

11/11/2021

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Tree Response

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Arboricultural Report

(Development Impact Assessment)

For the Proposed Development of
39-41 Holland Road,
Blackburn South 3130

23rd September 2020

Client	: Glenn Porteous
Report by	: Tree Response Pty Ltd
Consulting Arborist	: Lachlan Williams



Table of Contents

1. Consultant	3
2. Scope of report.....	3
3. Introduction	3
4. Methodology	5
5. Observations	6
6. Discussion.....	15
7. Recommendations.....	20
8. Conclusion	22
Appendix 1: Arboricultural Inventory for Subject Site	23
Appendix 2: Design Response, Tree Locations & Protection Areas	26
Appendix 3: Tree Protection Zones.....	27
Appendix 4: Descriptors	43
Appendix 5: References	48
Appendix 6: Recommendations for Replacement Tree Species	49

1. Consultant

Lachlan Williams (lachlan@treeresponse.com.au ph.: 0419-883-912)

Qualifications and further training:

- Bachelor of Horticulture (Arb) – University of Melbourne (Burnley)
- Certificate III Horticulture (Nursery Production)
- Quantified Tree Risk Assessment (QTRA)
- Visual Tree Assessment (VTA)
- Tree Risk Assessment Qualification (TRAQ) – International Society of Arboriculture (ISA)

2. Scope of report

Ausdraft contacted Tree Response (on behalf of the client) regarding a proposed development at 39-41 Holland Rd, Blackburn South. An arboricultural development impact assessment was requested for all significant trees on/near the client's site, which could be affected by the proposed development.

A site inspection was undertaken on 6th May 2020. Significant trees were identified, and the inspection process commenced. A second inspection was conducted on 15th May 2020 to quantify root damage to **Tree 16**.

A Pre-Design report was produced following the site inspection to highlight tree retention and protection requirements. Subsequent development plans have been formulated in response to this initial report.

3. Introduction

Vegetation makes a significant contribution to our standard of living, which is especially important in urban areas.

Demand for higher density housing frequently puts pressure on existing vegetation, but reasonable compromise is often possible. Incremental losses of significant trees and overall vegetation cover is causing profound changes to neighbourhood character, but this can be minimised with

appropriate selection of trees worthy of retention and ensuring future landscaping incorporates sufficient replacement planting to retain site character.

Rather than trying to protect all vegetation, focus should be placed on identifying and protecting larger trees of higher quality that will give greater amenity benefits into the future.

It is considered unreasonable to prevent development when trees of low amenity benefit conflict with planning. At the same time, modifications to footprints and construction techniques can be implemented in many cases, to suitably protect root zones of trees that contribute significantly to the landscape and have a moderate life expectancy.

The key objectives of the report are:

- Identify and assess the current state of all significant trees located on/near the client's site, with the potential to be affected by the proposed development
- Determine suitability and priority for retention/removal for all trees assessed
- Determine appropriate protection measures for all trees assessed
- Identify required remedial works on assessed trees
- Recommend management strategies for trees throughout the development process

Tree retention/removal suitability was determined by considering the following factors:

- Tree health, structure and size
- Level of risk of harm to people and/or assets
- Amenity value (origin and related habitat for native fauna, neighbourhood character contribution, species suitability, privacy screening etc.)
- Useful Life Expectancy (ULE)
- Restrictions the tree would impose on a development if retained (in accordance with AS4970-2009, Protection of Trees on Development Sites)
- Management issues/costs in relation to the amenity benefit and ULE (this includes remedial pruning works in accordance with AS4373-2007, Pruning of Amenity Trees)
- Whether the tree would be likely to remain viable following development disturbance
- Whether the trees are owned by the client, neighbours, or council

Limitations and Assumptions:

- Where access to a property was not possible, trunk diameters were estimated to the nearest 5cm (e.g. **Trees 18 & 19**)
- Root distribution is considered to be symmetrical unless otherwise discussed
- Canopy spread for some trees on plans is not considered consistent with inspection information
- It is assumed all trees have been accurately located on plans provided (unless otherwise discussed – e.g. **Trees 19-24**)
- It is assumed all recommendations will be thoroughly implemented

4. Methodology

- The inspection consisted of a Visual Tree Assessment (VTA) taken from ground level to determine; health, structure, Useful Life Expectancy (ULE) and amenity value of each tree (See Appendix 4). No advanced diagnostics (e.g. aerial inspection, exploratory excavation, trunk radar) were performed unless otherwise stated
- Measurements were taken to ascertain tree height (laser rangefinder), and trunk diameters (diameter tape)
- Canopy spread was estimated, and averaged where asymmetry occurs
- Photographs were taken of each tree and other relevant aspects of the site
- In accordance with AS4970-2009 Protection of Trees on Development Sites, calculations were made to determine Tree Protection Zones (TPZ) and Structural Root Zones (SRZ)
- In accordance with AS4970-2009, calculations were made to determine the level of encroachment (minor or major encroachment). The level of encroachment was used as a benchmark to determine if trees would remain viable (See Appendix 3):
 - Minor encroachment (development disturbance infringes by less 10% of the total TPZ area, and is outside the SRZ). TPZ area infringed must be compensated for elsewhere contiguous with the likely root spread
 - Major encroachment (development disturbance infringes by more than 10% of the total TPZ area, and/or is inside the SRZ). The project arborist must demonstrate the tree will remain viable

5. Observations

5.1. Site description

The subject site is a residential property, with corner frontage to Holland Rd and Wicking Ct. The site is roughly rectangular in shape, has a minor sloping north-easterly aspect, and currently supports a double-storey brick dwelling with a detached brick garage serviced via a loosely paved driveway. Two crossovers exist on Wicking Ct. Vegetation within the site is comprised of both native and exotic trees/shrubs, several; large canopy trees dominate the vicinity. A 2.44m wide drainage and sewerage easement exists along the rear boundary of the site. Neighbours' houses exist near each side boundary.

Significant recent disturbance was apparent within the TPZ of **Tree 16** (driveway widening by client).

5.2. Zoning/Planning Overlays

- City of Whitehorse. Local Law 5 Part 8 Clause 40 requires:
 - A permit to remove/lop/destroy a significant tree (basal diameter $\geq 110\text{cm}$) (e.g. **Trees 1, 2, 4, 7, 10, 14, 16 & 17**), or carry out works within a Critical Root Zone (similar to Structural Root Zone – See Appendix 1 & 3)
 - Pruning must be in accordance with AS4373 1996/2007 Pruning of Amenity Trees
 - All properties within the City of Whitehorse are temporarily covered by a Significant Landscape Overlay (SLO) (Amendment C191 extends this policy to June 2020). This requires a permit to remove all trees $>5\text{m}$ height
- Neighbourhood Residential Zone – Schedule 3 (NRZ3):
 - At least 2 canopy trees (12m+ mature height) to be included to plans per dwelling (one in private open space), and should be of native/indigenous origin (See Appendix 6)
 - Plans to show existing trees to be removed, and proposed landscaping (including tree species/mature height)
 - Plans to allow sufficient space for planting of trees (not encumbered by easement)
 - Development should retain/plant trees that are part of neighbourhood character
- Significant Landscape Overlay – Schedule 9 (SLO9):

- Permit not required to remove a tree; <5m height with a single trunk circumference <1.0m at 1.0m height, or outside the minimum applicable street setback (e.g. no trees assessed are <5m height)

5.3. Proposed Development

The proposed development consists of three new double-storey units (Units 1-3) with attached garages. Unit 1 will have a pool and decking, Units 2 & 3 will have paved areas. The existing crossover near the northeast corner will be modified/shifted east, the other crossover on Wicking Ct could be reinstated (not annotated on plans). Two new crossovers on Holland Rd are proposed (one street tree requires removal), concrete driveways are proposed for all units.

Two mature canopy trees will be retained (**Trees 2 & 16**), one semi-mature canopy tree will be retained (**Tree 13**). All other vegetation will be removed. Proposed landscaping includes ten new small-medium sized trees.

Plans provided are titled:

- 'Existing Site Plan' (21/9/2020)
- 'Proposed Site Plan' (21/9/2020) - ground floor
- 'Proposed Site Plan' (21/9/2020) - first floor
- 'Elevations' (21/9/2020)
- 'Elevations & Streetscape' (21/9/2020)
- 'Shadow Diagrams' (21/9/2020)
- 'Landscape Plan' (Zenith Concepts Landscape Design, August 2020)

5.4. Photo Guide



Photo One: Tree 2 showing general condition, architecture, landscape contribution, and existing features in the TPZ.

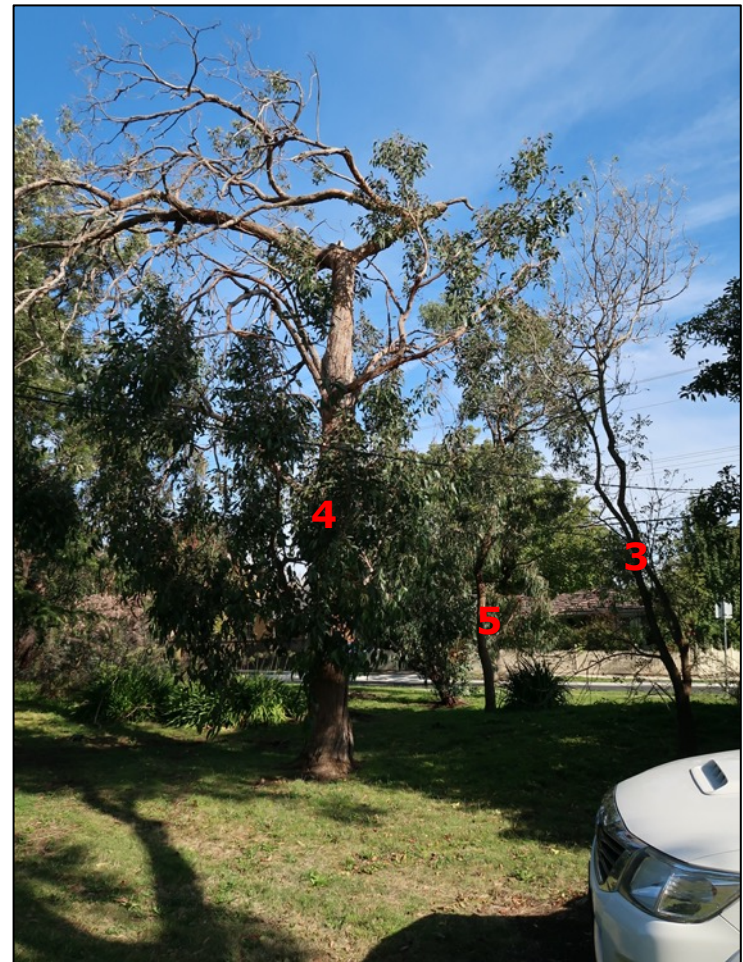


Photo Two: Tree 4 has extensive dieback. Removal of **Trees 3-5** is supported.



Photo Three: Tree 6 is not on plans, it has poor architecture making removal appropriate.



Photo Four: Trees 7 & 8 require removal for a new driveway, **Tree 26** must be retained and protected.



Photo Five: Trees 10 & 11 are semi-mature specimens suited to retention but their location restricts site development substantially.



