northern beaches council

Tree Removal And Tree Pruning Development Application

UNDER SECTION 78A OF THE ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

NORTHERN BEACHES COUNCIL
- 4 DEC 2017
MONA VALE CUSTOMER SERVICE
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Signature ....

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Office use only	T0428/17
Form ID	4000
TRIM Ref	C000902
Last Updated	16 August 2017
Business Unit	Parks and Recreation
Application No.	DA20
Receipt No.	419292 $645.00 4/12/17

Privacy Protection Notice	
Purpose of collection:	For Council to provide services to the community
Intended recipients:	Northern Beaches Council staff
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Access/Correction:	Please contact Customer Service on 1300 434 434 to access or correct your personal information

Part 1: Applicant Details

1.1 APPLICANT DETAILS			
Applicant name	MATER MARIA CATHOLIC COLLEGE		
Landowner(s) name	MARC REICHER (PRINCIPAL)		
Phone number	9997 7044	Fax	
Mobile			
Email	marc.reicher@dbb.catholic.edu.au		

1.2 ADDRESS OF PROPERTY WHERE TREE(S) LOCATED			
Address	5 Forest Rd ~~Warriewood~~		
Suburb	Warriewood NSW	Postcode	2102
Title details (Lot/DP as shown on rates notice)	Lot 13 / DP 1083731		

1.3 INSPECTION FEES (NON-REFUNDABLE)			
1 Tree	☑ $150		
Additional fee per tree for pruning/removal	○ $45 x number of additional trees = 11 $495		
On site appointment	○ $85	Total	$645

Part 2: Site Plan and Details

Please provide sufficient details to locate tree(s) including labeling the tree(s) numerically on the plan. It is recommended that you tie a marker to tree(s) once this application has been lodged.	
Reason for application and outline of proposed work	
1. Removal of trees as per Arboricultural Appraisal Quantified Tree Risk Assessment dated 23 October 2017	
2. Trimming of 2 trees located near crossing adjacent to 12/13-19 Angophora Court Warriewood. Trees are overhanging backyard. Please see attached copy of letter.	

Sketch

Street Frontage

TREE AND SITE INFORMATION	
Is the tree(s) on private property? (*This application is only for trees on private property.*)	☑ Yes ◯ No
Is there a dog on the property?	◯ Yes ☑ No
Special arrangements required for site access	◯ Yes ☑ No
If yes, please provide details	
Is there a current development application lodged for this property? (*Tree removal as part of a separate development application is assessed under that application and this application may not be required*).	☑ Yes ◯ No

- Please note trees will not be assessed under this application process for complying development.
- Applications for removal of significant trees will require an arborist's report by an independent qualified arborist. Please attach to this application.
- Significant trees include local endemic trees, habitat trees, heritage listed trees or trees of large amenity and visual significance.
- Replacement trees may be a condition of approval of this application.

Please list any supporting documents attached to your application eg. engineer's report or arborist report.	Arboricultural Appraisal Quantified Tree Risk Assessment dated 23 October 2017

FAXED 10/7/17

General Manager

Northern Beaches Council

Dear Sir

Our address is 12/13-19 Angophora Crt Warriewood and our residence backs on to the boundary of Mater Maria School.

It is not sure if the land immediately on the other side of our back fence is council property or it is part of the school grounds. However, just inside that area is a row of trees that have grown to the extent that the branches now tower virtually over our entire backyard and block out most of the days sunlight.

In addition to the sunlight problem, and a more worrying issue, the trees continually shed branches of varying sizes that drop directly into our backyard and pose a risk to our family and particularly to our two very young children. This coupled with the spikey nuts that are forever falling have made the back lawn into a virtual no go zone.

In time to come we expect the trees have scope to grow much larger and will no doubt provide severe issues to the high retaining wall that rises up from the back of our yard.

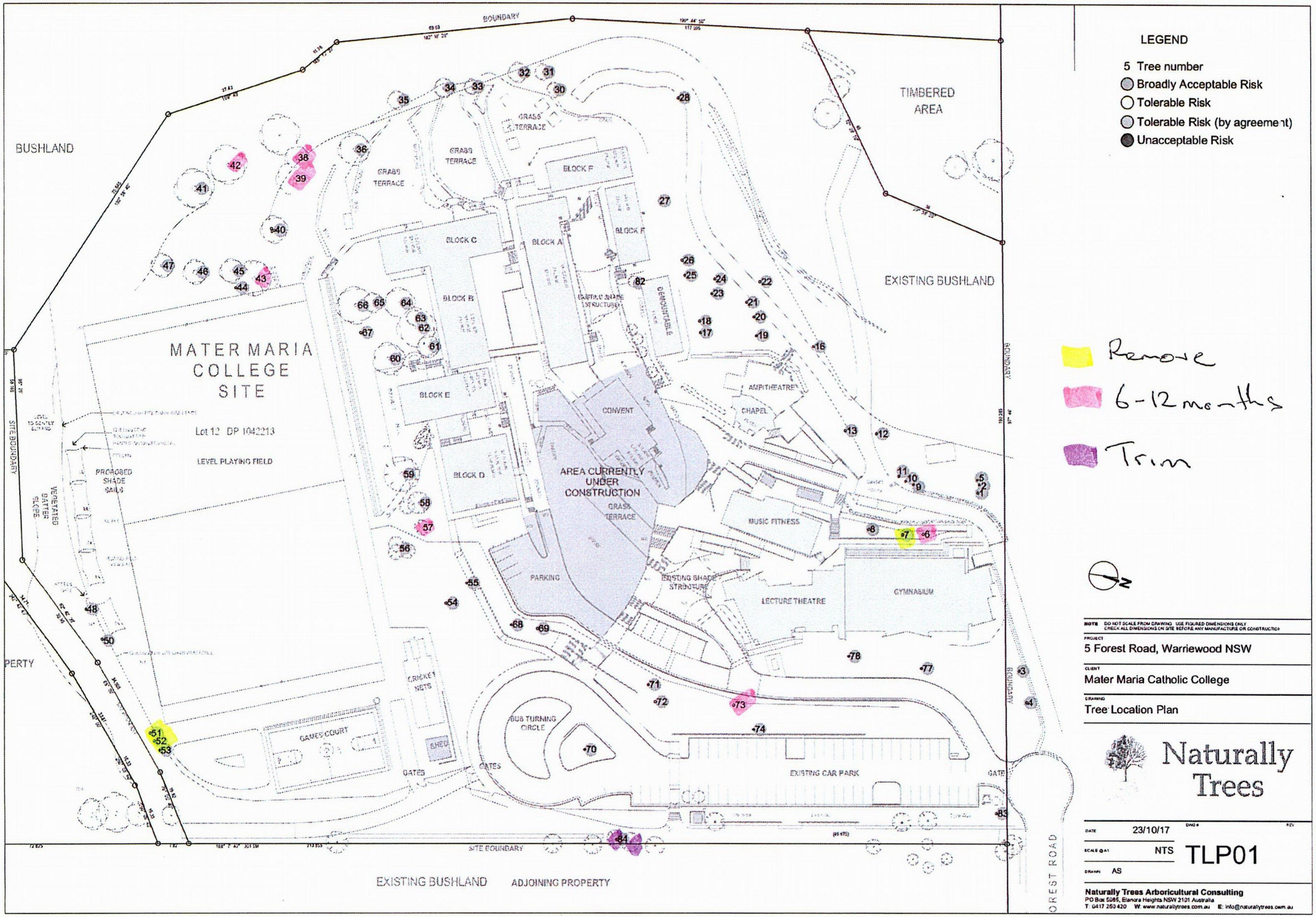
It would be appreciated if you would address the problem, firstly by arranging for the overhanging branches to be cut well back and also reducing the height and secondly, giving consideration to replacing the trees with something less imposing.

Regards

Mr & Mrs S. Eden

(M) 0411 100121

09 July 17



LEGEND
5 Tree number
Broadly Acceptable Risk
Tolerable Risk
Tolerable Risk (by agreement)
Unacceptable Risk
Remove
6-12 months
Trim
BOUNDARY
BUSHLAND
TIMBERED AREA
EXISTING BUSHLAND
MATER MARIA COLLEGE SITE
Lot 12 DP 1042213
LEVEL PLAYING FIELD
PROPOSED SHADE SAILS
VEGETATED BATTER SLOPE
SITE BOUNDARY
GRASS TERRACE
BLOCK A
BLOCK B
BLOCK C
BLOCK D
BLOCK E
BLOCK F
DEMOUNTABLE
EXISTING SHADE STRUCTURE
AMPITHEATRE
CHAPEL
CONVENT
AREA CURRENTLY UNDER CONSTRUCTION
PARKING
MUSIC FITNESS
GYMNASIUM
LECTURE THEATRE
CRICKET NETS
GAMES COURT
SHED
GATES
BUS TURNING CIRCLE
EXISTING CAR PARK
GATE
EXISTING BUSHLAND
ADJOINING PROPERTY
PERTY
FOREST ROAD
NOTE DO NOT SCALE FROM DRAWING. USE FIGURED DIMENSIONS ONLY. CHECK ALL DIMENSIONS ON SITE BEFORE ANY MANUFACTURE OR CONSTRUCTION
PROJECT
5 Forest Road, Warriewood NSW
CLIENT
Mater Maria Catholic College
DRAWING
Tree Location Plan
Naturally Trees
DATE 23/10/17
SCALE @A1 NTS
DRAWN AS
TLP01
Naturally Trees Arboricultural Consulting
PO Box 5085, Elanora Heights NSW 2101 Australia
T: 0417 250 420 W: www.naturallytrees.com.au E: info@naturallytrees.com.au

Naturally Trees

Expert Arboricultural planning, advice and care since 1998

**Arborist Reports, Landscape Design, Flora and Fauna Surveys,
Biodiversity and Ecological Impact Assessments &
Bushfire Protection Assessment Services**

ARBORICULTURAL APPRAISAL
QUANTIFIED TREE RISK ASSESSMENT

5 Forest Road
Warriewood, NSW

Prepared for
Mater Maria Catholic College

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23 October 2017

by Andrew Scales
Dip. Horticulture / Dip. Arboriculture AQF5
PO Box 5085, Elanora Heights NSW 2101

E: info@naturallytrees.com.au M: 0417 250 420

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Appendices

1. INTRODUCTION

1.1 **Instruction:** I am instructed by Robert Scheffers to survey the tree population at 5 Forest Road, Warriewood and to provide a tree management plan based on priority of risk.

