MPTrees

Arboriculture Implications Assessment

At

**Rhyddings Park,
Oswaldtwistle,
Lancashire**

Prepared by

MP Trees

For

Hyndburn Borough Council

April 2016

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Disclaimer

Comments upon the condition and safety of any tree relate to the condition of the tree at the time of the survey. It should be recognized that tree condition is subject to change due to, for example, the effects of disease, wind or nearby development works. Changes in land use are also significant in respect of risk assessment.
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Contents

1.0 Introduction

1.1 Matthew Potier of MPTrees has written this report further to the instructions of Hyndburn Borough Council Community Services. Mr Potier has a BSc Honours Degree in Forestry, a Technicians Certificate in Arboriculture and is a registered and licensed user of the Quantified Tree Risk Assessment system. He has twenty years experience in tree management and has been asked to produce this report in the role of an independent expert.

1.2 Hyndburn Borough Council Community Services have commissioned this report in order to inform debate centred on a *Sequoiadendron giganteum* tree, commonly known as a Sequoia or Giant Redwood or Wellingtonia, located in Rhyddings Park, Oswaldtwistle, Lancashire (Photograph 1). The Leader of Hyndburn Council in a statement issued on March 24th 2016, asked Council Officers "to arrange for an independent, expert assessment of the implications of the tree remaining and continuing to mature in its existing position". He went on to reiterate that "the assessment will be independent and that we will commission an expert who has played no part in the plans to date". I can confirm as author of this report that I have had no part in the plans for Rhyddings Park to date.

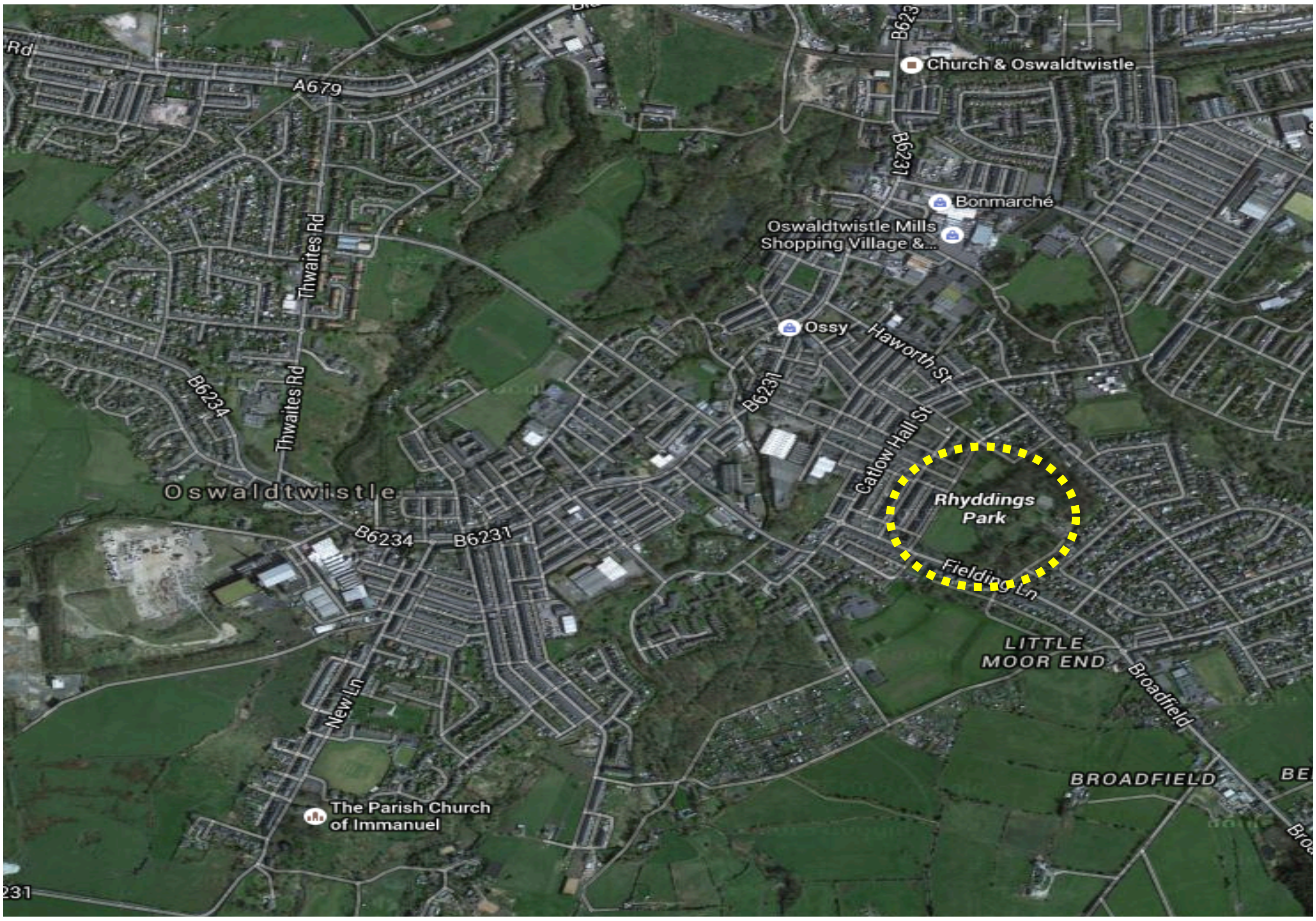
1.3 Records show that the then Rhyddings Park committee planted the Sequoia tree in its present location in 1973. As Sequoia trees are capable of growing considerably larger than the current size of the tree in question, and the tree is relatively close to a residential area, residential road and footpath, Hyndburn Council wish to have an open, informed debate around the retention of this tree. This report provides an assessment of potential implications of the Sequoia tree in Rhyddings Park remaining and maturing in its current position.

Photograph 1 – The Sequoia tree in Rhyddings Park viewed from the east

2.0 Background

2.1 Rhyddings Park is a formally landscaped, public open space, located on the eastern slopes of Oswaldtwistle, see Figure 1 below. The Park is the only formal, open green space in Oswaldtwistle and as such performs an important amenity role for the inhabitants of the area.

