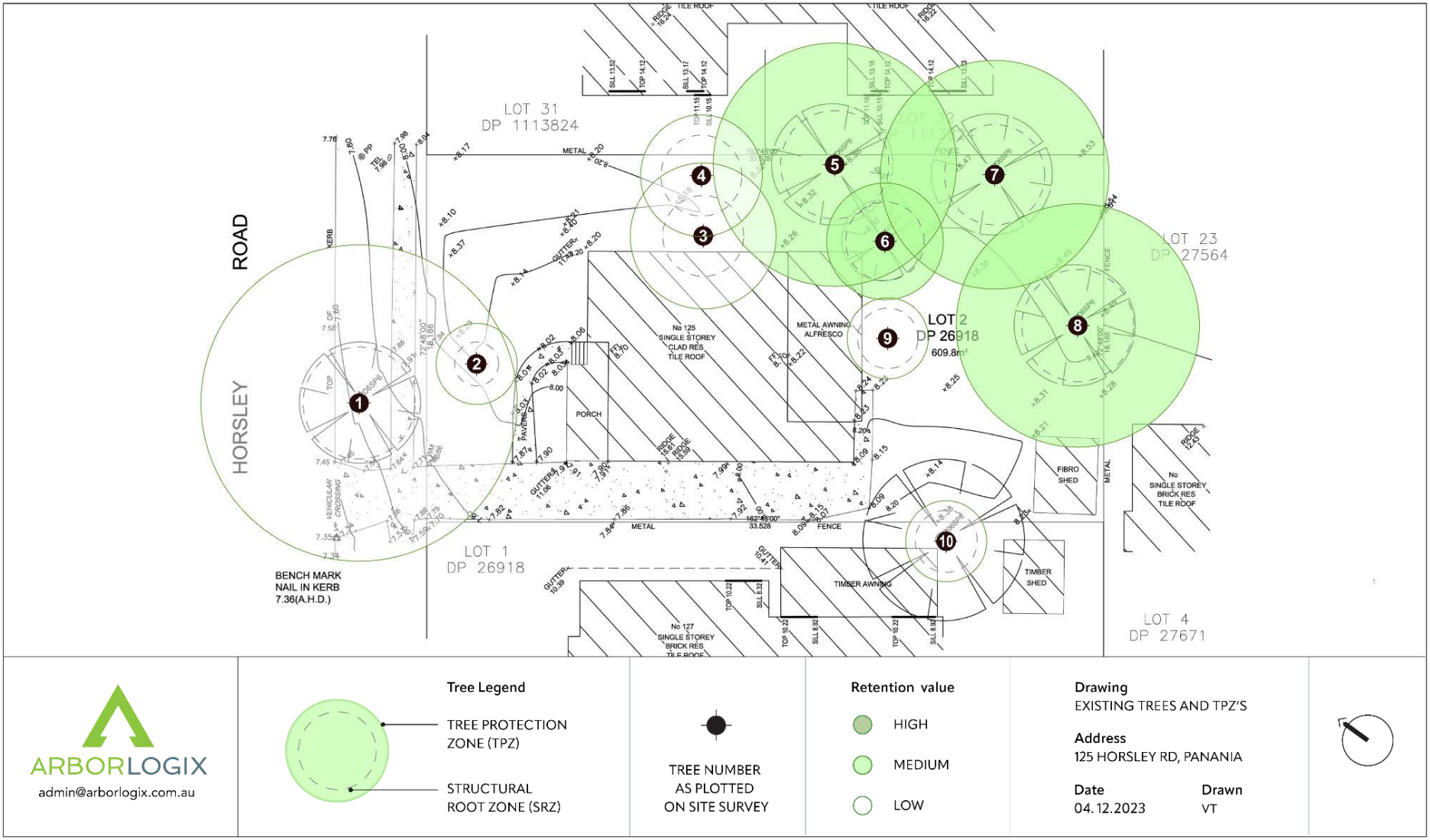
- Site Survey -John McDonald Group - 08.11.2023 - Drawing no.210580
- DA Drawings - Masterton Homes -17.11.2023 - Site plan - Drawing no.2017695

6. Site details

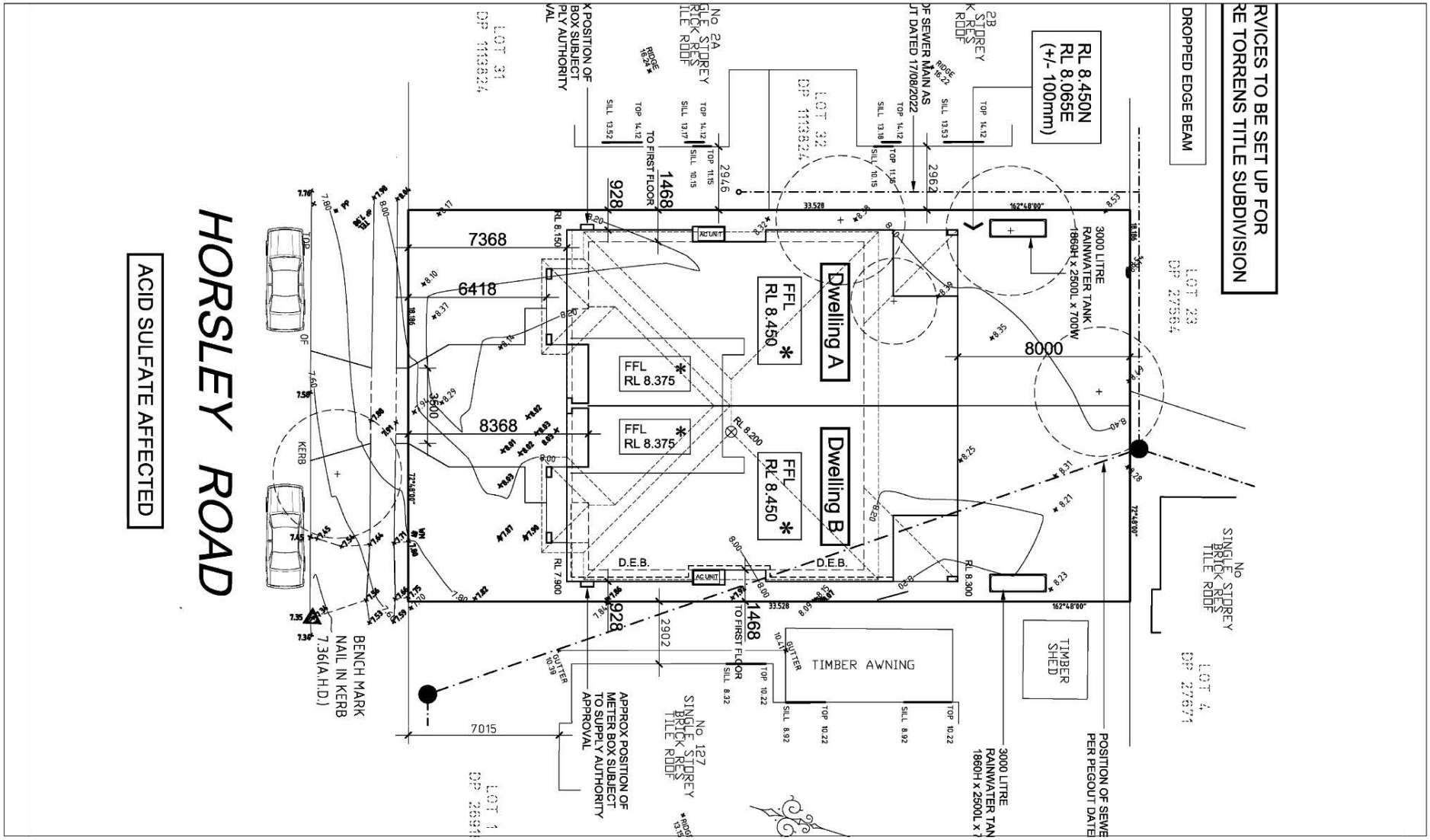
6.1. Map of site



6.2. Plan of site showing existing site and location of trees surveyed in report with TPZs and retention values



6.3. Plan of site showing proposed development



7. Tree Assessment

7.1. Tree schedule

KEY FOR TABLE:

AGE - Y = Young, M = Mature, OM = Over Mature D = Dead
DBH – Diameter Breast Height (mm)
SRZ – Structural Root Zone
Risk Rating – LOW, MEDIUM, HIGH, EXTREME (Colour Coded)
HT – Estimated Height (m)
DRC – Diameter above Root Crown (mm)
Health/ Condition – G = Good, F = Fair, P = Poor, D = Dead
SRIV – Sustainable Retention Index Value (Appendix 3)
CS – Estimated Crown Spread (m)
TPZ – Tree Protection Zone

Defects/Comments – NIL = Deadwood <20mm Diameter, Minor D = Minor Deadwood 20-70mm Diameter, Major D = Major Deadwood 70+mm Diameter
Significance/Retention – LOW, MEDIUM, HIGH (Colour Coded according to Retention Value)
SULE – H = High (40+ Yrs), M = Medium (15-40 Yrs), S = Short (5-15 Yrs), R = Remove, S/Y = Small or Young

No.	*Botanical Name* (Common Name)	HT	CS	DBH (mm)	DRC (mm)	TPZ (m)	SRZ (m)	Age	Health / Cond.	SRIV	Defects / Comments	Risk Rating	SULE	Significance / Retention Value)	Recommendations
1	Eucalyptus crebra (Narrow-leaved Ironbark)	14	10	650	650	7.8	2.8	M	P/P	MGVP	Council street tree, poor form with codominant stem, one half of tree dead, dead section over main road and power lines, remove for safety. Council already approved removal.	LOW	M	LOW / LOW	Remove & Replace
2	Leptospermum sp. (Tea tree)	5	4	60	70	0.7	1.1	Y	G/F	YGVF	Tiny specimen	LOW	M	LOW / LOW	Remove & Replace

No.	*Botanical Name* (Common Name)	HT	CS	DBH (mm)	DRC (mm)	TPZ (m)	SRZ (m)	Age	Health / Cond.	SRIV	Defects / Comments	Risk Rating	SULE	Significance / Retention Value)	Recommendations
3	Livistona australis (Cabbage Tree Palm)	5	3	300	300	3.6	2.0	M	F/F	MGVF	Trunk touching wall existing house, no space for growth	LOW	S	LOW / LOW	Remove & Replace
4	Olea europaea ssp. africana (African Olive)	6	5	250	300	3.0	2.0	M	F/F	MGVF	Exempt weed species	LOW	S	LOW / LOW	Remove & Replace
5	Melaleuca styphelioides (Prickly leaved Paperbark)	10	6	500	600	6.0	2.7	M	G/F	MGVF	Touching boundary fence	LOW	L	MED / MED	Remove & Replace
6	Exotic sp. (Exotic species)	10	7	240	280	2.9	1.9	M	F/F	MGVF	Sparse canopy	LOW	M	MED / MED	Remove & Replace
7	Melaleuca styphelioides (Prickly leaved Paperbark)	10	8	470	500	5.6	2.5	M	G/F	MGVF	Council already approved removal.	LOW	L	MED / MED	Remove & Replace

No.	*Botanical Name* (Common Name)	HT	CS	DBH (mm)	DRC (mm)	TPZ (m)	SRZ (m)	Age	Health / Cond.	SRIV	Defects / Comments	Risk Rating	SULE	Significance / Retention Value)	Recommendations
8	Jacaranda mimosifolia (Jacaranda)	12	12	500	650	6.0	2.8	M	G/F	MGVF	At far rear of garden	LOW	M	MED / MED	Retain and Protect (AS-4970-2009)
9	Pittosporum undulatum (Sweet Pittosporum)	5	3	100	150	1.2	1.5	Y	F/F	YGVF	Regrowth from old stump, small specimen	LOW	S	LOW / LOW	Remove & Replace
10	Diospyros sp. (Persimmom)	5	3	140	160	1.7	1.5	M	G/G	MGVG	Neighbours tree, small specimen	LOW	M	LOW / LOW	Retain and Protect (AS-4970-2009)

TABLE 1 – TREE SCHEDULE

7.2. Site observations and photos

Tree assessments were carried out on the 28th November 2023. Photographs are shown below.