A risk assessment strategy has been implemented as a need to inspect trees in or near public places, adjacent to buildings or working areas to assess whether they represent a risk to life or property, and to take remedial action as appropriate.

Mater Maria Catholic College, either in its capacity as owner or manager, is responsible for trees located on land for which it manages or has total control over. As such, it has a common law and statutory duty of care in relation to its trees. Compliance with the duty will require the operation of a reasonable systematic inspection of all its trees, which has been determined in accordance with a sufficient and informed risk assessment.

This document sets out minimum standards of inspection, competence and record keeping that Mater Maria Catholic College will commit to and is in accordance with industry guidelines, refer to Quantified Tree Risk Assessment Practice Note, Appendix 6.

1.2 **Qualifications and experience:** I have performed training and I am licensed to perform Quantified Tree Risk Assessments (QTRA - Licence No. 1655) using the method developed by Quantified Tree Risk Assessment Ltd. The recommendations within this report are based primarily on the review of trees and my interpretation of the QTRA system. I have experience and qualifications in arboriculture, and include a summary in Appendix 1.

1.3 **Documents and information provided:** Mark Suters provided me with copies of the following documents:

- Proposed Site Plan, Dwg No. AWD101 (rev. B), by Fulton Trotter Architects dated 18 June 2010.

1.4 **Scope of works:** Visually inspect trees in and around buildings and in areas congregated in numbers by students and teachers before and after school, during recess/ lunch and during learning activities. Identify those trees that pose an unacceptable and extreme risk due to location and condition and recommendation of immediate remedial action required and prioritise ongoing remediation and maintenance works.

2. SITE VISIT

2.1 **Site visit:** I carried out an unaccompanied site visit on 18 October 2017. All my observations were from ground level and I estimated all dimensions unless otherwise indicated. Aerial inspections, root or soil analysis, exploratory root trenching and internal diagnostic testing was not undertaken as part of this assessment. The weather at the time of inspection was clear and dry with good visibility.

2.2 **Brief site description:** 5 Forest Road is located in the residential suburb of Warriewood (refer figure 1). The site is on the western end of Forest Road and is surrounded residential development to the north and east and native bushland to the west. The property consists of Mater Maria Catholic College. A variety of indigenous trees are scattered throughout the site and around the site boundaries.

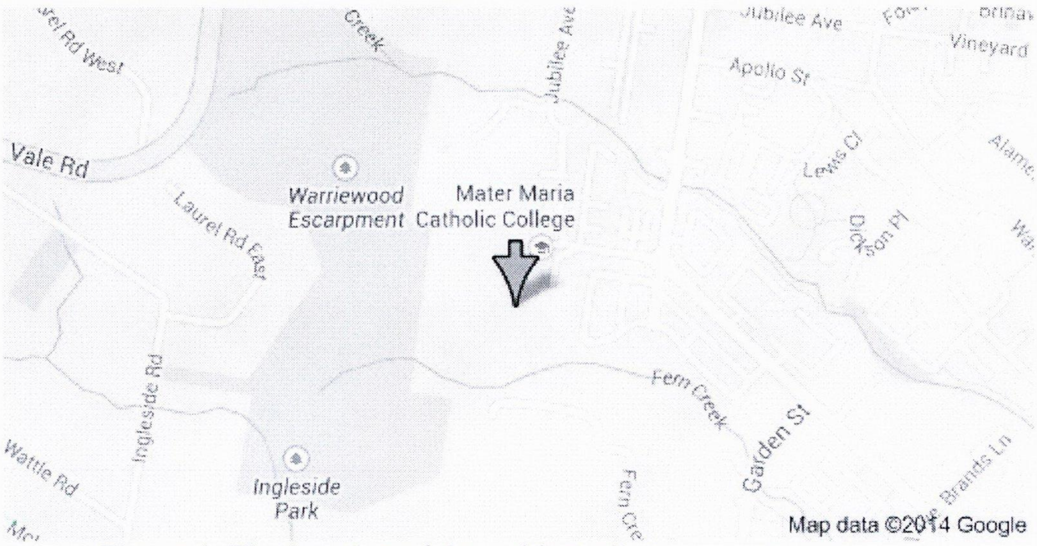

Figure 1: The location of the subject site (www.googlemaps.com).

2.3 **Identification and location of the trees:** I have illustrated the approximate locations of the trees on the Tree Location Plan included as Appendix 5. This plan is for illustrative purposes only and it should not be used for directly scaling measurements.

3. METHODOLOGY

3.1 **Visual Tree Assessment:** The subject trees were assessed using Visual Tree Assessment (VTA) techniques (Mattheck, 2004). VTA undertaken by tree professionals is a recognised systematic method of identifying tree characteristics and hazard potential. VTA is also an assessment method described by Claus Mattheck in the *Body Language of Trees – a handbook for failure analysis.*

3.2 **Quantified Tree Risk Assessment (QTRA):** The Quantified Tree Risk Assessment (QTRA) system has led the way in the field of tree management with a risk assessment approach that is led by the usage and value of the targets having potential to be affected by trees. The target-led approach to tree management is a considerable shift from the generally accepted wisdom where the tree assessor focuses on identifying defects in trees and then seeks to avoid legal liability by removing or modifying the tree.

This defect-led approach results in the allocation of disproportionate resources to both tree surveys, inspections and to the remediation of defective trees where the risks are low if only they were actually assessed.

One of the greatest benefits of QTRA is that it enables an informed overview of the risks associated with a tree population to be carried out as a desktop exercise before the survey of trees. When the risk overview is complete, the assessment will usually record only the general attributes of groups or collections of trees.

Assessing and recording individual trees will be necessary only where they are likely to be significant in relation to the targets.

3.3 **Limitations:** Care has been taken to obtain all information from reliable sources. All data has been verified as far as possible. However, I can neither guarantee nor be responsible for the accuracy of information provided by others.

4. FINDINGS / DISCUSSION

4.1 **General tree conditions:** After correlating the facts of the tree survey, it is evident that the subject trees on this site are of moderate to high significant value based on their individual merits. The tree varieties create shade, habitat and aesthetic value to the site. Overall, the majority of the tree population displays good health and structure and is suitable for long term retention.

There are eighty-one existing trees within the site and each were visually assessed during the course of my inspection. The tree population consists of a mixed age of trees.

4.2 **Targets:** Based on observations and discussions on site, it is evident that the occupancy rate throughout the site is moderate with some higher occupied areas. The areas surrounding the site boundaries are largely treed and are rarely used by students and teachers. Therefore, most trees within these areas are of very low risk or Target Rating of 4 (1/hr to 3/day pedestrians per hour).

The quadrangles and areas nearest buildings were seen as the highest occupied area, these areas were deemed as Target Range 3 or 2-7 pedestrians per hour. The oval and car-parking areas were seen as moderate usage, these areas were considered largely as Target Range 3 or 2-7 pedestrians per hour.

It should be noted that the oval and 'bush' areas are places where pedestrian traffic would be reduced significantly during adverse weather conditions. These weather affected areas further lessen the risks during storms when branch failure may be more prevalent.

4.3 **Arboricultural risk management:**
Goal: Reduce risks to public through systemic and prioritised tree management and planning.

Based on the QTRA results, seven trees (Tree 6, 38, 39, 42, 43, 57 and 73) are considered in the Tolerable risk range (yellow). Although Trees 38 and 73 are categorised within the Tolerable range, they should be considered for removal within the next 6-12 months. These trees are not an imminent risk but should.

Three trees (Tree 7, 51 and 52) are within the Unacceptable risk range (orange). These trees should be removed as high priority to mitigate risk of harm to persons or property.

The remaining trees within the site are considered as Broadly acceptable range (green).

4.4 Tree management and protection:

Goal: Conserve, sustain and develop the tree population over the long term.

There are a number of trees within the site that will require remedial pruning or further investigation and monitoring. Hazard mitigation is critical for the maintenance of public areas and will reduce the number of potentially hazardous trees and the associated risk.

Management of dead, declining and hazardous trees provides an opportunity for new planting, leading to an increase in species diversity and overall health of the tree population. Maintenance of healthy trees is more cost efficient than maintaining declining trees.

Management is advised to adopt Australian Standards for all arboricultural operations e.g. all tree works should be carried out to Australian Standards AS4373:2007 - *Pruning of Amenity Trees* and comply with Code of Practice for The Amenity Tree Industry 1998.

It is advisable to select a contractor from the directory of approved contractors - Arboriculture Australia. Selecting qualified contractors will ensure tree works are carried out to the highest quality.

