RESEARCH IN LOCAL GOVERNMENT CONTEXT B 15624

Dissertation

Name: Steve Lawler

Student No: 11295983

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Abstract

The purpose of this research is to appraise and ascertain the value urban forests provide in respect to the triple bottom line, gain an understanding of industry best practice in managing trees in the public domain and clarify what industry practitioners would like to see included in a resource to assist them in effectively managing trees in the public domain.

The exploratory research was informed by the constructivist theory where a variety of qualitative interviews were conducted with 6 (six) Sydney Metropolitan Councils to inform the objective of the research.

The research recognised that Tree Management Officers perform their roles under significant stress and in most councils, are not adequately resourced to carry out their duties in a professional manner.

These stressors can be negated if councils adopt quality Tree management Policies and sufficiently resource staff to respond to public safety issues and the ageing tree canopy in a timely manner.

Contents

1. Introduction/ Overview

Trees play an important part in the development of the urban fabric. An established urban forest provides considerable economic, environmental and social benefit (triple bottom line) to the community (Brack 2001); (Wolf, 2004). Despite the acknowledgment that trees provide great value, there is still concern expressed by sections of the community that trees pose significant risk to public safety. This research is conducted on the assumption that councils in the greater Sydney metropolitan area have policies with regard to managing trees in the public domain but also that there may be disparity in council policies in terms of the commitment towards valuing the urban forest.

The purpose of this study is to appraise and ascertain the value urban forests provide in respect to the triple bottom line, gain an understanding of industry best practice in managing trees in the public domain and clarify what industry practitioners would like to see included as a resource to assist them in effectively managing trees in the public domain.

It is also anticipated that this research will provide information for the local government sector on what needs to be included in council policies, what value the community places on the urban forest, and what commitment is required of local government to resource the management of trees in the public domain. The research will also contribute to gaining greater insight into asset management systems as they pertain to the urban forest, recognising that, due to the dynamic nature of trees, it is imperative that local councils have appropriate management systems in place to ensure the risk to public safety is minimised.

1.1 Research Questions

To ensure clarity on the extent of the research, the following questions are the focus of this dissertation:

- In metropolitan Sydney, how do councils balance the benefits of urban trees against the potential risk of trees to public safety and infrastructure?
- What support do senior managers in local government need to provide to officers so they can confidently perform their duties?
- What would be the ideal scope, style, content and format of a resource that would assist tree management officers fulfil their role in a competent manner?

1.2 Ethics Approval

Prior to conducting the research, it was necessary to gain ethics approval from the University of Technology Ethics Committee. This involved formally applying to the Ethics Committee, explaining the purpose of the research, confirming the format and process of how the research will be conducted and finally identifying the benefits the research will provide to local government.

Until the ethics approval (Appendix 1) was granted, no contact was made with prospective local government areas in respect to their participation in the research. On receipt of the ethics approval, contact was made with six local government areas to seek in principle agreement to participate in the research.

Upon receipt of the ethics approval, the following information was given to potential council participants for dissemination and response to participate in this research project:

- the standard information sheet
- a copy of the ethics approval
- a consent form including acknowledgement
- a copy of the proposed questionnaire including an overview.

2. Context of this Study

Local governments in Australia operates under State based legislative frameworks where size and population density varies greatly between and within each State. As of 2012, there were approximately 556 local governments nationally and due to the recent amalgamations on the 12 May 2016 there are currently 129 local councils in New South Wales (Local Government NSW 2016).

Sydney is the largest capital city by population within Australia, with over 5 million residents and a projected increase of 100,500 people per annum till 2031 (NSW Planning & Environment 2016).

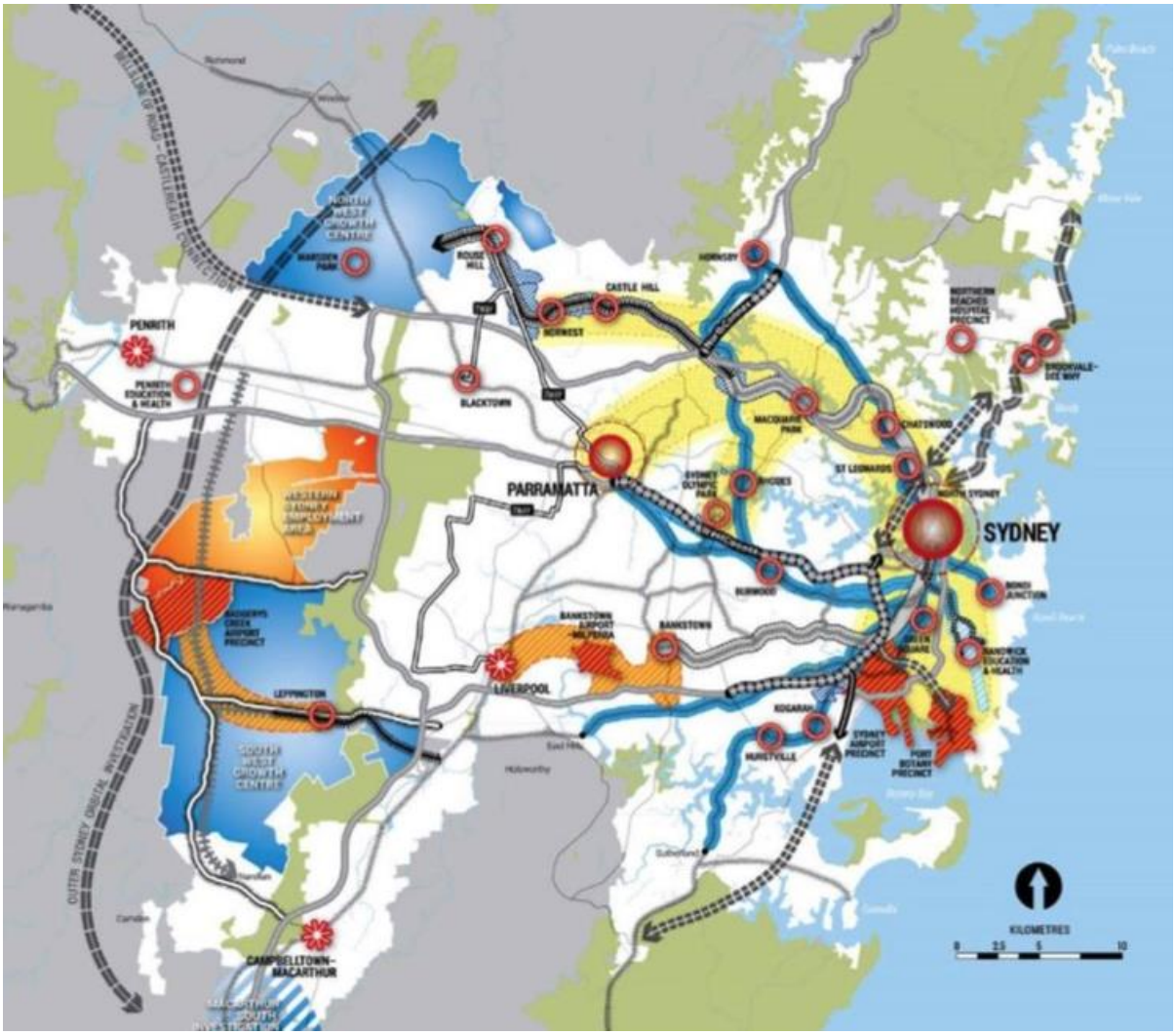
Metropolitan Sydney (MS) is classified as Greater Sydney (Greater Capital Statistical Area) by the Australian Bureau of statistics (ABS). The area extends from Wyong in the north to the Royal National Park in the south and the coastline provides the eastern boundary. To the west the local government areas of Wollondilly, Hawkesbury and the Blue Mountains bound the area.

With a land area of 12,397 square kilometres the population density of MS is 404.30 people per square kilometre or 4.03 people per hectare. The low population density of the MS area is significantly lower than the local government areas that form the basis of this research due to the MS area including large areas of undeveloped land in the outer suburbs.

The area of study focuses on local government areas that are within 40 kilometres of the Sydney Central Business District that have population densities ranging from 7.10 to 50.56 per hectare (table 2). This is in stark contrast to the council of the City of Sydney that is covered by 69% hard surfaces and 13% grass-bare surface. Currently, tree canopy density across New South Wales ranges from a high of 59% at the former Pittwater Council, now part of Northern Beaches Council and a low of 12% in Botany Council (Institute for Sustainable Futures (ISF) 2014).

In terms of the density of the urban forest, research by the ISF (2014) ranked Sydney as sixth amongst Australia's capital cities, with a tree canopy density of 15%. Hobart has the most dense tree canopy at 59% with Melbourne being the sparsest capital city with 13% tree canopy density, slightly less than Sydney.

Below is a map of the Greater Sydney area, which provides the reader a visual understanding of the total area of MS plus highlights where within MS the Sydney CBD is located.



Map 1 of Greater Sydney

(Source: Department of Planning & Environment)

As land managers, local government has both a moral and legal obligation to effectively manage trees in the public domain (*Local Government Act 1993*). Councils are able to effectively manage trees on community land through the implementation of Plans of Management, which with the support of the community, guide the use and protection of reserves and bushland in local government areas.

It is the intention of this study to provide information that will assist decision makers to formulate good policy, discuss how potential risks to the public and infrastructure can be more effectively managed, the benefits that trees in urban areas provide, what value that is placed on the urban forest by the community and what Tree Management Officers (TMOs) would like to see included in a best practice guidelines.

3. Literature Review

3.1 Rationale, objectives and methodology

This chapter discusses the literature review performed by the author in June 2016 relating to the subject area of urban tree management. Please refer to Appendix 2, the Table of Evidence, which summarises the objectives of the reviewed studies, their methodologies and their findings. The objective of the literature review was to identify the focus and gaps in the current literature and provide a theoretical basis for analysing the current practices and stakeholder coordination efforts of local governments in relation to tree management. The following questions guided the literature review:

- What are the key understandings in the current literature of local government and its role with regard to the environment?
- How does the literature conceptualise the governance and management of trees in the public domain, especially the balancing of benefits and risks?
- What methodologies have researchers adopted to study the management of trees in the public domain, and what evidence has been generated through this body of work?

The objective of the literature review was to support the qualitative data collected through interviewing six metropolitan TMOs on how they manage trees in the public domain plus what they would like to see included in an industry best practice guide.

The literature review included the analysis of available documentation eleven council's websites as well as peer-reviewed journals. The scholarly literature described the key concepts, conceptual frameworks and related theories, including research carried out on similar issues, policies and council documentation which included current tree management policies, master plans and guidelines.

For the scholarly review, Google Scholar, Pro Quest and Sage were the main search engines extensively interrogated using a very broad range of headings. These included the public benefits of tree and risk in the public domain, the value of the urban forest, environmental benefits of trees, what problems do trees cause in public areas and the health benefits of trees. When conducting the search for relevant documents, I scanned the abstract and in some instance the introduction to ascertain if the document had any relevance. For council policy and documentation, the websites of eleven councils were randomly selected and critiqued to gain an understanding on what policies and documentation council's possess. The literature review predominately used only research post 2000 documents for trees, except where limited data was available as it was considered research that was pre 2000 might now be out-dated.

To gain a thorough understanding of the body of knowledge of trees in the public domain, a table of evidence was created (refer to Appendix 2) which highlights the objectives and various methodologies researchers used to generate evidence on trees in the public domain. The table of evidence clearly summarises the findings of the researchers. On interrogating the table of evidence, it became obvious that there were, on the whole, similar findings for the researchers on the various topics.

At the same time, the methodologies of the studies varied greatly. These included qualitative interviews, random surveys, and the establishment of educational workshops where the participants participated in a survey that determined there level of knowledge and then how the responses were interpreted on public risk (Koeser et al. 2015); Davison & Kirkpatrick (2013); and Ellison (2005). In another study, Kuo, Bacaicoa & Sullivan (1998), three focus groups were

formed to gain an understanding on the views of residents who live in a high-rise tower adjacent to an area that was being considered for tree panting.

To gain a clear understanding on the effect trees have on property prices a number of researchers have used the Hedonic model to demonstrate the positive effect trees had on property prices in the adjoining area on adjoining properties (Donovan & Burry 2010); (Pandit 2012); (Jones, Davis & Bradford 2012). Kirkpatrick, Davison & Daniels (2012) used a survey questionnaire that subsequently grouped the respondents into seven categories, to gain an understanding of how the public attitudes to trees and replanting programs.

