URBAN FOREST
STRATEGIC MANAGEMENT PLAN
TOWN OF OAKVILLE:
2008 - 2027

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with input and amendments by Town of Oakville Forestry staff

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ACKNOWLEDGEMENTS

As Associates of Urban Forest Innovations Inc., Dr. Andy Kenney, Adrina Ambrosii, John Ghent, Peter Alexander and Vanessa Hayward contributed to the development of this Urban Forest Strategic Management Plan. We thank the Town of Oakville staff for their valuable input.

EXECUTIVE SUMMARY

This document is a strategic management plan for Oakville's urban forest south of Dundas St. It represents a revamped and more effective approach to the management and stewardship of the Town of Oakville's "green infrastructure" than is possible with current practices. The plan sets out the steps necessary to achieve short-, medium- and long-term goals for the urban forest over a 20-year period within the framework of the Town's Official Plan. It is a proactive management plan that will also enable staff to respond effectively to environmental and regulatory change, complexity, and unforeseen events.

The report begins with a description of the urban forest and an explanation of the extensive benefits that trees provide to urban communities. Public consultation provided ideas from residents about a vision for the Town of Oakville's urban forest.

To understand this vision in a practical and technical sense, we describe criteria and performance indicators of success to measure progress towards the sustainability of Oakville's urban forest. This includes the concept of "canopy cover" as one measure of forest health. A policy commitment to achieve a specific level or percentage of canopy cover has a range of implications for the Town's resources and management, which we discuss.

Our proposed concept of urban forest strategic management planning for the Town of Oakville consists of a 20-year strategic plan for the years 2008 – 2027, supported by a series of four management plans of five-year duration. Annual operating plans complement the five-year plans. The principle of adaptive management permits flexible tree operations by Town staff that respond to changes in the environment, the community and the direction of Town policy.

We then explain the context of Oakville's urban forest. This includes the ecology and geography of Oakville, the Town's current management structure and the municipal resources with an impact on urban forestry distributed among a number of departments and administrative units. The structure and authority for the policy context derives from Oakville's Official Plan. Within this structure are current management policies and procedures, Town by-laws, and related regional and provincial policies.

The section "Responding to the Challenges" states what Oakville must do to achieve its urban forest vision. We provide a comprehensive set of management solutions, and a description of the tools and methods Oakville will require to implement them. A high quality tree inventory will be the foundation of effective long-term management, to ensure the Town has the information it requires about the resources it seeks to protect and sustain. The plan describes new technologies such as geographic information systems that will give Oakville powerful and more efficient management options.

This plan includes an important discussion on tree habitat, and builds on this critical part of urban forest stewardship with descriptions of a plan for tree establishment (that is, planting sustained over time with ongoing management), and a strategy for proactive town-wide pruning, tree protection and plant health care. Other required responses to the challenges facing Oakville's urban forest include a woodland stewardship program and tree risk management plan (including hazard abatement). We make suggestions on recommended elements of a public education and private land stewardship program.

To ensure the viability and success of the plan, with the assistance of Ghent Planning Services, we include recommendations for policy reforms to protect and sustain Oakville's urban forest. These suggested policy reforms should be seriously considered and discussed by Town Council and staff. The *status quo* of by-laws, policies and procedures in Oakville is a good foundation, but is not ideal to permit the Town to achieve its vision of leadership in the field of urban forestry, and ensure benefits for Town residents. This supplement to our direction to Town staff in Forestry and other sections and departments is a critical component of successful urban forest management. The report sets out the required features of policy reforms and some suggestions on how Oakville's policy framework for planning, zoning and engineering can be improved to enable the Town to achieve its goals and realize its urban forest vision.

RECOMMENDATIONS

Table 1 presents a summary of the recommendations made throughout the body of this plan. Each recommendation has been assigned a priority of 1 (highest) to 3 (lowest). Where possible and appropriate, Town of Oakville staff has provided a preliminary cost estimate for the implementation of each recommendation.

Table 1. Recommendations for the Town of Oakville. Preliminary cost estimates provided by John McNeil, Manager of Forestry and Cemetery Services, Town of Oakville.

Number	Recommendation	Priority	Estimated Cost	Timing	Page
1	The Town should consider amending its Official Plan to designate its municipally owned urban forest as 'green infrastructure'.	1	In-house	2009	1
2	The Town should develop a separate Urban Forest Strategic Management Plan for the lands north of Dundas Street consistent with the principles outlined in this document.	1	$85,000	2012	2
3	The Town should use the vision and mission statements cited in this plan to guide urban forest management in the Town of Oakville.	1	In-house	On-going	4

Number	Recommendation	Priority	Estimated Cost	Timing	Page
4	The Town should use the series of criteria and indicators in Table 1 to track progress towards short- and long-term objectives. This should be used to measure, monitor and evaluate the implementation of the UFSMP at the end of each 5-year Management Plan and report to Council on the State of the Urban Forest. Furthermore, the Criteria and Indicators Table should be added to the Town's 2007-2010 Corporate Strategic Plan in order to help track the Town of Oakville's progress on managing its urban forest on a sustainable basis.	1	In-house	2012, 2017, 2022, 2027	8
5	The stocking level in all land use types (except woodlots) should be increased by 10% (based on the assumptions of the UFORE Growout simulation) to achieve an estimated overall canopy cover of 30%.	1	In-house	On-going	10
6	The Town should consider incorporating an assessment of potential leaf area by land use type into the 2009 UFORE study.	1	$15,000	2009	12
7	The Town will develop each 5-year management plan. The second, third and fourth 5-year management plans will be developed based on a review of the successes and challenges of the preceding management plans.	1	$20K - $30K per plan	2008, 2012, 2017, 2022	17

Number	Recommendation	Priority	Estimated Cost	Timing	Page
8	The Town will adopt the principle of active adaptive management to accomplish urban forest policy objectives in light of the constantly changing ecological, social and regulatory environment.	1	In-house	On-going	18
9	The Town should change the name of the "Large Tree Heritage Business Unit" and "Small Tree Heritage Business Unit" to avoid confusion with other common uses of the term "heritage tree".	3	In-house	2008	23
10	The Town's Official Plan, Section 10.3(b) should be amended to read: "It is the objective of the Town that there will be no net loss of existing urban forests. As such, for every square metre of leaf area that is removed from Town property or from road rights-of-way, that sufficient trees will be replanted to replace the lost square metres of leaf area."	1	In-house	2008	26
11	The Town should amend the Environmental Strategic Plan to refer to the Urban Forest Strategic Management Plan where appropriate.	3	In-house	2008	29
12	The Town should create five urban forest management units in such a manner that their areas are distributed more-or-less equally. These management units will be used to allocate activities within the 5- year management plans.	1	In-house	2013	32

Number	Recommendation	Priority	Estimated Cost	Timing	Page
13	The Town will complete a tree inventory for all street trees within the first 2 years of the first management plan with a focus on collecting information on trees in the oldest and youngest age classes in the first year.	1	$350,000 in Year 1	2008 to 2009	36
14	The Town should develop an approach to identifying and designating heritage trees based on the approach of the Ontario Heritage Tree Alliance.	3	In-house	2010	36
15	The Town should enter into a partnership with the USDA Forest Service to establish Oakville as a Reference City for STRATUM in Southern Ontario.	2	$87,000	2009	37
16	The Town should ensure that there is adequate species diversity throughout the urban forest and where possible ensure that the seed source is within the Collection Zone for Oakville as established by the Forest Gene Conservation Association.	1	In-house	On-going	39
17	The Town will complete a tree inventory for all woodlands based on accepted forest stand inventory protocols within the first 5-year management plan.	1	To be determined	2008 to 2012	41
18	The Town should establish 1 permanent sample plot (PSP) per hectare in each woodland tract so that the woodlands can be monitored systematically over time.	1	In-house; Forestry	On-going	41

Number	Recommendation	Priority	Estimated Cost	Timing	Page
19	The Town should hire an urban forestry specialist with GIS training to administer the tree inventory software and database as well as other asset management systems in the Department in 2008.	2	$100,000 / year	Starting in 2008	41
20	The Town should consider configuring CityWorks to display a version of the tree layer including location, species and size (crown width, DBH), on the corporate web site for use by the public.	3	In-house	2009	44
21	The Town's Planning, Development Services, Engineering & Construction and Parks and Open Space Departments should consider adopting minimum soil volume standards as outlined in Table 5 into existing departmental drawings for situations that have the potential to impact municipal trees.	1	In-house	2008 to 2010	48
22	The Town's Interdepartmental/Interagency Technical Advisory Committee (IITAC) should collaborate in a review of Tree Habitat Design Guidelines, and the potential role of zoning by-laws in reserving sufficient good tree habitat to support the canopy cover/leaf area targets identified for each Land Use Type (Oakville 2006, Action Items 15 & 17).	1	In-house	2008	52

Number	Recommendation	Priority	Estimated Cost	Timing	Page
23	The Town's Interdepartmental/Interagency Technical Advisory Committee (IITAC) should discuss and consider for adoption the canopy cover targets proposed in the UFSMP.	2	In-house	2008 to 2010	52
24	The Town's Interdepartmental/Interagency Technical Advisory Committee (IITAC) should establish canopy cover targets for parking lots and should develop design and implementation guidelines to achieve these targets. (Oakville 2006. Action Items 22).	2	In-house	2008	52
25	The Town's Interdepartmental/Interagency Technical Advisory Committee (IITAC) should collaborate in the development of guidelines for the protection of tree habitat during the maintenance and upgrading of grey infrastructure.	1	In-house	2008-2010	52
26	The Town's Forestry staff and the ITTAC should host a workshop on the use of enhanced rooting environment techniques. This workshop will bring together forestry and engineering staff from across southern Ontario and other jurisdictions with experience in the use of various root zone modifications.	3	In-house	2008	53
27	The Town should develop a set of engineering road cross sections using root zone modifications for implementation in difficult sites.	1	In-house	2008 -2010	53

Number	Recommendation	Priority	Estimated Cost	Timing	Page
28	The Town should develop removal and replacement plans to increase the age class and species diversity in areas identified as having a canopy dominated by mature Norway and silver maples.	2	In-house	On-going	56
29	The Town should reserve appropriate lands for the development of a nursery and conduct a study to determine the feasibility of producing its own nursery stock versus entering into a long term relationship with a local grower.	2	$250,000	2008-2010	57
30	The Town should establish a project that will identify (through GIS) areas at risk for exotic invasions (i.e. near natural areas such as woodlots, wetlands, ravines, etc.).	3	$100,000	2009	57
31	The Town's tree asset management system, CityWorks, should include a system of tracking survivorship to inform species selection and management.	1	In-house	2008	58
32	The Town should develop a Prime Site strategy which will identify priority sites to amend the soil quantity and quality in accordance with the Town of Oakville's Our Solution to Our Pollution report.	2	$100,000/yr	2013	58
33	The Town should conduct a feasibility study for the creation of a municipal arboretum.	3	In-house	2013-2017	59

Number	Recommendation	Priority	Estimated Cost	Timing	Page
34	The Town should outline the creation of a pro-active under planting program in those communities at risk of decreasing urban forest canopy cover due to aging trees (Town of Oakville 2006, Action Item 4).	2	$100,000/yr.	On-going	59
35	The Town's Forestry Section should work with the Forest Gene Conservation Association to create a gene conservation program for the Town (Town of Oakville 2006, Action Item 9).	2	In-house	2008-2012	59
36	The Town's Parks and Open Space Department will identify opportunities for Parks Naturalization that contribute to the forest canopy and prepare capital budget costs (Town of Oakville 2006, Action Item 10).	1	In-house	2008-2010	59
37	The Town should produce a GIS-based planting plan incorporating the UFORE-Tree Locator Module, "Tree Habitat Design Guidelines for Oakville" (Town of Oakville 2006, Table 9) and taking into consideration the "Best Species for Air Quality Improvement" and species best suited to the changing climate.	1	In-house	2009	59
38	The Town should develop an urban forestry emergency response plan that integrates with the corporate emergency plan.	2	In-house	2012	60

Number	Recommendation	Priority	Estimated Cost	Timing	Page
39	The Town should adopt a 5-year pruning cycle for all intermediate and mature trees and a 3-year cycle for all juvenile trees. Line clearing operations should be consistent with these pruning cycles.	1	$300,000/yr	On-going	62
40	The Town must complete the update to its Tree Protection Policy and Street Tree By-law	1	In-house	2008	65
41	The Town should consider transferring the responsibility for private tree protection from the Development Services Department to the Parks and Open Space Department.	1	In-house	2008	67
42	The Town should hire four additional inspectors to enforce tree protection on both public and private land.	1	$320,000/yr	2008	68
43	The Town's Development Services Department should create guidelines for the implementation of the Tree Protection Policy as it applies to various permitting processes and where possible utilize conditions of approval to protect trees on private property.	1	In-house	2008	68
44	The Town should investigate the feasibility of developing and implementing a private tree preservation by-law based on the principle of no net loss of leaf area/canopy cover within the urban forest.	2	In-house	2008	68

Number	Recommendation	Priority	Estimated Cost	Timing	Page
45	The Town should develop a strategy for the monitoring and control of alien invasive species. Where appropriate the Town will coordinate its efforts with the Canadian Food Inspection Agency, the Canadian Forest Service, the Ontario Ministry of Natural Resources, Conservation Halton and other area municipalities.	2	In-house	2008	70
46	The Town will use the forest stand inventory data to complete a Forest Management Plan for its remaining 47 woodland properties under the FSC program.	1	$50,000	2010	71
47	The Town should develop a Tree Risk Management Plan and establish an inspection protocol based on the data from the Municipal Tree Inventory.	1	In-house	2011	73
48	The Tree Risk Management Plan will prioritize trees requiring further investigation by a tree risk assessment specialist.	1	$25,000/yr	on-going	74
49	The Town's Forestry staff should conduct a pilot project to fine-tune IR photography as a cost saving technique to identify areas that contain hazard trees (Town of Oakville 2006, Action Item 23).	3	$10,000	2013	75
50	The Town should provide the staff and equipment resources required to implement hazard abatement strategies.	1	To be determined upon completion of inventory	2008-2012	76

Number	Recommendation	Priority	Estimated Cost	Timing	Page
51	The Town should develop a tree cabling policy that includes the provision of an inspection cycle. This policy will incorporate risk and heritage value.	2	In-house	2008	76
52	The Tree management software (CityWorks) should provide an annual summary of all risk trees to be inspected.	1	In-house	2008	76
53	The Town should hire additional staff to undertake inspections of risk trees in the street and park tree population, in woodlands and along nature trails.	1	To be determined upon completion of inventory	2009	76
54	The Town should develop a private urban forest stewardship education program (Town of Oakville 2006, Action Item 3).	2	In-house	2008	78
55	The Town should establish a Citizen Urban Forest Advisory Committee (CUFAC).	1	In-house	2008	80
56	The Town's Urban Forestry Services should work with the Parks Horticultural Section to formalize a methodology for Public Engagement, based on their existing Volunteer Recognition Program.	2	In-house	2009	81
57	The Town should hire a Volunteer Coordinator to specifically address the needs of the urban forest.	1	$70,000/yr	2009	81

Number	Recommendation	Priority	Estimated Cost	Timing	Page
58	The Town should ensure that the sites on which volunteer planting projects have taken place are not sold or developed.	2	In-house	On-going	81
59	The Town should develop stronger partnerships with NGOs to implement effective volunteer coordination with respect to urban forest initiatives.	3	In-house	On-going	82
60	The Town's Corporate Communications Department should work with Urban Forestry Services to develop effective, wide-spread marketing strategies and branding for various events and workshops.	2	In-house	On-going	82
61	The Town should consider an amendment to the Zoning By-law for Employment, Commercial (excluding the C3R zone), and Industrial land use types to regulate the planting area for trees (i.e., the tree growing area) in support of the Town's canopy cover target.	1	In-house	2008-2010	88
62	The Town should undertake a study to assess the impact on the Town-wide canopy cover of implementing a "Planting Area for Trees" policy on all land uses which are subject to site plan approval.	2	In-house	2008-2010	91

Number	Recommendation	Priority	Estimated Cost	Timing	Page
63	The Town's Forestry Section should chair an Interdepartmental Technical Advisory Committee, to include staff from the Town's Forestry, Planning, Engineering and Legal departments to assist in implementing the Urban Forest Strategic Management Plan and to prepare proposals for new policies for consideration by Council.	1	In-house	On-going	92
64	The Town's Finance Department and the Parks & Open Space Department should review the Forestry Section Business Plan and the 10 Year Capital Forecast to ensure that operating costs for street trees and park trees and Woodland Parks are captured based on a maintenance standard recommended in the UFSMP (Town of Oakville 2006, Action Item 2).	1	In-house	2008-2012	93
65	The Town should hire the staff and equipment resources necessary to implement this Plan as detailed in Appendix J.	1	To be determined upon completion of inventory	start in 2008	93
66	The Town should implement the Tree Seed and Seedling Development Program to support the Town of Oakville's Urban Forest Canopy Cover	1	tbc	2009-2012	Appendix H

INTRODUCTION

The purpose of this strategic plan is to review the existing management of the Town's urban forest and to recommend improvements for its stewardship on both public and private land.

Oakville's urban forest extends from individual trees to open space, forest and roadside plantings; it is found in parks, around schools, churches, hospitals, ravines, streets, and all other privately-owned property. A well-managed green infrastructure contributes directly to neighbourhood vitality, overall health and liveability of the urban area, enhancement of business centres and by providing natural recreation environments. Trees planted around homes, along streets and parking lots, and in urban lots and parks can reduce the impact of the heat islands that develop around most urban communities and play a supporting role in the sequestration of carbon, particulate matter and gaseous pollutants.

Strategic planning and management of the urban forest is essential to ensure a healthy and diverse tree cover that can provide a sustained supply of environmental, economic and social benefits to society. According to Moll (1989) the average city tree lives only 32 years; the closer to the city's centre, the shorter the life of the average tree. To help address these issues a long-range plan is essential for management of a resource that is by its very nature a long-term matter.

Trees in urban spaces are important resources, which require an organized plan to ensure their efficient management and long-term health. Planning also enables tree care professionals to attend to specific maintenance requirements to maximize the wide range of benefits that urban trees provide. The Town of Oakville has recently acknowledged the need for a standardized approach to tree care. To address this need, the authors developed the following strategic urban forest plan. The plan is structured to span a 20-year period beginning in 2008, and it encompasses an overall objective and addresses a wide spectrum of goals for Oakville's urban forest.

The Urban Forest

The urban forest resource is often overlooked and its sustainable management is often the exception rather than the rule. The wealth of benefits that the urban forest provides may be lost in the development and expansion of small communities, or as a result of in-fill development in established neighbourhoods. As with any resource, the urban forest requires care and attention to ensure its sustainability. More attention needs to be given to *planning* for the stewardship of this economically, environmentally and socially important resource.

RECOMMENDATION 1: The Town should consider amending its Official Plan to designate its municipally owned urban forest as 'green infrastructure'.

Conservation of trees in the urban environment can only be achieved effectively through the development and implementation of an urban forest strategic management plan

(UFSMP) that coordinates the policies and practices surrounding all activities related to trees. A plan that encompasses a long-term vision with short-term goals is necessary for the conservation and management of trees in the Town of Oakville.

As directed by the Town of Oakville, this plan addresses only lands south of Dundas Street. Urban forestry management activities north of Dundas Street, while beyond the scope of this plan will have implications for overall urban forest planning in the Town.

RECOMMENDATION 2 : The Town should develop a separate Urban Forest Strategic Management Plan for the lands north of Dundas Street consistent with the principles outlined in this document.

Benefits that the Urban Forest Provides to Communities

Conservation of urban forests is vital to sustain communities. Urban forests have many values, provide a multitude of environmental, economic and social services and are necessary contributors to the maintenance of lovable communities:

- The amount of air pollution filtered by Oakville's urban forest exceeds (102%) that which is produced by local industrial and commercial emissions of particulate matter (PM10) and 15% PM2.5 and over two times (243%) the amount of sulphur dioxide plus other criteria pollutants (Town of Oakville 2006).
- The total environmental benefits of the ecological services provided by the trees within the Town of Oakville have an annual value of $2.1 million (Town of Oakville 2006).
- Trees provide benefits associated with physical, mental and social human health (Sorte 1995; Dwyer et al 1992; Grahn and Stigsdotter 2003; Kuo 2003; Ulrich and Parsons 1993).
- Trees help to conserve energy by indirectly mitigating climatic effects through providing evaporative cooling, windbreak and shading functions, thus reducing human dependence on power generation (McPherson 1994; Pouyat and McDonnell 1991; Nowak 1994).
- Trees improve air quality by producing oxygen, absorbing pollutants and sequestering carbon (McPherson et al 1999; Nowak 1992; Rowntree et al 1991).
- Trees contribute to water quality and quantity improvement through storm water control, attenuation of peak flows, maintenance of base flow, erosion control and rainfall interception (Floyd 2002; Peck and Callaghan 1999; Bernatzky 1983; Xiao et al 1998).
- Urban forests cool watercourses and mitigate noise and dust (Harris 1992) that adds undue stress to wildlife populations.
- Trees provide habitat and food sources for wildlife such as birds, insects, small mammals and fish (Friesen et al 1995; Tilghman 1987).
- Urban forests create an appealing consumer environment in business districts (Wolf 2003).
- Trees increase property values (Canada Mortgage and Housing Corporation 1996; Environment Canada 1991).

While most people identify with these benefits at some level, there is a need for better quantification, awareness and appreciation of how they are linked to a healthy urban forest.

We have developed a strategic planning process for the Town of Oakville to help combine the requirements of urban growth with the need for ecosystem viability. This approach will allow the Town to better manage their urban forest as a resource, including municipal street trees and municipal woodlots. The details in each section are governed by the characteristics of Oakville's forest and the vision and objectives that the Town identified through a focus group meeting with a broad cross section of the Community on June 8th, 2006. This plan will make it possible for Town staff to address issues in a proactive, rather than reactive, way. While the details provided here might appear to be intimidating at first, the intention is to highlight important aspects of the protection and enhancement of Oakville's urban forest.

A VISION FOR THE TOWN OF OAKVILLE'S URBAN FOREST

Stakeholder Engagement Process

A visioning process was established whereby the goals and objectives of the Oakville community were determined through a focus group visioning session (see Appendix A) as well as other available resources and materials.

Focus Group Meeting

A focus group meeting was held on June 8th, 2006 directed by a team of professional facilitators. The purpose of the evening was to capture community input to the vision statement for the Urban Forest Strategic Management Plan for the Town of Oakville. Staff then took the results of this Focus Group and prepared a report to Council; at its meeting on October 16th, Council approved the following Vision and Mission Statements that serve to guide the development of this Plan:

Vision Statement for the Urban Forest

The vision statement for the Town of Oakville's UFSMP is:

> **Oakville's urban forest, an equal part of the community's infrastructure, contributes positively to the health of all residents. Oakville is a proud leader in urban forest stewardship.**

Mission Statement for the Urban Forest

The mission statement for the Town of Oakville's UFSMP is:

> **This Vision will be accomplished through protecting and enhancing the health and diversity of our urban forest to ensure the economic, environmental and social benefits for future generations.**

RECOMMENDATION 3: The Town should use the vision and mission statements cited in this plan to guide urban forest management in the Town of Oakville.

Criteria and Indicators of Success

This strategic plan includes a series of criteria and associated performance indicators. The performance indicators enable measurement of progress towards the achievement of the key objectives for each criterion. This in turn permits ongoing evaluation of success in implementing the plan.

Urban forest managers must be able to clearly identify where specific goals or targets have been met and when adaptations to approaches appear to be necessary. Sustainable urban forest management therefore requires clearly defined targets or criteria and specific indicators of success. For example, the Canadian Council of Forest Ministers has published *Criteria and Indicators of Sustainable Forest Management in Canada: National Status 2005* (Canadian Council of Forest Ministers 2005).

In addition, Clark *et al*. (1997) provided a list of criteria and indicators (C&I) for urban forest sustainability that considers

- the vegetation resource
- the community framework, and
- resource management approaches (see Appendix C).

Each criterion includes indicators describing low, moderate, good and optimal levels of performance. In this UFSMP we have expanded the C&I developed by Clark *et al*. (1997) and provide more detail in a number of areas (see Appendix D). These expanded C&I do not represent a complete list for all activities addressed in the UFSMP but rather focus on the main issues. While the coverage is comprehensive, the principles of adaptive management to be described later in this document must also apply to the C&I. Some modifications to the approach may therefore become necessary over the lifespan of the UFSMP; however, the plan should retain its general principles.

We assessed progress towards the sustainability of Oakville's urban forest by using the expanded C&I. The current status for the Town is indicated by shaded cells within Table 2.

Table 2. Criteria and performance indicators for sustainable urban forest management (Adapted from Clark et al. (1997)). Shaded cells indicate the status for the Town of Oakville at the time of writing this Urban Forest Strategic Management Plan. Where no shaded cells appear beside a criterion, insufficient data exists to accurately assess its current status.

Vegetation Resource

Criteria	Performance indicators				Key Objectives
	Low	Moderate	Good	Optimal	
Canopy Cover	The existing canopy cover equals 0-25% of the potential.	The existing canopy cover equals 25-50% of the potential.	The existing canopy cover equals 50-75% of the potential.	The existing canopy cover equals 75-100% of the potential.	Achieve climate-appropriate degree of tree cover, community-wide
Age distribution of trees in the community	Any Relative DBH (RDBH) class (0-25% RDBH, 26-50% RDBH, etc.) represents more than 75% of the tree population.	Any RDBH class represents between 50% and 75% of the tree population	No RDBH class represents more than 50% of the tree population	25% of the tree population is in each of four RDBH classes.	Provide for uneven-aged distribution city-wide as well as at the neighbourhood and/or street segment level.
Species suitability	Less than 50% of trees are of species considered suitable for the area.	50% to 75% of trees are of species considered suitable for the area.	More than 75% of trees are of species considered suitable for the area.	All trees are of species considered suitable for the area.	Establish a tree population suitable for the urban environment and adapted to the regional environment.
Species distribution	Fewer than 5 species dominate the entire tree population city-wide.	No species represents more than 10% of the entire tree population city-wide.	No species represents more than 5% of the entire tree population city-wide.	No species represents more than 5% of the entire tree population city-wide or at the neighbourhood/street segment level.	Establish a genetically diverse tree population city-wide as well as at the neighbourhood and/or street segment level.
Condition of Publicly-owned Trees[1] (trees managed intensively)	No tree maintenance or risk assessment. Request based/reactive system. The condition of the urban forest is unknown	Sample-based inventory indicating tree condition and risk level is in place.	Complete tree inventory which includes detailed tree condition ratings.	Complete tree inventory which includes detailed tree condition and risk ratings.	Detailed understanding of the condition and risk potential of all publicly- owned trees
Publicly-owned natural areas (trees managed extensively, e.g. woodlands, ravine lands, etc.)	No information about publicly-owned natural areas.	Publicly-owned natural areas identified in a "natural areas survey" or similar document.	The level and type of public use in publicly-owned natural areas is documented	The ecological structure and function of all publicly-owned natural areas are documented and included in the city-wide GIS	Detailed understanding of the ecological structure and function of all publicly-owned natural areas.
Native vegetation	No program of integration	Voluntary use of native species on publicly and privately- owned lands.	The use of native species is *encouraged* on a project-appropriate basis in both intensively and extensively managed areas.	The use of native species is *required* on a project-appropriate basis in both intensively and extensively managed areas.	Preservation and enhancement of local natural biodiversity

[1] Assumed that the municipality has little control of the condition of trees on private land except through property standards by-law.

Community Framework

Criteria	Performance indicators				Key Objective
	Low	Moderate	Good	Optimal	
Public agency cooperation	Conflicting goals among departments and or agencies.	Common goals but no cooperation among departments and/or agencies.	Informal teams among departments and or agencies are functioning and implementing common goals on a project-specific basis.	Municipal policy implemented by formal interdepartmental/ interagency working teams on ALL municipal projects.	Insure all city department cooperate with common goals and objectives
Involvement of large private and institutional land holders	Ignorance of issues	Educational materials and advice available to landholders.	Clear goals for tree resource by landholders. Incentives for preservation of private trees.	Landholders develop comprehensive tree management plans (including funding).	Large private landholders embrace city-wide goals and objectives through specific resource management plans.
Green industry cooperation	No cooperation among segments of the green industry (nurseries, tree care companies, etc.) No adherence to industry standards.	General cooperation among nurseries, tree care companies, etc.	Specific cooperative arrangements such as purchase certificates for "right tree in the right place"	Shared vision and goals including the use of professional standards.	The green industry operates with high professional standards and commits to city-wide goals and objectives.
Neighbourhood action	No action	Isolated or limited number of active groups.	City-wide coverage and interaction.	All neighbourhoods organized and cooperating.	At the neighbourhood level, citizens understand and cooperate in urban forest management.
Citizen-municipality-business interaction	Conflicting goals among constituencies	No interaction among constituencies.	Informal and/or general cooperation.	Formal interaction e.g. Tree board with staff coordination.	All constituencies in the community interact for the benefit of the urban forest.
General awareness of trees as a community resource	Trees seen as a problem, a drain on budgets.	Trees seen as important to the community.	Trees acknowledged as providing environmental, social and economic services.	Urban forest recognized as vital to the communities environmental, social and economic well-being.	The general public understanding the role of the urban forest.
Regional cooperation	Communities cooperate independently.	Communities share similar policy vehicles.	Regional planning is in effect	Regional planning, coordination and /or management plans	Provide for cooperation and interaction among neighbouring communities and regional groups.

Management Approach

Criteria	Performance Indicators				Key Objective
	Low	Moderate	Good	Optimal	
Tree Inventory	No inventory	Complete or sample-based inventory of publicly-owned trees	Complete inventory of publicly-owned trees AND sample-based inventory of privately-owned trees.	Complete inventory of publicly-owned trees AND sample-based inventory of privately-owned trees included in city-wide GIS	Complete inventory of the tree resource to direct its management. This includes: age distribution, species mix, tree condition, risk assessment.
Canopy Cover Inventory	No inventory	Visual assessment	Sampling of tree cover using aerial photographs or satellite imagery.	Sampling of tree cover using aerial photographs or satellite imagery included in city-wide GIS	High resolution assessments of the existing and potential canopy cover for the entire community.
City-wide management plan	No plan	Existing plan limited in scope and implementation	Comprehensive plan for publicly-owned trees accepted and implemented	Comprehensive plan for ALL components of the urban forest (private and public assets) accepted and implemented.	Develop and implement an urban forest management plan for private and public property.
Municipality-wide funding	Funding for reactive management	Funding to optimize *existing* urban forest.	Funding to provide for net increase in urban forest benefits.	Adequate private and public funding to sustain maximum urban forest benefits.	Develop and maintain adequate funding to implement a city-wide urban forest management plan
City staffing	No staff.	No training of existing staff.	Certified arborists and professional foresters on staff with regular professional development.	Multi-disciplinary team within the urban forestry unit.	Employ and train adequate staff to implement city-wide urban forestry plan
Tree establishment planning and implementation	Tree establishment is *ad hoc*	Tree establishment occurs on an annual basis	Tree establishment is directed by needs derived from a tree inventory	Tree establishment is directed by needs derived from a tree inventory and is sufficient to meet canopy cover objectives	Urban Forest renewal is ensured through a comprehensive tree establishment program driven by canopy cover, species diversity, and species distribution objectives
Pruning of publicly-owned, intensively managed trees	No pruning of publicly-owned trees	Publicly-owned trees are pruned on a request/reactive basis. No systematic (block) pruning.	All publicly-owned trees are systematically pruned on a cycle longer than five years.	All mature publicly-owned trees are pruned on a 5-year cycle. All immature trees are structurally pruned.	All publicly-owned trees are pruned to maximize current and future benefits. Tree health and condition ensure maximum longevity.

Management Approach					
Criteria	**Performance Indicators**				**Key Objective**
	Low	**Moderate**	**Good**	**Optimal**	
Hazard tree management	No tree risk assessment/ remediation program. Request based/reactive system. The condition of the urban forest is unknown	Sample-based tree inventory which includes general tree risk information; Request based/reactive risk abatement program system.	Complete tree inventory which includes detailed tree failure risk ratings; risk abatement program is in effect eliminating hazards within a maximum of one month from confirmation of hazard potential.	Complete tree inventory which includes detailed tree failure risk ratings; risk abatement program is in effect eliminating hazards within a maximum of one week from confirmation of hazard potential.	All publicly owned trees are safe.
Tree Protection Policy Development and Enforcement	No tree protection policy	Policies in place to protect public trees.	Policies in place to protect public and private trees with enforcement.	Integrated municipal wide policies that ensure the protection of trees on public and private land are consistently enforced and supported by significant deterrents	The benefits derived from large-stature trees are ensured by the enforcement of municipal wide policies.
Publicly-owned natural areas management planning and implementation	No stewardship plans or implementation in effect.	Reactionary stewardship in effect to facilitate public use (e.g. hazard abatement, trail maintenance, etc.)	Stewardship plan in effect for each publicly-owned natural area to facilitate public use (e.g. hazard abatement, trail maintenance, etc.)	Stewardship plan in effect for each publicly-owned natural area focused on sustaining the ecological structure and function of the feature.	The ecological structure and function of all publicly-owned natural areas are protected and, where appropriate, enhanced.

RECOMMENDATION 4: The Town should use the series of criteria and indicators in Table 2 to track progress towards short- and long-term objectives. This should be used to measure, monitor and evaluate the implementation of the UFSMP at the end of each 5-year Management Plan and to inform a report to Council on the State of the Urban Forest. Furthermore, the Criteria and Indicators Table should be added to the Town's 2007-2010 Corporate Strategic Plan in order to help track the Town of Oakville's progress on managing its urban forest on a sustainable basis.

Canopy Cover

A popular way to describe the extent of the urban forest is to measure the amount of canopy cover provided by trees. "Canopy cover" is essentially a two-dimensional measurement of the horizontal surface area of the forest as seen from a "birds-eye" view. As part of the emerging public policy and scientific dialogue on urban forest management, canopy cover goals have received a great deal of attention as a strategic management target. Setting such goals has many implications, including the associated need for increased tree planting and the long-term resources to manage the expanding urban forest. The following discussion on targets for canopy cover provides some context for policy makers and managers.

The advantage of measuring canopy cover is that it is a simple, intuitive indicator. However, measuring only canopy cover does not provide information about other essential parameters required to effectively manage and sustain a community's urban forest. For example, canopy cover provides no indication of the species diversity of the

forest, no measure of the condition of the forest, and no indication of the age or size class distribution of the trees making up the forest. Canopy cover measures alone provide no estimate of the carrying capacity of a particular part of the city. For example, one area may have a canopy cover of 10% but it is possible that this may be all that this area could support; for example a commercial area. Another part of the community may be dominated by light industry and also exhibiting 10% cover but with a potential to support significantly more. Canopy cover alone tells us little of this variation.

In 2005 the Town had an average canopy cover of 29.1% with a distribution across the various communities as illustrated in Figure 1.

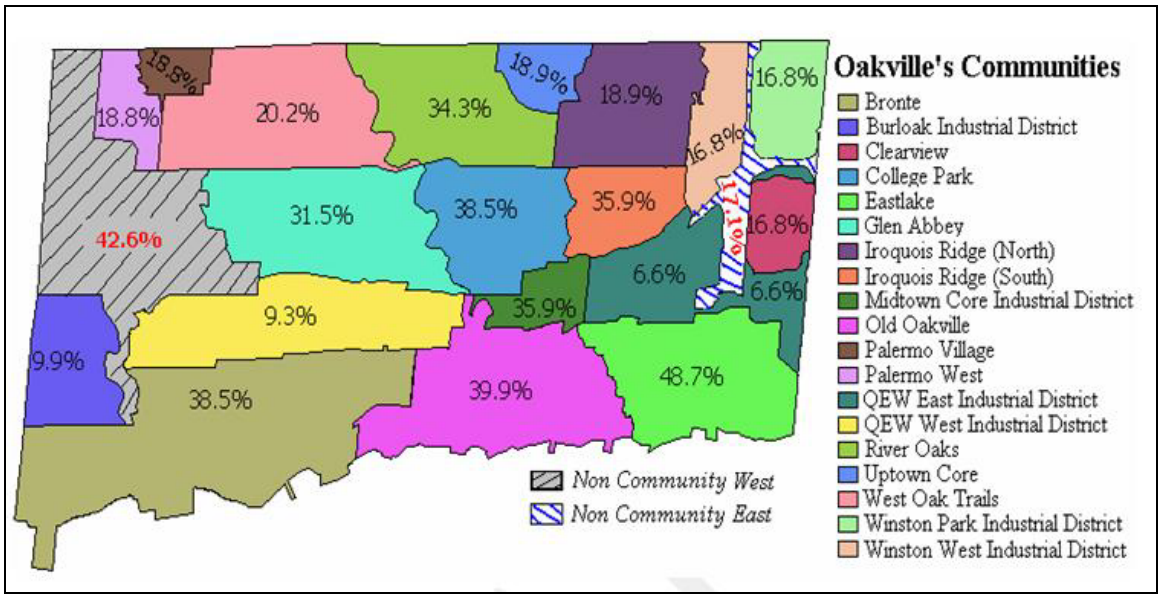

Figure 1: Existing urban forest canopy cover by community (Town of Oakville 2006).

In discussions with staff, a 10% stocking was applied to the plantable space for each land use type (excluding woodlots) and simulations were run in 2006 by Dr. David Nowak of the USDA Forest Service using the UFORE growout model. This simulation resulted in an estimated canopy cover increase of 0.5% by 2040 or a change from the current 29.1% to 29.6%. This was the basis upon which we established a working canopy cover target for the development of this plan.

RECOMMENDATION 5: The stocking level in all land use types (except woodlots) should be increased by 10% (based on the assumptions of the UFORE Growout simulation) to achieve an estimated overall canopy cover of 30%.

During the finalization of this plan the consulting team was informed that the Town intended to embark on a bold initiative to pursue a new canopy cover goal. As part of National Forest Week in September, 2007 the Mayor's Office put forward a goal of "40% tree canopy coverage in 50 years" as a proposed sesquicentennial legacy project for Oakville. Staff and the authors of this plan spent considerable time examining many options and their implications *vis a vis* this long-term goal. To examine the feasibility of

achieving this goal, Dr. Nowak was asked to provide a number of additional simulations to estimate the size of a tree establishment program required to meet this target. A consolidated summary of the simulations run in 2007 is provided in Appendix B1. This document outlines the methods used to arrive at the estimates for the 30% and 40% canopy cover tree establishment targets which are illustrated in Table 3. The variables considered are mortality rates of 2%, 4%, 6% and 8% as well as the estimated growth rates for crown expansion. For the latter, Dr. Nowak provided simulations using sugar maple as a mid-range model species.

Table 3. Approximate number of trees to be established annually to reach tree and shrub cover goals of 30 and 40%. These values represent the number of trees if medium-sized (sugar maple) trees are planted.

Mortality Rate	30% Goal	40% Goal
2%	0	4,000
4%	16,000	32,000
6%	39,000	70,000
8%	70,000	121,000

These simulations assume that certain percentages of the space not currently occupied by trees can support tree growth. Discussion between staff and the authors of this plan also considered the feasibility of increasing the growing space in some particular locations. John Ghent was asked to explore the feasibility of expanding the tree cover from a planning perspective, in some selected landuse types within the Town. The document in Appendix B2 provides some evidence that a 40% canopy cover could be achieved by using creative planning and construction techniques in some parts of the Town.

Although the consulting team feels it is appropriate to "aim high", we have not had the opportunity to consider all the challenges associated with achieving such an ambitious level of canopy cover. However, it is our opinion that these challenges are significant and we would be remiss not to present them here and to express some concerns we have about how these challenges relate to the overall stewardship of the Town's urban forest as it is illustrated in the rest of this plan.

Mortality rates

Little information is available about actual mortality rates in urban forests (Nowak *et al.*, 2004) but Table 3 clearly illustrates that any effort to sustain or enhance canopy cover is extremely sensitive to mortality. The 2% rates used in some of the early simulations that were considered are conservative; it is the lowest rate considered by Nowak when running the models. For example Nowak *et al.*, (2004) estimated an overall mortality rate for Baltimore of 6.6%. Other simulations cited in the same study indicated that decreasing annual mortality rates from 6.6% to 2.3% would lead to a 540% increase in canopy cover in 100 years. However, *increasing* mortality from 6.6% to 11.6% would virtually eliminate the canopy in 100 years. The importance and difficulty in predicting

mortality rates are particularly critical when adding consideration of the potential impacts of climate change in general and extreme weather more specifically.

Invasive pests

The potential impacts of invasive alien insects such as Emerald Ash Borer and Asian Long Horned Beetle are also difficult to predict but could have a significant impact on these estimates. For example, almost 10% of the Town's urban forest is susceptible to Emerald Ash Borer and could be lost within 15 years to this one invasive insect alone. During the preparation of this management plan, Emerald Ash Borer was confirmed to exist in the urban forest of London, and Toronto. It is hard to imagine that Oakville could be spared.