Utilizing the data collected in this report, Mater Maria Catholic College can develop a strategy for improving the quality of its tree population. This strategy is included in the recommendations (refer Appendix 3).

5. INFORMIMNG MANAGEMENT DECISIONS

5.1 **Priority works:** The works required to establish acceptable levels of risk for the subject site are listed in Works Schedule, Appendix 3 and should be carried out within the time scale indicated.

5.2 **Cyclical Pruning Program:** Regular pruning and tree management are crucial for the management of retained trees within the site. These works are only required as they become necessary. The benefits for an ongoing maintenance program are:

- Further defects may be observed (i.e. trees are continually assessed)
- Proactive instead of reactive tree management.
- Improvement in the general condition of most of trees.
- Increase in the overall value of the tree population becomes (creating assets)
- Minimising liability (i.e. duty of care)

5.3 **Implementation of works:** All tree works should be carried out to Australian Standards AS4373 - 2007, Pruning of Amenity Trees and comply with the Code of Practice for The Amenity Tree Industry 1998. It is advisable to select a contractor from the directory of approved contractors - Arboriculture Australia.

5.4 **Scheduled inspection and recording:** In this report, the QTRA rating was used to prioritise inspections and determine the date for re-inspection. Generally, trees in an area with a 'higher occupation' will be inspected at least every year, every two years is probable for 'lesser occupation' areas. All trees should be inspected by a qualified (AQF5) Arborist.

6. BIBLIOGRAPHY

6.1 List of references:

Australian Standard AS4373-2007 *Pruning of Amenity Trees.*
Standards Australia.

Brooker, M. Kleinig, D (1999) Field guide to eucalypts – South eastern Aust.
Blooming Books, Hawthorn Vic.

Matheny, N. Clark, R (1999) Arboriculture
Prentice-Hall, Inc. New Jersey 07458

Mattheck, C.,Breloer, H (1994) The Body Language of Trees- A handbook for failure analysis . HMSO, London.

Kozlowski, T.T & Pallardy, S.G (1997) Growth Control in Woody Plants
Academic Press, San Diego.

Henderson, M. 1987. Living with Risk. The British Medical Association Guide.
John Wiley and Sons, Chichester, UK

Robinson, L (1994) Field Guide to the Native Plants of Sydney
Kangaroo Press, Kenthurst NSW

QTRA Ltd (2010) Quantified Tree Risk Assessment User Manual (Version 5)
Poynton, United Kingdom

7. DISCLAIMER

7.1 Limitations on use of this report:

Tree risk inspections are based on reasonably practicable assessment methods. Every condition that could possibly lead to stem or tree failure cannot expect to be detected. Trees may fail from a range of singular or cumulative reasons, some of which are not yet fully understood. Recommendations following inspections may or may be accepted by clients.

Assessment tools are variable and unless otherwise stated inspections are undertaken at ground level based on the permissible access granted. Inspection of underground portions is limited and potential reasons for failure are not always available for consideration. Naturally Trees cannot guarantee against tree or limb failure.

It is not possible to make a tree "safe" rather they can be managed to reduce the potential risk of harm to acceptable levels, should the consultant feel this is necessary. Recommendations in this report are based on qualifications, experience, knowledge and the use of assessment tools deemed necessary for the individual inspection.

The report is to be considered in full and sections are not to be selected for legal consideration without advice and approval from Naturally Trees.

ASSUMPTIONS

Care has been taken to obtain all information from reliable sources. All data has been verified insofar as possible: however, Naturally Trees can neither guarantee nor be responsible for the accuracy of information provided by others.

Unless stated otherwise:

- *Information contained in this report covers only those trees that were examined and reflects the condition of those trees at time of inspection: and*
- *The inspection was limited to visual examination of the subject trees without dissection, excavation, probing or coring. There is no warranty or guarantee, expressed or implied, that problems or deficiencies of the subject trees may not arise in the future.*

Yours sincerely

Andrew Scales
Dip. Horticulture / Arboriculture
Mobile: 0417 250 420

APPENDIX 1

Brief qualifications and experience of Andrew Scales

1. **Qualifications:**

Associate Diploma Horticulture	Northern Sydney Institute of TAFE	1995-1998
Certificate in Tree Surgery	Northern Sydney Institute of TAFE	1998
Associate Diploma Arboriculture	Northern Sydney Institute of TAFE	1999-2006

2. **Practical experience:** Being involved in the arboricultural/horticultural industry for in excess of 10 years, I have developed skills and expertise recognized in the industry. Involvement in the construction industry and tertiary studies has provided me with a good knowledge of tree requirements within construction sites.

   As director of Naturally Trees, in this year alone I have undertaken hundreds of arboricultural consultancy projects and have been engaged by a range of clients to undertake tree assessments. I have gained a wide range of practical tree knowledge through tree removal and pruning works.

3. **Continuing professional development:**

Visual Tree Assessment (Prof. Dr. Claus Mattheck)	Northern Sydney Institute of TAFE 2001
Wood Decay in Trees (F.W.M.R.Schwarze)	Northern Sydney Institute of TAFE 2004
Visual Tree Assessment (Prof. Dr. Claus Mattheck)	Carlton Hotel, Parramatta NSW 2004
Tree A-Z / Report Writing (Jeremy Barrell)	Northern Sydney Institute of TAFE 2006
Up by Roots – Healthy Soils and Trees in the Built Environment (James Urban)	The Sebel Parramatta NSW 2008
Tree Injection for Insect Control (Statement of Attainment)	Northern Sydney Institute of TAFE 2008
Quantified Tree Risk Assessment (QTRA) Registered Licensee #1655	South Western Sydney Institute TAFE 2011
Practitioners Guide to Visual Tree Assessment	South Western Sydney Institute TAFE 2011
Quantified Tree Risk Assessment (QTRA) Registered Licensee #1655	Richmond College NSW TAFE 2014
VALID Approach to Likelihood of Failure (David Evans)	Centennial Park NSW 2017

APPENDIX 2

Tree schedule and QTRA assesment

No.	Genus species	Height	Spread	DBH	Age Range	Vitality	Comments / Defects	Most Significant Part	Target	Target Range	Size Range	PoF	Risk Index	Weather affect	Review Years
1	*Angophora costata*	12	10	300	M	G	Borer, good reaction wood	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
2	*Corymbia gummifera*	14	12	350	M	G	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
3	*Corymbia gummifera*	15	13	500	M	G	Cambium damage	Deadwood	Pedestrian	4	4	6	**<1K**	N	1yr
4	*Eucalyptus scias*	14	12	500	M	G	Failures	Deadwood	Pedestrian	4	4	6	**<1K**	N	1yr
5	*Corymbia gummifera*	14	12	350	M	G	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
6	*Angophora costata*	16	12	300	M	G	Borer, Cockatoo damage first branch union	First order branch	Pedestrian	3	3	3	**500**	N	6mths
7	*Angophora costata*	16	10	300	M	G	Co-dominant, One stem dead, Borer infestation throughout base	First order branch	Pedestrian	3	2	2	**10**	N	6mths
8	*Angophora costata*	7	5	300	M	G	Nil	Deadwood	Pedestrian	3	4	4	**<1K**	N	1yr
9	*Angophora costata*	12	9	250	M	G	Nil	Deadwood	Pedestrian	3	4	5	**<1K**	N	1yr
10	*Angophora costata*	12	9	250	M	G	Nil	Deadwood	Pedestrian	3	4	5	**<1K**	N	1yr
11	*Angophora costata*	15	10	350	M	M	Cambium damage appears okay	Deadwood	Pedestrian	3	4	5	**<1K**	N	1yr
12	*Angophora costata*	14	13	350	M	M	Cavity appears okay	Deadwood	Pedestrian	4	4	2	**<1K**	Y	1yr
13	*Angophora costata*	17	13	500	M	G	Nil	Deadwood	Pedestrian	3	4	3	**<1K**	Y	1yr
16	*Angophora costata*	16	10	450	M	G	Borer at base of canopy	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
17	*Angophora costata*	15	14	500	M	G	Nil	Deadwood	Pedestrian	3	4	3	**<1K**	N	1yr
18	*Angophora costata*	15	12	400	M	G	Nil	Deadwood	Pedestrian	3	4	3	**<1K**	N	1yr
19	*Angophora costata*	15	12	400	M	G	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
20	*Eucalyptus scias*	9	11	300	M	M	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
21	*Angophora costata*	15	12	400	M	G	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
22	*Angophora costata*	17	13	500	M	G	Borer	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
23	*Angophora costata*	10	5	300	SM	G	Cavity	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
24	*Eucalyptus piperita*	17	14	500	M	G	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
25	*Corymbia gummifera*	20	14	500	M	G	Cambium damage in repair	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
26	*Angophora costata*	8	5	200	SM	G	Nil	Deadwood	Pedestrian	4	4	4	**<1K**	Y	1yr
27	*Allocasuarina & Banksia*	5	3	<100	M	G	Nil	Deadwood	Pedestrian	4	4	4	**<1K**	N	1yr