The majority of documents were sourced from peer-reviewed journals, websites, search engines, council documentation, government policies and manuals on urban tree management. This information was then processed into the following sub-sections:

- Importance of the Urban Tree Canopy
- Public Risk and Community perceptions
- Role of Local Government in Tree Management
- Management and Assessment of Urban trees
- Policies and Best Practice Guides

Insights from the literature are presented and analysed on the basis of these categories.

3.2 Importance of the Urban Tree Canopy

This section draws on the current literature to examine understandings of the benefits of urban forests in the public domain and the importance of having tree canopy's in urban areas. Researchers have used a variety of means to gauge the value of tress in the urban landscape, for example, Maco & McPherson (2003) used the combination of a rapid sampling technique together with previously published data to analyse street populations in small communities. Alternatively, Zhang (2007) conducted a state wide telephone survey, with 36% take up rate to determine the public attitude of street trees. Livesley, Baudinette & Glover (2013) conducted onsite evidence based research for a period of 5 months to gain understanding on how different tree species can reduce stormwater runoff whereas Pramova (2012) performed a scientific literature review to determine the role ecosystems can play in helping people adapt to climate change.

McPherson & Muchnick (2005) utilised data from Modesto's street tree inventory, geographic and information system and street services records plus the taking of asphalt core samples to determine the extent of weathering taken place in shaded compared to non-shaded areas. Alternatively, Mullaney, Lucke & Truemen (2014) reviewed literature spanning over 30 years to better understand what factors can improve the survival rates of trees in the urban environment. Wolf (2004) utilised economic valuation tools to determine the value of the urban forest and green space.

The overriding conclusion from the available studies (see Appendix 2) is that trees contribute positively to the urban environment in ways ranging from the tangible to benefits that are harder to quantify. Key insights are provided in Table 1 below.

Table 1 Importance of the Urban Tree Canopy

Positive Impacts	Key Points	Literature source
Economic	Increased economic return for local businesses, greater productivity and a sense of wellbeing for employees, reduction in energy costs, improved air quality, positive effect on house prices	Brack (2001) Wolf (2004) Donovan & Butry (2010) Pandit (2012) Jones, Davis & Bradford (2012)
Cultural and historical	Role in the framing community impressions of towns and cities, defining the identity of cities through the planting of themed avenue plantings	Olsen (2006) City of Burnside (2014)
Social and aesthetics	Increased usage of footpaths and public spaces, positively correlated with social capital and a feeling of peace, opportunity for citizens to discover more about the interactions between social and biophysical systems	Holtan, Dieterlen & Sullivan (2015) Jones, Davis & Bradford (2012)
Environmental values	Reduction in ambit temperature of public areas, removal of air pollution particulates, the storage and sequestration of carbon, reduced energy use due to the natural shading effect of trees, reduction in water runoff, contribution to ecological diversity	Pramova (2012) Nowak (2000) Brack (2002) Donovan & Butry (2009)
Health	Reduction in stress, and inducement of behavioural changes that improve mood and general wellbeing, enhanced patient rehabilitation, psychological wellbeing of children	Velarde et al. (2007) Raanas et al. (2011) Chawla (2015)

In summary the urban forest delivers a broad range of benefits to the local community and the environment. The majority of researchers identified the benefits of the urban forest but Roy, et al. (2012) demonstrated that the urban forest can also have negative effect on local communities with the reduction in solar access, the production carbon pollution caused through poor tree management practices, leaf and branch drop.

3.3 Public Risk and Community Perceptions

This section discusses the complications of managing public perceptions, risk and mitigation measures. The table below summarises the insights from the literature.

Table 2

Issues/ impacts	Key points	Literature
Public perception	Community perception that trees are potentially dangerous, severe weather events more frequent, demise in tree canopy,	Slovic (1986) Howden & Olding, (2014) United States EPA (2016) Davison & Kirkpatrick (2013)
Public risk	Physical characteristics of trees pose a potential risk to public safety	Statewide (2013)
Risk minimisation strategies	Quantified risk assessments to remove subjectivity, frangible tree species, professional development of the arboriculture industry, use of wire slings	Ellison (2005) Davison & Kirkpatrick (2013) Rust (2014)

Despite the known benefits of the urban forest unfortunately due to the greater regularity of severe storm events the community now has a heighten level of concern that trees now pose a greater risk to their safety.

3.4 The Role of Local Government in Tree Management

Local Government is the closest tier of government to the local community and is responsible for good governance and the care of local communities and their environment. The protection of trees at a local level is achieved through the Local Environmental Plan and Development Control Plan that prescribe what works require development consent and which tree species are exempt from development consent. The table below summarises the insights from the literature.

Table 3

Issue	Key points	Literature source
Responsibility	Councils have a legal and moral obligation to mange its assets to a standard that will not cause injury to the public, management of trees on private and public property	*Local Government Act 1993*
Protection of trees	Trees are protected through the councils' Local Environmental Plan and Development Control Plans	Council websites
Tree removal	Council is the consent authority, trees can be removed without consent if they are a risk to public safety	*Environmental Planning and Assessment Act 1979*

The above table summarises the local governments responsibility as a good corporate citizen and how the urban forest is protected through legislation.

3.5 Management and Assessment of Urban Trees

This section links closely with the purpose of this study, which is to understand the value of trees and identify industry best practice in managing trees in the pubic domain.
The table below summarises the insights from the literature on how local government manages trees in the public domain and the minimum qualifications required by staff to make informed decisions on whether a tree is a risk to public safety and or infrastructure.

Table 4

Issue	Key points	Literature source
Qualifications to perform a visual tree assessment (VTA)	Tree assessor should possess a minimum qualification of Cert 3 in arboriculture	New South Wales Technical and Further Education (2016)
Stages of visual tree assessments	Stage 1 is a visual assessment looking for tree defects, fungal fruiting bodies, local environment, stage 2 involves drilling into the trunk and checking resistance	(Mattheck & Breloer (1994)
Management initiatives	More regular inspection in high risk areas, acknowledging that trees have a reduced life spans in areas where services/ infrastructure is within the root zone	Ellison (2005) Mullaney, Lucke & Trueman (2014)
Value of urban trees	No industry accepted method, two methods are used by the industry to value trees, Burnley and Thyer methods	Moore (1999)

Box 1: Burnley Method

In the Burnley method, it was intended that by multiplying the size and value components together a basic tree value would be established, which would then be modified to allow for the peculiarities of the tree and its location. The modifiers to be used were:

1. Tree Size (V): With large trees, the values determined by the formula were unrealistically high. Accordingly, a modifier was developed to reduce the value.
2. Useful Life Expectancy (E): This modifier took into account the projected useful life expectancy of the specimen.
3. Form and Vigour (FV): This factor was used to assess the form and vigour of the tree .
4. Location (L): This modifier was used to assess the tree's suitability for its particular location.

The modifier tables were used to minimise the risk of significant discrepancies in tree values made for the same tree by different arborists. The value of an amenity tree was then determined using the formula:

VALUE ($) = TREE VOLUME x BASE VALUE x (E) x (V) x (FV) x (L) (Moore 1998).

Box 2: Thyer Method

The Thyer method uses a single formula with measures or scores being assigned to the following nine factors:

P = Planting cost of 200 litre NATSPEC grown tree in the City, with re-used paving
S = Size of plant specified by the City for new planting in the location (200 litre or 75 litre soil volume)

A = Age of the tree since planting

D = Diameter of the tree trunk

C = Condition of the tree (Tree health)

L =Life expectancy of the tree (Useful remaining life)

V =Visibility of the tree from public areas
H = Heritage status of the tree
O = Ownership of land where the tree is growing.

The tree valuation formula:

Tree Value = $ P/6 x S x [{(A + 6)/3}+4] x [D/(42x2)+0.5] x C x L/30 x V x H x O (City of Sydney 2003).

In both these methods it should be noted that there are supporting tables to assist in the calculations.

3.6 Policies

The protection of trees and vegetation through legislation varies considerably between the different States and Territories. What they do share in common is that the Acts and Regulations that are promulgated by the various state and territory parliaments and thus they therefore have a legal status.

The highest level of protection for trees is within National Parks where human interference is strongly discouraged and removal of plant material is prohibited. Cascading down, the protection of Indigenous plant species may also receive additional protection through *s266B* of the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* when considered threatened, endangered or vulnerable. In New South Wales, trees are further protected by the *National Parks and Wildlife Act 1974,* the *Threatened Species Conservation Act 1995, Native Vegetation Act 2003, the Environmental Planning and Assessment Act 1979, Heritage Act 1977* and the *Trees (Disputes between Neighbours) Amendment Act. At* a local level, trees are protected through the Local Environmental Plan and Development Control Plan. Also, council may have a significant tree register, heritage register and or a register of indigenous trees.

On council owned land, council is the consent authority. If a tree is determined to be unsafe following a VTA, council can remove it without further justification. If the proposed tree removal is to enable the installation of utilities or infrastructure at minimum a Part 5 Impact Assessment should be carried out in accordance with the *Environmental, Planning and Assessment Act, 1979* to determine the environmental impacts.

Whilst performing my literature review, it became evident that the detail of tree management policies and or guidelines in local government varied greatly, with some councils producing quite extensive documents whilst available information on their websites for other councils was minimal. Reviewing a number of council websites it became apparent that some have comprehensive tree management policies, which are supported by street tree masterplans (see e.g. Woollahra Council, 2014; City of Sydney, 2013). Quality tree management policies were clear in their intent, focused on community consultation where works would be considered to be significant and contained procedures for when public trees have been poisoned or damaged. They also assist in dealing with issues such as solar access, pruning for views from private properties and council requirements for damage to private property infrastructure. Councils who have acknowledged that they have a aging tree canopy have adopted street tree masterplans to ensure that tree replacement programs can be implemented

City of Sydney and Brisbane City Council provided detailed documents on their webpage on how trees are to be managed on public property, with the City of Sydney also providing information on managing trees on private property. Other councils, such as Auckland Council (2012) and Warringah Council (2014), provide limited information and Pittwater Council has yet to adopt a policy on tree management in the public domain. It should be noted that since the initial literature research was carried out there has been a number of amalgamations throughout New South Wales, of which included the amalgamating of Pittwater, Warringah and Manly Councils into one Northern Beaches Council.

3.7 Best Practice Guidelines

Currently, other than the Statewide Best Practice Manual, (2013), which is used by all the surveyed councils, there is no industry best practice guide available for TMOs. The Statewide Best Practice Manual (2013) is a comprehensive document with part one discussing the community value and the benefits of urban forest, describing that trees are a living structure, discussing recent legal decisions and the interaction between trees and physical structures.

Part two of the manual examines risk definitions and strategies to mitigate risk, tree management policies, and appropriate tree selection and placement.

There are various pieces of literature on the protection of trees and where and how they could have a greater chance of survival but nothing that can be used as a best practice manual. It became evident in this review that some councils have adopted quality tree management policies, tree planting strategies and technical manuals, these include Burwood Council (2013), Randwick City Council (2013) and Woollahra Council (2011).

3.8 Conclusion and Implications for the Study

The literature review established a theoretical framework for further research on the management of trees in the public domain, allowing the researcher to gain valuable background knowledge of urban trees. This section has provided an analysis of current literature, identifying the current state of evidence and the gaps in knowledge, suggesting further research. Trees in the public domain have been intensively researched over many years on their benefits, the perceived risk, how they impact on the streetscape and how they can be planted to increase their survival rate and reduce their impact on utilities and infrastructure.

The literature review has identified that researchers have utilised a broad suite of methodologies (see Appendix 2) to fully understand the benefits, risks and issues that can be attributed to trees in the public domain. The interrogation of the available literature has confirmed that there is no best practice guide currently available for TMOs on how to manage trees in the public domain.

This section draws on the findings from the literature review to respond to questions put forward in section 2 of this report.

What are the benefits that trees provide to the community?
The literature has highlighted that trees provide significant economic, environmental and social benefits. These range from the financial savings that householders enjoy through the reduction in energy costs for heating and cooling, increased property values and stimulation of the local business.
Environmentally, trees provide shade, wind breaks, reduce stormwater runoff, improve air quality, provide habitat for flora and fauna as well as storing and sequent carbon. The social benefits of trees include giving an area a sense of place and local identity, encouraging outdoor activity, improved physical, emotional and psychological wellbeing, providing safer walking environments and reducing urban traffic speeds.