Photo Six: Trees 12 & 13 showing minor landscape contribution at present, but Tree 13 has good long-term potential and will be retained.



Photo Seven: Tree 16 showing desirable condition, large landscape contribution, and existing features in the TPZ.



Photo Eight: Tree 16 had one large root severed (and later pruned), another was exposed but was undamaged. This tree requires diligent protection to maintain viability.

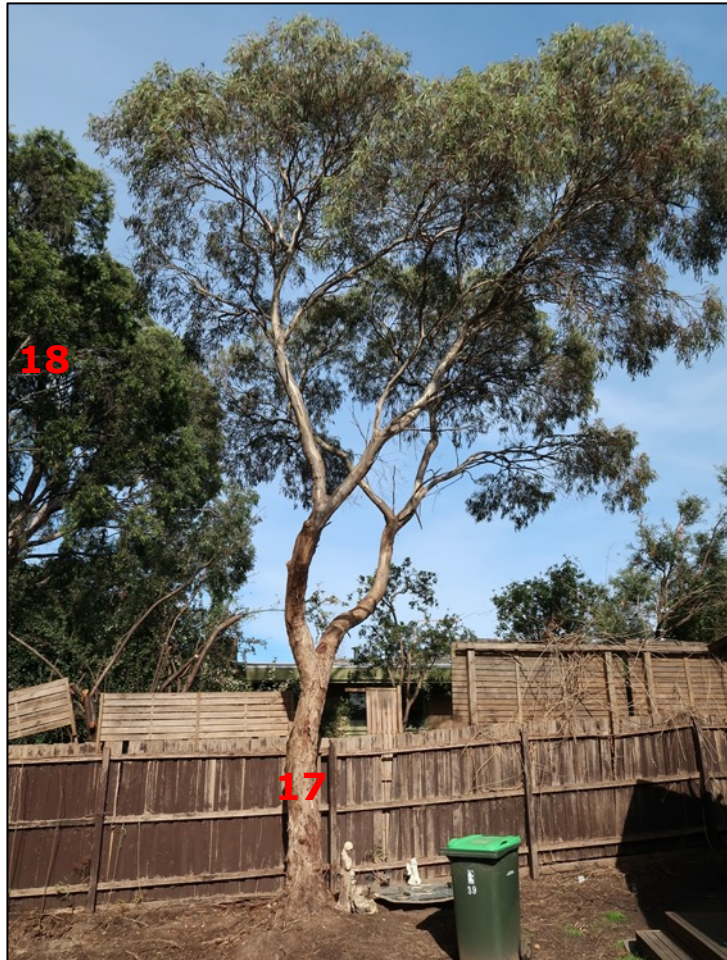


Photo Nine: Tree 17 showing general condition, architecture, landscape contribution, and proximity to boundary. Removal and replacement is proposed.



Photo Ten: Tree 18 is unlikely to be compromised because the existing shed is expected to have restricted root mass within the site.



Photo Eleven: Trees 23 & 24 require TPZ protection.



Photo Twelve: Tree 25 is a dominant tree, which should tolerate works with protection.



Photo Thirteen: Showing site from intersection. **Tree 31** requires removal for a new crossover.

6. Discussion

- Details of individual tree assessments can be found in Appendix 1
- Subject site and approximate tree locations can be found in Appendix 2
- Guidelines for tree protection and terminology can be found in Appendix 3 & 4

Thirty-one trees were assessed. Two of these trees (**Tree(s) 15 & 23**) represent multiple plants with similar attributes, locations, and protection requirements - they are treated here together.

Other vegetation exists on/near the client's site but was not assessed as it is deemed to be of insignificant stature (e.g. <5m height) and/or sufficient distance from the client's site that protection zones would not be encroached upon.

Trees On Client's Site (Trees 1-17)

- Two trees (**Trees 5 & 6**) incur no encroachment from the development proposal
- One tree (**Tree 13**) incurs a minor encroachment from the development proposal
- Fourteen trees (**Trees 1-4, 7-12 & 14-17**) incur a major encroachment from the development proposal
- Fourteen trees (**Trees 1, 3-12, 14, 15 & 17**) are required/recommended for removal
- Three trees (**Trees 2, 13 & 16**) require protection during works

Trees 1, 3 & 9 are all widely accepted environmental weed species and are on council's weed list. Removal of all three trees is recommended regardless of development necessity to prevent further landscape degradation.

Trees 2 & 4 are Messmate of varied condition (See Photo One). **Tree 2** adds moderate site character and habitat value, **Tree 4** is senescing and unsuitable for retention regardless of development (See Photo One).

Tree 2 has some prior wounds/pruning which may be indicative of a limited ULE, but retention is recommended because of its landscape prominence and overlay values. **Tree 2** incurs a major TPZ encroachment (approx. 14%), paving in the SRZ is recommended to be removed to minimise disturbance where large/structural roots will exist. **Tree 2** should remain viable with

fencing/ground protection as access requires, plus irrigation of the fenced area (See Recommendations & Appendix 2).

Trees 5-8 & 12 are all semi-mature native trees, mostly of inferior quality (See Photos Two-Six & Thirteen). **Trees 5-8** would all require extensive pruning to make long-term retention appropriate, **Tree 12** has a limited ULE. **Trees 5 & 6** require removal for a new driveway, others could be retained. Removal of all five trees is proposed/supported given the retention of several mature trees and capacity to replace it with superior quality stock. Inclusion of new trees has been incorporated to plans to offset the removal of **Trees 5-8** (See Recommendations & Appendix 6).

Tree 10 is a semi-mature Silky Oak, **Tree 11** is a semi-mature Himalayan Cedar. Both are of good condition and well suited to long-term retention of both trees would be preferred given their current stature and long-term potential, but their central location on the site makes this a major limitation to development. **Tree 11** is also incongruous with a mostly native landscape on/near the site. **Trees 2 & 16** are being retained and some new canopy trees are proposed, so removal of **Trees 10 & 11** is considered a reasonable compromise.

Trees 13-15 are relatively small exotic trees of low amenity value (See Photo Six). All are suitable for long-term retention, but only **Tree 13** has potential to increase in amenity value significantly and will be retained. **Tree 13** requires protection from driveway works and general construction activity (See Recommendations & Appendix 2). **Tree 14** is being mildly suppressed and is structurally inferior. **Tree(s) 15** would be difficult to retain during demolition and may be structurally compromised once the existing dwelling is removed. Removal of **Trees 14 & 15** is considered reasonable to facilitate works and new landscaping.

Tree 16 is a mature Silky Oak of good condition (See Photo Seven). This is the dominant tree of the site, adding substantial landscape character to the vicinity. Despite being in an easement, retention is recommended. Shallow roots are evident from raised areas in the brick driveway.

The client widened the driveway shortly before the initial inspection, severing several roots from **Tree 16**. Following concerns over total tree failure, a second inspection was conducted to quantify root damage and structural integrity. One large/structural root roots extending towards the garage was severed (approx. 105mm diameter), another less significant root (approx. 45mm diameter) was also torn, both roots were pruned to promote wound sealing (See Photo Eight). Another large/structural root extends towards the dwelling but was not damaged. Long-term retention is considered appropriate because root damage was not as excessive as indicated by the client.

Tree 16 incurs a TPZ encroachment from the Unit 1 of approx. 20%, the car space and other landscape works may cause additional disturbance. With preservation of existing levels and use of low-impact footings/surfacing (e.g. waffle pod and above-grade paving), **Tree 16** should not be compromised. However the amenity value, degree of encroachment and extent of works in the TPZ warrants mulching and irrigation where feasible to offset any root damage (See Recommendations & Appendix 2).

Tree 17 is a mature Yellow Gum of good-fair condition (See Photo Nine). Removal of weedy undergrowth was co-ordinated with minor uplift pruning. **Tree 17** is a substantial landscape addition with good long-term potential. Unit 1 just infringes the TPZ (approx. 2%), decking and paving are in the SRZ. Retention was initially intended, but a site cut is now proposed to mitigate issues with levels at the entrance of Unit 1 - making removal of **Tree 17** necessary. Removal of **Tree 17** will further reduce landscape character of the site, so design alternatives were discussed/investigated. Removal of **Tree 17** as proposed have been offset within plans via inclusion of another medium sized native canopy tree, which can offset then loss in time.

Trees on Neighbouring Properties (Trees 18-26)

- Five trees (**Trees 20-24**) incur no encroachment from the development proposal
- One tree (**Tree 25**) incurs a minor encroachment from the development proposal
- Three trees (**Trees 18, 19 & 26**) incur a major encroachment from the development proposal
- Nine trees (**Trees 18-26**) require protection during works

Trees 18-26 are located on neighbouring properties, so require retention and appropriate protection.

Tree 18 is a mature Willow-leaf Callistemon of fair-poor condition (See Photo Ten). The existing garage is likely to be restricting most roots entering the subject site, so the proposed site cut and retaining wall in the SRZ are not expected to compromise tree viability. With care during demolition and protection of the area between the retaining wall and boundary, **Tree 18** is expected to tolerate works (See Recommendations & Appendix 2).

Trees 19, 20 & 22 are recognised weed species, so removal should be discussed with the neighbour (See Photo Seven). All have excellent tolerance to disturbance. **Tree 19** is similarly infringed as **Tree 18**, while **Trees 20 & 22** are not directly encroached by works. TPZ protection

is not considered necessary, but protection measures are readily implemented given recommendations for **Tree 16** (See Recommendations & Appendix 2).

Trees 21 & 24 are exotic evergreen trees of low amenity value (See Photo Seven). Significant root spread is expected within the subject site, both species have very good tolerance so soil/root disturbance. Neither incur a TPZ encroachment from Unit 1, but proposed use of Lilydale toppings is in their protection zones. Protection from indirect disturbance is recommended (See Recommendations & Appendix 2).

Tree(s) 23 represents two semi-mature Lemon-Scented Gums of fair condition (See Photos Seven & Twelve). Both appear suitable for long-term retention. Neither incur a TPZ encroachment from Unit 1 or its driveway, but landscape works (e.g. Lilydale toppings) warrant careful installation. Protection from indirect disturbance is recommended (See Recommendations & Appendix 2).

Tree 25 is a mature Spotted Gum of good-fair condition (See Photo Twelve). This is a dominant tree of the vicinity, extensive root spread is expected within the subject site. Its species and condition indicates a good tolerance to disturbance/wounding.

Tree 25 incurs a minor encroachment from the required driveway, gravel surfacing in the easement has potential to cause root damage. Surfacing within the TPZ is recommended to be installed above-grade, although it is probable **Tree 25** would tolerate some shallow excavation. Protection of the TPZ area is recommended (See Recommendations & Appendix 2).

Tree 26 is a mature Long-leaved Box of fair condition. It is a significant specimen but is largely obscured by trees on the subject site, development will increase its prominence. Extensive root mass is likely to be within the subject site, the estimated driveway footprint is a TPZ encroachment of approx. 22%, and is within the SRZ. Long-term viability can be maintained by adopting above-grade permeable surfacing (concrete as annotated is not supported here). Ground protection until new surfacing is installed will also be imperative to prevent soil/root disturbance (See Recommendations & Appendix 2).

