Arboricultural Assessment and Report

NCCEC, Point Nepean

29 March 2021 I Tree Logic Ref. 011175

Prepared for Monash University

Prepared by Manori Senanayake – Consultant, Tree Logic Pty. Ltd.

Summary

Reason for Assessment

Tree Logic was engaged to undertake a visual assessment of trees located within and immediately adjacent to the nominated study area within the Point Nepean National Park. The report provides information relating to the trees' condition and recommended tree protection zones to assist with planning considerations for the proposed National Coastal Climate and Environment Centre (NCCEC) at Point Nepean.

Overview

Tree Logic recorded 23 individual trees and two shrub groups that could be potentially affected by work activity within the nominated study area. These primarily comprise a row of Drooping She-Oak (*Allocasuarina verticillata*) of varying condition in a row south of Badcoe Hall, and several maturing conifers of likely heritage significance: two Norfolk Island Pines (*Araucaria heterophylla*) north of Badcoe Hall and a row of maturing Monterey Cypress (*Cupressus macrocarpa*) northeast of the administration building.

An additional twelve individual shrubs and one dead shrub, all under 5m in height, were noted on the plan, being chiefly Pohutukawa (*Meterosideros excelsa*) and Oleander (*Nerium oleander*).

Tree protection zones (TPZ) were assigned according to the Australian Standard® AS4970-2009 (Protection of Trees on Development Sites).

Refer to Appendix 1 for tree assessment data and Appendix 2A-2C for tree location plans.

Refer to Appendix 3 for descriptions of arboricultural rating and other descriptors used in this assessment and Appendix 4 for details on applying and managing the TPZ.

Background

Site description

The nominated study area is shown in Figure 1, along the northeast coast of Point Nepean National Park north of Jacksons Road. The study area is in relation to the proposed location of a building and associated underground seawater pipes per a site markup supplied by the client titled Attachment 2 - Point Nepean Site Plan (referred to in Appendix 2B). The site slopes down towards the north, more steeply towards the parade ground.

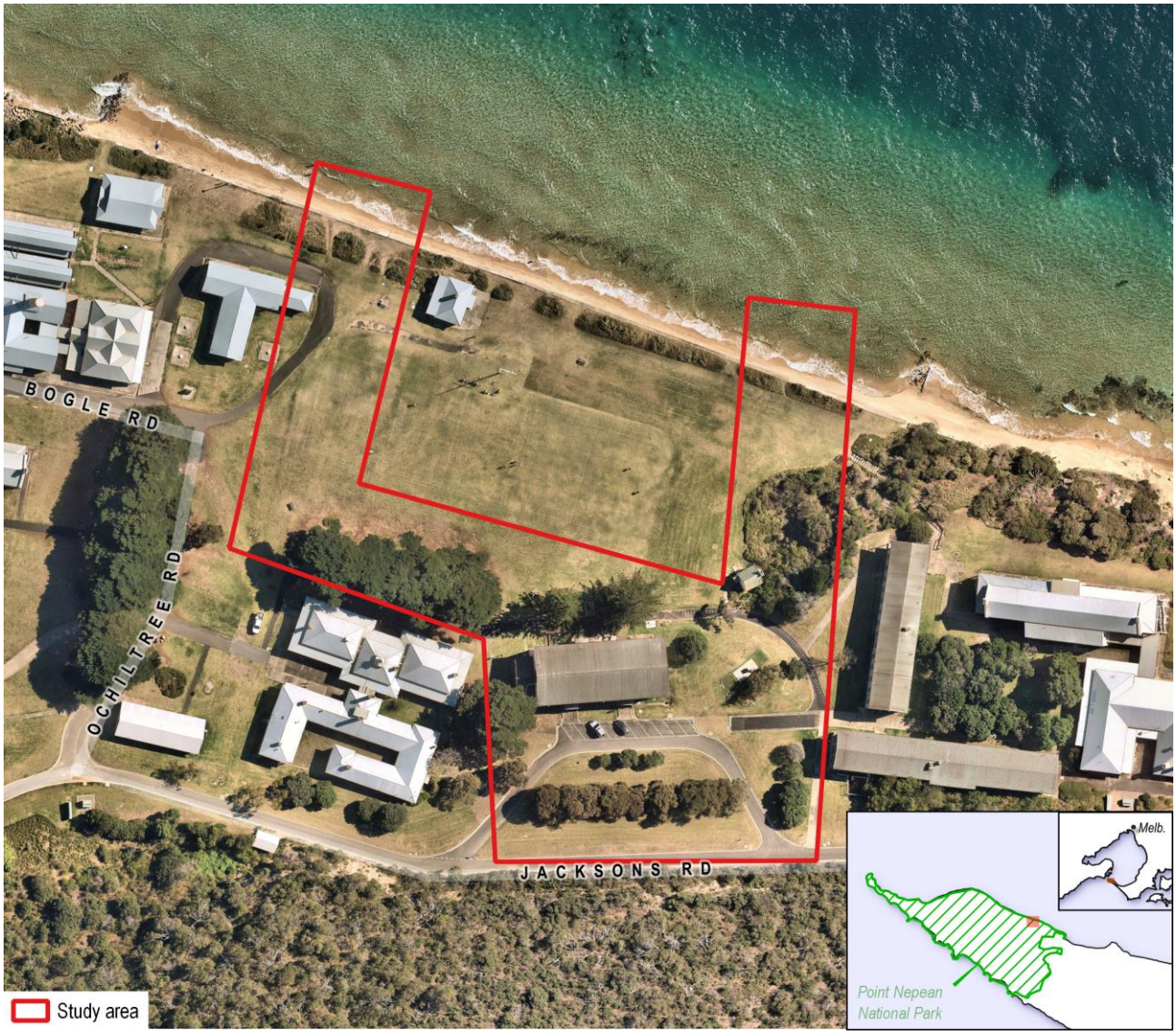

Figure 1: Overview of study area (red outline) in relation to Point Nepean National Park (inset). Aerial image – Nearmap 2021-02-10

Method

The site was inspected on **15 March 2021**. Tree locations were digitised based on recent georeferenced aerial imagery. Those above 5m in height were assessed from the ground with observations made of their growing environment. The trees were not climbed and no inspection of below-ground or internal tree parts was undertaken.