What is the real risk of trees in the public domain?
The literature review has confirmed that the perceived risk of trees varies greatly depending on the knowledge of the person involved. The informed community, who understand the benefits of trees are more likely to accept a greater risk than members of the public who do not see the value of trees. With the continued up skilling of TMOs, it has become apparent that they are now willing to assume a perceived greater risk than in the past.

How can council policies provide the basis for the development of a tree management policy that ensures the longevity of urban forest?
The review has demonstrated that tree management policies and supporting documents vary greatly between councils. It is imperative that councils who do not possess quality policies focus immediately on producing quality documents and policies that will provide TMOs the resources to preserve and maintain the exiting urban forest. The literature review has also identified that there is still no guiding document to support TMOs when carrying out their duties

where customers may become very emotive. It was anticipated that on completion of the qualitative survey with the 6 TMOs, there will be sufficient data available to develop a best practice guide for TMOs.

4. Research Design and Methodology

Research was conducted with six Sydney metropolitan councils to gain an understanding of how they manage the trees in the respective public domains of their local government areas (LGAs). To ensure that the survey was reflective of the management practices across the Sydney metropolitan area it was decided to survey Councils with varying tree canopy densities, based on data from the document produced by (ISF 2014).

- two councils have a canopy density cover of over 50%
- two councils are within the mid-range with a cover between 20 and 39.9%
- two councils have a canopy cover of between 10 and 10.9%.

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These percentages were derived from the ISF 202020 Vision document, which assessed local government areas total canopy cover. The research did not separate public from private property. Hence, the public canopy cover in these local government areas was assumed that any variance between public and private property would be reasonably consistent across all the participating local government areas.

The range in canopy cover has been chosen to ensure a broad spectrum of responses were analysed as part of the study. If there was a focus only on councils with similar canopy covers, the results would not display a true reflection of how urban tree management was performed in metropolitan Sydney.

Two of the councils that were selected for the study are adjoining and have distinctly different tree canopies and are subsequently in the process of merging. Once the merger takes place the percentage of tree canopy density would change significantly. The smaller of the planned amalgamated councils has a significantly greater tree canopy density but once merged due to the overall size of the adjoining council the tree canopy density will subsequently decrease.

Table 4.1 below highlights that the two Councils' with lowest population density/hectare also have the greatest tree canopy density with over 50%.

Conversely, the local government area with second highest population density/hectare still maintains a high tree canopy density of 30-39.9%, highlighting that even in densely populated areas that if there is a desire by the community and council to protect the tree canopy it is possible.

Table 4.1 Comparison of tree canopy density to population and area

Local Gov't Area	**Pittwater**	**Burwood**	**Randwick**	**Rockdale**	**Ku-ring-gai**	**Woollahra**
Tree Canopy Density (%)	50+	20-29.9	10-19.9	10-19.9	50+	30-39.9
Population	64,189	36,139	145,822	115,376	122,859	59,307
Population Density /Hectare	7.10	50.56	40.13	40.86	14.38	48.30

(Source: Forecast id)

4.1 Research Approach

The focus of this study suggests an exploratory research approach is ideal for answering the 'what', 'why' and 'how' questions. Barker et al. (2002) argues that exploratory research is needed when there is little known in a particular research area and when existing research is confusing and contradictory. This has become evident in the preliminary stages of research on this topic, with limited information on the management of urban trees in local government.

The exploratory research was informed by the constructivist theory where a variety of techniques were used to fully inform the objective of the research (WNET Education 2016). 'The constructivist researcher is most likely to rely on qualitative data collection methods and analysis (Mackenzie and Knipe, 2006, pp. 196)'. A constructivist methodology provides context and opportunities for rich description (Moffatt, 2009). Furthermore, it facilitates dialogue between researchers and subjects who construct reality together (e.g. interviewing, observation, text analysis) (Creswell, 2003, p.8). This constructivist approach will be successfully used in this study by adopting semi structured interviews and document review.

4.2 Research Questions

Three research questions were used to keep the research focussed:

1. In metropolitan Sydney, how do councils balance the benefits of urban trees against the potential risk of trees to public safety and infrastructure?
2. What support do senior managers in local government need to provide to officers so they can confidently perform their duties?
3. What would be the ideal scope, style, content and format of a resource that would assist tree management officers fulfil their role in a competent manner?

4.3 Methods of Data Gathering

Two qualitative research methods were used to collect data: semi structured interviews and a supporting literature review which analysed peer reviewed journals plus content analysis of council documentation available on their websites.

Document review is a proven data-gathering tool that has been important in formulating this dissertation. 'Documents of all types can help the researcher uncover meaning, develop understanding, and discover insights relevant to the research problem (Bowen 2009 pp29)'. Darke, Shanks and Broadbent (1998) warn that documents must be used carefully and should not be accepted as literal recordings of events that have taken place. Furthermore they insist that it is essential to corroborate and augment evidence from other sources to ensure the validity of a document. The results of the data collected through the documentation review of local councils and the literature review has helped develop an information basis to answer the aims of the research.

Initial contact was made with the proposed councils to confirm their willingness to participate in the survey prior to formally sending through the ethics standard project sheet, ethics approval, consent form and the survey questionnaire (Appendix 1)

A follow up phone call was made to personally thank the participants for committing to the survey and giving the respondents the opportunity to seek clarification on any questions. It was requested that the respondents fill in the word document prior to setting up a time to discuss the questions. This allowed the TMOs to start populating their responses when time permitted and consult colleagues for information that is outside their field of expertise prior to the formal

catch up. Unfortunately, due to work commitments, some respondents were delayed and thus the proposed timeline was put back by four weeks.

The interview guide was pretested with two Tree Management Officers from the former Pittwater Council before being provided to participants from other councils. This was to ensure the questions were relevant, logical and understandable for recipients so they would not be disengaged from participating in the study. It also provided the author with a good estimate of time it would take to complete the interview. This estimate was discussed with the prospective participants at the initial phone call and confirmed in the information sheet.

The use of a semi-structured interview allowed the interviewer to explore themes that emerge throughout the interview. Douglas, Hilson and Van Note Chism (2008) declared that this type of interview is suitable for qualitative research as it allows certain key elements to be covered, but also allows flexibility. Darke, Shanks and Broadbent (1998 p 92) agree that interviews can be a shortcut to prior history of the situation and help identify other relevant sources of information.

The responses from the six councils and relevant data from the literature review were processed into a qualitative findings matrix so any developing themes could more easily be interpreted (see Appendix 2). The questions in the interview guide (see Appendix 1) have been grouped into themes, allowing councils to respond to sections that pertain only to their Council. For example some Councils may only have a policy on how trees are managed in the public domain but do not have an asset management system.

The questions were designed so that the researcher can gain a clear understanding of how councils deal with the complexity of tree management in the public domain, no matter what the tree canopy density is for their local government area. The order of questions was planned quite deliberately, with the initial questions focussing on the council itself in respect to policy and what value the council and community place on trees. The next group of questions are designed to gain an understanding how councils manage risk, followed by questions on how they are resourcing staff to minimise risk. The final questions explored what type of asset systems they use to manage the tree canopy and what TMOs would like to see included in a best practice guide.

One limitation of the interview as a research method is that the data obtained does not necessarily portray the views of the broader community. This means that the data collected from the interview is highly selective and subjective. Another limitation is that the researcher can influence the answers of the interview participant. Seale (1999) suggests that the interviewer should aim to eliminate any influence they may have on the interviewee to encourage reliable results. Preparation and the transcription of verbal data are also seen as a common issue in qualitative interviews. Transcripts of the interview provided the opportunity to reinterpret and check the research leading to valid and reliable results. There was also the potential limitation of participants deciding not to participate. Thankfully all the participants responded. If this did not occur the sample size of the research would have been significantly reduced leading to insufficient data to formulate results for the study. If this did occur, to mitigate this, the researcher would have needed to approach other councils of similar tree canopy cover to replace the non-participant and therefore ensure reliable results.

The second research data gathering method involved document review, which included the analysis of councils' available documentation as well as any information from websites, peer reviewed journals and the literature review. "Documents of all types can help the researcher uncover meaning, develop understanding, and discover insights relevant to the research problem" (Bowen, 2009 pp29). This was completed prior to the interviews to provide a base understanding and so the interviews can build on the prior knowledge thus obtained. Darke, Shanks and Broadbent (1998) warn that documents must be used carefully and should not be accepted as literal recordings of events that have taken place. Furthermore they insist that it is

essential to corroborate and augment evidence from other sources to ensure the validity of a document. The results of the data collected through the comparative analysis, the documentation review of local councils and the literature review formed the basis of information to answer the aims of the research. All information provided by the research participants will be recorded and presented in a manner that ensures participant confidentiality is maintained.

4.4 Approach to Sampling

Pre-scripted open-ended questions were provided to TMOs in six Sydney metropolitan councils, two with a canopy cover of over 50%, two with a cover between 20 and 39.9% and two with a canopy cover of between 10 and 10.9% (ISF 2014). These percentages, derived from the ISF 202020 Vision document, which assess local government areas canopy cover as a total area. However they do not separate public from private property. Hence, the public canopy cover in these local government areas can be reasonably assumed to be consistent with the percentage values given above. The range in canopy cover has been chosen to give a broader spectrum of responses for the study. If the focus was on councils with similar canopy covers, the results would not display a true reflection of urban tree management in Metropolitan Sydney. By selecting three different categories, this study successfully portrays the varying densities of trees in the public domain and their associated issues. As noted above, the pre-scripted questions, found in Appendix 1, have been grouped into sub headings so that the responses can build on the information already collected from the analysis of web sites and the literature review.

Documents reviewed included sources of information from council policies and tree planting masterplans. These documents provided the most useful information for this study as they give an insight into the position of council's commitments and management plans of trees in the public domain. Documents created in recent years (last 5 years) will be targeted, as they provide the most current data on tree management to analyse in the public domain.

Interview participants will all be TMOs, who are employed by local governments specifically to address tree management issues within their local government areas, and who can be assumed to have a good understanding of the issues, policies and management of trees in public land.

4.5 Strategy Used to Analyse the Data

The researcher used multi-methods of data gathering to produce qualitative data for analysis. Therefore qualitative analysis is suitable for this study.

A thematic analysis is a method for identifying, analysing, and reporting patterns (themes) within the research data (Braun, 2006). There are several phases of the thematic analysis for processing qualitative research. The first step was to familiarise myself with the data collected by reading through all research, with meanings and patterns in mind. For the interview data, transcription of the interview into written form was essential for conducting a thematic analysis. The next phase was to identify interesting features of the data that could potentially form themes for the data set. This may take the form of extracts from interviews, or interesting sentences from the document review. In this stage, potential useful secondary data from documents was targeted with themes in mind. This ensured time was used efficiently and the review of documents produced relevant information.

Data from the open-ended questions was sorted into potential themes by collating the relevant extracts of the research data. The use of sub headings in preliminary stages of analysis was helpful and the qualitative findings matrix helped to classify some of this information. The next phase involved reviewing the initial themes. In the reviewing of the themes, attention was paid

to what Braun (2006) has described as the need to have a clear and identifiable distinction between themes, i.e. to be parsimonious, to avoid overlaps and to ensure that all data is categorised. Analysis of each theme was completed to ensure the data contained within each theme forms a coherent pattern. In those cases where coherence was not achievable, the extract was either removed entirely or formed a new theme. At completion of this phase, the researcher had a good idea of the different themes to be used, how they relate to each other and the importance of each theme to the aims of the study.

The next phase involved defining the themes by naming them. For each theme, it was essential to write a detailed analysis of how they fit into the overall 'story' of the collected data, in relation to your research questions (Braun, 2006). If you cannot do this, then further refinement of the theme is needed. The final phase was the production of the report. The analysis is a concise and coherent account of the data collected through the themes. The use of an analytic narrative with extracts of interesting data from interviews will help capture the story of the data and compliment the argument being made in relation to the research questions.

Once the data were synthesised into themes, the study's findings were compared and contrasted with published literature on the topic. This helped to identify whether the research data was valid and reliable, provided useful insights into the meaning of the data gathered, and ensured that this study could be put forward as a contribution to the knowledge base.

5. Presentation and Analysis of Findings

This chapter presents and analyses the findings from the study on the basis of six core themes:

- Importance of urban trees;
- The role of local government in tree management;
- Management and assessment of urban trees;
- Public risk and community perceptions;
- Policies; and
- Best practice guidelines.