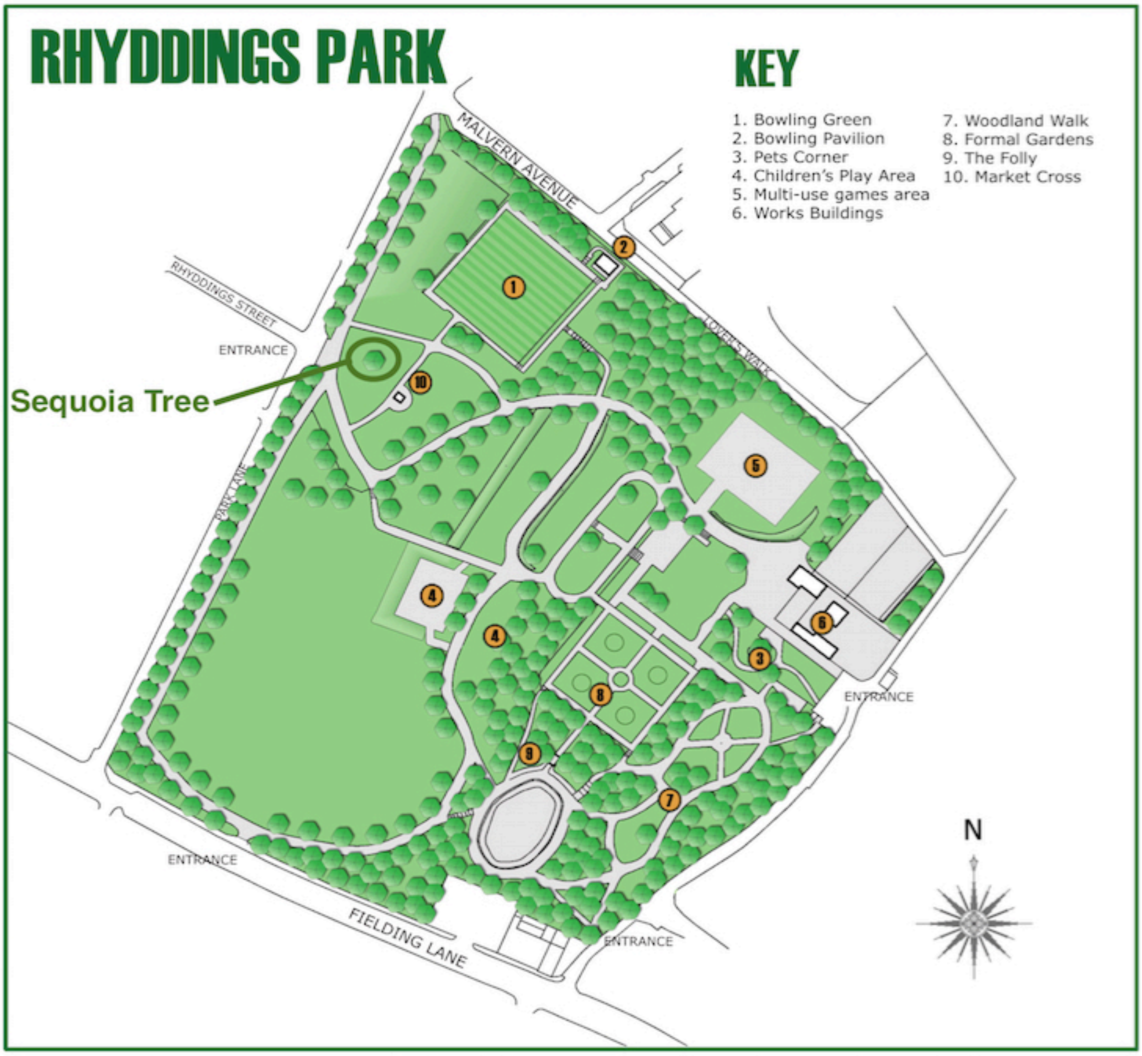
Figure 1 – Rhyddings Park Location



2.2 The Park was originally the garden and grounds of a private house belonging to a local mill owning family. The first house was demolished in 1853 and re-built in the style of an early Victorian country house villa for Mr Robert Watson, a local cotton magnate. Rhyddings Hall, as the house was known, ceased to be a private residence in 1909 when it was bought by Oswaldtwistle Urban District Council. The landscape character of the park today remains heavily influenced by the original landscape of Watson's time, being still largely set out in the formal style of the Victorian period.

2.3 Hyndburn Council have received a Heritage Lottery grant to re-landscape Rhyddings Park. The Council has developed a Landscape Concept Masterplan for the Park (as shown at appendix 1) that has been subject to consultation. Part of the Masterplan involves moving the Market Cross that can be seen at the front left of Photograph 1 and which is marked 10 on the Rhyddings Park map at Figure 2 below. The cross is a memorial stone cross that is part of the heritage of Oswaldtwistle and it is proposed that it is moved to a more visible and accessible location within an area of new hard landscaping at the entrance to the park from Park Lane. Given that Sequoia trees are capable of growing considerably larger than the tree in the park currently is, and that the tree is relatively close to a residential area, footpath and public open space, concerns have been raised about the suitability of retaining this Sequoia tree in its present location.

Figure 2 – Rhyddings Park Map and location of Sequoia Tree



2.4 Named after Sequoyah (1767–1843), the inventor of the Cherokee language syllabary, Sequoia trees are the sole living species in the genus *Sequoiadendron*. Their natural habitat is on the slopes of the Sierra Nevada Mountains of California, where they can attain heights of over 90 meters, diameters of main stems of over 17m, and are amongst the oldest living organisms on earth.

2.5 Sequoia trees were at one time logged for timber but this practice ceased almost a century ago and today they are planted throughout the world as an ornamental tree. They can be found in many parks, gardens and arboretums that have very high visitor numbers, such as The Forestry Commission’s National Arboretum at Westonbirt in Gloucestershire, which attracts over 400,000 visitors each year. They were first cultivated in the British Isles around 1853 and appear to grow well here. The tallest recorded tree in Britain is at Benmore in Scotland was measured at 56.4m (185ft) tall in 2014 at 150 years old. The tree with the widest diameter of main stem in Britain is in Perthshire, with a diameter of 4m (13ft).

2.6 They are evergreen trees characterised by their large mature size with a conical, tapering form and by their fibrous, ‘spongy’ red coloured bark on a fluted and fissured main stem. The trees natural habitat is characterised by harsh climatic conditions of freezing winters and dry, hot summers. As a result, as they mature they develop downward sloping branches, so that heavy snowfall does not collect on them, and they develop deep fibrous bark that protects them from the periodic forest fires that create the ideal environmental conditions for their natural regeneration. They also develop large, shallow root plates, designed to provide the stability required by a tree of its size and shape, as well as its requirements for water, oxygen and nutrients.