Trees on Council Property (Trees 27-31)

- One tree (**Tree 29**) incur no encroachment from the development proposal
- Two trees (**Trees 28 & 30**) incur a minor encroachment from the development proposal
- Two trees (**Tree 27 & 31**) incur a major encroachment from the development proposal
- One tree (**Tree 31**) requires removal for a new crossover
- Four trees (**Trees 27-30**) require protection during works

Trees 27-31 are located on council property, so require retention and appropriate protection.

Tree 27 is a significant streetscape element, although an exotic conifer is largely incongruous with native dominated landscaping of the vicinity. **Tree 27** incurs a major/SRZ encroachment from crossover relocation, although the actual encroachment is just 5%. Because Himalayan Cedar has poor tolerance to root disturbance, root investigation and/or crossover relocation are recommended to ensure it maintains long-term viability (See Recommendations & Appendix 3.10).

Trees 28 & 30 are mature native canopy trees, adding substantial streetscape character. Both incur minor TPZ encroachments from unit footprints, crossover works are not proposed on this frontage. **Tree 30** is considered to have exceptional species tolerance because of fibrous root morphology. With protection of the nature strips and some TPZ area within the site, both trees should readily tolerate works.

Tree 29 appears to be root stock regrowth, council should consider replacement post-development.

Tree 31 is a moderate specimen, but has a limited ULE and is conflicting with line clearance requirements (See Photo Thirteen). A new crossover is proposed within its SRZ of **Tree 31** (conflicting with typical 3m setback policy). Removal is considered necessary, although supervised excavation may allow it to be retained. Removal is supported here given the species and replaceability. Capacity for several new street trees on the Holland Rd frontage exists.

7. Recommendations

1. Remove **Trees 1, 3-12, 14, 15, 17 & 31**
 - a. Include at least three medium or large canopy trees to proposed landscaping to offset canopy trees being removed (See Appendix 6)
 - b. **Tree 31** requires council consent
2. Retain **Trees 2, 13, 16 & 18-30**
 - a. Discuss removal of **Trees 19, 20 & 22** with neighbours
 - b. Discuss removal/replacement of **Tree 29** with council
3. All surfacing within TPZs must be installed above-grade for:
 - a. Footings within the TPZ of **Tree 16** to be low-impact (e.g. pies and suspended slab or above-grade waffle pod)
 - b. Paving near **Trees 2 & 16**
 - c. Driveways for Units 1 & 3 (modify concrete driveways accordingly)
 - d. Gravel area near **Trees 16 & 21-25**
 - e. Landscaping works must not reduce the natural soil level >50mm within TPZs
4. No paving within SRZ of **Tree 2** (modify accordingly)
5. Conduct non-destructive root investigation to quantify actual root severance needed for crossover installation, and/or modify the crossover for Unit 1 outside the SRZ of **Tree 27** (See Appendix 3.10)
 - a. To be conducted by or under supervision of a qualified arborist (AQF Level 5+)
 - b. Project and council arborist to discuss crossover/tree viability from results
6. All earthworks within the TPZs of **Trees 2, 13, 16 & 25-27** to be conducted by hand. Any earthworks if required within a SRZ must only be conducted via hydro-excavation under supervision by the project arborist
7. Install an automated drip line irrigation system where TPZs of **Trees 2 & 16** extend in outdoor areas (See Appendix 2 & 3.4). 300l clean water to be applied to area from October-

March inclusive, starting immediately after installation and continuing until the March after all works are complete

8. Project arborist (AQF Level 5+) to:

- a. Inspect tree protection measures prior to demolition proceeding
- b. Any earthworks required within the TPZs of **Trees 2, 16 & 26**

9. For all trees being retained:

- a. Mulch the TPZ areas within the site (unit footprints excluded) with coarse mulch (e.g. composted wood chips 100mm deep). Install prior to heavy machinery entering the site for demolition, maintain for duration of works, or until surfacing proceeds
- b. Erect protective fencing (exclusion zone) to the extent of the TPZ areas where practical (e.g. nature strips, within 1.0m of construction footprints) (See Appendix 2 & 3.4). Install prior to heavy machinery entering the site for demolition, remove when construction is complete
- c. Install ground protection (rumble boards over a 100mm mulch layer) where TPZs extend in the site, where construction access is required (e.g. driveways, within 1.0m of building footprints) (See Appendix 2 & 3.6). Install prior to demolition, remove when construction is complete or when/where surfacing proceeds
- d. Large roots (>50mm diameter) if encountered must be left intact. Consult the project arborist if large roots are accidentally damaged, require severance, or where design modifications cannot accommodate their protection
- e. Underground services must not encroach into any SRZ, or be installed by open trenching within a TPZ. Underground services must be installed via a non-destructive technique where they pass through a TPZ (e.g. boring at ≥ 800 mm depth, or hydro-excavation supervised by the project arborist (AQF Level 5+) (See Appendix 3.12)
- f. Any pruning works to be done by a qualified arborist in accordance with AS4373 – Pruning of Amenity Trees (See Appendix 3.14)
- g. Avoid use of heavy machinery within TPZs during demolition (induct machinery operators to tree protection requirements)

8. Conclusion

The client's site is a large residential property widely covered in primarily native species. Many trees are of low amenity value, but removal of several desirable canopy trees will reduce canopy cover until new landscaping matures.

Trees 2 & 16 have been incorporated to the design to preserve some landscape maturity/character, some proposed replacement tree species are of marginal reliability and do not comparably offset canopy trees being removed. Removal of **Trees 7, 10, 11 & 17** are an unfortunate loss, but this is considered reasonable if larger replacement trees are incorporated to landscaping.

Most neighbouring trees are readily protected, **Tree 26** incurs a major encroachment and requires permeable surfacing. Above-grade driveways are intended in response to preliminary advice, but permeable driveway surfacing for considered essential for **Tree 26** and important for **Trees 21-25**.

Street trees are impacted to varying severity. **Trees 28-30** are readily protected, **Tree 27** requires crossover refinement and/or root investigation, **Tree 31** requires removal for a new crossover.

The design response will cause extensive landscape change, but the site is heavily vegetated at present. Retention of two large mature trees and capacity to replant with new canopy trees will mitigate long-term landscape change. Some design refinement is still considered necessary, protection measures will be critical to avoid indirect damage to many trees.

Appendix 1: Arboricultural Inventory for Subject Site

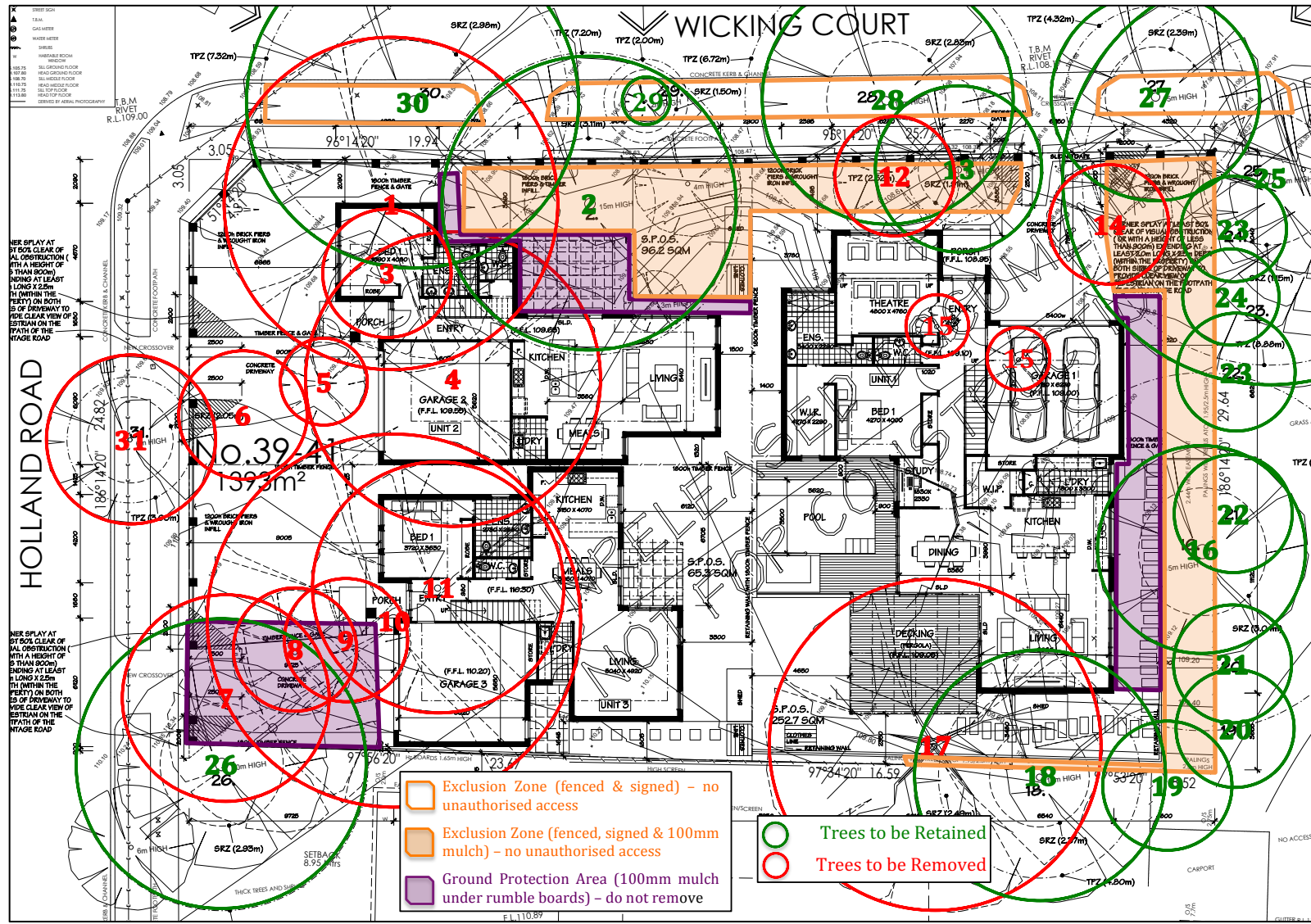
Tree no.	Genus Species (Common Name)	Type	Origin	Age	Height	D.B.H	TPZ	Form	Health	Structure	ULE	Amenity Value	Comments
					Spread (m)	Basal (cm)	SRZ (m)						
1	<i>Pittosporum undulatum</i> (Sweet Pittosporum)	Evergreen	Native (weed)	Mature	7 11	50 54	6.00 2.55	Symmetrical	Fair	Good-Fair	Remove	Low-Medium	Self-sown environmental weed species. Spreading over footpath
2	<i>Eucalyptus obliqua</i> (Messmate)	Evergreen	Indigenous	Mature	13 8	60 86	7.20 3.11	Asymmetrical	Fair	Fair-Poor	Long	Medium	No canopy to south, epicormics, pruning/failure wounds
3	<i>Fraxinus angustifolia</i> (Desert Ash)	Deciduous	Exotic (weed)	Semi-mature	6 2	18 22	2.16 1.75	Symmetrical	Poor	Fair	Remove	Low	
4	<i>Eucalyptus obliqua</i> (Messmate)	Evergreen	Indigenous	Mature	10 10	45 59	5.40 2.65	Asymmetrical	Poor	Fair	Short	Low-Medium	Extensive dieback (possums), canopy bias to SE
5	<i>Eucalyptus melliodora</i> (Yellow Box)	Evergreen	Indigenous	Semi-mature	7 4	17 23	2.04 1.79	Asymmetrical	Fair-Poor	Fair-Poor	Long	Low	Kinked trunk, thin canopy
6	<i>Eucalyptus goniacalyx</i> (Long-leaved Box)	Evergreen	Indigenous	Semi-mature	6 6	24 29	2.88 1.97	Asymmetrical	Good-Fair	Fair-Poor	Long	Low-Medium	Trunk lean to south, lower epicormics
7	<i>Eucalyptus goniacalyx</i> (Long-leaved Box)	Evergreen	Indigenous	Semi-mature	7 3	27 40	3.24 2.25	Symmetrical	Fair	Fair-Poor	Medium-Long	Low-Medium	Kinked/leaning trunk, lower stem removed
8	<i>Eucalyptus goniacalyx</i> (Long-leaved Box)	Evergreen	Indigenous	Semi-mature	5 2	14 22	2.00 1.75	Asymmetrical	Fair	Fair	Long	Low	Minor lean to west. Regrowth suckers between T7 & T8
9	<i>Acacia baileyana</i> (Cootamundra Wattle)	Evergreen	Native (weed)	Over Mature	5 7	32 33	3.84 2.08	Asymmetrical	Poor	Fair-Poor	Remove	Low	Extensive dieback, senescing
10	<i>Grevillea robusta</i> (Silky Oak)	Semi-Deciduous	Native Australia	Semi-mature	14 6	39 50	4.68 2.47	Symmetrical	Good-Fair	Good	Long	Medium	No major defects, exposed root to NE
11	<i>Cedrus deodara</i> (Himalayan Cedar)	Conifer	Exotic	Semi-mature	10 5	28 33	3.36 2.08	Symmetrical	Good-Fair	Good	Long	Low-Medium	No major defects, exposed root to NE
12	<i>Acacia melanoxylon</i> (Blackwood)	Evergreen	Indigenous	Semi-mature	7 4	15 20	2.00 1.68	Symmetrical	Fair	Good	Short-Medium	Low	No major defects