No.	Genus species	Height	Spread	DBH	Age Range	Vitality	Comments / Defects	Most Significant Part	Target	Target Range	Size Range	PoF	Risk Index	Weather affect	Review Years
28	*Eucalyptus scias*	13	9	350	M	G	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
30	*Eucalyptus scias*	18	15	400	M	G	Nil	First order branch	Pedestrian	3	3	4	**<1K**	Y	6mths
31	*Allocasuarina torulosa*	13	8	300	M	M	Leaning	Whole tree	Pedestrian	3	3	4	**<1K**	Y	1yr
32	*Eucalyptus scias*	12	7	250	SM	G	Nil	Deadwood	Pedestrian	3	4	4	**<1K**	Y	1yr
33	*Eucalyptus botryoides*	14	13	400	M	G	Nil	Deadwood	Pedestrian	3	4	4	**<1K**	Y	1yr
34	*Eucalyptus botryoides*	24	17	600	M	G	Nil	Deadwood	Pedestrian	3	4	4	**<1K**	Y	1yr
35	*Eucalyptus botryoides*	14	13	400	M	G	Minor borer activity in upper limbs	Deadwood	Pedestrian	4	4	4	**<1K**	Y	1yr
36	*Eucalyptus botryoides*	28	20	700	M	G	Nil	Deadwood	Pedestrian	3	4	3	**<1K**	Y	1yr
38	*Eucalyptus botryoides*	26	13	500	M	P	Failures, Advanced decline	First order branch	Pedestrian	3	2	3	**100**	Y	6mths
39	*Eucalyptus botryoides*	18	13	700	PO	M	Cavities	First order branch	Pedestrian	3	2	3	**100**	Y	6mths
40	*Syncarpia glomulifera*	10	7	250	SM	G	Nil	Deadwood	Pedestrian	3	4	5	**<1K**	Y	1yr
41	*Angophora costata*	20	11	300	M	G	Borer	Deadwood	Pedestrian	3	4	3	**<1K**	Y	1yr
42	*Angophora costata*	17	13	350	M	G	Leaning	First order branch	Pedestrian	3	3	3	**500**	Y	1yr
43	*Eucalyptus botryoides*	28	16	750	M	M	Borer activity in upper second order branches	Second order branch	Pedestrian	3	4	2	**500**	Y	1yr
44	*Syncarpia glomulifera*	10	7	250	SM	G	Nil	Deadwood	Pedestrian	3	4	4	**<1K**	Y	1yr
45	*Eucalyptus botryoides*	28	16	500	M	G	Nil	Deadwood	Pedestrian	3	4	4	**<1K**	Y	6mths
46	*Eucalyptus botryoides*	28	16	700	M	G	Failures	Deadwood	Pedestrian	3	4	4	**<1K**	Y	6mths
47	*Eucalyptus botryoides*	24	14	400	M	G	Failures	Second order branch	Pedestrian	3	4	4	**<1K**	Y	6mths
48	*Eucalyptus saligna*	16	11	400	M	G	Borer, Included bark union	Deadwood	Pedestrian	3	4	3	**<1K**	Y	1yr
50	*Eucalyptus saligna*	19	12	400	M	G	Nil	Deadwood	Pedestrian	3	4	3	**<1K**	Y	1yr
51	*Eucalyptus saligna*	19	12	400	M	G	Central leader failure	First order branch	Pedestrian	3	2	2	**10**	Y	1yr
52	*Eucalyptus saligna*	19	12	400	M	G	Borer infestation within included bark unions	First order branch	Pedestrian	3	2	2	**10**	Y	1yr
53	*Eucalyptus saligna*	16	10	350	M	G	Nil	Deadwood	Pedestrian	3	4	3	**<1K**	Y	1yr
54	*Eucalyptus botryoides*	14	11	400	M	G	Nil	Deadwood	Pedestrian	3	4	4	**<1K**	N	1yr
55	*Eucalyptus botryoides*	10	10	300	M	G	Nil	Deadwood	Pedestrian	3	4	4	**<1K**	N	1yr
56	*Syncarpia glomulifera*	11	6	250	M	G	Nil	Deadwood	Pedestrian	3	4	5	**<1K**	N	1yr

No.	Genus species	Height	Spread	DBH	Age Range	Vitality	Comments / Defects	Most Significant Part	Target	Target Range	Size Range	PoF	Risk Index	Weather affect	Review Years
57	*Eucalyptus botryoides*	9	9	400	M	G	Termite	First order branch	Pedestrian	3	2	3	**100**	N	6mths
58	*Eucalyptus botryoides*	20	14	500	M	G	Nil	Deadwood	Pedestrian	3	4	3	**<1K**	N	1yr
59	*Eucalyptus scoparia*	24	17	1000	M	G	Borer	Second order branch	Pedestrian	3	4	3	**<1K**	N	1yr
60	*Angophora costata*	26	22	500	M	G	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
61	*Syncarpia glomulifera*	16	8	300	M	M	Nil	Deadwood	Pedestrian	4	4	5	**<1K**	Y	1yr
62	*Angophora costata*	22	18	450	M	G	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
63	*Angophora costata*	14	10	300	M	G	Borer	Deadwood	Pedestrian	4	4	2	**<1K**	Y	1yr
64	*Syncarpia glomulifera*	17	10	400	M	G	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
65	*Eucalyptus botryoides*	19	13	400	M	G	Cavity	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
66	*Eucalyptus botryoides*	14	13	550	M	G	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
67	*Angophora costata*	24	14	450	M	G	Nil	Deadwood	Pedestrian	4	4	3	**<1K**	Y	1yr
68	*Eucalyptus sideroxylon*	6	4	200	SM	G	Nil	Second order branch	Pedestrian	3	4	6	**<1K**	N	1yr
69	*Eucalyptus sideroxylon*	6	4	200	SM	G	Failures	Second order branch	Pedestrian	3	4	6	**<1K**	N	1yr
70	*Ficus rubiginosa*	6	7	200	SM	G	Nil	Second order branch	Pedestrian	3	4	6	**<1K**	N	1yr
71	*Corymbia citriodora*	10	7	300	M	G	Borer	Second order branch	Pedestrian	3	4	6	**<1K**	N	1yr
72	*Corymbia citriodora*	11	8	350	M	G	Nil	Second order branch	Pedestrian	3	4	6	**<1K**	N	1yr
73	*Eucalyptus sideroxylon*	12	9	300	M	G	Failed included bark union	First order branch	Pedestrian	3	3	2	**50**	N	1yr
74	*Angophora costata*	11	6	250	SM	G	Nil	Second order branch	Pedestrian	3	4	6	**<1K**	N	1yr
77	*Angophora costata*	8	6	250	SM	G	Borer	Second order branch	Pedestrian	4	4	6	**<1K**	N	1yr
78	*Angophora costata*	9	8	250	SM	G	Nil	Second order branch	Pedestrian	4	4	6	**<1K**	N	1yr
82	*Eucalyptus robusta*	12	10	350	M	G	Nil	First order branch	Pedestrian	3	3	3	**<1K**	N	1yr
83	*Eucalyptus botryoides*	12	9	300	M	G	Nil	Second order branch	Pedestrian	3	4	6	**<1K**	N	1yr
84	*Eucalyptus scias*	9	5	400	M	G	Lopped canopy, Epicormic growth	Second order branch	Pedestrian	4	4	3	**<1K**	Y	1yr

Explanatory Notes

NO.:	TREE REFERENCE
SPECIES:	THE SPECIES IDENTIFICATION IS BASED ON VISUAL OBSERVATIONS AND THE BOTANICAL NAME. IN SOME INSTANCES, IT MAY BE DIFFICULT TO QUICKLY AND ACCURATELY IDENTIFY A PARTICULAR TREE WITHOUT FURTHER DETAILED INVESTIGATIONS. WHERE THERE IS SOME DOUBT OF THE PRECISE SPECIES OF TREE, IT IS INDICATED WITH A '?' AFTER THE NAME IN ORDER TO AVOID DELAY IN THE PRODUCTION OF THE REPORT. THE BOTANICAL NAME IS FOLLOWED BY THE ABBREVIATION SP. IF ONLY THE GENUS IS KNOWN. THE SPECIES LISTED FOR GROUPS AND HEDGES REPRESENT THE <u>MAIN</u> COMPONENT AND THERE MAY BE OTHER MINOR SPECIES NOT LISTED.
AGE RANGE:	Y = YOUNG, SM = SEMI MATURE, EM = EARLY MATURE, M = MATURE, PM = POST MATURE
HEIGHT:	OTHER THAN WHERE THE HEIGHT OF A TREE IS CRITICAL TO THE OUTCOME OF THE RISK ASSESSMENT, APPROXIMATELY 1 IN 10 TREES ARE MEASURED AND THE REMAINDER ESTIMATED AGAINST THE MEASURED TREES
SPREAD:	MEASURED OR ESTIMATED DIAMETER OF CROWN AT THE WIDEST POINT
DBH:	STEM DIAMETER - MEASURED AT A HEIGHT OF APPROXIMATELY 1.3 METRES
VITALITY:	A MEASURE OF PHYSIOLOGICAL CONDITION. D = DEAD, MD = MORIBUND, P = POOR, M = MODERATE, G = GOOD
SIZE RANGE:	SIZE CATEGORY OF MOST SIGNIFICANT PART CONSIDERED LIKELY TO FAIL. RANGES 1-5. 1 = LARGE, 5 = SMALL
PROB OF FAILURE RANGE:	PROBABILITY OF FAILURE WITHIN 12 MONTHS. RANGES 1-5. 1 = HIGH, 5 = LOW
TARGET RANGE:	HIGHEST VALUE TARGET THAT THE MOST SIGNIFICANT PART LIKELY TO FAIL COULD STRIKE. RANGES 1-6. 1 = HIGH, 6 = LOW VALUE/OCCUPANCY
WEATHER FACTOR:	ALLOWANCE FOR REDUCED ACCESS DURING HIGH WINDS WHEN IN SOME SITUATIONS TREE FAILURE IS MOST LIKELY, OR SITUATIONS WHERE THE PROBABILITY OF TREE FAILURE IS INCREASED BY HOT DRY WEATHER, WHICH AT THE SAME TIME INCREASES PEDESTRIAN ACCESS. TO BE APPLIED BY MULTIPLYING THE RISK INDEX BY THE WEATHER FACTOR
REDUCED MASS %	WHERE THE MASS OF A TREE OR BRANCH IS REDUCED BY DEGRADATION THE RISK INDEX IS MULTIPLED TO REFLECT THE PERCENTAGE OF MASS REDUCTION
RISK INDEX:	RISK OF SIGNIFICANT HARM ÷ 1,000 = RISK INDEX (E.G. RISK INDEX 20 = RISK OF SIGNIFICANT HARM 1 IN 20,000) AN ADDITIONAL FIGURE IN BRACKETS MAY BE SUFFIXED EITHER T OR F REPRESENTING 'F' THE RATE OF FAILURES OVER THE YEAR, AND 'T' THE RATE OF MULTIPLE OCCUPATION OVER THE YEAR, E.G. 1(10T)/10,000 REPRESENTS A RISK OF HARM 1/10,000 TO 10 OCCUPANTS OR AN EQUIVALENT MONETARY VALUE SUFFIXES: (M) = FOR GENERAL ARBORICULTURAL OR SILVICULTURAL MANAGEMENT; (S) = TO REMOVE OR REDUCE THE RISK OF DIRECT DAMAGE TO A FIXED STRUCTURE BY MEANS OF CIRCUMFERENTIAL GROWTH
REVIEW:	PERIOD (YEARS) TO NEXT INSPECTION