As an example of the magnitude of this threat, consider the efforts need to contain Asian Long Horned Beetle in the Toronto area. In their efforts to contain the spread of the beetle the cities of Toronto and Vaughan removed well in excess of 20,000 trees by 2005. Approximately 40% of Oakville's urban forest is represented by tree species which are known hosts to Asian Long Horned Beetle. Table 8 of the report *Our Solution to Our Pollution* (Oakville 2006) provides a summary of these and other pests that threaten the forest. Keep in mind these are the *currently* known pests that pose a significant threat but trends suggest that others may become apparent in the future. For example, Humble (2004) notes that many other invasive insects have been detected adjacent to the port of Vancouver illustrating that continued vigilance is imperative and that tree mortality rates must be considered with caution.

In-fill development

In established residential neighbourhoods in-fill development can be expected to contribute to further losses of mature tree canopy. At the time of writing the contribution of this loss to the overall mortality rate has not been quantified.

The significance of private ownership in the urban forest

A significant portion of the tree establishment proposed in Table 3 must occur in the residential zones of the Town. We do not have a clear indication at this time what proportion of this area would be accessible to the Town for tree establishment. Therefore achieving these goals will be contingent upon an effective public engagement program for tree establishment. This must include private landowners, developers and builders.

Tree planting alone will not be able to sustain the canopy cover of the Town, let alone increase it. There must also be policies and practices to protect existing trees, and attention paid to other factors discussed below to help achieve lower mortality rates.

Note that we have used the term "establishment" here to describe something more than merely tree *planting*. The point to emphasize is that the estimates are predicated on very good survival and growth of the planted trees.

To ensure that as many tree as possible survive and become large enough to contribute significantly to the Town's canopy, they must be:

- planted in good tree habitat
- irrigated regularly for at least the first five years after planting, and
- protected with budgeted and implemented tree maintenance services *throughout* their life.

Unfortunately, canopy cover estimates alone do not indicate the potential cover that could be accommodated across the city as a whole or in any specific areas within the Town. Kenney (2000) addressed this concept in assessing the "potential leaf area" as determined by land use and the extent and configuration of hard surfaces. In plain terms, potential leaf area is a three-dimensional measure and canopy cover is not. Ideally, an assessment of the potential leaf area should be completed for the Town of Oakville before any meaningful targets are set.

RECOMMENDATION 6: The Town should consider incorporating an assessment of potential leaf area by land use type into the 2009 UFORE study.

With this in mind, we invite the reader to review the discussion above dealing with the assumptions of tree mortality and other challenges that underpin estimates for future canopy cover. While effective tree establishment is important, it is only part of the picture. **The protection and maintenance of the existing trees that form the Town's urban forest canopy is absolutely critical. The importance of planning for and adequately funding tree maintenance and protection throughout the life of the trees cannot be overstated.**

Given the constraints and uncertainties outlined above, we are of the opinion that setting a canopy cover target as high as 40% could focus urban forest management activities on tree planting. This could be to the detriment of the strategic and comprehensive approaches that are outlined in this document if the Town does not also move forward with implementing the other programs that are measured by the Criteria and Performance indicators in Table 2.

We believe a number of significant challenges exist to accomplishing this specific goal of 40% in 50 years, including:

- Mortality rates: little scientific evidence available to support the mortality rates assumed in the grow-out models
- Climate change
- Invasive insects
- In-fill development/intensification
- Uncertainty in the available growing space for new trees
- The reliance on high levels of sustained planting in the private sector

- Budgetary and resource implications for long-term maintenance required to support aggressive tree establishment goals
- The time required to implement ALL of the aspects of this UFSMP – an imperative if the goals are to be met. Examples of such components of the strategy (discussed in more detail below) include but are not limited to:

    - Completion of a comprehensive tree inventory and creation of an asset management system
    - Creation of a new organizational business process that will facilitate collaboration and efficiency among Town departments
    - Creation of new corporate engineering road cross sections and new planning design guidelines which reflect the standard for tree habitat
    - Revision of zoning by-laws to regulate "tree growing areas" for each land use type
    - Creation of a public education and engagement plan using community-based social marketing tools

While canopy cover provides a very simple and intuitive measure of the extent of the Town's urban forest, we feel that a much more comprehensive measure of the success of the Town's efforts in urban forest stewardship rests with moving steadily and aggressively towards the "optimal" performance indicators of ALL of the criteria outlined in Table 2 of this plan.

THE URBAN FOREST STRATEGIC MANAGEMENT PLANNING (UFSMP) APPROACH

The objective of this strategic management plan is to implement an efficient and integrated approach to urban forest management for the promotion and growth of healthy, functioning trees. This objective is technical in nature while the aim is to fulfill the vision over the 20-year timeline.

This long-term (20+ years) plan will guide operations using a state-of-the-art tree information database in conjunction with a management cycle approach that will monitor short- and long-term trends. Based on these trends, it will serve as a tool for proactive management of Oakville's green infrastructure. This is intended to be an adaptive and "living" plan, creating a clear path for planning and activity, and the opportunity to celebrate these resources as a core value of the region.

The 20-year Strategic Plan 2008-2027

The highest level of the Strategy is the *20-Year Plan* which sets out the vision, goals and objectives to be achieved. These guiding principles were created through consultation with community members and Town staff. The vision, goals and objectives guided the development of this Plan. The 20-year plan works within the framework of the Town of Oakville Official Plan as well as upper-tier (regional, provincial, federal) land use plans.

Nested within this plan are four 5-year *management* plans. Each of these will incorporate strategies from the 20-year plan but will also build upon the successes or failures of the previous management plan. Finally, for each year there will be an *annual operating plan* in which the details of the day-to-day activities are outlined (see Figure 2).

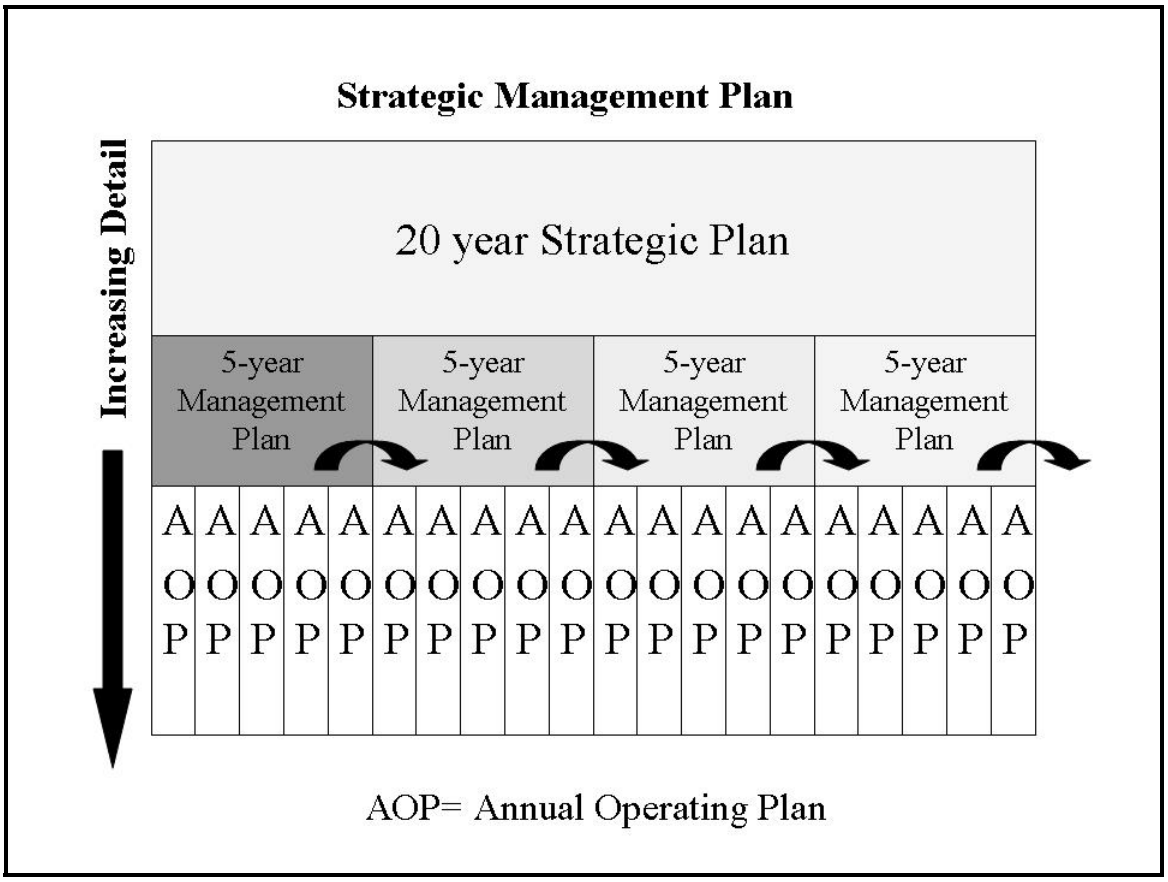

Figure 2: Temporal structure of the Urban Forest Strategic Management Plan.

Five-year Management Plans

The 20-year strategic plan will incorporate four of these 5-year management plans, each of which in turn is the first level of operational planning. The intention is not to attempt to develop the specific details of all four plans at once. Rather, developing these subsequent details becomes an ongoing process determined by reviewing the success or challenges of the previous five years of operations.

Each 5-year management plan will outline broad operational objectives for the relevant period, which in turn will then inform the annual operating plans. Figure 3 illustrates the contextual structure and indicates (shaded), the components that repeat throughout each plan. Those areas exist as a working document and will be revised accordingly based on the previous year's 5-year management plan review; any revisions will be done in the fifth year of each plan.

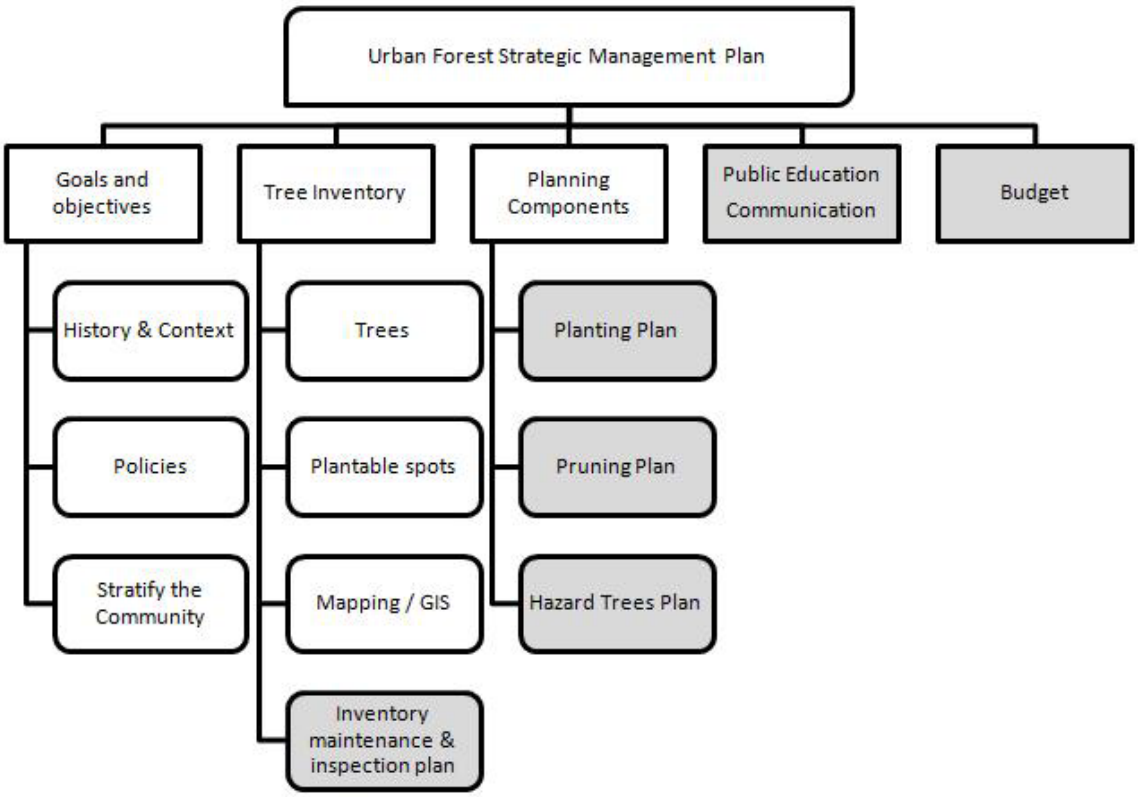

Figure 3: Contextual structure of the Urban Forest Strategic Management Plan.

RECOMMENDATION 7: The Town will develop each 5-year management plan. The second, third and fourth 5-year management plans will be based on a review of the successes and challenges of the preceding management plans.

Annual Operating Plans

Annual operating plans (AOP) will direct the day-to-day operations and can be used to project budget requirements for all aspects of maintaining the urban forest. The annual plan will include plans for planting, pruning, removals, inspections and maintenance of the inventory. Initially, the annual plan will need to address priorities derived from the inventory, but eventually will be focused on proactive management objectives. The preparation of all 20 AOPs is the responsibility of the Town.

Adaptive Management and the UFSMP

Forested ecosystems are complex and dynamic entities. With the addition of the human component, the complexity increases substantially; this is particularly the case when one considers dominance of human intervention in the urban environment. While managers cannot predict change they must be prepared to accommodate this change while working toward broader goals or a vision for the management of the resource in their care. The concept of adaptive management recognizes this paradox. The Millennium Ecosystem Assessment project of the United Nations defines adaptive management as:

> A systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices. In **active adaptive management**, management is treated as a deliberate experiment for the purpose of learning.

The concept is similarly defined by many other organizations, and the principles remain the same. The problem is first carefully assessed and a strategy or approach is designed and implemented. The impacts or results of the approach are then monitored in a systematic manner and any adjustments are made based on the experience gained and new information that has become available. The adjusted approach is implemented and the evaluation cycle continues for as long as is necessary to accomplish the goals or to accommodate changing environmental, social, or policy directions. This is represented graphically in Figure 4.

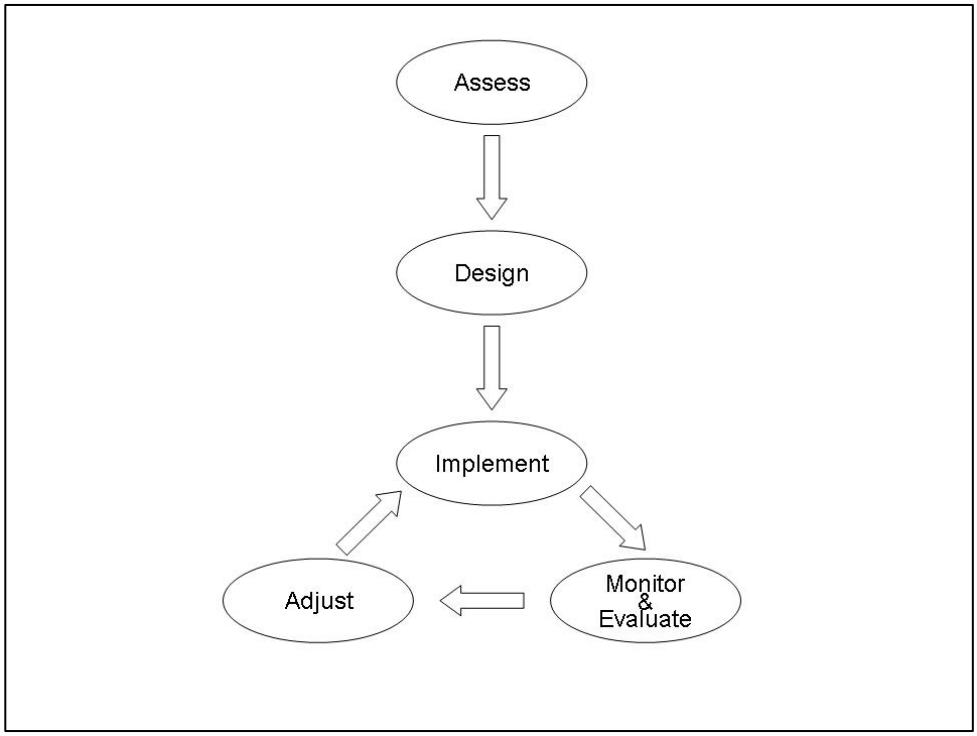

Figure 4: Evaluation cycle of the Urban Forest Strategic Management Plan.

RECOMMENDATION 8: The Town will adopt the principle of active adaptive management to accomplish urban forest policy objectives in light of the constantly changing ecological, social and regulatory environment.

THE CONTEXT FOR THE UFSMP

The Ecological Context

According to the National Ecological Framework of Canada, Oakville is situated in the Lake Erie Lowland Ecoregion of the Mixedwood Plains Ecozone (Environment Canada 2005). This zone is unique to Southern Ontario, and the ecological conditions are similar to other municipalities such as Toronto, Windsor, and Niagara Falls. The mean summer temperature is 18°C and the mean winter temperature is -2.5°C. The mean precipitation ranges from 750 to 900 mm, with no distinct dry period.

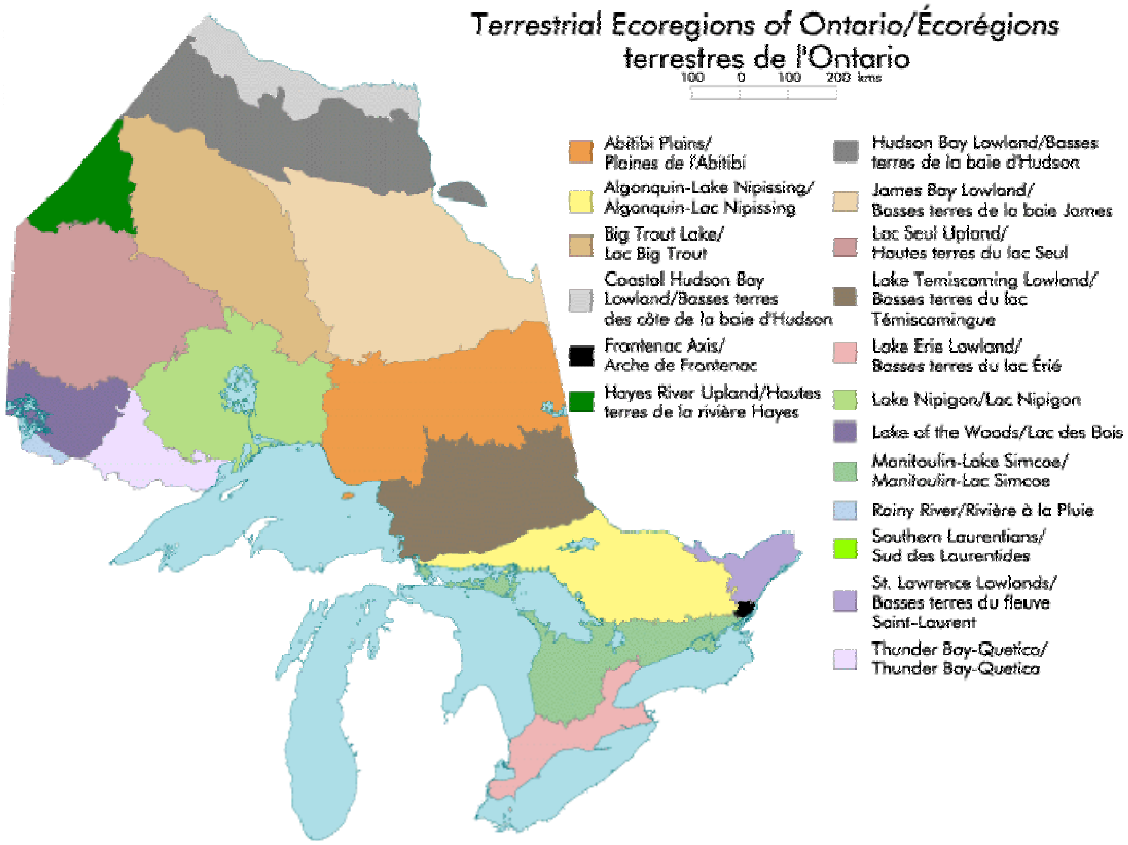

Figure 5: Terrestrial Ecoregions of Ontario (Source: http://wildspace.ec.gc.ca/maps-e.html).

In the ecoregion, the bedrock is carbonate-rich and the most common soils are Clayey Gleysolic and Gray Brown Luvisolic. East of the Niagara Escarpment, there are many levels, fine-textured lacustrine deposits, with some sandy to loamy till deposits as well. In Oakville, sandy to loamy soils are generally found between the lakeshore and the Queen Elizabeth Way (QEW). North of QEW until Dundas Street West, the soil texture changes from silt clay to clay.

Common tree species located in woodlands in the region include sugar and silver maple, beech, white and red oak, shagbark hickory, black walnut, butternut, red and black ash, balsam poplar, black cherry, bitternut hickory, and tulip tree. This species composition is

often referred to as Carolinian forest and in Canada is only found in Southern Ontario. Common wildlife species include white-tailed deer, chipmunk, cardinal, screech owl, green heron, and pileated and red-bellied woodpecker.

This ecoregion is also the most heavily populated area in Canada, with approximately 3,938,000 people. Of these, 161,500 live in Oakville (Town of Oakville 2006). Oakville's southern border is adjacent to Lake Ontario, and the city has two major valleys bisecting it in a north-south direction: Sixteen Mile Creek, which has steep, well-treed walls, and Bronte Creek. There are also several minor valleys and tributaries: Fourteen Mile Creek, Joshua's Creek, McCraney Creek, Taplow Creek, Glen Oak Creek, Osenego Creek, Shannon Creek, Munn's Creek, Morrison Creek, Sheridan Creek, Sheldon Creek, Wedgewood Creek, and both the upper and lower Morrison Creek systems. Figure F1 of Oakville's Official Plan shows valleys and significant woodlands. Figure F2 shows Environmentally Sensitive Areas, Areas of Natural and Scientific Interest, floodplains, and wetlands. Additionally, Appendix IV of the Official Plan highlights potential linkages in North Oakville to the Oak Ridges Moraine, which is a significant landform of Southern Ontario, containing the headwaters of 65 river systems (City of Toronto 2006).

Geographic Boundaries

This plan considers all land within the boundaries of the Town of Oakville south of Highway 5 (Dundas Street West). See Figure 6 below.

Figure 6: Map of Oakville showing study area of UFSMP.

The Current Management Context

Human Resources

Staff has indicated that, within the Forestry Section, by 2007/2008 the intent is to offer "one stop shopping" customer focus for all public tree issues. This will involve the transfer of responsibility for tree planting and establishment to the Forestry Section for: (1) assumed Parkland; and (2) Design and Construction capital projects. These moves complement the progress made in 2004 to (a) create a 'Tracking system' for offenders of the Town's Tree Policy through the AMANDA system as well as efforts underway to follow up on Council's directive to (b) prepare an Urban Forest Strategic Management Plan and (c) practice the highest standard for forest stewardship at Iroquois Shoreline Woods Park. In addition, Council approved a major 2005 project – Urban Forest Effects Model (UFORE) to quantify the environmental benefits of Oakville's urban forest.

To deliver these new initiatives a realignment within the urban forestry section was accomplished in 2005. Figure 7 shows the new responsibilities using the existing staff complement. This is intended to streamline urban forestry services and improve efficiency. This will permit Forestry staff to focus on the main areas of service. Staff have indicated that the "…Heritage Tree operations portfolio will continue to maintain Town trees and the Forest Health portfolio will concentrate on woodlands stewardship as well as tree protection policy".

The Municipal Tree Protection Inspector position was approved in the 2005 budget as a full-time position to help implement the Tree Policy within Community Services. This pertains to all issues associated with utilities during capital projects as well as residential driveway permits. During the May- September period, the Forestry staff member conducted 421 inspections with the intent to improve the standard for Town tree protection.

There are currently 14 full-time staff positions in the Town of Oakville's Forestry Section's five Business Units, and 10 summer students are hired for watering and care of trees within the Small Heritage Tree Business Unit. The Large Heritage Tree Business Unit is responsible for continued maintenance of the Town trees; however, stump removal is contracted. The Woodlands Business Unit concentrates on woodlands stewardship. The Tree Protection Business Unit administers the Tree Permit system; The Line Clearing/Region of Halton Business Unit performs tree care for Oakville Hydro and the Region of Halton respectively and the Administration Business Unit develops urban forest policy and procedure.

Management Structure

The Manager of Forestry and Cemetery Services is responsible for the overall program service delivery of two separate Sections: Forestry Services and Cemetery Services. The Supervisor of Heritage Trees coordinates the large tree maintenance program including inspections, work orders and supervision of the seven members of the maintenance staff. The Supervisor of Forest Health coordinates 5 staff divided among the stewardship of

woodlands business unit, Town tree protection in the Tree Protection Business Unit and tree planting in the Small Heritage Tree Business Unit.

These positions integrated into the Parks and Open Space Department as outlined in Figure 7:

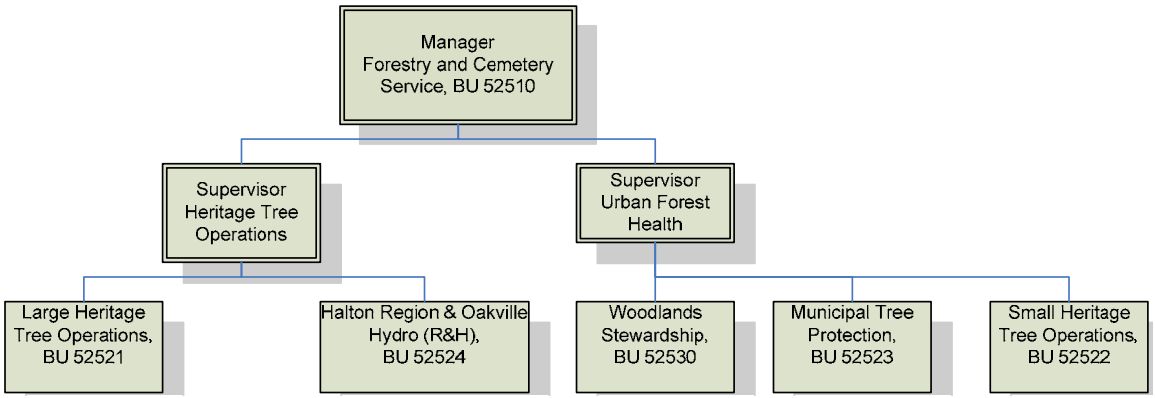

Figure 7: Organizational Structure of the Parks and Open Space Department

The focus of the Forestry Services Section is to meet people's needs for the safety of Town trees and stewardship of the environment through taking care of the urban forest. The Town assigns this service to the Forestry Section (Town of Oakville 1998). The Forestry Section Business Plan 1998-2000 outlines the following core activities, as updated:

1. Safety of Town trees:

   Large Heritage tree Business Unit – inspection services, advice, trimming, removal, cabling, stump removal, annual line clearing for Oakville Hydro, emergency response.

2. Plant Health Care:

   Small Heritage tree Business Unit – insect and disease advice, environmental outreach programs such as Arbor Day, watering and fertilizing new trees.

3. Town Tree Protection:

   Tree Protection Business Unit administers the Tree Permit system for municipal trees during construction activities. (Private trees and Town trees affected through the Site Plan are reviewed by the Development Services Department. Committee of Adjustment processes are reviewed and processed in Forestry as well as five other departments including: Development Services, Construction and Engineering, Planning, Building and Legal Departments. Forestry's main concern in these applications is Town trees.

4. Emergency Response

   Respond to Fire Dispatch via a 24 hour/day, 7 day a week basis due to trees breaking in storms (wind, ice) that block roads and cause hydro power outages.

5. Line Clearing

   Implement all Oakville Hydro Line Clearing and Capital project work through a 10 year agreement.

6. Regional Road Maintenance

   Responsible for tree care of the Region of Halton's street trees through the Agreement the Region has in place with its four lower-tier municipalities

7. Woodlands Stewardship

   In 2006, the Town became the first lower-tier municipality in Canada to have its woodlands certified sustainable under the Smartwood Program of the Forest Stewardship Council. It is the responsibility of this unit to ensure that the requirements for certification are met.

Physical Resources

The physical resources, as of February 1st, 2007, held by the Forestry and Cemetery Services Division of the Parks and Open Space Department are:

- 3 aerial devices (bucket trucks) (1 rental)
- 2 chipper trucks
- 1 Hiab crane truck
- 1 Gator utility vehicle for trails
- 5 water trailers
- 10 pick-up trucks (5 rentals)

NOTE: We feel that the use of the term "Heritage Tree" in the above context is inappropriate and will be confused with the term "heritage trees" as discussed elsewhere in the plan but more importantly elsewhere in the province, country and internationally.

RECOMMENDATION 9: The Town should change the name of the "Large Tree Heritage Business Unit" and "Small Tree Heritage Business Unit" to avoid confusion with other common uses of the term "heritage tree".

The Policy Context[2]

The Town of Oakville Official Plan (Ghent Planning Services)

The guiding policy for the UFSMP is the Town of Oakville Official Plan. This is the Town's overall planning document and it determines the pattern of physical development of Oakville with respect to land use, community organization, growth and the phasing of growth, investment in infrastructure, and policy formation.

The Town's Official Plan contains an Environmental and Open Space component as well as several Urban Forestry initiatives. Most importantly, the Official Plan includes a commitment to create an "Urban Forestry Green Plan." This initiative has resulted in the creation of the UFSMP.

Goals and Objectives of the Official Plan

One of the key objectives of the Official Plan is:

> To protect the natural environment and to promote a visual appearance in the built environment in sympathy with the natural landscape. (Part B.1. Municipal Structure)

The Official Plan states this will be achieved by:

> (implementing) an ecosystem approach to planning and development which minimizes the disruption of natural resources while ensuring the long-term health of the natural, social and economic systems which meets the needs of the present without compromising the needs of future generations. (Part B.1. Municipal Structure)

These statements provide the basis for policies in the Official Plan that relate to planning for the urban forest in the Town of Oakville.

The Official Plan contains a major section on "greenlands" with numerous provisions that bear directly on how the urban forest will be preserved, maintained, sustained, promoted, and enhanced.

The goals for Oakville greenlands are:

> To create a greenlands system of parkland, open spaces and natural areas which preserves the integrity of the natural environment, enhances urban form, improves the quality of life and provides for a diversity of recreational opportunities while minimizing disruption of natural features.
>
> To improve the quality of the natural environment by taking proactive measures to protect and enhance the quality and integrity of ecosystems, and natural processes including air, water, land, and biota; and, where quality and integrity

[2] Some sections of this document regarding the policy context were prepared by John Ghent of Ghent Planning Services (2007). These sections are marked to indicate this.

> have been diminished, to promote the restoration or remediation to healthy conditions where appropriate.
>
> To promote ecosystem health which requires the protection, maintenance, restoration and enhancement of natural ecological processes, native species, significant natural features, biological diversity, wildlife habitat and protection of irreplaceable natural resources. (Part B.8. Greenlands)

The objectives for Oakville greenlands are:

> To create a system of municipal parks and open spaces that provides a continuous network of lands to link, as much as practical, natural areas, regional and provincial open space systems and the waterfront.
>
> To identify and protect areas that have a high natural value; perform important ecological functions; have high biological value; contribute to ecosystem linkages; provide significant wildlife habitat; or represent the range of natural landscape types that characterize the Town of Oakville.
>
> To reduce or eliminate adverse impacts to existing natural features due to day-to-day human activities where appropriate.
>
> To rehabilitate natural features that have become degraded by urban influences in order to sustain a diversity of native plant and wildlife species.
>
> To identify opportunities for restoration of natural conditions in areas that have not been maintained in a natural condition such as valleylands, parkland adjacent to natural features and natural corridors and greenways, and to encourage the naturalization of these areas." (Part B.8. Greenlands)

Collectively, these goals and objectives provide a strong policy direction for the Town not only to protect the existing forest, but to restore, rehabilitate and expand the urban forest in Oakville to recover some of what has been lost or threatened.

Environmental Management of the Urban Forest (Ghent Planning Services)

Under the heading of Environmental Management, the Official Plan sets **a clear goal for Oakville's urban forest**.

> To preserve and enhance the level and quality of tree cover within developed areas of the Town and optimize the use of native species in order to develop a healthy urban forest. (Part B.9)

In response to this goal, the UFSMP closely addresses the concept of "level and quality of tree cover". In order to take into account not only the *amount* of tree cover ("level") but also the *quality* of tree cover, urban foresters and arborists may express this concept variously as "canopy cover" or "leaf area" where appropriate. For reasons discussed in this report, this UFSMP uses canopy cover as well as leaf area (see Glossary) as indicators of the extent of the urban forest.

According to the Official Plan, Oakville has five objectives for its urban forest:

> To develop an Urban Forestry Green Plan which will promote reforestation and replacement of Oakville's aging urban forest.

To increase the amount of urban forest on road rights-of-way.
To promote the use of native plant species on municipal-owned and managed properties and as street plantings.
To encourage land developers, businesses and individuals to maintain and preserve native tree species.
To encourage naturalization throughout the Town. (Part B.9)

The first objective provides direction for the development of this document: an Urban Forest Strategic Management Plan. The Official Plan also includes more detail regarding management, planning and policy direction for urban forests:

10.3 Urban Forests

a) The Town may prepare an Urban Forestry Green Plan which will establish policies for urban forest preservation, replacement of aging trees and reforestation through the practices of the Town, through conditions of planning approval, and through the landscaping practices of Town residents.
b) It is the objective of the Town that there will be no net loss of existing urban forests. As such, for every tree that is removed from Town property or from road rights-of-way, a replacement tree will be planted.
c) The Town shall set annual targets and identify priority streets for tree planting in order to increase the urban forest inventory on road rights-of-way.
d) The Town shall ensure that appropriate space for tree plantings within road rights-of-way are included in the design of new roads or road improvements.
e) The Town shall request local utilities to design and construct their services to minimize damage to trees.
f) The Town shall require as a condition of planning approval, site plan approval and subdivision agreement, landscape plans which maintain and preserve existing plant species where appropriate; integrate development with natural features on or adjacent to the site; maximize additional tree plantings.
g) The Town shall continue to naturalize municipally-owned open spaces.
h) The Town shall encourage the Province to amend the Trees Act to broaden local municipal powers to protect trees on private property.
i) The Town shall develop guidelines for protection of trees to assist with the review and approval of building permits, municipal consents by utilities and site plan approval." (Part C.10 Environmental Management)

Note that item 10.3 (b), above, states the Town objective that "there will be no net loss of existing urban forests. As such, for every tree that is removed from Town property or from road rights-of-way, a replacement tree will be planted."

We believe that this kind of 'one-for-one' replacement policy was a commendable initiative for the 1980's; however, current land use pressures such as in-fill housing trends have rendered this approach outdated. While well intended, one-for-one replacement is not adequate, principally because mature large-stature trees offer much greater benefits than newly planted trees. Although the Official Plan as written may preserve the absolute number of trees in Oakville, the Town should not assume it can prevent significant and perhaps irreparable loss of urban forest benefits with this stipulation alone.

RECOMMENDATION 10: The Town's Official Plan, Section 10.3(b) should be amended to read: "It is the objective of the Town that there will be no net loss of

existing urban forests. As such, for every square metre of leaf area that is removed from Town property or from road rights-of-way, that sufficient trees will be replanted to replace the lost square metres of leaf area."

Other Relevant Town of Oakville Policies (Ghent Planning Services)

There are other parts of the Official Plan that affect the urban forest. These include the following under "Part C – General Policies:"

The Town seeks to preserve trees in the evaluation of development proposals.

> 7.1 In order to encourage quality building and landscape design in sympathy with the distinct character of individual communities or neighbourhoods, and with the natural features of the landscape, the Town may apply the provisions of controlling development in the Planning Act and other provisions of this Plan to assess proposals for any development with respect to (…):
> b) the preservation and use of the natural contours and features such as trees, watercourses, hills, etc. (Part C.7 Urban Aesthetics)

The Official Plan addresses this objective directly in the criteria for evaluating infill projects.

> 7.12 The following criteria will be used to assist in the evaluation of infill development applications and to ensure these proposals are appropriate (…):
> d) The preservation of existing trees is encouraged and will be an important consideration in the evaluation of infill development. (Part C.7 Urban Aesthetics)

In addition to section C.10.3 (quoted above), the Official Plan also provides policy direction regarding the environmental stewardship of the urban forest, including direction to establish an "environmental ethic" as well as education programs and public awareness to support this ethic:

> 10.1
> b) The Town shall develop a strategic plan which establishes an environmental ethic for the Town. The strategic plan should:
> i) seek to involve the community in the stewardship of the Town through education programs, clean-up and environmental restoration projects;
> ii) promote an awareness of the ecosystem approach and the repercussions of our day-to-day actions on the environment. (Part C.10 Environmental Management)

Another major reference in the Official Plan to urban forests is found under "Greenlands" in "Land Use Policies" (Part D.4). The Greenlands consist of parkland, private open space, and natural areas. The general direction in the Official Plan is to preserve, protect, and enhance the natural features and natural vegetation in these areas.

Also important to note are those policies external to the Forestry Section which have profound impacts on the urban forest because they affect tree habitat: urban form as a consequence of zoning by-laws and engineering road cross sections.

Regional and Provincial Policy Framework (Ghent Planning Services)

The Region of Halton and the Ontario government have significant policies regarding the preservation and enhancement of natural systems such as greenlands. The Region of Halton Official Plan makes particular mention of woodlands and other natural areas, including provisions for tree protection by-laws.

The Government of Ontario issued a policy statement under the *Planning Act* in 2005 regarding natural features and significant woodlands. The province's growth plan for the Greater Golden Horseshoe, issued under the *Places to Grow Act* in 2006, includes policies to protect natural systems.

The provincial *Forestry Act* and the *Municipal Act* give towns and cities authority to pass tree-cutting and tree protection by-laws. For a summary of these policies, please see Appendix E. However, often the effectiveness of such by-laws is limited by constraints to tree growth created by the urban form as a result of the *Planning Act*. Provincial policies relevant to the urban forest include only the broadest framework for urban forest management practices. No clear standards exist in the regulatory framework for what is in essence a new and growing field of natural resource management. This is a challenge for the Town in terms of the demands and expectations of a public with growing interest in environmental preservation. But it is also an opportunity to be a leader in urban forest management, in keeping with the public vision expressed by Oakville residents.

Oakville Environmental Strategic Plan (Environmental Services) (Ghent Planning Services)

Oakville completed its Environmental Strategic Plan (ESP) in October 2005 after a series of consultations with Town staff, Regional groups, community members, and businesses. This resulted in six goals and 18 action plans developed to help Oakville achieve environmental improvement over the next 10 years.

The consultation sessions identified key issues which in turn guided the formulation of the goals and action plans. Those issues are: safety, cleanliness, and health; water quality; air quality; waste management; green space planning; development and conservation; transportation and traffic; education and outreach; innovation; energy; leadership; and natural heritage/environment. The action plans were divided into two phases for implementation depending on the priority of each.

The ESP sets a first priority: Action 1.1 is "To protect and enhance our natural habitats, including Oakville's urban forest". This directly links with the UFSMP. While there are other action plans that also relate to the protection, enhancement, and maintenance of Oakville's urban forest, the ESP has a very broad application. As such, it does not provide a strategic management plan specifically for the urban forest. The current document builds upon some elements that are mentioned in the ESP, and it provides further details where the ESP does not.

RECOMMENDATION 11: The Town should amend the Environmental Strategic Plan to refer to the Urban Forest Strategic Management Plan where appropriate.

Oakville's Existing Tree By-Laws

Oakville has two tree by-laws, under the *Municipal Act*, which regulate tree cutting on municipal property (#1988-73 for Parks and #1981-031, as amended, for Street Trees). Council and staff have consistently enforced the provisions since 1980 and this has assisted in creating a high level of tree conservation. Based on the success of this approach, Town staff is interested in exploring ways to extend existing Town policies for tree protection to protect more of Oakville's urban forest. At the time of writing, Town of Oakville Forestry staff is working with the Town's Legal Department to review By-Law 1983-031 with the intent to strengthen its enforcement provisions.

The *Municipal Act* also provides authority to lower tier municipalities to pass restrictions on tree cutting on private property. At the time of writing, the Town of Oakville does not have a Private Tree by-law[3]. Other Ontario municipalities have used various methods in an effort to regulate the cutting of private trees in order to protect their urban forest. For a summary of different approaches by Ontario municipalities see Appendix F. It should be noted that this proposal was not developed by the consultants as part of this UFSMP but is provided here for information. Another approach based on the conservation of leaf area described by one of the authors of this UFSMP, Dr. Andy Kenney, can be found in Appendix G and is also provided here for information.

It is beyond the scope of this management plan to assess the merits of all possible regulatory approaches to protecting trees on private land. Oakville Town Council should thoroughly consider the broad issue of what combination of voluntary and mandatory policy measures will ensure Oakville meets its urban forest goals as set out in the Official Plan. This document makes some planning policy recommendations to assist Council and Town staff.

Current Urban Forestry Policies

The following is a summary of Oakville's existing urban forestry policies:

Title of Policy	**Corporate Policy #**
Guidelines for Tree Preservation in New Subdivisions	10-03-05
Street Tree Planting	10-03-07
Street Tree Removal if No Public Interest Involved	08-03-06
Woodchips	10-03-04
Firewood	10-03-03
Flag Service	10-03-02
Banners	10-03-01
Tree Protection Specifications for Construction near Trees	01-03-08

[3] We are given to understand that at the time of writing, staff are developing a report to Council on this subject .