2.7 Sequoia trees develop a structure that is designed to achieve significant heights, in other words they are designed not to fall over. David Lonsdale, on page 339 of his book Principles of Tree Hazard Assessment and Management states “This species when well established fails less often through wind throw or snap of the main stem than most other tree species”. Due to their mature height they can be the one of the tallest if not the tallest feature in a landscape and as such, they can be targets for lighting strikes. The susceptibility of Sequoia trees to decay is low except occasionally by the fungal pathogen commonly known as Honey Fungus (*Armillaria sp.*).

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3.0 Assessment Methodology

3.1 In order to evaluate the implications of the Sequoia tree remaining and maturing in its existing position a Visual Tree Assessment (Lonsdale, D. *Principles of Tree Hazard Assessment & Management* 1999, page 151) of the tree was carried out on 5th April 2016 using non-invasive survey techniques from ground level. Full survey details can be found in the tree survey data table at appendix 2.

3.2 The detail recorded from the Visual Tree Assessment (VTA) was then used to calculate a probability of risk of harm associated with the tree using the Quantified Tree Risk Assessment (QTRA) method.

3.3 QTRA (http://www.qtra.co.uk) is a widely used method of evaluating the risk of harm to people and/or property from trees. It incorporates numerical estimates and uses statistical probability within defined value ranges as a measure of the risk of harm. Full technical detail of the QTRA risk assessment methodology is provided in the QTRA practice note v.5 at appendix 3.

3.4 Figure 1 and table 4 of QTRA practice note v.5 give the detail of the advisory risk level thresholds that have been used for this assessment. In summary, these thresholds are defined as:

- Where the probability of risk of harm is equal to or greater than 1:1,000, the level of risk is unacceptable and risk control is required.
- Where the probability of risk of harm is less than 1:1,000 and equal to or greater than 1:10,000, the level of risk is either unacceptable or tolerable only if there is stakeholder agreement to tolerate that risk or if the tree has exceptional value.
- Where the probability of risk of harm is less than 1:10,000 and equal to or greater than 1:1,000,000, the level of risk is tolerable if it is as low as reasonably practicable. Risk control should only be considered for risks of this level if significant benefit can be achieved for a reasonable cost.
- Where the probability of risk of harm is less than 1:1,000,000, the level of risk is broadly acceptable and risk is already as low as reasonably practicable.

3.5 In addition to the visual and risk assessment of the tree, reference was made to the Rhyddings Park Landscape Concept Masterplan drawing at appendix 1.

4.0 Assessment Results

(Full VTA results and QTRA calculations detail can be found at appendices 3 and 4).

4.1 The Sequoia tree in Rhyddings Park has achieved a height of 15.3m, or 50ft, in *circa* 45 years. It can therefore be said to have an average growth rate of approximately 0.34m, or 1.1ft, per year. This would suggest that the tree is growing well and at a rate that is comparable, if slightly slower, than the largest tree on record in the British Isles at Benmore, Scotland. The Sequoia tree at Benmore has been growing at an average rate of nearly 0.38m per year and had achieved a height of 56.4m at age 150 years when measured in 2014. If the Sequoia in Rhyddings Park continues to grow at a similar rate as currently, over the next 25 years it could potentially achieve a height of 23.8m or 78ft. Over the next 50 years it could achieve a height of 32.3m, or 106ft, and over the next 100 years could reach 49.3m, or 161.7ft. If the main stem of the tree were to grow in diameter at the same rate as currently, at 100 years from now, at age 145, the tree could have increased the diameter of its main stem from its existing 1.18m to a potential 3.8m, equivalent to a girth of 11.9m.

4.2 The stability of any tree is related in part to the diameter of its main stem at 1.5m and the size of its root plate. A tree with a stem diameter of 1.12m requires a rootplate with a radius of a minimum of 4m (Mattheck, C & Breloer, H. *Body Language of Trees* 1994, page 95). As the Sequoia in Rhyddings Park has a main stem diameter of 1.18m, it can be expected that its rootplate will have a radius of minimum 4m from its main stem, as this is the minimum required for stability. The roots of the tree will beyond the 4m radius rootplate required for stability (British Standard 5837: 2012 *Trees in relation to design, demolition and construction – Recommendations*, Section 4.6). Roots will develop beyond this distance in order to provide the tree with the water, nutrients and gas exchange that it requires.

4.3 The creation of new hard landscaping at the Park Lane entrance, as shown on the Concept Masterplan, will require excavation of the grassed slope where the tree is currently located. It will also require construction of a retaining structure and new hard surfaces at a distance of approximately 2m to the west of the tree. The excavation and subsequent construction of hard surfaces and retaining structure would result in the removal of the majority of the western hemisphere of the root plate of the tree and a significant amount of its overall root volume. This amount of root loss would result in a loss of stability provided by the root plate of the tree and would result in the tree having a higher probability of failure, particularly from prevailing storm events from the west and south-west in the U.K. It would also cause a significant decline in the condition and vitality of the tree that would lead to it becoming moribund.

4.4 From the VTA carried out, the most significant part of the tree that is most likely to fail in the twelve-month period following the assessment is currently the large, lowest, primary or first order branch (as shown on photograph 2 below). The branch currently has a length of approximately 6m and diameter of 27.5cm at its base. Its size and weight, when combined with the presence of the occluded wound at its base and the fact that it is growing upwards as a competing leader, create a probability of it failing at, or near, its base.

Photograph 2 – The large, lowest first order or primary branch of the Sequoia tree with wound

4.5 The Beaufort Scale and UK Wind Map at appendix 5 of this report shows that at the average wind speeds found at Rhyddings Park (10-20 knots or 18-40kph), large branches of trees are in motion. The probability of failure of the branch over the next twelve months under loads imposed by these average weather conditions (when compared to a 'non-compromised' branch that would not be expected to fail under loads imposed by the average weather conditions) is assessed as being in the range of 1:10,000 to 1:100,000.

4.6 There are an estimated 50 visitors to Rhyddings Park each day. This equates to an average of 2 visitors per hour to the Park and potentially within the vicinity of the tree. When these visitor numbers are input into QTRA along with the current size of the branch and its assessed probability of failure, the current level of risk of harm associated with the tree and the failure of its lowest primary branch is calculated as less than 1:1,000,000.