APPENDIX 3

Works schedule

(Denotes - *** Highest priority; * Lower priority)

No.	Genus species	Comments / Defects	Risk Index	Review Years	Priority of works	Management
6	*Angophora costata*	Borer, Cockatoo damage first branch union	**500**	6mths	***	Monitor in 6mths. Inspect borer damage @ main fork
7	*Angophora costata*	Co-dominant, One stem dead, Borer infestation throughout base	**10**	6mths	***	Remove tree
38	*Eucalyptus botryoides*	Failures, Advanced decline	**100**	6mths	**	Remove tree
39	*Eucalyptus botryoides*	Cavities	**100**	6mths	***	Further inspection, Assess cavities for decay, Thin canopy by 10%, Remove deadwood
42	*Angophora costata*	Leaning	**500**	1yr	*	Monitor
43	*Eucalyptus botryoides*	Borer activity in upper second order branches	**500**	1yr	**	Monitor
51	*Eucalyptus saligna*	Central leader failure	**10**	1yr	**	Remove tree
52	*Eucalyptus saligna*	Borer infestation within included bark unions	**10**	1yr	***	Remove tree
57	*Eucalyptus botryoides*	Termite	**100**	6mths	**	Monitor termites, Retain for short term only
73	*Eucalyptus sideroxylon*	Failed included bark union	**50**	1yr	*	Remove tree

APPENDIX 4

Quantified Tree Risk Assessment (QTRA)

The QTRA system quantifies three primary components of the tree failure risk:

1) **Target** - in tree risk management, the target is that which may be harmed by a falling tree or branch;
2) **Size** - of tree or tree part most likely to fail; and
3) **Probability of failure** - of the tree or branch within 12 months.

The product of these component probabilities is referred to as the 'Risk of Significant Harm';

Target Value X Size X Probability of Failure = **Risk of Harm**

A risk of significant harm of 1/10,000 (or 1 in 10,000) is considered by QTRA and a number of sources to be the limit of acceptable risk to the public at large. Using the 1/10,000 limit, a risk of harm exceeding 1/10,000 requires remedial action to reduce the risk (unless the risk is limited to a selective individual or group - such as a tree owner, who may choose to accept a greater or lesser risk).

Additionally, a tree might confer benefits that could be set against the risk of harm e.g. one with very high amenity. The 1/10,000 threshold is not intended to be applied absolutely rigidly but necessarily includes a degree of flexibility. For further information Quantified Tree Risk Assessment Practice Note, a copy of which is included at Appendix 5. Tree owners also need to be able to demonstrate that the risks posed by their trees are 'As Low As Reasonably Practicable' (ALARP), taking into account the benefit provided by the individual tree. This may result in work to some trees of a risk lower than the above threshold.

Where trees are identified to pose a risk of harm greater than 1 in 10,000 to users or structures, the tree owner should seek to ensure that the risk is reduced to an acceptable level and will, where such trees are identified to be 'Dangerous', take action using its powers under the local governing body.

Risk Thresholds	Description	Action
	Unacceptable Risks will not ordinarily be tolerated	• Control the risk
1/1 000	**Unacceptable** (where imposed on others) Risks will not ordinarily be tolerated	• Control the risk • Review the risk
	Tolerable (by agreement) Risks may be tolerated if • those exposed to the risk accept it, or • the tree has exceptional value	• Control the risk unless there is broad stakeholder agreement to tolerate it, or the tree has exceptional value • Review the risk
1/10 000	**Tolerable** (where imposed on others) Risks are tolerable if ALARP	• Assess costs and benefits of risk control • Control the risk only where a significant benefit might be achieved at a reasonable cost • Review the risk
1/1 000 000	**Broadly Acceptable** Risk is already ALARP	• No action required currently • Review the risk

Table 1: The risk categories and the risk of harm threshold. A risk higher than 1 in 10,000 is generally unacceptable.

APPENDIX 5

Tree location plan

-refer attached Tree Location Plan, Dwg No. TLP01, by Naturally Trees dated 23 October 2017

APPENDIX 6
Quantified Tree Risk Assessment Practice Note

"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind"

William Thomson, Lord Kelvin, Popular Lectures and Addresses [1891-1894]

1. INTRODUCTION

Every day we encounter risks in all of our activities, and the way we manage those risks is to make choices. We weigh up the costs and benefits of the risk to determine whether it is acceptable, unacceptable, or tolerable. For example, if you want to travel by car you must accept that even with all the extensive risk control measures, such as seat-belts, speed limits, airbags, and crash barriers, there is still a significant risk of death. This is an everyday risk that is taken for granted and tolerated by millions of people in return for the benefits of convenient travel. Managing trees should take a similarly balanced approach.

A risk from falling trees exists only if there is both potential for tree failure and potential for harm to result. The job of the risk assessor is to consider the likelihood and consequences of tree failure. The outcome of this assessment can then inform consideration of the risk by the tree manager, who may also be the owner.

Using a comprehensive range of values[1], Quantified Tree Risk Assessment (QTRA) enables the tree assessor to identify and analyse the risk from tree failure in three key stages. 1) to consider land-use in terms of vulnerability to impact and likelihood of occupation, 2) to consider the consequences of an impact, taking account of the size of the tree or branch concerned, and 3) to estimate the probability that the tree or branch will fail onto the land-use in question. Estimating the values of these components, the assessor can use the QTRA manual calculator or software application to calculate an annual Risk of Harm from a particular tree. To inform management decisions, the risks from different hazards can then be both ranked and compared, and considered against broadly acceptable and tolerable levels of risk.

A Proportionate Approach to Risks from Trees

The risks from falling trees are usually very low and high risks will usually be encountered only in areas with either high levels of human occupation or with valuable property. Where levels of human occupation and value of property are sufficiently low, the assessment of trees for structural weakness will not usually be necessary. Even when land-use indicates that the assessment of trees is appropriate, it is seldom proportionate to assess and evaluate the risk for each individual tree in a population. Often, all that is required is a brief consideration of the trees to identify gross signs of structural weakness or declining health. Doing all that is reasonably practicable does not mean that all trees have to be individually examined on a regular basis (HSE 2013).

The QTRA method enables a range of approaches from the broad assessment of large collections of trees to, where necessary, the detailed assessment of an individual tree.

Risk of Harm

The QTRA output is termed the Risk of Harm and is a combined measure of the likelihood and consequences of tree failure, considered against the baseline of a lost human life within the coming year.

ALARP (As Low As Reasonably Practicable)

Determining that risks have been reduced to As Low As Reasonably Practicable (HSE 2001) involves an evaluation of both the risk and the sacrifice or cost involved in reducing that risk. If it can be demonstrated that there is gross disproportion between them, the risk being insignificant in relation to the sacrifice or cost, then to reduce the risk further is not 'reasonably practicable'.

Costs and Benefits of Risk Control

Trees confer many benefits to people and the wider environment. When managing any risk, it is essential to maintain a balance between the costs and benefits of risk reduction, which should be considered in the determination of ALARP. It is not only the financial cost of controlling the risk that should be considered, but also the loss of tree-related benefits, and the risk to workers and the public from the risk control measure itself.

[1] See Tables 1, 2 & 3.

When considering risks from falling trees, the cost of risk control will usually be too high when it is clearly 'disproportionate' to the reduction in risk. In the context of QTRA, the issue of 'gross disproportion'[2], where decisions are heavily biased in favour of safety, is only likely to be considered where there are risks of 1/10 000 or greater.

Acceptable and Tolerable Risks

The Tolerability of Risk framework (ToR) (HSE 2001) is a widely accepted approach to reaching decisions on whether risks are broadly acceptable, unacceptable, or tolerable. Graphically represented in Figure 1, ToR can be summarised as having a Broadly Acceptable Region where the upper limit is an annual risk of death 1/1 000 000, an Unacceptable Region for which the lower limit is 1/1 000, and between these a Tolerable Region within which the tolerability of a risk will be dependent upon the costs and benefits of risk reduction. In the Tolerable Region, we must ask whether the benefits of risk control are sufficient to justify their cost.