Descriptors used in the tree assessment can be seen in Appendix 3.

Tree protection zones were calculated and mapped according to the method outlined in Australian Standard® AS4970-2009 (Protection of Trees on Development Sites). The method for calculating, applying and managing the tree protection zone is described in Appendix 4.

Indigenous species in relation to VPP Clause 52.17

As the broader site is greater than 0.4 hectares it is assumed that permit requirements in relation to the clearance of native vegetation (Clause 52.17 under the Victorian Planning Provisions) applies to the study area.

Of the species assessed on site that are understood to occur naturally within the area, it is assumed that most specimens (Trees 1-2, 4-13 *Allocasuarina verticillata* and Tree 16 *Leptospermum laevigatum*) are planted for ornamental/aesthetic purposes, owing to their planting pattern and size. These are understood to be exempt from permit requirements for removal under Clause 52.17.

Trees within the more naturally vegetated areas (Group 1, 2) are less certain in terms of planting purpose and consequently permit requirements under Clause 52.17 without further knowledge of specific site history in relation to these plants.

Tree Observations

General Observations

Table shows a breakdown of arboricultural ratings accorded to the assessed trees.

Arb. Rating	Trees	% Total
Mod.A	2	8.7%
Mod.B	6	26.1%
Mod.C	8	34.8%
Low	7	30.4%
Grand Total	**23**	**100.0%**

Over 60% of trees assessed were Moderate C to Low, indicating either smaller species in poor condition and/or maturing trees with accumulating defects that had a shorter useful life expectancy and/or tended towards a Low rating.

Row of Drooping She-oaks (Trees 4-14)

The row of Drooping She-Oaks south of Badcoe Hall are in rather varying condition with numerous trees exhibiting defects and/or dieback. Only three individual trees (6, 9 and 11) were rated Moderate B and expected to potentially have a longer life expectancy owing to health and structural condition. However as part of a massed planting the arboricultural rating of these trees tends towards a lower rating and are not a significant element of the landscape; replacement of trees in a similar condition could be accomplished within a 10 year period.

Maturing conifers

The site is also characterised by the presence of maturing conifers with heritage significance. These trees also have marked landscape significance owing to their size and location.

Several of the Monterey Cypress (*Cupressus macrocarpa*) have received a Moderate-C rating (Trees 20-23). The trees have a large canopy area and a bold presence in relation to the landscape and surrounding built form. The amenity of these trees is noted and there may be other sociocultural values beyond the scope of this report that would recommend the retention of these trees. However, the Moderate-C rating (as opposed to Moderate B) reflects increased input required to manage the trees's safety in relation to the level of large limb/branch failure that is typical of the species of the size and age observed in current conditions. Several cables and support systems have been installed in the canopy to mitigate risk, but with strong coastal winds and relatively little buffering of these winds, it is expected that as management inputs increase, amenity value is likely to decrease with further branch failures and associated loss of canopy/exposure of wounds to decay pathogens. It is also expected that the Moderate B-rated Monterey Cypress (Trees 3, 19) would reach a similar stage within the next 5-10 years.

The two Moderate A trees (Trees 17 and 18) are maturing Norfolk Island Pines (*Araucaria heterophylla*) north of Badcoe Hall; these trees are anchored on the top of a slope and have no visible health or structural defects. Both trees contribute positively to the landscape and are large specimens that would not be replaced by trees with similar attributes within a short span of time. The species is not expected to accumulate structural defects within the next 10 years.

Selected Images

Image 1: View of vegetation southwest of Badcoe Hall, facing north

Image 2: Row of Drooping She-oaks (Trees 4-14, L-R) south of Badcoe Hall, facing east

Image 3: Tree 3, maturing Monterey Cypress, facing south. Canopy gaps from past limb/branch failures. Recent failure to southeast with dead material on ground

Image 4: Row of maturing Monterey Cypress (Trees 19-23, front to rear) north of admin building, facing west.

Image 5: Trees 17 and 18, maturing Norfolk Island Pines north of Badcoe Hall, facing south.

Image 6: Row of Pohutukawa shrubs (not assessed) east of Drooping Sheoaks, potentially impacted by proposed saltwater pipe alignment, facing east.

Image 7: Vegetation north of Shephard's Hut, typically grassy/shrubby with mixed weedy and indigenous species, several dead/dying shrubs at crest. Facing west

Image 8: Closeup of Group 2 (Moonah shrubs), facing north

Conclusion and Recommendations

Potential impacts

- The indicative location “Site B” (refer to Appendix 2B) is likely to require the removals of Tree 4-14, a row of Drooping She-oaks in varying condition.
- Road realignments in relation to the indicative Site B may require the removal of Tree 2.
- It is uncertain whether design or construction impacts will affect Tree 3, which is recommended for consideration in design plans.
- The Alternative 1 saltwater pipe route (refer to Appendix 2B) would likely require the removals of Trees 17-23 if open cut trenching is utilized. To avoid tree roots and retain these trees under this alignment, the alternative would be to bore a tunnel at 600mm or greater depth; however, this may not necessarily be feasible due to other factors.
    - The Alternative 1 pipe route is not recommended in relation to tree retention. Despite the declining condition of the maturing Monterey Cypresses, the trees currently still provide a strong landscape value and other values beyond arboricultural that could justify their retention for at least the next 10 or more years. The route would also likely require the removal of Trees 17 and 18.
- The Alternative 2 saltwater pipe route (Appendix 2B), largely reflected as well in the indicative pipe layout shown in Appendix 2C, would require the removal of vegetation in Group 1, and possibly Group 2 and Tree 16.
    - The Alternative 2 pipe route is preferable in relation to tree retention as the vegetation in the affected area is highly disturbed (owing to the presence of various weed species) and the woody vegetation is of relatively low arboricultural value (small shrubs unlikely to become canopy trees and/or are in poor condition).
    - The proposed rainwater tanks in Appendix 2C should be relocated to avoid removal of Trees 17 and 18.
- Further impact assessments are subject to detailed design/engineering plans.