5.1 Importance of the Urban Tree Canopy

5.1.1 Insight from literature review

Research has highlighted that businesses in areas with established tree canopies are more likely to make a more positive economic return on investment than those in areas without a tree canopy. Maco & McPherson (2003) identified through the combination of a rapid sampling technique plus the analysis of published data that there is a return to the community of $3.76 for every $1.00 spent maintaining trees in the public domain. Studies by Wolf (2004) suggest that consumers are also willing to pay an extra 9-12% for products in shopping areas with trees.

Research by Maco & McPherson (2003) concluded that street trees in the City of Davis, California, United States of America, provided tangible benefits to the community of over 1 .7 million dollars in 1999/2000.

The interrogation of council websites suggests that the perception of the surveyed TMOs may be underestimating the value placed by the community on the urban forest. Zhang, et al. (2007) supports this view with the results from a state wide telephone survey in Alabama, United States of America, concluding that 90% of citizens appreciate urban trees and take into consideration when choosing their residential location and community. The majority of residents also supported tree lopping but insisted on controls for builders and developers so the urban forest was not reduced.

Also, there is noticeable reduction in energy costs and a positive increase in the value of houses of up to 9% where tree canopies exist adjacent to residential properties (Jones, Davis & Bradford 2012). Donovan & Butry (2010) established that street trees in Portland Oregon in the United States of America has had a positive impact on property prices where house prices rose on average $8,870 and the time on the market was reduced by 1.7 days. The positive value street trees give to property prices was further reinforced by the research performed by Pandit, et al. (2012) who found that houses within the suburbs of Perth, Australia, the median property prices increased by $16,889 due to the presence of broad leafed trees.

The use of public facilities such as footpaths and outdoor meeting areas with established tree canopies are more intensively used and have created a sense of place as opposed to areas that are barren of trees (Holten, Dieterlen and Sullivan 2015). A case study by Brack (2001) confirmed that trees add significant value to the aesthetic and landscape quantities.). Another benefit that street trees provide is the increased the life cycle of road pavements through their ability to provide shade thus generating savings in asset maintenance (McPherson& Muchnick 2005).

Trees have also demonstrated that they can reduce the ambit temperature by up to 2 degrees in public areas and making them more inviting as a place for recreation (Pramova, et al. 2012).

As well as reducing the ambit air temperature, research has identified that street trees have a positive impact on the surrounding air quality and play an active role in the storage and sequestration of carbon plus the interception of rainfall and limit the need for stormwater drainage (Nowak 2000); (Zhang,et al.2007). Research by Brack (2001) found that the urban forest in Canberra, Australia reduced energy consumption and pollution amelioration to the value of US $ 66- 227 per resident between 2008 and 2012.

The findings of research by Pramova, et al. (2012) was that urban trees have the ability to regulate water usage in resilient cities. This conclusion is supported by Mullaney, et al. (2014) where it was concluded that the summer rainfall is 62% greater on asphalt than in areas with established trees. It is also estimated that stormwater run-off ranges from 3.2 kilolitres to 11.3 kilolitres per tree.

There is considerable research into the health benefits provided by the presence of urban trees in communities. Areas with established gardens where patients can visit or at least view have improved the recovery times for patients that have been required to undergo major surgery (Raanas, et al 2011). Research has also identified natural areas of having a positive impact on the psychological wellbeing of children (Kreutz (2015). Research by Wolf (2004) has highlighted that employees with a view to the urban forest are more productive, take fewer sick days and have greater job satisfaction.

5.1.2 Insight from interviews

The majority of TMOs surveyed believed their community would place mid range value on the protection of trees in the public domain. Only the TMO from Pittosporum Council believed that their community are highly protective of the urban forest. Curiously, this is a view from a council that does not have a tree management policy but is still able to maintain a tree density canopy rating of over 50%.

The TMO from Rhodamnia Council commented that there is a group of residents that immediately contact council as soon as they hear chainsaws start up and expect council to investigate immediately to ensure there is no illegal tree works being carried out. The TMO from Westringia Council believes that there are sections of his community that are very passionate about protecting the urban forest. This view is supported through a number of councillors being elected at the last council election on the platform that they would protect a group of park trees.

Alternatively, the TMO from Rhodamnia Council is of the view that there is a large portion of the community who would be very happy if there were no trees in the vicinity of their properties.

5.1.3 Drawing out main findings

Figure 1 below summarises the main benefits that urban trees provide.

The benefits of trees include but are not limited to, shade, reducing the urban heat effect, reduced exposure to the sun, providing a greater connection to nature, creation of safer walking environments, reduction of energy costs, increased property values, increased lifespan of some assets, reduce the amount of drainage infrastructure required, decrease health costs, attract visitors, enhance business.

Trees also soften and screen unsightly street infrastructure, store and sequest carbon, contribute to ecological biodiversity, recharge groundwater and reduce air pollution and the concentration of airborne particulates.

With Sydney's population expected to reach five million during 2016, greater pressure will be placed on the urban forest and specifically local government to ensure the urban forest is maintained (Colebatch 2016). Pickett (2001) insists that with proper ecological management, cities such as Sydney can provide a healthy and resilient environment for people to live in.

There is broad consensus that the community highly value the urban tree canopy. This is strongly supported through the viewing of council documents such as the Pittwater Council Public Space and Recreation Strategy and Randwick City Council Local Environmental Plan, Pittwater Council (2014), Randwick City Council (2012).

The research by Kuo, Bacaicoa & Sulivan (1998) identified that if the community were involved in the planning stage of tree planting the survival rate is increased.

It was refreshing to note that, despite all the surveyed councils being within the Sydney metropolitan area, they all had areas within their LGAs where endemic trees or trees of cultural value still exist. The existence of endemic or cultural trees in local government areas reinforces the view that areas with high population density does not restrict the ability of local councils to maintain a dense tree canopy as demonstrated in (table 4.1). Research by Jones, Davis & Bradford (2012) identified that people with pro-environmental views are more supportive of the establishment of trees in their local area and would be more supportive of local governments adopting policies that protect the urban forest.

5.2 Public Risk and Community Perceptions

5.2.1 Insights from the literature

The research of Davison & Kirkpatrick (2013) attributes that the noticeable decline in the tree canopy density is due to the community perception that trees are a risk to public safety thus placing pressure on TMOs to take a cautious view when assessing the integrity of a tree. Research by Kirkpatrick, Davison & Daniels (2012) put forward the theory that community attitudes towards trees were strongly influenced by gender, income and education.

An example of how the public perception of how trees are now posing a greater risk to the community is the article by Howden & Olding (2014), which highlighted the unfortunate death of a child from a falling tree branch whilst playing in the school playground. Even the Statewide Best Practice Manual (2013) identifies that trees due to their physical characteristics, continuously pose a potential risk to public safety, property and infrastructure.

Ellison (2005) suggested that the subjectivity should be removed from the risk assessment by evaluating the general nature of tree populations and the range of targets in the event of failure. An example of how the subjectivity can better be managed is to have bi-annual inspections of aging trees in high traffic areas. This view was supported Koeser, et al. (2015) who put forward the theory that tree risk assessments should be a multi staged process that requires careful consideration of the target, tree and site factors.

Recent research by Davison & Kirkpatrick (2013) has also concluded that with the continued skill development of the arboriculture industry there is greater opportunity for the public and trees to cohabitate in an effort to retain the urban canopy.

5.2.2 Insights from the interviews

The majority of the surveyed councils do have a generic policy to manage risk, not a stand-alone policy relating purely to trees. The belief amongst the TMOs was that if one existed it would be very helpful, especially when dealing with difficult customers and when making subjective assessments on the integrity of a tree.
The views of TMOs were not consistent on whether the risk factor is now dominating management practices compared to five years ago. The majority of Tree Management Officers believe that the community now has a raised perception that trees pose a greater risk to public safety than five years ago. The reasons for greater concerns that trees are now a risk to public

safety is attributed to the storms of April 2015 and June 2016 which led to a significant amount of trees uprooted and power outages for a number of days.

The surveyed TMOs advised that they work very closely with their risk officers identifying issues that may in the future be a potential financial claim against council eg, a member of the public tripping over a raised section of footpath, blocked drains, damage to retaining walls and adjacent buildings.

5.2.3 Drawing out main findings

The research demonstrates that the assessment of 'real' risk is very subjective with the responsibility assigned to TMOs to make a decision in the best interests of the community. Several sources indicated there are significant risks with trees in the public domain however there is agreement amongst researchers that the risk can be reduced through the implementation of proper controls. To reduce the ongoing likelihood of tree failure, the literature suggested that good planning is required to ensure trees are planted in appropriate locations and that they have the opportunity to mature without being impacted by adjacent infrastructure (Statewide 2013).

The heightened risk perception can be attributed to storm events occurring more frequently and having a significant impact on infrastructure (United States Environment Protection Agency 2016).

A search of Sydney metropolitan councils' websites reveals that the majority of councils do have adopted a policy on how to manage risk. This was supported by the feedback from the surveyed TMOs who confirm that their respective councils have adopted a risk management policy. However, these are very generic policies that are not specifically designed for tree management.

As public safety is non negotiable, TMOs have been empowered with the delegation to authorise the removal of any tree in the public domain that is posing imminent risk to public safety even if the tree has significant heritage or cultural vale.

5.3 Role of Local Government in Tree Management

5.3.1 Insights from literature review

The *Local Government Act 1993* states that local government has both a legal and moral obligation to manage its assets in a responsible manner that does not cause injury or harm to the public. The Act clearly states that two of the main functions of local government are to protect the environment together with improving facilities for the community, *Local Government Act (1993)*.

Local government is in most instances the consent authority for the removal of trees in the public domain. Unfortunately, there are instances such as the removal of trees in Alison Road Randwick where the State Government overrode the local government authority as the consent authority to facilitate the provision of regional infrastructure. Similar to trees on private property, council can remove trees on public land without approval if they are an exempt species or the tree is posing a risk to public safety or property. If council is proposing to remove trees on public land to facilitate upgrades or the provision of services, councils are required to perform at minimum a Part 5 Impact Assessment under the *Environmental, Planning and Assessment Act, 1979.*

5.3.2 Insights from interviews

TMOs universally agree that the continued loss of the urban forest is strongly opposed by the community and they demand that council officers are committed to preserving the urban forest for future generations.

5.3.3 Drawing out main findings

As land managers, local government is the key player in ensuring that the tree canopy that the community values highly is not lost through poor stewardship of the local government area. This can be achieved through citizen engagement and the adoption of good environmental policies and regulations.

Notwithstanding the impact the provision of regional infrastructure and the increased population densities can have on the tree canopy, local government is still the key player in ensuring that the values of the community are not lost through poor stewardship of the local government area. To ensure the longevity of the tree canopy it is imperative that the community is suitably engaged prior to the adoption of good environmental policies and regulations councils. It is crucial that councils are diligent in their duties to ensure that developers carry out their works in accordance with conditions of consent and do not cause any unauthorised damage to the existing trees. Unfortunately, research by Koeser, et al. (2013) has highlighted that trees exposed to development had 50% higher mortality rates so proactive inspections on building sites will substantially increase the survival rates of trees.

5.4 Management and Assessment

5.4.1 Insights from literature review

TMOs should possess a minimum qualification in of Certificate 3 in Arboriculture, NEW South Wales Technical and Further Education (2016) prior to be making judgement calls on the potential risk of the urban forest.

To adequately assess the risk, council's level 3 arborist will perform an internationally accepted stage 1 VTA, which examines the general appearance of the tree checking for any growth defects such as fruiting bodies, growth defects and the local environment of the tree. Generally, unless the tree has significant cultural or heritage significance council will remove any trees that are considered being high risk following the VTA. If the organisation determines due to the community value that it would like to conserve the tree a stage 2 VTA would be carried out which provides a more detailed understanding of the trees integrity. On completion of the stage 2 VTA, the TMO will decide whether the tree can be retained, maybe through the use of restraining slings or exclusion fencing or organise to have the tree removed (Mattheck and Breloer 1994).

Research by Ellison (2005) proposes that more regular inspections in high-risk areas such as areas adjacent to schools, commercial centres and playgrounds would reduce the level of subjectivity in the inspections. This is closely aligned with Mullaney, Lucke and Trueman (2014) findings that trees in an urban environment will cause damage to infrastructure as they mature.

5.4.2 Insights from interviews

The majority of TMOs interviewed were of the view that staff carrying out VTAs should have a level 5 certificate in arboriculture, a perquisite of gaining a level 5 is you must have already completed a level 3 in arboriculture.