In respect of trees, some risks cross the Broadly Acceptable 1/1 000 000 boundary, but remain tolerable. This is because any further reduction would involve a disproportionate cost in terms of the lost environmental, visual, and other benefits, in addition to the financial cost of controlling the risk.

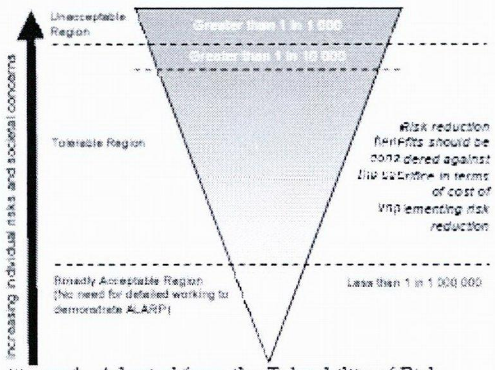

Figure 1. Adapted from the Tolerability of Risk framework (HSE 2001).

Value of Statistical Life

The Value of Statistical Life (VOSL), is a widely applied risk management device, which uses the value of a hypothetical life to guide the proportionate allocation of resources to risk reduction. In the UK, this value is currently in the region of £1 500 000 ($2 850 000), and this is the value adopted in the QTRA method.

In QTRA, placing a statistical value on a human life has two particular uses. Firstly, QTRA uses VOSL to enable damage to property to be compared with the loss of life, allowing the comparison of risks to people and property. Secondly, the proportionate allocation of financial resources to risk reduction can be informed by VOSL. *"A value of statistical life of £1 000 000 is just another way of saying that a reduction in risk of death of 1/100 000 per year has a value of £10 per year"* (HSE 1996).

Internationally, there is variation in VOSL, but to provide consistency in QTRA outputs, it is suggested that VOSL of £1 500 000 ($2 850 000) should be applied internationally. This is ultimately a decision for the tree manager.

2. OWNERSHIP OF RISK

Where many people are exposed to a risk, it is shared between them. Where only one person is exposed, that individual is the recipient of all of the risk and if they have control over it, they are also the owner of the risk. An individual may choose to accept or reject any particular risk to themselves, when that risk is under their control. When risks that are imposed upon others become elevated, societal concern will usually require risk controls, which ultimately are imposed by the courts or government regulators.

Although QTRA outputs might occasionally relate to an individual recipient, this is seldom the case. More often, calculation of the Risk of Harm is based on a cumulative occupation – i.e. the number of people per hour or vehicles per day, without attempting to identify the individuals who share the risk.

Where the risk of harm relates to a specific individual or a known group of people, the risk manager might consider the views of those who are exposed to the risk when making management decisions. Where a risk is imposed on the wider community, the principles set out in the ToR framework can be used as a reasonable approach to determine whether the risk is ALARP.

3. THE QTRA METHOD - VERSION 5

The input values for the three components of the QTRA calculation are set out in broad ranges[3] of Target, Size, and Probability of Failure. The assessor

[2] Discussed further on page 5.

[3] See Tables 1, 2 & 3.

estimates values for these three components and inputs them on either the manual calculator or software application to calculate the Risk of Harm.

Assessing Land-use (Targets)
The nature of the land-use beneath or adjacent to a tree will usually inform the level and extent of risk assessment to be carried out. In the assessment of Targets, six ranges of value are available. Table 2 sets out these ranges for vehicular frequency, human occupation and the monetary value of damage to property.

Human Occupation
The probability of pedestrian occupation at a particular location is calculated on the basis that an average pedestrian will spend five seconds walking beneath an average tree. For example, ten pedestrians per day, each occupying the Target for five seconds, is a daily occupation of fifty seconds. The total seconds in a day are divided to give a probability of Target occupation (50/86 400 = 1/1 728). Where a longer occupation is likely, as with a habitable building, outdoor café, or park bench, the period of occupation can be measured, or estimated as a proportion of a given unit of time, e.g. six hours per day (1/4). The Target is recorded as a range (Table 2).

Weather Affected Targets
Often the nature of a structural weakness in a tree is such that the probability of failure is greatest during windy weather, while the probability of the site being occupied by people during such weather is often low. This applies particularly to outdoor recreational areas. When estimating human Targets, the risk assessor must answer the question 'in the weather conditions that I expect the likelihood of failure of the tree to be initiated, what is my estimate of human occupation?' Taking this approach, rather than using the average occupation, ensures that the assessor considers the relationship between weather, people, and trees, along with the nature of the average person with their ability to recognise and avoid unnecessary risks.

Vehicles on the Highway
In the case of vehicles, likelihood of occupation may relate to either the falling tree or branch striking the vehicle or the vehicle striking the fallen tree. Both types of impact are influenced by vehicle speed; the faster the vehicle travels the less likely it is to be struck by the falling tree, but the more likely it is to strike a fallen tree. The probability of a vehicle occupying any particular point in the road is the ratio of the time it is occupied - including a safe stopping distance - to the total time. The average vehicle on a UK road is occupied by 1.6 people (DfT 2010). To account for the substantial protection that the average vehicle provides against most tree impacts and in particular, frontal collisions, QTRA values the substantially protected 1.6 occupants in addition to the value of the vehicle as equivalent to one exposed human life.

Property
Property can be anything that could be damaged by a falling tree, from a dwelling, to livestock, parked car, or fence. When evaluating the exposure of property to tree failure, the QTRA assessment considers the cost of repair or replacement that might result from failure of the tree. Ranges of value are presented in Table 2 and the assessor's estimate need only be sufficient to determine which of the six ranges the cost to select.

In Table 2, the ranges of property value are based on a VOSL of $2 850 000, e.g. where a building with a replacement cost of $28 500 would be valued at 0.01 (1/100) of a life (Target Range 2).

When assessing risks in relation to buildings, the Target to be considered might be the building, the occupants, or both. Occupants of a building could be protected from harm by the structure or substantially exposed to the impact from a falling tree if the structure is not sufficiently robust, and this will determine how the assessor categorises the Target.

Multiple Targets
A Target might be constantly occupied by more than one person and QTRA can account for this. For example, if it is projected that the average occupation will be constant by 10 people, the Risk of Harm is calculated in relation to one person constantly occupying the Target before going on to identify that the average occupation is 10 people. This is expressed as Target 1(10T)/1, where 10T represents the Multiple Targets. In respect of property, a Risk of Harm 1(10T)/1 would be equivalent to a risk of losing $28 500 000 as opposed to $2 850 000.

Tree or Branch Size
A small dead branch of less than 25mm diameter is not likely to cause significant harm even in the case of direct contact with a Target, while a falling branch with a diameter greater than 450mm is likely to cause some harm in the event of contact with all but the most robust Target. The QTRA method categorises

Size by the diameter of tree stems and branches (measured beyond any basal taper). An equation derived from weight measurements of trees of different stem diameters is used to produce a data set of comparative weights of trees and branches ranging from 25mm to 600mm diameter, from which Table 1 is compiled. The size of dead branches might be discounted where they have undergone a significant reduction in weight because of degradation and shedding of subordinate branches. This discounting, referred to as 'Reduced Mass', reflects an estimated reduction in the mass of a dead branch.

Table 1. Size

Size Range	Size of tree or branch	Range of Probability
1	>450mm (>18") dia.	1/1 - >1/2
2	250mm (10½") dia. - 450mm (18") dia.	1/2 - >1/8.6
3	110mm (4½") dia. - 250mm (10") dia.	1/8.6 - >1/82
4	25mm (1") dia. - 100mm (4") dia.	1/82 - 1/2 500

* Range 1 is based on a diameter of 600mm.

Table 2. Targets

Target Range	Property (repair or replacement cost)	Human (not in vehicles)		Vehicle Traffic (number per day)	Ranges of Value (probability of occupation or fraction of $2 850 000)
1	$2 850 000 – >$285 000 (£1 500 000 – >£150 000)	**Occupation:** **Pedestrians & cyclists:**	Constant – 2.5 hours/day 720/hour – 73/hour	26 000 – 2 700 @ 110kph (68mph) 32 000 – 3 300 @ 80kph (50mph) 47 000 – 4 800 @ 50kph (32mph)	1/1 – >1/10
2	$285 000 – >$28 500	**Occupation:** **Pedestrians & cyclists:**	2.4 hours/day – 15 min/day 72/hour – 8/hour	2 600 – 270 @ 110kph (68mph) 3 200 – 330 @ 80kph (50mph) 4 700 – 480 @ 50kph (32mph)	1/10 – >1/100
3	$28 500 – >$2 850	**Occupation:** **Pedestrians & cyclists:**	14 min/day – 2 min/day 7/hour – 2/hour	260 – 27 @ 110kph (68mph) 320 – 33 @ 80kph (50mph) 470 – 48 @ 50kph (32mph)	1/100 – >1/1 000
4	$2 850 – >$285	**Occupation:** **Pedestrians & cyclists:**	1 min/day – 2 min/week 1/hour – 3/day	26 – 4 @ 110kph (68mph) 32 – 4 @ 80kph (50mph) 47 – 6 @ 50kph (32mph)	1/1 000 – >1/10 000
5	$285 – >$29	**Occupation:** **Pedestrians & cyclists:**	1 min/week – 1 min/month 2/day – 2/week	3 – 1 @ 110kph (68mph) 3 – 1 @ 80kph (50mph) 5 – 1 @ 50kph (32mph)	1/10 000 – >1/100 000
6	$29 – $2	**Occupation:** **Pedestrians & cyclists:**	<1 min/month – 0.5 min/year 1/week – 6/year	None	1/100 000 – 1/1 000 000

Vehicle, pedestrian and property Targets are categorised by their frequency of use or their monetary value. The probability of a vehicle or pedestrian occupying a Target area in Target Range 4 is between the upper and lower limits of 1/1 000 and >1/10 000 (column 5). Using the VOSL $2 850 000, the property repair or replacement value for Target Range 4 is $2 850- >$285.