Photo 1: Tree 1 out front on council nature strip and Tree 2 in front yard.

Photo 2: Tree 3 on left and Tree 4 on right - at the side of the house.

Photo 3: Trees 5, 6, 7 in the rear yard.

Photo 4: Tree 8 in the rear yard.

Photo 5: Tree 10 in neighbours rear yard.

8. Impact of proposed development

8.1. Summary of construction impacts on trees surveyed onsite.

8.1.1. All trees that scored HIGH as priority for retention are good specimens and design efforts should be made for their protection throughout the development to ensure there are no detrimental effects to the health of the trees. Trees that have scored MEDIUM for retention should also be protected where possible without impacting the development. If it is not possible to construct the new development without seriously impacting the tree then those trees with MEDIUM retention value should be considered for removal. Trees with LOW retention value should be removed if required to accommodate the new development.

8.1.2. In some cases trees will need to be removed for the development to proceed regardless of their retention value since they are directly within the building footprint and alternative designs are not feasible. Table 2 below summarizes the trees that can be retained and protected and those that will require removal either due to conflicts with the proposed development or due to their condition, form or species type. The table also lists their retention values and the reasons they need to be removed or the TPZ encroachment that will be required if they are retained and protected.

Tree Impact Type	Reason/Details	High Retention	Medium Retention	Low Retention
Recommended for Removal	Impacts from demolition and construction works, new surfaces, grade changes; or trees in poor condition, poor health, poor form, undesirable species, safety concerns.		5-7	1-4, 9
Recommended for retention requiring major TPZ (>10%) encroachments and Tree sensitive construction and design.	Removal of existing structures, surfaces and/or construction of new structures, surfaces, grades, landscaping.			
Recommended for retention requiring only minor (<10%) or no TPZ encroachments.	Removal of existing structures, surfaces and/or construction of new structures, surfaces, grades, landscaping. Or no TPZ encroachment required.		8	10

Table 2 – Summary of construction impacts on trees surveyed onsite

8.2. Detailed impact appraisal for trees to be retained onsite

8.2.1. Tree sensitive construction techniques can generally be categorised into 2 types:

1. **Tree sensitive building footings** - to minimise the impact to root systems that require major TPZ encroachment it will be necessary to construct these footings using pier and beam / suspended slab style foundations that can be constructed above the root zone still allowing water infiltration and gaseous exchange for the root systems below. Designs for these construction works will need to be pre approved and done in consultation with the project arborist. Implementation of this form of construction will also need to be done according to the following conditions:
    a. Excavations for footings will need to be done manually or using non-destructive techniques (i.e Air Spade or Hydrovac) to ensure no roots are damaged. These excavations may also need to be supervised at the discretion of the project arborist.
    b. The exact location of piers will need to be flexible to ensure they can be moved if there is a conflict with a significant root (greater 50mm diameter).
    c. Piers will need to be located at least 150mm from any significant roots (greater 50mm diameter)
    d. Pruning of roots greater than 30mm diameter should only be done in consultation with the project arborist.
    e. There should be no grade changes without consultation with the project arborist.
    f. The suspended slab will need to be slightly above the ground level to ensure water infiltration and gaseous exchange for the root system.

2. **Tree sensitive surface installations** - driveways, footpaths, landscaping - new surfaces will need to be constructed above the existing grades in the TPZ, involve no excavations within the TPZ or any root pruning and still allow gaseous exchange for the root systems and water infiltration. Designs for these construction works will need to be pre approved and done in consultation with the project arborist. In general these tree sensitive surface installations above the existing grade levels involve a synthetic load spreading material and a large aggregate subbase above a geotech fabric or similar. The upper pavement level can then either be a large aggregate material, permeable pavers or permeable concrete depending on the load spreading material underneath. Many of the popular products on the market now use a plastic cellular product that can be filled with aggregate, spreading the load but preventing any compaction of the layers. Further examples of some of these techniques can be found in Appendix 5.

8.2.2. Table 3 below lists the actual TPZ and SRZ radius and details of any TPZ encroachments, tree sensitive construction and tree sensitive demolition techniques that will be required for each tree. The tree protection plan shown in section 8.4 below also shows details of any encroachment and the location of the TPZs for each tree. In all cases, no roots greater than 40mm diameter in the TPZs of any trees are to be pruned, and no roots at all within the SRZs for any tree, without consultation with the project arborist. TPZ fencing should be set-up as shown in section 8.4 and as directed by the project arborist.

TREES RECOMMENDED FOR RETENTION AND PROTECTION				
No	**Species**	**TPZ radius (m)**	**SRZ radius (m)**	**TPZ Encroachment required (<10%=Minor, >10%=Major) Details of any tree sensitive construction techniques and/or demolition required to ensure tree protection according to AS-4970-2009.**
8	Jacaranda mimosifolia (Jacaranda)	6.0	2.8	No TPZ encroachment required.
10	Diospyros sp. (Persimmom)	1.7	1.5	No TPZ encroachment required.

TABLE 3 – TPZ FOR RETAINED TREES AND ASSOCIATED ENCROACHMENTS

8.3. Trees recommended for removal

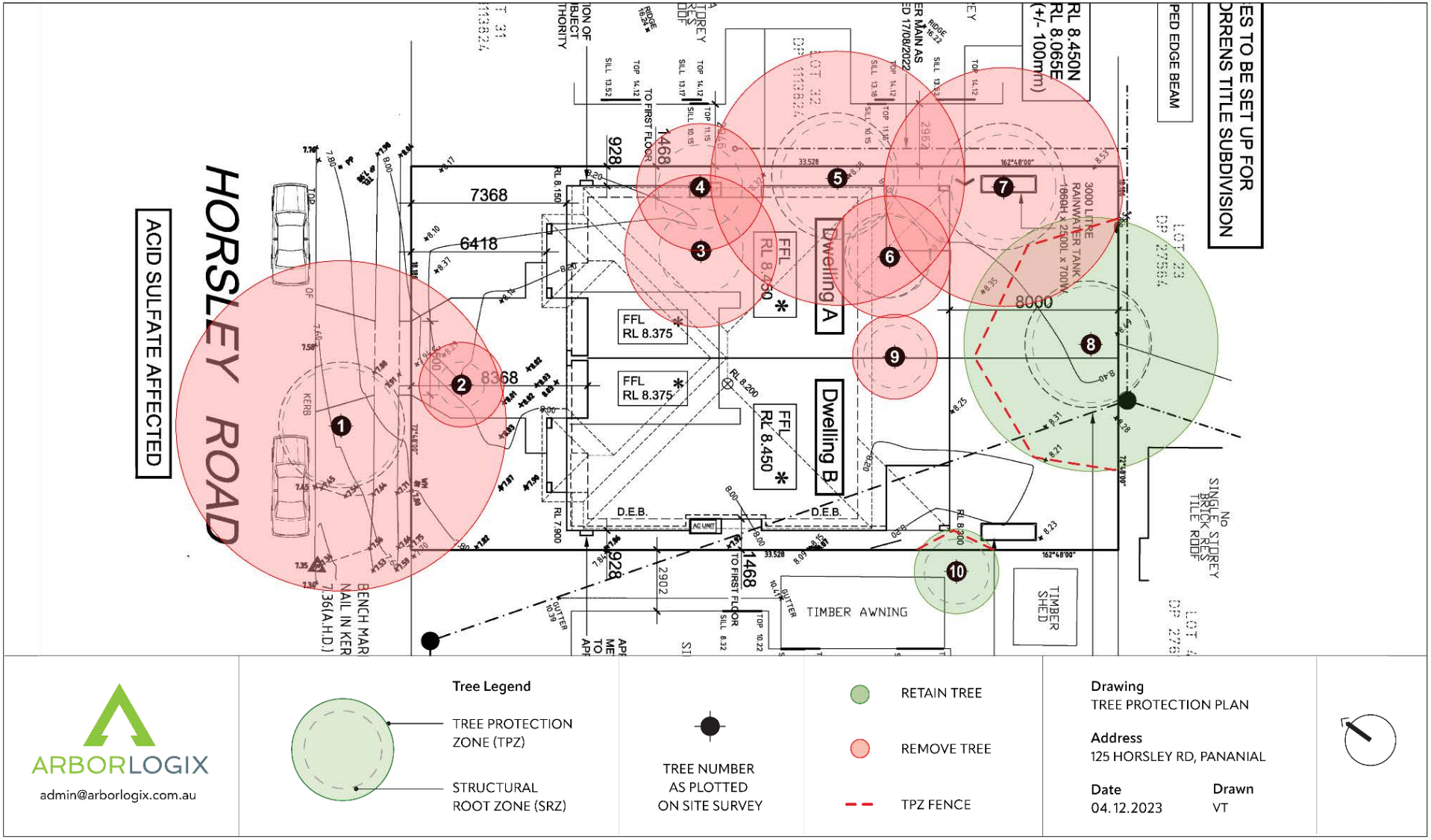
Table 3 below lists the trees onsite that have been recommended for removal together with reasons and any additional details.

TREES RECOMMENDED FOR REMOVAL			
No.	**Species**	**Significance / Retention Value**)	**Details / Specifications.**
1	Eucalyptus crebra (Narrow-leaved Ironbark)	LOW	Low retention value due to poor condition. Already approved for removal by council. Remove and replace new planting as per council conditions.
2	Leptospermum sp. (Tea tree)	LOW	Low retention value due to small size. Easily replaced new planting. Conflict with proposed driveway location. Remove and replace new planting.
3	Livistona australis (Cabbage Tree Palm)	LOW	Low retention value due to small size. Easily replaced new planting. Conflict with proposed development, located within the footprint of proposed new building. Remove and replace new planting.
4	Olea europaea ssp. africana (African Olive)	LOW	Low retention value due to being an exempt weed species. Conflict with proposed development, located within the footprint of proposed new building. Remove.
5	Melaleuca styphelioides (Prickly leaved Paperbark)	MED	Medium retention value but conflict with proposed development, located within the footprint of proposed new building. Remove and replace new planting.
6	Exotic sp. (Exotic species)	MED	Medium retention value but conflict with proposed development, located within the footprint of proposed new building. Remove and replace new planting.

TREES RECOMMENDED FOR REMOVAL			
No.	**Species**	**Significance / Retention Value**)	**Details / Specifications.**
7	Melaleuca styphelioides (Prickly leaved Paperbark)	MED	Medium retention value but already approved by council in previous application.
9	Pittosporum undulatum (Sweet Pittosporum)	LOW	Low retention value due to small size and poor form. Easily replaced new planting. Conflict with proposed development, located within the footprint of proposed new building. Remove and replace new planting.

TABLE 4 – DETAILS OF TREES RECOMMENDED FOR REMOVAL

8.4. Tree protection and removals plan



9. RECOMMENDATIONS

This arboricultural impact report recognizes that as a consequence of development in some cases certain trees may need to be removed to accommodate new constructions despite some of the specimen trees being of good health. This report has based its recommendations on ensuring that all trees that can be retained and integrated into this future development will be protected throughout all stages of development.

