Expert Witness Report

Parks and Playgrounds Movement Inc v Newcastle City Council [2010] NSWLEC 40745

Laman Street, Cooks Hill

(between Dawson Street and Darby Street)

Prepared for

Parks and Playgrounds Movement Inc

(Contact: Mr Doug Lithgow, President)

Prepared by

Ian McKenzie – Consulting Arborist

28 September 2010

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1 Summary

This report is an expert witness report to the Land and Environment Court in relation to Parks and Playgrounds Movement Inc v Newcastle City Council, Case 10/40745.

The purpose of this report is to provide expert opinion on the following matters.

1. Whether the removal of the fourteen fig trees is necessary for the purpose of removing a traffic hazard.

2. Whether the removal of the trees is likely to cause harm to the environment, considering the definitions of “environment” and “harm” under the Protection of the Environment Operations Act 1997.

3. Whether the removal of the trees is likely to affect the environment, taking into account the factors in clause 228(2) EPA Regulation; and if yes, whether that effect is likely to be significant.

The trees are a mature avenue of Hill’s figs in Laman Street (eight fig trees are located on the northern side and six on the southern side of Laman Street). The fig trees form part of the curtilage of the heritage items such as the buildings and park to the south and north, thus their contribution to the heritage value must be considered.

On a scale of excellent, good, fair and poor, all fourteen fig trees are assessed as having good health and normal vigour.

Thirteen of the figs *Ficus microcarpa* var. *hillii* (Hill’s weeping fig) are assessed as having fair structure and one *Ficus* cf. *obliqua* (small-leafed fig) has been assessed as having poor structure.

The thirteen *Ficus macrocarpa* var. *hillii* are rated as having 15 to 40 years tree sustainability. The *Ficus* cf. *obliqua* is assessed as having a sustainability rating of less than 5 years.

The trees are highly significant in the landscape and have high retention value, based on Newcastle City Council’s tree retention value methodology.

Using the Quantified Tree Risk Assessment (QTRA) methodology, only one of the trees has been assessed as presenting a level of risk to traffic (vehicles and pedestrians) less than the recommended 1:10,000. The level of risk is marginal for several of the trees but many of the trees currently present virtually no risk as they would fall into an adjoining tree if they were to fail.

As a result of the QTRA, the removal of the 14 trees is not considered necessary for the purpose of removing a traffic hazard.

However, it is not considered acceptable to do nothing to mitigate ongoing risk and a strategy for the staged removal and replacement of the trees over two to three decades is considered an acceptable way to manage the risk.

Various environmental benefits are outlined in section 6 of this report. The Newcastle Urban Forest Background Paper 2007 discusses the environmental benefits provided by trees in urban environments also, and the relevant section is attached as an appendix.

The 14 subject trees have an urban forest canopy cover of about 3,500 square metres. This constitutes about four percent of the urban forest cover in the square kilometre centred on the subject site. The urban forest cover for this area is about 8.62 percent but will decrease to about 8.28 percent if the subject trees are removed. This is a significant reduction in urban forest canopy cover.

In the opinion of the author of this report, removal of the 14 trees is likely to cause harm to the environment and will affect the environment to a significant degree.

2 Introduction

2.1 Acknowledgement

This report has been prepared in relation to Land and Environment Court hearing 10/40745 Parks and Playgrounds Movement Inc v Newcastle City Council.

In accordance with Part 31.23 (3), I, Ian McKenzie, acknowledge that I have read Schedule 7 of the Uniform Civil Procedures Rules 2005 – expert witness code of conduct – and agree to be bound by it.

I understand my paramount duty is to the court and acknowledge it is my responsibility to assist the court impartially.

A professional resume outlining my qualifications as an expert in the field of arboriculture is attached as Appendix 1, in accordance with Section 5(1) (a) of the Expert Witness Code of Conduct.

2.2 Disclaimer

This report is to be read and considered in its entirety. Visual Tree Assessment (VTA) methodology has been used to form the basis of the report. No aerial inspection, internal analysis or below ground root inspection has been undertaken. Extreme climatic conditions cannot be predicted and absolute safety cannot be guaranteed with any tree. The assessment and recommendations are based on the current situation and are based on current arboricultural information and research. Trees are living, dynamic entities and circumstances can change. The duty of care by owners of trees requires an ongoing appropriate level of professional inspection and assessment.

2.3 Background

Newcastle City Council (Newcastle City Council) considered a report regarding the future of fourteen *Ficus microcarpa* var. *hillii* (Hill's weeping figs) in late 2009. The report referred to arborists' reports by Dennis Marsden of The Sugar Factory and Dean Simonson of Treelogic Pty Ltd.

Based on the recommendations of council officers, which were based on the recommendations of the two arborists' reports, the elected Council resolved to remove the fourteen trees. Shortly thereafter, a rescission motion was lodged in relation to the Council's resolution.

The author of this report, Ian McKenzie, reviewed the Council report and the two arborists' reports. Mr McKenzie applied to address the Council in its Public Voice Committee in relation to its resolution to remove the fourteen trees. Mr McKenzie claimed that, whilst he acknowledged some level of risk, the only risk mitigation measure that was presented as an option to mitigate the risk to an acceptable level was the removal of all fourteen trees. Mr McKenzie stated that there were undoubtedly other risk mitigation measures that should be considered.

Mr McKenzie also claimed that the value of the trees and the benefits the trees provide had not been considered in the decision by the Council to remove the trees. He noted that a heritage report had not been prepared for the trees and that consultation with the community had not been undertaken.

2.4 Brief

The purpose of this report is to provide expert opinion on the following matters.

1. Whether the removal of the fourteen fig trees is necessary for the purpose of removing a traffic hazard.

2. Whether the removal of the trees is likely to cause harm to the environment, considering the definitions of “environment” and “harm” under the Protection of the Environment Operations Act 1997.

3. Whether the removal of the trees is likely to affect the environment, taking into account the factors in clause 228(2) EPA Regulation; and if yes, whether that effect is likely to be significant, taking into account the definition of “environment” under the Environmental Protection and Assessment Act 1979 which is:

   > *Environment includes all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings. (s4)*

The report can be used by the Court as expert witness testimony that aims to be objective and impartial in the matter before the Court, and to aid consideration by the Court.

Included in the report are:

- site information including a site plan showing the location of each of the subject trees;
- description of each tree;
- the condition of each tree;
- tree sustainability (useful life expectancy), landscape significance and tree retention value, as outlined in the Newcastle Urban Forest Technical Manual 2007, for each tree;
- risk assessment using Quantified Tree Risk Assessment (QTRA) methodology for each tree;
- review of QTRA undertaken by other arborists; and
- discussion about environmental benefits provided by the trees and whether their removal is likely to cause harm and/or affect the environment.