Tree no.	Genus Species (Common Name)	Type	Origin	Age	Height	D.B.H	TPZ	Form	Health	Structure	ULE	Amenity Value	Comments
					Spread (m)	Basal (cm)	SRZ (m)						
13	<i>Jacaranda mimosifolia</i> (Jacaranda)	Semi-Deciduous	Exotic	Semi-mature	6 4	21 27	2.52 1.91	Asymmetrical	Fair	Good-Fair	Long	Low	No major defects, soil raised from footpath/drive
14	<i>Eriobotrya japonica</i> (Loquat)	Evergreen	Exotic	Mature	5 5	22 37	2.64 2.18	Symmetrical	Good-Fair	Fair-Poor	Medium-Long	Low	Basal codominant stems
15	<i>Cupressus sempervirens</i> (Italian Cypress)	Conifer	Exotic	Semi-mature	6 1	10 15	2.00 1.50	Symmetrical	Good	Fair	Long	Low	2x trees against house
16	<i>Grevillea robusta</i> (Silky Oak)	Semi-Deciduous	Native Australia	Mature	17 12	71 82	8.52 3.04	Symmetrical	Good-Fair	Good-Fair	Long	High	No major defects, mild uplift. Root lifting bricks in front of garage. Root damage early May. No services in easement
17	<i>Eucalyptus leucoxylon</i> (Yellow Gum)	Evergreen	Indigenous	Mature	8 7	36 51	4.32 2.49	Symmetrical	Fair	Fair	Long	Medium	No major defects, uplifted
18	<i>Callistemon salignus</i> (Willow-leaf Callistemon)	Evergreen	Native Australia	Mature	8 5	40 45	4.80 2.37	Asymmetrical	Fair	Good	Short-Medium	Low-Medium	Neighbour's tree, approx. 0.25m from fence.
19	<i>Cotoneaster glaucophyllus</i> (Large Leafed Cotoneaster)	Evergreen	Exotic (weed)	Mature	5 4	25 35	3.00 2.13	Symmetrical	Fair	Fair	Long	Low	Neighbour's tree, approx. 0.25m from fence.
20	<i>Ligustrum lucidum</i> (Large Leafed Privet)	Evergreen	Exotic (weed)	Mature	6 5	31 42	3.72 2.30	Symmetrical	Good-Fair	Fair	Remove	Low	Neighbour's tree, 5m from fence. Basal codominant stems
21	<i>Eriobotrya japonica</i> (Loquat)	Evergreen	Exotic	Mature	5 4	17 22	2.04 1.75	Symmetrical	Good-Fair	Fair	Medium-Long	Low	Neighbour's tree, 1.2m from fence.
22	<i>Pittosporum undulatum</i> (Sweet Pittosporum)	Evergreen	Native (weed)	Semi-mature	5 4	18 23	2.16 1.79	Symmetrical	Fair	Fair	Long	Low	Neighbour's tree, 0.4m from fence.
23	<i>Corymbia citriodora</i> (Lemon-Scented Gum)	Evergreen	Native Australia	Semi-mature	11 7	15 20	2.00 1.68	Symmetrical	Fair	Good	Long	Low	2x trees approx.. 0.5m ff, no major defects

Tree no.	Genus Species (Common Name)	Type	Origin	Age	Height	D.B.H	TPZ	Form	Health	Structure	ULE	Amenity Value	Comments
					Spread (m)	Basal (cm)	SRZ (m)						
24	<i>Pittosporum eugenoides</i> 'Variegatum' (Variegated Lemonwood)	Evergreen	Exotic	Mature	5	14	2.00	Symmetrical	Fair	Fair	Short-Medium	Low	Neighbour's tree, 5m from fence.
					3	23	1.79						
25	<i>Corymbia maculata</i> (Spotted Gum)	Evergreen	Native Victoria	Mature	19	74	8.88	Symmetrical	Good-Fair	Fair	Long	High	Neighbour's tree 2.4m from fence, secondary stem from 3m
					11	89	3.15						
26	<i>Eucalyptus goniocalyx</i> (Long-leaved Box)	Evergreen	Indigenous	Mature	13	58	6.96	Symmetrical	Good-Fair	Fair	Long	Medium-High	Neighbour's tree approx. 1m from fence, no fence
					12	75	2.93						
27	<i>Cedrus deodara</i> (Himalayan Cedar)	Conifer	Exotic	Mature	12	36	4.32	Symmetrical	Fair	Good	Long	Medium	Street tree, no major defects
					8	46	2.39						
28	<i>Eucalyptus nicholii</i> (Narrow-Leafed Black Peppermint)	Evergreen	Native Australia	Mature	11	56	6.72	Symmetrical	Fair	Fair	Long	Medium	Street tree, codominant at 4m forming inclusion
					8	69	2.83						
29	<i>Prunus cerasifera</i> (Cherry Plum)	Deciduous	Exotic (weed)	Semi-mature	2	5	2.00	Symmetrical	Fair	Poor	Remove	Low	Street tree, basal suckers, congruous with streetscape
					2	10	1.50						
30	<i>Melaleuca linariifolia</i> (Flax Leaf Paperbark)	Evergreen	Native Australia	Mature	6	61	7.32	Symmetrical	Good-Fair	Good-Fair	Long	Medium	Street tree, some line clearance pruning
					6	78	2.98						
31	<i>Pyrus calleryana</i> (Callery Pear)	Deciduous	Exotic	Mature	6	25	3.00	Managed	Good	Fair	Medium	Low-Medium	Street tree, pruned for line clearance
					6	32	2.05						

Note: D.B.H = trunk Diameter at Breast Height (1.4m above the ground level) or where acceptable. Basal = trunk diameter at ground level (above root buttress)
Dimensions marked in blue represent average diameters for multiple trees (grouped together), or single trees with multiple stems (total diameter calculated accordingly).
Dimensions marked in red are based on an estimated DBH (to the nearest 5cm) due to limited site/trunk access.
 TPZ = Tree Protection Zone, SRZ = Structural Root Zone (dimensions are the radius in metres, calculated from the D.B.H. & Basal respectively in accordance with AS4970).

Appendix 2: Design Response, Tree Locations & Protection Areas



Appendix 3: Tree Protection Zones

Tree no.	Genus Species (Common Name)	TPZ radius (m)	SRZ radius (m)
1	<i>Pittosporum undulatum</i> (Sweet Pittosporum)	6.00	2.55
2	<i>Eucalyptus obliqua</i> (Messmate)	7.20	3.11
3	<i>Fraxinus angustifolia</i> (Desert Ash)	2.16	1.75
4	<i>Eucalyptus obliqua</i> (Messmate)	5.40	2.65
5	<i>Eucalyptus melliodora</i> (Yellow Box)	2.04	1.79
6	<i>Eucalyptus goniocalyx</i> (Long-leaved Box)	2.88	1.97
7	<i>Eucalyptus goniocalyx</i> (Long-leaved Box)	3.24	2.25
8	<i>Eucalyptus goniocalyx</i> (Long-leaved Box)	2.00	1.75
9	<i>Acacia baileyana</i> (Cootamundra Wattle)	3.84	2.08
10	<i>Grevillea robusta</i> (Silky Oak)	4.68	2.47
11	<i>Cedrus deodara</i> (Himalayan Cedar)	3.36	2.08
12	<i>Acacia melanoxylon</i> (Blackwood)	2.00	1.68
13	<i>Jacaranda mimosifolia</i> (Jacaranda)	2.52	1.91
14	<i>Eriobotrya japonica</i> (Loquat)	2.64	2.18
15	<i>Cupressus sempervirens</i> (Italian Cypress)	2.00	1.50
16	<i>Grevillea robusta</i> (Silky Oak)	8.52	3.04

Tree no.	Genus Species (Common Name)	TPZ radius (m)	SRZ radius (m)
17	<i>Eucalyptus leucoxylon</i> (Yellow Gum)	4.32	2.49
18	<i>Callistemon salignus</i> (Willow-leaf Callistemon)	4.80	2.37
19	<i>Cotoneaster glaucophyllus</i> (Large Leafed Cotoneaster)	3.00	2.13
20	<i>Ligustrum lucidum</i> (Large Leafed Privet)	3.72	2.30
21	<i>Eriobotrya japonica</i> (Loquat)	2.04	1.75
22	<i>Pittosporum undulatum</i> (Sweet Pittosporum)	2.16	1.79
23	<i>Corymbia citriodora</i> (Lemon-Scented Gum)	2.00	1.68
24	<i>Pittosporum eugenioides</i> 'Variegatum' (Variegated Lemonwood)	2.00	1.79
25	<i>Corymbia maculata</i> (Spotted Gum)	8.88	3.15
26	<i>Eucalyptus goniocalyx</i> (Long-leaved Box)	6.96	2.93
27	<i>Cedrus deodara</i> (Himalayan Cedar)	4.32	2.39
28	<i>Eucalyptus nicholii</i> (Narrow-Leafed Black Peppermint)	6.72	2.83
29	<i>Prunus cerasifera</i> (Cherry Plum)	2.00	1.50
30	<i>Melaleuca linariifolia</i> (Flax Leaf Paperbark)	7.32	2.98
31	<i>Pyrus calleryana</i> (Callery Pear)	3.00	2.05

TPZ & SRZ listed are the radius measured in metres, from the centre of the trunk at ground level. Under AS4970-2009 *Protection of Trees on Development Sites*, the project arborist can support a TPZ encroachment of up to 10% without justification, which is termed a 'minor encroachment'. For a minor encroachment, the encroached area must be compensated for elsewhere – contiguous with the likely root spread. If disturbance infringes >10% of the TPZ area or is within the SRZ at all, it is termed a 'major encroachment', and plans cannot be supported unless the project arborist can demonstrate the tree will maintain its long-term viability. Disturbance/encroachment to protection zones is considered to occur from; new building/surfacing footprints, cut/fill >50mm, trenching for services, or changes to surface permeability.

