



Tree Survey Report

Church of St Mary the Virgin
St Briavels, Lydney GL15 6RG

Survey Number TCS20001 (version 3)

Tree species amended 17th/18th February 2020 (Trees T8 and T18)

Report prepared by Terra Cultura SGS
3rd February 2020



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Disclaimer

This report is based on a visual tree survey carried out by Terra Cultura SGS using the Quantified Tree Risk Assessment system. All observations relate to the condition of the trees at the time of inspection. Terra Cultura SGS does not accept any liability for any tree failure, loss, damage or injury arising from reliance on the contents of this report or for any undetected or unpredicted faults or failures in any tree referred to in this report. No liability is accepted for the use of this report beyond the purposes for which it was originally prepared and provided. It is the responsibility of the Client to ensure regular tree assessments are carried out and to commission recommended work where needed.

Executive Summary

Client

Terra Cultura SGS was commissioned by Jessica Worgan, on behalf of Kirstie Watkins of St Briavels Parish Council, to carry out a tree survey at the Church of St Mary the Virgin, St Briavels.

Survey Methodology

A ground level visual (non-invasive) tree inspection was carried out following the Quantified Tree Risk Assessment (QTRA) system. All trees within the boundary of the Parish church were assessed.

Survey Findings and Recommendations

Overall, the survey found the trees to be in a good state of vitality and health with no mature trees at current risk of whole tree failure. A number of issues pertaining to safe public access, however, were observed as follows:

- A dead wood hazard has been identified (T18) which affects the main pedestrian path access
- Several trees are blocking safe public access to gravestones
- A pedestrian walkway is currently blocked by a fallen tree (T8)
- A number of trees (T1,T17,T19) are causing an obstruction to larger vehicle traffic driving on Church Street (adjacent to the southern survey boundary).
- A number of trees (T3,T4,T5,T6) are causing an obstruction to larger vehicle traffic driving on Mork Road (adjacent to the western survey boundary).

Full details of the survey findings can be found on Pages 6-9. A further tree assessment is recommended for 12 months from the date of this report.

Tree Survey Summary

Location	Church of St Mary the Virgin, St Briavels, Lydney GL15 6RG
Client	Kirstie Watkins on behalf of St Briavels Parish Council
Survey Number	TCS20001
Survey Type	Walkover tree risk survey with individual trees assessed
Survey Methodology	Ground level visual (non-invasive) tree inspection
Survey Date	31 st January 2020
Surveyor	Nathan Jones
Report Issued	3 rd February 2020
Report Timeframe	Next assessment recommended 12 months from report date

Client Instructions

Jessica Worgan, on behalf of the Client, requested a visual tree survey of all mature trees within the Church boundary as part of a regular tree survey assessment at the above location. Website links noting the conversation areas of the local council were provided as well as confirmation that there are no Tree Protection Orders in place. No further documents or additional information were provided.

Survey Methodology

The site was visited on 31st January 2020 to carry out a tree survey using the Quantified Tree Risk Assessment (QTRA) system. The weather at the time was adequate for carrying out the survey. Trees were inspected at ground level using a mallet and optics. No root mapping, ground excavations, soil sampling, woody tissue testing or dissecting, or any other kind of invasive testing was carried out. Each tree or group of trees were allocated a reference number and the following information was collected: species, age range, crown spread, height, diameter, vitality, target range, size range and probability of failure. This information was used to determine the risk index for tree failure and is reported in the Tree Survey Schedule.

Report Timeframe

This report is valid for 12 months from the date issued. Annual tree assessments are recommended, unless stated otherwise. If there are changes to the condition of the trees as a result of severe weather, natural decay or disease, or developments are made to the site, trees may need to be re-assessed sooner. It is the responsibility of the Client to maintain regular tree assessments.

Survey Limitations

Tree inspections are carried out visually at ground level and are based on the physiological and structural condition of the trees at the time of the inspection. This report does not address potential damage to foundations and other services by tree roots. Although great care is taken to determine any defects, the surveyor is limited in examining exact structural integrity by using non-invasive techniques. Where no work is recommended or where the risk of failure is reported as low, this does not mean that a tree will not suffer damage nor require work in the future. The Client is responsible for maintaining regular assessments of the trees referred to in this report and to commission work to be carried out where needed.