The report complies with the relevant parts of the NSW Land and Environment Court Expert Witness Practice Direction 2003.

2.5 Methodology

On-site inspection and assessment of the 14 subject trees was undertaken on 24 & 26 September 2010. Visual Tree Assessment (VTA) as described by Mattheck & Breloer (1994, pp. 145-6) and Quantified Tree Risk Assessment (QTRA) (Ellison, 2005) methodologies were used.

Assessment included the following:

- The subject trees were individually inspected and assessed from the ground. Species, size, age class, condition, tree sustainability, landscape significance and risk factors were recorded for each tree in the Tree Assessment Schedule (Appendix 1).
- The root zones were inspected above ground. No excavation or root investigation has been undertaken by ArborViews.
- The lower trunks and buttresses were 'sounded' with a Thor 710 nylon hammer.
- No soil analysis was undertaken.
- No internal analysis has been conducted.
- No tissue analysis has been undertaken.

ArborViews used two arborists to inspect and assess the trees – Mr Ian McKenzie and Ms Charmian Eckersley. Mr McKenzie has the AQF 5 and AQF 6 qualifications in arboriculture. Ms Eckersley has the AQF 5 qualification in arboriculture. Measurement of the trees was shared between the two arborists. Assessment of condition, tree sustainability, target evaluation, tree hazards and probability of failure were discussed by both arborists, with consensus generally being attained. Mr McKenzie is responsible for final assessment in all regards.

The following arborists' reports, statements and reviews have been read in order to consider the opinions, conclusions and recommendations of other qualified and experienced arborists.

- Dennis Marsden, The Sugar Factory – Arbor Advocate
- Dean Simonsen, Treelogic Pty Ltd
- Andrew Simpson and Anna Hopwood, Total Vegetation Management
- Adrian Swain, Arboreport (3 reports)
- Mark Hartley, The Arborist Network

3 Site Details

Figure 1 The subject fig trees form an arching canopy along Laman Street. The heritage listed Baptist Tabernacle can be seen on the right. Photo Dec 2009.

3.1 Site Description

The subject site includes both sides of Laman Street between Dawson Street and Darby Street, in the Newcastle civic precinct. Laman Street runs in an east west direction. The Baptist Tabernacle, Newcastle Memorial and Cultural Centre (library) and Newcastle Regional Art Gallery bound the southern side of the street and Civic Park bounds the northern side of the street. Across Civic Park is City Hall.

The subject site is approximately half a kilometre south of Newcastle Harbour and about a kilometre from the coast. The site is about 15 metres above sea level. The street slopes down to the east from about the Newcastle Memorial and Cultural Centre and slopes down to the west from about the Dawson street intersection. It steps down into Civic Park, with retaining walls running along the length between the park and the street. Direct access between Civic Park and Laman Street is attained by a central set of steps opposite the library entrance and another set of steps at the eastern end.

The subject trees are street trees in Laman Street. Eight fig trees are located in the footpath on the northern side of Laman Street. Six figs are growing in the road adjacent to the southern footpath.

3.2 Heritage Status

The fourteen fig trees form a significant component of the curtilage of several heritage items. The Newcastle War Memorial and Cultural Centre (library), which is located directly behind four of the trees, is listed as having state heritage significance. The Baptist Tabernacle (state significance), St Andrews Presbyterian Church (state significance), the former Signalman's Cottage (local significance) and former Railway overpass (local) are all within a short distance from the fig trees. Civic Park, which bounds the northern side of Laman Street, is listed as having local heritage significance (Newcastle City Council 2003).

The site is within the Newcastle City Centre Heritage Conservation Area immediately adjacent to the Cooks Hill Heritage Conservation Area.

The fig trees form part of the curtilage of most if not all the heritage items and as such their contribution to the heritage value must be considered. The risk they present to the heritage buildings in the event of failure should be considered also.

Figure 2 Looking up from Civic Park, past the Civic Fountain and through the Laman Street fig trees, to the state heritage significant Newcastle War Memorial and Cultural Centre.

3.3 Locality Plan & Aerial View

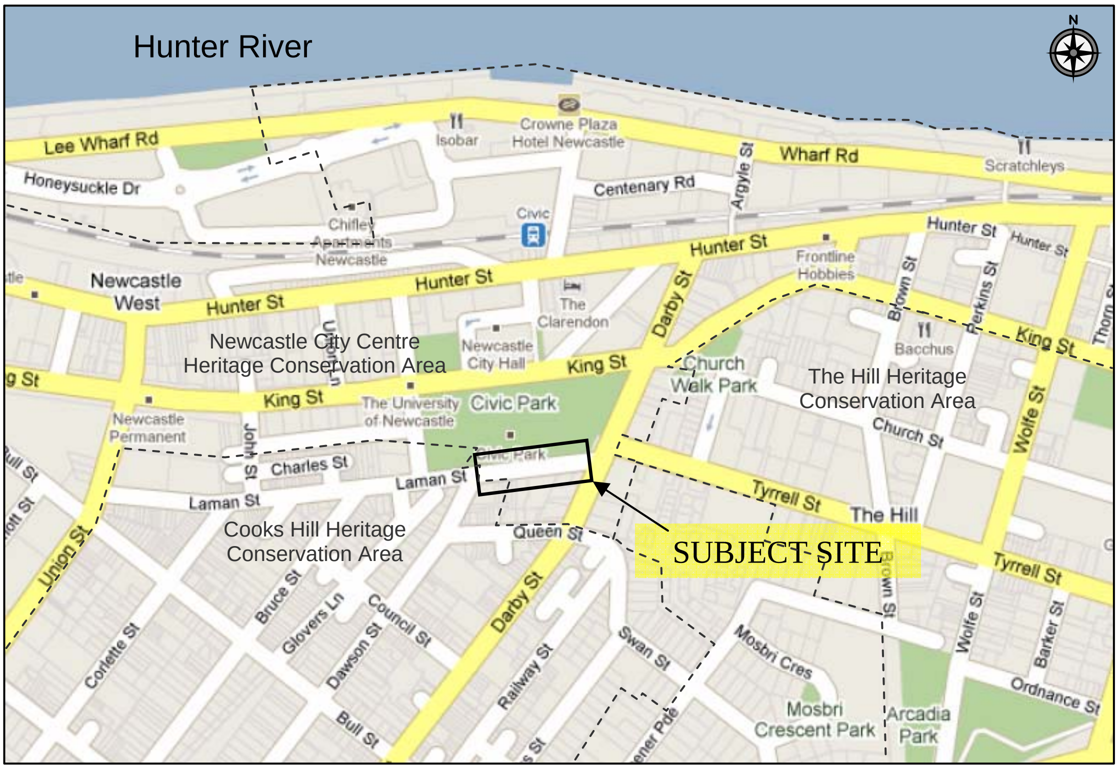

Figure 3 Locality plan. (Google Maps 2010)