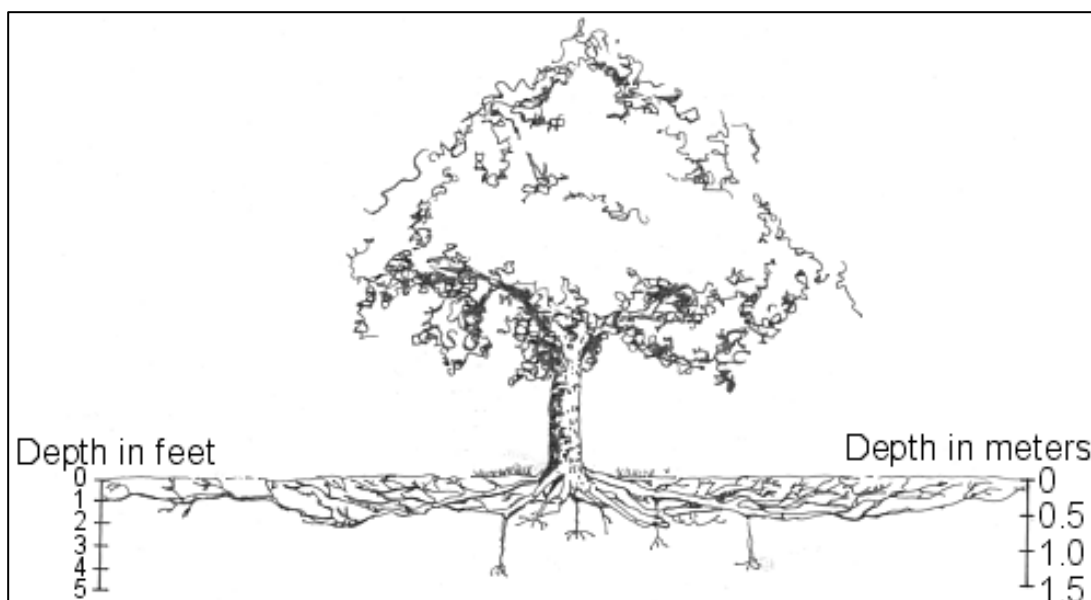
3.1. Understanding Roots

Tree roots are opportunistic; growing in the path of least resistance where conditions are most favourable (Gilman 1997). The spread of a root system can be variable and depends on the size, species, age, and health of the tree. Site factors such as soil conditions, surrounding structures, plus water and nutrient availability also influence root allocation.

Roots can be expected to extend up to twice the canopy spread, and approximately 95% of roots are found within the top metre of the soil profile. Roots have several purposes including; water and nutrient absorption, nutrient transfer and storage, anchorage, and synthesis of some compounds (e.g. hormones). Roots of most tree species develop beneficial relations with *Rhizobium* and/or mycorrhizae. These organisms increase the effective surface area of the root system, but this symbiosis is reliant on a soil that is not compacted and has a good organic fraction.

Root morphology is partly based on species, but is largely influenced by the soil environment and its limitations. Within the Structural Root Zone (SRZ) or root plate, there are commonly 3-6 large roots. 70% of the total roots are attached to these major structural roots. Tap roots are common on tree seedlings, but are rarely found on mature trees. Vertical 'sinker roots' develop occasionally extending as deep as 1.5m, and are important for tree stability (Harris et al. 2004, Gilman 1997).

Figure 1. Showing typical root distribution of a tree. Soil compaction, moisture, air and nutrient availability are most conducive to root growth near the surface (Harris et al. 2004).



3.2. Determining the TPZ

AS4970-2009 Protection of Trees on Development Sites is a formulated approach to managing trees on a construction site. The standard outlines appropriate guidelines to maintain a tree's long-term viability and structural integrity.

A Tree Protection Zone (TPZ) and Structural Root Zone (SRZ) are symmetrical areas around a tree. The TPZ reflects the area where the majority of roots exist, but roots may extend much further. The TPZ is the area requiring protection if tree viability is not to be affected. The SRZ reflects the area where large/structural roots are likely to be found, and where disturbance could compromise structural integrity of the entire tree.

The TPZ calculation is: Trunk diameter (DBH) X 12. Diameter at Breast Height (DBH) is measured at 1.40m above ground level, generating values of 2.00m-15.00m radius. The SRZ is a more complex formula, typically generating values between 1.50-3.50m radius. The TPZ and SRZ are measured from the centre of the trunk.

3.3. Encroachment Guidelines (Direct from AS4970-2009)

In some cases, it may be possible to encroach into or make variations to the standard TPZ. If the proposed encroachment is less than 10% of TPZ the area and is outside the Structural Root Zone (SRZ), it is termed a 'minor encroachment'. For 'minor encroachments' arborist justification and/or detailed root investigations should not be required, and the area lost to this encroachment should be compensated for elsewhere and contiguous with the TPZ. In some cases the project arborist may not support a TPZ encroachment <10% (e.g. trees of very poor vitality or where root spread bias may result in a disproportionately high amount of root damage).

Where encroachment to a TPZ is >10% or enters the SRZ to any degree, it is defined as a 'major encroachment' under AS4970. Major encroachments require the project arborist to justify why the tree will not be compromised, or clarify the actual root severance that will occur (e.g. via non-destructive exploratory excavation).

TPZ encroachments occur from; site cut/fill, reduced surface permeability, new building/paving/driveway, trenching for foundations/services, hard landscaping, fencing, or alterations to existing soil hydrology.

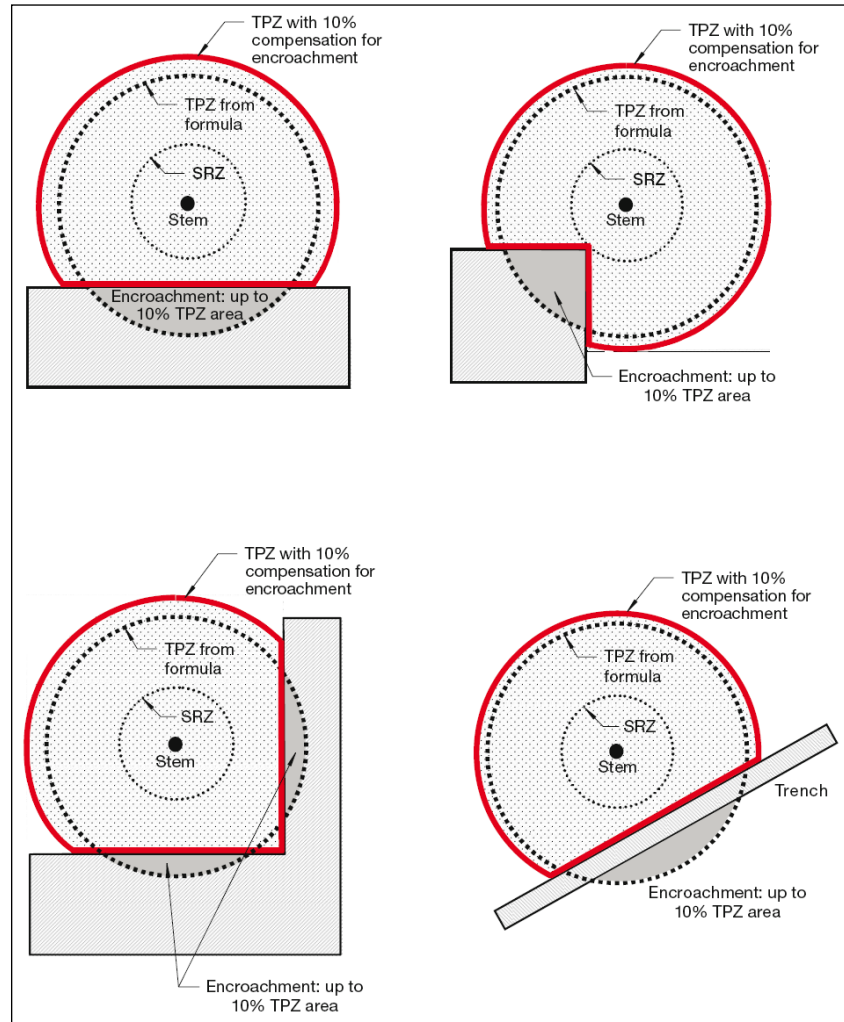


Figure 2: Examples of minor encroachments into a TPZ

3.4. TPZ Exclusion Zone & Maintenance

Protective Fencing

Installing protective fencing is recommended where access within a TPZ area will not excessively inhibit development works.

- Recommended: Temporary fencing (e.g. 1.80m high chain mesh panels with concrete anchor blocks), with shade cloth attached (see Figure 3)
- Alternatives: plywood, wooden palings or 'hi-vis.' plastic mesh, connected to star pickets (seek prior approval from project arborist)



Figure 3. Install fencing around the perimeter of the TPZ.



Figure 4. Signs must be clearly displayed at regular intervals.

Signs

Identification signs are to be fixed to the fencing, stating “Tree Protection Zone – No Access”, and be in accordance with AS1319-1994 Safety Signs for Occupational Environment (See Figure 4).

Mulching

- Minimum 100mm deep
- Composted wood chips
- Comply with AS4454-1997 Composts, Soil Conditioners and Mulches

Weed Control

Remove all weeds within the TPZ areas prior to mulching. Remove weeds manually if practical. Systemic herbicides must be used with caution to avoid wind drift that could impact tree being protected (seek qualified horticulturalist for use of herbicide).



Figure 5. Inline drip irrigation systems are water efficient, and are best installed below a mulch layer.



Figure 6. Automated controllers are a reliable way to regulate water quantity/frequency.