4.7 If the tree remains and matures in its existing position, the size of the branch will increase and as a consequence so will its probability of failure. As a result, the potential level of risk of harm associated with the tree and the failure of its lowest primary branch is calculated as 1:4,000.

4.8 The current level of risk of harm associated with the tree through wind throw or stem snap is calculated as less than 1:1,000,000. If the tree remains and matures in its existing position, it will continue to have a very low probability of failure through wind throw or stem snap. The potential level of risk of harm associated with wind throw or stem snap of the tree is calculated as 1:1,000,000, if the Landscape Concept Masterplan for Rhyddings Park is amended (section 4.3).

5.0 Assessment Conclusions

5.1 The proposed hard surface and retaining structure construction within 2m of the tree on its western side, as shown on the Landscape Concept Masterplan, would severely impact the stability of the tree. Unless new hard surfaces and retaining structures can be moved a minimum of 4m away from the tree's main stem and/or constructed so as not to require a significant level of root loss from the existing root volume of the tree, the tree will become moribund and unstable and its retention will be unsustainable. It is concluded therefore that for the tree to remain and mature in its existing position, a modification of the Landscape Concept Masterplan will be required.

5.2 The potential option of transplanting the tree would require an excavation of a trench around the tree at a minimum distance of 12m from its main stem (British Standard 5837: 2012 *Trees in relation to design, demolition and construction – Recommendations*, Section 4.6) and a minimum of 1m deep. The rootballed tree would then have to be crated up so that a large crane, able to lift approximately 50 tonnes, could move it to the nearest available planting position. The tree would then require an automatic irrigation system installed around its rootplate to provide water for the tree for a minimum of 5 years as well as the addition of supplementary nutrients for the same period.

5.3 From the risk assessment of the Sequoia tree at Rhyddings Park it can be concluded that there is currently a level of risk of harm to people and/or property associated with the tree of less than 1:1,000,000. QTRA advises this level of risk as being broadly acceptable, with risk being already as low as reasonably practicable. When compared to the annual risk of death from various causes over the entire U.K. population, as shown at appendix 6, a level of risk of harm of less than 1:1,000,00 can be described as being very low.

5.4 If the tree remains and matures in its existing position without a change in condition, the level of risk of harm associated with it failing through wind throw or snap of its main stem will remain very low (1:1,000,000). However, there is the potential for the level of risk of harm associated with the failure of its lowest primary branch to increase to a level of 1:4,000, where risk is advised as being unacceptable and risk control is required.

5.5 In order to control risk the cost of branch removal is considered. The overall cost is equivalent to the estimated financial cost of reducing or removing the branch combined with other costs that are: the potential reduction in the aesthetic quality of the tree; the risk to workers and the public from branch removal; and the increased potential for tree infection and decay through the creation of a pruning wound. From the cost benefit analysis at appendix 7, it is concluded that that cost of branch removal would be proportionate to the benefit it would provide i.e. reducing the level of risk of harm from 1:4,000 to less than 1:10,000, where risk is advised as being tolerable when imposed on others if it is as low as reasonably practicable.

5.6 Branch reduction pruning is a descriptive term that describes pruning intended to reduce the length, width, depth and mass of a branch. This type of pruning reduces load-induced stress, thereby decreasing the likelihood of structural failure of a branch and reducing risk to targets below (Goodfellow, J.W., and Detter, A., *Assessing the Potential of Reduction Pruning in Mitigating the Risk of Branch Failure*, May 2013, http://www.isa-arbor.com/events/conference/proceedings/2013). It is therefore concluded that a reduction of the size and weight of the Sequoia tree's lowest primary branch would reduce the probability of its failure.

5.7 The potential size of the tree, as described in section 4.1 of this report, will result in two further implications of the tree remaining and maturing in its existing position. These are the risk of lightning strike and the level of fear or anxiety that the tree could create. If the tree continues to grow at its current rate it will become one of the tallest (if not the tallest) structures in the local landscape. This will increase the risk of lightning striking the tree and causing significant structural damage. Any significant structural damage would increase the probability of whole or partial tree failure, which would increase the level of risk associated with the tree. Although not a risk *per se*, the potential size and scale of the tree could create a level of anxiety and fear within an urban, residential context.

5.8 As a result of the local environment in which the tree is growing there is also a potential risk of infection and decay of the tree by the fungal pathogen Honey Fungus (*Armillaria sp.*). Trees in formal landscapes can be more vulnerable to infection by Honey Fungus than trees in other environments as the removal of natural debris (wood and leaves) from the landscape deprives Honey Fungus of a natural host and can lead to an increased risk of infection of a healthy tree. The risk of infection can be further increased through surface roots being damaged by grass cutting machinery, or by sub-surface roots being damaged by disturbance from construction activities. Although not possible to quantify at this time, infection and decay of the tree by Honey Fungus would increase the probability of whole or partial tree failure over time, which would increase the level of risk associated with the tree.

6.0 Recommendations

6.1 It is not for the author of this report to decide what constitutes a tolerable or acceptable level of risk for the people of Oswaldtwistle. It is therefore recommended that all stakeholders give consideration to the QTRA advisory risk thresholds used in this report, and through consultation, agree what is a tolerable or acceptable level of risk associated with the Sequoia tree at Rhyddings Park.