Figure 4 Aerial photo of subject site. (NearMap, 2010)

3.4 Site plan

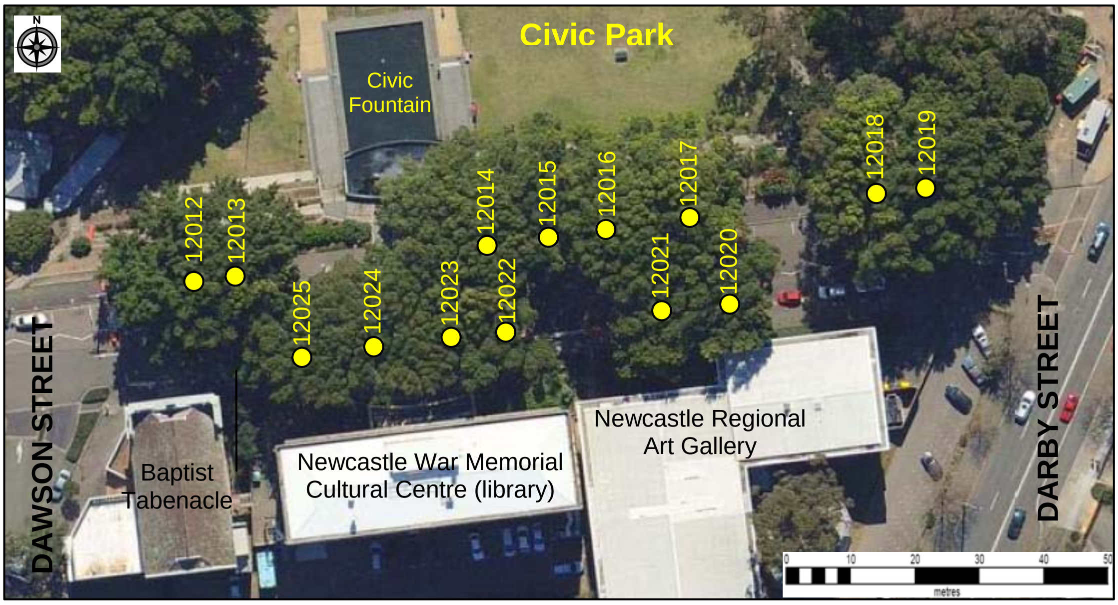

Figure 5 Site plan showing the fourteen Laman Street fig trees numbered and in relation to Civic Park and the Newcastle War Memorial Cultural Centre, both of which are heritage items. (Aerial photo – NearMap 2010)

4 Tree Assessment

Each of the fourteen fig trees has been individually inspected and assessed. Species, common name, age class, dimensions, health, vigour, structure, tree sustainability (useful life expectancy) and landscape significance are recorded in the Tree Assessment Schedule (Appendix 1). The remainder of this section discusses the tree assessment generally.

4.1 Description

Thirteen of the fourteen subject trees are *Ficus microcarpa* var. *hillii* (Hill's weeping fig). The other subject tree is believed to be a *Ficus obliqua* (small-leafed fig). The fourteen trees are mature age class. It is generally understood that they were planted in the 1930s.

They are growing in two rows along each side of Laman Street and have intertwining crowns, which forms a virtually a contiguous canopy. There is some separation between the two trees at the eastern end of the street and the other trees due to the removal of two figs in 2007. The two rows are about 12 metres apart. The crowns of the trees on either side of the street merge but there is adequate separation to permit reasonable north south crown spread. North south crown spread ranges up to about 30 metres.

The separation between the individual trees in the rows varies considerably but is as little as 5 to 6 metres between some trees. Consequently the east west crown spread is suppressed in some of the less dominant trees. At least three fig trees have been removed from the street in recent years providing additional space into which the remaining crowns can spread.

On average, the east west crown spreads are slightly less than three-quarters of the north south crown spreads.

The trees virtually all have single trunks to about 2 metres where they bifurcate into multiple first order structural branches. The trunk diameters range from just under a metre to more than a metre and a half.

4.2 Health and vigour

On a scale of excellent, good, fair and poor, all fourteen fig trees are assessed as having good health and normal vigour. There is limited deadwood and crown dieback. There are no obvious signs of disease, pest infestation or other ailments other than some decay of damaged exposed roots and pruning wounds. There is epicormic growth on some trees, probably as a response to recent pruning. Leaf size and colour, and new season growth are good. Crown density is generally normal (70-90%) but slightly sparse (50-70%) in a few of the trees.

4.3 Structure

Tree structure is the construction and arrangements of the parts of the tree. It incorporates defects in the tree, injury to the tree, decay and hollow wood, and the trees anchorage and stability in the ground. Structure is rated on a scale of excellent, good, fair and poor.

The thirteen *Ficus microcarpa* var. *hillii* are rated as having fair structure. The *Ficus* cf. *obliqua* is rated as having poor structure.

There are some general structural issues that are pertinent to all fourteen trees while remembering that they each have individual characteristics and need to be considered individually for care and management.

4.3.1 Roots

Tree's roots are necessary to anchor the tree and provide stability in the ground and to absorb water and nutrients and transport them to the tree above ground.

The size and good health of the crowns of the fig trees indicate that significant root systems must exist and access water and nutrients. A possible explanation is that roots have grown down into Civic Park, particularly those of trees on the northern side of Laman Street. The roots of the figs trees on the southern side of the street may travel up into the garden beds adjacent to the buildings.

The size of the trees above the ground is indicative of the roots' structural capacity. That is, there must be sufficient roots to hold the trees stable in the ground under significant weight and wind loads.

Gently tapping the root buttresses revealed general solidity of wood and relatively little decay or hollow. The only notable exception is tree 12015, which sounded 'hollow' in the lower trunk and root buttresses.

Several trees have exposed structural roots that have suffered damage from vehicles driving over and parking on them.

Marsden reports that the root plates are lineal rather than radial (2009, p.15). That is, the roots grow more or less in an east west direction parallel to the street and footpath and tend not to grow across the road. Marsden reported that trenching had taken place along the street to facilitate root investigation. He noted that "one trench only was found to have woody roots". He concluded that "the street did not provide an environment conducive to the development of roots".

Ground Penetrating Radar (GPR) testing was undertaken by GBG Australia in late 2009. The GPR results indicate roots greater than 50 mm diameter extending in all directions from all trees, before the roots become too small or go too deep for the equipment to discern them clearly. The GBG Australia findings were not consistent with the findings from earlier root investigation by trenching.