Ongoing management recommendations

In relation to the maturing Monterey Cypress (trees 3, 19-23), regular inspection of the trees’ condition should be undertaken (preferably annually and during late winter/spring prior to elevated visitor numbers) with any remedial tree work to be conducted within the timeframe recommended by the inspecting arborist. Visual inspection for any cracks or splits after major weather events is also recommended to enable flagging of further inspection or works by qualified arborists ahead of potential tree part failure.

Tree cables should be inspected on a 3-year cycle to ensure that the cable system continues to be functional and appropriate. If the cables currently installed have not been inspected within the last 3 years, inspection is strongly recommended within a year of this report.

In the event of any development, all other adjacent trees, as well as their surrounding areas, should be protected in accordance with the tree protection zones outlined in this report.

Manori Senanayake
Consultant, GDip. (Urb. Hort.)

Appendix 1: Tree Observations Table

DBH = Diameter at Breast Height (measured 1.4m above ground unless otherwise stated).
ULE = Useful Life Expectancy.
Arb. rating = arboricultural rating.
TPZ = Tree Protection Zone.
SRZ = Structural Root Zone.
TPZ & SRZ measurements are radius in metres from the centre of the trunk per AS 4970-2009. Definitions of the descriptor categories used in the assessment can be seen in Appendix 3.

Refer to the following **1** page.

No	Species	Common Name	Age Class	Origin/Type	DBH (cm)	Basal Ø (cm)	Height (m)	Width (m)	Health	Structure	Arb. Rating	ULE (yrs)	Comments	TPZ radius (m)	SRZ radius (m)
1	*Allocasuarina verticillata*	Drooping She-oak	Early-mature	Indigenous (planted)	26,24 @1.2	41	7	6	Poor	Fair to Poor	Low	1-5	Declining, sparse canopy. Included bark union at base.	4.2	2.3
2	*Allocasuarina verticillata*	Drooping She-oak	Maturing	Indigenous (planted)	36,33	48	12	7	Fair	Fair to Poor	Mod.B	11-20	Past branch failure to west.	5.9	2.4
3	*Cupressus macrocarpa*	Monterey Cypress	Maturing	Exotic conifer	190 @0.2	199	20	22	Fair	Fair to Poor	Mod.B	11-20	Past and ongoing failures typical of species. Overextended limbs particularly to southeast at increased risk of failure.	15.0	4.4
4	*Allocasuarina verticillata*	Drooping She-oak	Early-mature	Indigenous (planted)	55 @1.0	56	7	7	Fair	Fair to Poor	Mod.C	11-20	Acute forks, congested primary union.	6.6	2.6
5	*Allocasuarina verticillata*	Drooping She-oak	Early-mature	Indigenous (planted)	46 @1.2	47	7	7	Fair to Poor	Poor	Low	1-5	Past stem failure to north, reduced foliage density.	5.5	2.4
6	*Allocasuarina verticillata*	Drooping She-oak	Early-mature	Indigenous (planted)	34	42	7	7	Fair	Fair	Mod.B	21-40		4.1	2.3
7	*Allocasuarina verticillata*	Drooping She-oak	Early-mature	Indigenous (planted)	29,17,16	39	7	6	Fair to Poor	Fair	Mod.C	11-20	Reduced foliage density. Some dieback.	4.5	2.2
8	*Allocasuarina verticillata*	Drooping She-oak	Early-mature	Indigenous (planted)	27,14 @1.1	32	7	6	Poor	Fair	Low	6-10	Reduced foliage density.	3.6	2.1
9	*Allocasuarina verticillata*	Drooping She-oak	Early-mature	Indigenous (planted)	39,21	49	7	8	Fair	Fair	Mod.B	11-20	Overextended limb to south.	5.3	2.5
10	*Allocasuarina verticillata*	Drooping She-oak	Early-mature	Indigenous (planted)	54	60	7	6	Fair	Fair to Poor	Mod.C	11-20	Congested primary union, partly suppressed - crown bias west.	6.5	2.7
11	*Allocasuarina verticillata*	Drooping She-oak	Early-mature	Indigenous (planted)	45	48	8	8	Fair	Fair	Mod.B	11-20		5.4	2.4
12	*Allocasuarina verticillata*	Drooping She-oak	Early-mature	Indigenous (planted)	12,10	25	3	7	Fair to Poor	Fair to Poor	Low	6-10	Suppressed.	2.0	1.8
13	*Allocasuarina verticillata*	Drooping She-oak	Early-mature	Indigenous (planted)	57 @0.7	57	8	7	Fair	Fair to Poor	Mod.C	6-10	Congested primary union.	6.8	2.6
14	*Allocasuarina verticillata*	Drooping She-oak	Semi-mature	Indigenous (planted)	9	12	4	3	Fair	Fair to Poor	Low	6-10	Suppressed.	2.0	1.5
15	*Allocasuarina verticillata*	Drooping She-oak	Maturing	Indigenous (planted)	30	35	12	6	Poor	Fair	Low	1-5	Canopy 90% dead	3.6	2.1
16	*Leptospermum laevigatum*	Coast Tea-tree	Maturing	Indigenous (planted)	31	85	6	11	Fair to Poor	Poor	Low	1-5	Numerous stems removed from base, past failures on remaining stem to southwest, foliage dying back.	3.7	3.1
17	*Araucaria heterophylla*	Norfolk Island Pine	Maturing	Australian conifer	89	97	22	18	Fair	Fair	Mod.A	21-40	On top of slope. Barcode P013074.	10.7	3.3
18	*Araucaria heterophylla*	Norfolk Island Pine	Maturing	Australian conifer	69	72	19	15	Fair	Fair	Mod.A	21-40	Barcode P013075.	8.3	2.9
19	*Cupressus macrocarpa*	Monterey Cypress	Maturing	Exotic conifer	151 @1.1	156	16	18	Fair	Fair	Mod.B	11-20	Steel cable north and south limbs. Barcode P013014.	15.0	4.0
20	*Cupressus macrocarpa*	Monterey Cypress	Maturing	Exotic conifer	148 @0.9	151	16	18	Fair	Fair to Poor	Mod.C	6-10	Past major failures, canopy gap to southeast. Steel cable east west limbs. Barcode P013013.	15.0	3.9
21	*Cupressus macrocarpa*	Monterey Cypress	Maturing	Exotic conifer	183 @0.9	183	17	18	Fair	Fair to Poor	Mod.C	6-10	Past failures esp to north. Lower canopy gap to north and west. 4x steel cables in canopy. Barcode P013012.	15.0	4.3
22	*Cupressus macrocarpa*	Monterey Cypress	Maturing	Exotic conifer	130 @1.0	130	17	13	Fair	Fair to Poor	Mod.C	6-10	Steel cable between two remaining stems. Canopy gaps to north and south. Recent limb failure to north. Barcode P013011.	15.0	3.7
23	*Cupressus macrocarpa*	Monterey Cypress	Maturing	Exotic conifer	203 @0.5	203	17	18	Fair	Fair to Poor	Mod.C	6-10	2 stems from base, steel cable north-south and yale cable east-west, recent failures to north. Barcode P013010.	15.0	4.5
G1	*Acacia longifolia var. sophorae; Leptospermum laevigatum; Lycium ferocissimum; Coprosma repens*	Coast Wattle; Coast Tea-tree; African Boxthorn; Mirror Bush	Mixed	Mixed	18-21	20-23	9	3	Fair	Fair to Poor	Low	6-10	Mixture of indigenous shrubs and weeds - large Mirror Bush behind shed		
G2	*Melaleuca lanceolata*	Moonah	Maturing	Indigenous	80 @base	80	6	5	Fair	Fair	Mod.C	11-20	Row of 3x closely spaced shrubs, likely planted. Surrounded by African Boxthorn at base		