The view of the surveyed TMOs is that the community has a middle of the range attitude in respect to tree protection. They believe that residents, who may gain financially with the removal of trees in the public domain, will place a lower value on trees to help support their hidden agenda.

TMOs believe that in recent years there has been a heightened community interest in how trees are managed. The reasons for the greater interest can be attributed to high profile removal of established trees for the installation of regional infrastructure such as the light rail in Alison Road Randwick and the sale of residential blocks for development.

With respect to how TMOs believe the community perceives them, the responses varied from unrespected, environmental vandal to that of being the protector of trees (Pittosporum Council) and a bureaucrat (Westringia Council) for obstructing property owners from maximising their property by not agreeing to the removal of some trees. The view amongst the respondents was that having this perception of how you are viewed by the community could placed pressure on your decision-making when you are interacting with the public. The TMO from Rhodamnia Council was recently called an environmental vandal due to him permitting the removal of a bottlebrush that was in poor condition to permit the construction of a driveway.

The management of trees is high risk and poor management practices could expose council to potentially expensive insurance claims. Feedback from the surveyed TMOs is that resourcing levels are not keeping pace with the increasing workloads and the TMO from Randia Council believes other sections of the organisations are more favourably resourced compared to the tree management area.

With respect to determining a monetary value on trees for the purposes of determining a bond, the cost to replace a tree that has been removed as part of a new development or to quantify the value of a tree for legal prosecutions, the majority of surveyed TMOs believe there is no industry recognised methodology to value trees. Three out of the six surveyed councils if the situation arises utilise the Thyer tree valuation method and none of the surveyed made any reference to the Burnley method.

Obviously, councils are not immune to criticism but the responses from the TMOs have highlighted that councils take quite differing approaches when managing negative media enquiries. The councils that do respond to media enquiries in most instances seek advice from technical staff prior to responding. It is interesting to note that one council, that has a high tree canopy density, just ignores negative commentary expressed on social media.

5.4.3 Drawing out main findings

For effective management of the urban forest local government on behalf of the community, the governing body, the elected council, must commit to adequate resourcing levels and implementing sound policy. Inadequate resourcing levels increase the exposure of local government areas to potential public liability claims due to tree failure and a loss of the tree canopy that the community value so highly.

To reduce the potential risks local government employs TMOs who are appropriately trained to assess the risk. The majority of surveyed TMOs agreed that the minimum qualification TMOs should possess is a Certificate 5 in Arboriculture, attained through the New South Wales Technical and Further Education prior to making judgement calls on the potential risk of the urban forest.

Management of the urban forest as discussed previously generates significant community interest. If local government proposes to remove trees that are greatly valued by the

community they need to carry out extensive community consultation to convince the community that the proposed works are for the greater good of the community.

With greater pressures being placed on existing tree canopies through the maximisation of available land in the Sydney metropolitan area it is imperative that there is acknowledgment and action plans implemented to address the declining tree canopies. Obviously, with continued development, opportunities to revegetate are significantly reduced. Councils as the major landowner in local government areas must endeavour to offset the loss of tree canopy on private property through implementing tree planting program on public land such as road reserves and open space areas.

The survey of the TMOs confirmed that despite adopting street tree masterplans, there is only minimal commitment by councils to maintain current tree canopy levels through ad hoc planting. Some of the surveyed councils addressed the aging tree canopy through delivering project based street tree planting programs but the more common treatment was to conduct more regular inspections on the existing tree canopy focussing on the risk issues rather than investing in a replanting program.

With respect to tree maintenance the TMOs advised that the major component of their budget was expended on reactive works and only one council had a dedicated in-house crew that focuses solely on proactive tree maintenance. Only one out of the six surveyed councils (Westringia Council) felt that they were adequately resourced to competently fulfil their role and the majority believe that the resourcing levels have not kept pace with the increasing workloads.

The majority of TMOs advised that they employed contractors to carry out their tree maintenance works due to the high risk of the works and the cyclic nature. The contracting of these works gives councils greater capacity to respond quickly to wind storm events such as the April 2015 and June 2016.

The survey revealed that all the councils have Asset Management System but only two (Pittosporum and Westringia Councils) have a dedicated asset management system for trees. This is somewhat alarming that most councils do not have a dedicated asset management system to record the details of the tree, species, maintenance history and reinspection reminders. The two councils that do have a stand-alone asset management system for trees have taken different approaches as to how they collate their data.

One of the two councils with a dedicated asset management system only collects detailed data on trees in high risk areas such as playgrounds, adjacent to schools and commercial centres whereas the other council is sufficiently resourced to inspect and collect data annually on all street trees.

Information collected by both councils for the database includes date of inspection, the assigning of an identification number, common and botanical name of species, estimated age, condition, size and history of works performed on the asset.

5.5 Policies

5.5.1 Insights from literature review

There is a suite of Federal, State and Local Legislation that endeavours to protect the urban forest. These range from the Federal's *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* to at a local level the Local Environmental Plan and Development Control Plans and supporting Policy documents.

The review highlighted that there was significant inconsistency between councils on the quality of their tree management polices and the presence of street tree master plans. Councils such as Randwick, City of Sydney, Burwood and Woollahra have well documented street tree policies and master plans where alternatively the former Warringah and Pittwater Councils were either non existent or poor in detail.

Generally, council policies do not permit the pruning of trees on public land to provide improved views from private property. Interesting the Woollahra Council Tree Management Policy (2011), would consider permitting the lopping of tree to reinstate views or greater solar access to properties that have been diminished through the natural growth of a tree.

5.5.2 Insights from interviews

Five out of six respondents advised that their organisation has an adopted Policy/Strategy for the management of trees in the Public Domain. The only council that does not have an adopted (in draft) tree management policy/plan is the one with the highest tree canopy density. Five of the six councils have policies/strategies on how to manage trees in the public domain but the content varied.

With respect to the management of insurance claims, the responses from the TMOs confirmed there was a reasonable level of consistency across all local government areas as to how councils respond with the insurance officer taking the lead role in negotiations with the customer.

5.5.3 Drawing out main findings

There was commonality in how they deal with insurance claims, the assessing and prioritising of works, the provision of street tree masterplans and what will be considered for removal.

One of the surveyed councils acknowledges the value residents place on views, and will permit pruning of public trees at the customers expense to maintain their views, where the structure or the form of the tree is not compromised,

Also, the participating councils in the survey noted their concern for the aging tree canopy and how the organisation has endeavoured to strategically address this issue through the adoption of street tree master plans. Unfortunately, the advice from the TMOs is that the resourcing is not commensurate with the adopted policies/ master plans and the tree canopy will continue to decline unless there is a shift in philosophy of local councils.

All of the respondents agreed that the community values trees in the public domain both in tangible and intangible forms. For the community to garner maximum benefit from the urban forest it is imperative that local government takes a lead role in the protection and implements strategies for the aging canopy to perpetuate.

5.6 Best Practice Guidelines

5.6.1 Insights from literature review

The literature review identified that there is no industry adopted best practice guideline on how to manage trees in the public domain. In New South Wales the document that is used by many practitioners in the arboriculture industry is the Statewide Best Practice Manual (2013) that discusses how to mange risk and what mitigation measures can be implemented to reduce the potential risk.

5.6.2 Insights from interviews

Tree Management Officers expressed support for a Best Practice Guideline, especially in respect to supporting decision-making on whether trees should remain or be removed.

TMOs also thought it was important that there should be greater awareness of the value of trees and how their integrity can easily compromised if works occur that breach accepted arboriculture practices. Training should be provided to both internal and external bodies that carry out works in the vicinity of trees to ensure that the integrity and longevity of the tree is not compromised when civil works are performed adjacent to the tree.

5.6.3 Drawing out main findings

There was broad acknowledgement from the surveyed TMOs that the Statewide Mutual Best Practice Manual for trees and roots (2013) provides significant guidance to officers when required to assist in the decision making process in respect to risk but does not give advice on options available to reduce the risk through, crown thinning, the use of wire slings or exclusion fencing.

The ideal Best Practice Guideline would include, but not be limited to, the following:

- the standardising of tree inspections and maintenance programs
- clear risk assessment methodologies
- guidance on how to plant trees
- promotion of the importance and value of trees
- how to determine the monetary value of trees, recognising that currently there is no legal formula to value trees (most councils utilise the Thyer Tree Valuation Method, described above, when required).

It was suggested that the best practice guideline would be available online for ease of access together with an online forum for TMOs to be able to discuss issues with peers.

6. Summary, conclusions, recommendations

6.1 Summary

The purpose of this research is to gain a understanding of how local government manage trees in the public domain. The study was focused on responding to the following research questions:

- In metropolitan Sydney, how do councils balance the benefits of urban trees against the potential risk of trees to public safety and infrastructure?
- What support do senior managers in local government need to provide to officers so they can confidently perform their duties?
- What would be the ideal scope, style, content and format of a resource that would assist tree management officers fulfil their role in a competent manner?

To improve the body of knowledge on how trees are managed in the public domain interviews were conducted with TMO's from six metropolitan councils. To ensure that the proposed survey was reflective of local government across the Sydney metropolitan area it was decided to interview TMOs from councils that had different tree canopy densities ranging from 10-19.9% to 50+%. Understanding that TMOs are generally time poor the timing of survey could not be changed as the draft dissertation needed to be submitted by the 26 September 2016.The significant storm event of June 2016 that lashed the NSW east coast placed further pressure on the available time TMOs had to participate in the survey. In an effort to assist the TMOs it was decided to provide pre scripted questions so they could prepare responses to the questions when time permitted.

To support the qualitative data collected through the interviewing of TMOs, a literature review of current published journals and a comprehensive review of a number council policies, technical manuals and master plans was also performed.

The questions were designed in a format so that the responses would give the author a clear understanding of how councils deal with the complexity of managing trees in the public domain. The main limitation of this review is it does not portray the views of the broader community and the perceived opinions of how the community view the management of trees in the public domain by council may be not be in line with that of the community.

The surveyed TMOs believed that the community would place a value in the middle range as to the importance of trees. A review of council website suggests that there is compelling strategic intent in policies and master plans to protect the existing urban forest together with where possible address the issue of an aging tree canopy by implementing street planting programs. Regrettably, the advice from the surveyed TMOs is that councils only commit to street tree planting as one off projects and the funding programs are not ongoing.

From the survey it became apparent that several LGAs have not invested sufficient resources to develop and implement a policy to protect their urban forest. The research also highlighted the serious lack of resourcing by local government with only one of the six councils surveyed believes they are sufficiently resourced to carry out pro-active tree maintenance works.

Unfortunately, as there was only one council who performed pro-active tree maintenance there was no opportunity to measure what impact pro-active tree maintenance has on the frequency of public liability claims and whether there was a reduction in the paying out of claims compared to the cost of performing pro active maintenance.

The research has confirmed my concerns that TMOs are exposed to significant pressure from both internal and external forces in performing their role in a professional manner. There is a strong belief amongst the TMOs that their role over recent years is being performed under greater scrutiny due to the communities heightened perception that trees pose a risk to public safety due to the storm events of April 2015 and June 2016. The adoption of clearly written tree management policies on how trees are to be managed in the public domain would be greatly beneficial to TMOs when they are exposed to requests from well-connected members of the public to have works carried out for trees in the public domain so their views or property values are enhanced.

Local government managers can reduce the stress of TMOs by suppling the officers with adequate resourcing levels so they can perform pro-active works and long term reducing the quantum of reactive works still outstanding. Also, if council committed to the ongoing funding for street tree planting programs this would address the issue of a diminishing tree canopy.

There was support amongst the TMOs for an online best practice guideline that could be accessed on line but it was not as a priority due to the quality of the Statewide Best Practice Manual. If the development of a best practice were to proceed it would at minimum contain the following:

- the standardising of tree inspections and maintenance programs
- clear risk assessment methodologies
- guide on how to plant trees, promotion of the importance and value of trees
- how to determine the monetary value of trees

6.2 Conclusions

Responses are provided on the research questions drawing on the outcomes of the study.

6.2.1 In metropolitan Sydney, how do councils balance the benefits of urban trees against the potential risk of trees to public safety and infrastructure?

Trees are living structures that are prone to limb failure and over time die. Whilst removal is the last resort, the need to maintain public safety is the driver for councils to perform maintenance on the urban forest. The research has identified that local government has not yet fully acknowledged both the value and risk that trees provide. If councils were committed to the preservation and management of trees in the public domain there would be an increase in funding to ensure that the urban forest is managed in pro-active manner, not merely reactive performing works.