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Figure 6 Lifting and cracking of the street surface indicate the presence of roots extending from the buttress of tree 12020.

Figure 7 Lifting and cracking of the relatively new layer of bitumen indicating root presence from a buttress (tree 12021).

There are some signs that structural roots extend into the street. The lifting and cracking of the road surface is evidence that there is at least some rood development across the road (see figures 6 and 7). Root regrowth is not unusual for figs even after cutting and damage to roots. As Metro Trees notes in its Handbook: the Hill's fig has "a fine-textured, highly-meristematic root system. This meristematic root system allows Hill's Fig to respond quickly to root changes in its environment" (Metro Trees, 2010).

Mattheck and Breloer (1994, pp.12-13) explain the *axiom of uniform stress* as a self-optimising mechanical process that maximises the chances of the trees survival. Mechanical optimisation will determine biological design and this suggests that a tree will develop structural root system it requires for stability, even if that is not in the 'normal' pattern.

Whilst it is common for trees structural root systems to spread laterally, it is not impossible for structural roots to develop downwards and deeper in the ground than normal in order to maximise the tree's ability to remain stable in the ground.

4.3.2 Lopping

Lopping is described as an unacceptable practice in the Australian Standard for the Pruning of Amenity Trees: AS 4373–2007. Lopping can result in epicormic branch attachments that are acknowledged as being weaker than normal branch attachments.

The subject trees appear to have been lopped at around 4 metres. This possibly occurred in the late 1960s when lopping was systematically undertaken on many large figs in Newcastle (Newcastle Herald, 1968). The *Ficus microcarpa* var. *hillii* species responded to the lopping with vigorous epicormic regrowth branches forming with good cambium growth, which hid "joins". This sometimes makes it difficult to see the point of the lopping and development of the current canopy.

The single *Ficus* cf. *obliqua* regrew with less structurally sound epicormic branch attachments, resulting in the poor structure of this tree.

Figure 8 The *Ficus* cf. *obliqua* (tree 12015) is the one tree with significant structural problems. (Note tree 12014 – the Hill's fig in the foreground has healed over the lopping wounds)

Nonetheless the *Ficus microcarpa* var. *hillii* would appear to be a special case in the way the cambium tissue has grown over the wounds and the annual rings in the contact zone of the multiple attached branches are fused together (see Figure 8 and 9). Only one of these thirteen trees shows evidence of branch failure at the 2 - 4 m high epicormic regrowth location. It is a zone of the trees requiring monitoring in the normal care and management routine of Council for its street trees.

Figure 9 Strong cambrial growth over lopped branches has remediated previous damage making wounds almost invisible.

The low level of failure may be surprising given the textbook analysis of these types of branch unions. A risk which is further compounded by the textbook interpretation of the 'compression fork fracture', explained by Marsden as a "Cluster Wedge" (Marsden, 2010, p. 8),which would have seen many of the regrowth branches failing – but the evidence is that they have not. Judicious pruning, as proposed by Marsden, has most likely mitigated the risk presented by the most problematic branch unions. Rather than at the 4 metre, or point of lopping, a couple of branch failures were evident much higher in the canopy at around 8 to 10 metres.

4.3.3 Included bark

Branches with included bark are present in all the subject trees. As Marsden says, you would have to condemn all figs if you used this commonly used criterion for identifying areas of potential failure in figs. There are many figs with included bark whose branches do not fail.

4.3.4 Injuries by vehicle impact

As mentioned in section 4.3.1, several trees on the southern side of the street have exposed roots around their base that have been injured by cars driving over and/or parking on them. Injuries to structural roots can result in decay spreading back into the root crown, increasing the likelihood of whole tree failure. Sounding the lower trunks and buttresses of the affected trees does not reveal extensive decay in the roots.

The *Ficus* cf. *obliqua* showed evidence of extensive decay in the lower trunk and buttress roots from damage it has suffered.

A couple of trees with branches extending over the road have repeated mechanical damage on their underside, apparently from high vehicles impacting them. High vehicles are a hazard to the trees. Impacting the trees can break branches and increase the likelihood of future branch failure.

Figure 10 High vehicle impact creates a hazard for the tree 12012. This branch arises from a codominant union at the base of the tree and hitting this branch could result in whole tree failure.

4.4 Growing environment

Trees require space, both below and above ground. They require adequate sunlight, warmth, water, air, soil and nutrients in order to grow, remain healthy and to combat disease, insect attack and other ailments. A deficiency of any these resources will affect the health and potentially form and structure of a tree.

Soil must have sufficient macropores and micropores to hold air and water in the soil, so the soil cannot be compacted. Compacted soil also inhibits root growth. Impervious surface treatment limits water available to the roots and thereby for photosynthesis and transpiration, and the tree cannot produce food for energy to survive, grow and resist disease and insect attack.

Roads are constructed on compacted load-bearing sub-base, which is a hostile environment for effective root growth. Roads and footpaths are constructed with impervious materials that severely limit the availability of water for the tree.

It is hard to envisage where the trees on the southern side of Laman Street obtain water. There are some small garden beds but unlikely sufficient to sustain trees of the size of the fig trees.

The trees on the northern side are likely to have roots extend into Civic Park and attain the required resources from there.

Figure 11 The 'missing' roots would most likely have travelled to the favourable areas of Civic Park.

4.5 Tree retention value

The Newcastle Urban Forest Technical Manual 2007 supplements the Newcastle DCP Element 4.10 – Tree Management. Technically, the DCP is relevant to private land, not public land. However, tree assessment tests numbers 5, 6 and 8 specifically refer to public land and public infrastructure (pp.7-8) so it is reasonable to use the Technical Manual as guidance in relation to public trees.

Section 4 of the Urban Forest Technical Manual provides a standardised approach for assessing the retention value of trees. This is generally relevant to trees on development sites but it is useful to use the Newcastle City Council guidelines to determine the tree retention values for the 14 fig trees.

Tree retention value is derived from an assessment of two factors – the significance of the tree in the landscape and the sustainability, or remaining useful life expectancy, of the tree.

4.5.1 Landscape significance

Assessment of landscape significance considers amenity value, environmental value and heritage value. Amenity value is affected by the size and density of the crown, the tree's form and habit, visual prominence in the landscape and the tree's relationship to other trees and special elements (p.12). Environmental value includes whether the tree is: remnant or planted, a listed threatened species, exotic or weed, whether it provides habitat and whether it is rare or common in cultivation. Heritage values include cultural heritage, Aboriginal heritage, natural heritage and historical significance.

Landscape significance is rated on a 7-point scale ranging from 1. Significant down to 7. Insignificant.