Some of these policies are no longer in practice and the Town should consider removing them, namely, policies regarding Woodchips, Firewood, and Flag Service. The Banners policy is now being implemented by Oakville Hydro.[4]

Other policies of note include the Top of Bank Setback policies found in the Official Plan and the Fencing and Gating Policy developed in 1983.

The Forestry Section had input into the development of the Town's "Standard Drawings – Road Cross Section" through membership in the Oakville Utilities Coordinating Committee. The standard location for the Town street tree on local roads is 0.5 m from the property line. However, in addition to optimal tree location, there are broader policy considerations necessary to ensure Town street trees survive and thrive, such as design guidelines for tree habitat.

As a member of the Municipal Arborists and Urban Foresters Committee of the International Society of Arboriculture, the Section follows the "Urban Forestry Best Management Practices for Ontario Municipalities" including the ANSI A300 Tree Pruning Standards. All Forestry staff are technically qualified for their duties and receive regular re-training: Arborist 2, Arborist 1, Municipal Tree Protection Inspector, Leadhand, Supervisor and Manager.

[4] Source: John McNeil, personal communication

RESPONDING TO THE CHALLENGES

To this point in the document we have described the municipal planning role, management approach and context of the UFSMP. The following sections describe the various kinds of challenges this strategic management plan will address, as well as management and operational tools and techniques required to do so.

Stratification

The structure of Oakville's urban forest, as with any other community of its size, is extremely diverse. The extent of built forms or "grey infrastructure", as determined by the type of land use and zoning, will have a strong influence on tree habitat. This in turn will have an impact on the number and size of the trees in that particular part of the city. The age of the grey infrastructure, regardless of the zoning, will also have an impact on the ages of the trees, which will be reflected generally in tree size and possibly the trees' condition. Many far less predictable factors which may accumulate over the years will also add to the variability of the structure of the urban forest across the Town. These include storm damage, utility installation and maintenance, intensification and in-fill development and so on.

Effective strategic planning and the implementation of annual operating plans will require an understanding of how this variability in forest composition and structure is distributed across the Town. A clear understanding of this variability will make it possible to stratify the entire community into polygons – actual mapped areas of Oakville – with relatively similar forest structure. This is a careful and specific mapping exercise, not merely superimposing an arbitrary grid on a map of Oakville.

The most important structural features for the purposes of this stratification or grouping will be

a) classes of trees as defined by their age and size, and
b) available growing space.

This sorting and mapping exercise reduces the variability within these polygons. As a result managers can allocate resources and monitor change in the forest as a whole much more efficiently. These polygons or blocks of similar forest structure or will become the Town's **urban forest working groups**.

The polygons represented by the working groups will be distributed widely across the Town. Effective management will require the aggregation of the polygons into units that are both manageable within single Annual Operating Plans (AOP) and with a distribution of working groups that allows for a reasonably even distribution of management activities (tree establishment, pruning, etc.) from one AOP to the next. To accomplish this, Town staff implementing this management plan will examine the spatial distribution of the working groups and five **urban forest management units** will be identified such that the distribution of the area of the working groups is relatively even among the management

units. These management units will form the basis for the implementation phase of the work identified in the 5-year management plans explained elsewhere in this strategy.

The development of the working groups and hence management units will require information from the municipal tree inventory, which is to be completed early in the first 5-year management plan. This inventory will provide the detailed assessment of all street and park trees on municipal property – essential information for planning the management of the Town's public urban forest assets. The results of the plot-based UFORE study will also provide insight into the structure of the entire forest (public and privately owned areas).

RECOMMENDATION 12: The Town should create five urban forest management units in such a manner that their areas are distributed more-or-less equally. These management units will be used to allocate activities within the 5- year management plans.

The identification of working groups should be based on road segments for street trees and for individual parks. The age/size class and tree habitat from the street tree inventory will be summarized for each road segment.

Land use information not only provides a good coarse filter for identifying tree habitat suitable for stratification, but also provides insight into the issue of tree health and management needs. For example, the needs of trees in pavement pits in commercial areas can be expected to differ from those situated in wide tree lawns in a low-density residential area. The 11 land use types used for the establishment of the UFORE plots (see Figure 2, *Town of Oakville 2006*) should be used as the first level of stratification of the Town's urban forest.

Some of these land use types were consolidated for the purpose of distributing the plots for the UFORE study. Their use within this plan will relate more directly to tree management. Therefore the original 11 categories should be retained at least until the data can be reviewed and suitable combinations that are consistent with revised management activities per the UFSMP can be considered.

The predominant age/size class of the trees in each road segment should be recorded as:

- Juvenile, e.g. recently established, small trees which can easily be pruned or "trained" from the ground using secateurs (<5m height).
- Intermediate trees are those that can be pruned from the ground using pole pruners (5-15m).
- Mature trees are those that must be pruned by climbing or from a bucket truck (>15m).

The reference to pruning is used here only because it provides a convenient classification of tree size or age. However stratification will be important for other important aspects of urban forest management beyond pruning.

With this information, each road segment can be classified by land use and age/size class into working groups. For example, a particular segment might be described as: segment number, medium density residential, intermediate. Because the inventory and stratification are based on road segments, the Town's geographic information system (GIS) will be able to generate the length of the road segment as well as other useful information pertaining to the grey infrastructure, tree habitat and other details of this part of the urban forest.

Once all road segments have been classified, the overall distribution of the 33 potential combinations of land use (11) and age/size class (3) will require analysis to determine the location of the five final working groups. Note this process cannot be completed without a clear idea of the distribution of land use and age/size classes that will become apparent from a detailed tree inventory. Thereafter, staff implementing this management plan can identify five urban forest management units with similar distribution of working group polygons (that is, grouping together similar classifications of forest structure). This will provide staff with a practical spatial distribution of parts of the urban forest with common management and operational requirements. The result will be much better-targeted and more efficient urban forest maintenance and management practices.

As noted above, this detailed stratification cannot be completed without data from the municipal tree inventory. In the interim (prior to completion of the inventory and stratification), preliminary management units have been developed based on the combination of the existing "Forestry Zones" (see the inset in Figure 8) and an approximation of the age-class of the urban forest (based on information from Town staff).

The first zone represents the mature tree zone and stretches from Lake Ontario to the Queen Elizabeth Way (QEW). The intermediate tree age zone encompasses the area from the QEW to Upper Middle Road. The immature tree zone stretches from Upper Middle Road to Dundas Street (Figure 8).

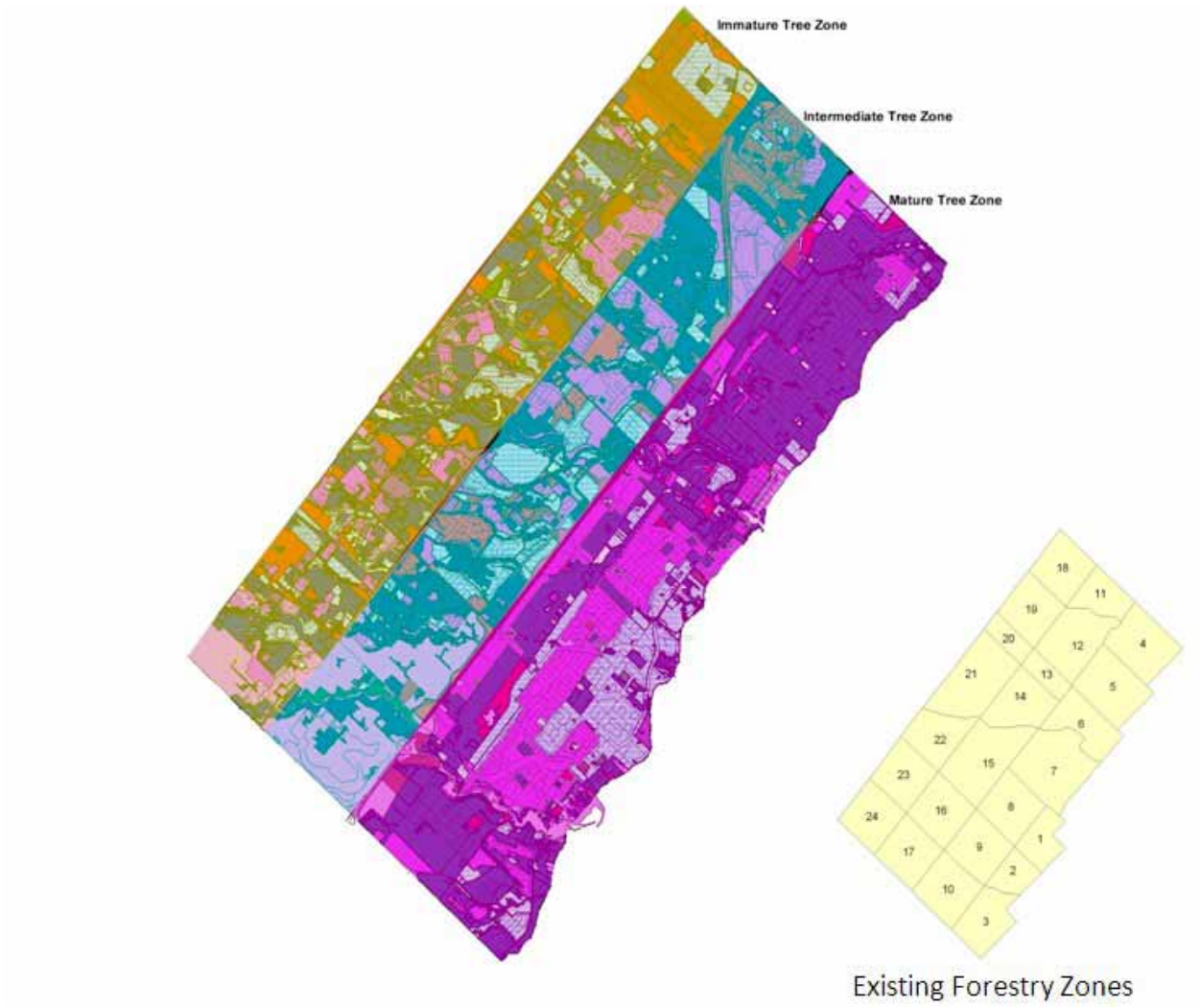

Figure 8: Preliminary tree age/size class zones to be combined with forestry zones (inset) to create preliminary urban forestry management units.

Preliminary management units are shown in Figure 9. These units have retained the boundaries of the existing "forestry units" for continuity during the implementation phase of this strategic management plan. By combining units across the preliminary age/size class zones the five urban forestry management units shown in Figure 9 should provide adequate distribution of land use and age/size class to guide urban forestry management practices until the refined management units can be developed.

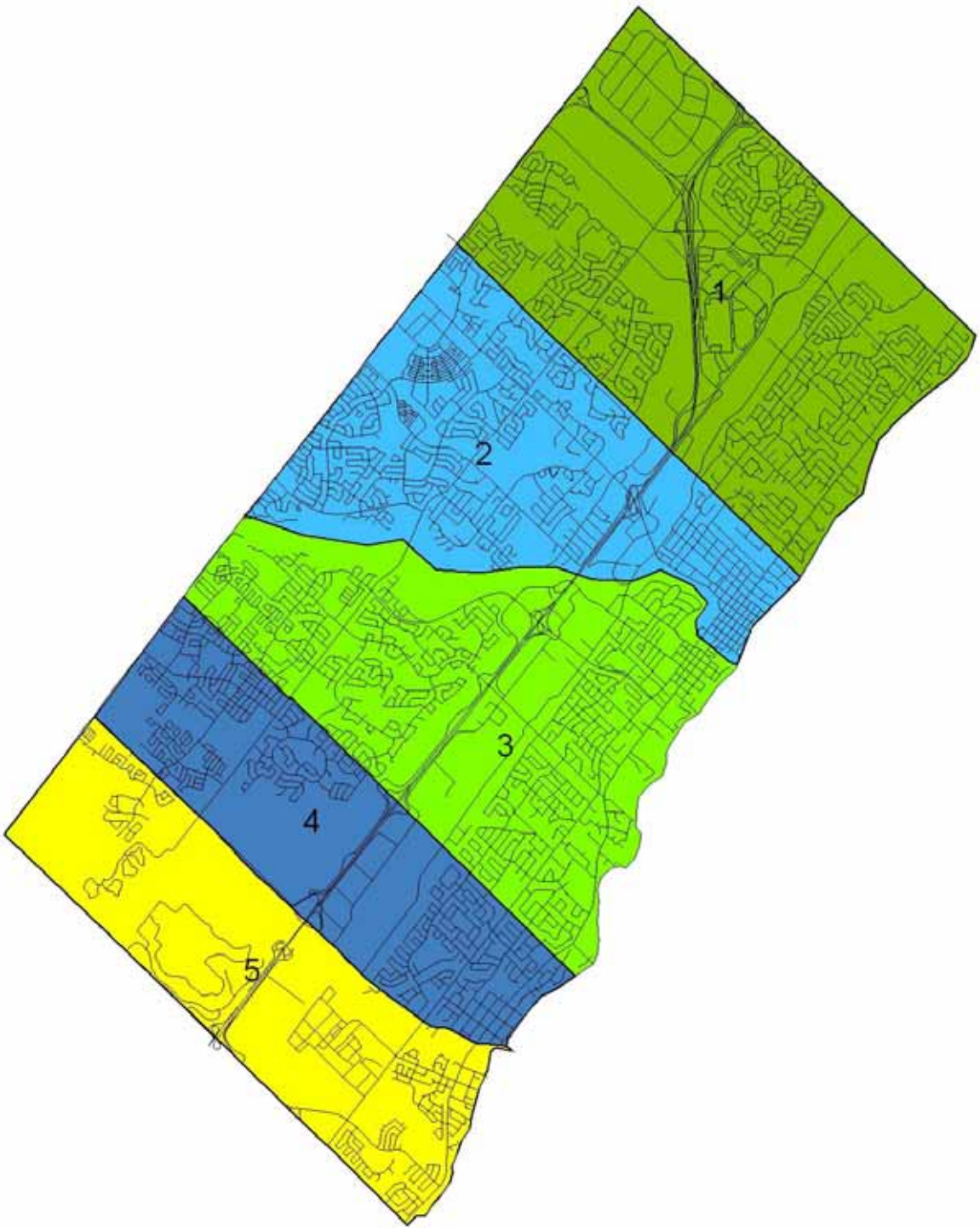

Figure 9: Preliminary urban forestry management units incorporating existing forestry units and preliminary age/size class zones. The units are to be used until the refined management units can be completed.

Tree Inventory

RECOMMENDATION 13: The Town will complete a tree inventory for all street trees within the first 2 years of the first management plan with a focus on collecting information on trees in the oldest and youngest age classes in the first year.

A comprehensive tree inventory is essential for the Town of Oakville to manage effectively its urban forest to maximize the benefits that trees provide, minimize risk from potential hazards and develop long-term management initiatives. It will identify details of the structure of the urban forest, which are necessary for the planning of management activities to achieve specific goals. These details may include species composition, the mixture of native and non-native species, age structure, tree condition, location, size, management history, and habitat. The inventory may also reveal other valuable assets such as the presence of rare or endangered species or heritage trees that may otherwise be overlooked.

The inventory will also differentiate between *intensively managed* parts of the municipal forest and *extensively managed* woodlands – that is, areas where individual trees are managed under arboricultural techniques as opposed to areas that are managed *en masse* using techniques more closely related to silviculture, (that is, large scale "non-urban" forestry).

In the absence of an inventory, the Town of Oakville's urban forest can be broadly divided into three average age classes (Figure 8):

The Parks and Open Space Department submitted a capital budget request for 2007 to take inventory of the following Town tree assets over year 1 of a 2 year project: 100% of the street trees; 10% of the woodlot trees and 6% of the open space trees. However, the 2007 Capital budget request for a $500,000 two-year inventory project was deferred until 2008. In addition, we see merit in an inventory of "heritage trees" as defined by the Ontario Urban Forest Council's Ontario Heritage Tree Alliance.[5]

RECOMMENDATION 14: The Town should develop an approach to identifying and designating heritage trees based on the approach of the Ontario Heritage Tree Alliance.

Subject to budget approval the inventory of the remainder of the municipal urban forest – that is, trees in park Open Spaces and trees in 'forest stands' – should be undertaken over the first 5-Year Operating Plan once more detailed costs are calculated.

Currently, the Forestry Section is in discussions with the USDA Forest Service to become the first 'Reference City' in Canada. A Reference City is a climate zone representative whose street trees characterize the entire zone. To be considered as a candidate, a municipality must have a current street tree inventory or at least has two-thirds of the inventory completed. In each Reference City approximately 800 trees are randomly

[5] For more information, see http://www.oufc.org/OHTA.asp

sampled. For each species, five to ten trees from each diameter class are measured in detail. Reference City reports describe the benefits and costs of planting trees in a specific climate region. Reference Cities inform the *STRATUM* component of *i-Tree*, a comprehensive tool for assessing and managing community forests. This leading edge software is described in *Oakville's Urban Forest: Our Solution to Our Pollution*.

Establishing Oakville as a Reference City would save the Town hundreds of thousands of dollars in future tree inventory projects by automating the annual update of tree age, height, crown volume, etc. Through a partnership with the USDA Forest Service, Oakville could become the first municipality in Canada to be a Reference City. This is anticipated to occur in 2009 subject to budget availability. Oakville would be assisting other southern Ontario municipalities who could apply the tree growth information to their own municipal urban forest inventories.[6]

For more information on Reference City please refer to the following web site: http://www.fs.fed.us/psw/programs/cufr/products/newsletters/UF632Fall2005Winter2006.pdf

RECOMMENDATION 15: The Town should enter into a partnership with the USDA Forest Service to establish Oakville as a Reference City for STRATUM in Southern Ontario.

Inventory Attribute Data

According to the Town of Oakville (2006), the Town has 1.9 million trees; 43% of which are Town trees. As determined by the pace of new residential land development in the 1980's and 1990's, the Town planted almost 40,000 street trees. The results of this planting effort can be seen in Figure 10. Town staff noted,

> Up to 1992, the older age classes, although they make up only about 20% of the number of trees, accounted for about 80% of the maintenance work. This historic balance will shift as Oakville's forest ages. Over the next 20 to 40 years, more resources will be needed for the developing, younger forest. By the end of this decade, the proportion of the current operating budget required for age classes younger than 50 years will double to 20% (Town of Oakville 2006).

[6] John McNeil, personal communication

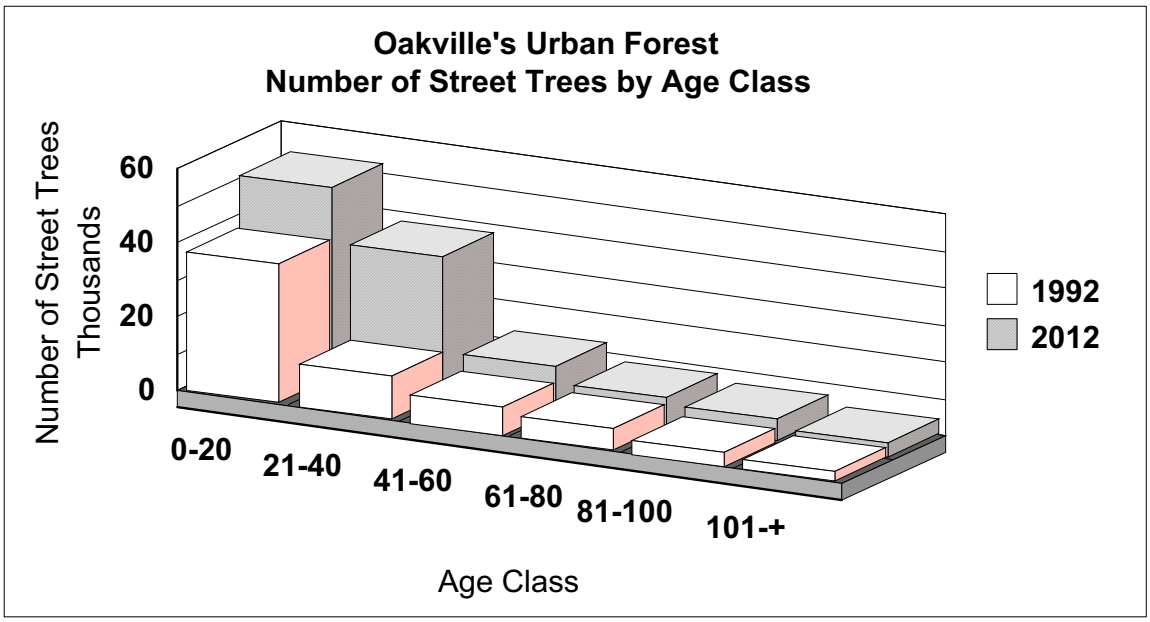

Figure 10: Number of street trees by age class in the Town of Oakville (Town of Oakville, Forestry Business Plan 1998- 2000). Note the large proportion of relatively young trees (40 years and younger).

"Up to 1992, the older age classes, although they make up only about 20% of the number of trees, accounted for about 80% of the maintenance work. This historic balance will shift as Oakville's forest ages. Over the next 20 to 40 years, more resources will be needed for the developing, younger forest. By the end of this decade, the proportion of the current operating budget required for age classes younger than 50 years will double to 20% (Town of Oakville 2006)."

In addition to age class distribution, the Town must also consider species diversity to achieve a healthy and robust urban forest. Species diversity is a vital safeguard against catastrophic losses such as those experienced when Dutch Elm Disease all but wiped out the white elm and drastically reshaped many communities' urban forests.

Diversity in the tree population will also permit the Town to use a wider range of planting sites, because some species are better adapted to certain urban stresses than others. Typical stresses on the urban forest include:

- soil compaction
- low soil oxygen
- high salt levels
- low levels of organics in soils
- improper pH ranges
- high levels of air pollution
- restricted growing areas.

These factors greatly influence mortality rates for tree planting. Selecting trees tolerant to site conditions will increase the likelihood of tree establishment – that is, trees reaching maturity and providing their full range of benefits. Trees that are not adapted to their site will become weak and more susceptible to insects and diseases.

RECOMMENDATION 16: The Town should ensure that there is adequate species diversity throughout the urban forest and where possible ensure that the seed source is within the Collection Zone for Oakville as established by the Forest Gene Conservation Association.

The size of the trees is important for many management and planning considerations. As the size of trees increases, the leaf area also increases; the ecological benefits of trees increase exponentially as leaf area increases (Figure 11):

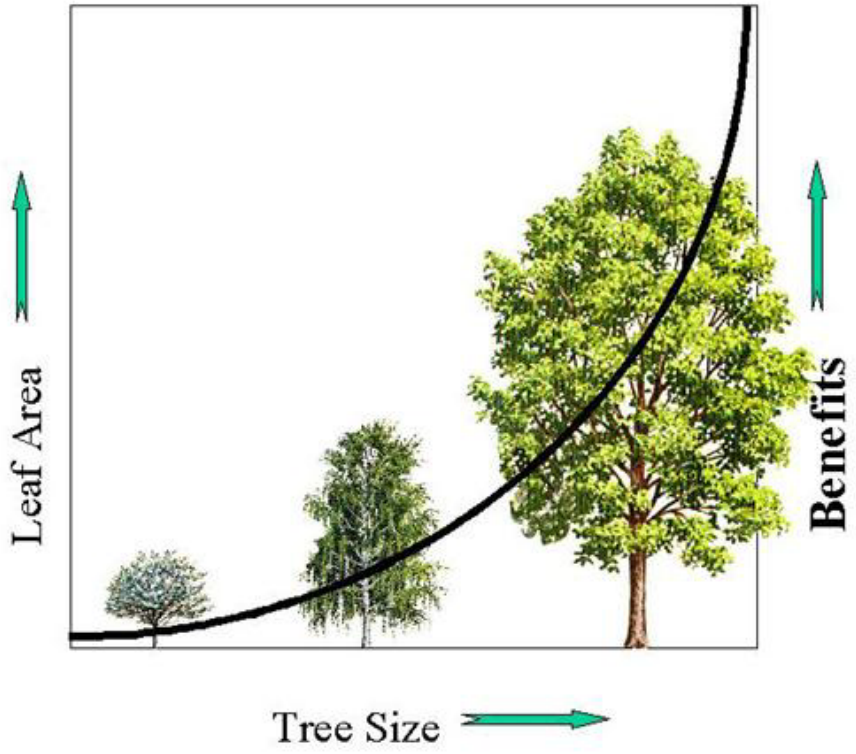

Figure 11: Example of the ecological benefits of trees increasing exponentially as leaf area increases (W.A. Kenney undated).

From a land use planning perspective, Oakville must provide adequate growing space for the establishment and maintenance of large-stature trees. If smaller stature trees are chosen for confined spaces, the Town must make efforts to maximize the longevity of these trees. Land use type has a significant influence on urban forest canopy cover (see Table 4).

Table 4: Urban forest canopy cover and available plantable space by Land Use type (Town of Oakville 2006, Table 5).

Land use	Canopy cover (%)	Plantable space (%)
Woodlots	90.3	8.5
Residential Low Density	47.4	22.8
Residential Medium +Residential High Density	26.4	18.9
Open space + Parkway Belt	26.1	47.3
Public use	11.2	21.6
Agriculture	9.5	39.2
Employment+ Industrial	6.8	27.4
Commercial	6.3	15.8

Only 0.5% of the Town's trees are large-stature. Most are found primarily in three Land Use types: Woodlots, Residential Low Density and Residential Medium+ High Density. Literature suggests that 10% representation of Large Stature trees is a minimum (USDA Forest Service 2003).

Tree condition is a crucial attribute to accurately assess when conducting a tree inventory. The condition of trees depends on the site conditions in which they grow, the species, and the past and present management practices that enhance or detract from their health. The current health of a tree can also reflect its history including storm damage, impacts by lawnmowers and vehicles as well as insect infestations and so on. Trees in poor condition can become structurally hazardous and are generally more prone to attack by pests. Tree crowns in decline are less capable of photosynthesizing and make a smaller contribution to the environmental, economic and social well-being of the Town. The inventory will identify such cases.

A Municipal Street Tree and Open Space Inventory

The Forestry Section has established a Street Tree Attribute list for the inventory project (Appendix K) based on attributes used in *STRATUM*. This will ensure compatibility with the Reference City project.

A Municipal Woodland Inventory

The Forestry Section has established the "forest stand" inventory attributes as detailed in the Street Tree Inventory and Tree Asset Maintenance Management System Requirements Analysis (ESRI Canada 2007). They are based on compliance with the Forest Management Policy Manual of the Town's Forest Stewardship Council (FSC) partner, the Eastern Ontario Model Forest.

RECOMMENDATION 17: The Town will complete a tree inventory for all woodlands based on accepted forest stand inventory protocols within the first 5-year management plan.

RECOMMENDATION 18: The Town should establish 1 permanent sample plot (PSP) per hectare in each woodland tract so that the woodlands can be monitored systematically over time.

When collecting data for the woodland areas, detailed attribute collection for each individual tree is not necessary depending on the objectives of the strategic plan. However, employing an organized method of data collection for the woodland areas is imperative and will relate to stratification.

GIS and Asset Management

The management tool recommended for optimum urban forest management is a web-based version of an ArcGIS server. Corporately the Tree Inventory project is being harmonized with the Tree Asset Management project[7]. This is fundamental to providing sustainable management of the municipal urban forest resource.

Inventory Maintenance

Once the inventory is in place, all changes to the health and structure of trees should be regularly entered into the system. As new trees are planted they are added to the inventory and the plantable spots that they now occupy are removed. Trees that are removed from the forest must be deleted from the inventory, and new planting spots recorded at these locations. Any arboricultural treatments that are undertaken must also be recorded. Implemented in this fashion, the inventory will be continuously updated.

RECOMMENDATION 19: The Town should hire an urban forestry specialist with GIS training to administer the tree inventory software and database as well as other asset management systems in the Department in 2008.

Analytical Tools

The Town has made a corporate decision to use attributes from the *i-Tree* software suite developed by the USDA Forest Service (http://www.itreetools.org/). This suite includes the following urban forest analysis tools:

UFORE (Urban Forest Effects Model) was designed to use standardized field data from randomly located plots throughout a community, along with local hourly air pollution and meteorological data, to quantify urban forest structure, environmental effects and value to communities.

[7] Town of Oakville, Requirements Analysis Report; prepared by ESRI Canada Limited 2007

STRATUM (Street Tree Resource Analysis Tool for Urban forest Managers) utilizes a sample or complete tree inventory to describe tree management needs and quantify the value of annual environmental and aesthetic benefits such as energy conservation, air quality improvement, CO_2 reduction, storm water control, and property value increases.

The *i-Tree* suite is part of the Reference City project developed by the Center for Urban Forest Research: http://www.fs.fed.us/psw/programs/cufr/new.shtml. As noted above, the Forestry Section is in discussion with the USDA Forest Service to become the first Reference City in Canada, conditional upon the Town completing at least two-thirds of its street tree inventory project.

The protocols and models that form the basis of UFORE have been under development for some time. Much of the underlying research originated from the Chicago Urban Forest Ecosystem project (McPherson et al 1994). Since then the associated models have been refined and the UFORE model has been applied to a number of North American cities (including Calgary and Toronto) and other parts of the world. UFORE has a strong scientific foundation and all publications stemming from the use of the models are subjected to a rigorous peer review process through the USDA.

UFORE in Oakville was undertaken as follows. During the summer of 2005, data were collected from 372 circular plots of 400m^2 distributed across the Town of Oakville (south of highway 5). These data were subsequently analyzed by Dr. David Nowak's team at the USDA Forest Service's Northeastern Experiment Station in Syracuse, NY. The results of these analyses were presented in a report titled *Oakville's Urban Forest: Our Solution to Our Pollution* prepared by staff in the Forestry Section of Oakville's Parks and Open Space Department. This report was accepted by Oakville Council on October 23, 2006.

The UFORE project does not provide detailed information on individual trees on Town property. Its purpose is to collect relevant information on the structure of the trees and shrubs throughout the community, regardless of whether on public or private land. Consequently, UFORE plots were not restricted solely to municipal property but had an equal likelihood of landing on private property. This means that the results generated by the UFORE analysis are representative of the Town of Oakville's urban forest as a whole and not just the portion that falls under the jurisdiction of the municipality. Since the economic, environmental, and social benefits derived from the urban forest accrue to the community as a whole and not just the owners of the trees, the results of the UFORE project provide an effective picture of the overall "value" of the town's urban forest ecosystems.

Development pressures, climate change, the invasion of exotic pests, urban intensification, and, in some parts of the Town, an aging urban tree population can all be expected to result in changes to the structure of the urban forest over the coming years and decades. The data provided by this project represents important base-line information that will be valuable in tracking changes over the coming years. Because the UFORE project was carried out in advance of the development of this strategic plan it will serve

as a critical benchmark against which the effectiveness of the plan and its implementation can be measured.

The Town must keep the UFORE DATA up to date for it to be effective. Action Item 25 of *Oakville's Urban Forest: Our Solution to Our Pollution* recommends that the UFORE plots established in 2005 be re-measured every four years and the analysis updated to identify trends in such criteria indicators as "% tree mortality" and change in "% urban forest canopy cover."

The Parks and Open Space Department's 10-year capital forecast contains a budget item for the UFORE project in 2009 and 2013, a four-year reassessment cycle. However it would be more efficient to conduct these re-assessments on a five-year cycle keeping with the structure of the UFSMP. The UFORE plots could be re-measured and the assessments updated in the final AOP of each five-year management plan. This would provide up-to-date information to guide the planning and management processes into the next five-year phase.

We refer the reader to *Oakville's Urban Forest: Our Solution to Our Pollution* for more details of the results of the UFORE project. Here we provide a summary of its findings.

The Town of Oakville is home to approximately 1.9 million trees (on private property as well as public). Of these, 43% are on municipal property. This figure is high when compared to estimates typically cited in literature of 10 to 20% ownership by municipalities. This is primarily because woodlots, which are extensively managed, are included in the Oakville estimate of 43%. In contrast, intensively managed trees may account for 10% – 20% (See the glossary for a definition of intensive and extensive management).

The UFORE analysis revealed an average canopy cover of 29.1%. Based on the Council of Tree and Landscape Appraisers trunk formula method, UFORE estimated that the Town's urban forest had a replacement value of $878 million. It should be noted that this does not represent the value of the forest in terms of air quality improvements, carbon sequestration, energy conservation, storm-water attenuation, property value or any of the other direct and indirect benefits that the residents of the Town derive from the forest. It simply represents an estimate of the cost to replace the existing forest based on the species present, their size, location and condition. If all factors are to be taken into consideration, the value of $878 million, while substantial, must be consider an under-estimation of the true monetary value of the resource.

This canopy has the potential to sequester a number of significant air pollutant including SOx, NO_X, CO and PM_{10} all of which have been clearly identified as major health hazards. The urban forest of Oakville removes approximately 6,000 tonnes of atmospheric carbon each year and 172 tonnes of other air-borne pollutants. Poor air quality poses a serious threat to the health and well-being of Ontarians.[8] UFORE

[8] For example, in 2005 the Ontario Medical Association estimated that there are 5,800 smog-related pre-mature deaths in Ontario each year.

indicates that the urban forest of the Town can play a significant role in mitigating the effects of poor air quality and the Town's official plan identifies the protection and enhancement of the urban forest as one mechanism to improve air quality.

The report *Oakville's Urban Forest: Our Solution to Our Pollution* notes that Health Canada has developed a computer model, referred to as the Air Quality Benefits Assessment Tool (AQBAT) and Action Item 1 of that report states that the Town should "Obtain detailed outputs on the human health benefits from Oakville's urban forest by combining the results of the AQBAT and UFORE in conjunction with the Halton Region Health" which had been expected in 2007. However, the most recent communication from the Region of Halton's Health Department is not optimistic since they do not have the current resources available that are necessary to implement AQBAT. [9]

Azteca Cityworks software **(http://www.azteca.com)** combined with the completed tree inventory will permit the Town to budget appropriately for sustainable management by recalculating the estimates which appear in the following strategy which has been prepared without the aid of either of these two necessary projects. At the time of writing the development of an urban forest asset maintenance and management system tool is under way.

> Azteca Cityworks is the only GIS-centric asset maintenance management system available. Cityworks is created especially for Forestry organizations facing the challenge of managing their urban forest assets. Cityworks is uniquely designed to fully leverage the Town's investment in ESRI GIS technology without costly duplication of effort, data synchronization or integration as the Cityworks system is built from the ground up using ESRI GIS technology. Cityworks uses the ESRI GIS database directly as its inventory or asset database allowing the Town the full flexibility to model the tree inventory database to suite their specific needs. Therefore, the inventory model is open and non-proprietary providing the Urban Forest section with full control of what tree attributes they wish to track in the system to meet present and future needs without costly redesign and programming. Coupled with ESRI's leading ArcGIS software, Cityworks provides the Forestry section a complete solution for asset and maintenance management for its tree asset inventory. (ESRI 2007).

RECOMMENDATION 20: The Town should consider configuring CityWorks to display a version of the tree layer including location, species and size (crown width, DBH), on the corporate web site for use by the public.

[9] Region of Halton, personal communication, December 2006

Tree Habitat

Environment Canada defines habitat as "the particular type of local environment occupied by an individual or a population."[10] In this document, the term "tree habitat" refers to the growing environment from which trees must derive all the essentials for their survival and growth and there-by their ability to provide environmental, economic and social benefits to the community. Habitat includes the physical growing space in which a tree exists and includes the associated grey infrastructure, soil and all its constituents, air, climate, etc.

Most of the economic, social and environmental benefits the residents of Oakville derive from their urban forest are directly or indirectly related to the leaf area of the forest (Kenney 2000). Large trees have significantly greater leaf area than small trees. Therefore a primary objective in sustainable urban forest management must be the establishment and tending of trees of large stature. The size that a tree ultimately reaches is not only a function of its genetic potential – for example, white oaks generally grow to be larger than Japanese Tree Lilacs – but also the habitat in which it grows. Thus a white oak planted in a significantly restricted growing space will not reach its genetic potential.

Tree maintenance and other environmental factors also have an impact on whether or not the tree can achieve its genetic potential and the potential of its specific habitat. Trees must compete with buildings, and other "grey infrastructure" for space. Tree crowns come into conflict with buildings, aboveground utilities (e.g. electric power transmission lines), streets, sidewalks, signs and traffic signals, etc. In many cases, the urban forest or "green infrastructure" is considered expendable when it becomes necessary to resolve these conflicts. Often, large trees are eliminated and replaced by smaller trees that can be readily transplanted. In some cases, small-statured trees are planted in areas that could support species of larger potential size in an effort to avoid future conflicts. This simplistic approach creates a tendency for the urban forest to become comprised of more and more trees of small stature. This results in missed opportunities to maximize the benefits derived from the forest (Kenney 2000).

Tree Requirements

Tree root systems are, for the most part, out-of-sight. Therefore, roots are very often forgotten as a critical component of any tree or shrub. Some arborists argue that 80-90% of tree problems actually originate below ground with the more obvious signs of crown die-back simply being in response to root damage or a poor rooting environment. The root system anchors the aerial part of the tree, and provides the interface between the soil and the rest of the living tree. As such, the soil must contain sufficient mineral nutrients to sustain tree functions and must be able to provide trees with sufficient water to enable transpiration and photosynthesis. Tree roots respire and therefore must also have access to adequate oxygen. An ideal loam will have a soil particle size distribution (soil texture) that results in approximately 50% of the soil volume consisting of air spaces. A well-

[10] Environment Canada. Species at Risk web site. http://www.speciesatrisk.gc.ca/default_e.cfm. Accessed October 21, 2006.

watered soil of this type will have approximately 50% of the pore-space (25% of the soil volume) occupied by water (Figure 12). Soil compaction reduces the pore space, which in turn reduces the ability of the soil to hold water and air as well as making it physically difficult for roots to penetrate the soil as they grow.

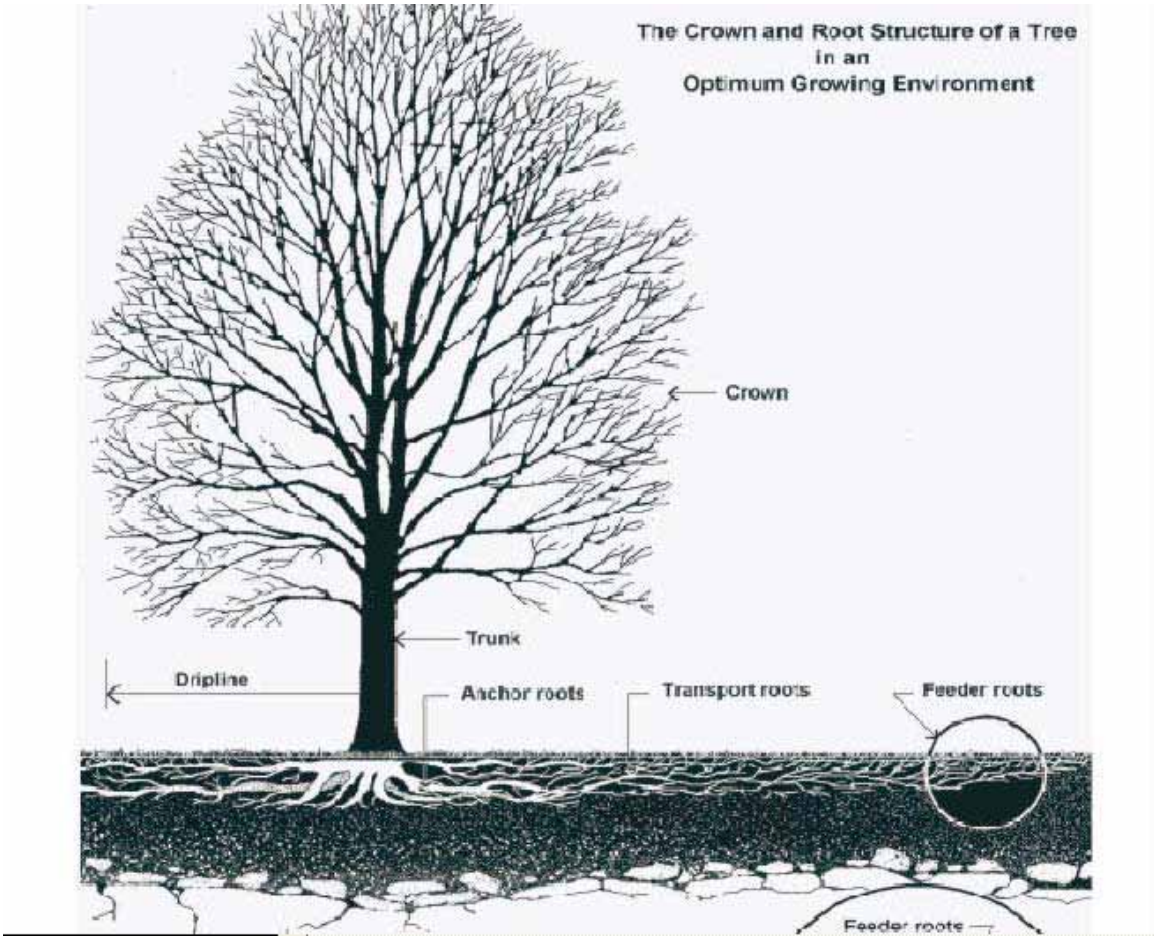

Figure 12: The crown and root structure of a tree in an optimum growing environment (Graphic with the permission of the City of Toronto supplied by the Town of Oakville 2006)

Tree root systems also store carbohydrates that can be transported to various parts of the tree as they are needed for growth and other functions. If trees lose a significant portion of their roots these reserves of carbohydrates will be lost, resulting in the gradual decline of the tree. This may be one of the reasons why trees that have suffered from trenching or other root damage may take 5 to 10 years to the show the complete range of symptoms.