Appendix 2A: Tree Location and Protection Zone Plan (Aerial)

Appendix 2B: Tree Location and Protection Zone Plan (Indicative)

Appendix 2C: Tree Location and Protection Zone Plan (Pipe Layout)

Refer to the following **3** pages.

LEGEND

Arboricultural Rating
- Mod-A
- Mod-B
- Mod-C
- Low

Protection Zones
- TPZ
- SRZ
- Small trees (<5m height)

Small tree groups
- Mod-C
- Low

Study area

NOTES
ME = *Metrosideros excelsa* (Pohutukawa)
NO = *Nerium oleander* (Oleander)

APPENDIX 2A
TREE LOCATIONS AND PROTECTION ZONES (Aerial)

PROJECT
Point Nepean - NCCEC

TL REF.
011175

MAP NO.
1 / 1

CLIENT
Monash University

DATE
2021-03-29

DATA SOURCES
Aerial imagery — Nearmap 2019-10-13

TREE LOCATION DISCLAIMER
Tree locations are approximate

COORDINATE REFERENCE SYSTEM
EPSG:28355 | GDA 94 MGA Zone 55

0 10 20m

TREELOGIC PTY LTD
ABN: 95 080 021 610
TEL: 1300 656 926
4 / 21 Eugene Tce
Ringwood, VIC
Australia 3134

Treelogic
Plan, manage, protect

Existing
New Building (indicative only)
Salt water pipe route - Alternative 1
Salt water pipe route - Alternative 2

LEGEND

Arboricultural Rating
- Mod-A
- Mod-B
- Mod-C
- Low

Protection Zones
- TPZ
- SRZ
- Small trees (<5m height)

Small tree groups
- Mod-C
- Low

NOTES
ME = *Metrosideros excelsa* (Pohutukawa)
NO = *Nerium oleander* (Oleander)

A **Badcoe Hall** - Community Engagement / Accomodation
B **Site B (New Building)** - Community Engagement / Research / Education / Workplace / Accommodation
C **Indicative Hardstand Area** - NCCEC tanks and shading structure (location to be agreed with PV)

APPENDIX 2B
TREE LOCATIONS AND PROTECTION ZONES (Indicative)

PROJECT
Point Nepean - NCCEC

TL REF. 011175
MAP NO. 1 / 1
CLIENT Monash University
DATE 2021-03-29

DATA SOURCES
Aerial imagery — Nearmap 2019-10-13
Schematic plan — Attachment 2, Point Nepean Site Plan, supplied by client

TREE LOCATION DISCLAIMER
Tree locations are approximate

COORDINATE REFERENCE SYSTEM
EPSG:28355 | GDA 94 MGA Zone 55

0 10 20m

TREELOGIC PTY LTD
ABN: 95 080 021 610
TEL: 1300 656 926
4 / 21 Eugene Tce
Ringwood, VIC
Australia 3134

Treelogic
Plan, manage, protect

Refer to full version of MSG3 DELWP Map, dated 10-Aug-2020 for legend of elements with circled numbers

der if this run of pipe can be
shore with a second tethered
on instead of running it South
d

Mornington Peninsula

Jacksons Rd

LEGEND

Arboricultural Rating
- Mod-A
- Mod-B
- Mod-C
- Low

Protection Zones
- TPZ
- SRZ
- Small trees (<5m height)

Small tree groups
- Mod-C
- Low

NOTES
ME = *Metrosideros excelsa* (Pohutukawa)
NO = *Nerium oleander* (Oleander)

APPENDIX 2C
TREE LOCATIONS AND PROTECTION ZONES (Pipe Layout)

PROJECT
Point Nepean - NCCEC

TL REF. 011175
MAP NO. 1 / 1
CLIENT Monash University
DATE 2021-03-29

DATA SOURCES
Aerial imagery — Nearmap 2019-10-13
Schematic plan — MSG3 DELWP Map, dated 10-Aug-2020, supplied by client

TREE LOCATION DISCLAIMER
Tree locations are approximate

COORDINATE REFERENCE SYSTEM
EPSG:28355 | GDA 94 MGA Zone 55

0 10 20m

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Australia 3134

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Plan, manage, protect

Appendix 3: Arboricultural Descriptors (February 2019)

Note that not all of the described tree descriptors may be used in a tree assessment and report. The assessment is undertaken with regard to contemporary arboricultural practices and consists of a visual inspection of external and above-ground tree parts.