Together with tree removal there needs to be an enduring commitment by councils to replant when trees are removed and implement that have been through community consultation street tree master plans to offset the gaps in the tree canopy caused through development on private property.

6.2.2 What support do senior managers in local government need to provide to officers so they can confidently perform their duties?

Councils need to provide greater funding to allow TMOs to perform proactive works on the urban forest with special attention given to trees that are showing signs of decline or are located in areas of potential high risk. The potential high-risk areas are adjacent to schools, playgrounds and commercial centres. Also, councils need to develop and adopt quality tree management policies and street tree master plans. This will assist the TMO in the decision-making process, especially in circumstances when there is undue pressure being applied.

The purchase of an asset management system that is designed specifically for the management of trees will be a great assistance to TMOs, especially providing reminders for reinspection and the maintaining the history of maintenance performed on the tree throughout its lifecycle.

6.2.3 What would be the ideal scope, style, content and format of a resource that would assist tree management officers fulfil their role in a competent manner?

The view of the TMOs in terms of priority is the development of a best practice manual is not high compared to the need to adopt quality tree management policies, the funding of proactive tree maintenance works and the implementing of an going tree planting program.
If one were to be developed it would include at minimum the following:
:

- the standardising of tree inspections and maintenance programs
- clear risk assessment methodologies
- guidance on how to plant trees
- promotion of the importance and value of trees
- how to determine the monetary value of trees, recognising that currently there is no legal formula to value trees (most councils utilise the Thyer Tree Valuation Method, described above, when required).

It was suggested that the best practice guideline would be available online for ease of access together with an online forum for TMOs to be able to discuss issues with peers.

6.3 Recommendations

On the basis of the conduct of this study, the following recommendations are made:

1. Councils who are yet to adopt a policy on the management of trees in the public domain should do so as a matter of urgency, which will provide a necessary administrative tool for TMOs who are also engaged in the role of conserving the urban forest in accordance with community wishes.
2. Councils need to resource TMOs so they can perform pro-active tree management works and not rely solely on reactive works. For example, areas of high usage such as playgrounds, adjacent to schools and commercial centres should be inspected at biannually. These types of pro-active works would significantly reduce the potential risk to public safety and property.
3. Councils commit to appropriate levels of funding to address the declining tree canopy.
4. Councils implement the adopted street tree master plans and in councils where they do not exist begin the planning process to develop.
5. Councils commit to funding an asset management system that can be used as a tool in managing the life cycle of the tree.
6. Carry out consultation with other TMOs and peak industry groups to gauge whether there is an appetite for the development of a best practice manual for the arboriculture industry, and especially local government practitioners.
7. Councils should be encouraged and supported to conduct in-house training to educate staff on the value of the urban forest and how infrastructure can be installed without compromising the integrity or longevity of the tree.
8. The peak industry body contact be proactive in the management of trees in the public domain and make contact with utilities who carry out works adjacent to trees highlighting the value of trees and demand that that they engage a level 5 arborist to provide technical advice at both the planning and installation stages.

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Appendix 1

CLG ETHICS PROGRAM FORM

USE THIS FORM EVERY TIME YOU INITIATE A RESEARCH PROJECT AS A CLG STAFF MEMBER, STUDENT OR ASSOCIATE.

Title of research project:	Managing trees in the public domain: Towards a best practice guide for local government tree management officers.
Chief Investigator:	Steve Lawler
Additional researchers:	Click here to enter text.
Funding body (including client):	Nil
Project start date:	24 April 2016

Is your project classified as research for reporting purposes?	☒Yes	☐No → No need to use this form
Does the research involve humans?	☒Yes	☐No → No need to use this form
Does the research support evidence-based policy formulation, promote informed debate on key policy issues and help address major challenges facing the local government sector?	☒Yes	☐No → Need to go through the HREC
What method/s does your proposed project use?	Please describe briefly, including description of participants:	
☐ Focus groups		
☒ Interviews (structured and semi-structured)	Interview 6 tree management officers who are currently employed in local government across the Sydney metropolitan area	
☐ Analysis of secondary data		
☐ Surveys		
☐ Deliberative panels		
☒ Desktop literature reviews	A desktop literature review will be carried out through accessing data on the UTS library	

☐ Other → Need to go through the HREC		
Does the research target any members of the following groups? ☐ Women who are pregnant and the human foetus ☐ Children and young people (clarify definition) ☐ People in dependent or unequal relationships ☐ People highly dependent upon medical care who may be unable to give consent ☐ People with a cognitive impairment, an intellectual disability or a mental illness ☐ People who may be involved in illegal activities ☐ Aboriginal and Torres Strait Islander Peoples ☐ People in other countries.	☒ No	☐Yes → Need to go through the HREC

Please complete the following ethics checklist and submit your application for ethics approval to the Delegated Approving Officer.

☒ Are all researchers competent and familiar with the Australian Code for the Responsible Conduct of Research, the UTS Privacy Principles, the National Statement on Ethical Conduct in Human Research 2007 (Updated December 2013) and the UTS Ethical Conduct of Research Policy?

☒ Have you developed appropriate Project Information sheets and Consent forms for all participants (or alternatives when methods are not undertaken face to face)

☒ Does your project plan detail whether the data collected will be anonymised and at what stage?

☒ Have you identified appropriate storage for the data (physical and electronic)? Yes, interview notes will be stored in a secure folder and interviewees will be deidentified.

ONCE APPROVED, SAVE THE FORM IN THE APPROPRIATE WORK FOLDER FOR THE PROJECT

APPROVAL

☑ Ethics form and checklist reviewed

☐ Any issues discussed with the chief investigator (please note below)

☑ Approved on Click here to enter a date. by Click here to enter text. (Delegated Approving Officer) 13/5/16 SuFei R

Notes:

Click here to enter text.

UTS:CLG
CENTRE FOR LOCAL GOVERNMENT

ACELG
Australian Centre of Excellence for Local Government

Consent Form

I *[participant's name]* .....

agree to participate in the research project *Managing trees in the public domain: Towards a best practice guide for local government tree management officers* conducted by the Centre for Local Government of the University of Technology, Sydney.

I understand that the purpose of the research is to investigate to what would be the ideal structure of a resource that would assist tree management officers fulfil their role in a competent manner. Also, the research will detail what support senior managers in local government need to provide to officers so they can confidently perform their duties.

Finally, the research will assist local councils to develop tree management policies focussing on retaining the existing tree canopy, explaining how to manage an aging tree canopy and especially public balancing risk versus public value.

I understand that my participation will involve responding to pre-scripted questions together with open ended that may arise as part of the interview and will take approximately 2 hours of my time. Both you and your Council will not be identifiable at any stage in the development of the research project.

I am aware that I can contact Ronald Woods (subject coordinator and research supervisor) on 9514 – 1112 if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish without giving a reason.

I agree that Steve Lawler has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify me in any way.

Signature ..... Date .....

Note:
Studies undertaken by the Centre for Local Government (CLG) and the Australian Centre of Excellence for Local Government (ACELG) have been granted program approval by the University of Technology, Sydney, Human Research Ethics

Committee. If you have any complaints or reservations about any aspect of your participation in this research you may contact *[name and contact details of lead researcher]* or the UTS Ethics Committee through the Research Ethics Officer, [tel: 02 9514 9772]. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

Project Information Sheet

Thank you for agreeing to participate in the research project *Managing trees in the public domain: Towards a best practice guide for local government tree management officers* being conducted by the Centre for Local Government of the University of Technology, Sydney.

The purpose of the research is to investigate what would be the ideal structure of a resource that would assist tree management officers fulfil their role in a competent and productive manner. Also, the research will detail what support senior managers in local government need to provide to officers so they can confidently perform their duties.

Finally, the research will assist local government to develop a tree management policy focussing on retaining the existing tree canopy, explaining how to manage an aging tree canopy and especially public balancing risk versus public value.

Your participation will involve responding to pre scripted questions, some will be open ended questions that will be provided at least two weeks prior to the telephone interview at a time that suits youself and will take approximately 2 hour of your time. . Both you and your Council will not be identifiable at any stage in the development of the research project.

You can contact Ronald Woods, coordinator of the subject and research supervisor, if you have any concerns about the research. You are also free to withdraw your participation from this research project at any time without giving a reason.

Steve Lawler, 0417 462 432 can answer your questions about the project.

The research data gathered from this project may be published in a form that does not identify participants in any way and the data will be stored by the UTS.

Note:
Studies undertaken by the Centre for Local Government and Australian Centre of Excellence for Local Government have been granted program approval by the University of Technology, Sydney, Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research you may contact Ronald Woods [tel; 9514-1112] or the UTS Ethics Committee through the

Research Ethics Officer, [tel: 02 9514-9772]. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

Managing trees in the public domain – Interview Guide

Thank you very much for agreeing to take part in the research project *Managing trees in the public domain* being conducted by the Centre for Local Government of the University of Technology Sydney. The objective of this research is to gain a clear understanding of the value of trees in the public domain, what is the level of the risk they pose to public safety, and what Tree Management Officers (TMOs) would like included in a best practice guide. A comparison of how councils manage trees in the public domain will be completed and provide data that will be useful towards a Council Tree Management Policy.

Our interview will be based on 22 open-ended questions clustered into six themes, and should take approximately two hours of your time. Both you and your Council will not be identifiable at any stage in the development of the research project, and you are free to withdraw your participation at any time.

Council

1. Does your Council have a policy or a management plan for the management of trees in the public domain?

2. If so, what areas does it contain, e.g. tree removal for development, pruning for views, replenishing an aging tree canopy, education and consultation.

3. How does your Council typically react to negative commentary on how trees are managed in its Local Government Area (LGA) through the social media and the media?

4. Does your LGA have areas of endemic trees or natural forests? If so are these trees located in urban areas with any particular type of management protection process?

Public Value

5. Does your Council have a methodology on how to determine the financial value of a tree?

6. If so in what circumstances has the financial value been applied?

7. Has there been a noticeable shift in the past 5 years of community interest in how trees are managed in the public domain?

8. On a scale of 1-5, where 5 is very protective, and what value do you believe your community would place on the protection of trees in the public domain?

9. What do you believe is the perception of tree management officers within the community?

Public Risk

10. In your opinion, is the 'risk factor' of tree management dominating management practices more now or less than it was 5 years ago and if so why?

11. Does your Council have a policy/ procedure on how staff are to manage risk?

12. Has it been adopted by council?

13. If so, have you found this to beneficial in performing your role, especially dealing with difficult customers?

Resourcing

14. Please discuss the resourcing of the TMO role at your council.

15. Please discuss the types of tree maintenance your council perform?

16. How does your Council address an aging tree canopy?

Asset Management

17. Does your organisation have an asset management system?

18. Do you have a criteria of where you collect information on individual trees and where you may collect data as a group eg individual trees in high risk areas playgrounds, commercial centres?

19. The data that your organisation collects, can you advise what the intended purpose is?

Best Practice Guidelines

20. Would you like to see an Industry Best Practice Guideline developed to assist you in performing your role?

21. If yes, what type of information would you like to see included. Please feel free to share any of the ideas you might have for the content of such a resource.

22. What would be the ideal format for such a resource e.g. online guide, printed guide, interactive peer-to-peer learning tool, restricted to council policy documentation?

Other
Is there anything else, not covered in our discussion, which you would like to add regarding the management of trees in the public domain and the role of council officers in this important local government function?

Thank you very much for your time

Appendix 2: Table of evidence

Researchers	Objectives of study	Methodology	Findings
Davison & Kirkpatrick (2013)	To understand how risk management has shaped the urban forest and developed the professional status of arborists	Qualitative interviews of practitioners	Perceptions that trees are a risk have led to their demise. An emerging risk culture has encouraged the development of arborists to enable cohabitation of people and trees.
Ellison (2005)	To introduce the concept of quantified tree risk assessments and enables owners of trees to the safety issues concurrently with trees value	Quantitative method of tree risk assessment which enables the probability of significant harm to be applied to tree failure risk	Reduces the subjectivity of the assessor on the outcome of the risk assessment. The proposed system evaluates the general nature of the tree population and the range of targets of which they could fail, therefore prioritising risk assessment. For example, a post mature tree population in a busy urban street may need to be assessed twice a year in comparison to the same tree population in a remote location.
Koeser, , et al. (2015)	To understand how professionals and members of the public perceive the risk of the urban forest	Three separate educational workshops focussed on the arboriculture and risk of Tampa Bay. Given their responses to a survey they were divided into three groups, non – professional, professional and advanced professional. Intuitive risk ratings for each of the 33 photographed scenarios were assessed using the	There is a need to educate both the public and arborists regarding risk factors beyond the tree condition. Tree risk assessments are multi-staged process that requires careful consideration of target, tree and site factors. There is a focus to target the tree. As the likelihood of failure is the most subjective aspect for tree assessments further research is required to provide empirically derived guidelines for gauging the severity of tree defects.