While soil quality is important, soil volume is also a major determinant of the longevity and vigour of a tree as well as its ability to reach the size typical for the species or cultivar. The majority of a tree's root system typically exists in the upper 50-100 cm of the soil profile and, while the drip-line of a tree provides a visible guide for the lateral extent of a root system, the extent in an unrestricted growing environment could be two to three times greater than the limit of the drip-line.

Lindsey and Bassuk (1991) estimated the soil volume required to provide sufficient moisture to balance the losses due to transpiration in a mature street tree. They took into consideration factors such as the rate of transpiration, precipitation and the water-holding capacity of the soil. They estimated that for the urban environment of Ithaca, New York, the equivalent of 0.61 m^3 of soil volume is needed for every 1 m^2 of crown projection area. If we consider a soil depth of 0.6 m, this volume is represented by an area equal to the crown projection area. In other words, a tree growing in good soil with a depth of 0.6m and an area equivalent to the area under its crown could be expected to have access to enough water through precipitation to balance transpiration. This estimate is for the climate of Ithaca, NY where the model was developed. A larger soil volume would be needed in growing environments with greater transpirational demand or lower precipitation. If the water-holding capacity of the soil were less than optimum due to poor soil texture or soil compaction, the surface area of the tree habitat would have to be increased. If the soil depth were less than 0.6m, similarly the surface area of the habitat needed to support the tree would have to be increased proportionally to compensate.

This estimate provides a handy reference: trees growing in spaces in which the area under the drip-line (the crown projection area) is not fully occupied by good quality soil to at least a depth of 0.6m will likely experience significant drought stress during some parts of the growing season. This moisture stress reduces the tree's growth and longevity and leaves the tree vulnerable to insects and disease attack.

Keep in mind this assumes the tree was supplied with water through rainfall. If the surface area of the tree habitat is sealed by concrete or asphalt to an extent that rainfall cannot recharge the soil volume with water on a regular basis,[11] then a large soil volume with good quality soil will be of little value in reducing moisture stress in the tree.

Town forestry staff used Dr. Bassuk's work to develop "Tree Habitat Design Guidelines for Oakville". These guidelines list the minimum soil quantity to support three size classes of healthy trees to maturity. Note that these estimates are based on a more optimistic soil depth of 0.9m.

[11] A common rule of thumb for regular rainfall is 3 cm per week during the growing season

Table 5: Tree Habitat Design Guidelines for Oakville (Town of Oakville 2006, Table 9)

Minimum soil quantity to support a healthy tree to maturity *1

Size of tree at maturity	Soil Volume *2 (m3)	Growing Space dimension*3 Length *4 (m)	Width (m)
Large-stature tree	98	12	9
Medium-stature tree	44	8	6
Small-stature tree (*5)	16	8	2

1. maturity = peak carbon filtration point , Figure 11, and is assumed to be 80-100 years
2. Calculated based on:
   a- Average crown diameter of 1700 street trees measured in a pilot project in the Town of Oakville in 2003, as follows: large stature tree= 14 meter crown diameter, medium stature tree=10 meters crown diameter and small stature tree= 3 meter crown diameter.
   b- "Trees in Urban Landscape", page 81, Dr. Nina Bassuk
3. Based on 0.9 meter growing depth for root system
4. 12 meter planting interval is based on Oakville Corporate Policy # 08-03-07, Street Tree Planting
5. Aesthetic purposes only; negligible environmental services value

RECOMMENDATION 21: The Town's Planning, Development Services, Engineering & Construction and Parks and Open Space Departments should consider adopting minimum soil volume standards as outlined in Table 5 into existing departmental drawings for situations that have the potential to impact municipal trees.

The aboveground growing space must also be adequate to accommodate tree growth. Buildings and aboveground utilities can potentially reduce the available growing space of a particular tree habitat. Other less obvious factors that affect tree habitat such as sight lines and clearances for vehicles and pedestrians could also be a constraint to tree growth.

A clear example of the impact of habitat on the growth and vigour of trees is shown in Figure 13. In Oakville, as in most communities, street trees are typically planted either between the sidewalk and the curb (in the case of collector roads) or between the sidewalk and the property line (local roads). In the latter cases, we often observe a significant increase in tree performance. Figure 13 shows two Norway maple trees, both planted in 1985. One is situated between the sidewalk and curb on a 30m road (on the left of the figure) and the other is situated between the sidewalk and the property line on an 18m road (on the right of the figure). The two trees reflect dramatic difference in growth, vigour and health as a result of the differing habitat.

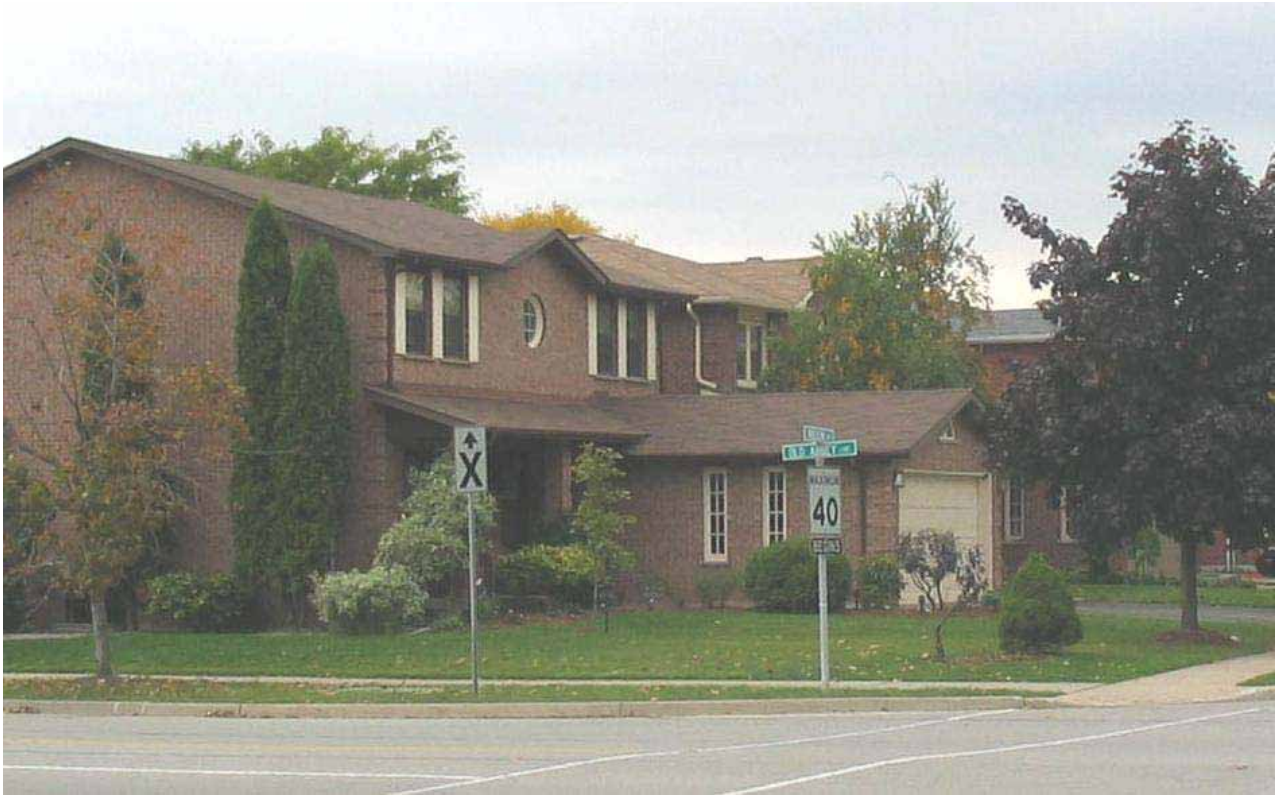

Figure 13: Two Norway maple trees planted at the same time. The tree on the left, planted between the sidewalk and the curb is in very poor condition as compared to the tree on the right that is planted on the house side of the sidewalk (Source: Town of Oakville Forestry Section 2007).

Undoubtedly, tree habitat has and will have a significant effect on the extent and condition of the Town's urban forest. Grey infrastructure, because of its impact on tree habitat, is a primary determining factor of the extent and condition of the Town's green infrastructure.

Impact of Change on Existing Development

The fabric and character of urban areas derives from the pattern of streets and sidewalks, existing utilities, existing buildings, and so on. Change to the existing developed urban area is inevitable; land use policies and regulations control how areas change. The Official Plan and Zoning By-law are two planning instruments that directly control, for example, approved land use, building density, amount of open space and amenity area, width of streets, and height of building. These documents influence the character of the urban fabric and, by extension, are a major factor influencing the urban forest.

An example of how policy can positively influence the urban forest is the watercourse preservation policies and the associated setback from the top of bank related to these watercourses in the Oakville Official Plan. In the early 1980s, Oakville initiated a policy first applied in the Glen Abbey Community, to consider minor and major water courses as natural feature amenities to be preserved and used as community organization elements. To preserve the watercourses, a development/lot line setback policy ensured the

protection of trees immediately adjacent to the top of bank (7.5 m setback from minor watercourses). Oakville staff report this policy effectively contributed to a 45.2% increase in the public valley lands system in the area, representing an additional 10.8 hectares over and above the lands located below the top of bank. This made an additional overall contribution to the Glen Abbey Community's urban forest canopy cover of 1.5%. The Glen Abbey Community currently has 31.5% urban forest canopy (Town of Oakville 2006).

Appropriate management controls are required in order to protect wooded (i.e. extensively managed) areas located along the top of bank associated with watercourses. This is in contrast to protecting a single tree or grouping of trees (i.e. intensively managed areas). Residential land use abutting wooded areas can create conflicts that potentially compromise the ecological health of the wooded area unless there is a clearly identified physical demarcation, such as a fence, along the property line. Oakville offers many examples of how human encroachment into wooded areas on a gradual (or not so gradual) basis negatively affects the forest environment. If left unchecked, individual trees may remain – but not a functional forested ecosystem. Figure 14 shows the example of a rear yard, graded and sodded with the resulting loss of the entire forest understorey. The Town's policy of "fencing with no gates" to demarcate property boundaries protects forested ecosystems and controls public access to trail systems. This is an effective management tool.

Figure 14: This photograph demonstrates two points: (1) Human encroachment impairs forest ecosystem structure and function. Note the lack of natural regeneration remaining in the rear yard due to its replacement with sod. (2) Controlling human encroachment into natural areas can using the Town's Fencing and Gating policy. Note the fence which is located at the rear property line between private property and a public woodland (Source: Forestry Section, 2007).

Impact of Zoning By-laws: Tree Habitat = Zoning + Engineering

A community's zoning by-laws directly shape the urban fabric. Parameters such as land use and building density have the greatest impact on available growing space and, to a lesser extent, the level of care that the urban forest can be expected to receive (e.g. single family residential vs. multiple family residential vs. industrial vs. commercial, etc.).

Ultimately, tree habitat will be a function of the planning policy and the actual engineering application of urban design. Town of Oakville staff have succinctly expressed this relationship with the equation, "Tree Habitat = Zoning + Engineering" (Oakville, 2006). Planning, land use policies, and implementation of these policies help determine tree habitat, and thus the ability of a tree to achieve its genetic potential.

For example, the placement of underground utilities and other grey infrastructure help determine rooting volume and the access to water (and drainage), oxygen and nutrients. Maintenance or expansion of these utilities has an impact on the health and extent of tree root systems. Techniques such as open trenching to access utilities below ground can injure tree root systems and can lead to tree decline and shorter life span.

The marginal cost to the Town of replacing dead or dying trees because of root damage reflects only part of the broader environmental, social and economic costs. Remember that the growth equity built up in a large tree is lost, even if the tree is promptly replaced. Negative impacts below ground on trees severely limit the likelihood that trees will achieve their genetic potential to maximize benefits to the community.

Given the impact of the grey infrastructure on tree habitat, realistic goals should be developed for each urban forest stratum. Such targets, and the Town's ability to achieve them, depend on a clear understanding of the constraints to tree growth imposed by the grey infrastructure.

No one department or section of the Town can, on its own, address all the challenges and implications of the relationship between tree habitat, zoning and engineering. The "Administration" section of this management plan discusses this, below. Note that Forestry Section staff recommended establishing a technical advisory committee comprised of staff from appropriate Town departments (Oakville, 2006). The proposed Interdepartmental/Interagency Technical Advisory Committee (IITAC) would include staff from Departments such as Parks and Open Space, Engineering, and Planning.

Decisions regarding committee structure and function are the purview of Town Council. For consistency with the report received by Council from staff (*Our Solution to Our Pollution*), a number of recommendations in this UFSMP make reference to input from the proposed ITTAC. For more discussion, see the section on "Administration" in this document, below.

One of the first tasks for the proposed IITAC should be to examine how the Town's policies currently affect tree habitat. Action Item 15 (Oakville 2006) calls for a review of the Town's Tree Habitat Design Guidelines by the IITAC. Similarly, action Item 17

specifically calls for an assessment of the relationship between zoning by-laws and tree habitat.

RECOMMENDATION 22: The Town's Interdepartmental/Interagency Technical Advisory Committee (IITAC) should collaborate in a review of Tree Habitat Design Guidelines, and the potential role of zoning by-laws in reserving sufficient good tree habitat to support the canopy cover/leaf area targets identified for each Land Use Type (Oakville 2006, Action Items 15 & 17).

This review should look beyond the borders of the Town to consider the science and best practice in tree habitat and policy guidelines from other provincial, national and international jurisdictions.

RECOMMENDATION 23: The Town's Interdepartmental/Interagency Technical Advisory Committee (IITAC) should discuss and consider for adoption the canopy cover targets proposed in the UFSMP.

Certain growing environments within the urban forest such as parking lots present particularly difficult challenges for tree growth. Chapter 37 of the Municipal Code for the city of Davis California requires that "… 50% of the paved parking lot surface shall be shaded with tree canopies within fifteen (15) years of the acquisition of a building permit". While the climate of Davis, CA is obviously different from that of Oakville ON, the summer climate of southern Ontario can be extreme and consideration should be given to increasing shade in parking lots from both an environmental and a human comfort perspective. Site plan guidelines for parking lots should be included in the review of policies affecting tree habitats (Oakville (2006) Item 22).

RECOMMENDATION 24: The Town's Interdepartmental/Interagency Technical Advisory Committee (IITAC) should establish canopy cover targets for parking lots and should develop design and implementation guidelines to achieve these targets. (Oakville 2006. Action Items 22).

If canopy cover goals are limited to the currently available growing space then the IITAC should establish policies and guidelines to ensure that the potential leaf area is realized. Such policies and guidelines should include issues of tree maintenance (covered elsewhere in this plan) but also aspects of the maintenance and expansion of the grey infrastructure that could negatively impinge on tree habitats over the expected life of the tree.

RECOMMENDATION 25: The Town's Interdepartmental/Interagency Technical Advisory Committee (IITAC) should collaborate in the development of guidelines for the protection of tree habitat during the maintenance and upgrading of grey infrastructure.

Trees in the urban core often have longevity of less than 10 years (Labrecque 1993). In many cases, this is due to the restrictive underground growing environment where the

engineering requirements of the grey infrastructure conflict with those of the green infrastructure; most often, the needs of the latter are poorly understood and therefore forgotten or ignored. One of the most obvious conflicts is the need to compact base course aggregates to support sidewalks. This compaction reduces the ability of roots to access moisture and oxygen and will physically impede root growth.

The term **enhanced rooting environment techniques** refers to specific design and engineering applications intended to ensure that tree roots can benefit from sufficient moisture availability (including rain fed infiltration or irrigation), drainage, aeration, nutrients and a bulk density conducive to good root extension while meeting the engineering specifications required by the site. Examples of root environment enhancements include but are not limited to applications such as engineered soils (for example, products such as Cornell University's "CU-Structural Soil" as well as DeepRoot's "Structural Cells" product. There may be other similar enhancements to the below ground environment worth considering along with the related surface treatments, such as porous paving, turf stone, mulch, etc.

In 2005, a limited trial of "CU structural soil" was installed in the uptown core of Oakville. Action Item 18 of *Our Solution to Our Pollution* (Oakville 2006) recommended an expansion of this initial trial. The use of enhanced rooting environment techniques should be expanded in the Town of Oakville.

RECOMMENDATION 26: The Town's Forestry staff and the ITTAC should host a workshop on the use of enhanced rooting environment techniques. This workshop will bring together forestry and engineering staff from across southern Ontario and other jurisdictions with experience in the use of various root zone modifications.

RECOMMEDATION 27: The Town should develop a set of engineering road cross sections using root zone modifications for implementation in difficult sites.

Tree Establishment Plan

At the level of the strategic plan, tree-planting priorities should reflect overall objectives with respect to tree cover, species distribution, tree replacement policy, etc. Detailed planting plans can be developed once an accurate assessment of the plantable spots is determined from the tree inventory. The Town of Oakville Official Plan currently requires replacement planting when mature trees are removed. The species chosen for plantings can also be directed by the inventory. Increasing diversity and the proportion of native species (where appropriate) in the urban forest should be a priority.

Leaf Area Density vs. Canopy Cover

The structure of the urban forest determines the benefits it can provide to the community as well as the management required to sustain these benefits in a cost effective and ecologically sustainable manner. Many parameters go into the characterization of the structure of an urban forest. At the individual tree level these include species (or cultivar),

the tree's diameter at breast height (DBH), age[12], total height, crown height, canopy width, and some measure of tree condition, to name but a few. At the level of the entire forest some of the possible parameters are species diversity (including richness, evenness, dominance, importance, etc.), age class distribution, stocking (the proportion of plantable spots actually occupied by trees), tree density, available growing space, canopy cover and leaf area or leaf area index (or density). Not all of these parameters will be discussed here; the reader is encouraged to consult the urban forestry literature or general forestry and ecological texts for more information. However, the question of canopy cover *vs.* leaf area does require further discussion.

Canopy cover, or the proportion of the land surface area covered by the crowns of trees (and shrubs) when viewed from above, is a commonly used and intuitive measure of the extent of an urban forest. Various techniques can be used to estimate canopy cover for the entire community or for specific parts of the community. An overview of these techniques can be found in Nowak, *et al.* (1996). While canopy cover is widely used in the urban forestry literature, is intuitive and easily estimated, it has drawbacks in some applications. For example, canopy cover is a two dimensional measure and, as such does not adequately represent the vertical structure of the urban forest. Moreover, measured canopy cover is an aggregation of the trees (and shrubs) in the urban forest or community. Thus it does not address the species variation or tree conditions that make up that forest (Kenney 2000).

Most of the ecological, social and economic benefits that the community derives from its urban forest can be either directly or indirectly related to the leaf area of the forest (Kenney 2000; McPherson 1998; Nowak 1994). Therefore some measure of leaf area would offer considerable insight to the discussion of urban forest management and conservation. In short, if our efforts are directed at sustaining or enhancing these environmental, social and economic benefits to the residents of the Town of Oakville, then we should be striving to sustain and enhance the leaf area of the Town's urban forest. Nowak (1996) developed an algorithm to estimate leaf area and this relationship is the basis for many of the estimates provided in the UFORE model.

While canopy cover is obviously related to leaf area the relationship is not easily translated from one measure to the other because the latter involves some factors not considered in the former. These factors include three dimensional crown size, species and crown condition, all of which contribute valuable information about the structure of the forest beyond their role in determining leaf area.

Because the concept of canopy cover is generally used in the urban forestry literature, is easy to estimate and is intuitive, it makes sense to continue to use this measure when discussing the extent of the urban forest as a whole or in particular areas of the Town. Currently, goals for urban forest sustainability and enhancement are based on canopy cover (among other factors). When dealing with certain other aspects of urban forest

[12] Age is often difficult to estimate in urban forests where increment coring is limited due to the high value of individual trees.

sustainability, particularly those addressed in single-tree issues, the use of leaf area provides some advantages. This is best illustrated by an example.[13]

Consider a Silver Maple (shading factor 0.83) with a crown length of 11 m and a crown width of 10 m. Such a tree would have a leaf area (LA) of 493 m^2. However, this assumes the tree is in perfect condition. If the tree in our example had lost 25% of its crown due to storms or topping, then the adjusted leaf area would be 370 m^2. This could be considered the target for restoration assuming an objective of "no net loss of benefits". This leaf area could be provided by 34 young Silver Maples assuming a crown length and width of 2 m each and 100% of the crown present and healthy, each tree with LA of 11 m^2.

The crown projection area (CPA) of a tree is the area of the circle enclosed in the drip line and represents the canopy cover attributable to that single tree assuming there is no crown over-lap in the urban forest. The large Silver Maple in question had a crown width of 10m which translates to a CPA of 78 m^2. It follows then that using the maintenance of canopy cover as the goal then 26 trees with a crown width of 2m (CPA=3.1m^2) would be required to replace the original tree. These 26 trees would have a total leaf area of 286 m^2 which would be 23% short of the leaf area lost by the removal of the original large tree. So, while the crown projection area might be recovered, there would be a significant net loss of leaf area and therefore net loss of benefits to the community.

If the original large Silver Maple had an excellent crown with only a trace of the leaf area missing (LA=493 m^2) then the use of crown projection area as a proxy for canopy cover would have resulted in a net loss of 42% of the leaf area of the original tree by planting only 26 smaller trees, even though CPA was sustained.

Clearly the difference between the replacement targets based on leaf area and those based on canopy cover will be most extreme in the case of the loss of large trees. However, using the same logic, if the original tree had a crown length of 6m and a crown width of 5m the shortfall in LA would still be 31% (assuming a 100% crown).

Goals and Guidelines for the Replacement of Trees Removed from Municipal Property

To ensure that the Town of Oakville's municipal forest does not decrease below 29.1 % over time, there must be a minimum replacement policy of one square metre of leaf area replaced for each square metre removed. However, if Oakville is to increase its potential canopy cover over the next 20 years, more than just minimum replacement must take place.

The necessary ratio for replacement of trees removed should be determined by the IITAC after confirming the canopy cover targets recommended in this document. Space that is identified for planting should be filled with the largest tree possible (at maturity). This is because, as stated, the benefits from trees increase significantly with the size of the mature canopy (Kenney 2000).

[13] Calculations of leaf area based on Nowak (1996).

Species Diversity, Age-Class Distribution and Associated Best Management Practices

In Oakville, the three most dominant species in terms of leaf area are all maples (*Acer*), comprising approximately 28% of the overall leaf area (Town of Oakville 2006). If a pest associated with maple trees were to infest Oakville, then a major portion of the urban forest would be threatened. In order to have a more robust urban forest, there needs to be a diversity of species and genera represented. A good guideline is to have no more than 10% of the forest comprised of one species, 20% of one genus, and 30% from one family (Santamour 1990). When planning the expansion of the urban forest, Oakville should use this ratio as a guiding principle.

A well distributed age-class helps maintain a stable canopy cover. If all the trees within a particular area or neighbourhood are approximately the same age they will mature and decline more or less at the same time, leaving that area with a deficient urban forest canopy. In some parts of Oakville, mature Norway and silver maple trees have begun to decline in health (Town of Oakville 2006). To mitigate against the impacts of a decreasing canopy cover in neighbourhoods dominated by these two species, Oakville should take steps to increase the age class and species distribution where possible.

For example, the City of Davis, CA established the following standard for desired age structure:

- 40% young (< 15 cm DBH)
- 30% maturing (15-30 cm DBH)
- 20% mature (30-60 cm DBH)
- 10% old (>60 cm DBH)[14]

At present, Oakville has only 0.5% large-stature trees.[15] Management activities should strive to improve this to at least 10% of all trees in Oakville.

RECOMMENDATION 28: ***The Town should develop removal and replacement plans to increase the age class and species diversity in areas identified as having a canopy dominated by mature Norway and silver maples.***

A Strategy for Nursery Stock Procurement

The Town of Oakville should develop a long-term strategy for nursery stock procurement to enable the administration to request appropriate species rather than relying solely upon the available stock. This will allow the Town to exert more control over its species diversity and to select the use of species that will thrive in an urban setting. A number of resources exist to assist in the selection of species.[16]

[14] Source: Town of Oakville (2006).
[15] *Ibid.*
[16] See for example Tree Canada's Urban Forestry Best Management Practices for Ontario Municipalities: (http://www.treecanada.ca/programs/urbanforestry/cufn/Resources_Canadian/ISA_BMP_2000.pdf

The Town should develop its own list based on its long-term objectives, but with built-in flexibility to accommodate changing needs and challenges.

In many jurisdictions, species selection for plantings is limited by availability of stock at the local nurseries. The common experience in Ontario has been that, even if a community wants to plant native species, there are limited supplies of these trees when they are needed. If the long-term planting stock requirements can be forecast, contracts can be negotiated with the nurseries and the community can demand the species, size and quality of trees to meet the goals and objectives of the strategic plan. Without this level of planning, the community must often be satisfied with the stock that the nurseries can supply. Long-term planning will make it possible for growers to accommodate planting needs for native species grown from local seed sources. Specification for planting stock quality and planting procedures should be clearly defined. Recommendations for other species, particularly those native to the region, will become available as a result of the performance tracking and species suitability trials recommended below.

RECOMMENDATION 29: The Town should reserve appropriate lands for the development of a nursery and conduct a study to determine the feasibility of producing its own nursery stock versus entering into a long term relationship with a local grower.

Native Species / Seed Source

Oakville should promote the establishment of native species in appropriate areas. Similarly, stock procurement strategies should promote the use of locally adapted seed sources. Special care should be taken to plant native species near woodland areas that may be susceptible to invasion from non-native stock (McGauley et al 2000).

RECOMMENDATION 30: The Town should establish a project that will identify (through GIS) areas at risk for exotic invasions (i.e. near natural areas such as woodlots, wetlands, ravines, etc.).

NOTE: During the preparation of this management plan, the Town received a draft proposal from Trees Ontario Foundation and the Forestry section, who have developed a strategy for the "establishment and management of tree seed and seedling development for restoration efforts". The proposal was developed separately from the UFSMP; we include it in Appendix H for information. Staff should further explore the merits of this proposal.

Stock Quality

Nursery stock quality has a significant impact on the survival and long-term growth of planted trees. All nursery stock procured for establishment in the Town must follow the Canadian Standards for Nursery Stock.[17]

[17] These can be found at (http://www.canadanursery.com/Page.asp?PageID=924&ContentID=841)

All planting stock must be inspected by Town staff before it is accepted for planting. This will ensure the best possible chance for survival and growth in a harsh urban setting.

Establishment and Monitoring Requirements

The trees should be planted according to the Landscape Standards of Landscape Ontario.[18]

When trees are planted by a subcontractor, Town staff must inspect them soon afterwards. Also, there must be a minimum of 2 years of aftercare (by the contractor) for newly planted trees (McGauley et al 2000). At the termination of the warranty period Town staff must re-inspect planted stock and determine if the warranty conditions have been met. Early maintenance should follow the guidelines suggested by Landscape Ontario.[19]

RECOMMENDATION 31: The Town's tree asset management system, CityWorks, should include a system of tracking survivorship to inform species selection and management.

Plantable Spots

As the inventory of existing trees is gathered, places where trees could be planted should also be noted. These sites are potential spots where the urban forest can be enhanced and where the first possibilities lie for increasing the number of trees in the community. The number of plantable spots can also help when the community is budgeting for, and ordering new trees.

While the establishment of trees across the Town will be required to sustain and enhance the urban forest, some "prime sites" will have a greater chance to ensure excellent survival and growth.

RECOMMENDATION 32: The T own should develop a Prime Site strategy which will identify priority sites to amend the soil quantity and quality in accordance with the Town of Oakville's Our Solution to Our Pollution report.

Species Suitability Trials

In light of the changing growing environment and the identification of species and cultivars more suited to these ever-changing conditions, the Town must continuously explore opportunities to incorporate new selections into their tree establishment program.

Several long-term performance trials should be set up throughout Oakville in order to test the suitability of a wider selection of species and new cultivars for establishment in the Town. By monitoring these trials the Town can identify the best choices for planting.

[18] Please see (http://www.landscapeontario.com/attach/1134078236.Chapter_6_-_Plants_and_Planting.doc).
[19] (http://www.landscapeontario.com/attach/1134078407.Chapter_17_-_Establishment_Maintenance.doc).

Arboretum

Arboreta are common in many municipalities and they offer a place for people to learn about different trees from around the world using living specimens. Additionally, they are often used for research. For example, the arboretum at the University of Guelph collects cuttings from putative Dutch Elm Disease-resistant elms from across Ontario to test for resistance (University of Guelph 2006). An urban arboretum is also an excellent place to conduct species suitability trials as are currently conducted at the Humber Arboretum (City of Toronto 2006). Oakville should consider developing plans to create an arboretum using species that are tolerant to the climate of the Lake Erie Lowland Ecoregions in which Oakville is located and the general growing conditions typical of urban environments. The arboretum should be situated in a cemetery or large park where there is ample room to plant new trees.

RECOMMENDATION 33: The Town should conduct a feasibility study for the creation of a municipal arboretum.

During the development of *Our Solution to Our Pollution* (Oakville 2006) Town staff identified a number of Action Items that relate to tree establishment. Several of those items are included here as recommendations for staff to consider during the implementation of this strategic plan.

RECOMMENDATION 34: The Town should outline the creation of a pro-active under planting program in those communities at risk of decreasing urban forest canopy cover due to aging trees (Town of Oakville 2006, Action Item 4).

RECOMMENDATION 35: The Town's Forestry Section should work with the Forest Gene Conservation Association to create a gene conservation program for the Town (Town of Oakville 2006, Action Item 9).

RECOMMENDATION 36: The Town's Parks and Open Space Department will identify opportunities for Parks Naturalization that contribute to the forest canopy and prepare capital budget costs (Town of Oakville 2006, Action Item 10).

RECOMMENDATION 37: The Town should produce a GIS-based planting plan incorporating the UFORE-Tree Locator Module, "Tree Habitat Design Guidelines for Oakville" (Town of Oakville 2006, Table 9) and taking into consideration the "Best Species for Air Quality Improvement" and species best suited to the changing climate.

Pruning Plan

Pruning plans are essential, not only to ensure healthy, aesthetically pleasing trees but also to increase public safety and to decrease public or private liability. A variety of requirements can inform pruning plans, some more desirable than others. Common factors that determine pruning priorities are residential requests and emergency pruning. This kind of "reactive management" is most common in jurisdictions where no planning

exists. Scheduling pruning based on these factors may actually increase liability for damages because many hazards remain unidentified until a failure occurs.

This category may also include task pruning, which encompasses pruning for utility line clearing, maintenance of sightlines for vehicles and for pedestrian passage along sidewalks. The Town of Oakville must move from a reactive pruning approach to a cyclic, proactive approach to tree maintenance.

From Reactive Pruning to a Proactive Approach

Tree health can be greatly increased by regular pruning, especially when the tree is young. Immature trees that are left unpruned can develop many structural problems such as weak branch structure, crossing branches, and co-dominant leaders (International Society of Arboriculture 2005). If corrected early, the tree can develop a strong support structure with a healthy canopy. This in turn will reduce the necessity of more expensive and often intrusive corrective pruning during the normal life of the tree. If tree condition is improved at a young age and maintained during the tree's life, there will be less need for a reactive approach to pruning.

If regular pruning is planned in a systematic manner, crews and equipment can work much more efficiently than if pruning is only done by request. The cost difference can be dramatic. The City of Toronto has compared efficiencies of both methods and found planned pruning to be at least twice as productive (see Table 6). When crews examine the urban forest in a block pattern for possible hazards and tree health problems, there is a reduction in citizen calls for emergency pruning (Luley et al. 2002). Additionally, the crews often find problems that would not have been reported by residents (Halstead 1999). The block pruning method can also focus on certain species that may require more attention; this is common when a pest needs to be controlled, for example. Block pruning maintains a greater safety level in the urban forest and can decrease liability for the municipality (McGauley et al 2000).

Currently, the Town of Oakville operates pruning crews primarily on a reactive basis. Part of December is devoted to proactive pruning and from January to March all crews focus on Oakville Hydro line clearing. For the most part, crews respond to citizen requests that Town trees be pruned due to safety concerns (personal communication, J. McNeil). As this is not the most efficient or effective way to maintain tree health, we recommend Oakville shift towards a more proactive approach to enhance the health of the urban forest, including both street trees and those located in parks. To develop an effective tree pruning program, Oakville needs to build capacity to be able to prune all Town trees in a systematic manner as well as responding to emergency pruning and safety concerns in good time. Emergency response must be coordinated with other Town emergency response planning.

RECOMMENDATION 38: The Town should develop an urban forestry emergency response plan that integrates with the corporate emergency plan.

Table 6: Pruning productivity guidelines for the City of Toronto 1999 season. Number of trees are those pruned per crew per day (Halstead 1999).

Type of Pruning	Congested Area		Non-congested Area	
	On Request Basis	Systematic Pruning	On Request Basis	Systematic Pruning
For large trees (>50 cm. diameter) using a 3 person crew combined unit	2 to 3 trees	4 to 6 trees	3 to 4 trees	6 to 8 trees
For medium trees (30 to 50 cm. diameter) using a 3 person crew combined unit	4 to 6 trees	8 to 10 trees	6 to 8 trees	8 to 10 trees
For small trees (<30 cm. diameter) using a 3 person crew combined unit	8 to 10 trees	12 to 16 trees	12 to 16 trees	15 to 23 trees

A Description of a Phased-in Transition from Current Practices to "Block Pruning"

According to the Town of Oakville (2006) report, there are 83,000 street trees and 330,000 trees found in parklands. These trees are currently divided into 32 forestry blocks, 24 of which are located south of Dundas Street. Some of these blocks are primarily filled with more mature trees, but many of Oakville's trees are less than 20 years old. These young trees need to be pruned as soon as possible in order to promote good structure, and they should be placed on a short pruning cycle until they mature. Areas with mature trees can be placed on a longer pruning cycle.

In practice, trees at different stages of their development will receive different standards for frequency and extent of care. These stages are:

- Juvenile (e.g. recently established, small trees which can easily be pruned (training) from the ground using secateurs (<5m).
- Intermediate trees are those that can be pruned from the ground using pole pruners (5-15m).
- Mature trees are those that must be pruned by climbing or from a bucket truck (>15m).

Using the calculations outlined by Miller (1988), the optimum pruning cycle for Oakville was stated to be approximately 6 years (Forestry Business Plan, Town of Oakville, 1998). This theoretical approach means that the value of Oakville's street trees would be maximized if all trees were appropriately pruned at this frequency to generally acceptable standards such as the ANSI-A300 pruning standards.

To be consistent with the structure of this plan (four 5-year management plans) it is recommended that the Town adopt a 5-year pruning cycle for all intermediate and mature trees.

Juvenile trees must be pruned on a 3-year cycle until they reach intermediate size at which point they will be included in the 5-year pruning cycle.

RECOMMENDATION 39: The Town should adopt a 5-year pruning cycle for all intermediate and mature trees and a 3-year cycle for all juvenile trees. Line clearing operations should be consistent with these pruning cycles.

Trees should be inspected in a systematic manner so that no problem is missed during regular pruning. All pruning activities should follow the ANSI A-300 Standards for Pruning[20] and the Urban Forestry Best Management Practices for Ontario Municipalities for clearance distances.[21]

To ensure that the pruning cycles for young and mature trees are implemented, the Oakville Parks and Open Space Department must increase its capacity. There must be enough crews so that scheduled blocks are completed each season; additional crews must also be available to address any emergencies or safety concerns from residents. Once block pruning and risk management methods have been implemented, there will be a significant decrease in requests for Town tree maintenance; however, failures due to strong storms will still need attention (Luley et al 2002).

Prior to the establishment of the working groups explained in the Stratification section of this plan, forestry staff provided Figure 15 and Table 7 to guide interim block pruning. These zones represent the management units in use prior to the implementation of this plan and should form the basis of the interim block pruning plan.

[20] Please see http://www.treecareindustry.org/Public/gov_standards_a300.htm

[21] http://www.treecanada.ca/programs/urbanforestry/cufn/Resources_Canadian/ISA_BMP_2000.pdf

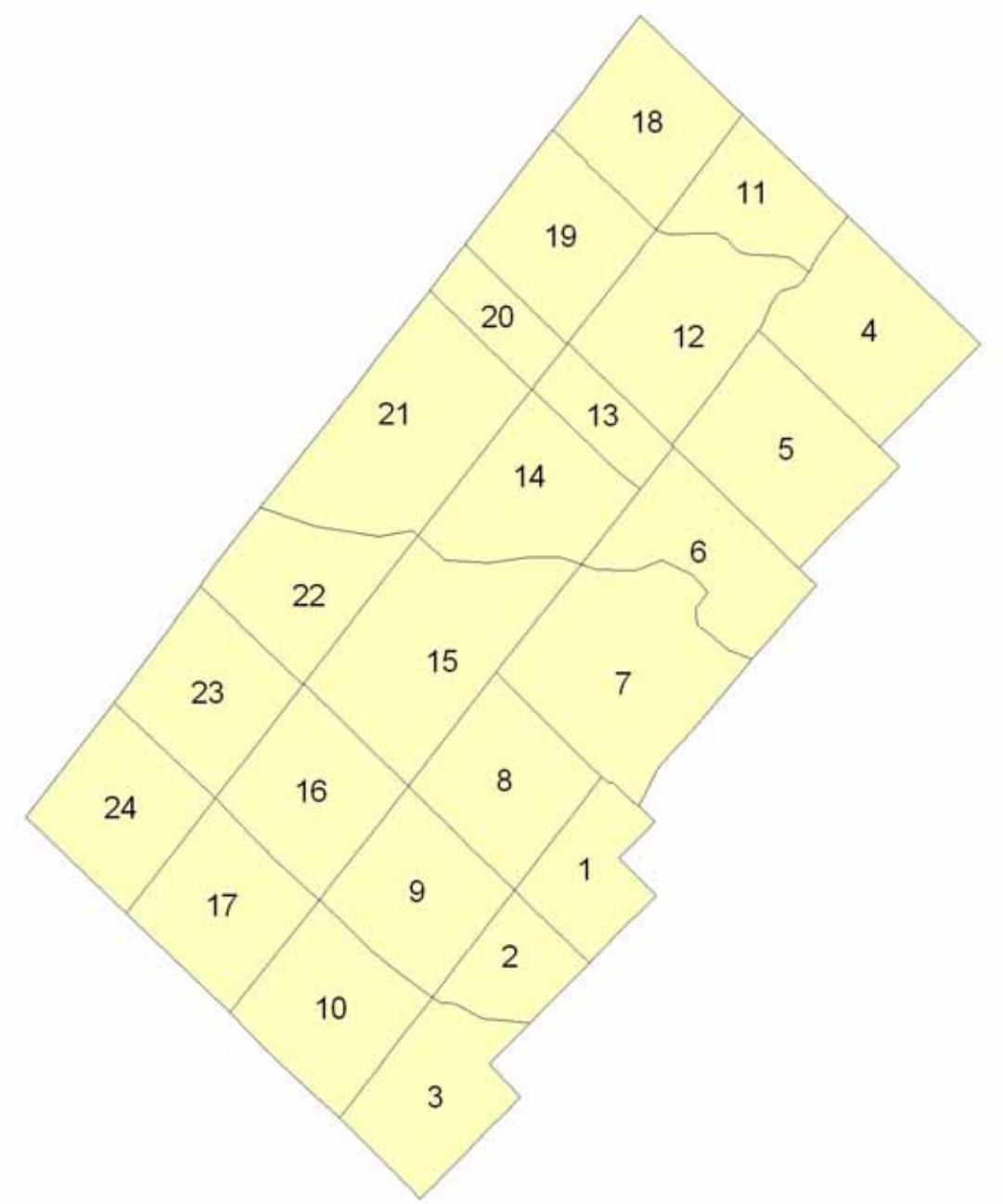

Figure 15: Current Forestry Zones to be used in the interim block pruning plan. See Table 7. (Source: Forestry Section 2007)

Table 7: Proposed interim block pruning allocations by zone and year. See Figure 15.

Age Class	Year 1	Year 2	Year 3	Year 4	Year 5
0-20	Zones 18,19	Zones 20,21	Zones 22,23,24	Zones18,19	Zones 20,21
21+	Zone 1,2,8,9	Zone 3,10,17	Zone 4,5,11,12	Zone 7,15,16	Zone 6,13 14

Public Education / Communication vis a vis Block Pruning

Currently, Oakville residents receive a letter regarding tree pruning prior to the day that pruning is scheduled in their neighbourhood. While this serves to inform people about the reasons for pruning Town trees, there is no regularity or advance warning in the system. Additionally, because the trees have not been pruned routinely, large branches may have to be removed. Consequently, residents are often concerned by the extent of the pruning.

When a block pruning approach is adopted by Oakville, each resident in the relevant blocks should receive notice of pruning activity in advance of the scheduled day. The notice should be accompanied by a map to illustrate that their neighbourhood is pruned systematically once every cycle. When people understand that pruning is conducted as regular maintenance, they will become less concerned during the activity. This regularity and advance notice will also help to educate Oakville residents about tree care needs and may lead some to undertake regular pruning on private trees.