1. Tree Condition

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

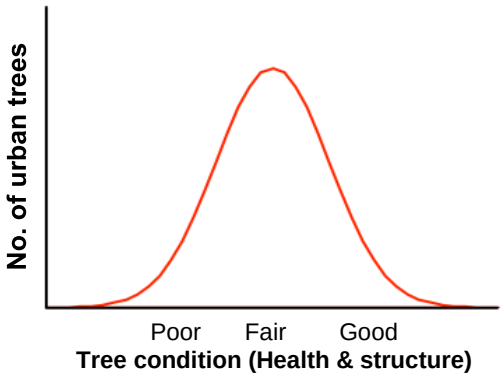


Diagram 1: Indicative normal distribution curve for tree condition

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

2. Tree Name

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

3. Tree Type

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

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

4. Height and Width

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

Crown height, crown spread are generally recorded to the nearest half metre (crown spread would be rounded up) for

dimensions up to 10 m and the nearest whole metre for dimensions over 10 m. Estimated dimensions (e.g. for off-site or otherwise inaccessible trees where accurate data cannot be recovered) shall be clearly identified in the assessment data.

5. Trunk diameters

The position where trunk diameters are captured may vary dependent on the requirements of the specific assessment and an individual trees specific characteristics. DBH is the typical trunk diameter captured as it relates to the allocation of tree protection distances. The basal trunk diameter assists in the allocation of a structural root zone. Some municipalities require trunk diameters be captured at different heights, with 1.0 m above grade being a common requirement. The specific planning schemes will be checked to ascertain requirements.

Stem diameters shall be recorded in centimetres, rounded to the nearest 1 cm (0.01 m).

Diameter at Breast Height (DBH)

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

Basal trunk diameter

The basal dimension is the trunk diameter measured at the base of the trunk or main stem(s) immediately above the root buttress. Used to ascertain the Structural Root Zone (SRZ) as outlined in AS4970.

6. Health

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

Category	Vitality, Extension growth	Decline symptoms, Deadwood, Dieback	Foliage density, colour, size, intactness	Pests and or disease
Good	Above typical. Excellent. Full canopy density	Negligible	Better than typical	Negligible
Fair	Typical vitality. >80% canopy density	Minor or expected. Little or no dead wood	Typical. Minor deficiencies or defects could be present.	Minor, within damage thresholds
Fair to Poor	Below typical - low vitality	More than typical. Small sub-branch dieback	Exhibiting deficiencies. Could be thinning, or smaller	Exceeds damage thresholds
Poor	Minimal - declining	Excessive, large and/or prominent amount & size of dead wood. Significant dieback	Exhibiting severe deficiencies. Thinning foliage, generally smaller or deformed	Extreme and contributing to decline
Dead	N/A	N/A	N/A	N/A

7. Structure

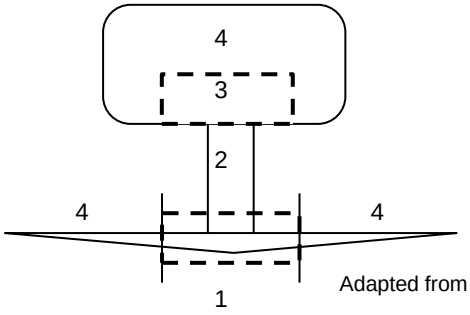
Assesses principal components of tree structure (Diagram 2).

Descriptor	Zone 1 - Root plate & lower stem	Zone 2 - Trunk	Zone 3 - Primary branch support	Zone 4 - Outer crown and roots
Good	No obvious damage, disease or decay; obvious basal flare / stable in ground	No obvious damage, disease or decay; well tapered	Well formed, attached, spaced and tapered. No history of failure.	No obvious damage, disease, decay or structural defect. No history of failure.
Fair	Minor damage or decay. Basal flare present.	Minor damage or decay	Generally, well attached, spaced and tapered branches. Minor structural deficiencies may be present or developing. No history of branch failure.	Minor damage, disease or decay; minor branch end-weight or over-extension. No history of branch failure.

Fair to Poor	Moderate damage or decay; minimal basal flare.	Moderate damage or decay; approaching recognised thresholds	Weak, decayed or with acute branch attachments; previous branch failure evidence.	Moderate damage, disease or decay; moderate branch end-weight or over-extension. Minor branch failure evident.
Poor	Major damage, disease or decay; fungal fruiting bodies present. Excessive lean placing pressure on root plate	Major damage, disease or decay; exceeds recognised thresholds; fungal fruiting bodies present. Acute lean. Stump re-sprout	Decayed, cavities or has acute branch attachments with included bark; excessive compression flaring; failure likely. Evidence of major branch failure.	Major damage, disease or decay; fungal fruiting bodies present; major branch end-weight or over-extension. Branch failure evident.
Very Poor	Excessive damage, disease or decay; unstable / loose in ground; altered exposure; failure probable	Excessive damage, disease or decay; cavities. Excessive lean. Stump re-sprout	Decayed, cavities or branch attachments with active split; failure imminent. History of major branch failure.	Excessive damage, disease or decay; excessive branch end-weight or over-extension. History of branch failure.

Diagram 2: Tree structure zones

1. Root plate & lower stem
2. Trunk
3. Primary branch support
4. Outer crown & roots



Adapted from Coder (1996)

Structure ratings will also take into account general branching architecture, stem taper, live crown ratio, crown symmetry (bias or lean) and crown position such as tree being suppressed amongst more dominant trees.

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

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

8. Age class

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

Category	Description
Young	Sapling tree and/or recently planted. Approximately 5 or less years in location.
Semi-mature	Tree increasing in size and yet to achieve expected size in situation. Primary developmental stage.
Early-mature	Tree established, generally growing vigorously. > 50% of attainable age/size.
Mature	Specimen approaching expected size in situation, with reduced incremental growth.
Over-mature	Mature full-size with a retrenching crown. Tree is senescent and in decline. Significant decay generally present.