Probability of Failure

In the QTRA assessment, the probability of tree or branch failure within the coming year is estimated and recorded as a range of value (Ranges 1 - 7, Table 3).

Selecting a Probability of Failure (PoF) Range requires the assessor to compare their assessment of the tree or branch against a benchmark of either a non-compromised tree at Probability of Failure Range 7, or a tree or branch that we expect to fail within the year, which can be described as having a 1/1 probability of failure.

During QTRA training, Registered Users go through a number of field exercises in order to calibrate their estimates of Probability of Failure.

Table 3. Probability of Failure

Probability of Failure Range	Probability
1	1/1 - >1/10
2	1/10 - >1/100
3	1/100 - >1/1 000
4	1/1 000 - >1/10 000
5	1/10 000 – >1/100 000
6	1/100 000 – >1/1 000 000
7	1/1 000 000 – 1/10 000 000

The probability that the tree or branch will fail within the coming year.

The QTRA Calculation

The assessor selects a Range of values for each of the three input components of Target, Size and Probability of Failure. The Ranges are entered on either the manual calculator or software application to calculate a Risk of Harm.

The Risk of Harm is expressed as a probability and is rounded, to one significant figure. Any Risk of Harm that is lower than 1/1 000 000 is represented as <1/1 000 000. As a visual aid, the Risk of Harm is colour coded using the traffic light system illustrated in Table 4 (page 7).

> **Risk of Harm - Monte Carlo Simulations**
>
> The Risk of Harm for all combinations of Target, Size and Probability of Failure Ranges has been calculated using Monte Carlo simulations[4]. The QTRA Risk of Harm is the mean value from each set of Monte Carlo results.
>
> In QTRA Version 5, the Risk of Harm should not be calculated without the manual calculator or software application.

Assessing Groups and Populations of Trees

When assessing populations or groups of trees, the highest risk in the group is quantified and if that risk is tolerable, it follows that risks from the remaining trees will also be tolerable, and further calculations are unnecessary. Where the risk is intolerable, the next highest risk will be quantified, and so on until a tolerable risk is established. This process requires prior knowledge of the tree manager's risk tolerance.

Accuracy of Outputs

The purpose of QTRA is not necessarily to provide high degrees of accuracy, but to provide for the quantification of risks from falling trees in a way that risks are categorised within broad ranges (Table 4).

4. INFORMING MANAGEMENT DECISIONS

Balancing Costs and Benefits of Risk Control

When controlling risks from falling trees, the benefit of reduced risk is obvious, but the costs of risk control are all too often neglected. For every risk reduced there will be costs, and the most obvious of these is the financial cost of implementing the control measure. Frequently overlooked is the transfer of risks to workers and the public who might be directly affected by the removal or pruning of trees. Perhaps more importantly, most trees confer benefits, the loss of which should be considered as a cost when balancing the costs and benefits of risk control.

When balancing risk management decisions using QTRA, consideration of the benefits from trees will usually be of a very general nature and not require detailed consideration. The tree manager can consider, in simple terms, whether the overall cost of risk control is a proportionate one. Where risks are approaching 1/10 000, this may be a straightforward balancing of cost and benefits. Where risks are 1/10 000 or greater, it will usually be appropriate to implement risk controls unless the costs are grossly disproportionate to the benefits rather than simply disproportionate. In other words, the balance being weighted more on the side of risk control with higher associated costs.

Considering the Value of Trees

It is necessary to consider the benefits provided by trees, but they cannot easily be monetised and it is often difficult to place a value on those attributes such as habitat, shading and visual amenity that might be lost to risk control.

A simple approach to considering the value of a tree asset is suggested here, using the concept of 'average benefits'. When considered against other similar trees, a tree providing 'average benefits' will usually present a range of benefits that are typical for the species, age and situation. Viewed in this way, a tree providing 'average benefits' might appear to be low when compared with particularly important trees – such as in Figure 2, but should nonetheless be sufficient to offset a Risk of Harm of less than 1/10 000. Without having to consider the benefits of risk controls, we might reasonably assume that below 1/10 000, the risk from a tree that provides 'average benefits' is ALARP.

In contrast, if it can be said that the tree provides lower than average benefits because, for example, it is declining and in poor physiological condition, it may be necessary to consider two further elements. Firstly, is the Risk of Harm in the upper part of the Tolerable Region, and secondly, is the Risk of Harm likely to increase before the next review because of an increased Probability of Failure. If both these conditions apply then it might be appropriate to consider the balance of costs and benefits of risk reduction in order to determine whether the risk is ALARP. This balance requires the tree manager to take a view of both the reduction in risk and the costs of that reduction.

[4] For further information on the Monte Carlo simulation method, refer to http://en.wikipedia.org/wiki/Monte_Carlo_method

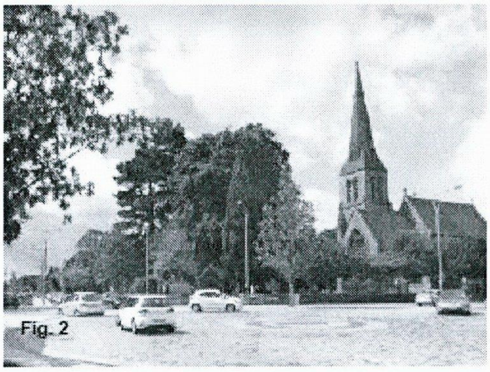

Fig. 2

further reduce an already relatively low risk. Conversely, a tree might be of such considerable value that an annual risk of death greater than 1/10 000 would be deemed tolerable.

Occasionally, decisions will be made to retain elevated risks because the benefits from the tree are particularly high or important to stakeholders, and in these situations, it might be appropriate to assess and document the benefits in some detail. If detailed assessment of benefits is required, there are several methodologies and sources of information (Forest Research 2010).

Lower Than Average Benefits from Trees

Usually, the benefits provided by a tree will only be significantly reduced below the 'average benefits' that are typical for the species, age and situation, if the life of the benefits is likely to be shortened, perhaps because the tree is declining or dead. That is not to say that a disbenefit, such as undesirable shading, lifting of a footpath, or restricting the growth of other trees, should not also be considered in the balance of costs and benefits.

The horse chestnut tree in Figure 3 has recently died, and over the next few years, may provide valuable habitats. However, for this tree species and the relatively fast rate at which its wood decays, the lifetime of these benefits is likely to be limited to only a few years. This tree has an already reduced value that will continue to reduce rapidly over the coming five to ten years at the same time as the Risk of Harm is expected to increase. There will be changes in the benefits provided by the tree as it degrades. Visual qualities are likely to reduce while the decaying wood provides habitats for a range of species, for a short while at least. There are no hard and fast measures of these benefits and it is for the tree manager to decide what is locally important and how it might be balanced with the risks.

Where a risk is within the Tolerable Region and the tree confers lower than average benefits, it might be appropriate to consider implementing risk control while taking account of the financial cost. Here, VOSL can be used to inform a decision on whether the cost of risk control is proportionate. Example 3 below puts this evaluation into a tree management context.

There will be occasions when a tree is of such minimal value and the monetary cost of risk reduction so low that it might be reasonable to

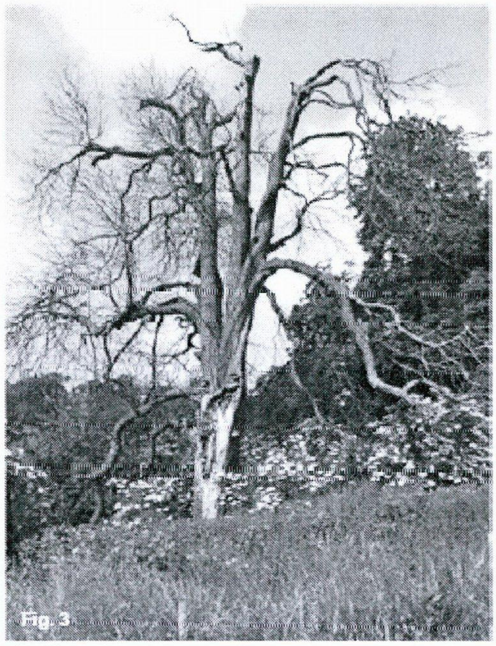

Fig. 3

Delegating Risk Management Decisions

Understanding of the costs with which risk reduction is balanced can be informed by the risk assessor's knowledge, experience and on-site observations, but the risk management decisions should be made by the tree manager. That is not to say that the tree manager should review and agree every risk control measure, but when delegating decisions to surveyors and other staff or advisors, tree managers should set out in a policy, statement or contract, the principles and perhaps thresholds to which trees and their associated risks will ordinarily be managed.

Based on the tree manager accepting the principles set out in the QTRA Practice Note and or any other specific instructions, the risk assessor can take account of the cost/benefit balance and for most situations will be able to determine whether the risk is ALARP when providing management recommendations.