Line Clearing for Oakville Hydro

In 2005, the Parks and Open Space Department signed a 10-year contract with Oakville Hydro to clear vegetation away from lines every winter. This is presently a beneficial agreement because it allows the department to ensure that Town trees are pruned in such a way that tree health is not compromised. The schedule is a 3-year pruning cycle and the standard requires an average of 0.3 m clearance on secondary lines and 1m on primary lines. In addition the Section is involved with Hydro Capital projects on a request basis.

Tree Protection Plan

Tree Protection Specifications for Construction near Trees

The Town of Oakville, Parks and Open Space Department developed a Departmental Procedural Policy (Procedure No. 01-03-08) in 2003 titled “Tree Protection Specifications for Construction near Trees”. The intent was to provide enhanced protection for Town trees by introducing requirements for tree protection prior to construction, rather than dealing with damaged trees after the fact. Damage to Town trees was costing time and money and altering streetscapes through the loss of trees.

The policy applies to "Town trees and other trees protected by Town by-laws or conditions of approval granted by the Town, and are recommended for all trees which may be impacted by construction activities."

Section 2 of the policy outlines how damage to Town trees will be prevented. Sections 3 and 4 provide specifications for the minimum Tree Protection Zones (TPZ's) for trees by diameter classes, as well as requirements for the construction of the barriers that will protect the TPZ's.

The remainder of the sections in the policy provide guidance for:

- tree removal and relocation of Town trees
- qualifications of consultants preparing tree protection plans
- standards for tree protection plans
- guidance on the retention of securities for tree protection
- a detailed checklist for the preparation of tree protection plans, and
- several helpful graphics detailing tree protection barriers and site plans with trees adequately represented.

Section 6 of the policy provides specific guidance for Utility Construction and Engineering and Construction Capital Projects, recognizing that these activities must occur near Town trees and that they have perhaps the greatest potential to damage them.

This comprehensive document has allowed for significant improvements in the protection of Town trees. The policy is enforced by two separate departments: Parks and Open Spaces (Urban Forestry) and Development Services.

The current Tree Protection Policy has been in place since 2003. Forestry staff, with input from Development Services, have prepared updated guidelines: the new standards increase the size of the TPZ. At the time of writing, the Town's Legal Department was reviewing the Street Tree By-law with the objective of re-drafting it to support the new Tree Protection Policy. Once in place, an infraction of the Tree Protection Policy will be an offence under the new Street Tree By-law (to be brought to Council for approval).

RECOMMENDATION 40: The Town must complete the update to its Tree Protection Policy and Street Tree By-law.

Enforcement of the Policy

The Urban Forestry section of the parks and Open Space Department has responsibility for enforcement of the policy on: Driveway applications, Road cut (excavation) permit applications, Park Access Permits, Capital Projects and Municipal Consents. In order to be aware of projects requiring these permits, Urban Forestry is represented on the Ontario Utility Coordination Committee. This committee provides an opportunity for all members to present all ongoing and future projects in the Town of Oakville. By attending these meetings Urban Forestry is able to monitor which projects may affect Town trees and to inform the appropriate agencies of their obligations to protect Town trees.

To facilitate better cooperation and understanding of the policy, Urban Forestry has created three documents and circulated them through the Ontario Utility Coordination Committee. They are: Tree Protection Zone Agreement Process, 2004; Tree Protection Inspection, Town of Oakville, 2005 (see Appendix I); and Special Provisions, 2006. With these three documents, urban forestry has described in detail a developer or contractor's obligations when a Town tree is involved in a construction project and specifically, when a permit is required if a TPZ cannot be provided according to the policy (Tree Protection Policy, Article 6).

The particular value of the Tree Protection Inspection document is that it explicitly explains the roles and responsibilities of a contractor in three phases of construction: pre-construction, during construction and post-construction. The document outlines the objectives and procedures for each phase and the possible outcomes. It also details the role of the project arborist and obliges the contractor to include the project arborist in all phases of the project. This is a key point because it allows the arborist to report on all phases of the project.

However, there is still a need for Town staff to inspect each construction project at various times because the project arborist is not on the site at all times. Currently there is only one dedicated staff member to implement and enforce the Tree Protection Policy. That staff member is responsible for: reviewing and processing approximately 530 applications, reviewing 150 Tree protection reports (pre-construction and post construction reports) and issuing 220 tree permits in a year. This creates approximately 1500 inspections a year. For the Policy to be fully effective, additional staff will be required (see Appendix J1 and J2).

Since the implementation of this policy and the creation of the supplemental documents to refine the process of protecting Town trees, Town staff observed significant changes and improvements. For example, staff saw a reduction in infractions from 13 in 2005 to just 4 infractions in 2006. While the process is greatly improved, it was noted that within the tree protection process, the highest level of cooperation has been from the external agencies working on municipal lands.[22]

The other Department responsible for enforcing the policy is Development Services. This department is responsible for all Site Plan Applications and the following permits: Industrial/Commercial/Institutional Building Permits, Residential Building Permits, Demolition Permits, and Pool Permits. All of these permits require a Site Alteration Permit. Through the Site Alteration Permit process, governed by the Site Alteration By-Law, tree permits to work within the TPZ can be issued when municipal trees are associated with a site.

The Site Alteration By-law also gives the Director the discretion to prevent the injury or destruction of other trees where they "could be reasonably avoided" (Section 5 (d) (viii)). In the issuance of the site alteration permits, conditions of approval can be added to the permitting process. Section 6 (d) allows the Director to add conditions "prescribing tree

[22] John McNeil, personal communication.

protection measures beyond the tree protection measures specified in Schedule F" (Schedule F is an abbreviated version of the Tree Protection Policy).

The Tree Protection Policy states in Section 1, "All trees situated on Town property are protected under provisions of Town by-laws. Some trees situated on private property are also protected by Town by-laws or as conditions of approvals granted by the Town." This policy statement creates the opportunity for protection of trees other than Town trees by adding conditions of approval to the various permits. By utilizing this opportunity and the relevant sections of the Site Alteration By-Law, Oakville can strengthen protection of trees other than Town trees. To determine the enforceability of conditions to protect trees under the Site Alteration By-Law, we recommend consultation with the Town's legal department.

The departments of Development Services and Parks and Open Spaces share responsibility for the enforcement of tree protection standards. As a result, two different standards are being applied. This undermines the effectiveness of the tree protection processes during construction.

RECOMMENDATION 41: The Town should consider transferring the responsibility for private tree protection from the Development Services Department to the Parks and Open Space Department.

Currently Oakville has no Private Tree By-law to protect trees on private property. As in-fill development proceeds, Oakville loses significant tree cover. If the enforcement of the Tree Protection Policy is improved through the addition of conditions on permit issuances, the need for a private tree by-law may be diminished.

To our knowledge, the Development Services Department has to date not created any supplementary documents similar to those of the Forestry department to guide policy interpretation and implementation. This can cause confusion as to what is required in terms of tree protection for the various permits. An inspector determines the requirements for an arborist report and which trees are to be addressed by means of a site visit. In most cases, the requirement for an arborist to be involved in all phases of a project is not required. Development Services could improve the tree protection process for the permits that they administer by creating or adopting similar supplementary documents to those developed by Forestry.

Current staffing levels make enforcement of tree protection conditions difficult. Staff has insufficient time to regularly visit sites. Infractions are detected in the following ways: when possible, staff visit sites that are close to other sites requiring preliminary inspections; other by-law officers report infractions; or members of the public report tree protection infractions. In 2006, two staff members were responsible for more than 900 site alteration applications (each requiring a site inspection), issuance of 150 tree permits, and the review and processing of 80 site plan applications. The Town requires additional staff to successfully enforce tree protection measures for public and private trees.

RECOMMENDATION 42: The Town should hire four additional inspectors to enforce tree protection on both public and private land.

RECOMMENDATION 43: The Town's Development Services should create guidelines for the implementation of the Tree Protection Policy as it applies to various permitting processes, and where possible, utilize conditions of approval to protect trees on private property.

RECOMMENDATION 44: The Town should investigate the feasibility of developing and implementing a private tree preservation by-law based on the principle of no net loss of leaf area/canopy cover within the urban forest.

NOTE: Please refer to Appendix G for an email discussion between Kenney and McNeil outlining the concept of a tree replacement policy based on leaf area.

Plant Health Care Plan

The urban environment is becoming increasingly hostile to the long-term health of trees and shrubs. Environmental stresses both above and below ground weaken natural defence systems and can leave plants prone to insect infestations and diseases. Structural and health problems with trees often go undetected until part of the tree fails or the whole tree dies.

Higher density land development generally reduces the quality and quantity of tree habitat below threshold levels necessary to support healthy trees. The result of these planning initiatives, mostly mandated by the provincial government, is an increased pressure on municipal forestry programs to sustain trees in difficult growing conditions.

Plant Health Care (PHC) is a philosophy derived from the concept of Integrated Pest Management (IPM). PHC takes a proactive approach to tree management that strives to increase the health and vigour of trees such that their natural defence mechanisms will protect them. Some aspects of PHC are:

- Proper tree selection: "the right tree in the right place"
- Early pruning of young trees to establish strong structure for long-term stability
- Fertilization and watering according to the soil conditions and the species requirements
- Using an array of cultural practices and biological controls to reduce the use of pesticides
- Structural support systems such as cabling and bracing

An integral part of PHC is regular monitoring. Early detection of health or structural problems will allow for expedient remedial care and will help to prevent damage to trees or the loss of whole trees.

Consequently, the concept of plant health care is an underlying theme of this entire UFSMP. As the Town implements the UFSMP and moves towards a proactive management approach the Town can anticipate significant general improvements in the health of Oakville's urban trees.

The inventory will identify the species in the urban forest, their location and condition. It will also identify prime sites such as parklands, road side berms, and low density industrial and residential sites where innovative programs such as soil restoration can be most effective. The inventory will also enable regular monitoring of plant health because of constant updating provided by the block pruning program.

Tree habitat considerations are of primary importance in areas where conflicts between the grey and green infrastructure arise. New standards, guidelines and policies will help to ensure that medium and large stature trees can be grown on difficult sites. The tree establishment plan focuses on the selection of appropriate species, good quality stock and protocols to ensure that they are planted and tended to correctly in the critical first years following planting.

The pruning plan places an emphasis on the training of young trees to establish good form and structure. The block pruning program will help to improve the health of trees of all ages by providing a more comprehensive and frequent approach to maintenance pruning and assessment of risks. The tree maintenance crews will also be able to assist in the early detection of pest and disease problems and can help to determine the extent of any infestations that may occur.

The tree risk management plan, to be developed and implemented after the completion of the inventory, will seek to improve the health of at-risk trees by utilizing arboricultural treatments to reduce or alleviate significant structural weaknesses in mature trees.

The largest numbers of trees in Oakville are located in approximately 50 municipally-owned woodland properties. The Forest Stewardship program seeks to have management plans for each of these woodlots, as required for FSC certification by 2009, as soon as possible. The silvicultural prescriptions developed for the management plans will help to improve or maintain the long term viability of this important urban forest resource. Permanent sample plots established in each woodlot will allow for the monitoring of tree health and may assist in the early detection of pest or disease issues. To date only three management plans have been completed. The completion of the remaining management plans should be a priority.

Monitoring and Management of Invasive Pests

Perhaps the greatest threats to the future health of urban forests are alien invasive species. As international trade accelerates, the number of introduced species has dramatically increased. Alien species are defined as "species of plants, animals and micro-organisms introduced outside their natural past or present distribution. Alien species become

invasive when they establish and spread in a new environment, and threaten the native species, the environment, the economy, or some aspect of society."[23]

Ontario has a history of significant damage to trees from invasive pests. The first prominent example is Dutch elm disease (DED) which was introduced in North America in 1930 and has since spread throughout most of the range of native elm species in North America. In the 1960's and 1970's a majority of the elms in Ontario were wiped out. A lack of consistent management contributed to the catastrophic losses.

In the last five years two significant destructive pests have been found in Ontario. The Asian Longhorned Beetle (*Anoplophora glabripennis*) was discovered in an industrial park between the Cities of Vaughan and Toronto in September 2003. The Emerald Ash Borer (*Agrilus planipennis*) was first discovered in Windsor, Ontario in 2002. Both of these pests have the potential to cause extensive damage to the urban (and wildland) forests of Ontario. Since 2005 the Town has undertaken annual Gypsy Moth Egg Mass Surveys and in 2006 the Town added Emerald Ash Borer to the survey.

Invasive plant species have also become a major stressor in urban forests. Invasive plant species can be described as species that are fast growing, prolific seeding and aggressively competitive with native species. Often these species are also non-native. The issue of invasive tree species is a concern for Oakville's ravines and natural areas. Species such as Norway maple (*Acer platanoides*), Manitoba maple (*Acer negundo*) and Siberian elm (*Ulmus pumila*) can and have invaded many of these areas and are out-competing native tree species on some sites. Invasive plant species are also a concern in the understorey of woodlands and natural areas where plants such as garlic mustard (*Alliaria petiolata*), European buckthorn (*Rhamnus cathartica)* and dog-strangling vine (*Cynanchum rossicum)* are rapidly displacing native ground flora and leading to a significant reduction in biodiversity. Once established in a natural area these species are often difficult to manage and can permanently alter ecosystem composition and function.

RECOMMENDATION 45: The Town should develop a strategy for the monitoring and control of alien invasive species. Where appropriate the Town will coordinate its efforts with the Canadian Food Inspection Agency, the Canadian Forest Service, the Ontario Ministry of Natural Resources, Conservation Halton and other area municipalities.

Woodland Stewardship Program

Oakville's Iroquois Shoreline Woods (ISW) has been under serious health decline for the past decade. As this is an important natural woodland, with a mature canopy of native oak (*Quercus*) species, management of this issue needed to be approached in a systematic manner. Town staff initiated assessment and control of an invasive insect, two-lined chestnut borer (*Agrilus bilineatus)*, and developed plans for prescribed burning projects in ISW to aid natural regeneration of oaks.

[23] Environment Canada, http://www.cbin.ec.gc.ca/issues/ias.cfm?lang=e

In 2003, the Parks and Open Space Department proposed that Oakville's woodlands, including ISW, be managed formally; they suggested four different approaches, ranging in rigor, to the Community Services Committee. The most rigorous management approach put forward was that of the Forest Stewardship Council (FSC), an international non-profit organization that sets standards for sustainable forest management. The international body has 10 principles by which all FSC-certified forests must comply, in addition to regional standards for the Great Lakes-St. Lawrence (GLSL) area. Their goal is to produce forest management units that are ecologically and socially responsible while still being economically viable. To become certified, each unit must have an up-to-date management plan (Forest Stewardship Council 2006).

In 2006, the Community Services Committee approved FSC-certification for all of Oakville's woodlands, which includes approximately 700 hectares of land. This initiative is in partnership with the Eastern Ontario Model Forest (EOMF). The EOMF is one of 11 model forests across Canada. It encompasses 1.5 million hectares of land in eastern Ontario, which is heavily urbanized. The Model Forests bring together diverse partners to collaborate on innovative ways of accomplishing sustainable forest management. One of their current objectives is to transfer their management principles and practices beyond the borders of the Model Forest itself (Eastern Ontario Model Forest 2006). In addition, they have created the Eastern Ontario Urban Forest Network, which consists of communities, agencies, and individuals working to promote healthy urban forests in Eastern Ontario (EOUFN). Given the objective and project mentioned here, it is appropriate that the EOMF should be involved with helping Oakville to become the first lower-tier Canadian municipality whose woodlands are FSC-certified. The Model Forest's main role in this project is to review any management plans created for the Town and give recommendations and final approval; they are also responsible for an annual audit of all certified woodlands.

Currently, three of Oakville's woodlands have complete and approved management plans; these are the Iroquois Shoreline Woods, Bayshire Woods, and Winston Woods, all of which showed signs of oak decline. They are all compliant with the FSC international and GLSL standards. However, there are approximately 50 municipal woodland properties in Oakville, all of which must eventually have a management plan as well.

RECOMMENDATION 46: The Town will use the forest stand inventory data to complete a Forest Management Plan for its remaining 47 woodland properties under the Forest Stewardship Council program.

Tree Risk Management Plan & Hazard Abatement

Liability is a major concern of urban forest managers. Certain conditions in trees increase the likelihood of a tree's structural failure, in whole or in part. Tree risk management can be described as a process of inspecting trees for defects and assessing whether a failure of a defective part could cause injury to people or cause damage to property. In traditional tree risk literature, the terms "hazard" or "hazardous" describe trees with defects.

However, where the consequences of failure are low, a structurally unsound tree represents no hazard. The term "hazard" should be reserved for trees that have significant structural defects *and* have a significant target that would be hit if a failure should occur. Using this definition, not every tree that has a defect is hazardous. Once described as a hazard, a tree will conjure the image of a risk of immediate failure.

It is preferable to use terms such as "low", "medium" or "high" risk to describe tree defects. These descriptions can help determine how soon a tree will require corrective actions. A tree rated "high risk" may require immediate attention; a tree with a low risk rating is a lower priority and may be addressed during regular maintenance pruning.

There are many approaches to assessing defects and rating the risk potential of trees. Some trees may appear hazardous even to a layperson, but many others only appear that way when viewed through a trained eye or when tested using more sophisticated technologies. It is important that tree risks are identified in the inventory process and then prioritized for repair or removal in the first stages of an implementation plan.

Tree risk assessment can also be used as an educational tool to demonstrate the necessity for urban forest planning. With proper planting and aftercare combined with regular pruning and periodic inspections, there is less chance for weaknesses or defects to become hazardous. Proper management will lead to permanent reductions in liability.

Importance of Risk Assessment and Hazard Abatement

According to the Oakville report *Our Solution to Our Pollution* there are 83,000 street trees and 330,000 trees found in parklands. As the owner of these trees the Town has a responsibility to create and maintain a safe and useful urban forest for its constituents. In a legal sense the Town has a 'duty of care'. Dunster and Murray (1997) state that "…the owner of one or more trees has some degree of legal responsibility (the duty) to exercise common prudence (the standard) in maintaining his or her trees in such a way that that they will not fall down or otherwise fail in a manner likely to cause damage to other property or people." In the absence of a provincial or federal standard, the Town must establish its own standard of care for trees.

Currently in Oakville, as in many other Ontario municipalities, the assessment of risk is the responsibility of Urban Forestry staff. The Supervisor of Urban Forestry inspects trees drawn to his attention or identified through operational activities. There is no systematic inspection process to identify trees at risk largely due to the lack of staff and resources.

Taking a city-wide tree inventory and implementing an urban forest management strategy creates an opportunity to develop a more comprehensive risk management plan to address the Town's responsibilities with respect to "duty of care". We recommend the following steps for the development of that plan:

- Complete the municipal tree inventory
- Query the database to determine the numbers and locations of low, medium and high risk trees

- Determine an acceptable level of risk with input from urban forestry staff and decision-makers such as city managers, city council, mayor, legal department, and others
- Determine the staff and resources available to address tree risk issues
- Develop a tree risk management plan.

These are the key points to consider. For a more comprehensive approach the Town should refer to a recent publication by the USDA Forest Service titled "Urban Tree Risk Management: A Community Guide to Program Design and Implementation". This publication is available at: http://www.na.fs.fed.us/spfo/pubs/uf/utrmm/.

RECOMMENDATION* 47: *The Town should develop a Tree Risk Management Plan and establish an inspection protocol based on the data from the Municipal Tree Inventory.

How Will Tree Risk be Assessed?

The Town is currently developing their municipal tree inventory and tree asset maintenance management system with ESRI Canada Limited. Forestry staff has developed a list of 23 attributes to be collected for street trees. In the ESRI Oakville Requirements Analysis document (2007) the proposed attributes appear in Appendix K. The attributes of primary interest for risk assessment are:

- **Attribute 13 – Condition wood**. Condition of the wood assessed by looking at branch attachments, included bark and V crotches, decay and cavities, loose and cracked bark, lean, scars, conks and fungi, crack type and size, etc. The assessor will then classify the condition of the wood into one of four categories: 1 = dead or dying, extreme problem, 2 = poor, major problem, 3 = fair, minor problem and 4 = good, no apparent problems.
- **Attribute 14 – Crown condition**. Condition of the crown assessed by looking for weak colour, chlorotic foliage, defoliation, small leaves, etc. The assessor will then classify the condition of the crown into one of four categories: 1 = dead or dying, extreme problem, 2 = poor, major problem, 3 = fair, minor problem and 4 = good, no apparent problems.
- **Attribute 17 – Management Recommendation.** In this field the assessor will choose a management recommendation from the following list: 1 = None, 2 = Small tree routine, 3 = Small tree immediate, 4 = Large Tree routine, 5 = Large tree immediate, 6 = Critical concern (public safety), 7 = Plantable space, 8 = Blank space:
- **Attribute 18 – Task**. The assessor can choose from a list of 14 different arboricultural treatments that could be performed on the tree. This is the work prescription for the tree.

The database user can query it to extract lists of tree risk priorities. Trees identified as a 6 in attribute 17 would be the first trees to address, followed by trees identified as a 5 and trees identified as a 3. Attributes 13, 14 and 18 would be used to focus the type of action be required to mitigate the identified risks.

This initial assessment gathered from the inventory will identify potential risk or hazard trees to be inspected in more detail by staff specifically trained in risk assessment. The more detailed inspection then determines whether further testing or inspection is required or if the tree should be removed.

Depending on the number of risk trees that are identified in the inventory, there may be an initial need for a dedicated forestry crew to deal with tree risk management. This could delay the full implementation of the proposed block pruning program, depending on staff and resource availability. The Municipal Tree Inventory must be complete before making this determination.

RECOMMENDATION 48: The Tree Risk Management Plan will prioritize trees requiring further investigation by a tree risk assessment specialist.

A Systematic Approach based on a Complete Municipal Forest Inventory and a Block Pruning Approach

Once the inventory is completed, there will also be a need for the continued assessment of risk trees. Assuming that all trees with some risk factor will not be immediately removed, trees that are retained will need to be inspected on a scheduled basis. The determination of which trees should be inspected and how often should be part of the development of a tree risk management plan once the tree inventory is completed. Dedicated staff will be required for tree inspections (see Appendix J1 and J2).

With the initiation of the block pruning program, at a minimum, each tree will be re-inspected once every five years. Pruning crews will be systematically working through blocks and when they are assessing pruning needs they can also be evaluating risks. Any new risks can be added to the database and then further inspections can be requested if required. Simple hazard abatement through pruning can be addressed as part of the block pruning program.

The other area of concern for risk assessment is in woodlots and along Oakville's more than 125 km of municipally- owned nature trails. The only way to effectively assess risk in these areas is to walk the trails and look for tree risks over the trails or trees that could fall onto the trails from the sides. This is labour-intensive and will require additional staff time if it is to be undertaken on an annual basis.

One alternative that may help to focus the assessments on nature trails is the use of infrared imagery (IR). The Town purchased digital colour infrared photography as part of the UFORE project and Forestry staff has been exploring the use of these images to interpret forest health. They have found some correlation between tree health and the degree of site alteration along nature trails. For example where soil compaction has occurred, colours in the infrared photographs appear to indicate reduced tree health.

While this technology cannot negate the need for ground inspections, it may be an efficient way to focus the efforts of inspectors to areas where poor health may be leading

to increased risks. More research into the use of this technology is needed to evaluate its place in a risk assessment protocol for woodlands and nature trails.

RECOMMENDATION 49: The Town's Forestry staff should conduct a pilot project to fine-tune IR photography as a cost saving technique to identify areas that contain hazard trees (Town of Oakville 2006, Action Item 23).

Hazard Abatement

Once a tree has been identified as having a failure-prone defect and a target is present, there are a variety of approaches to managing the risk associated with that defect. In general, serious defects are more likely to be found in large trees than in small trees. Recognizing that large trees with large canopies provide exponentially more benefits than small trees, efforts should be made to maintain large trees through techniques such as cabling and corrective pruning rather than removing them. This will allow time for younger trees to develop the mature canopies that can maintain the stream of benefits for the community. Some of the most common approaches for hazard abatement are:

1. **Remove dead wood** - Trees with this recommendation have large pieces of deadwood over a sidewalk, road, front yard, trail or other high-use area. These large pieces of deadwood should be taken out of the trees before they fall out.

2. **Cabling** - Cabling of trees can be used to stabilize parts of the crown that could be prone to failure. Generally two types of cabling systems are employed; static systems are generally installed where a crack already exists and needs to be stabilized, whereas dynamic systems are used as a precautionary action where the potential for failure exists under extreme conditions. The dynamic cables are meant to distribute loads more evenly in the crown and to dissipate wind energy in the crown. In most cases cabling systems are designed to restrict the movement of tree crowns within safe limits rather than completely eliminating movement.

   Movement of the cabled parts allows the tree to continue to react to the stimulus of movement by building new wood in the weak areas. If the stimulus of movement is completely removed then the tree will no longer build reaction wood in weakened areas. Traditional cabling involves the use of steel anchoring hardware and steel cable. These systems lack flexibility and require drilling through the tree to set the anchors. If there is any decay at the anchor points, the strength of the anchor is reduced and will further degrade over time. The use of J-lags is discouraged for large pieces of wood because they cannot bear the loads.

   The newest cabling systems are made of synthetic ropes with high breaking strengths. These systems are commonly available in North America. They can be described as dynamic systems because they allow for movement in the crown. The cables will stretch (10% elongation) and can be fitted with shock absorbers to help reduce peak loading when cabled parts are moving in wind events. The cables require no drilling for hardware to be installed and can therefore be used in

some situations where traditional cables cannot. All cables should be installed by an arborist who has experience with this type of maintenance work. The cables are meant to support the crowns but also to "catch" parts that do manage to break off and prevent them from reaching the ground.

Trees that have been cabled require a more-frequent inspection cycle. Generally, these trees should be inspected once a year to ensure the integrity of the cabling system and that the risk level of the tree has not changed. Currently approximately 100 cabled trees are inspected annually. If cabling systems are to be used more frequently to stabilize and maintain trees, there will be a need for additional inspection staff to undertake the annual inspections of those trees.

3. **Crown reductions** – The aim of crown reductions is to shorten the height of tall crowns or to shorten the length of long horizontal limbs with too much weight at the ends. By reducing the length or the height, the safety of the pruned part will be increased. This prescription is used for older trees to try to keep them standing while new trees can be planted to replace them. Crown reduction cuts should be made back to a healthy side branch that is at least one-third the diameter of the reduced part. This may not always be possible for some trees and a smaller side branch may have to be selected. It should be noted that for many older trees this is the last maintenance that can be performed before the tree is finally removed. Crown reductions are often undertaken in conjunction with cabling.

4. **Tree removal** – if there is no corrective action that can be taken then some trees will have to be removed. The Town is responsible for approximately 145 km of nature trails. The Woodlands Care Business Unit currently does not have sufficient resources to maintain the trees along the trail system in a safe condition and has had to initiate a rolling closure of various trail sections.

RECOMMENDATION 50: The Town should provide the staff and equipment resources required to implement hazard abatement strategies.

RECOMMENDATION 51: The Town should develop a tree cabling policy that includes the provision of an inspection cycle. This policy will incorporate risk and heritage value.

RECOMMENDATION 52: The Tree management software (CityWorks) should provide an annual summary of all risk trees to be inspected.

RECOMMENDATION 53: The Town should hire additional staff to undertake inspections of risk trees in the street and park tree population, in woodlands and along nature trails.

Public Education and Private Land Stewardship Program

Education is a vital part of urban forest management planning. In most jurisdictions, the urban forest is a largely unknown entity that the public and administrators fail to recognize. For urban forest management to be effective, an educational program must be implemented. Educational materials must be drafted and circulated throughout the community. Schools are often an effective starting point as children are very impressionable and will bring their newfound knowledge home to their parents. Flyers containing specific information can be mailed in conjunction with other municipal mail-outs. While the major challenge of education will occur during the initial stages of implementing a plan, ongoing communication strategies will have to be developed such that successes or failures of the program can be shared with all the stakeholders.

Objectives and Goals

- To increase residents' *awareness and knowledge* concerning Oakville's urban forest.
- To foster the *interest* of residents regarding the protection and enhancement of Oakville's urban forest, including trees on private land.
- To *involve* residents in caring for Oakville's urban forest.

See Appendix L for a comprehensive example: Objectives for achieving Oakville's education goals.

Current Municipal Program that Contributes to Education vis-à-vis the Urban Forest

Public education regarding Oakville's urban forest consists of Arbor Week activities, pamphlets for homeowners, and informal sessions with the Town of Oakville's staff members.

In late April, the Town celebrates Arbor Week with a series of plantings at schools and parks. All Grade Four students are invited to participate in planting a tree at their school. Forestry staff members show children the proper way to plant and care for a tree, and an educational comic book is given out. At the end of the week, the Mayor conducts a ceremonial planting at which councillors and other Town staff are generally present. These events are heavily advertised in advance, and the public is directed to the International Society of Arboriculture's web site for more information (http://www.isa-arbor.com/).

The Parks and Open Space department gives homeowners informational pamphlets during specific activities. When the Town conducts maintenance pruning of young trees, a flyer is given to affected homeowners with information on the importance of regular pruning; this reaches about 6,000 people every year. An additional 4,000 people per year receive a letter when the Parks department is conducting line clearing. This letter informs homeowners about line clearing and the importance of pruning. In 2006, a door hanger was developed for residents regarding how to care for newly planted Town street trees.

An informal but very important component of Oakville's current public education program consists of meetings and site visits with the Town's planners, engineers, senior managers, and landscape architects. These meetings happen frequently and are usually connected with a current project. At site visits, Parks staff, sometimes equipped with tools such as a compaction meter, demonstrate the importance of building appropriate tree habitat. There are also meetings to discuss ways in which engineers can contribute positively to the urban forest or to discuss specific technologies and tools.

RECOMMENDATION 54: The Town should develop a private urban forest stewardship education program (Town of Oakville 2006, Action Item 3).

Using a Community-Based Social Marketing Strategy

To protect and enhance Oakville's urban forest, it is desirable that all residents are aware and appreciative of the benefits of the urban forest and behave in ways that will lead to its growth and sustainability.

A municipality, such as Oakville, encompasses many people who have diverse interests, desires, and attitudes, which are influenced by factors such as income, cultural background (Fraser and Kenney 2000), and exposure to natural environments (Johnston & Shimada 2004; Tindall 2003; Appleyard 2000). Behaviour towards components of the urban forest found on private land is very personal and mostly unrestricted with the exception of the Private Tree By-law. However, repercussions of individual actions may affect the larger community in negative ways, possibly threatening the sustainability of the forest. Since individual landowners own approximately 80% of the urban forest (Kenney 2003), it is imperative that Oakville's urban forest education strategy contributes to real behavioural change towards the forest.

Public education initiatives commonly attempt to influence positive changes in behaviour by presenting people with the most environmentally sound options, often through the use of media advertising or the distribution of printed materials. Increasing awareness and knowledge about the urban forest is necessary to encourage public interest and involvement in action plans. However, current research reveals that this is not always enough to inspire positive action (Health Canada 2005a; McKenzie-Mohr 2000; Wegelin & de Jong 2000; Robinson 1998).

In particular, information-based approaches do not address the real concerns and barriers that people have with changing their behaviour; therefore, these types of programs often have little success. To affect real change in a society, researchers have found that individual interests and situations, including environmental, economic, social, and cultural situations, need to be considered (Health Canada 2005a; McKenzie-Mohr 2000; Wegelin & de Jong 2000). Residents must see a direct connection between their own needs and the benefits of changing their actions in order to believe the change is worthwhile and to take steps towards changing their behaviour (National Consumer Council 2006; Wegelin & de Jong 2000; Lagarde 1998).

An alternative approach to information-based initiatives, which is used successfully to encourage social change in the public health sector and is fully embraced by Health Canada (Health Canada 2005b), is that of community-based social marketing. Doug McKenzie-Mohr, an environmental psychologist at St. Thomas University in New Brunswick, is a leading advocate of this approach.

> Community-based social marketing merges knowledge from psychology with expertise from social marketing … emphasizes that effective program design begins with understanding the barriers people perceive to engaging in an activity … [and] underscores the importance of strategically delivering programs so that they target specific segments of the public. (McKenzie-Mohr 2000).

To remove barriers to a specific activity, they must first be identified. Broad public participation in a program may be blocked from either internal or external sources (McKenzie-Mohr 2000). For example, individuals may lack knowledge or motivation, or they may not experience community support. Additionally, not every resident of a community will have the same needs or barriers to change. Indeed, each different segment of society generally has barriers specific to that group that need to be considered (National Consumer Council 2006; McKenzie-Mohr 2000; Lagarde 1998). For example, single parents may find that time is a barrier, and ethnic communities may not feel connected to community action projects (Johnston & Shimada 2004). Therefore, if positive behaviour towards the urban forest is to be successfully enhanced, there must be an understanding of the best information and support services needed for each segment within a community (National Consumer Council 2006; McKenzie-Mohr 2000; Whiteman 1999; Lagarde 1998). If residents believe the behavioural change will be beneficial to them, and they are given the support they need to make the change, then they are much more likely to adopt the desired behaviour (Wegelin & de Jong 2000).

An effective education strategy, therefore, needs to address the barriers to behavioural change rather than only build awareness (McKenzie-Mohr 2000; Lagarde 1998; Robinson 1998). The field of community-based social marketing actively works to enable residents through encouraging supportive services and infrastructure in addition to providing information (McKenzie-Mohr 2000; Robinson 1998).

After barriers have been identified, and a specific strategy planned, the next step in the community-based social marketing approach is to conduct a pilot test, and then to evaluate its effectiveness, prior to broad implementation of the strategy. Both identifying barriers and conducting pilot tests are often skipped in designing and implementing an education strategy. Although they can add to the cost and length of the program, they are crucial if the desired level of behavioural change is to be achieved in the long term (McKenzie-Mohr 2000; Wegelin & de Jong 2000). Indeed, the community-based social marketing approach tends to be more cost-effective than standard information-intensive campaigns because it more successfully contributes to the desired level of behavioural changes (McKenzie-Mohr 2000; Lagarde 1998).

In summary, the community-based social marketing tool can be used successfully to influence and create behaviours among all residents that will enhance and protect Oakville's urban forest. Oakville is poised to become a leader in this area because this technique, while employed successfully in other areas, has yet to be applied specifically to the urban forest.

Public Engagement

Urban forests thrive when knowledgeable people are involved in their care and planning. Collaborations between elected officials, the Town staff, its citizens, private and non-profit sectors offer long-term sustainability for the urban forest. These relationships foster a collective consciousness of forest values and stewardship. Ultimately, a mechanism must exist that provides an on-going opportunity for citizen input into the planning and implementation of the UFSMP. The establishment of a citizen's tree committee with official standing at council would enable the free exchange of ideas between staff and the community.

RECOMMENDATION 55: The Town should establish a Citizen Urban Forest Advisory Committee (CUFAC).

A range of types of community involvement events are important to organize because they introduce residents to one another and to particular sites and projects. They also help people to understand their community's cultural and historical heritage.

The recommendations for achieving this local level of engagement address four general initiatives aimed at nurturing a sustainable community (City of Surrey, Parks, Recreation and Culture Department 2003):

- Recognition of current volunteers and attraction of more volunteers for stewardship of natural areas including waste removal and clean-up assistance;
- Organization of community events geared for volunteer participation;
- Facilitation of public participation in the planning, designing, construction and maintenance of natural areas; and
- Creation of partnerships and collaborative initiatives between the City and community groups.

Having a solid volunteer program enables people to help out with planting events and stewardship coordination. The Town needs the capacity in its organizational structure to accommodate the people who want to be engaged. Otherwise, people will lose interest and get discouraged.

Also, volunteers should not feel as though the Town is doing them a favour by letting them plant trees on their property; rather, volunteers should feel like they are contributing to their community. Thus, with sufficient resources and support, it will be possible for the Forestry Section to develop this as part of their core program.

Like many initiatives, there are various challenges that the Town must overcome. Due to the municipal process, which is often long and involved, community groups lose interest or become frustrated with the progression. Keeping in mind that it does take time and diplomacy to run programs, the process needs to be shorter and less bureaucratic.

Moreover, there needs to be consideration for the sites on which volunteers plant trees. For example, it is very discouraging for a community group to see that the site on which they planted trees years before has been slated for development. This is a major impediment to volunteerism.

RECOMMENDATION 56: The Town's Urban Forestry Services should work with the Parks Horticultural Section to formalize a methodology for Public Engagement, based on their existing Volunteer Recognition Program.

RECOMMENDATION 57: The Town should hire a Volunteer Coordinator to specifically address the needs of the urban forest.

RECOMMENDATION 58: The Town should ensure that the sites on which volunteer planting projects have taken place are not sold or developed.

As many non-governmental organizations already have existing volunteer programs with volunteer coordinators, developing partnerships with charitable organizations, groups and service clubs can greatly aid the Town with managing volunteers. When a position of Volunteer Coordinator for the Town is created, this person will work with these groups to facilitate joint efforts between such organizations (e.g., the Nature Conservancy of Canada has restoration events annually) and local volunteers. Notably, the Town remains liable and responsible for what the volunteers do, and to ensure that activities undertaken are safe and well-managed.

Currently, the Town of Oakville, in partnership with Oakville Green Conservation Association, is conducting a project called the Great Oakville Tree Hunt. Some other outreach events include:

- Expert-led site tours (e.g. walks on native plants, geology, and nature photography)
- Restoration efforts in parks
- Interpretative strategy meetings
- Environmental stakeholder meetings
- Workshops (heritage tree issues, gypsy moth, seed collection)
- One-on-one community meetings
- Hosting international conferences about tree care (e.g. ISA)

Evergreen (www.evergreen.ca), is a national, non-profit organization that focuses on community naturalization efforts. This organization is a source of technical support, volunteer support, and potentially funding.

Additional on-line urban forestry resources that could support this programming include:

- Ontario Nature pamphlet: Urban Forests – An Important Part of Our Natural Heritage (www.ontarionature.org)
- Website: Compendium of Best Management Practices for Canadian Urban Forests. (www.treecanada.ca/programs/urbanforestry/cufn/resources_bmp.html#_top)
- Website: Canadian Urban Forest Network (www.treecanada.ca/programs/urbanforestry/cufn/cufn.html)

RECOMMENDATION 59: The Town should develop stronger partnerships with NGOs to implement effective volunteer coordination with respect to urban forest initiatives.

One of the most important components to Public Engagement is effective communication. The key is to repeat the message as much as possible so that citizens become familiar with key ideas and values and move to action. Successful marketing strategies are a very important asset. The Town should assess their advertising strategy in different ways to better position them in the public eye. The notion of branding can be very effective (e.g. "Urban Forestry: Putting down roots").

RECOMMENDATION 60: The Town's Corporate Communications Department should work with Urban Forestry Services to develop effective, wide-spread marketing strategies and branding for various events and workshops.

Planning Policy Reforms (Ghent Planning Services)

The Town of Oakville aspires to be a highly liveable, vibrant, urban area in which the continued improvement to the quality of life is a core goal. An attractive, clean, and healthy environment is a key component of this vision – a vision in which trees play a major role. Policy documents must be amended to reflect this vision

The following sections outline policy changes to the Oakville Official Plan, changes to the Zoning By-law regulations, and changes to the Site Plan approval process as they relate to the community's vision for its urban forest. The last section examines two recently approved site plans in the Town of Oakville and looks at the amount of canopy cover currently being achieved and what would be required to boost the canopy cover to 40% on those two sites.

The Town of Oakville Official Plan

The policies relating to trees in the current Official Plan are extensive and have served the Town well. However, amendments to these policies are necessary to protect and enhance the urban forest and to identify specific mechanisms to achieve these goals. It is recommended that the following statements be incorporated into the Official Plan.

Goals and Objectives

To develop a culture among landowners, residents, builders and developers and in the municipal operations that conserves the existing canopy and promotes the increase of urban forest canopy cover across the Town of Oakville.

To achieve an urban forest canopy cover (trees and shrubs) across the Town of Oakville of 30% of the land area over the long term.

To establish policies, regulation, processes and procedures that will increase urban forest cover through the preservation of existing trees and the planting of new trees.

To allocate appropriate levels of capital funding in the municipal budget to plant and maintain trees on public lands.

To develop innovative standards for tree growing mediums (area of land, depth of soil and quality of soil) including the use of enhanced rooting environment techniques that permit the growing of trees in non-traditional areas where trees would not typically reach the growth potential of the species.

To promote the use of enhanced rooting environment techniques in both private and public sector developments where the existing environment will not support the growth of trees (i.e. road allowances, parking lots, sidewalks and boulevards).

General Policies

To encourage development in sympathy with the distinct character of individual communities and neighbourhoods, and with the natural features of the landscape, the Town may assess proposals for development with respect to the preservation and use of the natural contours and watercourses; the preservation of trees wherever possible, and the planting of trees in conjunction with the development of land so that a significant portion of the site has the potential for urban forest cover.

The preservation of existing trees is encouraged and will be an important consideration in the evaluation of infill development. Where existing trees cannot be preserved because of development objectives, or where there are no existing trees, the creation of tree habitat will be required in conjunction with the development of the land so that a portion of the site has the potential to support urban forest cover.

The Town shall ensure that in the design of new roads or road improvements, there is sufficient space and quality of soil for the planting of trees to enhance the long-term survival of tree corridors within the road right-of-way. It may be necessary to use enhanced rooting environment techniques to achieve the necessary quality of soil to maximize tree growth adjacent to public roads.

The objective of the Town of Oakville is to achieve an urban forest canopy cover of 30% over the long term.