The recommendations of this report include:

9.1. Retention and Protection of Trees 8 and 10 according to AS-4970-2009 (Protection Trees on Development Sites). No roots are to be pruned greater than 40mm diameter within any TPZ and no roots at all within any SRZ without the authorisation of the project arborist. Details of any TPZ encroachment and tree protection required are found in sections 8.1, 8.2 and 8.4 (Tree Protection Plan).

9.2. Removal and replacement of Trees 1-7 and 9 due to their low retention values, conflicts with the proposed development design or already approved for removal by council. More details can be found in section 8.1 and 8.3.

9.3. Generally all activities involving soil level changes, excavation, storage, cleaning and refueling are prohibited (a full list is found in section 4.2 AS-4970) within the TPZ. Installation of any underground services including stormwater infrastructure will need to be done in accordance with the conditions listed in 10.4.2. Some activities may be authorized if required but only by the project arborist. Any additional mulching or irrigation required should be done at the discretion of the project arborist.

9.4. Branch and Truck protection, if required (only if access into TPZ needed), should be installed as detailed in section 10.3.2 of this report.

9.5. All other tree protection measures required during construction and detailed in section 8.4 (Tree Protection Plan) of this report are to be complied with.

9.6. Any tree removal works and tree protection measures should be carried out by an arborist with a minimum qualification of AQF level 3 and certified by the project arborist. The project arborist should have a minimum qualification of AQF level 5 or equivalent.

9.7. All works on-site should be carried out according to Workcover Authority NSW 2007, *Code of Practice Amenity Tree Industry,* NSW.

9.8. All works should be carried out according to AS-4373-2007 (Pruning of Amenity Trees) and AS-4970-2009 (Protection trees on development sites).

10. Tree protection requirements - method statement

10.1. Project arborist

10.1.1. A project arborist with a minimum of 5 years experience within the arboriculture industry, demonstrated management of trees on construction sites and a minimum certification of AQF-Level 5 (Diploma Level) should be appointed to oversee all areas of the project regarding any activities that may occur close to or within any TPZs of tree that are to be retained. They should be involved in all stages of early planning to prevent any damage to the trees to be retained and any unnecessary hold ups for the development if certain conditions and requirements have not been addressed.

10.1.2. The project arborist should complete regular inspections and monitoring of the site to ensure all tree protection measures are being adhered to, any additional protection measures are implemented if tree health appears to be in decline and all monitoring is documented for compliance certification. It is very important that communications channels between planners, architects, builders and the project arborist are kept open to ensure that the trees are protected throughout every stage of the development. Remediation measures are far less likely to be successful than careful planning with regards to tree protection. All site personnel must be properly briefed before any work starts.

10.2. Construction hold points and responsibilities

10.2.1. In order to ensure that all the required tree protection works are complied with and carried out in the correct sequence it is important that all site personnel understand the details of the arboricultural method statement and the site specific conditions that apply. This is done through clear communication channels between the developer, the project arborist and the site demolition and construction personnel. In order to ensure this is done correctly a series of construction hold points need to be met at each stage of the development and continuation to the next hold point cannot happen until the prior one has been inspected and signed off by the project arborist.

10.2.2. It is the site developers responsibility that all personnel are aware of these construction hold points and communication with the project arborist is maintained throughout the development process. It is too late to contact the project arborist at the end of the construction phase and ask them to certify that tree protection measures were in place at the beginning of the project 6 months earlier. Table 4 below details each of the construction hold points and the persons responsible for implementation and certification.

Hold Point	Details	Project Stage	Responsibility	Inspection & Certification
1	Pre construction meeting between project arborist and principal contractor to discuss tree protection requirements, methods and any issues relating to practicality and feasibility of tree protection requirements.	Prior to demolition and development work commencing.	Principal contractor	Project arborist
2	Marking of all trees that are proposed for removal onsite.	Prior to demolition and development work commencing.	Principal contractor	Project arborist
3	Installation of all tree protection requirements (TPZ fencing, ground protection, trunk protection, irrigation) in accordance with AS-4970-2009 and the arboricultural impact assessment report for the site.	Prior to demolition and development work commencing.	Principal contractor	Project arborist
4	Supervision of all demolition, excavations, underground service installations and construction works that will involve a major TPZ encroachment (greater 10% TPZ) of any trees to be retained and protected onsite. No roots greater 40mm diameter pruned without consultation project arborist.	Throughout the development, prior to works occuring within the TPZ.	Principal contractor and construction personnel.	Project arborist
5	Site inspections to ensure AS-4970-2009 compliance during construction, monitor health of trees and determine any measures required to mitigate detrimental impacts on protected trees. Advice on any modifications to tree protection in later stages of development to allow landscaping and approved low impact construction within tree TPZs.	Every 1-2 months as determined by the project arborist in Hold Point 1.	Principal contractor	Project arborist
6	Removal of tree protection measures and inspection of protected trees to ensure health and condition the same as pre construction. Advice on any mitigation works required to improve tree health and new tree planting management.	Construction completion.	Principal contractor	Project arborist

Table 4 – Details of trees recommended for removal

10.3. Tree protection works – prior to demolition

All TPZs (Tree Protection Zones) will need to be constructed as shown in a Tree Protection Plan produced by the project arborist prior to any demolition. Any encroachments or setbacks required to accommodate the new development need to be done in consultation with the project arborist.

10.3.1. General TPZ – no access authorised

The Protective fencing, signage and area within the TPZ should be constructed according to AS-4970-2009.

- Protective Fencing – The fencing delineates the boundary of the TPZ and should be positioned in accordance with Site Plan – Tree Protection zones and in consultation with the project arborist. Section 4, 4.3 of AS-4970 states " Fencing should be erected before any machinery or materials are brought onto the site and before the commencement of works including demolition. Once erected, protective fencing must not be removed or altered without approval by the project arborist. The TPZ should be secured to restrict access. AS-4687 specifies applicable fencing requirements. Shade cloth or similar should be attached to reduce the transport of dust, other particulate matter and liquids into the protected area. Fence posts and supports should have a diameter greater than 20mm and be located clear of roots.

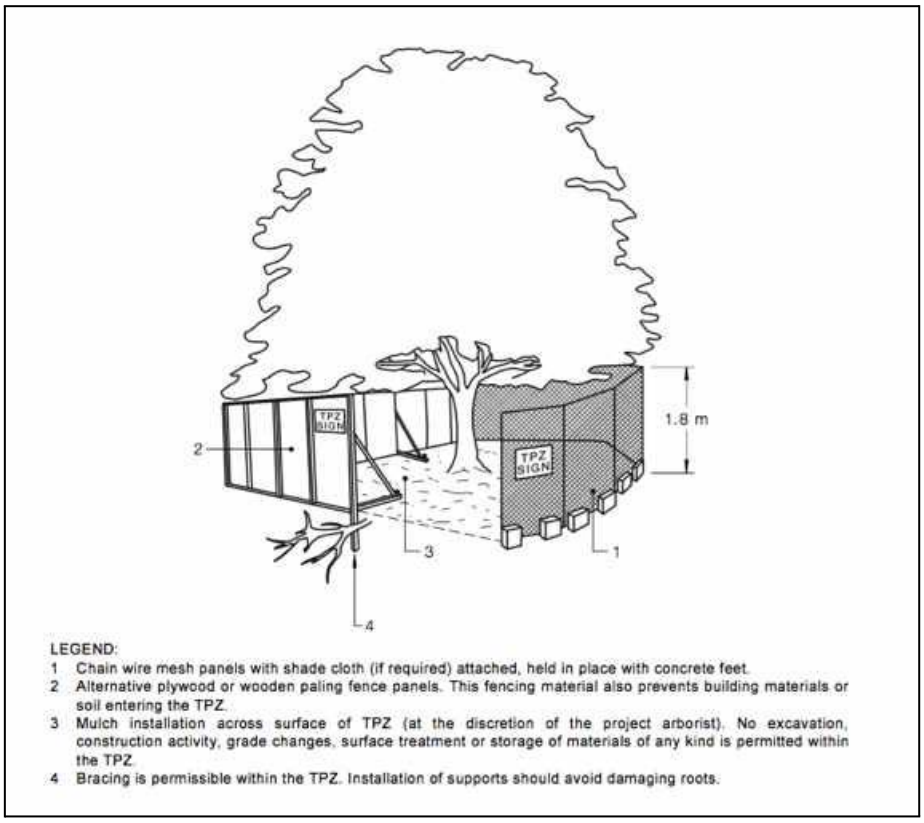


Figure 1 – TPZ fencing example from AS-4970-2009.

- TPZ encroachment – If encroachment is required to accommodate the building footprint then consideration should be given to the fact that the TPZ does actually extend outside of the fenced area and the rules regarding activities prohibited in the TPZ should apply to the distances presented in table 3 section 8.2 above and not just inside the fenced TPZ area.

- Signage – Signs identifying the TPZ should be placed around the edge of the TPZ and be visible from the development site.
- Mulching – Mulch installation across the surface of the TPZ should be carried out at the discretion of the project arborist. If required it should be applied to a depth of 100mm, consisting of approximately 75% leaf litter and 25% wood, and preferably from the same genus and species of tree to which they are protecting.
- Irrigation – At the discretion of the project arborist a timed drip irrigation system can be installed prior to any demolition works if it is deemed necessary.

10.3.2. Access to TPZ – temporary or permanent

The client has not detailed the exact location of logistical vehicular traffic and/or pedestrian traffic required during the construction phase. In general no access or any works are authorized inside a TPZ although pedestrian and vehicular access should still be allowed on roads and pavements already in place. If it is determined that entry into or through any of the TPZs are required then additional protection measures will be required. These are outlined in AS-4970-2009 in section 4.5 and listed below:

- Trunk and Branch Protection
  If access into the TPZ area is required for any scaffolding, or machinery, within 2m of the trees, then trunk and branch protection will need to be installed on limbs up to those above the height of tallest vehicle/scaffold. This should be installed by wrapping 2 layers of hessian (or similar material) around the branches and then securing hardwood battens (75x50x2000mm) at 100mm centers as shown in figure 2 below.