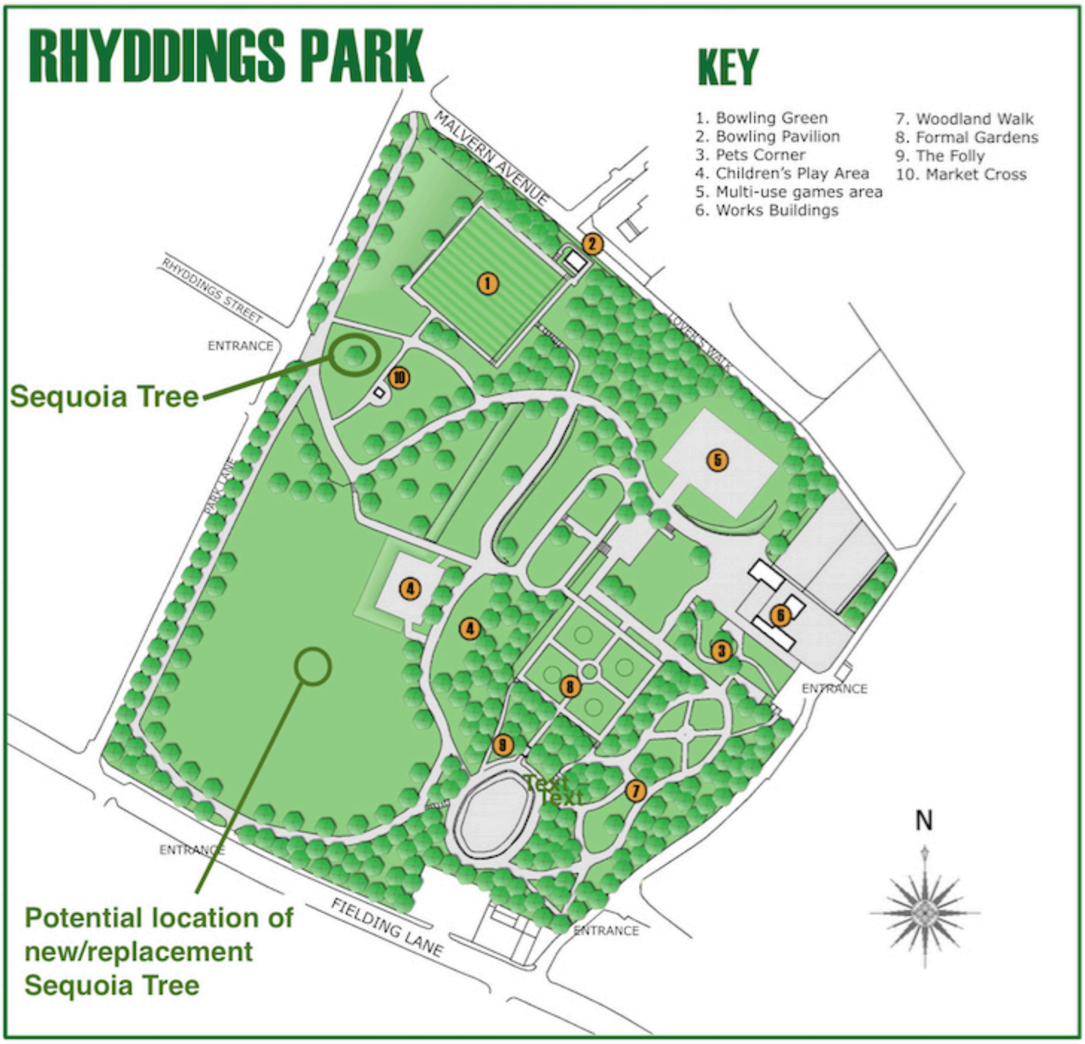
6.2 Although the level of risk of harm currently associated with the tree can be described as being very low, if the tree remains and matures in its existing position it is recommended that in order to mitigate a potential increase in the level of risk associated with the failure of its lowest primary branch, that the branch be reduced by 25% in size and weight in the next three years from the date of this report. It is further recommended that this work be carried out by a fully qualified and insured tree work contractor, working as a minimum to the standards recommended in British Standard 3998: 2010 Tree Work – Recommendations, so that risk reduction work does not unintentionally have a greater negative impact on the quality or condition of the tree.

6.3 Although the level of risk of harm currently associated with the tree can be described as being very low, this level can change as a result of factors such as storm damage or decay. It is therefore recommended that if the tree remains and matures in its existing position it is surveyed and assessed for its associated level of risk on a periodic basis and after any tree works or major storm events.

6.4 In the event that the Landscape Concept Masterplan is implemented, it is recommended that transplanting the tree to another location within the park is not a viable option due to the high risk of failure and the high cost involved. It is recommended however that space is available within the park and the Masterplan to plant a replacement tree of the same or alternative species in a different location, as proposed on Figure 3 below. A tree planted in this proposed location would have a much larger, un-restricted space in which to develop its root structure and canopy spread and would also be at a greater distance from residential properties, roads and footpaths. It could also potentially induce less fear or anxiety and become a focal point and prominent visual feature of the Park. Over time a new tree in this location could become a sustainable feature of the local landscape and even a local visitor attraction.

6.5 Finally, at the instruction of Hyndburn Borough Council Environmental Services for the purposes of this report, research has provided an approximate cost of £8,250 for the supply and delivery from Holland of a new Sequoia tree approximately 10m tall with a 120-140cm girth. There is an inherent risk of failure when planting large trees and in the first few years after planting they can experience low growth rates. However, there is nothing to suggest that a new large tree, planted in the location proposed on Figure 3, would not have access to the water and nutrient resources it requires to grow at a similar rate as the tree currently growing in the park.

Figure 3 – Rhyddings Park Map and locations of existing & potential replacement trees