		Conjoint () function in R	
Donovan & Butry (2010)	To determine what impact trees have on property prices	Quantitative method. A hedonic price model is used to estimate the effects of trees on sale price and time on market of Portland houses, Oregon.	The research found that house prices were increased by $8870 and time on market reduced by 1.7 days due to the presence of street trees.
Pandit, et al. (2012)	To gain an understanding what street trees have on property prices	Research Paper that used hedonic pricing model and multiple sources of data on property sales, geographic locations, neighbourhood characteristics and extent of property to estimate the value of urban trees in Perth, Western Australia.	Results found increases of median house prices by about $16,889 due to the presence of broad-leaved trees on the street. Research suggests the planting and maintaining of broad-leaved trees on street verges would generate public and private benefits of street trees.

Jones, Davis & Bradford (2012)	To understand the value and importance of urban trees from a home owner perspective.	Examination of mail survey data obtained from a representative sample of 800 home owners in rapidly urbanising Southern Appalachia. Combined with a multiple regression analysis.	The findings indicated that home owners with stronger pro-tree attitudes, have greater environmental concerns and place more importance on trees when looking for a place to live. It concluded that urban trees provide a wide range of benefits of significant value. It also showed that knowledge of social-psychological factors is essential for understanding support for urban tree protection. For example, knowledge of these factors can assist in the creation of tree policies and programs and reduce the risk of alienating key stakeholders such as the community.
Velarde, Fry & Tveit (2007)	To analyse the range of landscapes used in environmental psychology studies, and the evidence of health effects related to viewing these landscapes.	A literature review of major ecology, health and psychology journals were reviewed. The focus was reviewing papers that related to the viewing of landscapes.	The literature review identified that the main health aspects of exposure to landscapes related to reduced stress, improved attention capacity facilitating recovery from illness, ameliorating physical well being in elderly people, and behavioural changes that improve mood and general well being.

Chawla (2015)	Review the different ways that contact with nature can contribute to the health and well – being of children.	The author searched for relevant referred articles and chapters in academic books. Also a number of data bases were searched between the period 2010 and 2015.	The researcher found that evidence exists to confirm that trees and natural areas are essential elements of healthy communities for children
Kirkpatrick, Davison & Daniels (2012)	To gain an understanding of the motives of residents for planting and removing different species of trees	A questionnaire asked the motives of residents for planting and removing trees, questions were numerically classified to derive seven classes of residents. The questionnaire was designed so the researcher could obtain data on the individual attitudes to trees, survey respondents were asked to indicate their response along a 5-point Likert scale	The seven attitude groups were significantly different from each other. The attitudes towards trees were strongly predicted by income, education and gender. Reasons for trees being removed were they were too big, too close to houses and did not fit in with neighbourhood

Maco, & McPherson (2003)	To quantify the structure, benefits and costs of street trees in resource limited communities.	The combination of a rapid sampling technique together with previously published data was used to analyse street tree populations in small communities	Street trees produced $1.7 million in tangible benefits for the residents of city of Davis, California, United States in 1999/2000. Street trees returned a benefit $3.78 per tree for every $1.00 spent on their management
Zhang, et al.(2007)	To gain understanding of the attitudes of Alabama urban residents towards urban trees	A state wide telephone survey was conducted to gain an understanding of the public attitude to street trees and supporting urban tree programs, there was 1379 participants with 36% response rate	90% of citizens appreciate urban trees in choosing their residential location and community, a majority supported tree lopping and controls for builders and developers. The knowledge of public urban tree programs has appositive relationship with favourable attitudes to urban forestry initiatives
Nowak (2000)	To gain an understanding of how trees influence water movement through the urban landscape	The measurements of through fall of two Eucalyptus species in an urban environment over a 5-month period comparing rough and smooth bark species. The research provided evidence base for tree canopy impacts	Trees with greater tree canopy intercepted greater amounts of gross rainfall. In impervious areas trees can significantly reduce stormwater runoff.

Brack (2001)	To identify the value of Canberra's urban forest in respect to pollution mitigation	A case study of the value of urban trees with reference to pollution mitigation. The study used a tree inventory, modelling and decision support system to collect and use data about trees for tree asset management in Canberra	The trees have a significant value for the aesthetic and landscape quantities. They also reduce energy consumption and ameliorate pollution in the city. The study estimated the value of amelioration of between US$ 66-227 per resident between 2008 and 2012
McPherson & Muchnick (2005)	To determine the effect street trees have on the road pavement	Data from Modesto's street tree inventory, geographic and information system and street services records were used to identify areas that met specific criteria. Forty-eight street segments were paired into 24 high and low pairs in Modesto, California. Core samples of asphalt were taken from the sample area plus an adjacent roadway to ensure sample materials matched and could be fairly compared.	The research proved that shade trees reduces the amount of maintenance needs to be performed throughout its lifecycle and supports the theory that street trees have a positive effect on road pavements and are not liabilities

Kuo, Bacaicoa & Sullivan(1998)	To understand how inner city residents would respond to the incorporation of trees in their neighbourhood	3 focus groups were established to interview the residents who live in adjacent public housing towers. The scale models were used to gain an understanding of where and how the residents would prefer tree planting to take place	Residents were enthusiastic about having trees planted and did not feel that their sense of security would be reduced. It was also agreed that through involving everybody the survival rate of the trees would be increased
Pramova, et al. (2012)	To identify the role ecosystems play in helping people adapt to climate variability and change	A review of scientific literature	Urban trees have the ability to regulate and water for resilient cities
Koeser, et al. (2013)	To identify factors that impact on the long term survival of street trees	The study draws on 25 years of urban forest monitoring data from the city of Milwaukee. Tree attributes were measured in 1979, again 1989 and 2005 and compared to construction over the same period. Multivariate logistic regressions were used to identify factors associated with tree survival.	Cross validation showed final model could successfully predict tree survival 85% of the time. Trees were more likely to die as the trunk diameter increased. Trees exposed to development had a 50% higher mortality rate

Wolf (2004)	To highlight how urban trees, forests and green space benefit people in areas of social, environmental and economic domains.	An economic valuation study was conducted to determine economic value of the urban forest and green. Economic valuations can be applied to a variety of situations including planning for urban green and value of an amenity.	Parks and the city green are often managed in a hap hazard manner. The research identified the benefit of long term management so that the urban forest attains its greatest productivity. The term "public value" describes the widely held perception around the function and service contributions of public utilities. Expanded public values perception precedes commitments of adequate budget and resourcing. Studies show how shopper's behaviour in retail business districts employ the contingent valuation method. Consumers claim they are willing to pay an extra 9 to 12 per cent more for products in shopping areas with trees. Office workers with a view have a higher productivity, fewer sick days and greater job satisfaction
Mullaney, Lucke & Truemen (2014)	To gain an understanding of the challenges to establishing street trees in an urban environment. Also, the perception of street trees from the perspective of residents and what measures are available to prevent trees damaging infrastructure	Reviewing literature spanning 30 years on the benefits, the public perception and preventative options that are available to prevent damage caused by street trees.	The runoff from summer rainfall is 62 % greater on asphalt than in areas with tree pits. It is estimated that annual stormwater runoff ranges from 3.2 kilolitres to 11.3 kilolitres per tree. Trees are able to diminish noise and capture air borne pollution particles. Residents in Melbourne prefer medium sized trees, this conclusion is unclear but is assumed that greater information on the potential damage large trees may cause infrastructure may have influenced their choice.

Appendix 3

Managing Trees in the Public Domain – Raw responses to survey questions

Questions	Local government					
	Pittisporum	**Banksia**	**Randia**	**Rhodamnia**	**Kunzea**	**Westringia**
1. Does your Council have a policy or a management plan for the management of trees in the public domain?	No – draft management plan	Yes, Street Tree Management Strategy – Parks PoMs	Council does not have a management plan for the future management of the tree canopy in the LGA. What it does have is a series of policies which act as guidelines in assessment of public domain trees and/ or general policies which are more of a philosophy in relation to trees in the LGA .There is a detailed Street Tree Masterplan for selection of species for planting in accordance with different topographical zones.	We have a Tree Management Policy which covers both private and public trees. Additionally we have a draft Street Tree Management Plan which is yet to be adopted by Council	Tree Management Policy	Yes – Tree Management Policy (2011) and Tree Management Development Control Plan (Chapter E3)

Questions	Local government					
	Pittisporum	**Banksia**	**Randia**	**Rhodamnia**	**Kunzea**	**Westringia**
2. If so, what areas does it contain, eg tree removal for development, pruning for views, replenishing an ageing tree canopy, educational and consultation?		Yes – planting, maintenance, species selection and insurance claims	Tree Policy :Tree Shrouding Policy: Significant Tree Removals Policy: Sewer/ Stormwater Drain Blockage Policy: Urban Forest Policy; The Tree Preservation Order was reviewed in 2013 ,redefined and incorporated into a LEP/DCP	The Tree Management Policy essentially stipulates the priority for inspections, factors for consideration in assessing trees and directions for assessing officers. The Draft Street Tree Management Plan that requires further work focuses on identifying existing plantings and recommendations for additional/ replacement and future planting. We will probably wait for an announcement on an amalgamation	Education and Consultation: When Council is undertaking “Street Refurbishment” consultation with residents, the local community and Ward Councillors is implemented “Ageing Tree Canopy” we have a Street Tree Master Plan The policy outlines Council’s position on tree management and addresses the following issues: • Protection and replenishment • Assessment, review, reporting and notification • Tree works and removal • Trees on development sites • Tree related	Identifies prescribed trees, exempt species and works, In general what will be considered for pruning / removal, what won’t be considered for pruning / removal, view pruning guidelines, defines when a permit or a consent is required for works associated with Environmental Heritage Items listed within the LEP and Significant Trees.

Questions	Local government					
	Pittisporum	**Banksia**	**Randia**	**Rhodamnia**	**Kunzea**	**Westringia**
				before proceeding further as our potential amalgamation partner has a far superior Street Tree Master Plan	planning instruments • Administration • Education	
3. How does your Council typically react to negative commentary on how trees are managed in its Local Government Area (LGA) through the social media and the media?	Well informed replies – social media responses are responded to quicker than other forms of correspondence	Ignore media. Provide written responses to critical emails/letters	Council generally views itself as "green" and will seek advice down the structure for advice on specific cases.	We generally respond through our Media Unit with an explanation of the background and goals etc. in relation to complaints about specific projects	They are generally informed that the matter will be investigated	Negative commentary expressed within social (and other) media is ignored as it generally doesn't get much oxygen. We don't respond.
4. Does your LGA have areas of endemic trees or natural forests? If so, are these trees located in urban areas with any particular type of management protection process?	Yes – *Threatened Species Act 1992* – encapsulate EECs. Any work in these areas will involve a 7 part Test Ecological Assessment	No	National Park land areas managed by NPWS. There are some isolated pockets of bushland, coastal heath and remnant trees. Some managed by Council's Bushland Care Unit which	We have several areas of natural bushland, which are under the control of the National trust. Maintenance work is carried out by our Bush regeneration	Yes we do and our Bushlands Operational Co Coordinator and his staff manage this area Council has a significant number of Bushland reserves that include a number of Endangered Ecological Communities. These areas are managed in accordance	We have some examples of relatively old endemic species of street and privately owned trees however there is no evidence that they are remnant or natural. These are