Irrigation

- Drip line irrigation system to be installed under 100mm deep mulch layer (See Figure 5)
- Minimum application of 5-10 litre/week clean water per centimetre of trunk diameter
- Higher application rates may be recommended; irrigation must be applied from October-April inclusive unless otherwise recommended
- Irrigation should ideally be implemented prior to demolition works, and maintained until post-development (to promote tree vitality and root re-allocation)
- Automatic controllers must be used to activate irrigation systems (See Figure 6). Manual application of water or control of irrigation system is not approved

3.5. Restrictions within the TPZ

Activities excluded from the TPZ (AS4970-2009) include:

- Machine excavation including trenching
- Excavation for silt fencing
- Cultivation
- Storage
- Preparation of chemicals, including preparing cement products
- Parking of vehicles and plant
- Refuelling
- Dumping of waste
- Wash down and cleaning of equipment
- Placement of fill
- Lighting of fires
- Soil level changes
- Temporary or permanent installation of utilities and signs
- Physical damage to the tree

Table 1. Common damage within a TPZ during development can be found below:

DAMAGE	CAUSES	EFFECTS
Root severance	<ul style="list-style-type: none"> Excavation for footings Trenching for underground services Grade changes for footings/landscaping Preparation for installation of paving, driveways, paths, crossovers 	<ul style="list-style-type: none"> Tree decline (leaf drop, loss of vitality, branch dieback) Limb failure Total tree failure
Soil profile degeneration	<ul style="list-style-type: none"> Compaction from machinery Compaction for footings or paving Lack of moisture penetration from sealed surfacing Lack of gas exchange from sealed surfacing/increased soil level pH changes from lime or concreting 	<ul style="list-style-type: none"> Roots crushed Root decline/death Tree decline/death
Chemical injury	<ul style="list-style-type: none"> Fuel/paint/solvent dumping/spills Herbicide uptake (e.g. via root grafting between trees, or wind drift) 	<ul style="list-style-type: none"> Tree decline/death Canopy dieback
Physical damage	<ul style="list-style-type: none"> Poor pruning cuts (e.g. lopping, flush cuts, lions tailing) Impacts from machinery, material storage Attaching signs/fencing to tree 	<ul style="list-style-type: none"> Facilitating pathogens Initiating decay Epicormic shoots (prone to failure)

3.6. Other Protection Measures (Direct from the AS4970-2009)

When tree protection fencing cannot be installed or requires temporary removal, other tree protection measures must be used, including those set below.

Trunk and Branch Protection

Where necessary, install protection to the trunk and branches of the tree as shown in Figure 7 below. The materials and positioning are to be specified by the project arborist. A minimum height of 2m is recommended. Do not attach temporary power lines, stays, guys and the like to the tree. Do not drive nails into the trunk or branches.

Ground Protection

If temporary access for machinery is required within the TPZ ground protection measures will be required. The purpose of the ground protection is to prevent root damage and soil compaction within the TPZ. Measures may include a permeable membrane such as geotextile fabric beneath a layer of mulch or crushed rock below rumble boards as per image on next page.

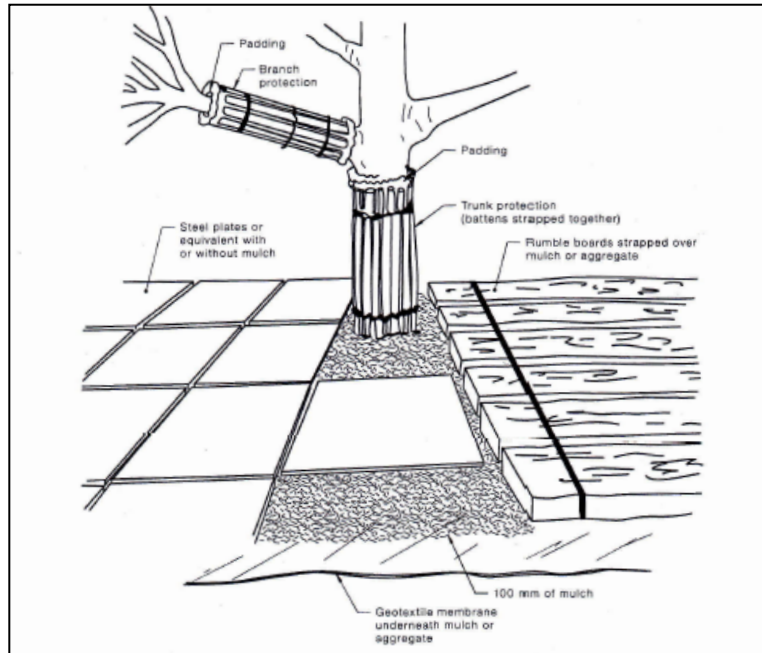


Figure 7. Example of trunk, branch & ground protection (AS4970, 2009)

Root Zone Protection during works within the TPZ

Some approved works are allowed within the TPZ. The installation of pier and beam footings or screw piles can be used as foundations for building construction within the TPZ. The project arborist must be involved with the engineer or building foreman to prevent damage to larger roots during construction (hand excavation may be recommended).

If the soil level grade is to be raised the material must be coarser or more porous than the underlying material (AS4454). Depth and compaction should be minimised. Relocation or redesign of works may be required.

Where the project arborist identifies roots to be pruned within or at the outer edge of the TPZ, the roots must be pruned with a final cut to undamaged wood. Pruning cuts should be made with sharp and sterile tools such as; secateurs, bypass loppers, handsaw or chainsaw. Pruning wounds must not be treated with dressing paints. It is not acceptable for roots within the TPZ to be 'pruned' with machinery such as axes, shovels or excavators.

Where roots within the TPZ are exposed by excavation, temporary root protection must be installed to prevent them drying out (e.g. moist hessian or mulch).

3.7. Low-impact Construction

Low-impact construction should adhere to the following guidelines:

- No changes to the existing soil levels within a TPZ (removal of 50mm turf layer is considered acceptable)
- Any soil disturbance within a TPZ must be done by hand
- Soil disturbance within a SRZ must not occur (unless conducted by hand under direct supervision by a qualified arborist)
- Impermeable surfacing may be approved pending arborist assessment of the trees capacity to tolerate such changes to gas exchange and moisture infiltration rates
- New buildings not to be located within the SRZ of the tree's expected mature size
- Soil compaction must be minimised to maintain acceptable bulk density levels (see below)

Table 2: General relationship of soil bulk density to root growth based on soil texture

Soil Texture	Ideal bulk densities	Bulk densities that may affect root growth	Bulk densities that restrict root growth
Sand	<1.60 (g/cm ³)	>1.70 (g/cm ³)	>1.80 (g/cm ³)
Loam (<45% clay)	<1.40 (g/cm ³)	>1.60 (g/cm ³)	>1.75 (g/cm ³)
Clay (>45% clay)	<1.10 (g/cm ³)	>1.40 (g/cm ³)	>1.50 (g/cm ³)

Bridging systems

- Other protection method (appendix 3.5) to the satisfaction of the project arborist/guiding authorities must be implemented to reduce mechanical injury and compaction of the soil while constructing the bridging system
- Pier holes must be positioned so no major roots are interfered with
- Excavation performed within the TPZ & SRZ must be performed manually
- The system should be designed by an engineer and approved by the project arborist

Figures 7 & 8. Bridging system within the SRZ of a canopy tree (Council of Arboriculture Victoria)



Permeable Surfacing

- The surface should only be constructed at the existing grade after the removal of organic matter and loose top soil (e.g. 50mm maximum)
- Substrate should be permeable, and compaction should be limited to levels which allow continued root function (See Table 2)
- Surfacing within a SRZ should be avoided to prevent long-term damage from roots as their caliper increases
- The surfacing system should be designed by an engineer to tolerate the load applied while fulfilling the arboricultural requirements

Some available permeable surfacing products:

- Adbri masonry (Turfgrid®, Ecotrihex®, Ecopave®)
- Hydrocon (Hydroston)
- Boral (porous asphalt, no-fines concrete)
- New Dawn Permeable Paving (Pebble Pave)
- Enviro Concrete (Grasscrete)



Figure 9. Adbri Masonry (Ecotrihex®)

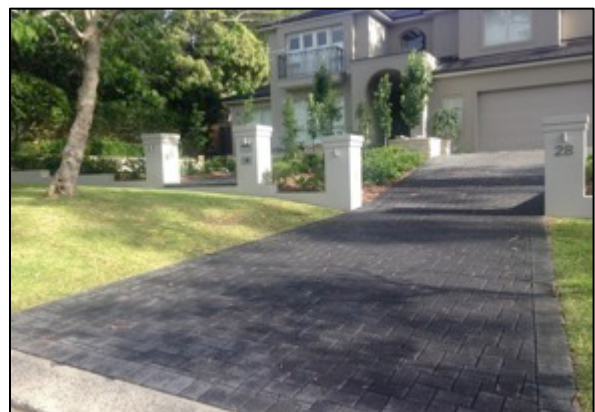


Figure 10. Enviro Concrete(Grasscrete)

Figure 11. Pebble Pave



Figure 12. Hydrocon (Hydroston)



Low-Impact Foundation Systems

Many non-invasive foundation techniques can be engineered to both fulfil the functional requirements of the development while preventing any long-term damage to the root system. The primary design requirement is to preserve existing soil levels within the TPZ, and minimise soil/root disturbance.

Trenching/site cuts are highly invasive, while isolated pier holes cause minimal impact to tree vitality. Capacity to relocate piers should ideally be incorporated to design in case large roots are encountered during excavation.

Low-impact foundation systems include:

- Piers/screw piles with above-grade beams
- Cantilevered/floating slabs
- 'Pin' foundations (e.g. Mega Anchor/Surefoot™/Securepier/Diamond Pier®)
- Waffle Slab (if installed above-grade)

Figure 16. Diamond Pier causes negligible soil/root disturbance.



Figure 17. 'Pin' foundations are suitable for urban dwellings.



3.8. Structural Soils

Soil structure refers to the proportions and size of soil particles and pore spaces between. Tree growth is influenced by a soils ability to absorb moisture, exchange air, and allow root penetration. Soil volume is also a major influence on potential tree size and susceptibility to moisture stress. Structural soils are engineered to provide a balance between pore size, moisture retention, and minimal compaction. Structural soils are commonly used where long-term compaction will occur (e.g. beneath roads/car parks), or where favourable soil volumes are limited (e.g. between buildings/under roads). Structural soils can increase the soil volume that can be utilised by a tree while allowing hard surfacing to encroach a TPZ than might otherwise be allowable.



Figure 13. Structural soil system by Citygreen.com

3.9. Root Barriers

Root barriers are used to limit/direct/deflect root growth away from structures, where damage may result from changes to soil moisture (e.g. reactive clay soils), or lifting of surfacing (e.g. driveway/footpath). Root exclusion barriers must be installed to depths exceeding root activity (e.g. 1-2m), and protrude above the surface (roots can extend over a barrier if mulch/soil accumulates).

Root deflectors are used to direct large/structural roots below surfacing, thereby reducing the likelihood of surfacing being lifted as root calliper increases. Root barriers are best installed prior to tree planting, as installing near established trees can cause extensive root damage and potentially kill the tree.

Root barriers are not considered good long-term management solutions, as breaches on the barrier will render it useless (e.g. holes from rocks/forks, soil/mulch building up on surface, roots extending under/around barrier). Chemical root growth inhibitors are available, which must be installed during surface subgrade installation. Appropriate tree species selection for the site is viewed as the preferable approach for root damage management.

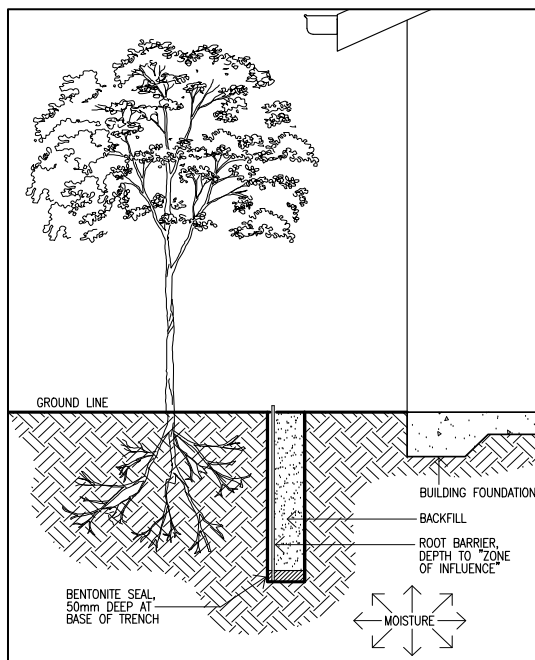


Figure 14. Image courtesy of Root Barrier.
Figure 15. Root deflector can direct roots below surfacing to avoid damage.