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Appendix 1

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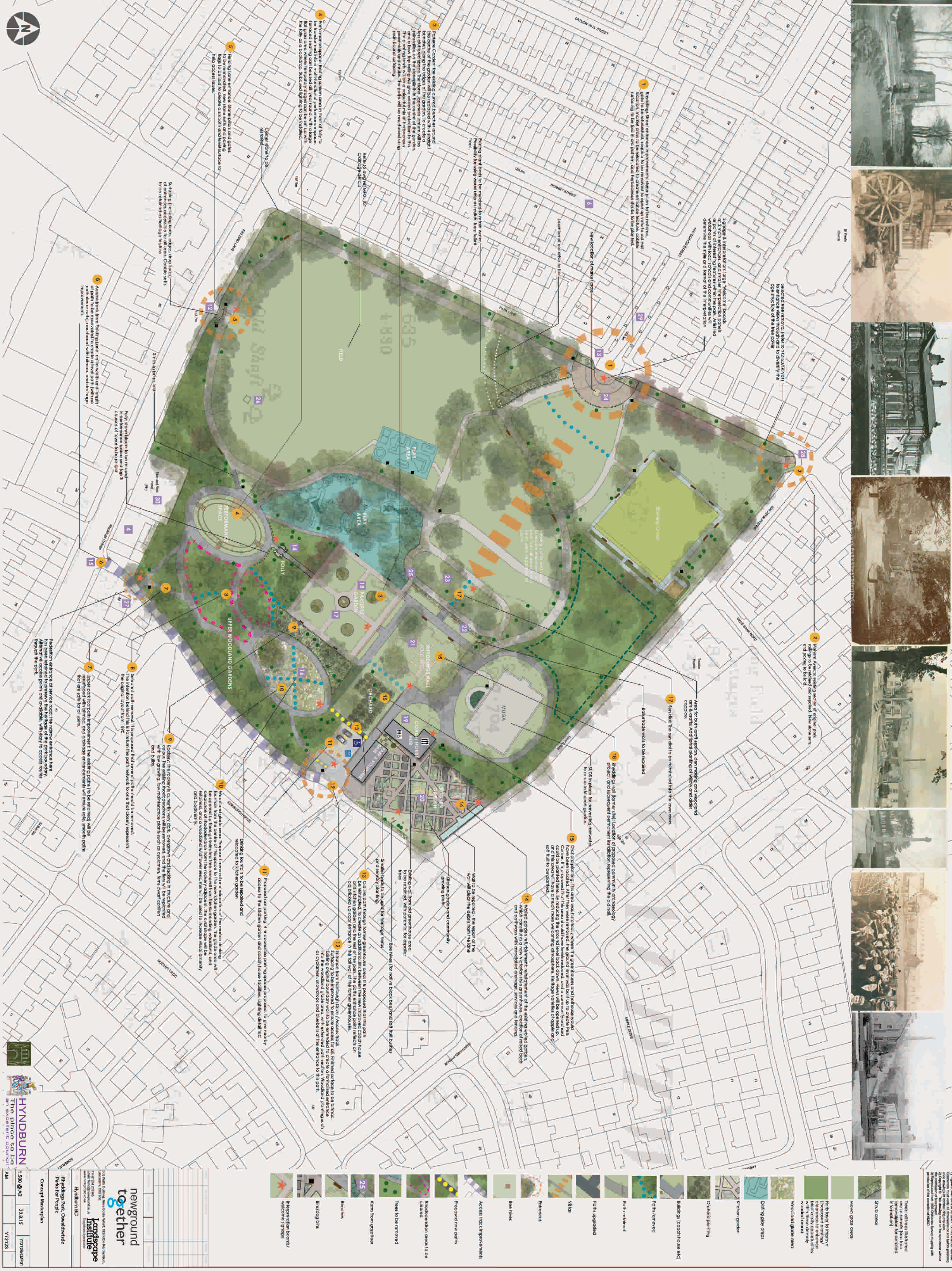
RHYDDINGS PARK, OSWALDTWISTLE

PARKS FOR PEOPLE concept masterplan



Appendix 2

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QTRA 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 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.

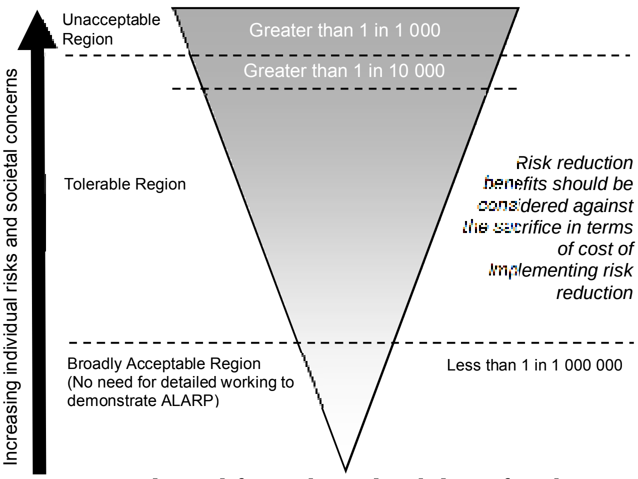

Figure 1. Adapted from the Tolerability of Risk framework (HSE 2001).

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, 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 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 £1 500 000, e.g. where a building with a replacement cost of £15 000 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 £15 000 000 as opposed to £1 500 000.

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	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.

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 £1 500 000)
1	£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	£150 000 – >£15 000	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	£15 000 – >£1 500	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	£1 500 – >£150	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	£150 – >£15	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	£15 – £1	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 £1 500 000, the property repair or replacement value for Target Range 4 is £1 500 - >£150.

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

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).

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 £350. To establish whether this is a proportionate cost of risk control, the following equation is applied. £1 500 000 (VOSL) x 1/500 000 = £3 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 5.1.2. Monetary values for non-uk versions updated at 1st January 2014

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MPTrees

Appendix 3

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MPTrees

Visual Tree Assessment and Quantified Tree Risk Assessment (QTRA) Tree Survey Data Table

Key
Ref: Reference number, individual tree = T, group of trees = G
Species: Common Name
Age Range: Y = young, SM = semi mature, EM = early mature, M = mature, PM = post mature
Height: Height to top of crown of individual or tallest tree in group in metres.
Crown Spread: Diameter of crown at widest point in metres.
Stem Diam.: Stem diameter measured at 1.5m above ground level in mm.
Vitality: D = dead, MD = moribund, P = poor, M = moderate, G = good
Target Range: Highest value target that most significant part likely to fail could strike, 1 = high value/occupancy, 6 = low value/occupancy
Size Range: Size of most significant part of tree likely to fail, P= where target is property, 1 = large, 4 = small
Prob. Failure Range: Probability of failure within 12 months, 1 = high, 7 = low
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.
Reduce Mass %: Where the mass of a tree or branch is reduced by degradation the risk index is multiplied to reflect the % of mass reduction.
Risk Index: Risk of significant harm expressed as a probability
Review Years: Period in years to next inspection

Ref.	Species	Age	Height	Crown Spread	Stem Diam.	Vitality	Target Range	Size Range	Prob. Failure Range	Weather Factor	Reduced Mass %	Risk Index	Review Years
T1	Sequoia	45	15.3	12.5	1180	Good	3	2	5	/	/	less than 1:1,000,000	2

Comments:
Tree is sheltered at moment by adjacent mature trees, closest poplar 20m tall, grassed slope 1m over 25m east to west, base of slope 10m to west, no signs of rootplate movement in ground, minor depression on upslope from settlement, tree growing at 5degrees towards east north east from vertical with good buttress formation to northeast, surface roots to east, good buttress root development, potentially less good on down slope to west, minor dead wood branches <50mm diam. on ground, small girdling roots <100mm diam., good extension growth, small branch pruning wounds <150mm, small deadwood branch stubs <100mm, lowest primary limb to south at 1.75m above ground level has occluded wound on west side from base of branch to approx 1m along branch and has compression buckling of fibres at base of underside of branch, branch has diameter at base of 275mm, primary branch at 3m to southwest has flat cross section at 4m above ground level, primary branch to west at 4m with bark wound at base of branch, cctv is 5m to west, canopy to west is 4.5m, two lowest primary branches growing upwards as leaders, all other branches generally horizontal and/or sloped down, young cones present.
Management Recommendations:
Reduce lowest primary branch in next three years.