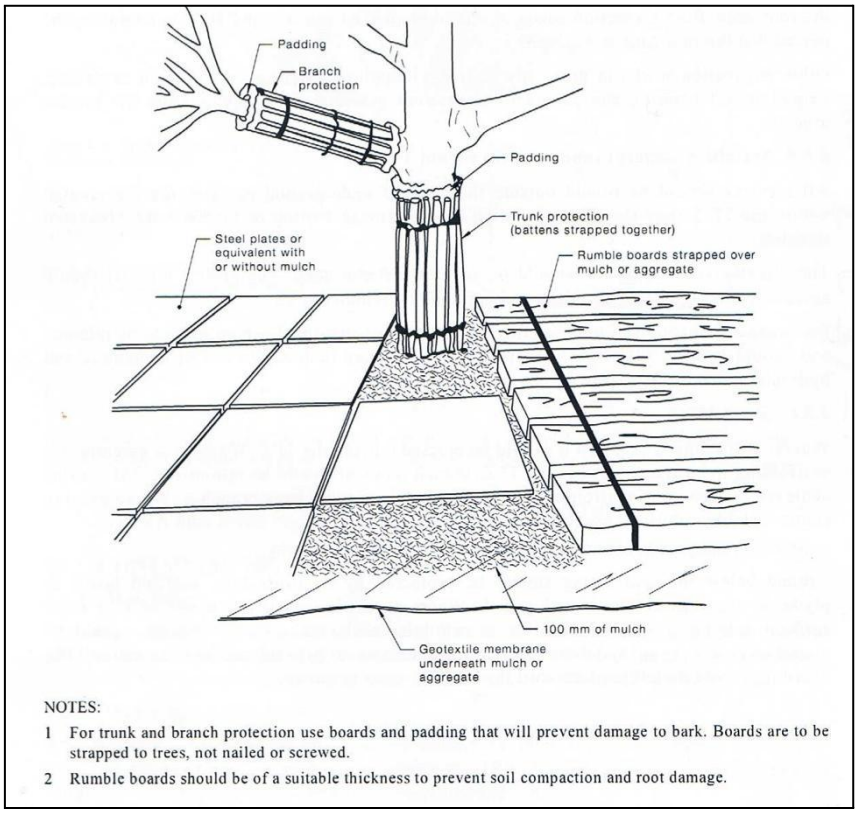


Figure 2 – TPZ TEmporary access – protection measures

- Ground Protection.
  If machinery or pedestrian access is required within the TPZ then ground protection measures will be required to prevent any compaction or root damage. These measures require a permeable membrane such as geotextile fabric beneath a 100mm layer of mulch with rumble boards or steel plates laid above as shown in figure 2 above.

10.4. Tree protection measures – during construction

Some activities may be authorized by the project arborist but generally all activities involving soil level changes, excavation, storage, excavation, cleaning and refueling are prohibited (a full list is found in section 4.2 AS-4970). There are some additional guidelines that do allow certain activities within the TPZ during construction but all of these need to be supervised and determined by the project arborist.

10.4.1. Excavation and fill in TPZ

Guidelines for excavation within the TPZ:

- All works must be carried out under the supervision of the project arborist.
- Root mapping for any encroachment greater than 10% of the TPZ will need to be carried out by the project arborist to determine the extent of root growth within the area designated for development. All root mapping will need to be done with non destructive techniques such as an air spade, water laser, manual digging (taking care not to damage roots or bark) or ground penetrating radar. The root mapping exercise should determine the extent of woody structural roots greater than 50mm diameter within the proposed development footprint and determine the amount of root pruning that would be possible. When the project arborist identifies roots to be pruned (>50mm) they should be cut with sharp tools such as pruners or chainsaws and back to undamaged wood. No 'pruning' is to be done by machinery.
- Root protection during works – Some approved works such as regrading, installation of piers or landscaping may have potential to damage roots. Where roots are exposed within the TPZ, temporary root protection should be installed to prevent them drying out. This may include jute matting or hessian sheeting as multiple layers. This should be pegged in place and kept moist during the period that the root zone is exposed.

Guidelines for adding fill within the TPZ:

- Any material used as fill should be approved by the project arborist and consist of a coarse, gap-graded material to provide aeration and infiltration to the root zone. Clays and any sort of fines should not be used since this will seriously impact the future health of the tree.
- No grade changes greater than 250mm should be done without approval of the project arborist and any compaction should be done with a non-vibrating roller.

10.4.2. Demolition and installation of structures in TPZ

- All demolition and installation of structures within the TPZ will need to be done under the instruction of the project arborist.
- Great care should be taken to ensure no roots are damaged as structures or surfaces are removed since roots are often very close to the surface. No heavy machinery is allowed within any TPZs and any removal of structures and surfaces should be done using appropriate hand and power tools to ensure roots are not damaged underneath the surface being removed.
- Installation of new surfaces should be semi permeable to allow water and gaseous exchange to the root zone underneath. There are several specialised surface materials and technologies that can allow for this whilst ensuring adequate loading is still possible without any additional compaction. The project arborist will need to determine which of these will be suitable for the application.
- Installation of building structures within the TPZ may require piled supports that are located between the larger structural roots and enable the structure to be suspended. This is an engineering solution that

will require the collaboration of the project arborist and the architect to develop the correct designs. above the root zone and therefore limit the detrimental effects of the encroachment into this area.

- Installing underground services – If services must be routed through a TPZ they should be installed by directional drilling (at least 600mm deep) or in manually excavated trenches using non-destructive techniques such as hydrovacs or airspades (supervised by project arborist) and the services can then be laid underneath or between the root system.
- Scaffolding – When it is essential to erect scaffolding within a TPZ it should be designed to minimize any branch removal. Branches should be tied back, or when unavoidable, pruned as required according to AS-4373. These works may require authority from LGA. Ground protection as detailed in section 10.3.2 above may also be required.

10.4.3. Soft landscaping in TPZ

Guidelines for Soft Landscaping within the TPZ:

- Soft landscaping involves the addition of soil, trees and plants, lawns and mulch. These all have the potential to be extremely damaging to trees if not done according to directions of the project arborist.
- No significant excavations, turfing, plantings, grade changes, soil addition or removal, addition of fertilisers or mulching should be done without consultation with project arborist
- Areas too close to tree trunks should not be have grade changes or be excessively mulched

10.4.4. Monitoring during construction

All the TPZs for the retained trees are to be monitored and maintained throughout the construction phase of development. Areas that may require maintenance include:

- Mulching – mulch (if required) must be maintained to a depth of 50-100mm. Where the existing landscape within the TPZ is to remain unaltered, mulch may not be required.
- Irrigation – Soil moisture levels may need to be monitored by the project arborist. Temporary irrigation or watering may be required within the TPZ upon discretion of project arborist.

The project arborist should monitor at regular intervals all construction works and excavations on site that are within the proximity of any TPZ to ensure that protection measures are being adhered to and no works are likely to affect the health of the protected trees.

10.5. Post construction

At completion of all construction works the project arborist should assess the tree conditions and provide certification for tree protection with a condition that outstanding works or landscaping must not injure the trees. After this all tree protection measures should be removed from the site.

Following the final inspection and completion of remedial works the project arborist should certify the completed works have been carried out in compliance with the approved plans and specifications according to AS-4970-2009. Monitoring documentation and any deviations should also be provided

11. QUALIFICATIONS

- **Master Science Degree (MSc Hons)** – Information Technology (Sheffield Hallam University, UK)
- **Graduate Diploma (Arboriculture) – AQF Level 8** - (University of Melbourne) – 1st Class Hons
- **Bachelor Science Degree (BSc Hons)** - Environmental Science (Leeds University, UK)
- **Diploma Horticulture (Arboriculture)** – **AQF Level 5** - (Kurri Kurri TAFE) – Distinction
- **Certified Tree Risk Assessor** –QTRA Certified and ISA TRAQ Certified Risk Assessor
- **Arboriculture AQF Level 3** – Horticulture (Arboriculture) (Ryde TAFE)
- Member Arboriculture Australia – 12 Years
- 20 years arboriculture industry experience - Tree contractor and consulting arborist

12. References

1. Barrell, Jeremy (2009). *SULE: Its use and status into the new Millennium*. Barrell Tree Consultancy. http://www.barrelltreecare.co.uk/pdfs/BT08-Sydney.pdf
2. Matheny, N.P & Clark, J.R (1994). A photographic Guide to the Evaluation of Hazard Trees in Urban Areas. International Society Arboriculture (ISA)
3. Mattheck, K and Breloer, H (2007). *The Body Language of Trees* – A handbook for failure analysis.
4. Standards Australia (2009). AS-4970: *Protection of Trees on Development Sites*
5. Standards Australia (1996). AS-4373 – *Pruning of Amenity Trees*.
6. Draper, D.B & Richards, P.A (2009). *Dictionary for Managing Trees in Urban Environments*. CSIRO Publishing.
7. Urban Forest Technical Manual. Newcastle council. 2012.
8. Tree Retention Values Table. A.Morton from: Couston, Mark and Howden, Melanie (2001). Footprint Green Pty Ltd, Sydney Australia.
9. Canterbury Bankstown Council DCP and Tree Management Policy
10. IACA Significance of a Tree, Assessment Rating System (STARS) © (IACA 2010) http://www.iaca.org.au/home/index.php/publications
11. Sustainable Retention Index Value (SRIV) Version 4 © (IACA 2010) http://www.iaca.org.au/home/index.php/publications
12. Manual for managing trees on development sites v3.0. Barrell Tree Consultancy 2020.
13. Terram Geocell Ground Reinforcement - Tree Root Protection. Terram Geocell 2019. https://terram.com/app/uploads/2020/07/TERRAM_Ground_Reinforcement_Solutions.pdf

13. Appendices

13.1. Appendix 1 – Visual Tree Assessment (VTA) Method

THE PRINCIPLES OF RECOGNIZING PREDICTABLE TREE FAILURES

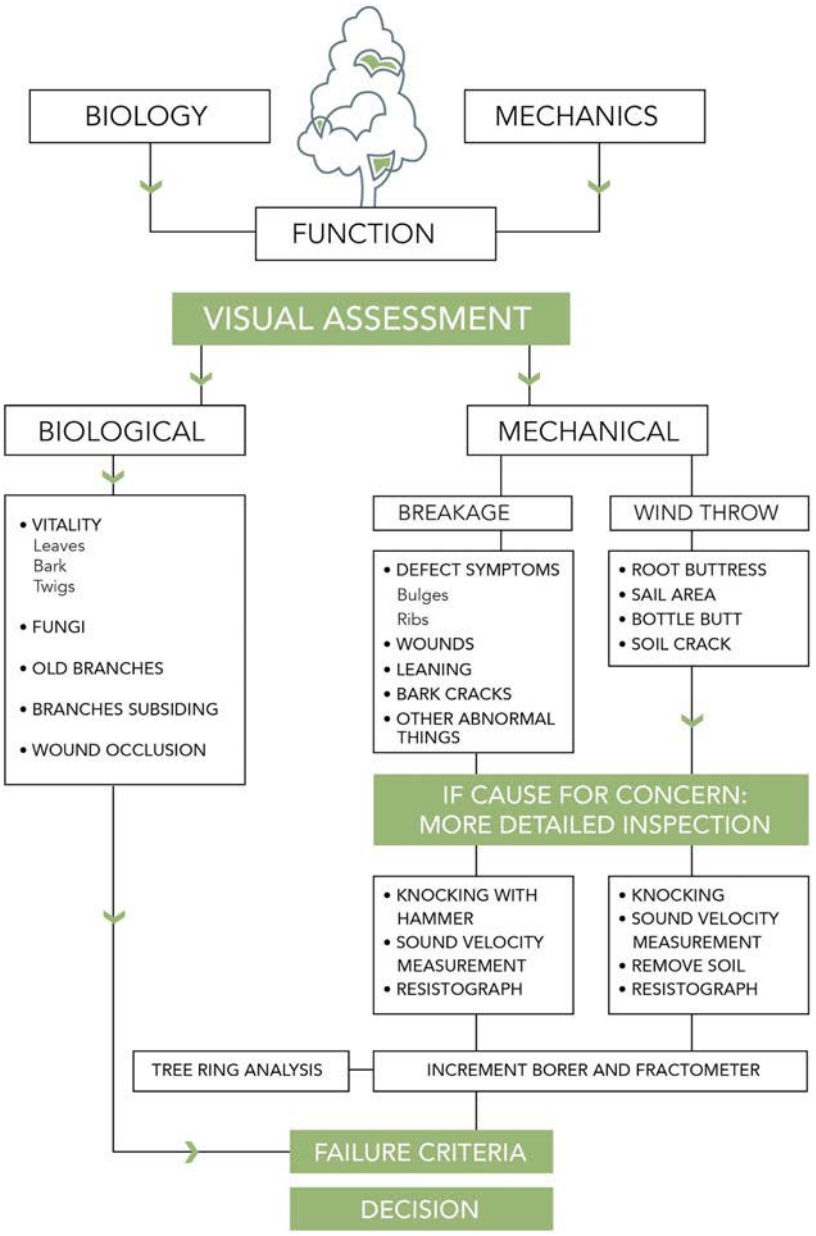


Figure 3 - Schematic Representation of the procedure for evaluating a tree with the VTA system

Source: Mattheck and Breloer "The body Language of Trees" 2007 p.196

13.2. Appendix 2 – (IACA 2010)© IACA Significance of a Tree, Assessment Rating System (STARS)

Institute of Australian Consulting Arboriculturists, Australia, **www.iaca.org.au**. In the development of this document IACA acknowledges the contribution and original concept of the Footprint Green Tree Significance & Retention Value Matrix, developed by Footprint Green Pty Ltd in June 2001.