3.10. Exploratory Excavation

Establishing the location of tree roots prior to construction is critical to the longevity of the tree. Exploratory excavation is considered the most effective method of root mapping, allowing management decisions to preserve the tree. Exploratory excavation is a sensitive process that should be performed with great care. Minor exploration can be performed manually with hand tools, while larger jobs may require high-pressured air or water equipment. Substantial roots that are exposed should be left intact.

Management decisions can be made once the area of the root zone under scrutiny is exposed. The other factors of tree species, health, age and potential root loss will affect the management decision. All exploratory excavation works should be conducted by or under the supervision of the project arborist.

Figures 18 & 19. Exploratory excavation clarifies root spread and determines viability of design (e.g. new crossover) where major encroachments occur. A proposed crossover was supported in this case, as roots were at greater depth than needed for installation.



3.11. Soil Fill

Some approved works within a TPZ (e.g. landscaping) have potential to damage roots. If the soil level is to be raised, the material must comply with AS4454 Composts, Soil Conditioners and Mulches. Depth of fill and compaction must not exceed levels on approved plans, unless the project arborist has approved such changes.

3.12. Underground Services

Underground services such as electricity, telecommunications, sewerage, gas, drainage pits, garden lighting and irrigation systems may be required to encroach into the TPZ.

- Services must not be located within or pass through the SRZ, because of the likelihood for significant root damage and the associated potential for total tree failure
- Where services cannot avoid a TPZ, they must not be installed via open trenching, but utilise boring/directional drilling at a minimum depth of 1000mm to ensure significant root damage is avoided
- If manual excavation within a SRZ is necessary, it must be carried out under the supervision of the project arborist to ensure structural roots are not compromised. Relocation of services may be required

3.13. Root Pruning

Where the project arborist identifies roots to be pruned within a TPZ:

- Roots must be pruned with a final cut to undamaged wood
- Pruning cuts must be made with a sharp sterile tool such as secateurs, handsaw or chainsaw. It is not acceptable for roots within a TPZ to be pruned with an axe/mattock, or machinery such as backhoes or excavators
- A suitably qualified arborist must conduct any root pruning
- Pruning wounds must not be treated with dressing paints.

Where roots within a TPZ are exposed by excavation, temporary root protection should be installed to prevent them drying out. This may include moist hessian sheeting, compost or mulch. Root protection must be kept moist, and maintained during the period that the root zone is exposed.

3.14. Branch Pruning

Minor pruning (e.g. uplifting, canopy reduction, deadwood removal) may be required/desired. All pruning works must be conducted by a qualified arborist (minimum qualification – Certificate IV in Arboriculture) and be in accordance with AS4373-2007 Pruning of Amenity Trees.

3.15. Stump Grinding

Stump grinding within TPZs of tree being retained is the only suitable method of stump removal. This will minimise soil/root disturbance to trees being retained, but care should be taken by the operator to prevent damage to roots of retained trees. Where stumps are not within a TPZ of a tree being retained, stump grinding may still be recommended as removal of stumps by an

excavator can lift/tear roots for several meters, which may indirectly damage roots for trees being protected.

3.16. Site Access

Suitable site access can often be determined by the project arborist, but may need discussion with the site manager. Ideally TPZs should not conflict with site access, but this is not always achievable. Where TPZs conflict with site access requirements (e.g. near building footprints), the project arborist will determine appropriate protection measures required (e.g. ground protection to preserve roots and the soil profile) (See Appendix 2).

Implementing ground protection (mulch and rumble boards) is frequently required where new driveways are proposed until surfacing proceeds (See Appendix 2). If branches require tying back or pruning for suitable vehicle/machinery clearance, a qualified arborist (minimum qualification of Cert.IV in Arboriculture) should conduct such works.

3.17. Landscaping

Landscaping is generally the last element to be completed in a development project, where the potential negative effects are often overlooked. Exclusion zones and other protection measures must be maintained where feasible. Mini-excavators (e.g. Dingos/Kanga/Bobcat) must not be used within an exclusion zone without ground protection, and all holes for plants/posts must be dug manually. No trenching for irrigation should occur unless conducted by hand. No grade changes within a TPZ are to occur to without prior approval from the project arborist. During any landscape works (e.g. irrigation/lighting system, fencing) if large roots (>50mm diameter) are encountered, they must be left intact and works modified accordingly.

Appendix 4: Descriptors

4.1. Species/Common Name

Species refers to the botanical name of the plant, including genus followed by the species (sub species or variety, if any). This nomenclature classification system is internationally governed. There are numerous Common Name plants, depending on the region in which it grows. Reputable plant identification literature is referenced in the report for both botanical and common names.

4.2. Type

Type	Description
Conifer	A non flowering tree, that bears its seeds in a cone.
Deciduous	A plant that loses its leaves on an annual basis. Usually winter for temperate climate and dry season for sub tropical to tropical climates.
Evergreen	A plant that retains its leaves throughout the year.
Palm	A monocot (same division as grasses), that typically has a single growth point (apical meristem).
Semi deciduous	A plant that may or may not loses its leaves, depending on climatic factors and species.
Other	Stated in the notes.

4.3. Origin

Origin	Description
Exotic	A plant that originates outside the Australian region
Native (Australia)	Originates within Australia, but not Victoria.
Native (Victoria)	Originates within Victoria, but not the local region.
Indigenous	Originates from the local region
Weed	Recognised as an urban/environmental weed species

4.4. Age

Age	Description
Juvenile	A tree that has recently been planted or still in its establishment phase. Less than 25% of expected mature size
Semi-Mature	Signs of rapid growth, still to reach its full canopy size and trunk diameter. 25-50% of expected mature size
Maturing	Minor reduction in growth rates, establishment of mature structure, 50-75% of expected mature size
Mature	Reduction in growth, the tree has reached its maximum expected size
Over-Mature	Mature size has been reached and senescence has begun. Symptoms include: canopy dieback, extensive deadwood, lack of wound wood production, reduced growth rates, branch failures, decay

4.5. Height

The height of the tree was estimated using a digital clinometer (Nikon Forestry Pro Laser Rangefinder) or Master Tree Growers technique (Reid & Stephen 2001). Where site limitations prevented accurate height reading, estimations were made utilising scaled objects nearby.

4.6. Spread

The spread of the canopy/crown was measured with a tape or paced out. The average distance from the edge of the drip line is recorded.

4.7. D.B.H.

D.B.H represents the diameter at breast height (cm). Breast height defined at 1.4m above the ground level unless stipulated otherwise. Measurements are taken in accordance to the AS4970 (AS4970, 2009). The diameter is measured with the Master Tree Growers tape.

4.8. Form

Form	Description
Symmetrical	Evenly balanced full crown
Asymmetrical	One side of the crown more dominant, lopsided appearance
Re-growth	Reaction shoots growing off a cut stump
Suppressed	Growth is limited by light/space competition with surrounding vegetation
Managed	The form of the tree is manipulated, different from its natural habit. Example: Hedge, pollard, espaliers, topiary and coppice
Lopped	Large trunks/branches cut off at random locations. Pruning cuts that have not been made to lateral branches (e.g. large stubs with no foliage left). Does not conform to AS4373 Pruning of Amenity Trees
Hedge	Multiple trees planted in close proximity and managed as a single entity

4.9. Health

In most situations, the lowest symptoms identified in the descriptors are used to assign the relevant health rating. Where the health rating falls between the descriptors, combinations of the ratings are used. Example: Fair-Poor for moderate signs of stress.

Health Rating	Description
Good	Dense well coloured canopy with good shoot extension. Above average callus production on pruning cuts/wounds. Vigorous growth rates with no signs of dieback, pest or diseases.
Fair	Minor signs of stress and dieback. Thinning and discolouring of canopy. Slowing of growth rates, maybe signs of pests and diseases.
Poor	Major signs of reduced health and stress. Extreme thinning of canopy with large amounts of dead wood present. Minimal growth with pest and diseases contributing to the decline.
Dead	No living tissue throughout the tree.

4.10. Structure

Based on comparison to an ideal specimen of that species. Considers; apical dominance, presence of codominant unions, branch arrangement, angles of branch attachment, likelihood of failures, presence of wounds/failures, canopy distribution, and union integrity.

Structure Rating	Description
Good	No obvious signs of wounding/decay/failures. No codominant/bifurcated unions. Symmetrical canopy, sound unions, good trunk/branch taper
Fair	Minor signs of wounding or decay in root zone, trunk or canopy. Branch arrangement and angles of attachment less than ideal. Small failures may have occurred. Prior lopping and canopy re-establishment may have occurred. No major defects
Poor	Major defects limiting the ULE; extensive wounding/decay in root zone/trunk/scaffold branches, poor quality unions (e.g. codominant/bifurcated, bark inclusions, wounds/decay), excessive canopy end weight, history of large branch failures, major trunk lean or weight bias

4.11. Amenity Value

Trees are not only aesthetically pleasing but they have functional values in society. Hartman, Pirone, & Ann Sall, (2000) highlight overlooked functional issues such as shade, O₂ production or CO₂ bank, noise barrier, energy saving in terms of heating and cooling of buildings, glare reduction, increased life of hard surfaces and wind break. Moore, (1992) describes trees as a treasured asset, which in today's society must be measured with a monetary value to claim recognition. McGarry and Moore, (1988) designed a model incorporating the five factors of; market value, tree size, life expectancy, form, vigour & suitability which placed a monetary value on an amenity tree (Moore 1992). These factors are incorporated in the rating system below.

Amenity Value	Description
High	Significance to the site and neighbourhood (e.g. canopy trees >15m height and/or with substantial landscape prominence)
Medium	Moderate contribution to the site and surrounding landscape (e.g. canopy trees 8-15m height, or notable horticultural specimens)
Low	Little to no contribution to the site and surrounding landscape (e.g. weed species, and vegetation readily replaced in <10 years)

4.12. Useful Life Expectancy (ULE)

ULE is the length of time that an individual tree can will provide amenity benefits in excess of management costs or acceptable level of risk. This rating is based on the information available at the time of inspection. ULE is not static, but is closely related to tree health and the surrounding conditions. Further changes to the site or the tree may result in alterations to the original assessment (Barrel 1995). The following table details the ratings within the ULE.