Quantified Tree Risk Assessment System

Tree safety management is a matter of limiting the risk harm from tree failure while maintaining the benefits conferred by trees. Although it may seem counter intuitive, the condition of trees should not be the first consideration. Instead, tree managers should first take account of the usage of the land on which the trees stand, which in turn will inform the process of assessing the trees.

The Quantified Tree Risk Assessment (QTRA) system applies established and accepted risk management principles to tree safety management. Firstly, the targets (people and property) upon which trees could fail are assessed and quantified, thus enabling tree managers to determine whether to assess trees and to what degree of rigour a survey or inspection of the trees is required. Where necessary, the tree is then considered in terms of both size (potential impact) and probability of tree or branch failure. Values derived from the assessment of these three components (target, size and probability of failure) are combined to calculate the probability of significant harm occurring.

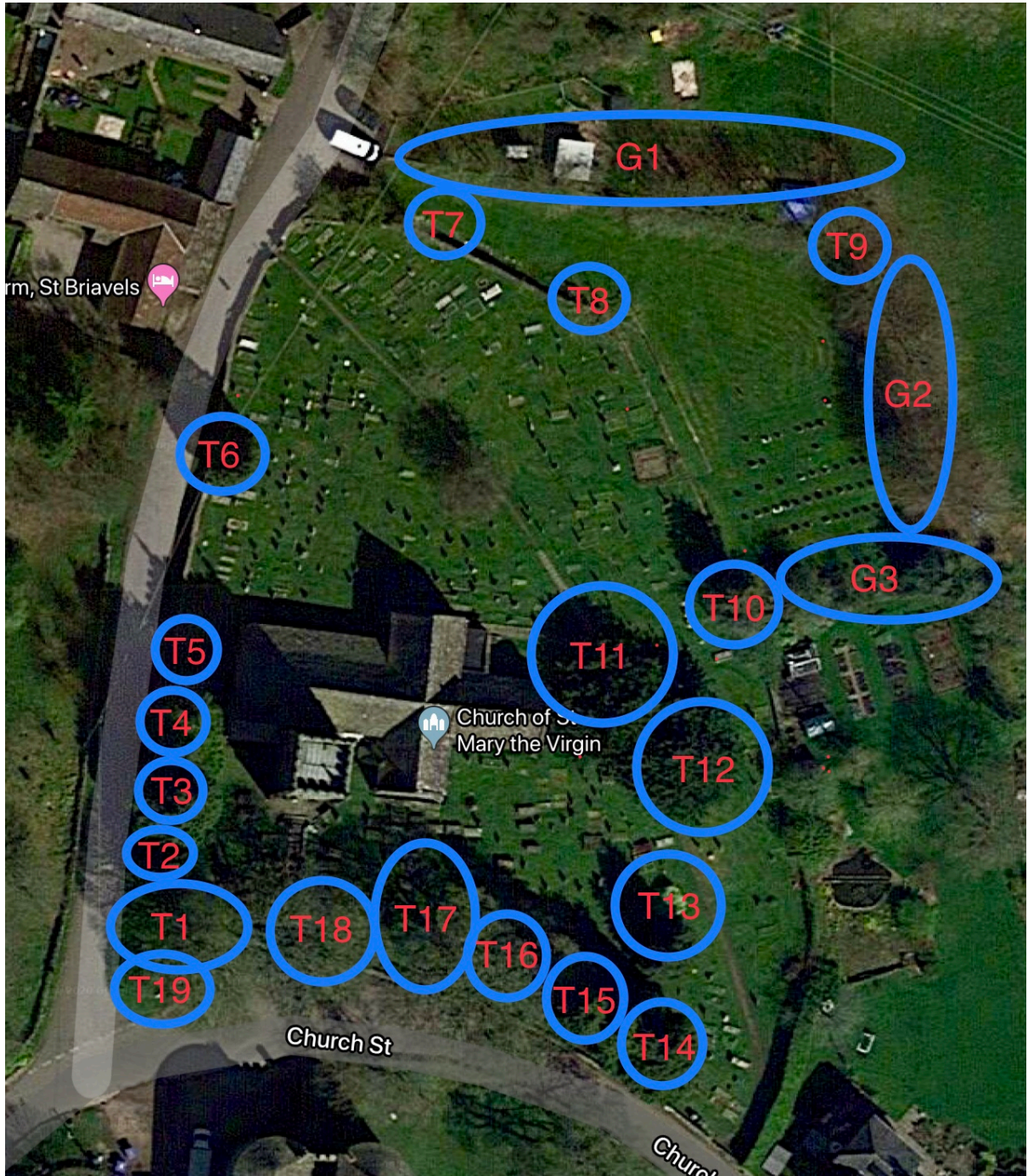
QTRA quantifies the risk of harm from tree failure in a way that enables tree managers to balance safety with tree value and operate to predetermined risk thresholds (See Table 1 below). Full details of the QTRA system can be found in the QTRA practice note (See Appendix).