Half the fig trees attained the highest landscape significance rating. Five of the trees were rated as having very high landscape significance and two were rated as high.

The landscape significance of the entire row of trees cannot be understated. They are iconic in the city.

The high individual ratings reflect the location, the size, the arching form and their relationship to Civic Park and the various heritage buildings that surround them.

4.5.2 Tree sustainability

Tree sustainability can be thought of as the remaining useful life expectancy of the tree. This is affected by the health and vigour of the tree, the tree's structural condition and suitability to the general locality and specific position. The growing environment is fundamental to the tree's health and structural condition.

The Newcastle Urban Forest Technical Manual has four tree sustainability period categories and a dead or hazardous category. The four sustainability periods reflect the Safe Useful Life Expectancy (SULE) categorisation (Barrell, 1995) used by some other arborists.

The thirteen *Ficus macrocarpa* var. *hillii* (Hill's weeping fig) are rated as having 15 to 40 years tree sustainability. The *Ficus* cf. *obliqua* (small-leafed fig) is assessed as having a sustainability rating of less than 5 years.

These medium term ratings are despite the harsh growing environment in which the fig trees exist. As reflected in section 4.2, all the trees are in good health and have normal vigour.

Tree sustainability periods can change with circumstances. Impacts on the trees, such as drought or nearby works, can shorten their remaining useful life expectancy whereas good care and management can lengthen it.

Currently though, it is envisaged that life expectancies closer to 15 years than to 40 years may be realistic.

Other arborists have categorised the trees as having less than 15 years useful life expectancy, and some even less than 5 years life expectancy. The shorter useful life expectancies appear to reflect concern about the potential for the trees to fail rather than the actual health of the trees.

4.5.3 Tree retention value

Tree retention value is the product of the landscape significance rating and the tree sustainability. Table 1 is the matrix used to derive tree retention value.

Table 1 Newcastle City Council methodology used to assess Tree Retention Value

	Landscape Significance Rating						
Useful Life Expectancy (ULE)	1 significant	2 very high	3 high	4 moderate	5 low	6 very low	7 insignificant
greater than 40 years	**high**						
15 to 40 years			**moderate**				
5 to 15 years					**low**		
less than 5 years						**very low**	
dead or hazardous							

Twelve of the *Ficus macrocarpa* var. *hillii* have high retention value and one has moderate retention value. The *Ficus* cf. *obliqua* has low retention value.

5 Quantified Tree Risk Assessment (QTRA)

5.1 Explanation of QTRA

Quantified Tree Risk Assessment **(**QTRA) (Ellison, 2005) quantifies the risk of significant harm from tree failure by quantifying the independent probabilities of three components of the tree hazard – 1) target; 2) impact potential; and 3) probability of failure.

This enables the risk of significant harm, which is the product of these components, to be compared with a generally accepted level of risk.

An overall probability of 1/10,000 is generally considered the limit of acceptable risk to the public at large (cited by Ellison 2010, p.6).

Further information about QTRA is included in Appendix 2 – *What is Quantified Tree Risk Assessment? A Non-technical Summary* and/or can be obtained from the QTRA website – www.qtra.com.uk.

It should be noted that in QTRA, the figure given as the risk of significant harm is calculated using an arithmetical formula. This is seen in Appendix 3. This results in a number that may imply a level of precision that is misleading. The risk of significant harm is indicative and should not be considered an absolute determinant. The figures for risk of harm in Appendix 1 have been rounded to minimise perception of precision than may be implied.

QTRA is a tool to assess risk, not an absolute determinant. It does not factor in the value of the tree or the level of risk that is acceptable to the decision makers. Risk of harm levels greater than 1:10,000 should not automatically result in the removal of a tree, nor should risk of harm levels less than 1:10,000 automatically result in the retention of a tree.

Ultimately decisions as to what risk is acceptable and what mitigation measures are practical and acceptable need to be made on a case by case basis.

5.2 Traffic hazard

This report considers whether the removal of the fourteen fig trees is necessary for the purpose of removing a traffic hazard.

“Traffic” is understood to include both vehicular and pedestrian traffic. “Traffic hazard” is taken to mean the risk of significant harm to moving vehicles and/or pedestrians.

Following Simonsen’s QTRA report (2009), which concluded an unacceptable level of risk, and Newcastle City Council’s decision on 15 December 2009 to “implement whatever safety measures deemed necessary to ensure the public safety of the Laman

Street precinct, apart from removing the trees," various risk measures were implemented to mitigate risk to an acceptable level.

Swain considered the level of risk using QTRA methodology following the implementation of the risk mitigation measures and supported the measures as being reasonable and appropriate (2010a, p.8).

Newcastle City Council expanded Swain's brief following concerns about the effectiveness of the risk mitigation measures. Swain reviewed his QTRA calculations based on the information regarding the reduced effectiveness of the mitigation measures and recommended enhanced risk mitigation measures be put in place (Swain 2010b).

The risk mitigation measures implemented by Newcastle City Council are considered to be temporary measures until such time as a final decision regarding the 14 trees is made. Consequently, in considering whether the 14 fig trees present a "traffic hazard" that it is necessary to remove, the circumstances and data upon which QTRA is provided in this report are those in effect prior to the risk mitigation measures being implemented by Newcastle City Council.

Normally target evaluation will consider all potential targets. However, as this brief is specifically considering "traffic hazard", only targets that could reasonably be considered traffic in Laman Street are included. The risk to people in Civic Park from any of the trees falling into Civic Park is not considered or calculated in this instance.

5.3 Consideration of targets

Ellison states that target evaluation is the first step of the QTRA process and this will inform the degree of rigour required for assessment of the other two factors (2010, p.8). ArborViews understood that the target values are high and that maximum rigour would be required in consideration of potential hazards and probability of failure.

In response to the brief for this report, it is only necessary to assess the target that would be considered a 'traffic hazard'. The target areas to the north of the street, being Civic Park, and to the south of the street, being the buildings, are not considered for the purpose of this report.

However, they should be considered in the general assessment and management of risk from the trees, outside the scope of this report.

Data in relation to pedestrian and vehicular traffic provided to Simonsen (2009, p.5) by Newcastle City Council (Newcastle City Council) and used in his report has been relied upon for consideration of target values in this report. These data are:

Annual average attendance to the art gallery = 72,155
Annual average attendance to the library = 360,000

The author of this report, Mr McKenzie, was a regular weekly visitor to the Civic Cultural Precinct, City Hall in particular, over a 9-year period until 2008 and is to some extent familiar with the area. Based on that experience, the number of pedestrians using Laman Street other than to visit the art gallery or library is estimated to be no more than 200 per day, or 73,000 per annum.