ULE	Description
Long	Where amenity benefits will exceed management requirements or acceptable levels of risk for >40 years. May require some management actions during this period
Medium	Where amenity benefits will exceed management requirements or acceptable levels of risk within 15-40 years. Management actions may prolong this period
Short	Where amenity benefits will exceed management requirements or acceptable levels of risk for <15 years. Remedial actions unlikely to extend this period
Remove	Management requirements and/or acceptable levels of risk already exceed amenity benefits, (e.g. recognised environmental weed species, imminent failures)

Appendix 5: References

- Australian Standard AS4373, 2007, Pruning of Amenity Trees, Council of Australian Standards.
- Australian Standard AS4454, 2012, Composts, Soil Conditioners and Mulches, Council of Australian Standards.
- Australian Standard AS4970, 2009, Protection of Trees on Development Sites, Council of Australian Standards.
- Costermans, L. 2000, Native Trees and Shrubs of South Eastern Australia, Reed New Holland, N.S.W, Australia.
- Harris, R. W, Clarke, J. R. & Matheny, N. P. 2004, Arboriculture: Integrated Management of Landscape Trees, Shrubs and Vines, 4th edu, Pearson Education, New Jersey, USA.
- Hartman, J. R, Pirone, T. P & Sall, M. A, 2000, Pirone's Tree Maintenance, 7th edu, Oxford University Press, NY, U.S.A.
- Watson, G.W, Hewitt, A.M, Custic, M & Lo, M 2014, The Management of Tree Root Systems in Urban and Suburban Settings: A Review of Soil Influence on Root Growth. ISA Journal of Arboriculture & Forestry, pp 198.

Appendix 6: Recommendations for Replacement Tree Species

Small Sized Trees (<8m)
<i>Acacia pravissima</i> (Ovens Wattle)
<i>Angophora hispida</i> (Dwarf Apple)
<i>Banksia serrata</i> (Old Man Banksia)
<i>Bursaria spinosa</i> (Sweet Bursaria)
<i>Callistemon sieberi</i> (River Bottlebrush)
<i>Eucalyptus cosmophylla</i> (Cup Gum)
<i>Eucalyptus crenulata</i> (Buxton Gum)
<i>Eucalyptus crenulata</i> (Victorian Silver Gum)
<i>Eucalyptus pauciflora</i> 'Little Snowman' (Snow Gum)
<i>Eucalyptus pulverulenta</i> 'Baby Blue' (Silver-leaved Mountain Gum)
<i>Hakea laurina</i> (Pin Cushion Hakea)

Medium Sized Trees (8-15m)
<i>Allocasuarina torulosa</i> (Forest Oak)
<i>Corymbia ficifolia</i> (Flowering Gum)
<i>Eucalyptus radiata</i> (Narrow-leaved Peppermint)
<i>Eucalyptus spathulata</i> (Swamp Mallet)
<i>Eucalyptus woodwardii</i> (Lemon-flowered Gum)

Large Sized Trees (>15m)
<i>Angophora costata</i> (Smooth-barked Apple)
<i>Araucaria cunninghamiana</i> (Hoop Pine)
<i>Casuarina cunninghamiana</i> (River She-Oak)
<i>Eucalyptus camaldulensis</i> (River Red Gum)
<i>Eucalyptus leucoxylon</i> (Yellow Gum)
<i>Eucalyptus melliodora</i> (Yellow Box)
<i>Eucalyptus polyanthemos</i> (Red Box)
<i>Eucalyptus pulchella</i> (White Peppermint)
<i>Eucalyptus sideroxylon</i> (Red Ironbark)

-Prior to selection a site assessment should be conducted by a qualified person to ensure the tree is suitable for the desired position.

Assumptions and limiting conditions of this report:

- This report is to be used only in its complete form. Any submission, verbal or written, report or presentation that includes statements made in this report, may only be used when the complete report is referenced in, and directly attached to that submission.
- Alterations made to this report by anyone who is not a current Tree Response employee renders the entire report invalid.
- Any legal documentation or description provided to Tree Response Pty Ltd is assumed to be correct. No responsibility is assumed for the accuracy of information gained from other sources.
- Information contained within this report covers only the tree(s) that were examined and reflects the conditions of that tree(s) at the time of inspection.
- The inspection is limited to visual examination of the subject tree(s) from the ground without dissection, excavation, probing or coring. There is no guarantee, expressed or implied, that problems or deficiencies of the subject tree(s) may not arise in the future.
- Sketches, diagrams, graphs and photographs in this report, being intended as visual aids, are not necessarily to scale and should not be construed as engineering or architectural drawings, reports or surveys.
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WHITE HORSE CITY COUNCIL
TREE ROOT INVESTIGATION ADJACENT TO INFRASTRUCTURE REPORT

Site Address	39-41 HOLLAND ROAD BLACKBURN SOUTH		Crew on site	Damien	Marcus	
Tree Species						
Additional Traffic Management Required	yes	no	Start time	7.30am	Finish time	11.30am
<p style="font-size: 1.2em; color: blue;">ROOTS LOCATED ALL AROUND 10mm IN DIAMETER</p>				<p>Works description Tree root investigation along red line</p> <p style="font-size: 1.5em; color: blue;">3 LOCATIONS TO BE INVESTIGATED</p> <p style="font-size: 1.5em; color: blue;">LOCATION ①</p>		

Site map and comments - Approximate location of roots found and pruned, mark with 'x' diameter to be recorded

	<p>Footings/Foundations Construction material (please circle)</p> <p>BRICKS</p> <p>CONCRETE</p> <p>NONE</p> <p>Footings Depth _____ cm</p> <p>Underground services (please circle)</p> <p>Mains Water</p> <p>Storm Water</p> <p>Gas</p> <p>Other</p>
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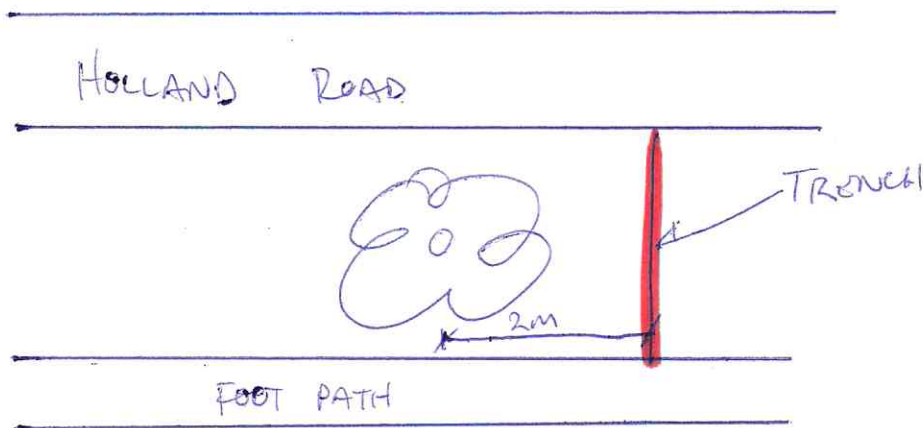
Depth of excavation	600	Length of trench	7
Root pruning information			
Size	<10mm	10mm to 20mm	20mm to 50mm
Number	4	—	—
Location	Below infrastructure		Penetrating fence
	yes	no	yes no

FOOTINGS/FOUNDATION construction material (please circle)			
Bricks	Concrete	none	
Depth of footings: _____			
PHOTOS	Pre works site photos	Root photos	Post works site photos
SIGNED			
DATED	12/05/2021		

WHITE HORSE CITY COUNCIL
TREE ROOT INVESTIGATION ADJACENT TO INFRASTRUCTURE REPORT

Site Address	39-41 HOLLAND ROAD BLACKBURN SOUTH		Crew on site	Damien	Marcus	
Tree Species						
Additional Traffic Management Required	yes	no	Start time	7.30am	Finish time	11.30am
<p style="font-size: 24px; color: blue;">No Roots Found</p>				<p>Works description</p> <p>Tree root investigation along red line</p> <p style="font-size: 24px; color: blue; text-align: center;">LOCATION (2)</p>		

Site map and comments - Approximate location of roots found and pruned, mark with 'x' diameter to be recorded



Footings/Foundations Construction material (please circle)

BRICKS
CONCRETE
NONE

Footings Depth
_____ cm

Underground services (please circle)

Mains Water
Storm Water
Gas
Other

Depth of excavation	600mm		Length of trench	2.5m	
Root pruning information					
Size	<10mm	10mm to 20mm	20mm to 50mm	>50	
Number	—	—	—	—	
Location	Below infrastructure		Penetrating fence		
	yes	no	yes	no	

FOOTINGS/FOUNDATION construction material (please circle)

Bricks Concrete none

Depth of footings:

PHOTOS Pre works site photos Root photos Post works site photos

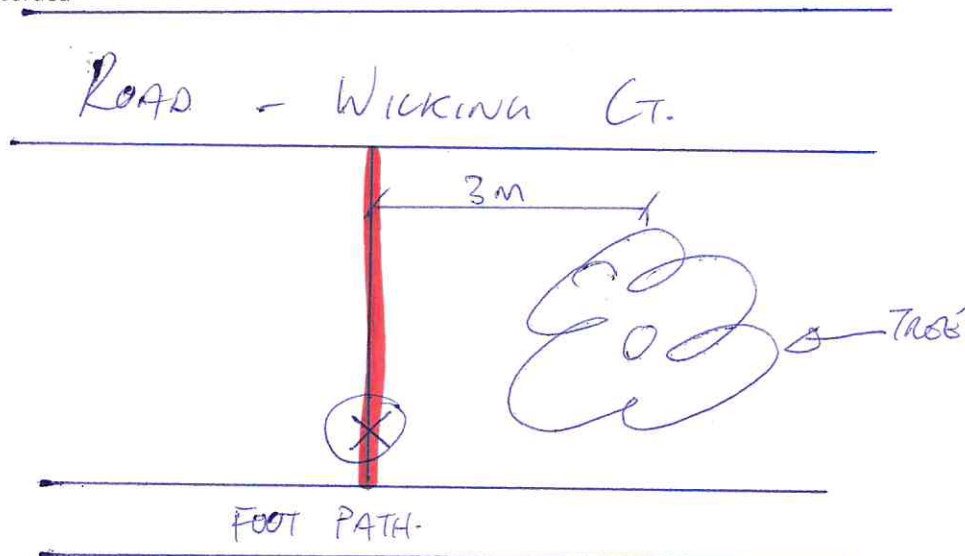
SIGNED [Signature]

DATED 12/05/2021

WHITE HORSE CITY COUNCIL
TREE ROOT INVESTIGATION ADJACENT TO INFRASTRUCTURE REPORT

Site Address	39-41 HOLLAND ROAD BLACKBURN SOUTH		Crew on site	Damien	Marcus	
Tree Species						
Additional Traffic Management Required	yes	no	Start time	7.30am	Finish time	11.30am
<p style="font-size: 1.2em; color: blue;">Small Root 2mm in size.</p>				<p>Works description</p> <p>Tree root investigation along red line</p> <p style="font-size: 1.5em; color: blue; text-align: center;">LOCATION ③</p>		

Site map and comments - Approximate location of roots found and pruned, mark with 'x' diameter to be recorded



Footings/Foundations
Construction material
(please circle)

BRICKS

CONCRETE

NONE

Footings Depth

_____ cm

Underground services
(please circle)

Mains Water

Storm Water

Gas

Other

Depth of excavation	600		Length of trench	2.5m	
Root pruning information					
Size	<10mm	10mm to 20mm	20mm to 50mm	>50	
Number	1	—	—	—	
Location	Below infrastructure		Penetrating fence		
	yes	no	yes	no	

FOOTINGS/FOUNDATION construction material
(please circle)

Bricks

Concrete

none

Depth of footings:

PHOTOS

Pre works
site photos

Root
photos

Post works
site photos

SIGNED

DATED

12/05/2021