The landscape significance of a tree is an essential criterion to establish the importance that a particular tree may have on a site. However, rating the significance of a tree becomes subjective and difficult to ascertain in a consistent and repetitive fashion due to assessor bias. It is therefore necessary to have a rating system utilising structured qualitative criteria to assist in determining the retention value for a tree. To assist this process all definitions for terms used in the *Tree Significance - Assessment Criteria* and *Tree Retention Value - Priority Matrix*, are taken from the IACA Dictionary for Managing Trees in Urban Environments 2009.

This rating system will assist in the planning processes for proposed works, above and below ground where trees are to be retained on or adjacent a development site. The system uses a scale of *High, Medium and Low significance* in the landscape. Once the landscape significance of an individual tree has been defined, the retention value can be determined.

Tree Significance - Assessment Criteria

1. High Significance in landscape

- The tree is in good condition and good vigour;- The tree has a form typical for the species;- The tree is a remnant or is a planted locally indigenous specimen and/or is rare or uncommon in the local area or of botanical interest or of substantial age;- The tree is listed as a Heritage Item, Threatened Species or part of an Endangered ecological community or listed on Councils significant Tree Register;- The tree is visually prominent and visible from a considerable distance when viewed from most directions within the landscape due to its size and scale and makes a positive contribution to the local amenity;- The tree supports social and cultural sentiments or spiritual associations, reflected by the broader population or community group or has commemorative values;- The tree's growth is unrestricted by above and below ground influences, supporting its ability to reach dimensions typical for the taxa in situ - tree is appropriate to the site conditions.

2. Medium Significance in landscape

- The tree is in fair-good condition and good or low vigour;- The tree has form typical or atypical of the species;- The tree is a planted locally indigenous or a common species with its taxa commonly planted in the local area- The tree is visible from surrounding properties, although not visually prominent as partially obstructed by other vegetation or buildings when viewed from the street,- The tree provides a fair contribution to the visual character and amenity of the local area,- The tree's growth is moderately restricted by above or below ground influences, reducing its ability to reach dimensions typical for the taxa in situ.

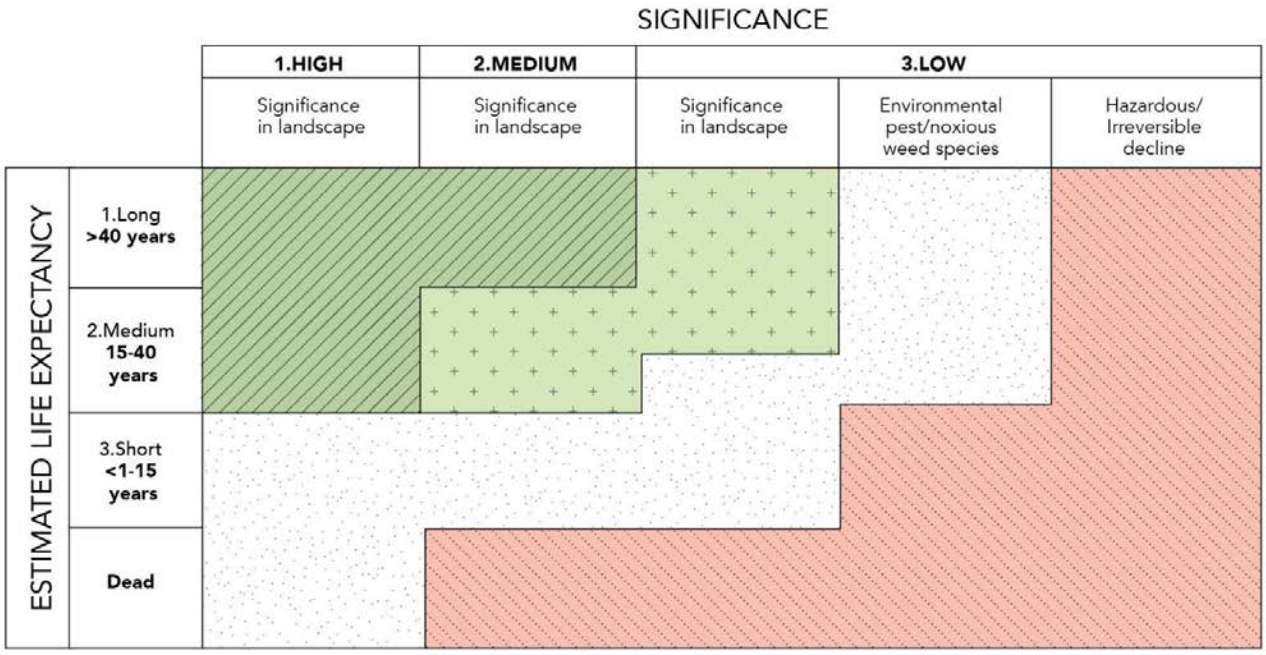
3. Low Significance in landscape

- The tree is in fair-poor condition and good or low vigour;- The tree has form atypical of the species;- The tree is not visible or is partly visible from surrounding properties as obstructed by other vegetation or buildings,- The tree provides a minor contribution or has a negative impact on the visual character and amenity of the local area,- The tree is a young specimen which may or may not have reached dimension to be protected by local Tree Preservation orders or similar protection mechanisms and can easily be replaced with a suitable specimen,- The tree's growth is severely restricted by above or below ground influences, unlikely to reach dimensions typical for the taxa in situ - tree is inappropriate to the site conditions,- The tree is listed as exempt under the provisions of the local Council Tree Preservation Order or similar protection mechanisms,- The tree has a wound or defect that has potential to become structurally unsound.Environmental Pest / Noxious Weed Species- The tree is an Environmental Pest Species due to its invasiveness or poisonous/ allergenic properties,- The tree is a declared noxious weed by legislation.Hazardous/Irreversible Decline- The tree is structurally unsound and/or unstable and is considered potentially dangerous, - The tree is dead, or is in irreversible decline, or has the potential to fail or collapse in full or part in the immediate to short term.

The tree is to have a minimum of three (3) criteria in a category to be classified in that group.
Note: The assessment criteria are for individual trees only, however, can be applied to a monocultural stand in its entirety.

Table 1.0 below shows how to use the significance ratings to provide a value for the Tree Retention Value – Priority Matrix.

Table 1.0 Tree retention Value- Priority matrix



LEGEND FOR MATRIX ASSESSMENT

	Priority for retention (HIGH) –These trees are considered important for retention and should be retained and protected. Design modification or relocation of building/s should be considered to accomodate the setbacks as prescribed by the Australian Standard AS4970 *Protection of Trees on Development Sites*. Tree sensitive construction measures must be implemented eg. pier and beam etc if works are to proceed within the Tree Protection Zone
	Consider for retention (MEDIUM) – These trees may be retained and protected. These are considered less critical; however their retention should remain priority with removal considered only if adversely affecting the proposed building/works and all other alternatives have been conisdered and exhausted
	Consider for removal (LOW) – These trees are not considered important for retention, nor require special works or design modification to be implemented for their retention
	Priority for removal (LOW) – These trees are considered hazardous, or in irreversible decline, or weeds and should be removed irrespective of development

REFERENCES:

IACA, Institute of Australian Consulting Arborists

Australia ICOMOS Inc.1999, The Burra Charter – *The Australian ICOMOS Charter for Places of Cultural Significance*, International Council of Monuments and Sites., www.icomos.org/australia

Draper BD and Richards PA 2009, *Dictionary for Managing Trees in Urban Environments*, IACA, Institute of Australian Consulting Arborists, CSIRO Publishing, Collingwood Victoria, Australia

Footprint Green Pty Ltd, 2001, F*ootprint Green Tree Significance & Retention Value Matrix, Avalon* NSW Australia www.footprintgreen.com.au

13.3. Appendix 3 - IACA, 2010, Sustainable Retention Index Value (SRIV)©

The matrix is to be used with the value classes defined in the Glossary for Age / Vigour / Condition.An index value is given to each category where ten (10) is the highest value.

Age Class	Vigour Class and Condition Class					
	Good Vigour & Good Condition (GVG)	**Good Vigour & Fair Condition (GVF)**	**Good Vigour & Poor Condition (GVP)**	**Low Vigour & Good Condition (LVG)**	**Low Vigour & Fair Condition (LVF)**	**Low Vigour & Poor Condition (LVP)**
	Able to be retained if sufficient space available above and below ground for future growth. No remedial work or improvement to growing environment required. May be subject to high vigour. Retention potential - Medium - Long Term.	Able to be retained if sufficient space available above and below ground for future growth. Remedial work may be required or improvement to growing environment may assist. Retention potential - Medium Term. Potential for longer with remediation or favourable environmental conditions.	Able to be retained if sufficient space available above and below ground for future growth. Remedial work unlikely to assist condition, improvement to growing environment may assist. Retention potential - Short Term. Potential for longer with remediation or favourable environmental conditions.	Retained if sufficient space available above and below ground for future growth. No remedial work required, but improvement to growing environment may assist vigour. Retention potential - Short Term. Potential for longer with remediation or favourable environmental conditions.	May be able to be retained if sufficient space available above and below ground for future growth. Remedial work or improvement to growing environment may assist condition and vigour. Retention potential - Short Term. Potential for longer with remediation or favourable environmental conditions.	Unlikely to be able to be retained if sufficient space available above and below ground for future growth. Remedial work or improvement to growing env. unlikely to assist condition or vigour. Retention potential - Likely to be removed immediately or retained for Short Term. Potential for longer with remediation or favourable environmental conditions.
(Y) Young	**YGVG - 9Index Value 9** Retention potential - Long Term. Likely to provide minimal contribution to local amenity if height Retain, move or replace.	**YGVF - 8 Index Value 8** Retention potential - Short - Medium Term. Potential for longer with improved growing conditions. Likely to provide minimal contribution to local amenity if height Medium-high potential for future growth and adaptability. Retain, move or replace.	**YGVP - 5Index Value 5** Retention potential - Short Term. Potential for longer with improved growing conditions. Likely to provide minimal contribution to local amenity if height Low-medium potential for future growth and adaptability. Retain, move or replace.	**YLVG - 4Index Value 4** Retention potential - Short Term. Potential for longer with improved growing conditions. Likely to provide minimal contribution to local amenity if height Medium potential for future growth and adaptability. Retain, move or replace	**YLVF - 3Index Value 3** Retention potential - Short Term. Potential for longer with improved growing conditions. Likely to provide minimal contribution to local amenity if height <5m. Low-medium potential for future growth and adaptability. Retain, move or replace.	**YLVP - 1Index Value 1** Retention potential - Likely to be removed immediately or retained for Short Term. Likely to provide minimal contribution to local amenity if height
(M) Mature	**MGVG - 10Index Value 10** Retention potential -Medium - Long Term.	**MGVF - 9Index Value 9** Retention potential - Medium Term. Potential for longer with improved growing conditions.	**MGVP - 6Index Value 6** Retention potential - Short Term. Potential for longer with improved growing conditions.	**MLVG - 5Index Value 5** Retention potential - Short Term. Potential for longer with improved growing conditions.	**MLVF - 4Index Value 4** Retention potential - Short Term. Potential for longer with improved growing conditions.	**MLVP - 2Index Value 2** Retention potential - Likely to be removed immediately or retained for Short Term.