In addition, it is recognised that not all visitors to the art gallery and/or library follow the same route. There are five main routes visitors would take to access these buildings.

A. from the east using the southern footpath
B. from the east using the northern footpath
C. from the west using the southern footpath
D. from the west using the northern footpath
E. up the steps from Civic Park.

Most pedestrians crossing Laman Street would use the pedestrian crossing at the top of the steps from Civic Park opposite the library entrance. However, many would not and there are undoubtedly various other routes used. There is an access lane between the art gallery and library that connects the car park behind those buildings to Laman Street that would be used by a proportion of visitors.

Feedback was sought from a small number of people who are familiar with the Laman Street area including regular visitors to the area, as to the relative proportion of the five routes described above. A rough average of the estimations has been used to more closely establish target values. The percentages for each of the five main routes are shown in table 1. It is not claimed that the numbers of pedestrians calculated by using these proportions is accurate, but it is believed that is more realistic than assuming every visitor to the art gallery and library walks under every tree.

Table 2 Estimated proportion of pedestrian traffic for various routes

A	from the east using the southern footpath	35%
B	From the east using the northern footpath	5%
C	from the west using the southern footpath	25%
D	from the west using the northern footpath	15%
E	up the steps from Civic Park.	20%

Normally QTRA uses five seconds as the amount of time taken for a pedestrian to traverse the target area of a tree (Ellison 2010, p.10). Simonsen uses a walking speed of 5 km/hr and a 20 metre target area based on average crown spread, resulting in 14.4 seconds to traverse the targets area. ArborViews has used 5 km/hr and individual east west crown spreads to calculate times within individual target areas.

Newcastle City Council provided traffic volume data to Simonsen also (2009, p.6). The average yearly traffic volume for Laman Street is 877,095 vehicles, or 2,403 per day. The average number of persons per vehicle used for QTRA purposes is 1.6 (Ellison 2010, p.9).

Some visitors would arrive by car and park outside the library or art gallery, thereby not needing to pass within the target area of most of the trees. It is likely that data for vehicles and that for visitors may double count some people.

5.4 Probability of failure

Generally, the probability of failure is greater for smaller branches than for larger branches and for larger branches than for whole tree failure. However, it is the combination of the size of the part that will impact the target and the likelihood that it will impact the target that guides what is the most likely significant harm. A piece of deadwood is highly likely to fall and could cause some injury if it impacted a person's head. However, whilst considerably less likely, a whole tree falling on someone is likely to cause significant harm.

With regard to the subject trees, both failure of branches and whole tree failure has been considered in relation to the level of risk of significant harm occurring. Whilst the probability of failure of branch failure is often greater than whole tree failure, the risk of significant harm is greater from whole tree failure when the size of part and extent of the target area are factored in.

Consequently, the risk of significant harm from the subject trees has been calculated based on whole tree failure towards Laman Street. That is the trees on the northern side of the street falling in a southerly direction and the trees on the southern side of the street falling in a northerly direction.

5.5 Level of risk

Having evaluated targets, assessed potential hazards and estimated the size of tree parts likely to impact the target, secondary components can be considered where appropriate.

5.5.1 Weather factor

Ellison (2010, p.14) explains that as the probability of a tree failing is greatest during storm conditions that it is reasonable to incorporate 'weather' as a factor that affects probability of failure.

The most significant risk of harm is whole tree failure and this is most likely to occur during storms when the ground is very wet and wind speeds are high. The probability of tree failure increases as wind strength increases. Numerous tree failures and partial tree failures occurred throughout the Newcastle local government area and beyond during such conditions in June 2007. Probability of failure is assessed on the understanding that the most likely time of a failure is during strong winds.

Conversely, the frequency of pedestrians and vehicles is likely to decrease significantly during storms. Following investigation, Hartley concluded that the storms that hit Newcastle during 7-9 June 2007 justified a weather factor of 2 (2010, p.7). Hartley states that in comparison with the daily average attendance of 197, daily attendance during the worst days of the storm dropped to 52 visitors on the Friday and 37 visitors on the Saturday, down 74 percent and 81 percent respectively on the average number of visitors for each day. Access to the city centre and Laman Street was affected by flooding on Saturday 9 June, and this too would have affected attendance figures for that day.

It is likely that the reduction in visitation was even greater during the periods during which the storm was most intense.

A weather factor of 2 has been incorporated into the risk of harm calculations effectively halving the calculated level of risk of harm.

5.5.2 Hang ups

From a risk management perspective, one of the benefits attained from the close proximity of the trees to one another in relation to their size is that many of the trees, if they were to fail at ground level, would fall and 'hang up' in adjacent trees.

This is the case for the following trees.

- Tree 12014 would get hung up in tree 12022, if it fell southward;
- Tree 12015 would get hung up in tree 12014, if it fell northward (away from the street);
- Tree 12016 may get hung up in tree 12021, if it fell southward;
- Tree 12017 would get hung up in trees 12021 and 12022, if it fell northward;
- Tree 12021 would get hung up in trees 12016 and 12017, if it fell northward;
- Tree 12022 would get hung up in tree 12014, if it fell northward; and
- Tree 12025 may get hung up in tree 12013, if it fell northward.

These trees may fail but they would be inhibited from impacting any target, thus there would be no significant harm. This is not reflected in the QTRA calculations of either this report or other the arborists' reports.

Figure 11 Trees in the avenue would in many cases get hung up in adjacent trees if they fell. Each tree has been assessed for the "annulling" of targets that would occur if it failed. This effect is not considered by QTRA but lessens the risk to traffic.

Removal of some trees will expose potential targets to impact by remaining trees that would otherwise not have impacted the target.

5.5.3 Type of failure

Failure of one of at least one of the fig trees in Laman Street during the June 2007 storms was only partial. The tree had moved in the ground but had not fallen over. Failure of this type is not unlikely if any of the subject trees do fail, again resulting in no significant harm. This effect is due in part to the heavy road infrastructure around the tree bases.

5.6 Risk mitigation

As stated in section 5.1, QTRA calculations are not the absolute determinant of whether risk should be mitigated and whether a tree should be removed.

Whilst only tree 12025 is calculated to present a risk of significant harm greater than 1:10,000, many of the trees present a level of risk that is considered marginal.

It is the firm belief of the author of this report that it is not acceptable to take no measures to mitigate the risk from these trees. However, removal of all 14 trees is not considered necessary. The risk presented by any of the subject trees can be managed through various risk mitigation measures. Examples of these measures have been implemented by Newcastle City Council over the past nine months and have mitigated the level of risk.

The probability of failure of the subject trees is likely to incrementally increase over years, requiring ongoing and increasing mitigation measures.