9. Useful life expectancy

Assessment of useful life expectancy provides an indication of health and tree appropriateness and involves an estimate of how long a tree is likely to remain in the landscape based on species, stage of life (cycle), health, amenity, environmental services contribution, conflicts with adjacent infrastructure and risk to the community. It would enable tree managers to develop long-term plans for the eventual removal and replacement of existing trees in the public

realm. It is not a measure of the biological life of the tree within the natural range of the species. It is more a measure of the health status and the trees positive contribution to the urban landscape.

Within an urban landscape context, particularly in relation to street trees, it could be considered a point where the costs to maintain the asset (tree) outweigh the benefits the tree is returning.

The assessment is based on the site conditions not being significantly altered and that any prescribed maintenance works are carried out (site conditions are presumed to remain relatively constant and the tree would be maintained under scheduled maintenance programs).

Useful Life Expectancy	**Typical characteristics**
<1 year (No remaining ULE)	Tree may be dead or mostly dead. Tree may exhibit major structural faults. Tree may be an imminent failure hazard. Excessive infrastructure damage with high risk potential that cannot be remedied.
1-5 years (Transitory, Brief)	Tree is exhibiting severe chronic decline. Crown is likely to be less than 50% typical density. Crown may be mostly epicormic growth. Dieback of large limbs is common (large deadwood may have been pruned out). Major structural defects that cannot be remedied. Tree may be over-mature and senescing. Infrastructure conflicts with heightened risk potential. Tree has outgrown site constraints.
6-10 years (Short)	Tree is exhibiting chronic decline. Crown density will be less than typical and epicormic growth is likely to present. The crown may still be mostly entire, but some dieback is likely to be evident. Dieback may include large limbs. Structural defects present that influence the tree's risk rating, amenity or vitality. Over-mature and senescing or early decline symptoms in short-lived species. Early infrastructure conflicts with potential to increase regardless of management inputs.
11-20 years (Moderate)	Tree not showing symptoms of chronic decline, but growth characteristics are likely to be reduced (bud development, extension growth etc.). Developing structural defects that reduce viability with limited scope for management. Tree may be over-mature and beginning to senesce. Potential for infrastructure conflicts regardless of management inputs.
21-40 years (Moderately long)	Trees displaying normal growth characteristics, but vitality is likely to be reduced (bud development, extension growth etc.). Structural issues relatively minor and manageable with arboricultural input. Tree may be growing in restricted environment (e.g. streetscapes) or may be in late maturity. Semi-mature and mature trees exhibiting normal growth characteristics. Juvenile trees in streetscapes.
>40 years (Long)	Generally juvenile and semi-mature trees exhibiting normal growth characteristics within adequate spaces to sustain growth, such as in parks or open space. Could also pertain to maturing, long-lived trees. No observable major structural defects. Tree well suited to the site with negligible potential for infrastructure conflicts.

Note that ULE may change for a tree dependent on the prevailing climatic conditions, sudden changes to a tree's growing environment creating an acute stress or impact by pathogens.

The ULE may not be applicable for trees that are manipulated, such as topiary, or grown for specific horticultural purposes, such as fruit trees.

There may be instances where remedial tree maintenance could extend a tree's ULE.

10. Arboricultural Rating

Relates to the combination of assigned tree condition factors, including health and structure (arboricultural merit) and ULE, and conveys an amenity value (An amenity tree can occupy a site that complements its surroundings in a useful manner which culminates in the aid, protection, comfort and emotional response of humans. Adapted from Coder, 2004). Amenity relates to the trees biological, functional and aesthetic characteristics (Hitchmough, 1994) within an urban landscape context. The presence of any serious disease or tree-related hazards that would impact risk potential are considered.

The arboricultural rating can be used by applying only the main category high, moderate, low or very low without using the sub categories. The sub-categories can assist in differentiating a trees value and/or characteristic in more detail within the specific tree assessment context, such as a development site.

Arboricultural rating

Category	*Description*
High	Exemplary specimen due to multiple factors which could include; good condition and vitality, large size/canopy and prominence in the landscape. Likely to be a very long-term component in the landscape with a long ULE. Other factors that could contribute to a high rating: • Particularly good example of the species; rare or uncommon. • Tree has visual importance as a landscape feature; provides substantial contribution to landscape character. • Tree may have significant ecological or conservation value. • *Tree has historical, commemorative or other distinct social/cultural significance. Trees in this category must be considered for retention and/or incorporated within design proposals.

Category	*Description*	*Sub category*	*Description*
Moderate	Tree of moderate quality, in fair or typical condition. Tree may have a condition, and or structural problem that will respond to arboricultural treatment. These trees have the potential to be moderate- to long-term components of the landscape (moderate to long ULE) if managed appropriately. The sub-categories relate predominately to age, size and amenity. Trees in this category should be considered for retention and/or incorporated within design proposals.	A	Moderate to large, maturing tree. Suited to the site & contributes to the landscape character. Tree may have conservation or other cultural/social value.
		B	Moderate sized, established tree, > 50% of attainable age/size. Suited to the site & contributes to the landscape character (other attributes covered under 'Moderate' description)
		C	• Young to semi-mature, generally a smaller tree, established, >15 cm DBH, >5 years in the location. Not a dominant canopy. No significant qualities currently but has the potential to become a higher value tree & long-term component of the landscape. Replacement of tree is likely to take up to 6 - 10 years to attain similar attributes. • Semi- to mature tree with accumulating deficiencies and reducing ULE, trending towards Low arboricultural value.