(O) Over-mature	**OGVG - 6Index Value 6** Retention potential - Medium - Long Term.	**OGVF - 5Index Value 5** Retention potential - Medium Term.	**OGVP - 4Index Value 4** Retention potential - Short Term.	**OLVG - 3Index Value 3** Retention potential - Short Term. Potential for longer with improved growing conditions.	**OLVF - 2Index Value 2** Retention potential - Short Term.	**OLVP - 0Index Value 0** Retention potential - Likely to be removed immediately or retained for Short Term.

13.4. Appendix 4 – Further Information on Tree Protection Zones from AS4970 2009 (Protection of trees on development sites)

Following extracts and definitions taken from AS-4970-2009:

Tree protection zone (TPZ)

"The tree protection zone (TPZ) is the principal means of protecting trees on development sites. The TPZ is a combination of the root area and crown area requiring protection. It is an area isolated from construction disturbance, so that the tree remains viable.

The TPZ incorporates the structural root zone (SRZ) (refer to Clause 3.3.5 in AS4970-2009)."

Determining the TPZ

The radius of the TPZ is calculated for each tree by multiplying its DBH x 12

Where TPZ = DBH x 12

DBH = trunk diameter measured at 1.4 m above ground (DBH = Diameter at Breast Height)

Radius is measured from the centre of the stem at ground level.

Note: Minimum TPZ size is 2.0m.

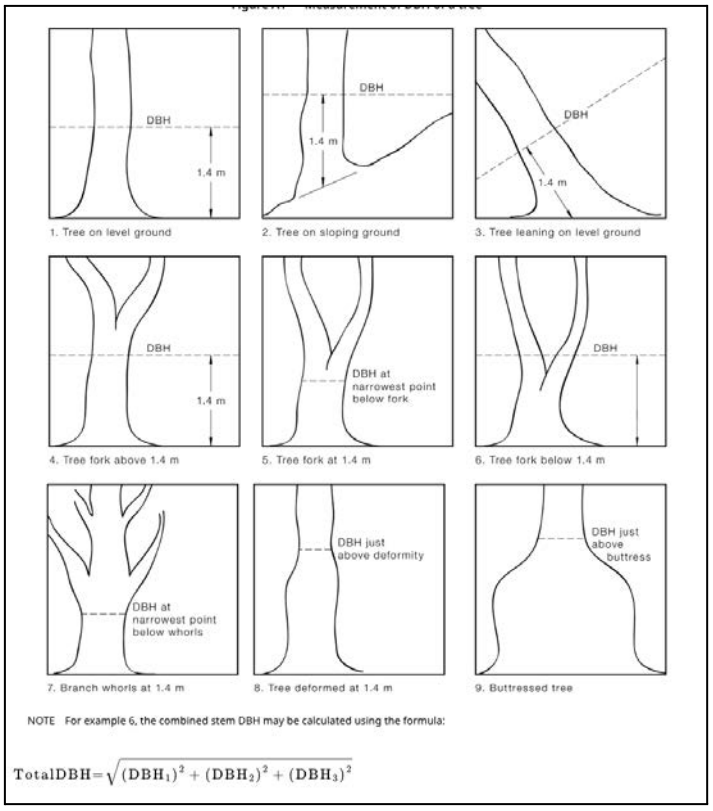


Figure 4 - Examples of DBH measurements on a variety of tree forms - from AS-4970-2009

Structural root zone (SRZ)

"The SRZ is the area required for street stability. A larger area is required to maintain a viable tree. The SRZ only needs to be calculated when a major encroachment into a TPZ is proposed. Root investigation may provide more information on the extent of these roots."

Determining the SRZ

SRZ radius = (DRC x 50) 0.42 x 0.64

Where

DRC = trunk diameter, in metres, measured above the root crown (DRC = Diameter Above Root Crown)

Note: The SRZ for trees with trunk diameters (DRC) less than 0.15 m will be 1.5 m.

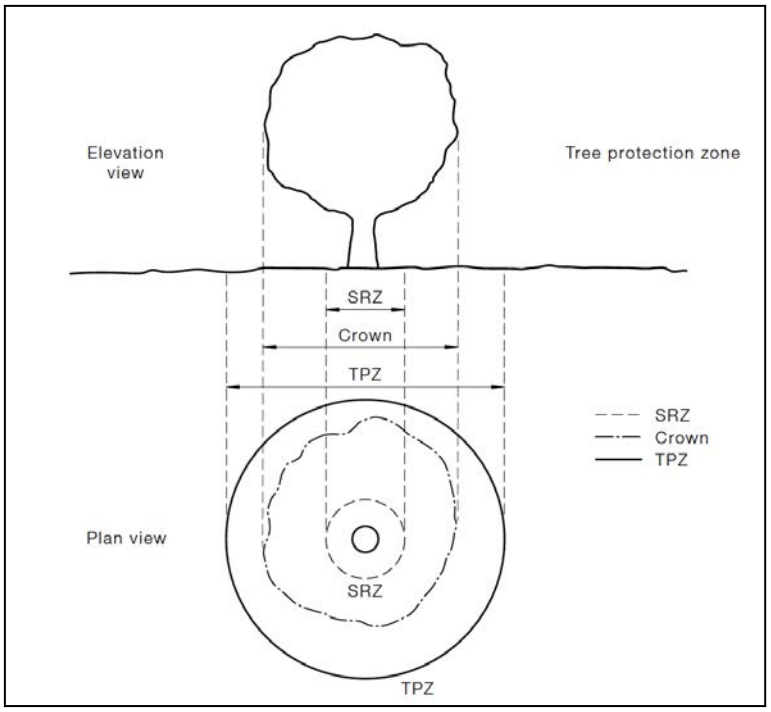


FIGURE 5 - TPZ AND SRZ EXAMPLES FROM AS-4970-2009

Variations to Tree Protection Zones (TPZs) - TPZ Encroachments

It is possible to encroach inside the TPZ radius for development works including root pruning, excavations, compacted fill and machine trenching provided certain conditions are met. There are 2 categories of TPZ encroachments:

1. **Minor TPZ Encroachment** - The proposed encroachment is less than 10% of the area of the TPZ and is outside the SRZ, detailed root investigations should not be required. The area lost to this encroachment should be compensated elsewhere and continuous with the TPZ. Variations must be made by the project arborist considering the relevant factors listed in Clause 3.3.4 of AS-4970-2009. Figure 6 below shows some examples of minor TPZ encroachment.

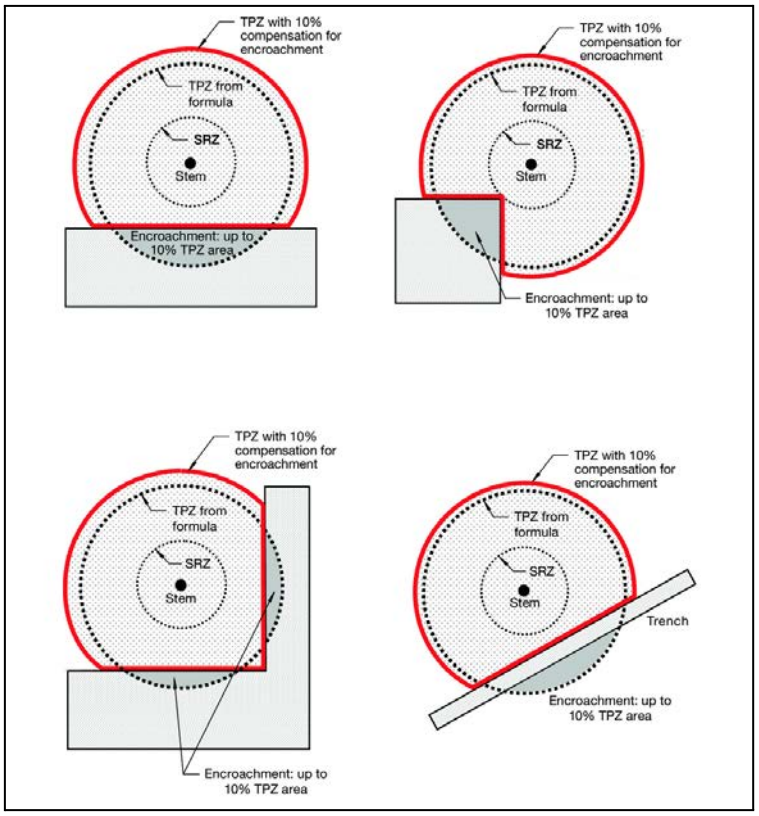


FIGURE 6 - EXAMPLES OF MINOR TPZ ENCROACHMENTS FROM AS-4970-2009

2. **Major TPZ Encroachment** - The proposed encroachment is greater than 10% of the TPZ or inside the SRZ. The project arborist must demonstrate that the tree would remain viable. The area lost to this encroachment should be compensated elsewhere and continuous with the TPZ. This may require root investigation by non-destructive techniques and consideration of relevant factors listed in Clause 3.3.4 of AS-4970-2009. A summary of these factors is listed in section 5.2 above.

13.5. Appendix 5 - Installation of hard surfaces through Tree Protection Zones

Tree sensitive surface installations need to be installed above the current grade levels and involve no excavations or any root pruning. This is primarily done by using some form of load bearing material that can be installed above the current grade without needing to compact the soil surrounding the existing root system. The materials above will also need to be permeable to allow water infiltration and gaseous exchange for the root system. There are numerous construction and engineering techniques used to achieve this. One of the most popular involves a cellular system that can be filled with large aggregates and then some form of permeable pavement or permeable concrete above. The following figures show a few examples of these tree sensitive hard surface installations.