The author of this report believes that an appropriate strategy to mitigate the risk of harm to a high level of acceptability is a staged removal of the subject trees and the planting of new trees over a 20 to 30 year period. The order of when each tree should be removed would require further consideration and discussion in a broader context of the future management of the precinct.

6 Benefits to the environment

There are various environmental benefits provided by trees. It is difficult to quantify some of these benefits but some work in this area has been undertaken by the Centre for Urban Forest Research in the USA. Little research has been undertaken in Australia to date.

6.1.1 Ecological value

The subject fig trees are large mature specimens that could be expected to fruit twice per year. There will be small hollows and crevices in the canopy that one would expect to be frequented by a range of arboreal mammals and birds, some of which may be threatened species. Arborists would normally have a responsibility to include a recommendation in their report, for an ecologist, with appropriate expertise in fig ecology, to undertake a study to determine the ecological importance of the figs.

6.1.2 Energy saving

Trees can reduce energy usage by reducing the need for air conditioning in summer and heating in winter.

Urban areas develop what is known as a heat island effect. This is when the sun's radiation is absorbed by hard surfaces such as buildings and roads during the day and re-emitted at night time. The temperatures over successive hot days are compounded by the nightly re-emission of radiated heat resulting in urban ambient temperatures significantly higher than in suburban residential or rural environments.

Trees can help mitigate the heat island effect. Trees provide shade over hot surfaces significantly reducing the absorption of radiated heat. In addition, trees evapo-transpire. They work in the same way as an air conditioner. In fact, they could be considered nature's air conditioners. Water absorbed from the ground through the roots transpires through the leaves in the photosynthesis process and evaporates into the surrounding atmosphere. Evapo-transpiration can cool the surrounding air by as much as 5 °C. It also humidifies the air, further adding to comfort levels.

Appropriate shading of buildings can reduce the direct solar radiation absorbed and reduce the cooling demands in hot weather in particular. The Laman Street fig trees are perfectly located to significantly reduce temperatures in Laman Street and reduce energy demand for cooling in the buildings along the southern side of the street that they shade.

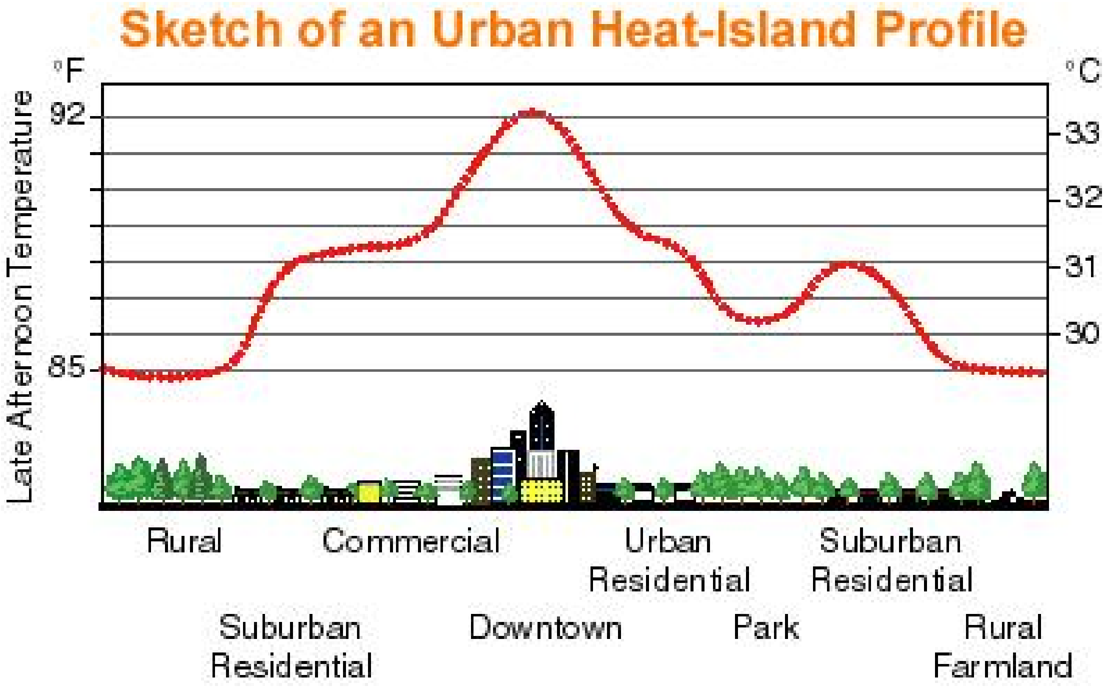

Figure 12 Many U.S. cities and suburbs have air temperatures up to 10°F (5.6°C) warmer than the surrounding natural land cover (US EPA, 2005).

6.1.3 Carbon storage and sequestration

Trees sequester and store carbon. Retention of the subject trees will sustain carbon in its solid form whereas the removal and chipping of the trees will see the production of carbon dioxide released back into the atmosphere in the short term.

Table 3 provides an estimation of the energy, carbon sequestration, and stored carbon (that is the amount of carbon which will be released into the atmosphere if the trees are felled and chipped which is the usual process for the removal of urban trees). The CUFR Tree Carbon Calculator (Center for Urban Forest Research, 2010) was used to calculate this data for the trees. Use of this tool was modified for the Australian environment and the data for an equivalent fig species (*Ficus benjamina*) was used since the Calculator did not include data for the subject species of figs.

From table 3, the energy use reduction effect of the trees through the reduced use of air conditioning in the adjacent buildings is a total of 19,272 kilowatt hours for all trees per year.

The annual amount of CO_2 sequestered as biomass is a total of 2,661 kg per year. (This is calculated as the difference between the total amount of CO_2 stored in the tree in year x minus the amount stored in year x-1).

The total amount of CO2 stored in the trees is currently 198,220 kg

The final column gives the total amount of biomass stored aboveground in dry weight which is a total of 84,257 kg for all the trees. This amount excludes foliar and root biomass.

The above benefits of the trees will be dissipated with their removal and the 198,220 kg of carbon will be released into the atmosphere if they are chipped.

Table 3 Carbon Calculator Results for the Figs (annual)

Tree ID	Energy reductions Cooling (kWh/tree)	CO_2 Sequestration (kg/tree)	Total CO_2 Stored (kg/tree)	Above ground biomass (dry weight) (kg/tree)
12012	865	117	17306	7356
12013	1702	281	17306	7356
12014	1702	117	17306	7356
12015	1470	217	10789	4586
12016	722	117	2516	1070
12017	1702	117	17306	7356
12018	1702	117	17306	7356
12019	865	117	17306	7356
12020	1470	217	10789	4586
12021	1357	194	8827	3752
12022	865	281	17306	7356
12023	1470	217	10789	4586
12024	1676	273	16242	6904
12025	1702	281	17124	7279
Total:	**19,272**	**2,661**	**198,220**	**84,257**

6.1.4 Pollution amelioration

Trees absorb gaseous pollutants from the atmosphere and filter particulate matter from the air. This is a particularly important function in the vicinity of busy road. One of the most significant threats to human health is from poor air quality. Large leafy trees provide an extremely important environmental benefit by reducing air pollution.