Table 1: Overview of QTRA Thresholds for Risk Assessment

Thresholds	Description	Action(s)
>1/1,000	Unacceptable: risks will not ordinarily be tolerated	<ul style="list-style-type: none"> Control the risk
Between 1/1,000 and 1/10,000	<p>Unacceptable (where imposed upon others): risks will not ordinarily be tolerated</p> <p>Tolerable (by agreement): risks may be tolerated if those exposed to the risk accept it, or the tree has exceptional value</p>	<ul style="list-style-type: none"> Control the risk Review the risk Control the risk unless there is broad stakeholder agreement to tolerate it, or the tree has exceptional value Review the risk
Between 1/10,000 and 1/ 1,000,000	Tolerable (where imposed on others): risks are tolerable if ALARP	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> No action currently required Review the risk

The survey that follows utilises the above colour coding to indicate risk thresholds.

Tree Location Reference Map



INDIVIDUAL TREE RISK SURVEY

SITE: CHURCH OF ST MARY THE VIRGIN, ST BRIAVELS	SURVEYOR: NATHAN JONES	
CLIENT: KIRSTIE WATKINS ON BEHALF OF ST BRIAVELS PARISH COUNCIL	ASSESSMENT DATE: 31/01/2020	
BRIEF: VISUAL TREE SURVEY OF ALL MATURE TREES WITHIN CHURCH BOUNDARY	JOB REFERENCE: TCS20001	

TREE NO.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD (M)	STEM DIA. (MM)	VITALITY	COMMENTS	MANAGEMENT	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB RANGE	REDUCED MASS	RISK OF HARM	PRIORITY
T1	Sycamore	M	20M	15M	> 450	G	Mature ivy-covered Sycamore with South facing lower limbs that may impede passing vehicular traffic	Removal of two South facing lowest limbs. Sever ivy to aid future inspections. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	2	1	6	N/A	<1M	L
T2	Yew	EM	10M	8M	> 450	G	Early mature Yew with lower limbs that may prevent pedestrian access to gravestones	Removal of lower limbs to improve pedestrian access to gravestones. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	2	1	6	N/A	<1M	L
T3	Western Red Cedar	M	20M	10M	> 450	G	Mature Western Red Cedar with lower limbs that may prevent pedestrian access to gravestones and impede vehicular traffic on Mork Road, adjacent to Western boundary.	Removal of lower limbs to improve pedestrian and vehicle access. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	2	1	6	N/A	<1M	L
T4	Western Red Cedar	M	20M	10M	> 450	G	Mature Western Red Cedar with lower limbs that may prevent pedestrian access to gravestones and impede vehicular traffic on Mork Road, adjacent to Western boundary.	Removal of lower limbs to improve pedestrian and vehicle access. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	2	1	6	N/A	<1M	L
T5	Western Red Cedar	M	20M	10M	> 450	G	Mature western red cedar with lower limbs that may prevent pedestrian access to gravestones and impede vehicular traffic on Mork Road, adjacent to Western boundary.	Removal of lower limbs to improve pedestrian and vehicle access. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	2	1	6	N/A	<1M	L