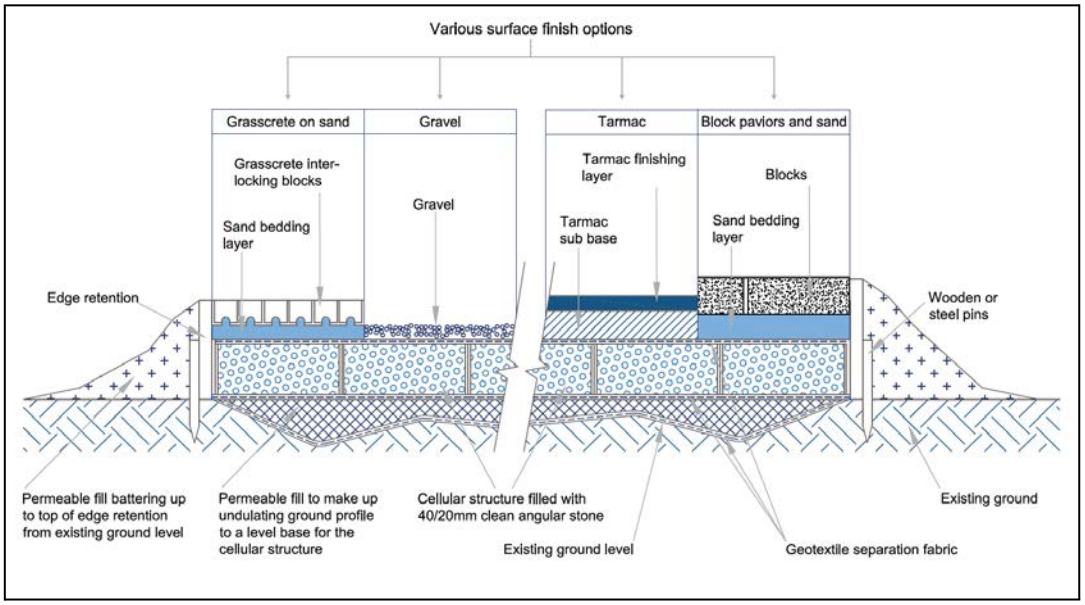


Figure 7 - No dig cellular confinement surfacing with examples of finishing options (Source: Barrel Tree Consultancy 2020)

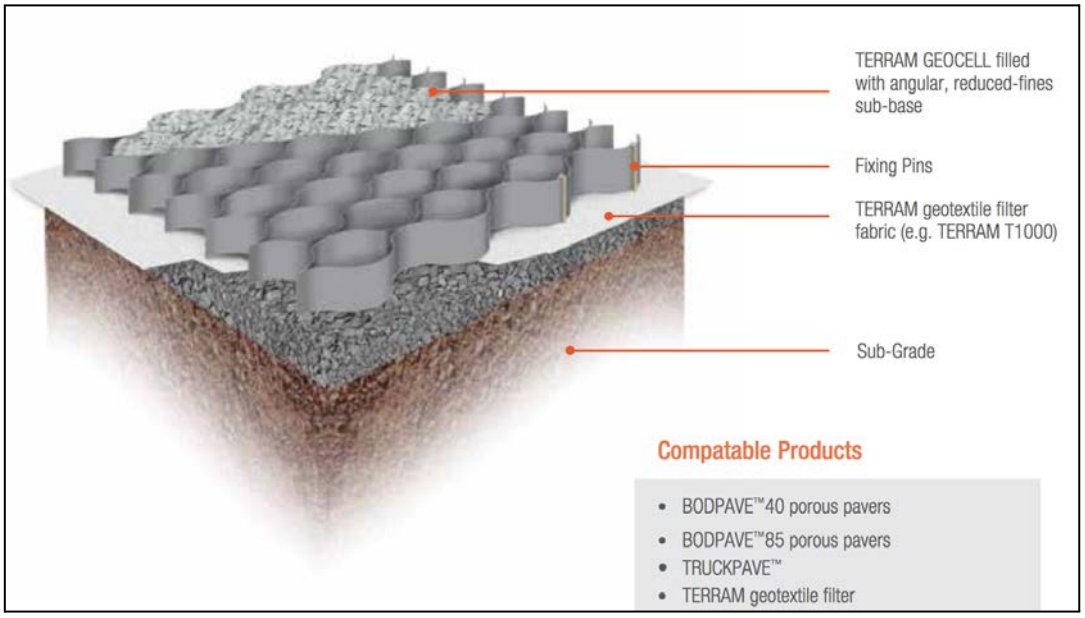


Figure 8 - Terram Geocells - Tree root protection (Source: Terram Geocell 2019)

13.6. Appendix 6 - Glossary

From Dictionary for Managing Trees in Urban Environments
Institute of Australian Consulting Arboriculturists (IACA) 2009.

Age of Trees

Age Most trees have a stable biomass for the major proportion of their life. The estimation of the age of a tree is based on the knowledge of the expected lifespan of the taxa in situ divided into three distinct stages of measurable biomass, when the exact age of the tree from its date of cultivation or planting is unknown and can be categorized as Young, Mature and Over-mature (British Standards 1991, p. 13, Harris et al, 2004, p. 262).

Young Tree aged less than <20% of life expectancy, in situ. **Mature** Tree aged 20-80% of life expectancy, in situ.

Over-mature Tree aged greater than >80% of life expectancy, in situ, or senescent with or without reduced vigour, and declining gradually or rapidly but irreversibly to death.

Condition of Trees

Condition A tree's crown form and growth habit, as modified by its environment (aspect, suppression by other trees, soils), the stability and viability of the root plate, trunk and structural branches (including structural defects such as wounds, cavities or hollows, crooked trunk or weak trunk/branch junctions and the effects of predation by pests and diseases. These may not be directly connected with vigour and it is possible for a tree to be of normal vigour but in poor condition. Condition can be categorized as Good Condition, Fair Condition, Poor Condition and Dead.

Good Condition Tree is of good habit, with crown form not severely restricted for space and light, physically free from the adverse effects of predation by pests and diseases, obvious instability or structural weaknesses, fungal, bacterial or insect infestation and is expected to continue to live in much the same condition as at the time of inspection provided conditions around it for its basic survival do not alter greatly. This may be independent from, or contributed to by vigour.

Fair Condition Tree is of good habit or misshapen, a form not severely restricted for space and light, has some physical indication of decline due to the early effects of predation by pests and diseases, fungal, bacterial, or insect infestation, or has suffered physical injury to itself that may be contributing to instability or structural weaknesses, or is faltering due to the modification of the environment essential for its basic survival. Such a tree may recover with remedial works where appropriate, or without intervention may stabilise or improve over time, or in response to the implementation of beneficial changes to its local environment. This may be independent from, or contributed to by vigour.

Poor Condition Tree is of good habit or misshapen, a form that may be severely restricted for space and light, exhibits symptoms of advanced and irreversible decline such as fungal, or bacterial infestation, major die-back in the branch and foliage crown, structural deterioration from insect damage e.g. termite infestation, or storm damage or lightning strike, ring barking from borer activity in the trunk, root damage or instability of the tree, or damage from physical wounding impacts or abrasion, or from altered local environmental conditions and has been unable to adapt to such changes and may decline further to death regardless of remedial works or other modifications to the local environment that would normally be sufficient to provide for its basic survival if in good to fair condition. Deterioration physically, often characterised by a gradual and continuous reduction in vigour but may be independent of a change in vigour, but characterised by a proportionate increase in susceptibility to, and predation by pests and diseases against which the tree cannot be sustained. Such conditions may also be evident in trees of advanced senescence due to normal phenological processes, without modifications to the growing environment or physical damage having been inflicted upon the tree. This may be independent from, or contributed to by vigour.

Dead Tree is no longer capable of performing any of the following processes or is exhibiting any of the following symptoms;
Processes
Photosynthesis via its foliage crown (as indicated by the presence of moist, green or other coloured leaves);
Osmosis (the ability of the root system to take up water);
Turgidity (the ability of the plant to sustain moisture pressure in its cells);
Epicormic shoots or epicormic strands in Eucalypts (the production of new shoots as a response to stress, generated from latent or adventitious buds or from a lignotuber);
Symptoms
Permanent leaf loss;
Permanent wilting (the loss of turgidity which is marked by desiccation of stems leaves and roots);
Abscission of the epidermis (bark desiccates and peels off to the beginning of the sapwood).

Removed No longer present, or tree not able to be located or having been cut down and retained on a site, or having been taken away from a site prior to site inspection.

Deadwood

Deadwood Dead branches within a tree's crown have been categorised into 3 categories for the purpose of this report:

Nil – There are no dead branches or they are less than 20mm in diameter so not significant.
Minor – Dead branches are 20-75mm in diameter.
Major – Dead branches are 75mm in diameter and above.

Deadwooding Removing of dead branches by pruning. Such pruning may assist in the prevention of the spread of decay from dieback or for reasons of safety near an identifiable target.

Dieback

Dieback The death of some areas of the crown. Symptoms are leaf drop, bare twigs, dead branches and tree death, respectively. This can be caused by root damage, root disease, bacterial or fungal canker, severe bark damage, intensive grazing by insects, abrupt changes in growth conditions, drought, water-logging or over-maturity. Dieback often implies reduced resistance, stress or decline which may be temporary. Dieback can be categorized as Low Volume Dieback, Medium Volume Dieback and High Volume Dieback.

Low Volume Dieback Where <10% of the crown cover has died. See also Dieback, High Volume Dieback and Medium Volume Dieback.

Medium Volume Dieback Where 10-50% of the crown cover has died.

High Volume Dieback Where >50% of the crown cover has died.

Form of Trees

Crown Form The shape of the crown of a tree as influenced by the availability or restriction of space and light, or other contributing factors within its growing environment. Crown Form may be determined for tree shape and habit generally as Dominant, Codominant, Intermediate, Emergent, Forest and Suppressed. The habit and shape of a crown may also be considered qualitatively and can be categorized as Good Form or Poor Form.

Good Form Tree of typical crown shape and habit with proportions representative of the taxa considering constraints such as origin e.g. indigenous or exotic, but does not appear to have been adversely influenced in its development by environmental factors in situ such as soil water availability, prevailing wind, or cultural practices such as lopping and competition for space and light.

Poor Form Tree of atypical crown shape and habit with proportions not representative of the species considering constraints and appears to have been adversely influenced in its development by environmental factors in situ such as soil water availability, prevailing wind, cultural practices such as lopping and competition for space and light; causing it to be misshapen or disfigured by disease or vandalism.

Crown Form Codominant Crowns of trees restricted for space and light on one or more sides and receiving light primarily from above e.g. constrained by another tree/s or a building.

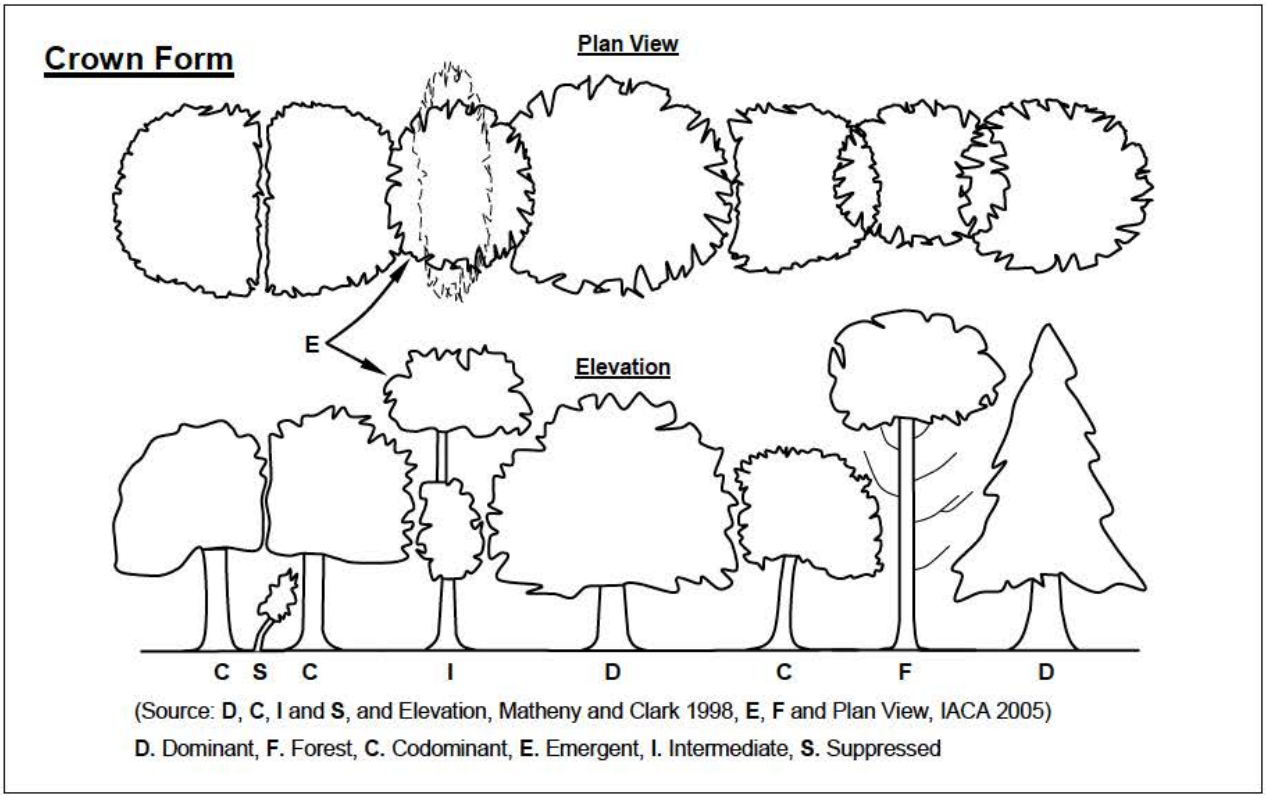
Crown Form Dominant Crowns of trees generally not restricted for space and light receiving light from above and all sides.