Category	*Description*
Low	Unremarkable tree of low quality or little amenity value. Tree in either poor health and/or with poor structure. Short to transitory useful life expectancy (<10 years). • Tree is not prominent in the landscape due to its size or age, such as young trees with a stem diameter below 15 cm. Tree < 5 years in location. These trees are easily replaceable or capable of being transplanted. • Tree (species) is functionally inappropriate to the specific location. Is causing excessive damage/nuisance to adjacent infrastructure or would be expected to be problematic if retained (i.e. palm tree under power lines). • Unremarkable tree of no material landscape, conservation or other cultural value. Not visible from surrounding landscapes. • Tree infected with pathogens that could lead to its decline. • Tree has potential to be an environmental woody weed (may be dependent on location of tree in an urban landscape). • Tree impacting or suppressing trees of better quality. Retention of such trees may be considered if not requiring a disproportionate expenditure of resources for a tree in its condition and location.
Category	*Description*
Very low	Trees of low quality with a brief to no remaining ULE (<5 years). • Tree has either a severe structural defect or health problem or combination that cannot be sustained with practical arboricultural techniques and the loss of the tree or tree part would be expected in the short term. • Tree whose retention would not be viable after the removal of adjacent trees, such as trees that have developed in close spaced groups and would not be expected to adapt to severe and sudden alterations to environmental & site conditions, e.g. removal of adjacent shelter trees. • Small or young tree, <5m in height, <10cm DBH. Easily replaced in short-term or capable of being transplanted. • Acknowledged environmental woody weed species. Tree has a detrimental effect on the environment, for example, the tree has weed potential and is likely to spread into waterways or natural areas if nearby. • Tree infected with pathogens that will lead to decline and has potential to spread to adjacent trees. • Tree is dead (dead tree may offer habitat values) or is showing signs of significant, immediate, and irreversible overall decline. Tree cannot realistically be retained and should be considered for removal.

Other considerations - Even though a tree may be declining or dead, a tree could be retained for other purposes such as habitat or soil stabilisation. These trees would still need to be managed appropriately to reduce risk.

*A tree may have (attract) a high value by the community for historical, commemorative or other distinct social/cultural significance factors, albeit the tree may not be in good condition. In the context of an assessment, for multiple reasons, but more so for development, if it is a noted 'significant' tree it should receive higher consideration during the planning process.

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

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

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Appendix 4: Tree Protection Zones

1. Introduction

To sustain trees on a development site, consideration must be given to the establishment of tree protection zones.

The physical dimensions of tree protection zones can sometimes be difficult to define. The projection of a tree's crown can provide a guide but is by no means the definitive measure. The unpredictable nature of roots and their growth, differences between species and their tolerances, and observable and hidden changes to the trees growing environment, because of development, are variables that must be considered.

Most vigorous, broad canopied trees survive well if the area within the drip-line of the canopy is protected. Fine root density is usually greater beneath the canopy than beyond (Gilman, 1997). If few to no roots over 3cm in diameter are encountered and severed during excavation the tree will probably tolerate the impact and root loss. A healthy tree can sustain a loss of between 30% and 50% of absorbing roots (Harris, Clark, Matheny, 1999), however encroachment into the structural root system of a tree may be problematic.

The structural root system of a tree is responsible for ensuring the stability of the entire tree structure in the ground. A tree could not sustain loss of structural root system and be expected to survive let alone stand up to average annual wind loads upon the crown.

2. Allocation of tree protection zone (TPZ)

The most important consideration for the successful retention of trees is to allow appropriate above and below ground space for the trees to continue to grow. This requires the allocation of tree protection zones for retained trees.

The method of allocating a TPZ to a tree will be influenced by site factors, the tree species, its age, and developed form.

Once it has been established, through an arboricultural assessment, which trees and tree groups are to be retained, the next step will require careful management through the development process to minimise any impacts on the designated trees. The successful retention of trees on any particular site will require the commitment and understanding of all parties involved in the development process.
The most important activity, after determining the trees that will be retained, is the implementation of a TPZ.

The intention of tree protection zones is to:

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

The Australian Standard AS 4970-2009 Protection of trees on development sites has been used as a guide in the allocation of TPZs for the assessed trees. The TPZ for individual trees is calculated based on trunk (stem) diameter (DBH), measured at 1.4 metres up from ground level. The radius of the TPZ is calculated by multiplying the trees DBH by 12. The method provides a TPZ that addresses both the stability and growing requirements of a tree. TPZ distances are measured as a radius from the centre of the trunk at (or near) ground level. The minimum TPZ should be no less than 2m and the maximum no more than 15m radius. The TPZ of palms should be not less than 1.0m outside the crown projection.

Encroachment into the TPZ is permissible under certain circumstances though is dependent on both site conditions and tree characteristics. Minor encroachment, up to 10% of the TPZ, is generally permissible provided encroachment is compensated for by recruitment of an equal area contiguous with the TPZ. Examples are provided in Diagram 1. Encroachment greater than 10% is considered major encroachment under AS4970-2009 and is only permissible if it can be demonstrated that after such encroachment the tree would remain viable.

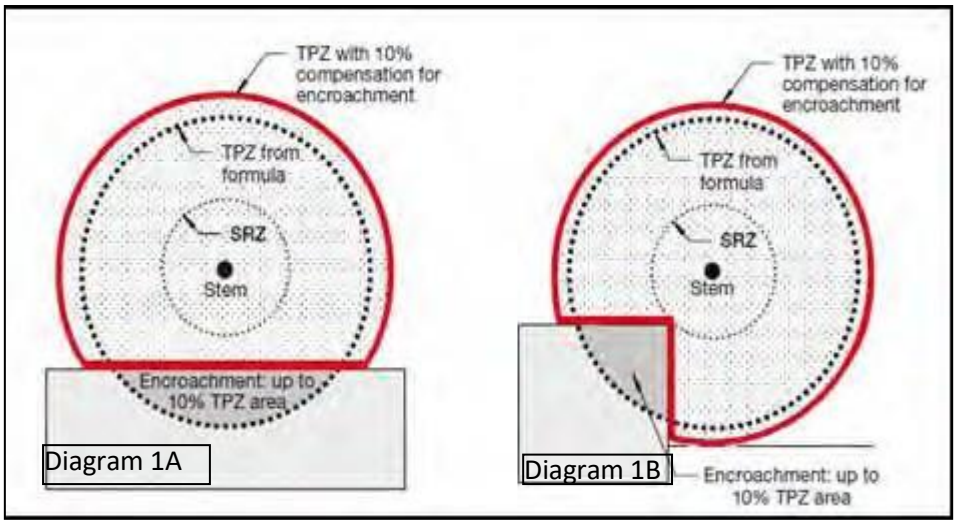

Diagram 1: Examples of minor encroachment into a TPZ. (Extract from: AS4970-2009, Appendix D, p30 of 32)

The 10% encroachment on one side equates to approximately ⅓ radial distance. Tree root growth is opportunistic and occurs where the essentials to life (primarily air and water) are present.
Heterogeneous soil conditions, existing barriers, hard surfaces and buildings may have inhibited the development of a symmetrically radiating root system.