HEADINGS & ABBREVIATIONS

REF:	REFERENCE FOR TREE
SPECIES:	THREE TO FIVE CHARACTER ABBREVIATION OF COMMON NAME OF THE SPECIES BEING RECORDED
AGE RANGE:	Y = YOUNG, SM = SEMI MATURE, EM = EARLY MATURE, M = MATURE, PM = POST MATURE, V = VETERAN
HEIGHT:	MEASURED OR ESTIMATED HEIGHT (IDENTIFY WHERE HEIGHTS ARE ESTIMATED)
STEM DIA:	STEM DIAMETER – MEASURED AT A HEIGHT OF APPROXIMATELY 1.5 METRES
VITALITY:	A MEASURE OF PHYSIOLOGICAL CONDITION. D = DEAD, MD = MORIBUND, P = POOR, R = REDUCED FOR THE SPECIES AND AGE, N = WITHIN THE NORMAL RANGE FOR THE SPECIES AND AGE
SIZE RANGE:	QTRA SIZE RANGE OF THE TREE OR BRANCH THAT HAS BEEN ASSESSED
POF RANGE:	QTRA RANGE OF PROBABILITY OF FAILURE WITHIN 12 MONTHS
TARGET RANGE:	QTRA TARGET RANGE. WHERE THERE IS CONSTANT OCCUPATION OF THE TARGET BY MORE THAN ONE PERSON, OR A PROPERTY TARGET HAS A REPAIR OR REPLACEMENT VALUE THAT IS GREATER THAN VOSSL. THIS IS EXPRESSED AS A 'MULTIPLE TARGET' E.G. CONSTANT OCCUPATION BY 10 PEOPLE WOULD BE EXPRESSED AS TARGET RANGE 1(10T). THE 'MULTIPLE TARGET' IS THEN CARRIED THROUGH TO THE RISK OF HARM TO IDENTIFY THE INCREASED CONSEQUENCE
REDUCED MASS %:	WHERE THE MASS OF A BRANCH IS REDUCED BY DEGRADATION. THE RISK OF HARM IS MULTIPLIED BY A FRACTION OF EITHER ¼ OR ½ TO REFLECT THE REMAINING PROPORTION OF THE ORIGINAL BRANCH
RISK OF HARM:	THE RISK OF HARM FOR THE COMING YEAR
RISK ASSESSMENT OF:	DESCRIPTION OF THE TREE/BRANCH AND TARGET THAT HAS BEEN ASSESSED

INDIVIDUAL TREE RISK SURVEY

SITE: CHURCH OF ST MARY THE VIRGIN, ST BRIAVELS	SURVEYOR: NATHAN JONES	
CLIENT: KIRSTIE WATKINS ON BEHALF OF ST BRIAVELS PARISH COUNCIL	ASSESSMENT DATE: 31/01/2020	
BRIEF: VISUAL TREE SURVEY OF ALL MATURE TREES WITHIN CHURCH BOUNDARY	JOB REFERENCE: TCS20001	