Crown Form Emergent Crowns of trees restricted for space on most sides receiving most light from above until the upper crown grows to protrude above the canopy in a stand or forest environment. Such trees may be crown form dominant or transitional from crown form intermediate to crown form forest asserting both apical dominance and axillary dominance once free of constraints for space and light.

Crown Form Forest Crowns of trees restricted for space and light except from above forming tall trees with narrow spreading crowns with foliage restricted generally to the top of the tree. The trunk is usually erect, straight and continuous, tapering gradually, crown often excurrent, with first order branches becoming structural, supporting the live crown concentrated towards the top of the tree, and below this point other first order branches arising radially with each inferior and usually temporary, divergent and ranging from horizontal to ascending, often with internodes exaggerated due to competition for space and light in the lower crown.

Crown Form Intermediate Crowns of trees restricted for space on most sides with light primarily from above and on some sides only.

Crown Form Suppressed Crowns of trees generally not restricted for space but restricted for light by being overtopped by other trees and occupying an
understorey position in the canopy and growing slowly.



Symmetry Balance within a crown, or root plate, above or below the axis of the trunk of branch and foliage, and root distribution respectively and can be
categorized as Asymmetrical and Symmetrical.

Asymmetrical Imbalance within a crown, where there is an uneven distribution of branches and the foliage crown or root plate around the vertical axis of the trunk. This may be due to Crown Form Codominant or Crown From Suppressed as a result of natural restrictions e.g. from buildings, or from competition for space and light with other trees, or from exposure to wind, or artificially caused by pruning for clearance of roads, buildings or power lines. An example of an expression of this may be, crown asymmetrical, bias to west.

Symmetrical Balance within a crown, where there is an even distribution of branches and the foliage crown around the vertical axis of the trunk. This usually applies to trees of Crown Form Dominant or Crown Form Forest. An example of an expression of this may be crown symmetrical.

Crown Spread Orientation Direction of the axis of crown spread which can be categorized as Orientation Radial and Orientation Non-radial.

Crown Spread Orientation Non-radial Where the crown extent is longer than it is wide, e.g. east/west or E/W. Further examples, north/south or N/S, and may be Crown Form Codominant, e.g. **A** or **B**, Crown Form Intermediate e.g. **A**, or Crown Form Suppressed e.g. **B**, and crown symmetry is symmetrical e.g. **A**, or asymmetrical e.g. **B**.

Crown Spread Orientation Radial Where the crown spread is generally an even distance in all directions from the trunk and often where a tree has Crown Form Dominant and is symmetrical.

Crown Projection (CP) Area within the dripline or beneath the lateral extent of the crown (Geiger 2004, p. 2). See also Crown spread and Dripline.

Dripline A line formed around the edge of a tree by the lateral extent of the crown. Such a line may be evident on the ground with some trees when exposed soil

is displaced by rain shed from the crown. See also Crown Projection.

Epicormic Shoots Juvenile shoots produced at branches or trunk from epicormic strands in some Eucalypts (Burrows 2002, pp. 111-131) or sprouts produced from dormant or latent buds concealed beneath the bark in some trees. Production can be triggered by fire, pruning, wounding, or root damage but may also be as a result of stress or decline. Epicormic shoots can be categorized as Low Volume Epicormic Shoots, Medium Volume Epicormic Shoots and High Volume Epicormic Shoots.

- **Low Volume Epicormic Shoots** Where <10% of the crown cover is comprised of live epicormic shoots.
- **Medium Volume Epicormic Shoots** Where 10-50% of the crown cover is comprised of live epicormic shoots.
- **High Volume Epicormic Shoots** Where >50% of the crown cover is comprised of live epicormic shoots.

Trunk A single stem extending from the root crown to support or elevate the crown, terminating where it divides into separate stems forming first order branches. A trunk may be evident at or near ground or be absent in acaulescent trees of deliquescent habit, or may be continuous in trees of excurrent habit. The trunk of any caulescent tree can be divided vertically into three (3) sections and can be categorized as Lower Trunk, Mid Trunk and Upper Trunk. For a leaning tree these may be divided evenly into sections of one third along the trunk.

- **Acaulescent** A trunkless tree or tree growth forming a very short trunk. See also Caulescent.

- **Caulescent** Tree grows to form a trunk. See also Acaulescent

Leaning Trees

Leaning A tree where the trunk grows or moves away from upright. A lean may occur anywhere along the trunk influenced by a number of contributing factors e.g. genetically predetermined characteristics, competition for space or light, prevailing winds, aspect, slope, or other factors. A leaning tree may maintain a static lean or display an increasingly progressive lean over time and may be hazardous and prone to failure and collapse. The degrees of leaning can be categorised as Slightly leaning, Moderately Leaning, Severely leaning and Critically leaning.

Slightly Leaning – A leaning tree where the trunk is growing at an angle within 0-15 degrees from upright.

Moderately leaning - A leaning tree where the trunk is growing at an angle within 15-30 degrees from upright.

Severely Leaning - A leaning tree where the trunk is growing at an angle within 30-45 degrees from upright.

Critically leaning - A leaning tree where the trunk is growing at an angle greater than 45 degrees from upright.

Progressively Leaning – A tree where the degree of leaning appears to increase over time

Static Leaning A leaning tree whose lean appears to have stabilized over time.

Roots

First Order Roots (FOR) Initial woody roots arising from the root crown at the base of the trunk, or as an adventitious root mass for structural support and stability. Woody roots may be buttressed and divided as a marked gradation, gradually tapering and continuous or tapering rapidly at a short distance from the root crown. Depending on soil type these roots may descend initially and not be evident at the root crown, or become buried by changes in soil levels. Trees may develop 4-11 (Perry 1982, pp. 197-221), or more first order roots which may radiate from the trunk with a relatively even distribution, or be prominent on a particular aspect, dependent upon physical characteristics e.g. leaning trunk, asymmetrical crown; and constraints within the growing environment from topography e.g. slope, soil depth, rocky outcrops, exposure to predominant wind, soil moisture, depth of water table etc.

Orders of Roots The marked divisions between woody roots, commencing at the initial division from the base of the trunk, at the root crown where successive branching is generally characterised by a gradual reduction in root diameters and each gradation from the trunk and can be categorized numerically, e.g. first order roots, second order roots, third order roots etc. Roots may not always be evident at the root crown and this may be dependent on species, age class and the growing environment. Palms at maturity may form an adventitious root mass.

Root Plate The entire root system of a tree generally occupying the top 300-600mm of soil including roots at or above ground and may extend laterally for distances exceeding twice the height of the tree (Perry 1982, pp. 197-221). Development and extent is dependent on water availability, soil type, soil depth and the physical characteristics of the surrounding landscape.

Root Crown Roots arising at the base of a trunk.

Zone of Rapid Taper The area in the root plate where the diameter of structural roots reduces substantially over a short distance from the trunk. Considered
to be the minimum radial distance to provide structural support and root plate stability. See also Structural Root Zone (SRZ).

Structural Roots Roots supporting the infrastructure of the root plate providing strength and stability to the tree. Such roots may taper rapidly at short distances from the root crown or become large and woody as with gymnosperms and dicotyledonous angiosperms and are usually 1st and 2nd order roots, or form an adventitious root mass in monocotyledonous angiosperms (palms). Such roots may be crossed and grafted and are usually contained with the area of crown projection or extend just beyond the dripline.

Significance

Significant Tree A tree considered important, weighty or more than ordinary. Example: due to prominence of location, or in situ, or contribution as a component of the overall landscape for amenity or aesthetic qualities, or curtilage to structures, or importance due to uniqueness of taxa for species, subspecies, variety, crown form, or as an historical or cultural planting, or for age, or substantial dimensions, or habit, or as remnant vegetation, or habitat potential, or a rare or threatened species, or uncommon in cultivation, or of aboriginal cultural importance, or is a commemorative planting.

Sustainable Retention Index Value (SRIV) - A visual tree assessment method to determine a qualitative and numerical rating for the viability of urban trees for development sites and management purposes, based on general tree and landscape assessment criteria using classes of age, condition and vigour. SRIV is for the professional manager of urban trees to consider the tree in situ with an assumed knowledge of the taxon and its growing environment. It is based on the physical attributes of the tree and its response to its environment considering its position in a matrix for age class, vigour class, condition class and its sustainable retention with regard to the safety of people or damage to property. This also factors the ability to retain the tree with remedial work or beneficial modifications to its growing environment or removal and replacement. SRIV is supplementary to the decision made by a tree management professional as to whether a tree is retained or removed (IACA - Institute of Australian Consulting Arboriculturists 2005).

Vigour

Vigour - Ability of a tree to sustain its life processes. This is independent of the condition of a tree but may impact upon it. Vigour can appear to alter rapidly with change of seasons (seasonality) e.g. dormant, deciduous or semi-deciduous trees. Vigour can be categorized as Normal Vigour, High Vigour, Low Vigour and Dormant Tree Vigour.

Good Vigour Ability of a tree to maintain and sustain its life processes. This may be evident by the typical growth of leaves, crown cover and crown density, branches, roots and trunk and resistance to predation. This is independent of the condition of a tree but may impact upon it, and especially the ability of a tree to sustain itself against predation.

High Vigour Accelerated growth of a tree due to incidental or deliberate artificial changes to its growing environment that are seemingly beneficial, but may result in premature aging or failure if the favourable conditions cease, or promote prolonged senescence if the favourable conditions remain, e.g. water from a leaking pipe; water and nutrients from a leaking or disrupted sewer pipe; nutrients from animal waste, a tree growing next to a chicken coop, or a stock feed lot, or a regularly used stockyard; a tree subject to a stringent watering and fertilising program; or some trees may achieve an extended lifespan from continuous pollarding practices over the life of the tree.

Low Vigour Reduced ability of a tree to sustain its life processes. This may be evident by the atypical growth of leaves, reduced crown cover and reduced crown density, branches, roots and trunk, and a deterioration of their functions with reduced resistance to predation. This is independent of the condition of a tree but may impact upon it, and especially the ability of a tree to sustain itself against predation.

Dormant Tree Vigour Determined by existing turgidity in lowest order branches in the outer extremity of the crown, with good bud set and formation, and where the last extension growth is distinct from those most recently preceding it, evident by bud scale scars. Normal vigour during dormancy is achieved when such growth is evident on a majority of branches throughout the crown.