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Appendix 4

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Quantified Tree Risk Assessment Calculations

Present Risk associated with Branch Failure

There are an estimated 50 visitors to Rhyddings Park each day. This equates to 2 visitors per hour on average. 2 pedestrians per hour is within QTRA target range 3 of between 2 to 7 pedestrians per hour. At present, if the tree or its lowest primary branch were to fail no property would be damaged.

The size of the most significant part of the tree that is most likely to fail in the twelve-month period following the assessment, the tree's lowest, primary or first order branch, has a diameter at its base of 275mm. A diameter of 275mm is within QTRA size range 2, within a diameter range of 260mm to 450mm.

The probability of failure of the branch over the next twelve months under loads imposed by average weather conditions (when compared to a 'non-compromised' branch that would not be expected to fail under loads imposed by the average weather conditions) is assessed as being in the range of 1:10,000 to 1:100,000, QTRA range 5.

The level of risk of harm currently associated with the tree and the failure of its lowest first order or primary branch is calculated as:

	Target		Size		Probability of Failure		Risk of Harm
QTRA Range	3	x	2	x	5	=	<1:1,000,000

Present Risk associated with Wind Throw or Main Stem Snap

If the size of the most significant part of the tree that is most likely to fail within the 12 months after survey is considered to be the whole tree or part of its main stem, the QTRA target range is currently range 3, 2 to 7 pedestrians per hour.

If the size of the most significant part of the tree that is most likely to fail within the 12 months after survey is considered to be the whole tree or part of its main stem, the QTRA size range is 1, diameter greater than 45cm.

Quantified Tree Risk Assessment Calculations

Present Risk associated with Wind Throw or Main Stem Snap (cont.)

The probability of failure of the whole tree or part of the tree within the 12 months after survey under loads imposed by average weather conditions is assessed as being in the range 1:1,000,000 to 1:10,000,000, QTRA probability of failure range 7.

The level of risk of harm currently associated with the tree through wind throw or snap of its main stem is calculated as:

	Target		Size		Probability of Failure		Risk of Harm
Range	3	x	1	x	7	=	<1:1,000,000

Potential Risk associated with Branch Failure

As a result of the Landscape Concept Masterplan for Rhyddings Park there will be a potential increase in visitor numbers and therefore a potential increase in the QTRA target value from 3 to 2, where there is a minimum occupation time by pedestrians within harming distance of the branch of average 15 minutes per day.

Without a change in the landscape of the park, over time, the potential length of the branch will also result in an increase in QTRA target value from 3 to 2, as pedestrians and property (parked cars with a value of between £15,000 to £150,000) on Park Lane will become potential targets.

Over time, the branch has the potential to achieve a diameter of greater than 450mm, QTRA size range 1, where the size of the most significant part of the tree that is most likely to fail within the 12 months after survey has a diameter greater than 450mm.

The probability of failure of the branch has the potential, under loads imposed by average weather conditions (when compared to a 'non-compromised' branch that would not be expected to fail under loads imposed by the average weather conditions) to increase from QTRA range 5 to range 3, a probability of failure range of 1:100 to 1:1,000.

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Quantified Tree Risk Assessment Calculations

Potential Risk associated with Branch Failure (cont.)

The potential level of risk of harm associated with the tree and the failure of its lowest first order or primary branch is therefore calculated as:

	Target		Size		Probability of Failure		Risk of Harm
QTRA Range	2	x	1	x	3	=	1:4,000

Potential Risk associated with Wind Throw or Main Stem Snap

As the height of the tree increases over time there will be an increase in QTRA target range from 3 to 2, where a potential property target value in the range of £15,000 to £150,000 is considered.

As the size of the tree increases the probability of failure will not increase with sufficient significance to increase the QTRA probability of failure range.

The level of risk of harm potentially associated with the tree through wind throw or snap of its main stem is calculated as:

	Target		Size		Probability of Failure		Risk of Harm
QTRA Range	2	x	1	x	7	=	<1:1,000,000

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Appendix 5

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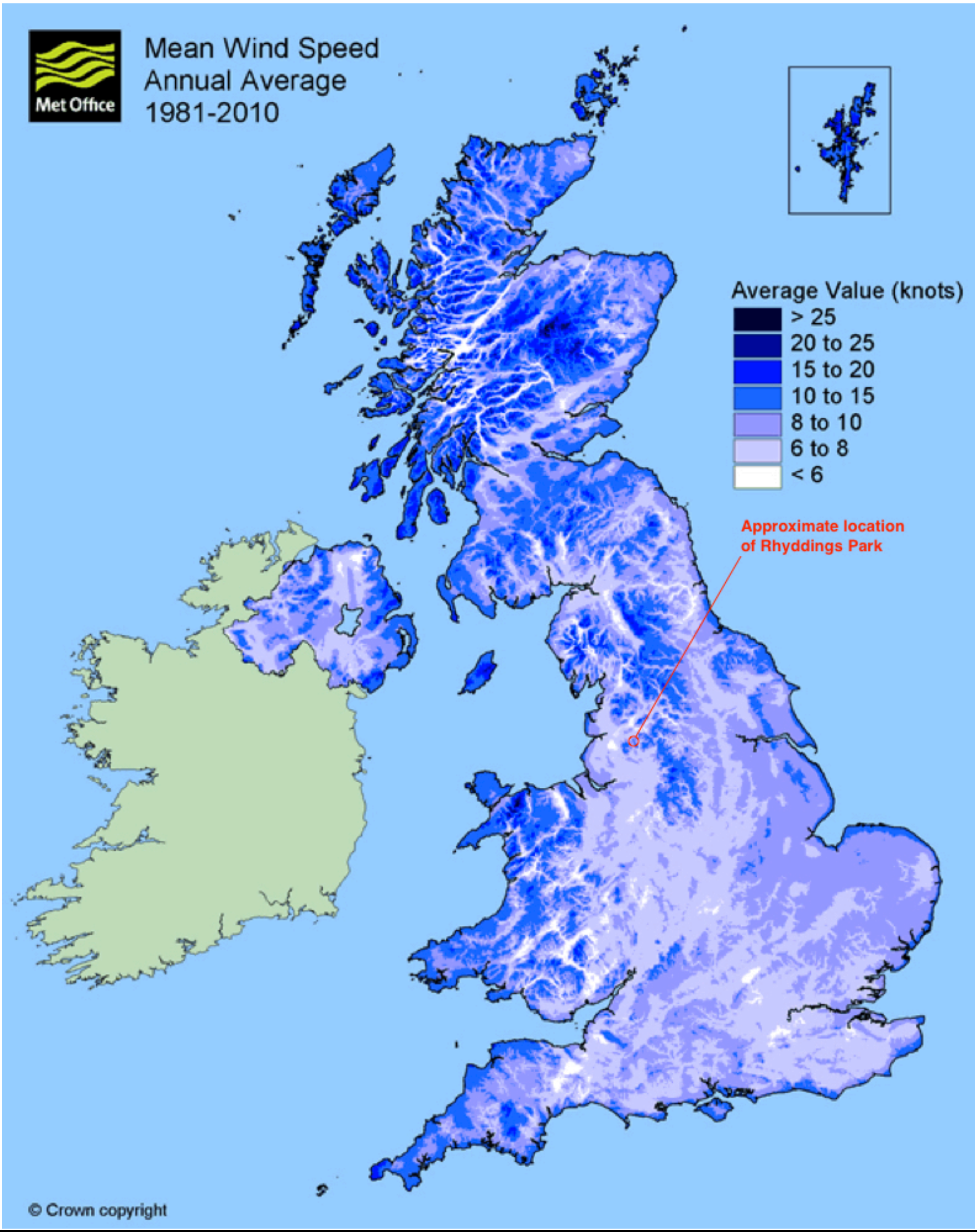
UK Wind Map