TREE NO.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD (M)	STEM DIA. (MM)	VITALITY	COMMENTS	MANAGEMENT	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB RANGE	REDUCED MASS	RISK OF HARM	PRIORITY
T6	Cypress	M	20M	10M	> 450	G	Mature Cypress with lower limbs that may prevent pedestrian access to gravestones and impede vehicular traffic on Mork Road, adjacent to Western boundary.	Removal of lower limbs to improve pedestrian and vehicle access to gravestones. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	2	1	6	N/A	<1M	L
T7	Poplar	SM	15M	7M	300	G	Semi mature poplar with no apparent defects	Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	3	2	6	N/A	<1M	L
T8	Indian Bean	SM	15M	10M	300	MD	Complete failure in root. Fallen tree is blocking pedestrian access. Further movement is possible.	Removal to ground level.	WHOLE TREE FAILURE	3	2	3	N/A	1/100K	M
T9	Beech	SM	15M	10M	300	G	Semi mature Beech with lower limbs that may prevent pedestrian access to gravestones.	Removal of lower limbs to improve pedestrian access to gravestones. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	3	2	6	N/A	<1M	L
T10	Cypress	EM	15M	10M	300	G	Early mature Cypress with lower limbs that may prevent pedestrian access to gravestones.	Removal of lower limbs to improve pedestrian access to gravestones. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	3	2	6	N/A	<1M	L
T11	Yew	M	15M	10M	> 450	G	Mature Yew with lower limbs that may prevent pedestrian access to gravestones.	Removal of lower limbs to improve pedestrian access to gravestones. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	3	1	6	N/A	<1M	L
T12	Yew	M	15M	10M	> 450	G	Mature Yew with lower limbs that may prevent pedestrian access to gravestones.	Removal of lower limbs to improve pedestrian access to gravestones. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	3	1	6	N/A	<1M	L

INDIVIDUAL TREE RISK SURVEY

SITE: CHURCH OF ST MARY THE VIRGIN, ST BRIAVELS	SURVEYOR: NATHAN JONES	
CLIENT: KIRSTIE WATKINS ON BEHALF OF ST BRIAVELS PARISH COUNCIL	ASSESSMENT DATE: 31/01/2020	
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TREE NO.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD (M)	STEM DIA. (MM)	VITALITY	COMMENTS	MANAGEMENT	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB RANGE	REDUCED MASS	RISK OF HARM	PRIORITY
T13	Cypress	M	20M	10M	> 450	G	Mature Cypress with lower limbs that may prevent pedestrian access to gravestones.	Removal of lower limbs to improve pedestrian access to gravestones. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	3	1	6	N/A	<1M	L
T14	Western Red Cedar	M	20M	10M	> 450	G	Mature Western Red Cedar with lower limbs that may prevent pedestrian access to gravestones.	Removal of lower limbs to improve pedestrian access to gravestones. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	2	1	6	N/A	<1M	L
T15	Cypress	M	20M	10M	> 450	G	Mature Cypress with lower limbs that may prevent pedestrian access to gravestones.	Removal of lower limbs to improve pedestrian access to gravestones. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	2	1	6	N/A	<1M	L
T16	Cypress	M	20M	10M	> 450	G	Mature Cypress with lower limbs that may prevent pedestrian access to gravestones.	Removal of lower limbs to improve pedestrian access to gravestones. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	2	1	6	N/A	<1M	L
T17	Sycamore	M	20M	15M	> 450	G	Mature ivy-covered Sycamore with lower limbs that may impede vehicular traffic on Church Street, adjacent to southern boundary.	Removal of lower limbs to improve vehicle access. Sever ivy to aid future inspections. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	2	1	6	N/A	<1M	L
T18	Sycamore	M	20M	15M	> 450	G	Mature sycamore with dead wood apparent above main pedestrian access to church. Risk of whole tree failure ALARP.	Remove dead wood from crown. Sever ivy to aid future inspections. Inspect tree for structural defects in 12 months' time.	DEAD LIMB	3	3	3	N/A	1/500K	M

INDIVIDUAL TREE RISK SURVEY

SITE: CHURCH OF ST MARY THE VIRGIN, ST BRIAVELS	SURVEYOR: NATHAN JONES	
CLIENT: KIRSTIE WATKINS ON BEHALF OF ST BRIAVELS PARISH COUNCIL	ASSESSMENT DATE: 31/01/2020	
BRIEF: VISUAL TREE SURVEY OF ALL MATURE TREES WITHIN CHURCH BOUNDARY	JOB REFERENCE: TCS20001	