The Town shall establish regulations in the Zoning By-law that require minimum planting areas capable of growing trees. This regulation will be applicable to development that is subject to site plan control including commercial, employment, and institutional uses. The planting area may be on hard surfaced areas and on lands also used for parking, but if this is the case, the growing environment in the tree planting area would be amended using enhanced rooting environment techniques.

The Town shall establish design guidelines and procedures in the Site Plan process which require the planting of trees in planting areas under the zoning regulations and provide for standards relating to the planting of trees for the following matters:

- spacing of trees;

- location of trees;
- type of trees to be planted with encouragement for the planting of large stature trees;
- protection of trees and separation of trees from uses that would damage trees (i.e., curbs, bollards etc.);
- design of the planting areas to minimize the effect of de-icing salt;
- growing medium (volume and quality of soils) for the planting area;
- criteria for enhanced rooting environment technique and where they shall be applied;
- maintenance and replacement of trees;
- drainage and irrigation of the planting area for trees; and
- the type of permeable surface material if the planting area for trees is also used for parking or driveway purposes so that sufficient exchange of water and air to tree root zone is provided.

The Town shall contribute to reducing carbon dioxide and other air pollutants by protecting and enhancing the urban forest and specifically promoting the growth and protection of large stature trees.

The objective of the Town is that there will be no net loss of leaf area in existing urban forests. As such, for every tree that is removed from Town property or from road rights-of-way, a replacement tree or trees having total leaf area equal to that of the removed tree will be planted.

Zoning By-law

The Zoning By-law is primarily a mechanism to control land use. The zoning by-law creates a number of zones or classes of land. The by-law establishes a range of uses permitted in a zone. In addition, the by-law establishes regulations that are applicable to each zone.

Based on research undertaken by Forestry and Cemetery Services of the Town in 2005 (Town of Oakville 2006), the amount of tree cover appears to be directly related to the amount of space available for the planting of trees. In low density areas with larger amounts of landscape area, there are proportionally more trees planted. In areas with higher building coverage and paved surface areas, there are fewer trees planted.

Development of land in urban situations typically has three components, all of which are regulated in the zoning by-law: the area for building(s); the area for driveways and parking, and; the landscape area.

The landscape area consists of planting and lawn areas, walkways, detention ponds, buffers, end islands associated with parking lots, and space adjacent to the buildings. These are the spaces to which trees are generally relegated. For many land use classifications, the landscape area is a relatively small component of the site (10%), and in some cases, the landscape area is “left-over” space, which may not always be well suited to the planting of trees.

Technological innovations with respect to tree habitat and soils now permit trees to be planted in areas where they traditionally have not been expected to survive and grow well. The use of enhanced rooting environment techniques allows trees to be planted in parking lots and close to sidewalks and driveways.

To achieve increased tree canopy cover, there is an opportunity to plant trees in and adjacent to parking lots. Unless the soils are amended, the long-term survival of trees in these locations is doubtful and it is less likely trees would grow to their full size potential. With the introduction of structured soils and other measures to provide appropriate growing conditions for trees, the long-term health, growth potential and survival of the tree is enhanced.

The following chart shows the relationships between size of tree, the necessary planting area, and the canopy cover that would be achieved at maturity. This chart is useful in understanding how the urban forest canopy objectives could be implemented and is fundamental in considering a zoning regulation that seeks to increase tree canopy in various zones.

Table 8: Planting Area Required To Achieve Maximum Canopy Cover, By Tree Size

Planting Area Required To Achieve Maximum Canopy Cover, By Tree Size			
Tree Size	**Required Planting Area (m^2)**	**Canopy Diameter (m)**	**Canopy Projection Area (m^2)**
Large Stature	98	14	154
Medium Stature	44	10	79
Small Stature	16	3	7
Note: the minimum area required for the trunk of each tree is 1m x 1m			

To more fully understand how the standards in the above chart might be applied, the following simplified example is provided.

Table 9: Example of the number of trees needed to be planted to achieve 30% tree canopy cover on the lot by tree size based on a 1 ha lot.

Tree Size	Number of Trees	Planting Area Required	Planting Area of Lot	Tree Canopy Area
Large Stature	20	1960 m^2	20%	30%
Medium Stature	38	1672 m^2	17%	30%
Small Stature	429	6864 m^2	69%	30%
The number of trees to achieve 30% forest cover could be all of one size, as outlined above, or any combination of various tree sizes. Note: the minimum area at grade required for the trunk of each tree is 1m x1m.				

With respect to the urban forest and the objective of increasing forest canopy to 30% across the Town, it is recommended that the Zoning By-law be changed to provide increased opportunity for the growing of trees. These changes would apply to land use classes that typically have extensive hard surface areas (for parking and driveways, etc) and consequently do not achieve significant tree cover. The change to the Zoning By-law would initially apply to commercial, employment and institutional zones that generally have relatively low proportions of tree cover. It may be appropriate to extend this regulation to medium and high density residential uses but it is recommended that further research be undertaken on recently approved site plans to determine a reasonable standard.

It is recommended that a zoning regulation be established to achieve a minimum tree cover canopy over the lot area. Initially it is suggested that the minimum tree canopy cover be established at 30%. It is not recommended that the actual growing of trees be a provision that is regulated in the Zoning By-law. However, the Zoning By-law should have a regulation for “planting area for trees”. This would be similar to other regulations such as a landscape area, parking space, and building area that are currently required in the by-law.

To minimize the impact of this provision on the viability of sites from a development perspective, it is recommended that the “planting area for trees” also permit uses that typically would not be expected to co-exist with trees. With the use of enhanced rooting zone techniques, trees could be planted in parking lots and adjacent to driveways. The placement of trees in the parking area would have the effect of shortening the length of the parking space, which could be addressed in the Zoning By-law by providing a regulation for “short cars”. Other than a reduction in the parking space length, no other negative effect on the number of parking spaces is expected.

The application of the zoning regulation would be based on the following criteria and qualifications:

The development of vacant land.

The redevelopment of land where the existing building(s) are to be removed or partially removed and new buildings are constructed.

The development of existing developed sites where a significant portion of the site is to be redeveloped. Minor redevelopment proposals consisting of 25 m2 or 5% of the floor area of the site would be exempt from the regulation.

The partial redevelopment of a site in which case the regulation would apply to the portion of the site where the redevelopment is proposed and to any parts of the site that are being altered to accommodate the redevelopment (parking areas, driveways, etc).

The phased development of sites where part of the site is proposed for development and where further development of the land is anticipated in the future on the balance of the lands and this future development would be subject to a further Site Plan approval. In this case, where it is difficult to distinguish the landscape area directly associated with the proposed development, the regulation would apply to the portion of the site that is currently being proposed for development for the building and parking area only.

Tree canopy calculations are based on the canopy of the tree at maturity.

Where trees planted on the subject land provide canopy on adjacent public land, the canopy area derived from the tree(s) planted on the subject site would be attributed to the subject site

Plantable area for trees on rooftops in containers would be included in the regulation for calculations of the overall "planting space for trees".

In some areas of the C3R zone, 100% building coverage is permitted and private parking for commercial and other non-residential land uses is not required. Also, structured parking is often provided in conjunction with relatively high building coverage. Where this is the case, a "planting area for trees" provision would not be appropriate or the planting area for trees should be revised to reflect the area of the site that is not covered by buildings.

An example of a zoning regulation that incorporates a tree planting area sufficient to achieve a tree canopy cover of 30% of the lot but which takes into consideration some of the points raised above could take the following form:

Planting Area for Trees: Planting area for trees that would provide tree canopy on 30% of the lot (based on Table 10). Tree planting on rooftops of buildings are included as part of the tree canopy.

Definition of Planting Area for Trees: An area that contains soil of a depth and quality that is capable of growing trees as outlined in the following chart. If the growing medium is natural or amended with other natural soils, the planting area for trees shall not be used for parking, driveways, outdoor storage, or outdoor processing, and it shall not be covered by hard surface materials. If the planting area utilizes enhanced root zone techniques, it may be used for parking and driveways, and it may be covered with permeable hard surface materials. In no case shall there be an area less than 1 metre by 1 metre reserved exclusively for each tree trunk (i.e. no hard surfaces or other uses permitted).

Table 10: Planting Area Required To Achieve Canopy Cover by Tree Size

Planting Area Required To Achieve Canopy Cover by Tree Size		
Tree Size	**Required Planting Area for Trees (m^2)**	**Tree Canopy Area (m^2)**
Large Stature	98	154
Medium Stature	44	79
Small Stature	16	7
Note: the minimum depth of soil required for the planting area is 0.9 m		

Notwithstanding the minimum dimensions used for parking spaces, where the "planting area for trees" is located in a parking area, the area of a parking space directly abutting a tree may be reduced to reflect a reduction in the length of the parking space of 0.5 metres, and the parking space shall be marked for use by "short cars".

Definition of Short Cars: A car that is not longer than 4.5 metres (e.g. a Honda Civic)

Application of Planting Area for Trees provision;

The "planting area for trees" regulation shall apply as follows:

To all employment and institutional zones and to all commercial zones except the C3R zone.

In zones where the "planting area for trees" is in effect, the provision shall be applied to any lot where there is an application for the development of the land that requires site plan approval. Lots that are developed and where this development was in existence prior to the approval of this provision and that do not meet the "planting area for trees" regulation will be considered to be in conformity with the zoning by-law. Any further development of the lot shall be required to comply with the "planting area for trees" provision.

The minor redevelopment of land with existing buildings consisting of additional floor area of less than 25 m2 or 5% of the existing floor area, whichever is the lesser, shall be exempt from the "planting area for trees" regulation.

The development or redevelopment of a portion of a lot shall provide a planting area for trees proportional to the area of the lot being developed, including the area of the building coverage, parking area, driveways and landscaping related to the proposed development, so that a tree canopy of 30% is achieved on the area of the lot related to the proposed development.

RECOMMENDATION 61: The Town should consider an amendment to the Zoning By-law for Employment, Commercial (excluding the C3R zone), and Industrial land use types to regulate the planting area for trees (i.e., the tree growing area)in support of the Town's canopy cover target.

Site Plan Control

In the Town of Oakville, under the Official Plan, Site Plan Control applies to all medium and high density residential areas, and all commercial employment and institutional development. As part of the review and approval of site plans, the Planning Act states in Section 41.7 that:

> 7. As a condition to the approval of the plans and drawings, … a municipality may require the owner of the land to:
>
> (a) provide to the satisfaction of and at no expense to the municipality any or all of the following:
>
> 6. Walls, fences hedges, trees, shrubs, or other groundcover or facilities for the landscaping of the lands or the protection of adjoining lands.
>
> (b) maintain to the satisfaction of the municipality and at the sole risk and expense of the owner any or all of the facilities or works mentioned in paragraphs …6 … of clause (a) …

The site plan approval process can be a very effective tool in implementing the canopy cover objectives outlined in the Official Plan. It is recommended that the following steps be undertaken in the Site Plan process to give effect to these urban forest objectives.

1. That Design Guidelines be prepared to advise applicants and designers of the objectives of the Town and of how and where trees should be planted. These guidelines would include the following components:
   - spacing of trees;
   - location of trees;
   - type of trees to be planted;
   - protection of trees and separation of trees from uses that would damage trees (i.e., curbs, bollards etc,);
   - design of the planting areas to minimize the effect of de-icing salt;
   - growing medium (depth and quality of soils) for the planting area;
   - criteria for the use of enhanced rooting environment techniques (see glossary for details) and where they would be used;
   - maintenance and replacement of trees;
   - drainage and irrigation of the planting area for trees; and
   - the type of impermeable surface material if the planting area for trees is also used for parking or driveway purposes.
2. That in the evaluation of site plans by staff, there be specific consideration for how trees are provided.

3. That the inspection and monitoring procedures during and after the development of the site ensure that the tree planting, maintenance and protection measures are in place.

4. That in the Site Plan application form, the applicant and designers be made aware of the Town's canopy cover and tree planting objectives and the design guidelines and procedures.

Current Level of Tree Canopy Cover and the 40% Lot Canopy Cover Opportunity

Two recently approved site plans were analyzed to determine the level of tree canopy that is being achieved under the site plan approval process. These two site plans were also analyzed to consider what would be required to achieve a canopy cover of 40% of the lot area (see Appendix B).

The two site plans were:

1. A small commercial plaza in the West Oak Trails Community, at the southwest corner of Dundas Street and Third Line.
2. A large office site in Winston Park, at the northwest corner of Upper Middle Road and Buckingham Road.

The analysis of the approved plans was undertaken using the following methodology:

- Establish the total site area.
- Review the approved Landscape Plan to determine the size of trees that were to be planted (i.e. large, medium or small stature trees).
- Plot the tree canopy on the site plan using the mature canopy area for each tree (large: 154 m^2; medium 79 m^2; small 7 m^2).
- Measure the area covered by tree canopies.
- Calculate the canopy area as a percentage of the total site area.

For the purposes of this exercise, it was assumed that the trees would have sufficient habitat, in terms of growing area, quality of soil and maintenance, to grow to maturity. However, it is recognized that in many situations, trees are planted in areas where a mature stature tree cannot grow to its potential because of deficient habitat. In these situations, many trees are either smaller than optimum or die prematurely. The use of enhanced rooting environment techniques and a regular maintenance schedule would assist in assuring the long-term growth and health of trees.

The results of the analysis are as follows:

Small Commercial Plaza – The tree canopy covers 28.6% of the total site.
Large Office Site – The tree canopy covers 27.0% of total site.

In considering what is needed to achieve 40% canopy cover over the sites, the plans were modified to include more trees. Many of these trees were located in the parking lot since the landscaped areas were already fully planted. In the parking areas, it is assumed the trees would be planted in enhanced rooting environments. It is interesting to note that relatively few parking spaces (approximately 10%) would be required to be shortened to the small car size to accommodate trees planted in the parking lots.

The drawings showing tree canopy on the approved Landscape Plans and what would be required to achieve a 40% canopy cover on the same plans can be found in Appendix M. Also attached are other relevant statistics relating to the two sites.

There are several relevant points that can be drawn from this exercise of examining these recently approved site plans:

- The current site plan approval process could be effective in achieving between 25% and 30% canopy cover of the development site *if* the trees grow to maturity.
- This amount of tree canopy on commercial and employment sites is significantly higher than what currently exists for this general land use category across the municipality.
- Many trees on many sites across the Town will not achieve their potential mature size because they are planted in areas where there is deficient habitat or where the level of maintenance is not adequate to sustain the trees.
- The trees actually planted on the sites in accordance with the approved Landscape Plans are spaced too close together for each individual tree canopy to optimize their contribution to the total canopy area. When the mature canopies are plotted on the plan, it is seen that there is often a very large amount of overlapping. If the same number of trees were planted in accordance with the optimal spacing guidelines for their tree size, the canopy cover on the site would increase significantly. For these two sites, if there were no overlapping effect, the number of trees planted would achieve approximately 38% canopy cover on the small commercial site and 48% canopy cover on the office site.
- The number of trees planted on a site may not be the most important issue in achieving the desired canopy cover. The provision of appropriate planting area for trees is more critical, since it allows for optimal spacing and ensures the long-term health and growth of the tree.
- A policy to achieve 40% canopy cover in the land use types represented in these two studies appears to be feasible in the long-term. The actual number of trees to be planted does not increase significantly. The impact on the parking spaces is minimal given the predominance of smaller cars. The functioning of the site in terms of building area, parking area, number of parking spaces, and circulation routes are not affected. However, it is recognised this can only be achieved with the use of enhanced rooting environment techniques and a commitment to long-term tree care, both of which will increase the overall costs of landscape establishment and maintenance.

RECOMMENDATION 62: The Town should undertake a study to assess the impact on the Town-wide canopy cover of implementing a "Planting Area for Trees" policy on all land uses which are subject to site plan approval.

Administration

This document sets out a management plan primarily for use by the Town of Oakville's Forestry Section. However, many of the necessary steps to sustain and enhance Oakville's urban forest cannot be undertaken by Forestry staff alone. Policy guidance will ultimately come from Council, but successful implementation of this plan will require strong interdepartmental cooperation. Town Council and the Senior Management Team will need to enlist the collaboration of Town staff in other departments such as Planning, Engineering and Legal.

For example, a new approach to ensuring viable habitat for trees planted by the Town would, at a minimum, require the collaboration of staff from Forestry, Planning and Engineering. By bringing staff together in a cross-functional working group the Town will be more likely to develop better site design guidelines and standard blueprints for combining "grey" and "green" infrastructure that will permit a tree to thrive. To give another example, the Town's Legal department can offer advice on enforcement mechanisms for the protection of private trees identified in a permit application process, should Council choose to consider this option.

Our Solution to Our Pollution (Oakville 2006) included a recommendation to establish a technical advisory committee comprised of staff from appropriate Town departments. The Interdepartmental/Interagency Technical Advisory Committee (IITAC) will be comprised of staff from Departments such as Parks and Open Space, Engineering, and Planning. A number of recommendations in this Plan require input from the ITTAC. Because Engineering and Planning are involved, good sites for tree planting can be preserved or created so that Oakville can work towards increasing its canopy cover. Ultimately, the establishment and maintenance of large-stature trees will become part of the design and construction culture of the Town.

This staff working group would bring a multi-disciplinary perspective to the tasks of developing staff operating procedures or proposing new Town policies for Council to consider. The purpose of the committee should be to ensure the early consideration of measures intended to protect and enhance the Town's urban forest so as to eliminate or minimize unintended negative consequences. Consideration for the development and maintenance of Oakville's urban forest or "green" infrastructure should be considered on an equal footing as the development and maintenance of Oakville's "grey" infrastructure. The committee should meet on a regular basis and its membership should be flexible to accommodate broad staff input.

RECOMMENDATION 63: The Town's Forestry Section should chair an Interdepartmental Technical Advisory Committee, to include staff from the Town's Forestry, Planning, Engineering and Legal departments to assist in implementing the Urban Forest Strategic Management Plan and to prepare proposals for new policies for consideration by Council.

Budget

This strategy contains many recommendations aimed at achieving the mission of "protecting and enhancing the health and diversity of our urban forest to ensure the economic, environmental and social benefits for future generations.'

Furthermore, the Town has established a bold initiative of attaining a 40% canopy cover in 50 years. To accomplish the mission and to achieve and sustain the canopy cover goals, the Town must fully commit to all aspects of this strategic management plan. The costs associated with the implementation of the management plan must be developed within the context of the overall financial structure and administration of the Town. On adoption of this strategic management plan it is imperative that the Town develop long-range budget forecasts for its implementation.

RECOMMENDATION 64: The Town's Finance Department and the Parks & Open Space Department should review the Forestry Section Resource Plan and the 10 Year Capital Forecast to ensure that operating costs for street trees and park trees and Woodland Parks are captured based on a maintenance standard recommended in the UFSMP (Town of Oakville 2006, Action Item 2).

The consulting team reiterates that to implement this plan and to realize the benefits of a healthy urban forest all aspects of this plan must be adequately supported with human and financial resources. Forestry staff has proposed a staffing requirement chart based on meeting these needs (Appendix J).

RECOMMENDATION 65: The Town should hire the staff and equipment resources necessary to implement the UFSMP as detailed in Appendix J.

Recommendations 64 and 65 should be completed in the first 5-year management plan.

Plan Review

All of the affected stakeholders (e.g. residents of the community, Town council and staff, utilities, regional and municipal planners, local business groups, industries, institutions, etc.) should participate in a review of this Strategic plan. This would be best achieved by distributing the document and holding a public consultation meeting to inform the stakeholders and to seek their endorsement of the Strategy.

In keeping with the principles of strategic planning and adaptive management the accomplishments and short-comings for each 5-year management plan must be reviewed. This will be completed in the final year of each successive plan by Town staff with input from the Citizen Urban Forest Advisory Committee. At this stage there is a need for extensive "in-house" review and consultation to move towards the next steps.

GLOSSARY OF TERMS

Available Growing Space:
The space above and below ground that is available to grow and sustain trees and shrubs. AGS embraces not only the physical space but the resources required by the trees and shrubs. AGS can be considered areas of "soft surface" with a soil depth of at least 60 cm and no physical impediment to crown growth.

Canopy Cover:
The proportion of land area occupied by tree crowns when visualized from above. It is the two-dimension horizontal extent of the combined canopies of all trees on a given land area.

Carbon Sequestration: Amount of carbon removed annually by trees.

Carbon Storage: carbon currently held within tree tissue (roots, stems, and branches).

Crown Projection Area (CPA): the area under the drip line of a tree.

DBH: diameter at breast height (approximately 1.3 meters from the ground).

Enhanced Rooting Environment Techniques: specific design and engineering applications intended to ensure that tree roots can benefit from sufficient moisture availability (including rain fed infiltration or irrigation), drainage, aeration, nutrients and a bulk density conducive to good root extension while meeting the engineering specifications required by the site. Such enhancements would include, but are not limited to such applications as engineered soils (which would include *CU-Structural Soil*) as well as *Structural Cells* (a product of DeepRoot) and/or any similar enhancements to the below ground environment and the related surface treatments (such as porous paving, turf stone, mulch, etc.)

Extensive Management: The application of stand or forest level practices, primarily silviculturally-based, to achieve certain goals. Forest or stand management (See Intensive Management)

Integrated Pest Management (IPM): an environmentally responsible and economically practical method of controlling pest populations incorporating a variety of cultural, biological and chemical methods to efficiently manage pest populations while lowering dependence on chemical means of control (University of Georgia USA).

Intensive Management:
The application of practices at the individual tree level, primarily arboriculturally-based, to achieve certain goals. Individual tree management (see Extensive Management).

Large-Stature Tree: a tree that has the potential to be greater than 12m tall and wide with trunk diameters (dbh) commonly over 76cm at maturity – 40 years after planting (Center for Urban Forest Research, Davis, CA 2004).

Leaf Area Density (LAD):
The total leaf area (one side) present in the vegetation of a given area, divided by the land area in question.

Municipal Forest:
The part of the urban forest under the jurisdiction of the Municipality. The publicly-owned part of the urban forest.

Naturalization: The process of using local plant material to create an area of structural and botanical diversity for educational, social and environmental benefits.

Paradigm Shift: Major shift in a certain thought pattern – a radical change in personal beliefs, complex systems or organizations, replacing the former way of thinking with a radically different way of thinking or organizing (Wilkipedia.org August 16, 2006).

Small-Stature Tree: a tree that has the potential to be less than 7.6m tall and wide with trunk diameters (dbh) less than 51cm at maturity – 40 years after planting (Center for Urban Forest Research, Davis, CA 2004).

Tree: UFORE Model defines a "tree" to be any woody plant with a dbh larger than 2.5 centimetres (1 inch).

Tonne: a metric measure of mass equal to 1,000 kilograms or 2,204.6 pounds. A Megagram (Mg).

Strategic planning: "a continuous and systematic process where people make decisions about intended future outcomes, how these outcomes are to be accomplished, and how success is to be measured and evaluated."[24]

Urban Forest Canopy Cover: the proportion of area occupied by tree canopies when viewed from above (Nowak and McPherson 1993).

Urban Forest: trees, forests, greenspace and related abiotic, biotic and cultural components in and around cities and communities. It includes trees, forest cover and related components in the surrounding rural areas (peri-urban forests) (Canadian Urban Forest Strategy 2004-2006).

[24] Industry Canada <http://strategis.ic.gc.ca/epic/site/stco-levc.nsf/en/h_qw00053e.html> Accessed February 7, 2007

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APPENDICES

APPENDIX A

APPENDIX A: FOCUS GROUP RESULTS FROM VISIONING SESSION: JUNE 8TH, 2005

COMMUNITY ATTENDEES

1. Liz Benneian, Ground Breakers
2. Rob Burton, Joshua Creek Ratepayers Inc
3. Dan Collins, West River Residents' Association
4. Barry Dawe, West River Residents' Association
5. Mike Lansdowne, Oakville Council
6. Tony Molnar, Town of Oakville
7. Andrew Pask
8. Amy Rolf von den Baumen

PRESENTATION TEAM

- Dr. Andy Kenney, University of Toronto
- John McNeil, Town of Oakville
- Philip van Wassenaer, University of Toronto

FACILITATORS

- Daphne FitzGerald, BOARDrx Inc
- Terrie Russell, BOARDrx Inc
- Chantal Gagnon, BOARDrx Inc

PROCEEDINGS

- John McNeil welcomed the representatives of the community
- John McNeil re-stated the purpose of the evening as outlined in the letter of invitation
- The purpose of the evening is to capture community input to the vision statement for the Strategic Urban Forest Management Plan
- Dr Kenney provided an overview of what a Strategic Urban Forest Management Plan entails and entertained questions from the floor
- Terrie Russell provided a brief primer on strategic planning and introduced the first exercise
- Community representatives were challenged to write a newspaper headline for the year 2026 that reflected the success of the Town of Oakville's Strategic Urban Forest Management Plan
- Samples of good and poor headlines and words that might prove useful were provided
- Community representatives shared their headlines with one another
- Daphne FitzGerald provided a brief primer on the visioning aspect of strategic planning and introduced the second exercise
- Community representatives were asked to identify the prevailing themes in the headlines written by their group
- It was explained that these themes would help to form the vision statement - i.e. what the community representatives would like to see included
- Groups discussed the themes they found prevailing in the headlines
- The facilitators captured the results of the discussion on flip charts
- Groups then compared and discussed the themes they had developed
- A summary flip chart of the key themes was prepared
- Philip van Wassenaer outlined the next steps in the planning process
- John McNeil thanked the group for their participation

OUTCOMES:

Headlines:

"PEOPLE OF OAKVILLE FOREST CELEBRATE SUCCESS OF 'EDEN PLAN'"

"OAKVILLE TREE PLAN WINS AWARD FROM ENVIRONMENT CANADA"

"FEDERAL ENVIRONMENT MINISTRY HIGHLIGHTS SUCCESSFUL TOWN TREE PLAN AT SUMMIT"

"OAKVILLE MODLE FORESTS CELEBRATED AT INTERNATIONAL FOREST CONFERENCE"

"OAKVILLE FORESTS RAISING HEALTHY CHILDREN"

"OAKVILLE'S TREES KEEP POPULATION HEALTHY"

"OAKVILLE TREES REDUCE POLLUTION BY 90%"

"OAKVILLE'S URBAN FOREST A REAL MODEL FOREST"

"OAKVILLE'S URBAN FOREST IS TREE-MENDOUS!"

"OAKVILLE PRESERVES LARGE NUMBER OF MATURE TREES"

"TREE PLANTING OVER LAST 20 YEARS ACHIEVES OBJECTIVE OF LARGE URBAN FOREST"

"OAKVILLE RESIDENTS BIG WINNERS IN TOWN'S SUCCESS WITH LONG-TERM PROGRAM TO REHABILITATE AND PRESERVE TREES"

"OAKVILLE URBAN FOREST COVER BEST IN ONTARIO"

"TOWN'S URBAN FOREST COVERS GREATEST AREA"

"OAKVILLE REVERSES URBAN FOREST LOSSES"

"OAKVILLE REBUILDS FOREST"

"OAKVILLE URBAN FOREST RESTORED"

"OAKVILLE'S 'GREEN UMBRELLA' SAVES LIFE OF TODDLER"

Themes

Paradise	Healthy Harmony	Sustaining Environment			
Community Wins	Benefits Future Generations	Intrinsic Value of Trees	Value of Mature Trees	Quality of Life/Balance	
Innovation	Leader	Recognition	Pride	Model to Aspire To	Stewardship
Restore	Protect	Expand			
Flexibility & Adaptability	Respect & Resonate with Townspeople	Education & Communication			

APPENDIX B

Appendix B1

Oakville Establishment Rate for 2, 4, 6, and 8% Mortality to Sustain 30% or 40% Tree and Shrub Cover

Dr. D. Nowak
USDA Forest Service

Revised March 2008

This report is an update to previous estimates of the number of trees needed to sustain a certain level of tree cover given various mortality rates. Like similar runs, the results are dependent upon the assumption, which vary in the past based on user suggestions and cover variables from satellites and UFORE ground plots.

Model Assumptions
Oakville currently has 29.1% tree and shrub cover (based on Quickbird satellite analysis). Given 18.8% tree cover from UFORE, shrub cover would be 10.3% in the satellite cover estimate. Assuming shrub cover and woodland tree remain constant (6.1% of total tree cover), the non-woodland tree cover (12.7%) would need to increase to 13.6% to sustain a 30% tree cover goal (13.6 non-woodland + 6.1% woodland + 10.3% shrub = 30% tree and shrub cover). To attain 40% tree and shrub cover, non-woodland tree cover would need to reach 23.6%.

Land use	Current Tree Cover Contribution	Space for New Tree Cover
Woodlots	6.1	1.3
Residential low density	3.2	2.6
Residential medium density	5.8	6.5
Open space / Parkway Belt	2.1	7.9
Public use	0.1	0.5
Agricultural	0.1	1.8
Employment / Industrial	1.1	4.6
Commercial	0.4	0.7
Total	18.8	25.9

The numbers given in this table are percent of the entire study area that is covered with trees or available space for trees. For example, trees in woodlots cover 6.1 percent of the study area (Oakville developed area).

You can see by the column of space for new tree cover, that if all available space was filled with trees, tree cover could reach 44.7% or 55% tree and shrub cover. For this scenario, we are only trying to increase total tree cover to 19.7% or 29.7%, thus one need to fill about 3.5% (0.9/25.9) of available planting space with trees to sustain 30% tree and shrub cover, or 42% (10.9/25.9) of available planting space with trees to sustain 40% tree and shrub cover.

To estimate the number of new trees to be established annually to sustain the desired tree cover, the non-woodland tree population was loaded in the UFORE population projector. In this model

the tree planting size was assumed to be 2.5 inches (63.5 mm); average annual growth rate was 0.25 in/yr (6.35 mm/yr); average tree condition was 0.87; average mortality was run at 2, 4, 6, and 8% to reach the desired tree and shrub cover goal; the number of trees established was assumed to be constant among the years. To project canopy cover, one representative tree species needs to be selected in the program. There are 12 species to select from and each species has a different canopy – dbh relationship. The species that represented the mid-range of values was sugar maple, which was used in this simulation.

Mortality rates

Below are the average annual mortality rates by dbh class for varying average mortality rates

Mortality rates by dbh class used in the UFORE simulation to estimate the tree planting requirements assuming an overall average mortality rate of 2%, 4%, 6% or 8%

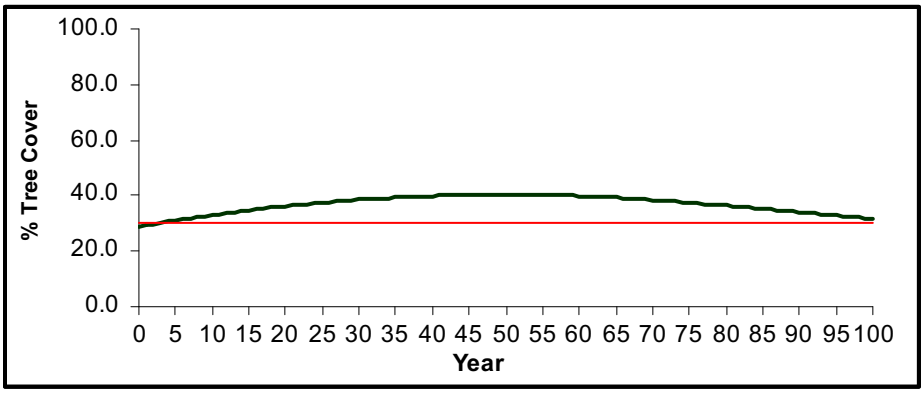
DBH Range (cm)	Mortality Rate (%)			
0-7.6	2.2	4.5	6.7	9.0
7.7 -15.2	1.7	3.4	5.1	6.8
15.3-30.5	1.6	3.3	4.9	6.5
30.6-45.7	1.6	3.3	4.9	6.5
45.8-61.0	2.2	4.5	6.7	9.0
61.1-76.2	2.3	4.6	7.0	9.3
>76.2	4.2	8.4	12.5	16.7
Average	**2.0**	**4.0**	**6.0**	**8.0**

Approximate number of trees to be established annually to reach tree and shrub cover goal based on the assumptions described in the text.

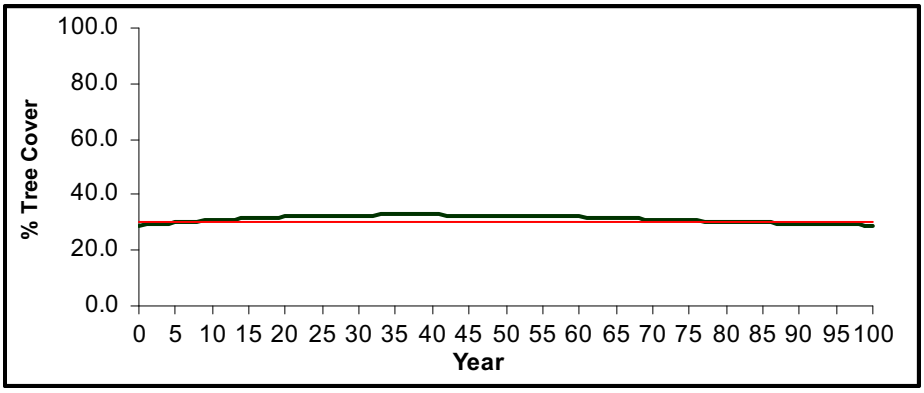
Mortality Rate	30% Goal	40% Goal
2%	**0**	**4,000**
4%	**16,000**	**32,000**
6%	**39,000**	**70,000**
8%	**70,000**	**121,000**

Fitting the actual cover curve to the desired cover level is an approximation. Below are the actual cover curves compared to the desired canopy cover levels.

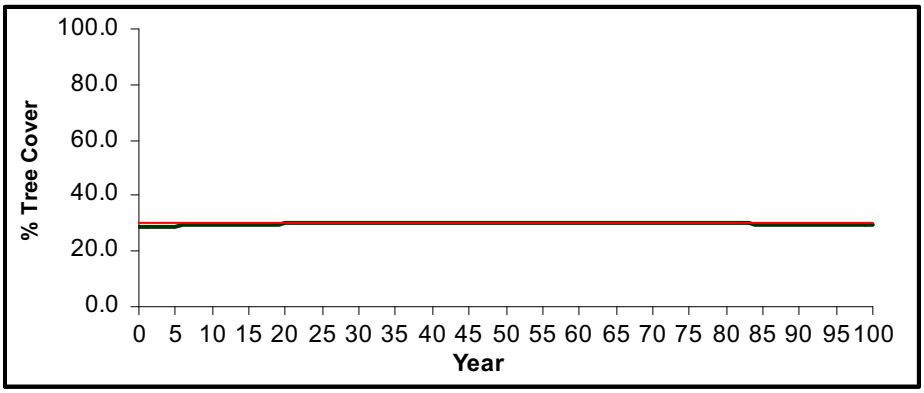
30% Goal 2% Mortality
(0 trees annually)



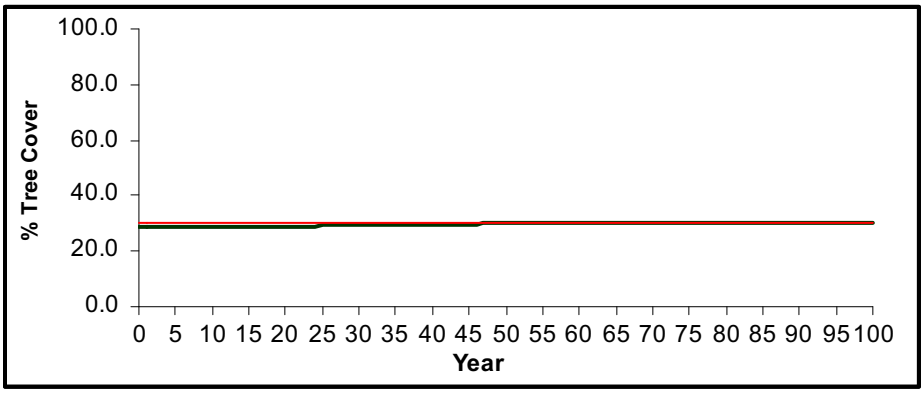
30% Goal 4% Mortality
(16,000 trees annually)



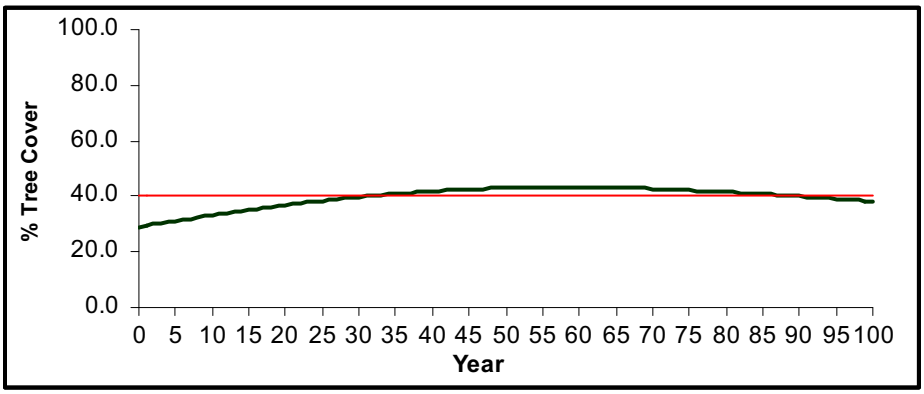
30% Goal 6% Mortality
(39,000 trees annually)



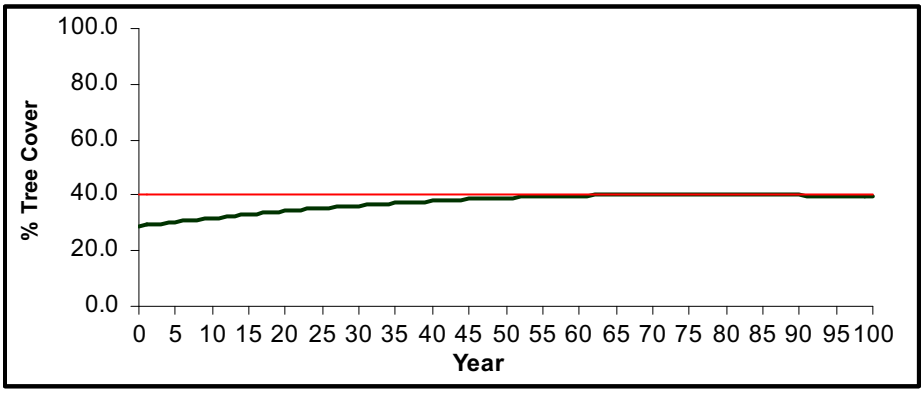
30% Goal 8% Mortality
(70,000 trees annually)



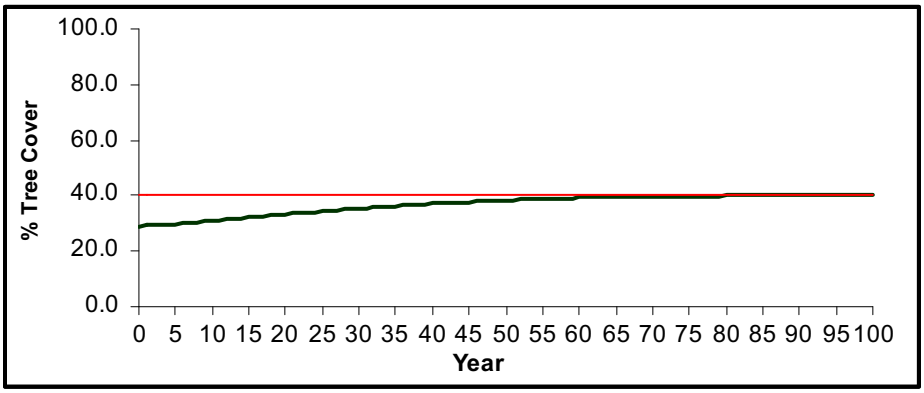
40% Goal 2% Mortality
(4,000 trees annually)



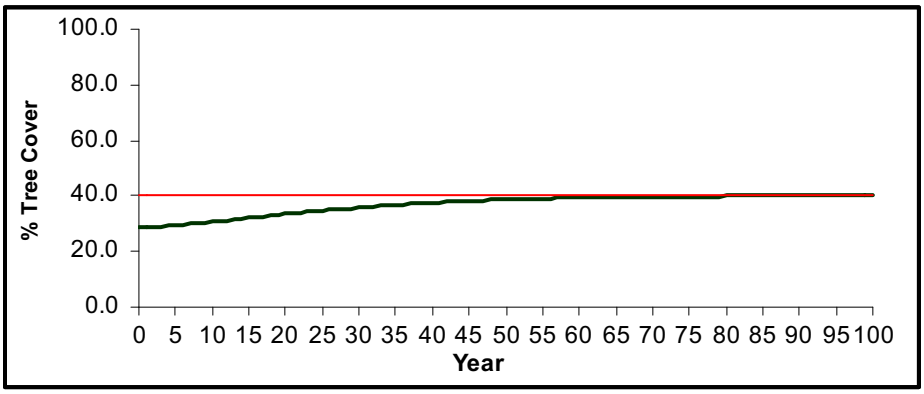
40% Goal 4% Mortality
(32,000 trees annually)



40% Goal 6% Mortality
(70,000 trees annually)



40% Goal 8% Mortality
(121,000 trees annually)



Appendix B 2
Strategic Management Plan for the Urban Forest

Policy Reforms to give Effect to a 40% Urban Forest Canopy

The Policy Context

The Town of Oakville aspires to be a highly liveable, vibrant, thriving urban area. Continued improvement to the quality of life is a core goal. An attractive, clean, and healthy environment is a key component of this vision - a vision in which trees play a major role. The urban environment benefits greatly from an increase in canopy cover.