Table 4. QTRA Advisory Risk Thresholds

Thresholds	Description	Action
	Unacceptable Risks will not ordinarily be tolerated	• Control the risk
1/1 000		
	Unacceptable (where imposed on others) Risks will not ordinarily be tolerated	• Control the risk • Review the risk
	Tolerable (by agreement) Risks may be tolerated if those exposed to the risk accept it, or the tree has exceptional value	• Control the risk unless there is broad stakeholder agreement to tolerate it, or the tree has exceptional value • Review the risk
1/10 000		
	Tolerable (where imposed on others) Risks are tolerable if ALARP	• Assess costs and benefits of risk control • Control the risk only where a significant benefit might be achieved at reasonable cost • Review the risk
1/1 000 000		
	Broadly Acceptable Risk is already ALARP	• No action currently required • Review the risk

QTRA Informative Risk Thresholds

The QTRA advisory thresholds in Table 4 are proposed as a reasonable approach to balancing safety from falling trees with the costs of risk reduction. This approach takes account of the widely applied principles of ALARP and ToR, but does not dictate how these principles should be applied. While the thresholds can be the foundation of a robust policy for tree risk management, tree managers should make decisions based on their own situation, values and resources. Importantly, to enable tree assessors to provide appropriate management guidance, it is helpful for them to have some understanding of the tree owner's management preferences prior to assessing the trees.

A Risk of Harm that is less than 1/1 000 000 is Broadly Acceptable and is already ALARP. A Risk of Harm 1/1 000 or greater is unacceptable and will not ordinarily be tolerated. Between these two values, the Risk of Harm is in the Tolerable Region of ToR and will be tolerable if it is ALARP. In the Tolerable Region, management decisions are informed by consideration of the costs and benefits of risk control, including the nature and extent of those benefits provided by trees, which would be lost to risk control measures.

For the purpose of managing risks from falling trees, the Tolerable Region can be further broken down into two sections. From 1/1 000 000 to less than 1/10 000, the Risk of Harm will usually be tolerable providing that the tree confers 'average benefits' as discussed above. As the Risk of Harm approaches 1/10 000 it will be necessary for the tree manager to consider in more detail the benefits provided by the tree and the overall cost of mitigating the risk.

A Risk of Harm in the Tolerable Region but 1/10 000 or greater will not usually be tolerable where it is imposed on others, such as the public, and if retained, will require a more detailed consideration of ALARP. In exceptional circumstances a tree owner might choose to retain a Risk of Harm that is 1/10 000 or greater. Such a decision might be based on the agreement of those who are exposed to the risk, or perhaps that the tree is of great importance. In these circumstances, the prudent tree manager will consult with the appropriate stakeholders whenever possible.

5. EXAMPLE QTRA CALCULATIONS AND RISK MANAGEMENT DECISIONS

Below are three examples of QTRA calculations and application of the QTRA Advisory Thresholds.

Example 1.

	Target		Size		Probability of Failure		Risk of Harm
Range	6	x	1	x	3	=	<1/1 000 000

Example 1 is the assessment of a large (Size 1), unstable tree with a probability of failure of between 1/100 and >1/1 000 (PoF 3). The Target is a footpath with less than one pedestrian passing the tree each week (Target 6). The Risk of Harm is calculated as less than 1/1 000 000 (green). This is an example of where the Target is so low consideration of the structural condition of even a large tree would not usually be necessary.

Example 2.

Target	Size	Probability of Failure		Risk of Harm
Range 1	x 4	x 3	=	1(2T)/50 000

In Example 2, a recently dead branch (Size 4) overhangs a busy urban high street that is on average occupied constantly by two people, and here Multiple Target occupation is considered.

Having an average occupancy of two people, the Risk of Harm 1(2T)/50 000 (yellow) represents a twofold increase in the magnitude of the consequence and is therefore equivalent to a Risk of Harm 1/20 000 (yellow). This risk does not exceed 1/10 000, but being a dead branch at the upper end of the Tolerable Region it is appropriate to consider the balance of costs and benefits of risk control. Dead branches can be expected to degrade over time with the probability of failure increasing as a result. Because it is dead, some of the usual benefits from the branch have been lost and it will be appropriate to consider whether the financial cost of risk control would be proportionate.

Example 3.

Target	Size	Probability of Failure		Risk of Harm
Range 3	x 3	x 3	=	1/500 000

In Example 3, a 200mm diameter defective branch overhangs a country road along which travel between 470 and 48 vehicles each day at an average speed of 50kph (32mph) (Target Range 3). The branch is split and is assessed as having a probability of failure for the coming year of between 1/100 and 1/1 000 (PoF Range 3). The Risk of Harm is calculated as 1/500 000 (yellow) and it needs to be considered whether the risk is ALARP. The cost of removing the branch and reducing the risk to Broadly Acceptable (1/1 000 000) is estimated at $665. To establish whether this is a proportionate cost of risk control, the following equation is applied. $2 850 000 (VOSL) × 1/500 000 = $5.7 indicating that the projected cost of $665 would be disproportionate to the benefit. Taking account of the financial cost, risk transfer to arborists and passers-by, the cost could be described as being grossly disproportionate, even if accrued benefits over say ten years were taken into account.

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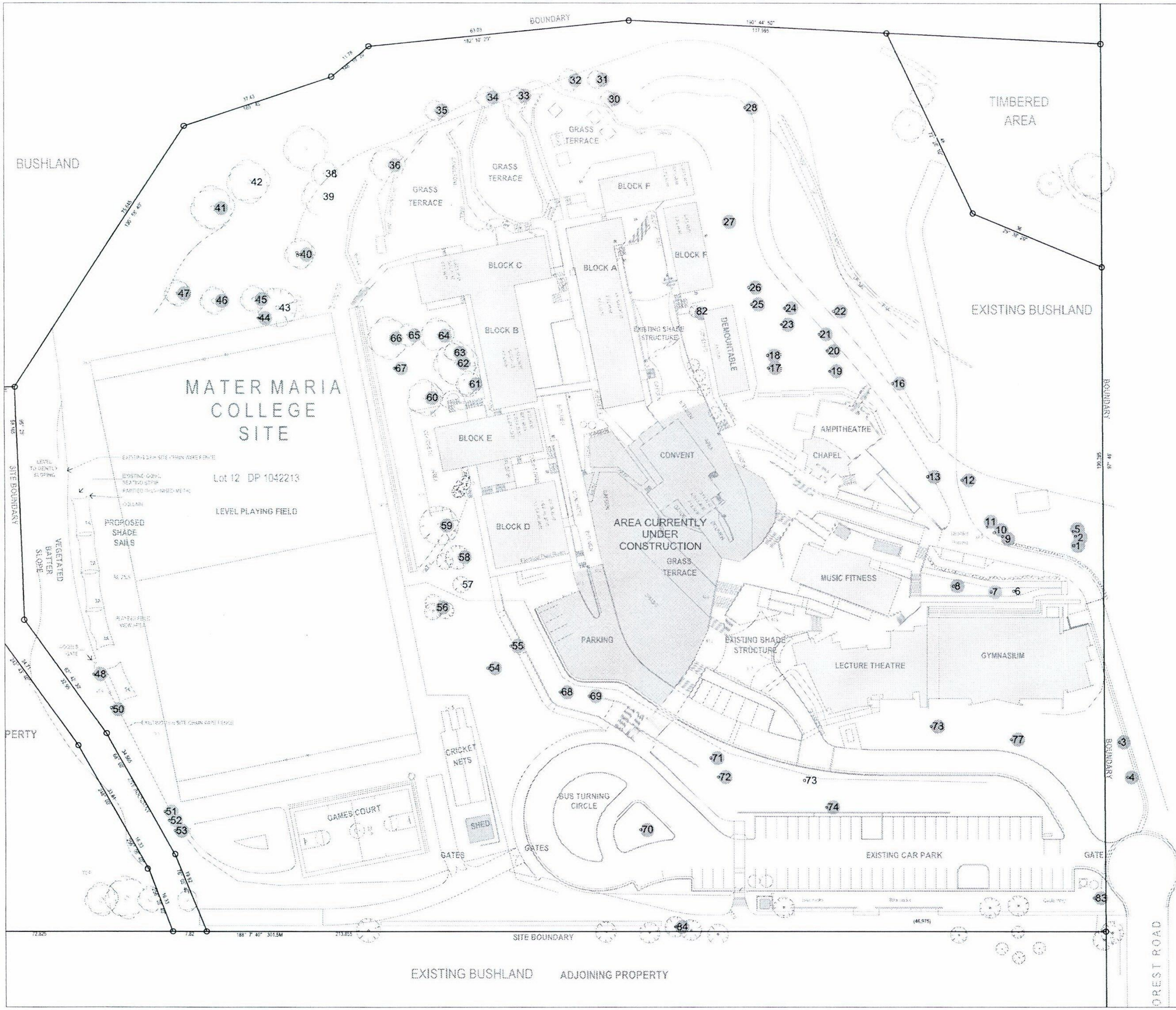
Revision 5.1.2. Monetary values for non-uk versions updated at 1st January 2014



LEGEND

5 Tree number
Broadly Acceptable Risk
Tolerable Risk
Tolerable Risk (by agreement)
Unacceptable Risk

NOTE DO NOT SCALE FROM DRAWING. USE FIGURED DIMENSIONS ONLY. CHECK ALL DIMENSIONS ON SITE BEFORE ANY MANUFACTURE OR CONSTRUCTION

PROJECT
5 Forest Road, Warriewood NSW

CLIENT
Mater Maria Catholic College

DRAWING
Tree Location Plan

Naturally Trees

DATE	23/10/17	DWG #	REV
SCALE @ A1	NTS	TLP01	
DRAWN	AS		

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