TREE NO.	SPECIES	AGE RANGE	HEIGHT (M)	CROWN SPREAD (M)	STEM DIA. (MM)	VITALITY	COMMENTS	MANAGEMENT	RISK ASSESSMENT OF	TARGET RANGE	SIZE RANGE	PROB RANGE	REDUCED MASS	RISK OF HARM	PRIORITY
T19	Sycamore	M	20M	15M	> 450	G	Mature ivy-covered Sycamore with lower limbs that may impede vehicular traffic on Church Street, adjacent to southern boundary.	Removal of lower limbs to improve vehicle access. Sever ivy to aid future inspections. Inspect tree for structural defects in 12 months' time.	WHOLE TREE FAILURE	2	1	6	N/A	<1M	L
G1	Mixed native broadleaves	SM	15M	8M	250	G	Mixed self-seeded group on northern boundary with lower limbs that may prevent pedestrian access to gravestones and are inhibiting growth of newly planted trees.	Removal of lower limbs to improve pedestrian access to gravestones. Inspect trees for structural defects in 12 months' time.	WHOLE TREE FAILURE	3	2	6	N/A	<1M	L
G2	Mixed native broadleaves	SM	15M	8M	250	G	Mixed self-seeded group on north eastern boundary with lower limbs that may prevent pedestrian access to gravestones and are inhibiting growth of newly planted trees.	Removal of lower limbs to improve pedestrian access to gravestones. Inspect trees for structural defects in 12 months' time.	WHOLE TREE FAILURE	3	2	6	N/A	<1M	L
G3	Mixed native broadleaves	SM	15M	8M	250	G	Mixed self-seeded group on north eastern boundary with lower limbs that may prevent pedestrian access to gravestones and are inhibiting growth of newly planted trees.	Removal of lower limbs to improve pedestrian access to gravestones. Inspect trees for structural defects in 12 months' time.	WHOLE TREE FAILURE	3	2	6	N/A	<1M	L



Quantified Tree Risk Assessment
Simply Balancing Risks With Benefits



Quantified Tree Risk Assessment **PRACTICE NOTE**

VERSION 5

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 values¹, 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.

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

¹ See Tables 1, 2 & 3.

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.

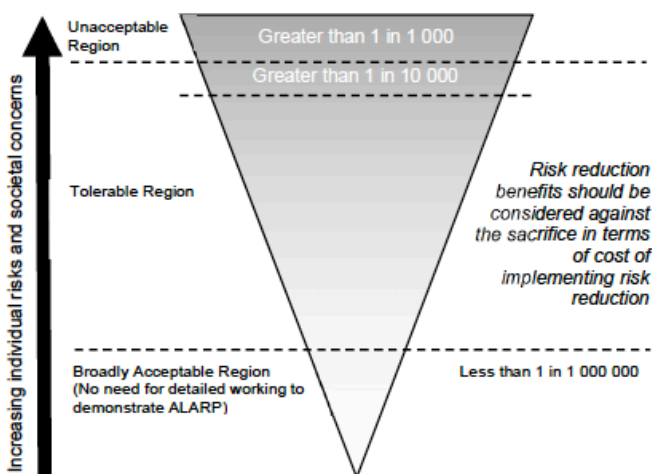


Figure 1. Adapted from the Tolerability of Risk framework (HSE 2001).

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 £2 000 000, 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 £2 000 000 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 ranges³ of Target, Size, and Probability of Failure. The assessor estimates values for these three components and inputs them on either the manual calculator or software application to calculate the Risk of Harm.

² Discussed further on page 5.

³ See Tables 1, 2 & 3.

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, an average occupation of ten pedestrians per day, each occupying the Target for five seconds is a daily occupation of fifty seconds, giving a likelihood of occupation 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

Table 1. Size

Size Range	Size of tree or branch	Range of Probability
1	> 450mm (>18") dia.	1/1 - >1/2
2	260mm (10 ¹ / ₂ ") dia. - 450mm (18") dia.	1/2 - >1/8.6
3	110mm (4 ¹ / ₂ ") 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.

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 £2 000 000, e.g. where a building with a replacement cost of £20 000 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 £20 000 000 as opposed to £2 000 000.