Trees also improve air quality be reducing air temperatures. Reducing air temperatures helps reduce air pollution by reducing demand of energy generation and its resulting emissions, decreasing temperature dependent emissions of hydro-carbons and by reducing chemical reaction rates that result in ozone formation (City of Boulder Water Conservation Office 2002, ch.4, p.5).

6.1.5 Stormwater

Trees reduce the need for stormwater infrastructure by capturing stormwater and reducing stormwater runoff and soil erosion. Rainwater is captured by the foliage. Some will evaporate back into the atmosphere while the passage to the ground of the remaining stormwater is slowed, reducing overall volumes and flows.

Photo courtesy of University of Colorado. (Adapted from: City of Boulder Water Conservation Office, 2002)

Figure 13 Boulder's canopy cover is responsible for retaining 374 megalitres of stormwater during a 50 mm storm event, roughly equivalent to the volume a 20–story building the size of a football field.

6.1.6 Large trees

Large trees are disappearing from our urban areas as spaces of sufficient size for large trees are taken up for urban development of one type or another. Large trees provide exponentially greater benefit than do smaller trees. A tree that is only twice the crown spread and twice the height will provide four times the crown area and eight times the volume of the smaller tree.

Environmental benefits such as discussed above are mainly produced by the foliage, so trees with greater volume will provide greater benefit.

See Appendix 5 for the crown area and crown volumes of the fourteen fig trees.

6.1.7 Urban forest canopy cover

The urban forest canopy cover in the square kilometre centred on the subject site is approximately 8.61 percent. The canopy area of the 14 fig trees in Laman Street is about 3,500 square metres and constitutes about 4 percent of the moderate to large size woody vegetation (trees) in that square kilometre. Removing the 14 fig trees will reduce the urban forest canopy cover from about 8.61 percent to about 8.28 percent.

An increase in urban forest canopy cover of this amount would take many years to achieve.

Figure 14 The square kilometre around the subject site has a urban forest canopy cover of about 8.61%, which will reduce to about 8.28% with the removal of the 14 fig trees.

7 Conclusion

ArborViews' brief was to address the three issues identified in the brief of this report. In the opinion of the author:

1. The removal of the fourteen fig trees is not necessary for the purpose of removing a traffic hazard.

2. The removal of the trees is likely to cause harm to the environment, based on the definitions of "environment" and "harm" under the Protection of the Environment Operations Act 1997.

3. The removal of the trees is likely to affect the environment, taking into account the factors in clause 228(2) EPA Regulation, and that effect is likely to be significant, taking into account the definition of "environment" under the Environmental Protection and Assessment Act 1979.

8 References

Barrell, J.D. (1995), “Pre-development Tree Assessments” in Watson, G.W. & Neely, D. (Eds)*, Trees and Building Sites*, International Society of Arboriculture, Savoy, IL.

Centre for Urban Forest Research, (2003), *The Large Tree Argument*, Urban Forest Research newsletter, Fall 2003, Centre for Urban Forest Research, viewed 22 February 2005, http://cufr.ucdavis.edu/products/cufr_419.pdf.

Centre for Urban Forest Research, (2010) *CUFR Tree Carbon Calculator*, viewed 27 September 2010, http://www.fs.fed.us/ccrc/topics/urban-forests/ctcc/

City of Boulder Water Conservation Office (2002), *Calculating the Value of Boulder’s Urban Forest*, http://bcn.boulder.co.us/basin/boulder/urbanforest/ [date visited 27 February 2005]

Ellison, Michael J. (2005), ‘Quantified Tree Risk Assessment Used in the Management of Amenity Trees’, *Journal of Arboriculture*, vol. 31, no. 2, pp. 57-65.

Ellison, Michael J. (2010), *Quantified Tree Risk Assessment User Manual Version 3,* Quantified Tree Risk Assessment Ltd, Poynton, UK

GBG Australia (2010) *Ground Penetrating Radar Investigation to map Tree Roots Along Laman Street, Newcastle, New South Wales*, GBG Australia, North Parramatta.

Hartley, M. (2010), ‘Arborist Report’ 30 August 2010, The Arborist Network, Shanes Park, NSW.

Marsden, D. (2009), ‘Assessment of Hill’s Weeping Fig *Ficus microcarpa* var. *hillii* In Civic Cultural Precinct, Laman Street Cooks Hill, Newcastle’ 7 August 2009, The Sugar Factory – Arbor Advocate, West Pennant Hills, NSW.

Mattheck, C. & Breloer, H. (1994), *The Body Language of Trees: A Handbook for Failure Analysis.* TSO, London, England.

Mattheck, C. (2007) *Updated Field Guide for Visual Tree Assessment*, Karlsruhe Research Centre, Karlsruhe.

Metro Trees (2010) Tree HandBook. Date viewed 27 September 2010
http://www.metrotrees.com.au/treehandbook/trees_listing.html

Newcastle City Council (2003), *Newcastle Local Environmental Plan, 2003*, NSW Government Gazette (8 August 2003).

Newcastle City Council (2007), *Newcastle Urban Forest Background Paper*, Newcastle City Council, Newcastle, NSW.

Newcastle City Council (Newcastle City Council) (2008), *Newcastle DCP 2005, Element 4.10, Tree Management*, Newcastle City Council, Newcastle, NSW.

Newcastle City Council (2008), *Newcastle Urban Forest Technical Manual, July 2008,* Newcastle City Council, Newcastle, NSW.

Simonsen, D. (2009), 'Aboricultural Statement – Quantified Tree Risk Assessment Fig trees in Laman Street, Cooks Hill – Newcastle', Treelogic Pty Ltd, Ringwood, Vic.

Swain, A. (2010a), 'Laman Street Figs, Cooks Hill Newcastle – Quantified Tree Risk Assessment & Review, March 2010', Arboreport – Vegetation Management Consultants, Carlingford, NSW.

Swain, A. (2010b), 'Laman Street Figs, Cooks Hill Newcastle – Quantified Tree Risk Assessment & Review, July 2010', Arboreport – Vegetation Management Consultants, Carlingford, NSW.

United States Environmental Protection Agency, *Heat Island Effect – Glossary*, http://www.epa.gov/heatisland/resources/glossary.html [date visited 30 August 2005]