Questions	Local government					
	Pittisporum	**Banksia**	**Randia**	**Rhodamnia**	**Kunzea**	**Westringia**
			uses volunteers to control exotics. Remnant trees may be listed on Council's Significant Tree Register	staff and volunteers under the supervision of Council staff	with relevant legislation, Council Policies, Strategies and Operational Guidelines.	located in urban areas and most are Environmental Heritage Items listed within the LEP however there is no dedicated management strategy for these trees.
5. Does your Council have a methodology on how to determine the financial value of a tree?	No – there is not legally recognised formula	Not published, but we use the Thyer Tree Valuation Method	There is no adopted tree valuation methodology, and values if required are derived from stock standard methodology. Often removal and replacement value forms the basis of a valuation.	We use the Thyer Tree Valuation Method to calculate the value of trees	No, though consideration has been given to this to be possibly implemented in the future	Yes – we use the Thyer Valuation Method
6. If so, in what circumstances has the financial value been applied?	Value of penalties, where development affects public trees, eg driveway, new development	Requiring monetary bonds/bank guarantees for Das – trees on council land	Valuations are a most frequently used for removal of a street tree for a proposed development . The derived value forms a cost for the	We have valued trees in order to determine appropriate bonds for protection of significant trees	N/A	We are only legally able to place a bond on publicly managed trees i.e street and park

Questions	Local government					
	Pittisporum	**Banksia**	**Randia**	**Rhodamnia**	**Kunzea**	**Westringia**
			applicant for removal replacement and loss of amenity. Also used for reports to committee meeting determination of large tree removal cases			
7. Has there been a noticeable shift in the past 5 years of community interest in how trees are managed in the public domain?	Yes – far more informed, due to the recent storms more media after raising rates, people have higher expectation, council provides more information, ageing population, more pressure	No	Yes ,significantly this year	Not really. We have quite a few individuals within the community who don't want trees cut under any circumstances and complain any time they hear a chainsaw or see a tree disappear! We also have a large portion of the community who simply don't like trees or want them anywhere near their properties.	Yes, overall there less community interest in the management of trees	Yes – a number of Councillors were elected partly because of their position of retaining a group of park trees. Conversely our 2011 Tree Management Policy has the provision of pruning park trees for views

Questions	Local government					
	Pittisporum	**Banksia**	**Randia**	**Rhodamnia**	**Kunzea**	**Westringia**
8. On a sale of 1-5, where 5 is very protective, and what value do you believe your community would place on the protection of trees in the public domain?	4	3	If a survey was taken in the community all responses would generally be preservation of public trees at all costs. However individuals will be governed by self-interest if there are consequences for their property which they perceive as detrimental, they will disregard community interest. It would be difficult to rate 1-5 on this basis.	3	3 – Community	The answer is highly dependent on where the tree is positioned in relation to the individual. That is, if the tree is blocking a view the value of the tree is low.
9. What do you believe is the perception of tree management officers within the community?	Protective of trees	Polarised views from the community – 50/50	Generally Tree Officers are seen as doing their duty and many residents sympathise with the difficulties involved. However if a decision is not seen as preferable to them they will escalate the issue	I was recently described as an environmental vandal by a resident who was upset about the removal of a small Callistemon to enable construction of	They are not respected and considered to be authoritarian as they are making decisions regarding trees on their property	My perception is they believe we are Bureaucrats getting in the way of a person maximising the value of their property.

Questions	Local government					
	Pittisporum	**Banksia**	**Randia**	**Rhodamnia**	**Kunzea**	**Westringia**
			and increase political pressure until they reach a satisfactory outcome.	a driveway for a new dwelling. Otherwise I believe that most residents don't have an opinion unless I have refused their application		
10. In your opinion, is the 'risk factor' of tree management dominating management practices more now or less than it was 5 years ago and if so, why?	More – greater focus on Council's responsibility if there is any tree failure; greater awareness of the potential damage that trees can do; more severe weather events	Unchanged. The Risk Management Policy is the same as it was 5 years ago. Claims are refused in the first instance.	Council has an insurance department which manages property damage and potential risk factors. The perception of risk in the community has risen. The perception that trees pose a significant risk is common.	Probably. The increasing incidence of significant storm events and related media coverage seems to be raising people's fear of trees. As a consequence we need to be extremely thorough in our assessments.	Ageing and declining trees have taken a more focal point Risk has significantly influenced tree management practices in the last 5 years. In relation to both person and property, insurers have become increasingly risk adverse. A number of fatalities have further influenced this position. Staff undertaking inspections should have a minimum of AQF level 4 in Arboriculture with a preference for staff with AQF level 5 in	I don't believe that it is any more or less. We are essentially risk managers

Questions	Local government					
	Pittisporum	Banksia	Randia	Rhodamnia	Kunzea	Westringia
					Arboriculture. That clear inspection protocols be implemented that includes date person undertaking inspections and an approach that assesses above ground and below ground tree components. Over time this will no doubt influence the approaches that Local Government Tree Officers are expected to take. Therefore increasing the detail and time required to undertake an inspection in an already resource poor environment. From a property perspective, there is increased pressure from Council insurance officers to remove trees. Furthermore, when a claim is deferred to an insurer for advice the response is often to remove trees.	

Questions	Local government					
	Pittisporum	**Banksia**	**Randia**	**Rhodamnia**	**Kunzea**	**Westringia**
					These trends are making it increasingly difficult to maintain canopy and place increased demands on Council Tree Officers to justify and argue for tree retention.	
11. Does your Council have a policy/ procedure on how staff is to manage risk?	Staff who assess are trained with a minimum qualification of level 3. Carry out VTA assessment. Risk assessment. Staff assessing trees should have level 5 qualifications	Yes. Risk Management Policy and Street Tree Management Strategy	There is no criteria determining the levels of acceptable risk	Yes. We have a Risk Management Policy	Council also has a proactive Tree works Policy that applies to Council land that is aimed at pro actively managing risk. Council's Tree management Policy does provide some advice on Council's position in relation to potential claims. It is my understanding that Council also holds regular meetings with insurance claims to review approaches and discuss any issues associated with risk.	Policy – Imminently dangerous trees can be removed without a permit. A hazardous tree is a justifiable reason for removal/pruning. All of our street trees are assessed annually and all work orders generated from these assessments are generally based on risk. We often work closely with our Risk Department.

Questions	Local government					
	Pittisporum	**Banksia**	**Randia**	**Rhodamnia**	**Kunzea**	**Westringia**
12. Has it been adopted by council?	No	Yes – DCP	No	Yes	Council has adopted tree management Policies. The tree assessment processes are based on accepted industry approaches and form part of Council's operational guidelines.	Yes
13. If so, have you found this to be beneficial in performing your role, especially dealing with difficult customers?	If one existed would it be beneficial – yes.	Yes	The assessment of risk is determined by the onsite officer and is in accordance with the specific case scenario or the level of pressure exerted by customer/management	Yes		It useful dealing with any customer

14. Please discuss the resourcing of the TMO role at your council	Are you adequately resources – yes but require admin support	1 x TMO responsible for Council trees, private trees, Das – trees and landscape plans, insurance claims (trees)	Resourcing is inadequate and does not keep pace with other areas of Council. Staff levels do not change in accordance with workload. Budgets regularly fall short at the end of financial year which can result in increased work processes. Contractors are often chosen for the lowest contract price resulting in an increase in workload due to uncompleted works. Technology is convoluted and cumbersome. Adoption of new or more efficient technology is slow, not appropriate or non-existent .	The TMO role (1 position) is primarily responsible for all private tree matters and assessment of Council trees in relation to developments plus oversight of major tree replacement projects whilst supervision of the Tree Services Team (and maintenance of Council trees) is the responsibility of the Team Leader Tree Services (1 position)		3 x TMO (one does proactive inspections)

15. Please discuss the types of tree maintenance your council performs	Reactive – 90%; proactive – 10%, listing trees AM and reinspecting follow up maintenance purely canopy. All works are performed by contractors	Pruning, removal, planting, watering, pest-control, de-compaction of soil	The role involves staff management, contract management, drafting Council reports, advice of tree issues to senior management staff/councillors, budget/resource management, departmental meetings, legal matters and expert witness, policy review and strategy formulation, day to day tree matters and providing education and advice to the community. Staff often take on roles of accountants, social workers, psychologists legal practitioners authors teachers etc with minimal or no training. Need to clarify maintenance works performed by contractors	With a team of just eight staff, tree maintenance is largely reactive. The work is mostly just general pruning involving crown reduction and modification, dead wooding, and simpler removals. Larger and more difficult removals and pruning are allocated to contractors.	Removal and pruning predominantly reactive works	One crew assigned to proactive work and one crew assigned to reactive works
16. How does your council address the ageing tree canopy?	Ad hoc tree planting program with alternate tree species. In the past, successful tree planting has occurred where Council worked	Increased frequency of inspection and maintenance work. No proactive tree planting	Tree management is reactive and in response to a situation or an issue. Policy can often be derived from an issue which has political repercussions and which needs management. There is no research derived from data to provide a direction for an increase in canopy cover or	We have identified a number of streets with ageing trees however budget constraints have largely prevented further progress to date. The one exception was a major road with	Council has a no net loss position on tree removal. It is important to note however, that canopy targets have not been measured for some time.	We have a replanting program for street trees. However, there is no focused strategy to address block removals within parks or streets

	in with Ausgrid where Ausgrid paid for the removal and council covered the replanting costs.		to map the current status.	many senescent E. nicholii which were removed with the assistance of Ausgrid due to constant power line clearance work compromising the trees. We are currently undertaking replacement planting.	Council currently funds a project budget for tree replacement.	
17. Does your organisation have an asset management system?	Yes – linked to CRMS	Yes, but this council does not recognise trees as 'Assets' in the Assets Register. . No proactive tree planting – GIS – history, table record	No data available on the age or viability of the public tree population. There is an ad hoc approach of planting a where requested and removal where required following a request.	An Asset Management System is currently being established but is yet to include Council trees	Yes but doesn't include trees	Yes – Arbortrack
18. Do you have a criteria of where you collect information on individual trees and where you may collect data as a group eg, individual trees in high risk areas, playgrounds,	Yes – one asset where they grow close together	Street trees are individually assessed. Trees in parks are often assessed as groups. High target areas are given more attention and	No asset management system	Not at present	No	We only collect information on individual trees. All street trees are inspected and assessed each year. Criteria: Date inspected

commercial centres?		trees assessed more frequently				and next due inspections ID # Common and botanical name Type of tree Age Condition Dimensions Any works to be done
19. The data that your organisation collects, can you advise what the intended purpose is?	Insurance claims, history of works, condition rating that triggers re-inspection, resource info	Records for court cases. Prioritisation of scheduled works – inventory	No	Not as yet	N/A	The main function is to minimising risk. The results of the survey inform work orders for pruning / removal. The data collected is focused on maintenance.

20. Would you like to see an Industry Best Practice Guideline developed to assist you in performing your role?	Yes	Yes. However, Statewide Mutual has one that we use. Our policies reflect that Best Practice Manual	Data collection is in relation to works which have been undertaken.	Yes probably but I'm not sure how it would fit with the Tree Management Policy	Yes. There is currently a real need for this particularly in supporting decision making.	The management of public trees is generally in line with the Statewide Mutual Best Practice manual trees and tree Roots
21. If yes, what type of information would you like to see included? Please feel free to share any of the ideas you might have for the content of such a resources.	Standardised methodology of tree inspections, maintenance programs, customer package, tree planting guidelines, info on how to deal with heritage trees	Guides on how to plant trees, FAQs, Developer checklist	Best practice guidelines should be concerned with the promotion of the importance and value of tree canopies in urban areas. This will need to be based on a monetary value derived from collected data and collated with values obtained in relation to the valuable attributes that public trees provide.(carbon sequestration, storm water control, heat reduction, pollution reduction, oxygen production, property values etc)US. Models have been developed and used for some time and have been successfully applied to	I'm not sure that I can answer this at present	Preferred risk assessment methodologies, guidance on the detail and level of assessments, education for other stakeholders ie insurance/risk officers, Insurers	

			AUST species. The result would be significant $ value given to tree canopies and would allow tree managers/community to make strong cases for allocation of appropriate resources			
22. What would be the ideal format for such a resource, eg online guide, printed guide, interactive peer-to-peer learning tool, restricted to council policy documents?	Replacement program on local basis. Online/printed – underpaid – high risk decisions, greater recognition of the value of the role, need greater involvement in the planning stage of infrastructure upgrades	Doesn't matter		I'm not sure that I can answer this at present	A combination of the above. It is extremely important that the respective Council's ratify the guidelines to be used	On line guide and also a peer to peer forum is important due to the subjective nature of tree management

23 Other comments

Educate engineers and other land managers on the value trees provide to the community and how the longevity of trees are compromised due to poor planning and lack of consultation with the experts who can give advice on how to reduce the impact on trees when working adjacent