From research that was undertaken in 2005, it is known that the urban forest currently covers 29.1% of the Town of Oakville, south of Dundas Street. This forest cover is composed of approximately 21% tree cover and 8% shrub cover. The Urban Forest Effects Model (UFORE) used to quantify urban forest structure in 2005 is intended to be repeated in 4 years to monitor the effectiveness of the forest canopy cover goals.

Oakville's goal is to sustain the existing level of forest cover and to gradually and progressively increase this forest cover to 40% of the area of the Town. This canopy target could consist of 30% tree cover and 8% shrub cover, which would realize approximately 40% urban forest canopy over the long term. This is a long-term goal that may take 40 to 50 years to accomplish. A welcome outcome of the implementation measures would be forest cover in excess of 40% across the Town.

The Town of Oakville controls most of the open space areas across the municipality. Open space is active parkland consisting of sports fields, playgrounds and recreation facilities. Currently forest canopy cover in open space areas is at 26%. The Town has committed to increasing this canopy cover to 33% over time. Other lands controlled by the Town are woodlands. These lands are almost totally covered in forest. Together, these two land use components controlled by the Town will achieve approximately 60% forest canopy cover in the parks and open space land use category.

To implement the Oakville vision for the urban forest, it is recommended that policy documents, regulations, processes and guidelines be amended to implement this goal. The following three sections outline changes to planning documents as they relate to plans in the Town of Oakville and looks at the amount of urban forest canopy cover currently being achieved and what would be required to increase the urban forest canopy cover up to 40% of the lot area. Based on this research, it would appear that the goal is feasible.

The fifth section is a compilation of the recommendations.

1. Town of Oakville Official Plan

The main policy document giving guidance as to what kind of place Oakville wishes to be – the character and quality of the Town - is the Oakville Official Plan. The policies relating to trees in the current plan are extensive and have served the Town well in the past. However, amendments to these policies are necessary to encourage enhanced tree cover in the future and to be specific as to how the objectives of enhanced tree cover will be achieved. It is recommended that the following statements should be incorporated into the Official Plan.

Goals and Objectives

- To develop a culture among landowners, residents, builders and developers and in the municipal operations that promotes the increase of forest canopy cover across the Town of Oakville.

- To sustain the existing level of urban forest canopy cover (trees and shrubs) and to progressively increase the urban forest canopy cover across the Town of Oakville to 40% of the land area over the long term through focusing efforts on increasing tree planting, improving tree habitat and establishing effective processes to manage and maintain trees.

- To establish policies, regulations, processes and procedures in the planning process that will increase forest cover through the preservation of existing trees and the planting of new trees.

- To allocate appropriate levels of capital funding in the municipal budget to plant and maintain trees on public lands.

- To develop innovative standards for tree growing mediums (area of land, depth of soil and quality of soil) including the use of enhanced rooting environment techniques that permit the growing of trees in non-traditional areas where trees would not typically grow well.

- To promote the use of enhanced rooting environment techniques in both private and public sector developments where existing soils will not support the growing of trees (i.e. road allowances, parking lots, sidewalks and boulevards).

General Policies

- To encourage development in sympathy with the distinct character of individual communities and neighbourhoods, and with the natural features of the landscape, the Town may assess proposals for development with respect to the preservation and use of the natural contours and watercourses; the preservation of trees wherever possible, and the planting of trees in conjunction with the development of land so that a significant portion of the site has the potential for forest cover.

- The preservation of existing trees is encouraged and will be an important consideration in the evaluation of infill development. Where existing trees cannot be preserved because of development objectives, or where there are no existing trees, the planting of new trees will be required in conjunction with the development of the land so that a significant portion of the site has the potential for forest cover.

- The Town shall ensure that in the design of new roads or road improvements, there is sufficient space and quality of soil for the planting of trees to enhance the long-term survival of tree corridors within the road right-of-way. It may be necessary to use enhanced rooting environment techniques to achieve the necessary quality of soil to maximize tree growth adjacent to public roads.

- The objective of the Town of Oakville is to sustain the existing level of urban forest canopy cover and to progressively increase the urban forest canopy cover to 40% over the long term.

- The Town shall establish regulations in the Zoning By-law that will require minimum planting areas capable of growing trees. This regulation will be applicable to commercial, employment, and institutional uses that are subject to site plan control. The planting area may be on lands used for parking and other hard surfaced areas, but if this were the case, the soil in the tree planting area would be amended with technically advanced products designed to support trees such as structural soils.

- The Town shall establish design guidelines and procedures in the Site Plan process which require the planting of trees in planting areas under the zoning regulations and provide for standards relating to the planting of trees for the following matters:
    - spacing of trees;
    - location of trees;
    - type of trees to be planted with encouragement for the planting of large stature trees;
    - protection of trees and separation of trees from uses that would damage trees (i.e., curbs, bollards etc,);
    - design of the planting areas to minimize the effect of de-icing salt;
    - growing medium (volume and quality of soils) for the planting area;
    - maintenance and replacement of trees;
    - drainage and irrigation of the planting area for trees;
    - criteria for enhanced rooting environment technique and where they shall be applied; and
    - the type of permeable surface material if the planting area for trees is also used for parking or driveway purposes so that an exchange of water and air to tree root zone is provided.

- The Town shall contribute to reducing carbon dioxide and other air pollutants by protecting and enhancing the urban forest and specifically promoting the growth and protection of large stature trees.

- To recognize the municipal urban forest as a component of the municipality's infrastructure

2. Zoning By-law

The Zoning By-law is primarily a mechanism to control land use. The zoning by-law creates a number of zones or classes of land. The by-law establishes a range of uses permitted in each zone. In addition, the by-law establishes regulations that are applicable to each zone.

Based on research undertaken by Forestry and Cemetery Services of the Town in 2005 (Town of Oakville 2006), the amount of tree cover appears to be directly related to the amount of space available for the planting of trees. In low density areas with larger amounts of landscape area, there are proportionally more trees planted. In areas with higher building coverage and paved surface areas, there are fewer trees planted.

Development of land in urban situations typically has three components, all of which are regulated in the zoning by-law

- the area for building(s),
- the area for driveways and parking, and
- the landscape area.

The landscape area consists of walkways, detention ponds, buffers, end islands associated with parking lots, and space adjacent to the buildings and it is the space to which trees are generally relegated. For many land use classifications, the landscape area is a relatively small component of the site (10%), and in some cases, the landscape area is "left-over" space, which may not be well suited to the planting of trees.

Technological innovations with respect to tree habitat and soils now permit trees to be planted in areas where they traditionally have not been expected to survive and grow well. The use of products such as structural soils allows trees to be planted in parking lots and close to sidewalks and driveways.

To achieve increased tree canopy cover, there is an opportunity to plant trees in and adjacent to parking lots. Unless the soils are amended, the long-term survival of trees in these locations is doubtful. With the introduction of structured soils and other measures to provide appropriate growing conditions for trees, the long-term health and survival of the tree is enhanced.

The following chart shows the relationships between size of tree, the necessary planting area, and the canopy cover that would be achieved at maturity. This chart is useful in understanding how the urban forest canopy objectives could be implemented and is fundamental in establishing a zoning regulation that seeks to increase tree canopy in various zones.

Planting Area Required To Achieve Maximum Canopy Cover, By Tree Size

Tree Size	Required Planting Area (m^2)	Canopy Diameter (m)	Canopy Projection Area (m^2)
Large Stature	98	14	154
Medium Stature	44	10	79
Small Stature	16	3	7
Note: the minimum area required for the trunk of each tree is 1m x 1m			

To more fully understand how the standards in the above chart might be applied, the following simplified example is provided.

Example: Number of trees needed to be planted to achieve 30% tree canopy cover on the lot by tree size based on a 1 ha lot				
Tree Size	**Number of Trees**	**Planting Area Required**	**Planting Area of Lot**	**Tree Canopy Area**
Large Stature	20	1960 m^2	20%	30%
Medium Stature	38	1672 m^2	17%	30%
Small Stature	429	6864 m^2	69%	30%
The number of trees to achieve 30% forest cover could be all of one size, as outlined above, or any combination of various tree sizes. Note: the minimum area required for the trunk of each tree is 1m x1m.				

With respect to the objective of progressively increasing forest canopy to 40% across the Town, it is recommended that the Zoning By-law be changed to provide increased opportunity for the growing of trees. These changes would apply to land use classes that typically have extensive hard surface areas (for parking and driveways, etc) and consequently do not achieve significant tree cover. The change to the Zoning By-law would initially apply to commercial, employment and institutional zones that generally have relatively low proportions of tree cover. It may be appropriate to extend this regulation to medium and high density residential uses but it is recommended that further research be undertaken on recently approved site plans to determine a reasonably standard.

It is recommended that a zoning regulation be established to achieve a minimum tree cover canopy of the lot area. Initially it is suggested that the minimum tree canopy cover be established at 30% but that this be monitored over time to determine if 40 % is feasible. It is not recommended that the actual growing of trees be a provision that is regulated in the Zoning By-law. However, the Zoning By-law should have a regulation for “planting area for trees”. This would be similar to other regulations such as a landscape area, parking space, and building area that are currently required in the by-law.

To minimize the impact of this provision on the viability of sites from a development perspective, it is recommended that the ”planting area for trees” also permit uses that typically would not be expected to co-exist with trees. With the use of structural soils, trees could be planted in parking lots and adjacent to driveways. The placement of trees in the parking area would have the effect of shortening the length of the parking space, which could be addressed in the Zoning By-law by providing a regulation for “short cars”. Other than a reduction in the parking space length, no other negative effect on the number of parking spaces is expected.

The application of the “planting area for trees” regulation would apply to various land use classifications. Generally, the zoning provision requiring a “planting area for trees” could apply to any land use that is subject to site plan control. Initially it is suggested that this regulation would apply to employment, commercial and institutional zones, although it may be appropriate

to also apply a similar standard to medium and high density residential zones. The application of the regulation would be based on the following criteria and qualifications:

- The development of vacant land.

- The redevelopment of land where the existing building(s) are to be removed or partially removed and new buildings are constructed.

- The development of existing developed sites where a significant portion of the site is to be redeveloped. Minor redevelopment proposals consisting of 25 m^2 or 5% of the floor area of the site would be exempt from this proposal.

- The partial redevelopment of a site in which case the regulation would apply to the portion of the site where the redevelopment is proposed and to any parts of the site that are being altered to accommodate the redevelopment (parking areas, driveways, etc).

- The phased development of sites where part of the site is proposed for development and where further development of the land is anticipated in the future on the balance of the lands and this future development would be subject to a further Site Plan approval. In this case, where it is difficult to distinguish the landscape area directly associated with the proposed development, the regulation would apply to the portion of the site that is currently being proposed for development for the building and parking area only.

- Tree canopy calculations are based on the canopy of the tree at maturity.

- Where trees planted on the subject land provide canopy on adjacent public land, the canopy area derived from the tree(s) planted on the subject site would be attributed to the subject site.

- Plantable area for trees on rooftops in containers would be included in the regulation for overall plantable area.

- In some areas of the C3R zone, 100% building coverage is permitted and private parking for commercial and other non-residential land uses is not required. Also, structured parking is often provided in conjunction with relatively high building coverage. Where this is the case, a “planting area for trees” provision would not be appropriate or the planting area for trees should be revised to reflect the area of the site that is not covered by buildings.

An example of a zoning regulation that incorporates the a tree planting area sufficient to achieve a tree canopy cover of 30% of the lot but which takes into consideration some of the points raised above could take the following form:

- Planting Area for Trees, (based on the following chart)

  Planting area for trees that would provide tree canopy on 30% of the lot. Tree planting on the rooftops of buildings are included as part of the tree canopy.

- Definition of Planting Area for Trees:

  An area that contains soil of a depth and quality that is capable of growing trees as outlined in the following chart. If the growing medium is natural or amended with other natural soils, the planting area for trees shall not be used for parking,

driveways, outdoor storage, or outdoor processing, and it shall not be covered by hard surface materials. If the planting area contains 'structured soils', it may be used for parking and driveways, and it may be covered with permeable hard surface materials. In no case shall there be an area less than 1 metre by 1 metre reserved exclusively for tree trunks (i.e. no hard surfaces or other uses permitted).

Planting Area Required To Achieve Canopy Cover by Tree Size		
Tree Size	**Required Planting Area for Trees (m^2)**	**Tree Canopy Area (m^2)**
Large Stature	98	154
Medium Stature	44	79
Small Stature	16	7
Note: the minimum depth of soil required for the planting area is 0.9 m		

- Notwithstanding the minimum dimensions used for parking spaces, where the "planting area for trees" is located in a parking area, the area of a parking space directly abutting a tree may be reduced to reflect a reduction in the length of the parking space of 0.5 metres, and the parking space shall be marked (signed) for use by "short cars".

- Definition of Short Cars - a car that is not longer than 4.5 metres (e.g. a Honda Civic)

- Application of Planting Area for Trees provision:

  The "planting area for trees" regulation shall apply as follows:

  - To all zones that are subject to site plan control excluding zones that permit residential uses.

  - In zones where the "planting area for trees" is in effect, the provision shall be applied to any lot where there is an application for the development of the land that requires site plan approval. Lots that were developed and where this development was in existence prior to the approval of this provision and that do not meet the "planting area for trees" regulation, will be considered to be in conformity with the zoning by-law. Any further development of the lot shall be required to comply with the "planting area for trees" provision.

  - The minor redevelopment of land with existing buildings consisting of additional floor area of less than 25 m^2 or 5% of the existing floor area, whichever is the lesser, shall be exempt from the "planting area for trees" regulation.

3. Site Plan Control

In the Town of Oakville, under the Official Plan, Site Plan Control applies to all medium and high density residential areas, and all commercial, employment and institutional development. As part of the review and approval of site plans, the Planning Act states in Section 41.7 that:

> 7. As a condition to the approval of the plans and drawings, … a municipality may require the owner of the land to,
>
> (a) provide to the satisfaction of and at no expense to the municipality any or all of the following:
>
> 6. Walls, fences hedges, trees, shrubs, or other groundcover or facilities for the landscaping of the lands or the protection of adjoining lands.
>
> (b) maintain to the satisfaction of the municipality and at the sole risk and expense of the owner any or all of the facilities or works mentioned in paragraphs …6 … of clause (a) …

The site plan approval process is a very effective tool in implementing the urban forest canopy objectives outlined in the Official Plan and the regulations established in the Zoning By-law. It is recommended that the following steps be undertaken in the Site Plan process to give effect to these urban forest objectives.

i) That Design Guidelines be prepared to advise applicants and designers of objectives of the Town and of how and where trees should be planted. These guidelines would include the following components:

- spacing of trees;
- location of trees;
- type of trees to be planted;
- protection of trees and separation of trees from uses that would damage trees (i.e., curbs, bollards etc,);
- design of the planting areas to minimize the effect of de-icing salt;
- growing medium (depth and quality of soils) for the planting area;
- criteria for structured soils would be required and where structured soil would be used;
- maintenance and replacement of trees;
- drainage and irrigation of the planting area for trees; and
- the type of impermeable surface material if the planting area for trees is also used for parking or driveway purposes.

ii) That in the evaluation of site plans by staff, there be specific consideration for how trees are provided in the “planting area for trees”.

iii) That the inspection and monitoring procedures during and after the development of the site ensure that the tree planting, maintenance and protection measures are in place.

iv) That in the Site Plan application form, the applicant and designers be made aware of the Town’s canopy cover and tree planting objectives and the design guidelines and procedures.

4. Current Level of Tree Canopy Being Achieved and the 40% Opportunity

Two recently approved site plans were analyzed to determine the level of tree canopy that is being achieved under the site plan approval process. These two site plans were also analyzed to consider what would be required to achieve an urban forest canopy cover of 40%.

The two site plans were:

- A small commercial plaza in the West Oak Trails Community, at the southwest corner of Dundas Street and Third Line.

- A large office site in Winston Park, at the northwest corner of Upper Middle Road and Buckingham Road.

The analysis of the approved plans was undertaken using the following methodology:

- Establish the total site area.

- Review the approved Landscape Plan to determine the size of trees that were to be planted – large, medium or small stature trees.

- Plot the tree canopy on the site plan using the mature canopy area for each tree (large: 154 m^2; medium 79 m^2; small 7 m^2).

- Measure the area covered by tree canopies.

- Calculate the canopy area as a percentage of the total site area.

For the purposes of this exercise, it was assumed that the trees would have sufficient habitat, in terms of growing area, quality of soil and maintenance, to grow to maturity. However, it is recognised that in many situations, trees are planted in areas that cannot support a mature tree because of deficient habitat. In these situations, many trees die prematurely. The use of structural soils and a regular maintenance schedule would assist in assuring the long-term growth and health of trees.

The results of the analysis are described as follows.

- Small Commercial Plaza – The tree canopy covers 28.6% of the total site and 39.5% of the site exclusive of buildings.

- Large Office Site – The tree canopy covers 27.0% of total site, and 29.3% of the site exclusive of buildings.

In considering what is needed to achieve 40% urban forest canopy cover over the site, the plans were modified to include more trees. In the modified plan, many of these trees were located in the parking lot since the landscaped areas were already fully planted. In the parking areas, it is assumed the trees would be planted in structural soils. It is interesting to note that relatively few parking spaces (approximately 10%) have to be shortened to the small car size to accommodate trees planted in the parking lots.

The drawings showing tree canopy on the approved Landscape Plans and what would be required to achieve a 40% urban forest canopy cover on the same plans are attached. Also attached are other relevant statistics relating to the two sites.

There are several points that become apparent from the exercise of examining these recently approved site plans.

- The current site plan approval process could be effective in achieving between 25% and 30% tree canopy cover if the trees are able to grow to maturity.

- This amount of tree canopy on commercial and employment sites is significantly higher than what currently exists for this general land use category across the municipality.

- Many trees on many sites across the town may not achieve their potential mature size because they are planted in areas where there is deficient habitat or where the level of maintenance is not adequate to sustain the trees.

- The trees actually planted on the sites in accordance with the approved Landscape Plans are spaced relatively close together, to the extent that the canopies of individual trees are not maximized with respect to cover over the lot. When the mature canopies are plotted on the plan, it is seen that there is often a very large amount of overlapping canopies. If the same number of trees were planted in accordance with the optimal spacing guidelines for their tree size, the canopy cover on the site would increase significantly. For the two sites studied, if there were no overlapping effect, the number of trees planted would achieve approximately 38% canopy cover on the small commercial site and 48% canopy cover on the office site.

- The number of trees planted on a site may not be the most important issue in achieving the desired canopy cover. The provision of appropriate planting area for trees is also critical, since it allows for optimal spacing and ensures the long-term health of the tree.

- A policy to achieve 40% urban forest canopy cover appears to be feasible for the sites investigated if aggressive habitat modification measures are used. The actual number of trees to be planted would not increase significantly. The impact on the parking spaces is minimal given the predominance of smaller cars. The functioning of the site in terms of building area, parking area and number of parking spaces, circulation routes would not be affected. However, it is recognised this can only be achieved with the use of technically advanced products designed to support trees such as structural soils which will increase the overall landscaping costs.

5. Recommendations - Summary

a) That the Urban Forest Effects Model be repeated every 4 four years over the mid term to monitor the effectiveness of the program of sustaining the current forest canopy cover and increasing the forest canopy to 40%.

b) That the overall goal of sustaining the current level of forest cover in the Town of Oakville and increasing this forest canopy cover to 40% be adopted.

c) That additional policy be incorporated in the Official Plan to implement the forest canopy goal.

d) That the Zoning By-law be amended to require a minimum of 30% tree canopy cover in employment, commercial (excluding the C3R zone) and institutional zones.

e) That the Town research a tree canopy standard that would be reasonable for medium and high density residential uses and include this standard as a “planting area for trees” regulation in the Zoning By-law.

f) That the 30% tree canopy cover regulation in the Zoning By-law be monitored with respect to:

- feasibility
- whether the minimum canopy could be increased to 40%
- whether the tree canopy cover regulation could be applied to other zones.

g) That Site Plan Control processes be modified to ensure that trees are planted in the “Planting area for trees” areas established in the Zoning By-law.

h) That Site Plan Design Guidelines and Application Forms be modified to advise applicants of the Towns regulations and expectations with respect to tree canopy cover objectives.

i) That the Site Plan evaluation and inspection procedures ensure that the planning and installation of tree habitat and the planting of trees will facilitate the long-term growth of the trees.

APPENDIX C

A MODEL OF URBAN FOREST SUSTAINABILITY

by James R. Clark, Nelda P. Matheny, Genni Cross and Victoria Wake

Abstract. We present a model for the development of sustainable urban forests. The model applies general principles of sustainability to urban trees and forests. The central tenet of the model is that sustainable urban forests require a healthy tree and forest resource, community-wide support and a comprehensive management approach. For each of these components, we present criteria and indicators for assessing their status at a given point in time. The most significant outcome of a sustainable urban forest is to maintain a maximum level of net environmental, ecological, social, and economic benefits over time.

Creation and management of urban forests to achieve sustainability is the long-term goal of urban foresters. The notion of sustainability in urban forests is poorly defined in both scope and application. Indeed, the question of how to define sustainability, and even whether it can be defined, is an open one (9, 12). At a simple level, "a sustainable system is one which survives or persists" (5). In the context of urban forests, such a system would have continuity over time in a way that provides maximum benefits from the functioning of that forest.

Since there is no defined end point for sustainability, we assess sustainability by looking backwards, in a comparative manner (5). In urban forests, we measure the number of trees removed against those replanted or regenerated naturally. In so doing, we assess progress towards a system that "survives or persists." Therefore, our ideas of sustainability are "really predictions about the future or about systems . . . (5)."

This paper presents a working model of sustainability for urban forests. We describe specific criteria that can be used to evaluate sustainability, as well as measurable indicators that allow assessment of those criteria. In so doing, we accept sustainability as a process rather than a goal. As suggested by Kaufmann and Cleveland (12) and Goodland (5), we consider social and economic factors as well as natural science. Goodland believed that "general sustainability will come to be based on all three aspects" (social, economic and environmental). Maser (14) described sustainability as the "overlap between what is ecologically possible and what is societally desired by the current generation", recognizing that both will change over time.

Therefore, our approach integrates the resource (forests and their component trees) with the people who benefit from them. In so doing, we acknowledge the complexity of both the resource itself and the management programs that influence it. We also recognize that communities will vary in both the ecological possibilities and societal desires.

Defining Sustainability

In developing a model of sustainable urban forests, we first examined how other sustainable systems were defined and described. Although we have concentrated on forest systems, other examples were considered. While some principles of sustainable systems were directly applicable to urban forests, others require modification or were in conflict with the nature of urban forests and forestry.

The Brundtland Commission Report (21) has generally served as the starting point for discussion about sustainable systems. It defined sustainable forestry as:

"Sustainable forestry means managing our forests to meet the needs of the present without compromising the ability of future generations to meet their own needs by practicing a land stewardship ethic which integrates the growing, nurturing and harvesting of trees for useful products with the conservation of soil, air, and water quality, and wildlife and fish habitat."

Both Webster (22) and Wiersum (23) examined this definition from the perspective of forest management. They recognized that issues of *what* is to be sustained and *how* sustainability is to be implemented are unresolved. Wiersum (23)

acknowledged the historical focus on sustaining yield and its recent broadening to sustainable management. Webster (22) suggested a need for focus on the issue of *scale:* the size of the area or space to be included.

Further refinements in the Brundtland Commission's definition of sustainability were made by Salwasser (16) and Sample (17). Salwasser (16) described sustainability as:

"Sustainability means the ability to produce and/or maintain a desired set of conditions or things for some time into the future, not necessarily forever."

Salwasser (16) included environmental, economic and community based components, acknowledging that sustainability is not simply a resource matter. He also stressed that the goals and objectives for forest management cannot exceed the biological capacity of the resource, now and into the future.

Sample (17) focused more closely on forest management, emphasizing the need for shared vision among diverse property owners. In a workshop on ecosystem management, Sample described sustainable forestry as:

"Management and practices which are simultaneously environmentally sound, economically viable and socially responsible."

Some definitions of sustainable forests are not directly applicable to urban settings. For example, the description presented at the conference on Sustainable Forestry (18) included comments about capacity for self-renewal. Since regeneration of urban forests must occur in a directed, location-specific manner, use of such a definition is inappropriate.

Other definitions consider the goal of sustainable forests in a manner inconsistent with our concept of urban forests. Thompson *et al.* (20) described sustainability as "programs that yield desired environmental and economic benefits without wasteful, inefficient design and practices." While these authors were interested in urban settings, their approach was limited to municipal forestry programs rather than city-wide processes or results. Dehgi *et al.* (6) focused on California's native Monterey pine forest and restricted their definition of sustainability to that system. Moreover, their interest was limited to sustaining the "natural dynamic genetic process." In another approach, the American Forest and Paper Association's Sustainable Forestry Initiative (1) is largely aimed at industrial forest practice and products. This focus on industrial forestry seems largely incompatible with urban environments.

Given the examples noted above, the role of humans in sustainable systems (including forests) is generally accepted. However, Botkin and Talbot (2) (as criticized by Webster) argued that sustainable development of tropical forests requires non-disturbance by humans. Again, this idea is incompatible with urban forests.

Applying Concepts of Sustainable Forests to Urban Forests

In moving the concepts of sustainable development of forests towards implementation and practice, Webster (22) raised several significant questions. We have considered these questions from the urban forest perspective:

What objects, conditions, and values are to be sustained?

In urban areas, we focus on sustaining net benefits of trees and forests at the broadest level. We are sustaining environmental quality, resource conservation, economic development, psychological health, wildlife habitat, and social well-being.

What is the range of forest activities that contribute to sustainable development?

Simply put, urban forests require a broad set of activities, from management of both single trees and large stands to education of the community about urban forests and development of comprehensive management plans.

What is the geographic scale at which sustainable development can be most usefully applied?

Political borders do not respect biology (and vice versa). Principles of ecosystem management argue for a scale based on ecological boundaries such as watersheds. However, cities form discrete political, economic and social units. We must respect the reality that political borders may be more significant to management than ecological boundaries. Urban forestry programs work within

this geographical framework.

For this project and model, we have chosen to focus on the city and its geographic limits. While this approach may violate some of the biological realities of forest stands, it logically reflects the jurisdictional boundaries and typical management units found in cities. The more common alternative approach, working with ecosystems, is not without problems of definition and scale (7).

What is the relationship of sustainable development for (urban forests) to new technology, effectively applied research and investment in forest management?

Urban forests stand to benefit tremendously from new technology, information and investment. Not only will the ability to select and grow trees in cities be enhanced, but the ability to quantify the benefits accrued by their presence will expand.

Wiersum (23) provided an in-depth look at sustainability in forest systems, noting the long history of the concept in forest practice. Many would argue that the concept of sustained yield is not equivalent to sustainable development. Gatto (9) discusses this fact at length. However, Wiersum (23) observed the evolution of forest sustainability towards multiple use, biological diversity, mitigating climate change and socioeconomic dimensions. Wiersum summarized four concepts involved with sustainable forest management as maintenance or sustenance of:

- forest ecological characteristics
- yields of useful forest products and services for human benefit
- human institutions that are forest-dependent
- human institutions that ensure forests are protected against negative external institutions.

A similar perspective on sustainable forest management (13) described the measurable criteria as:

- desired future condition (the vision of the forest in the future)
- sustained yield
- ecosystem maintenance
- community (city) stability

Keene (13) also noted that these principles can be practiced in traditional forest management. Products derived from forests in which sustainable forest management is practiced may receive a third-party certification as such, in a manner similar to certification of organically-grown produce.

Maser, (14), Wiersum (23) and Charles (4) all argued that a sustainable forest would include biological, social and economic issues. For example, from the perspective of a fishery resource, sustainability is the simultaneous pursuit of ecological, socioeconomic, community and institutional goals (4). In Maser's view of ecological sustainability, the goals and needs of society must reflect the potential of the resource to meet them. This idea may be universal for sustainable development and must certainly be for urban forests.

This approach can be directly applied to cities, for we want urban forests to contribute to environmental, economic and social well-being. We need not sacrifice one goal in pursuit of another. Trees reduce atmospheric contaminants at the same time that they enhance community well-being. While there may be conflicts in specific situations (eg. planting trees under utility lines or using invasive species), in general, all of the broad goals for urban forest sustainability are compatible with the others. In this sense, when we focus on appropriate management of trees and urban forests, where management activities take place with community-supported goals and objectives, we focus on sustaining a broad range of values.

We also concur with Charles' (4) conclusion that sustainability can only be achieved when:

- Control is local (for fisheries, community and region-wide)
- Management is adaptive, recognizing the dynamic resource and its complexity
- Property rights are respected

In summary, a wide range of definitions for sustainable development have been derived from the original concept of the Brundtland Commission. No universally accepted derivation has arisen for forestry. Despite this problem, progress has been made in identifying criteria and markers for success.

Characteristics of Urban Forest Sustainability

Given the general characteristics of sustainable systems and the specific nature of urban forests, we identified 4 principles to which any model of sustainability must adhere.

1. Sustainability is a broad, general goal. While we may be able to describe the desired functions of a sustainable urban forest, we cannot yet design the forest to optimize them. Although we know that urban forests act to reduce atmospheric contaminants, we do not yet know how to design those forests to maximize that function. However, we accept that existing urban forests provide these functions to some degree. Trees in cities serve to improve community well-being, reduce the urban heat island, eliminate contaminants from the atmosphere, etc. While there are costs involved in planting, maintaining and removing trees in cities, in a sustainable urban forest the net benefits provided by these functions are greater than the costs associated with caring for the forest. A sustainable urban forest provides continuity of these net benefits over time and through space. We therefore have decided to recognize the general character of sustainable systems and develop steps that form such a system in urban areas.

2. Urban forests primarily provide services rather than goods. Descriptions of sustainable systems usually focus on the goods that system provides, i.e. sustained yield. Forests provide fuel and fiber, agronomic systems provide food and fiber, fisheries provide food, etc. In such examples, goods are the primary output.

In contrast, goods comprise a rather limited output of the urban forests. The most important outputs are services, such as reducing environmental contamination (from removing atmospheric gases to moderating storm water runoff), improving water quality, reducing energy consumption, providing social and psychological well-being, providing for wildlife habitat, etc. These services, or benefits, are provided in two ways: 1) direct (shading an individual home, raising the value of a residential property) and 2) indirect (enhancing the well-being of community residents).

In planting and maintaining sustainable urban forests, we should strive for a balance among all benefits and not maximize the output of one service at the expense of all others. For example, one of the benefits that urban forests provide is wildlife habitat. Maintaining the largest wildlife habitat possible could conflict with other services, such as limiting economic development from property development or creating conflicts with humans.

3. Sustainable urban forests require human intervention. One of the wonderful characteristics of natural systems is their capacity for self-maintenance. Sustainable forests, farms and fisheries take advantage of this fact by harvesting some limited segment of the resource, often with a period of rest to allow renewal and replacement. The Brundtland Commission Report (21), Maser (14) and Charles (4) emphasized this critical aspect of the resource to be sustained. For example, Goodland (10) defined environmental sustainability as "maintenance of natural capital." Maser noted that a biologically sustainable forest is the foundation for all other aspects of a sustainable system. In forestry, there can be no sustainable yield, sustainable industry, sustainable community or sustainable society without a biologically sustainable resource. As Charles put it (for fisheries), "If the resource goes extinct, nothing else matters."

Many (but not all) urban forests are a mosaic of native forest remnants and planted trees. The native remnants may have some capacity for self-renewal and maintenance, particularly in greenbelts and other intact stands. However, the planted trees have essentially no ability to regenerate *in place*. Therefore, we must accept, acknowledge and act on the fact that urban forests (particularly in the United States) may have a limited ability to retain or replace biological capital (to use Maser's term). This is particularly the case when we desire that regeneration occur in a manner appropriate for human benefits. Indeed, unwanted tree reproduction may actually have a net cost for control and eradication programs.

Sustainable urban forests cannot be separated from the activities of humans. Such activity can be both positive and negative. In the latter case, creation and maintenance of urban infrastructure

can be extremely destructive and disruptive. In essence, we superimpose cities atop forests. The greater the imposition, the less natural the forests appear and function (D. Nowak, personal communication).

The adverse impacts of humans can be mitigated by positive actions such as planning, planting, and management; all occurring with common commitment and shared vision. We cannot separate sustainable urban forests from the people who live in and around them. In fact, we want to meld the two as much as possible.

The implications of this principle are far-reaching. First, urban forests require active, consistent, continuing management. The accrual of net benefits can only occur when adequate and reasonable care is provided. Second, tree managers (both public and private) must involve the surrounding community in decisions and actions regarding urban forests. We do not suggest abdicating responsibility on the part of tree managers; we advocate sharing it.

4. Trees growing on private lands compose the majority of urban forests. While publicly - owned trees (primarily in parks and along streets and other rights-of-way) have been the long-standing focus of urban forestry, they comprise only a portion of the urban forest. An estimated 60 - 90% of the trees in urban forests in the United States are found on privately owned land (see 19; also G. McPherson, pers. communication). Therefore, sustainable urban forests depend to a large degree on sustainable private forests.

If we consider further that trees probably are not evenly distributed among all private landholders, then we may also conclude that a small number of land owners and managers may be responsible for a large fraction of urban trees. For example, universities, business parks, corporate campuses, commercial real estate, autonomous semi-public agencies, utilities, etc. may manage large numbers of trees. The success of any effort at sustainability must include their participation and commitment.

However, small private landholdings, particularly residential properties, may also constitute a significant fraction of community trees. Their contribution to the urban forest must be considered in any effort towards sustainability.

Defining Sustainable Urban Forests. Applying these 4 principles leads to the following definition of a sustainable urban forest:

"The naturally occurring and planted trees in cities which are managed to provide the inhabitants with a continuing level of economic, social, environmental and ecological benefits today and into the future."

Applying this definition in urban areas requires accepting 3 ideas:

1. Communities must acknowledge that city trees provide a wide range of net benefits. Planting, preserving and maintaining trees is neither simply a good thing nor an exercise. Rather, urban forests are essential to the current and future health of cities and their inhabitants.

2. Given the goal of maintaining net benefits over time, the regeneration of urban forests requires intervention and management by humans. To quote David Nowak, "people want and need to direct the renewal process because natural regeneration does not meet most urban needs." Therefore, urban forests cannot be sustained by nature, but by people.

3. Sustainable urban forests exist within defined geographic and political boundaries: those of cities. Moreover, sustainable urban forests are composed of all trees in the community, regardless of ownership.

A Model of Urban Forest Sustainability

Given the 3 premises listed above, we developed a model of urban forest sustainability which is founded on three components: 1) vegetation resource, 2) a strong community framework and 3) appropriate management of the resource. Within each component are a number of specific criteria for sustainability (see Tables 1, 2 and 3).

1. Vegetation resource. The vegetation resource is the engine that drives urban forests. Its composition, extent, distribution, and health define the limit of benefits provided and costs accrued. As dynamic organisms, urban forests (and the trees that form them) change over time as they grow, mature and die. Therefore, sustainable urban forests must possess a mix of

Table 1. Criteria of urban forest sustainability for the Vegetation Resource.

Canopy cover	Achieve climate-appropriate tree cover, community-wide.	Though the ideal amount of canopy cover will vary by climate and region (and perhaps by location within the community, there is an optimal degree of cover for every city.
Age distribution	Provide for uneven age distribution.	A mix of young and mature trees is essential if canopy cover is to remain relatively constant over time. To insure sustainability, an on-going planting program should go hand in hand with the removal of senescent trees. Some level of tree inventory will make monitoring for this indicator easier. Small privately owned properties pose the biggest challenge for inclusion in a broad monitoring program.
Species mix	Provide for species diversity.	Species diversity is an important element in the long-term health of urban forests. Experience with species-specific pests has shown the folly of depending upon one species. Unusual weather patterns and pests may take a heavy toll in trees in a city. It is often recommended that no more than 10% of a city's tree population consist of one species.
Native vegetation	Preserve and manage regional biodiversity. Maintain the biological integrity of native remnant forests. Maintain wildlife corridors to and from the city.	Where appropriate, preserving native trees in a community adds to the sustainability of the urban forest. Native trees are well-adapted to the climate and support native wildlife. Replanting with nursery stock grown from native stock is an alternative strategy. Planting non-native, invasive species can threaten the ability of native trees to regenerate in greenbelts and other remnant forests. Invasive species may require active control programs.

species, sizes and ages that allows for continuity of benefits while trees are planted and removed (Table 1).

The vegetation resource of a sustainable urban forest is one that provides a continuous high level of net benefits including energy conservation, reduction of atmospheric contaminants, enhanced property values, reduction in storm water run-off,

Table 2. Criteria of urban forest sustainability for the Community Framework.

Public agency cooperation	Insure all city departments operate with common goals and objectives.	Departments such as parks, public works, fire, planning, school districts and (public) utilities should operate with common goals and objectives regarding the city's trees. Achieving this cooperation, requires involvement of the city council and city commissions.
Involvement of large private and institutional landholders	Large private landholders embrace city wide goals and objectives through specific resource management plans.	Private landholders own and manage most of the urban forest. Their interest in, and adherence to, resource management plans is most likely to result from a community-wide understanding and valuing of the urban forest. In all likelihood, their their cooperation and involvement cannot be mandated.
Green industry cooperation	The green industry operates with high professional standards and commits to city-wide goals and objectives.	From commercial growers to garden centers and from landscape contractors to engineering professionals, the green industry has a tremendous impact on the health of a city's urban forest. The commitment of each segment of this industry to high professional standards and their support for city-wide goals and objectives is necessary to ensure appropriate planning and implementation.
Neighborhood Action	At the neighborhood level, citizens understand and participate in urban forest management.	Neighborhoods are the building blocks of cities. They are often the arena where individuals feel their actions can make the biggest difference in their quality of life. Since the many urban trees are on private property (residential or commercial), neighborhood action is a key to urban forest sustainability.
Citizen - government - business interaction	All constituencies in the community interact for the benefit of the urban forest.	Having public agencies, private landholders, the green industry and neighborhood groups all share the same vision of the city's urban forest is a crucial part of sustainability. This condition is not likely to result from legislation. It will only result from a shared understanding of the urban forest's value to the community and commitment to dialogue and cooperation among the stakeholders.

Table 2. Criteria of urban forest sustainability for the Community Framework (continued)

General awareness of trees as a community resource	The general public understands the value of trees to the community.	Fundamental to the sustainability of a city's urban forest is the general public's understanding of the value of its trees. People who value trees elect officials who value trees. In turn, officials who value trees are more likely to require the agencies they oversee to maintain high standards for management and provide adequate funds for implementation.
Regional cooperation	Provide for cooperation and interaction among neighboring communities and regional groups.	Urban forests do not recognize geographic boundaries. Linking city's efforts to those of neighboring communities allows for consideration and action on larger geographic and ecological issues (such as water quality and air quality).

and social well-being.

There are costs associated with the accrual of these benefits. Dead, dying and defective trees may fail and injure citizens or damage property. Some species may pose a health risk from allergenic responses. Others may compete with native vegetation and limit the function of naturally occurring fragments and systems.

2. Community framework. A sustainable urban forest is one in which the all parts of the community share a vision for their forest and act to realize that vision through specific goals and objectives (Table 2). It is based in neighborhoods, public spaces and private lands.

At one level, this requires that a community agree on the benefits of trees and act to maximize them. On another level, this cooperation requires that private landowners acknowledge the key role of their trees to community health. Finally, in an era of reduced government service, cooperation means sharing the financial burden of caring for the urban landscape.

3. Resource management. In many ways, this component is not simply management of the resource but the philosophy of management as well (Table 3). On one hand, specific policy vehicles to protect existing trees, manage species selection, train staff and apply standards of care focus on the tree resource itself. In contrast, acceptance of a comprehensive management plan and funding program by city government and its constituents allows shared vision to develop.

Cities must recognize that management approaches will vary as a function of the resource and its extent. A goal of maintaining native wildlife habitat may best be achieved where there is a strong native forest resource. For some cities, this is simply not attainable. Similarly, management of the urban forest must exist in connection to the larger landscape (such as adjacent forests). For example, maintenance of intact riparian corridors requires the cooperation of the managing agency of the stream.

Achieving Sustainable Urban Forests. A sustainable urban forest is founded upon community cooperation, quality care, continued funding and personal involvement. It is created and maintained through shared vision and cooperation with an ever-present focus on maximizing benefits and minimizing costs. Taken together, they acknowledge the need for shared vision and responsibility, for direct intervention with the resource and for programs of care that are on-going and responsive. The implementation of

Table 3. Criteria of urban forest sustainability for Resource Management.