Existing infrastructure around some trees may be within the TPZ or root plate radius. The roots of some trees may have grown in response to the site conditions and therefore if existing hard surfaces and building alignments are utilised in new designs the impacts on the trees should be minimal. The most reliable way to estimate root disturbance is to find out where the roots are in relation to the demolition, excavation or construction works that will take place (Matheny & Clark, 1998). Exploratory excavation prior to commencement of construction can help establish the extent of the root system and where it may be appropriate to excavate or build.

The TPZ should also consider the canopy and overall form of the tree. If the canopy requires severe pruning to accommodate a building or other works and in the process the form of the tree is diminished it may be worthwhile considering altering the design or removing the tree.

3. General tree protection guidelines

The most important factors are:

- Prior to construction works the trees nominated for tree works should be pruned to remove larger dead wood. Pruning works may also identify other tree hazards that require remedial works.
- Installation of tree protection fencing. Once the tree protection zones have been determined the next step is to mulch the zone with woodchip and erect tree protection fencing. This must be completed prior to any materials being brought on-site, erection of temporary site facilities or demolition/earth works. The protection fencing must be sturdy and withstand winds and construction impacts. The protection fence should only be moved with approval of the site supervisor. Other root zone protection methods can be incorporated if the TPZ area needs to be traversed.
- Appropriate signage is to be fixed to the fencing to alert people as to importance of the tree protection zone.
- The importance of tree preservation must be communicated to all relevant parties involved with the site.
- Inspection of trees during excavation works.

4. Exploratory excavation

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

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

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

Substantial roots are to be exposed and left intact.

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

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

5. How to determine the diameter of a substantial root

The size of a substantial root will vary according to the distance of the exposed root to the trunk of the tree. The further away from the trunk of a tree that a root is, the less significant the root is likely to be to the tree's health and stability.

The determination of what is a substantial root is often difficult because the form, depth and spread of roots will vary between species and sites. However, because smaller roots are connected to larger roots in a framework, there can be no doubt that if larger roots are severed, the smaller roots attached to them will die. Therefore, the larger the root, the more significant it may be.

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

6. No root or soil disturbance is permitted within the SRZ

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

Table 1: Estimated significant root sizes outside SRZ

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

7. Ground buffering

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

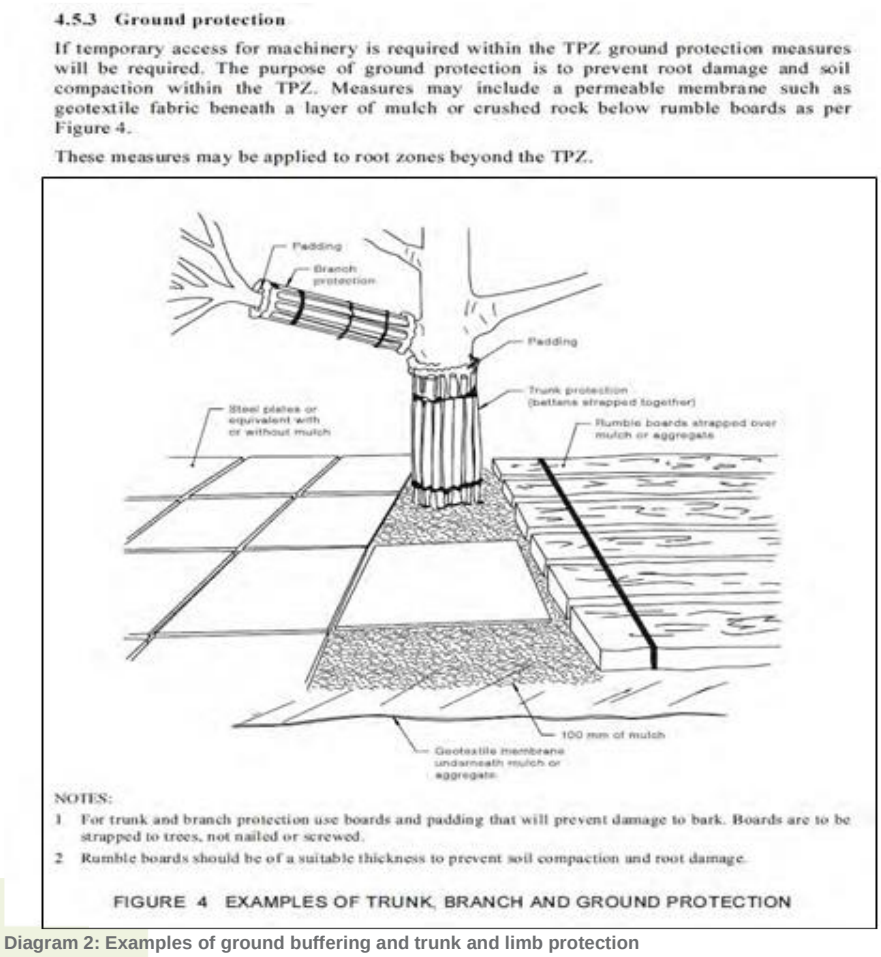

Diagram 2: Examples of ground buffering and trunk and limb protection

(Extract from: AS4970-2009, Appendix D, pg17)

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There can be no guarantees provided for on-going tree safety. It should be noted that not all of the potential structural concerns associated with trees can be eliminated and that there will always be a residual risk following any mitigation works. Also, not all tree defects are observable and extreme weather events are unpredictable. Since trees are complex, living organisms, it is difficult to quantify and precisely measure all variables when inspecting a standing tree for hazard.

Trees should be reassessed on a regular basis; the scheduled period of reassessment will be dependent on the characteristics of the tree, the landscape context and perceived targets, and resources available to maintain them.