Met Office
Mean Wind Speed
Annual Average
1981-2010
Average Value (knots)
> 25
20 to 25
15 to 20
10 to 15
8 to 10
6 to 8
< 6
Approximate location
of Rhyddings Park
© Crown copyright

The Beaufort Scale

The Beaufort Scale			
Beaufort scale		**Average wind speed (km/h)**	**Estimating speed over land**
0	Calm	less than 1	Calm, smoke rises vertically.
1	Light Air	1 - 5	Direction of wind shown by smoke drift, but not by wind vanes.
2	Light breeze	6 - 11	Wind felt on face; **leaves rustle**; ordinary wind vane moved by wind.
3	Gentle breeze	12 - 19	**Leaves and small twigs in constant motion**; wind extends light flag.
4	Moderate breeze	20 - 28	Raises dust and loose paper; **small branches moved**.
5	Fresh breeze	29 - 38	Small **trees in leaf begin to sway**; crested wavelets form on inland waters.
6	Strong breeze	39 - 49	**Large branches in motion**; whistling heard in telegraph wires; umbrellas used with difficulty.
7	Near gale	50 - 61	**Whole trees in motion**; inconvenience felt when walking against the wind.
8	Gale	62 - 74	**Breaks twigs off trees**; generally impedes progress.
9	Strong gale	75 - 88	Slight structural damage occurs (chimney pots and slates removed).
10	Storm	89 - 102	Seldom experienced inland; **trees uprooted**; considerable structural damage occurs.
11	Violent storm	103 - 117	Very rarely experienced; accompanied by widespread damage.
12	Hurricane	118 and over	Severe and extensive damage.

Appendix 6

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Annual risk of death from various causes over entire U.K. population

Cause of death	Annual risk	Basis of risk and source
Cancer	1 in 387	England and Wales 1999
Injury and poisoning	1 in 3,137	UK 1999
All types of accidents and other external causes	1 in 4,064	UK 1999
All forms of road accident	1 in 16,800	UK 1999
Lung cancer from radon in dwellings	1 in 29,000	England 1996
Gas incident (fire, explosion or carbon monoxide poisoning)	1 in 1,510,000	GB 1994/95–1998/99
From trees	1 in 10,000,000 or less if high wind incidents are excluded	This study
From lightning	1 in 18,700,000	England and Wales 1995–99

MPTrees

Appendix 7

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MPTrees

Risk reduction cost benefit analysis

To determine whether a risk is as low as reasonably practicable it is necessary to consider the balance of costs and benefits of risk reduction work and decide if risk control is proportionate.

Cost benefit analysis of removal of lowest primary branch of tree

Although the level of risk associated with the failure of the tree's lowest primary branch is currently assessed as broadly acceptable, it has the potential to increase to an unacceptable level.

The financial cost of removal of the tree's lowest primary branch, thereby removing the potential for the level of risk to become unacceptable is estimated to be £250.

To determine whether this is a proportionate allocation of financial resources to risk reduction, the following calculation can be carried out:

£1,500,00 (Value of Statistical Life, see QTRA practice note v5 at appendix 2) x 1/4,000 (level of risk) = 375(£)

Not only financial cost is considered when assessing the costs and benefits of risk control however. Other costs that are considered include the loss of tree-related benefits, such as aesthetic quality and environmental and health benefits, and the risk to workers and the public from the risk reduction work.

Another potential 'cost' to be considered in this instance is that the removal of the branch will leave a relatively large diameter stem wound that will create a potential site for infection and decay of the tree. A larger wound has increased potential for infection and decay than a wound of lesser diameter and can therefore potentially increase the probability of tree failure. Poor pruning practice when removing a branch can also increase potential for infection and decay of a wound and therefore also potentially increase the probability of tree failure.

Risk reduction cost benefit analysis

Cost benefit analysis of removal of lowest primary branch of tree (cont.)

When combined with a potential reduction in tree-related benefits, the risk to workers and the public from the risk reduction work and the increased potential for tree infection and/or decay, an estimated risk reduction cost of £250 can be described as being proportionate to the benefit it would provide i.e. reducing the risk level of the tree associated with the failure of its lowest primary branch from 1:4,000, where risks are advised as being unacceptable, to a level less than 10:000 where risks are advised as being tolerable when imposed on others if they are as low as reasonably practicable.

Cost benefit analysis of removal of tree

The level of risk associated with the failure of the tree through wind throw or main stem snap is assessed as broadly acceptable (<1:1,000,000).

In the event that this level of risk is seen as unacceptable, the financial cost of removing the tree is estimated to be currently £800.

To determine whether this is a proportionate allocation of financial resources to risk reduction, the following calculation can be carried out:

£1,500,00 (Value of Statistical Life, see appendix 2) x 1:1,000,000 (level of risk) = 1.50(£)

When combined with the loss of tree-related benefits, such as aesthetic quality and environmental and health benefits, and the risk to workers and the public from the risk reduction work, an estimated risk reduction cost of £800 can be described as disproportionate to the benefits it provides.