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 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 £2 000 000)
1	£2 000 000 – >£200 000	Occupation: Constant – 2.5 hours/day Pedestrians & cyclists: 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	£200 000 – >£20 000	Occupation: 2.4 hours/day – 15 min/day Pedestrians & cyclists: 72/hour – 8/hour	2 600 – 270 @ 110kph (68mph) 3 200 – 330 @ 80kph (50mph) 4 700 – 480 @ 50kph (32mph)	1/10 – >1/100
3	£20 000 – >£2 000	Occupation: 14 min/day – 2 min/day Pedestrians & cyclists: 7/hour – 2/hour	260 – 27 @ 110kph (68mph) 320 – 33 @ 80kph (50mph) 470 – 48 @ 50kph (32mph)	1/100 – >1/1 000
4	£2 000 – >£200	Occupation: 1 min/day – 2 min/week Pedestrians & cyclists: 1/hour – 3/day	26 – 4 @ 110kph (68mph) 32 – 4 @ 80kph (50mph) 47 – 6 @ 50kph (32mph)	1/1 000 – >1/10 000
5	£200 – >£20	Occupation: 1 min/week – 1 min/month Pedestrians & cyclists: 2/day – 2/week	3 – 1 @ 110kph (68mph) 3 – 1 @ 80kph (50mph) 5 – 1 @ 50kph (32mph)	1/10 000 – >1/100 000
6	£20 – £2	Occupation: <1 min/month – 0.5 min/year Pedestrians & cyclists: 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 £2 000 000, the property repair or replacement value for Target Range 4 is £2 000 - >200.

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 simulations⁴. 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

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 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).

Delegating Risk Management Decisions

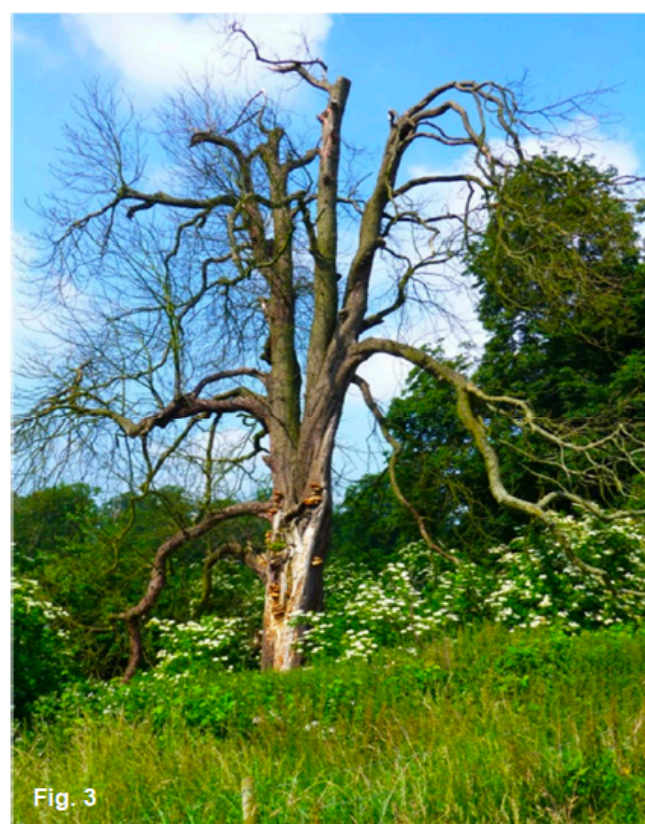


Fig. 3

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
1/1,000	Unacceptable Risks will not ordinarily be tolerated	<ul style="list-style-type: none"> Control the risk
	Unacceptable (where imposed on others) Risks will not ordinarily be tolerated	<ul style="list-style-type: none"> Control the risk Review the risk
1/10 000	Tolerable (by agreement) Risks may be tolerated if those exposed to the risk accept it, or the tree has exceptional value	<ul style="list-style-type: none"> Control the risk unless there is broad stakeholder agreement to tolerate it, or the tree has exceptional value Review the risk
	Tolerable (where imposed on others) Risks are tolerable if ALARP	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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 £350. To establish whether this is a proportionate cost of risk control, the following equation is applied. £2 000 000 (VOSL) x 1/500 000 = £4 indicating that the projected cost of £350 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 5.2.4. Monetary values for non-uk versions updated at 1st January 2019.

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