City-wide management plan	Develop and implement a management plan for trees on public and private property.	A city-wide management plan will add to an urban forest's sustainability by addressing important issues and creating a shared vision for the future of the community's urban forest. Elements may include: species and planting guidelines; performance goals and standards for tree care, requirements for new development (tree preservation and planning); and specifications for managing natural and open space areas.
Funding	Develop and maintain adequate funding to implement a city-wide management plan.	Since urban forests exist on both public and private land, funding must be both public and private. The amount of funding available from both sources is often a reflection of the level of education and awareness within a community for the value of its urban forest.
Staffing	Employ and train adequate staff to implement a city-wide management plan.	An urban forest's sustainability is increased when all city tree staff, utility and commercial tree workers and arborists are adequately trained. Continuing education in addition to initial minimum skills and/or certifications desirable.
Assessment tools	Develop methods to collect information about the urban forest on a routine basis.	Using canopy cover assessment, tree inventories, aerial mapping, geographic information systems and other tools, it is possible to monitor trends in a city's urban forest resource over time.
Protection of existing trees	Conserve existing resources, planted and natural, to ensure maximum function.	Protection of existing trees and replacement of those that are removed is most often accomplished through policy vehicles. Ordinances that specify pruning standards and/or place restrictions on the removal of large or other types of trees on public and private property and during development are examples.
Species and site selection	Provide guidelines and specifications for species use, on a context-defined basis.	Providing good planting sites and appropriate trees to fill them is crucial to sustainability. Allowing adequate space for trees to grow and selecting trees that are compatible with the site will reduce the long- and short-term maintenance requirements and enhance their longevity. Avoiding species known to cause allergenic responses is also important in some areas.

Table 3. Criteria of urban forest sustainability for Resource Management (continued)

Standards for tree care	Adopt and adhere to professional standards for tree care.	Sustainability will be enhanced by adhering to the professional standards such as the Tree Pruning Guidelines (ISA) and ANSI Z133 publications.
Citizen safety	Maximize public safety with respect to trees.	In designing parks and other public spaces, public safety should be a key factor in placement, selection, and management of trees. Regular inspections for potential tree hazards is an important element in the management program.
Recycling	Create a closed system for tree waste.	A sustainable urban forest is one that recycles its products by composting, reusing chips as mulch and/or fuel and using wood products as firewood and lumber.

Table 4. Criteria and performance indicators for the Vegetation Resource.

Criteria	Performance indicators				Key Objective
	Low	Moderate	Good	Optimal	
Canopy cover	No assessment	Visual assessment (i.e. photographic)	Sampling of tree cover using aerial photographs.	Information on urban forests included in city-wide geographic information system (GIS).	Achieve climate-appropriate degree of tree cover, community-wide.
Age - distribution of trees in community	No assessment	Street tree inventory (complete or sample)	Public - private sampling	Included in city-wide geographic information system (GIS).	Provide for uneven age distribution.
Species mix	No assessment	Street tree inventory	City-wide assessment of species mix	Included in city-wide geographic information system (GIS)	Provide for species diversity.
Native vegetation	No program of integration	Voluntary use on public projects	Requirements for use of native species on a project-appropriate basis	Preservation of regional biodiversity	Preserve and manage regional biodiversity. Maintain the biological integrity of native remant forests. Maintain wildlife corridors to and from the city.

Table 5. Criteria and performance indicators for the Community Framework.

Criteria	Performance indicators				Key Objective
	Low	Moderate	Good	Optimal	
Public agency cooperation	Conflicting goals among departments	No cooperation	Informal working teams	Formal working teams w/ staff coordination	Insure all city departments operate with common goals and objectives.
Involvement of large private and institutional land holders	Ignorance of issue	Education materials and advice available to land holders	Clear goals for tree resource by private land-holders; incentives for preservation of private trees	Land-holders develop comprehensive tree management plans (including funding)	Large private landholders embrace city-wide goals and objectives through specific resource management plans.
Green industry cooperation	No cooperation among segments of industry (nursery, contractor, arborist). No adherence to industry standards.	General cooperation among nurseries - contractors - arborists, etc.	Specific cooperative arrangements such as purchase certificates for right tree, right place	Shared vision and goals including the use of professional standards.	The green industry operates with high professional standards and commits to city-wide goals and objectives.
Neighborhood action	No action	Isolated and/or limited no. of active groups	City-wide coverage and interaction	All neighborhoods organized and cooperating	At the neighborhood level, citizens understand and participate in urban forest management.
Citizen - government - business interaction	Conflicting goals among constituencies	No interaction among constituencies	Informal and /or general cooperation	Formal interaction, e.g., tree board w/ staff coordination	All constituencies in the community interact for the benefit of the urban forest.
General awareness of trees as community resource	Low -- trees as problems; a drain on budgets	Moderate -- trees as important to community	High -- trees acknowledged to provide environmental services	Very high -- trees as vital components of economy and environment	The general public understands the value of trees to the community.
Regional cooperation	Communities operate independently	Communities share similar policy vehicles	Regional planning	Regional planning coordination and/or management plans	Provide for cooperation and interaction among neighboring communities and regional groups.

a model for urban forest sustainability would further redirect the traditional orientation of urban forest management away from municipal trees to the mix of public and private trees.

Achieving sustainability for urban forests involves meeting each of these criteria. To assist in this task, we have described indicators of success for each criteria (Tables 4, 5, and 6). A city that meets the highest level of each indicator for each criteria would have the best tools and resources to achieve sustainability.

Our approach of developing criteria and

Table 6. Criteria and performance indicators for Resource Management.

Criteria	Performance indicators				Key Objective
	Low	Moderate	Good	Optimal	
City-wide management plan	No plan	Existing plan limited in scope and implementation	Government -wide plan, accepted and implemented	Citizen - government - business resource management plan, accepted and implemented	Develop and implement a management plan for trees and forests on public and private property.
City-wide funding	Funding by crisis management	Funding to optimize existing population	Adequate funding to provide for net increase in population and care	Adequate funding, private and public, to sustain maximum potential benefits	Develop and maintain adequate funding to implement a city-wide management plan.
City staffing	No staff	No training	Certified arborists on staff	Professional tree care staff	Employ and train adequate staff to implement city-wide management plan.
Assessment tools	No on-going program of assessment	Partial inventory	Complete inventory	Information on urban forests included in city-wide GIS	Develop methods to collect information about the urban forest on a routine basis.

indicators is patterned after that found in the Santiago Agreement (11) which suggested criteria and indicators for the conservation and sustainability of temperate and boreal forests. It recognized that both quantitative and qualitative (descriptive) indicators were needed, for not all criteria could be accurately measured.

Conclusions

Maser suggested that ecological sustainability encompasses 4 ideals:

1. Providing a long-term balance between society and the resource, today and in the future.
2. Seeking to increase the overlap between societal desires and ecological possibilities.
3. Developing assessment tools for both the resource and its outputs (benefits, services).
4. Restoring ecosystems.

Our model for urban forest sustainability adheres to these 4 ideals, placing them in an urban context. It recognizes the nature of society in cities and encourages participation at the broadest level. The model also acknowledges the need to foster regeneration, to provide for the continuity of the resource. Management of a sustainable urban forest is based upon a shared vision for the resource, in which goals and needs are balanced. Since sustainability is a general goal, we must be able to assess our progress relative to defined standards. Finally, we recognize that our actions, through such activities as development, will damage forests and their function. We accept the responsibility of restoration.

Urban trees and forests are considered integral to the sustainability of cities as a whole (3, 8). Yet, sustainable urban forests are not born, they are made. They do not arise at random, but result from a community-wide commitment to their creation and management.

Obtaining the commitment of a broad community, of numerous constituencies, cannot be dictated or legislated. It must arise out of compromise and respect. While policy vehicles such as ordinances play a role in managing the

Table 6. Criteria and performance indicators for Resource Management (continued)

Protection of existing trees	No policy vehicle or policy not enforced	Tree preservation ordinance present and enforced	Tree preservation plan required for all projects....public, private, commercial, residential	Integrated planning program for conservation and development	Conserve existing resources, planted and natural, to ensure maximum function.
Species and site selection	Arbitrary species prohibitions	No consideration of undesirable species	Identification/prohibition of undesirable species	On going use of adapted, high-performing species with good site - species match	Provide guidelines and specifications for species use, including a mechanism for evaluating the site.
Standards for tree care	None	Standards for public tree care	Standards for pruning, stock, etc. for all trees	Standards part of community - wide vision	Adopt and adhere to professional standards for tree care.
Citizen safety	Crisis management	Informal inspections	Comprehensive hazard (failure, tripping, etc.) program	Safety part of cost - benefit program	Maximize public safety with respect to trees.
Recycling	Simple disposal (i.e. land filling) of green waste	Green waste recycling	Green and wood waste recycling - reuse	Closed system -- no outside disposal	Create a closed system for tree waste.

urban forest, developing commitment is probably more a function of education, awareness and positive incentives. This may represent our most significant challenge: to provide information that creates commitment and guides action.

This is not to ignore the budgetary requirements for sustainable urban forests. It has long been our belief that if education were adequate, funding would soon follow. Despite the current state of funding, we must hold to this perspective.

Finally, sustainable urban forests also require a viable resource base. While urban foresters and arborists have long felt confident in their ability to sustain the resource, we must acknowledge our limitations as well as our strengths. The optimal structure of urban forests, i.e. the arrangement of trees in a city, remains the subject of research. Our industry must strive to resolve conflicts such as quality of nursery stock, appropriate cultural practices and the match between site considerations and species selection.

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Zussammenfassung. Das Modell des sich selbsterhaltenden Stadtwaldes wendet allgemeine Prinzipien der Selbsterhaltung auf städtische Bäume und Wälder an. Sich selbst erhaltende Stadtwälder erfordern eine gesunde Herkunft der Pflanzen, kommunale Unterstützung und ein umfassendes Management. Die Kriterien und Indikatoren, um diesen Status zu überprüfen werden hier vorgestellt. Das deutlichste Resultat eines sich selbst erhaltenden Stadtwaldes besteht darin, einen maximalen Grad an umweltbezogenen, ökologischen, sozialen und ökonomischen Vorzügen zu erreichen.

APPENDIX D

APPENDIX D: CRITERIA AND PERFORMANCE INDICATORS FOR SUSTAINABLE URBAN FORESTRY (ADAPTED FROM CLARK ET AL. (1997)

Criteria and performance indicators for sustainable urban forestry (Adapted from Clark *et al.* (1997)					
Vegetation Resource					
Criteria	**Performance indicators**				**Key Objectives**
	low	**moderate**	**Good**	**Optimal**	
Canopy Cover	The existing canopy cover equals 0-25% of the potential.	The existing canopy cover equals 25-50% of the potential.	The existing canopy cover equals 50-75% of the potential.	The existing canopy cover equals 75-100% of the potential.	Achieve climate-appropriate degree of tree cover, community-wide
Age distribution of trees in community	Any Relative DBH (RDBH) class (0-25% RDBH, 26-50% RDBH, etc.) represents more than 75% of the tree population.	Any RDBH class represents between 50% and 75% of the tree population	No RDBH class represents more than 50% of the tree population	25% of the tree population is in each of four RDBH classes.	Provide for uneven-aged distribution city-wide as well as at the neighbourhood and/or street segment level.
Species suitability	Less than 50% of trees are of species considered suitable for the area.	50% to 75% of trees are of species considered suitable for the area.	More than 75% of trees are of species considered suitable for the area.	All trees are of species considered suitable for the area.	Establish a tree population suitable for the urban environment and adapted to the regional environment.
Species distribution	Fewer than 5 species dominate the entire tree population city-wide.	No species represents more than 10% of the entire tree population city-wide.	No species represents more than 5% of the entire tree population city-wide.	No species represents more than 5% of the entire tree population city-wide or at the neighbourhood/street segment level.	Establish a genetically diverse tree population city-wide as well as at the neighbourhood and/or street segment level.
Publicly-owned Tree Condition[1] (Trees managed intensively)	No tree maintenance or risk assessment. Request based/reactive system. The condition	Sample-based inventory indicating tree condition and risk level is in place.	Complete tree inventory which includes detailed tree condition ratings.	Complete tree inventory which includes detailed tree condition and risk	Detailed understanding of the condition and risk potential of all publicly- owned trees

[1] Assumed that the municipality has little control of the condition of trees on private land except though property standards by-law.

	of the urban forest is unknown			ratings.	
Publicly-owned natural areas (trees managed extensively, e.g. woodlands, ravine lands, etc.)	No information about publically-owned natural areas.	Publicly-owned natural areas identified in a "natural areas survey" or similar document.	The level and type of public use in publicly-owned natural areas is documented	The ecological structure and function of all publicly-owned natural areas are documented and included in the city-wide GIS	Detailed understanding of the ecological structure and function of all publically-owned natural areas.
Native vegetation	No programme of integration	Voluntary use of native species on publicly and privately- owned lands.	The use of native species is *encouraged* on a project-appropriate basis in both intensively and extensively managed areas.	The use of native species is *required* on a project-appropriate basis in both intensively and extensively managed areas.	Preservation and enhancement of local natural biodiversity

Community Framework					
Public agency cooperation	Conflicting goals among departments and or agencies.	Common goals but no cooperation among departments and/or agencies.	Informal teams among departments and or agencies are functioning and implementing common goals on a project-specific basis.	Municipal policy implemented by formal interdepartmental/ interagency working teams on ALL municipal projects.	Insure all city department cooperate with common gaols and objectives
Involvement of large private and institutional land holders	Ignorance of issues	Educational materials and advice available to landholders.	Clear goals for tree resource by landholders. Incentives for preservation of	Landholders develop comprehensive tree management plans (including funding).	Large private landholders embrace city-wide goals and objectives through

			private trees.		specific resource management plans.
Green industry cooperation	No cooperation among segments of the green industry (nurseries, tree care companies, etc.) No adherence to industry standards.	General cooperation among nurseries, tree care companies, etc.	Specific cooperative arrangements such as purchase certificates for “right tree in the right place”	Shared vision and goals including the use fo professional standards.	The green industry operates with high professional standards and commits to city-wide goals and objectives.
Neighbourhood action	No action	Isolated or limited number of active groups.	City-wide coverage and interaction.	All neighbourhoods organized and cooperating.	At the neighbourhood level, citizens understand and cooperate in urban forest management.
Citizen-municipality-business interaction	Conflicting goals among constituencies	No interaction among constituencies.	Informal and/or general cooperation.	Formal interaction e.g. Tree board with staff coordination.	All constituencies in the community interact for the benefit of the urban forest.
General awareness of trees as a community resource	Trees seen as a problem, a drain on budgets.	Trees seen as important to the community.	Trees acknowledged to provide environmental, social and economic services.	Urban forest recognized as vital to the communities environmental, social and economic well-being.	The general public understanding the role of the urban forest.
Regional cooperation	Communities cooperate independently.	Communities share similar policy vehicles.	Regional planning is in effect	Regional planning, coordination and /or management plans	Provide for cooperation and interaction among neighbouring communities and regional groups.

Management Approach					
Tree Inventory	No inventory	Complete or sample-based inventory of publicly-owned trees	Complete inventory of publicly-owned trees AND sample-based inventory of privately-owned trees.	Complete inventory of publicly-owned trees AND sample-based inventory of privately-owned trees included in city-wide GIS	Complete inventory of the tree resource to direct its management. This includes: age distribution, species mix, tree condition,

					risk assessment.
Canopy Cover Inventory	No inventory	Visual assessment	Sampling of tree cover using aerial photographs or satellite imagery.	Sampling of tree cover using aerial photographs or satellite imagery included in city-wide GIS	High resolution assessment of the existing and potential copy cover for the entire community.
City-wide management plan	No plan	Existing plan limited in scope and implementation	Comprehensive plan for publically-owned trees accepted and implemented	Comprehensive plan for ALL components of the urban forest (private and public assets) accepted and implemented.	Develop and implement an urban forest management plan for private and public property.
Municipality-wide funding	Funding by crisis management	Funding to optimize existing urban forest.	Funding to provide for net increase in urban forest benefits.	Adequate private and public funding to sustain maximum urban forest benefits.	Develop and maintain adequate funding to implement a city-wide urban forest management plan
City staffing	No staff.	No training of existing staff.	Certified arborists and professional foresters on staff with regular professional development.	Multi-disciplinary team within the urban forestry unit.	Employ and train adequate staff to implement city-wide urban forestry plan
Tree establishment planning and implementation	Tree establishment is *ad hoc*	Tree establishment occurs on an annual basis	Tree establishment is directed by needs derived from a tree inventory	Tree establishment is directed by needs derived from a tree inventory and is sufficient to meet canopy cover objectives	Urban Forest renewal is ensured through a comprehensive tree establishment programme driven by canopy cover, species diversity, and species distribution objectives
Pruning of publicly-owned, intensively managed trees	No pruning of publicly-owned trees	Publicly-owned trees are pruned on a request/reactive basis. No systematic (block) pruning.	All publicly-owned trees are systematically pruned on a cycle longer than five-years.	All mature publicly-owned trees are pruned on a five-year cycle. All immature trees are structurally pruned.	All publically-owned trees are pruned to maximize current and future benefits. Tree health and condition ensure maximum longevity.

Hazard tree management	No tree risk assessment/ remediation programme. Request based/reactive system. The condition of the urban forest is unknown	Sample-based tree inventory which includes general tree risk information; Request based/reactive risk abatement programme system.	Complete tree inventory which includes detailed tree failure risk ratings; risk abatement programme is in effect eliminating hazards within a maximum of one month from confirmation of hazard potential.	Complete tree inventory which includes detailed tree failure risk ratings; risk abatement programme is in effect eliminating hazards within a maximum of one week from confirmation of hazard potential.	All publicly owned trees are safe.
Tree Protection Policy Development and Enforcement	No tree protection policy	Policies in place to protect public trees.	Policies in place to protect public and private trees with enforcement.	Integrated municipal wide policies that ensure the protection of trees on public and private land are consistently enforced and supported by significant deterrents	The benefits derived from large-stature trees are ensured by the enforcement of municipal wide policies.
Publicly-owned natural areas management planning and implementation	No stewardship plans or implementation in effect.	Reactionary stewardship in effect to facilitate public use (e.g. hazard abatement, trail maintenance, etc.)	Stewardship plan in effect for each publically-owned natural area to facilitate public use (e.g. hazard abatement, trail maintenance, etc.)	Stewardship plan in effect for each publically-owned natural area focused on sustaining the ecological structure and function of the feature.	The ecological structure and function of all publically-owned natural areas are protected and, where appropriate, enhanced.

APPENDIX E

APPENDIX E: REGIONAL AND PROVINCIAL POLICY CONTEXT

This is a summary of regional and provincial policies that affect the urban forest.

Regional Policies

Region of Halton Official Plan

The Region of Halton consolidated its Official Plan in 2006. The Regional Official Plan is the senior planning document and establishes long-term vision, sets goals and objectives, and outlines policy. Growth and development within Halton must conform to the Official Plan. Several parts of the Halton Official Plan relate to forestry in general. In establishing Halton's Planning Vision, the Plan supports sustainable development and defines this term:

> 25. Sustainable development… 'meets the need of the present without compromising the ability of future generations to meet their own need.'

The Vision Statement goes on to establish the protection of the natural environment as one of three factors on which planning decisions will be based.

The Official Plan categorizes the designation of land into three functional systems: The Urban System, the Rural System, and the Greenlands System.

> 114. The goal of the Greenlands system is to maintain as a permanent land form an interconnected system of natural areas and open space that will preserve areas of significant ecological value while providing, where appropriate, some opportunities for recreation.

There are 2 categories of Greenlands that are directly applicable to Oakville and relate to forestry – Greenlands A and Greenlands B. Both of these designations seek to preserve natural areas – both landforms and vegetation. These are strong policies that support the preservation, protection and enhancement of forested areas in Oakville.

Significant woodlands are identified in the Greenlands B designation. It is useful to note how 'significant' woodlands are defined in the Regional Official Plan:

> 277. Significant Woodland means a Woodland 0.5 ha or larger determined through a Watershed Management Plan, a Subwatershed Study, or a site-specific Environmental Impact Assessment to meet one or more of the four following criteria:
> 1) the Woodland contains forest patches over 99 years old,
> 2) the patch size of the Woodland is 2 ha or larger if it located in the Urban Area, or 4 ha or larger if it is located outside the Urban Area but below the Escarpment Brow, or 10 ha or larger if it located outside the Urban Area but above the Escarpment Brow,
> 3) the Woodland has an interior core area of 4 ha or larger, measured 100m from the edge, or
> 4) the Woodland is wholly or partially within 50m of a major creek or certain headwater creek or within 150m of the Escarpment Brow.

The Halton Official Plan recognizes that trees play an important role in improving the quality of air and reducing energy use.

> 142. The objectives of the Region are: …

7) To promote tree planting in both rural and urban areas for the purposes of improving air quality and reducing energy use through shading and sheltering.

There are a number of policies that are directly related to preserving and enhancing tree cover in Halton Region.

146. The objectives of the Region are:
- 6) To protect significant tree-covered areas as a natural resource…
- 8) To promote a linked system of woodlands in Halton where appropriate.
- 9) To maintain a system of Regionally owned forests.

147. It is the policy of the Region to:
- 4) Recognize, encourage and protect forestry both as an essential conservation land use and as a potentially significant resource industry.
- 5) Recognize and protect trees as renewable natural resources essential to the health and welfare of Halton residents, wildlife and rural environment, and to this end:

  Enact, in cooperation with the Local Municipalities, a tree protection bylaw, including the requirement of a permit to regulate the removal of trees within the Greenlands System and in Woodlands 0.5 ha or larger outside the Greenlands system.

  Encourage the Local Municipalities to enact their own tree conservation bylaws to regulate tree removal within the Urban Areas;

  Monitor, in conjunction with the local Municipalities and appropriate agencies, the amount and quality of tree cover in Halton on a regular basis and report the results as part of the State of the Environment Report.

  Promote the preparation by private landowners of Forestry Management Plans for established woodlands.

- 6) Promote the planting of new trees, and to this end:
  - c) Promote the development of treescapes along streams and valleys so as to reduce flooding and excessive soil erosion and to provide suitable fish habitat.
  - e) Promote reforestation programs on lower classes of Agricultural Soil.

- 7) Discourage recreational activities within woodlands where such activities will adversely affect forest health.

- 11) Encourage the Provincial government to maintain property tax incentives affecting tree-covered lands to promote stewardship of woodlands.

In addition, there are policies about trees that relate directly to development proposals, public works and road construction in urban environments.

147. 5)
- e) Require that all development proposals, to the maximum degree possible, preserve existing trees and plants in addition to trees in accordance with good forestry management practice.

f) Require all development proposals to submit, at the time of initial application, an inventory of trees on site and, at subsequent stages of the application, a tree saving and planting plan.

147.(6)

b) Retain treescapes along major transportation corridors, replace trees cut down for public works and, wherever possible, develop new treescapes consistent with safe and aesthetically pleasing road or corridor design.

Provincial policies

The Provincial Policy Statement: 2005

The Provincial Policy Statement (PPS) issued under Section 3 of the *Planning Act* came into effect on March 1, 2005. The PPS provides policy direction on matters of provincial interest related to land use planning and development.

There are parts of the Provincial Policy Statement that relate to the urban forest.
Section 1.5 of the PPS entitled "Public Spaces, Parks and Open Space" contains the following policies:

1.5.1 Healthy, active communities should be promoted by:

b) providing for a full range and equitable distribution of publicly-accessible built and natural settings for recreation, including facilities, parkland, open space areas, and, where practical, water-based resources;

d) considering the impacts of planning decisions on provincial parks, conservation reserves and conservation areas.

The PPS supports the promotion of a diverse and healthy urban forest across the Oakville area in parks, open space areas and conservation areas.

Section 2 of the PPS entitled "Wise Use and Management of Resources" outlines policy relating to Natural Heritage. Under this section there are a number of policies that are directed to maintaining or improving the ecological function, natural heritage systems and preserving significant woodlands.

2.1.2 The diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features.

2.1.4 Development and site alteration shall not be permitted in:

b) significant woodlands south and east of the Canadian Shield
significant valleylands south and east of the Canadian Shield
significant wildlife habitat; and
significant areas of natural and scientific interest unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions.

These policies recognize the value of forests to our overall prosperity, environmental health, and social well-being.

Growth Plan for the Greater Golden Horseshoe

The Province of Ontario's Growth Plan for the Greater Golden Horseshoe (GGH) took effect on June 16, 2006. This plan was prepared and approved under the *Places to Grow Act*. The purpose of this plan is to build on other provincial initiatives, including the Greenbelt Plan and the Provincial Policy Statement, to guide decisions on transportation, infrastructure, planning, land use planning, urban form, and housing.

The Introduction to the Growth Plan outlines the Vision for the Greater Golden Horseshoe. It states that "open spaces in our cities, towns and countryside will provide people with a sense of place."

The GGH establishes a number of guiding principles. One of these principles addresses natural areas: "Protect, conserve, enhance and wisely use the valuable natural resources of land, air and water for current and future generations."

Part 4 of the Growth Plan deals with the topic, "Protecting what is Valuable." Section 4.2.1 deals with "Natural Systems" and the following policies are relevant to forests:

1. Through sub-area assessment, the Minister of Public Infrastructure Renewal and other Ministers of the Crown, in consultation with municipalities and other stakeholders will identify natural systems for the GGH, and where appropriate develop additional policies for their protection.
2. For lands within the Greenbelt Area, all policies regarding natural systems set out in provincial plans, applicable to lands within the Greenbelt Area, continue to apply.
3. Planning authorities are encouraged to identify natural heritage features and areas that complement, link, or enhance natural systems.
4. Municipalities, conservation authorities, non-governmental organizations, and other interested parties are encouraged to develop a system of publicly accessible parkland, open space and trails, including shoreline areas, within the GGH that
    a) clearly demarcates where public access is and is not permitted
    b) is based on a coordinated approach to trail planning and development
    c) is based on good land stewardship practices for public and private lands.
5. Municipalities are encouraged to establish an urban open space system within built-up areas, which may include rooftop gardens, communal courtyards, and public parks.

The focus of these policies is supportive of forests in all environments that are applicable to Oakville – urban, suburban and rural.

Provincial Legislation

The regulation of trees on private property in Ontario started with the *Trees Act*, which enabled municipalities to pass by-laws to restrict and regulate the cutting of trees. This Act addressed the protection of woodlots on private property and only applied to upper tier municipalities (regional municipalities and counties) Since that time, numerous by-laws to restrict tree cutting have been implemented. In 1990 the *Forestry Act* (1990) replaced the *Trees Act*.

The *Municipal Act* gives powers to towns and cities to enact tree protection measures. Any community with a population of 10,000 or greater has the right to pass woodlot or tree protection by-laws. The Act provides lower-tier municipalities with an opportunity to implement permit processes, fines for infractions, and access to an appeal process. Over the past five years, several

communities have passed tree preservation by-laws that protect larger trees (defined as greater than 30 cm diameter at breast height, or DBH). One community, Mississauga, monitors the cutting of trees with 15 cm DBH or larger.

Federal Authority

In certain limited circumstances, federal authority can affect municipal forest management. For example, the Canadian Food Inspection Agency has the power to order a municipality to cut trees in order to respond to pests such as the Emerald Ash Borer.

APPENDIX F

APPENDIX F: SUMMARY OF PRIVATE TREE BY-LAWS IN SOUTHERN ONTARIO MUNICIPALITIES

Regulation of trees on private land in Ontario is not new. The first *Trees Conservation Act* was implemented in 1946 and allowed larger (i.e., upper tier) municipalities to pass by-laws regulating the cutting of trees in woodlands. Since that time there has been the *Trees Act* (1950) which was amended by the *Forestry Act* (1998) which were both essentially updates to the first act. The first piece of legislation allowing lower-tier municipalities (with populations greater than 10,000) to enact tree by-laws was the former *Municipal Act* (1990). This act was updated in 2001, came into effect in 2003, and is currently the principal piece of legislation that governs private tree by-laws in Ontario.

The *Municipal Act* (2001) allows municipalities of any size to enact tree by-laws, provides more effective tools for protecting trees, and enables harmonization with area municipalities. Key elements to this new legislation are found in the Natural Environment sections (Ch. 25, Sections 135 to 147) of the act, and include: by-law administration through a permitting process, the ability to hand out stop work orders in cases of infractions, appeal procedures, higher ceilings on fines, and different fines for individuals versus corporations. Specific clauses in this section of the act give a lower tier municipality the authority to, through a private tree by-law:

- require permits and impose conditions to a permit;
- share powers with an upper-tier municipality;
- order discontinuation of activity;
- set fines for convictions of up to $10,000 for persons and $50,000 for corporations for a first time offense, and up to $25,000 for persons and $100,000 for corporations for a subsequent offense; and
- order an offender to replant trees in addition to the above fines.

There are a number of exemptions which must be included in any private tree by law and have been included in the by-law developed for Markham. These include tree cutting activities undertaken by the Town as well as tree cutting undertaken for approved surveying activities, or as part of the development or expansion of an approved pit or quarry. It is also important to recognize that a private tree by-law only applies to development sites when the *Planning Act* is not applicable (i.e., prior to site plan approval and after the construction is completed).

Under the *Municipal Act* (2001), a property owner also has the right to appeal to the Ontario Municipal Board if their permit application is rejected by the Town and they do not accept the terms of that rejection.

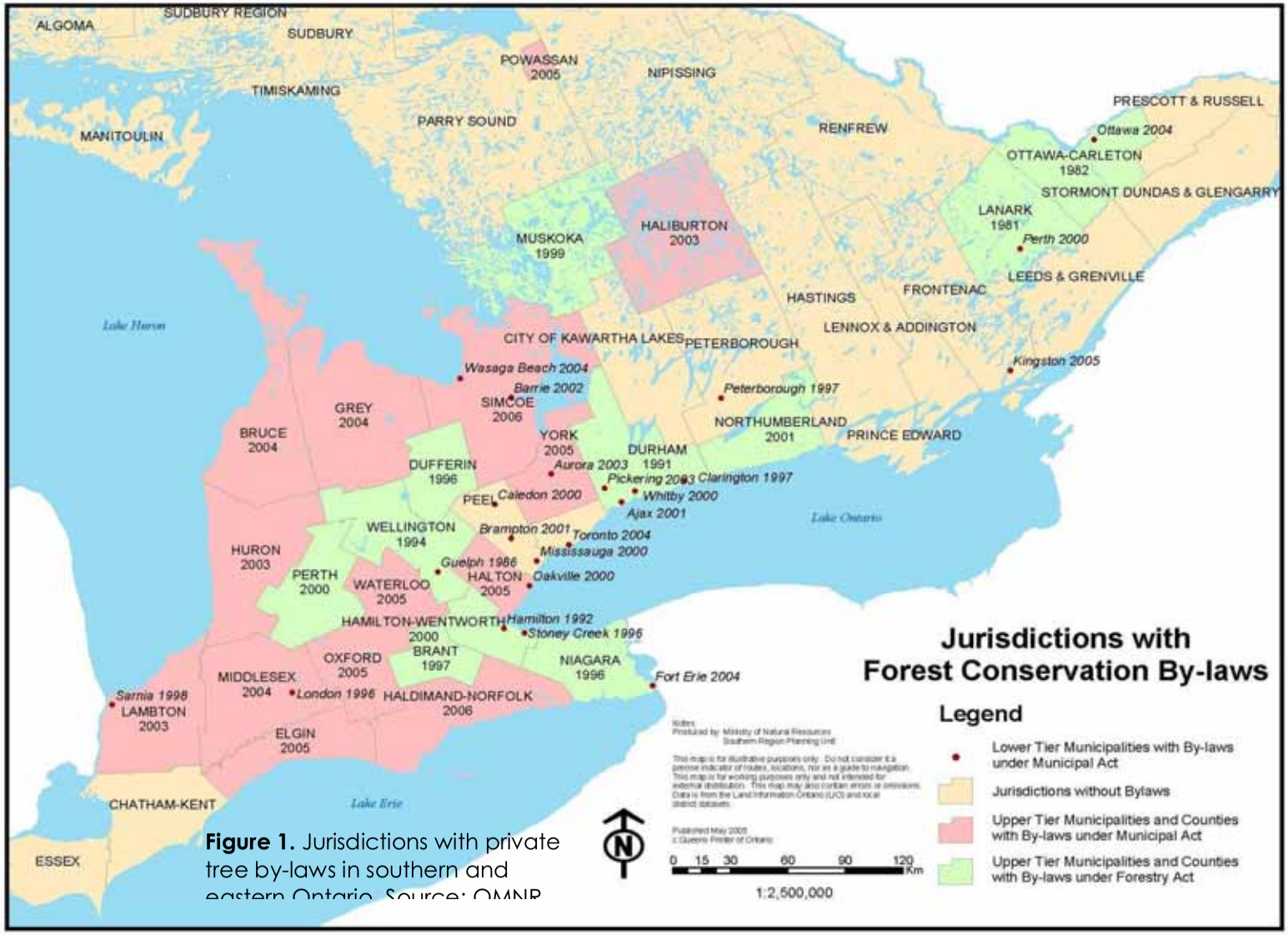


Figure 1. Jurisdictions with private tree by-laws in southern and eastern Ontario. Source: OMNR

Table 1. Summary of scope and permit fees for private tree by-laws in southern Ontario municipalities.

Municipality (Tier) Year of Enactment	Scope of By-law	Permit Fees
City of Stoney Creek (now part of Hamilton) 1996	woodlands (+0.5 ha) on NEC lands	1 tree $0, 2-10 trees $25, 11-20 trees $50, +20 trees $100
Town of Clarington (Lower Tier) 1997	woodlands (+0.2ha) + environmentally sensitive areas (EPAs & in PSW buffer)	$25 <2ha woodlot; $50 in >2ha woodlot; $75 in EPAs & PSWs
Town of Ajax (Lower Tier) 1998; updated 2001	all trees in identified areas	1-5 trees $0; +5 trees $250
Town of Ancaster (now part of Hamilton) 2000	Heritage Trees (+45 cm DBH), woodlands (+0.2 ha) & designated Tree Preservation Areas in Urban Areas + CA lands	No charge
Town of Oakville (Lower Tier) 2000; revised 2002	woodlands (+0.2 ha)	$300
City of Mississauga (Lower Tier) 2001	all trees +20cm DBH, except for 1st four cut per property per year	Only for healthy trees, $200 - $400 (depending on # trees)
City of Brampton (Lower Tier) 2001	woodlands (+0.2 ha)	$100
City of Barrie (Lower Tier) 2002	woodlands (+0.2 ha)	$750
Town of Pickering (Lower Tier) 2003	all trees in identified Tree Preservation Areas +25 mm DBH	$100
Town of Fort Erie (Lower Tier) 2004	woodlands (+0.5 ha) & all Community Significant Trees	1 to 10 trees - $0; 10 to 20 trees - $25; 20-30 trees $50; +30 trees - $100
Town of Wasaga Beach (Lower Tier) 2004	woodlands (+1 ha); all trees in Natural Heritage System; all trees on parcels of at least 1 ha	$50
City of Kingston (Lower Tier) 2005	all trees +15 cm DBH outside of residential lots	1 tree - $50; 2 to 10 trees - $100; 11-20 trees $150; +20 trees -

		$200
City of Hamilton (Single Tier) 1992	woodland	yes $100 for 20 or more trees
City of Toronto (Single Tier) 1995; updated 2004	all trees +30 cm DBH & all trees in specified areas	$100 per tree up to $300; $200 per tree for development-related
Town of Caledon (Single Tier) 2000	woodlands (+0.5 ha)	$50

APPENDIX G

APPENDIX G: LEAF AREA DISCUSSION BETWEEN W. A. KENNEY AND JOHN MCNEIL

From: Andy Kenney
Sent: Saturday, April 08, 2006 7:08 AM
To: John McNeil
Subject: By-law thoughts

John:

Further to our discussion earlier yesterday about innovative tree protection by laws, I thought it might be helpful if I tried to summarize some of the discussion.

I think it is safe to assume that the main driver for an urban tree protection by-law is the desire to sustain the supply of ecological, social and economic benefits derived from the forest to the people of Oakville and the broader environment. I hesitate to suggest that the by-law should also enhance the supply of these services, as it seems to me that this should not be the role of this by-law but rather for the broader objectives of the Town and its inhabitant. However, the by-law should also adopt the principle of **no net loss** of benefits to the residents of Oakville. To the best of my knowledge, most current by-laws attempt to discourage the loss of trees by imposing fines or other penalties for convictions. It is questionable if these punitive by-laws serve as much of a deterrent in the case of construction projects involving millions of dollars. Fines are likely often considered just the cost of doing business to be passed on to taxpayers or consumers, and it is unlikely that we will see the implementation of jail sentences, as permitted under the municipal act, any time soon. When all is said and done, if fines are being considered, the trees are usually already gone and, depending on the age (size) of the tree, the equity associated with the growth in leaf area has already been lost. Here I refer to the now well-documented association between numerous ecological, social and economic benefits that are directly related to the leaf area of the urban forest (the aggregate of all the individual trees in the forest - the "drops in the bucket" that DO make up the forest). This premise is, of course, the basis of the estimation of benefits derived by the UFORE model currently being applied in Oakville. Please see my paper from 2000 in the Forestry Chronicle relating to potential leaf area density for further discussion.

You had expressed your opinion that a tree protection by-law should relate to canopy cover and you asked if I was aware of any existing by-laws that do this. I do not know of any. However, as I expressed in our conversation, I suggest that an innovative by-law with the "no net loss" principle in mind needn't necessarily be much different from some by-laws currently in effect in Ontario, at least "up front". In my opinion, it is the penalty component of the by-law that should be revisited. Rather than fining someone some arbitrary amount determined by the courts or the CLTA assessment (neither of which are likely to relate to the benefits), I feel the penalty should be directly related to sustaining the benefits derived by the tree or trees in question. While the science behind the determination of these benefits is maturing, it can still be an unwieldy estimate. It is also important to keeping mind that some of these benefits (for example, air pollutant removal) are dependent on temporal factors such as pollutant loading at a particular time. Since we know that most of these benefits vary directly with leaf area, then why not

strive to maintain no net loss of leaf area? Under such a scenario, someone found guilty of an offence (injury or killing a tree) would be required to pay restitution to the community for the leaf area involved (and indirectly the loss of benefits). In practice, they could be directed to establish enough trees of suitable size (say 60-90 mm caliper) to provide the equivalent leaf area of the trees lost. These trees could be required in the same general area or in some site deemed suitable by Forestry Services as indicated by the Strategic Urban Forest Management Plan. These could be planted by the individual found guilty or they could provide the Town with sufficient funds to establish the required trees and to maintain them to a point at which they are likely able to survive. I would suggest this would be for a period of 5 years at least, depending on the site but I am sure this could be debated at length.

It is critically important to keep in mind that such a penalty would only be considered in cases in which the original tree(s) could not be saved. If it was suggested that all someone had to do is pay the cost of replacing the leaf area, then I am afraid the protection of large well-established trees would be seriously compromised. So, initially every effort should be made to avoid losing existing trees.

Someone could argue that it is unfair for the guilty party to have to plant enough trees to maintain the leaf area present before the tree loss occurred. If all the trees survive, then there will actually be MORE leaf area. I see an analogue to this argument; let's say I was found guilty of fraud or theft and the courts directed me to pay back the funds as restitution, let's say $100,000. Could I successfully argue that I indeed would accept this penalty but I will only give the defendant $20 with the understanding that, if they invest it wisely, they might eventually have their $100,000 back? I think not. If the defendant is paid the full $100,000 at one time, should they be prevented from benefiting from its growth? Probably not.

We discussed the idea or relating leaf area to a more easily calculated or visualized value such as crown projection area (canopy cover from a single tree) or perhaps basal area (stem cross–sectional area at breast height). There is some merit to this. However, I still think leaf area is the correct value to use. Again, it is directly related to many benefits. But more importantly, the calculation of leaf area can also take into consideration tree condition and species. This becomes problematic if we were to convert leaf area to crown projection area (for example, this could be done by assuming a leaf area index of 4). Leaf area as estimated from crown morphological parameters as is done in the UFORE model could be adjusted for any part of the crown missing due to insects, disease, pruning, storm damage etc. Leaf area could also be adjusted for species by applying the shading coefficient used in UFORE. This would recognize species differences such as those that are obvious between a very dense-crowned Norway maple and a very open-crown honey locust. In this way, the defendant could be protected from being over-penalized for damaging or killing a tree which has a given crown width (or diameter at breast height) but with a large amount of the crown missing, or of a species with a very light crown.

I personally feel that a by-law based on a system similar to this would directly address the

sustainability of the benefits derived from the urban forest rather than simply trying to reduce tree loss by threatening fines, while still losing trees.

I hope this helps.

Andy

APPENDIX H

Proposal to the Town of Oakville

Establishment and Management of a Tree Seed and Seedling Development Program to support the Town of Oakville's Urban Forest Canopy Cover initiative

Overview/Background

The Town of Oakville has recently proposed a long-term objective of increasing canopy cover to 40% over the next 50 years. Part of this initiative will require the Parks and Open Space Department to develop a new program to undertake extensive restoration activities within selected high priority areas within the Town to reforest some if its Parkland. This new program will be called the "turn turf to trees (TtT) programme." Most of the restoration will include tree planting of local native species and may include uncommon or unique "heritage" tree gene conservation

A focus on native tree species and long-term planning is essential to ensure successful long-term maintenance, enhancement, and restoration of the landscape's biodiversity.

The use of non-native species or native species stock of unknown or un-adapted seed sources can result in poor quality, disease susceptible trees/forests with a long-term loss of productivity and biodiversity. Inappropriate stock substitution may occur if native supplies are limited and nurseries and tree planting agencies are faced with short-term budgets and targets.

Long term planning is critical in addressing annual stock demands. It allows for coordination of seed collection, seed storage and seedling production to meet the annual demand for appropriate native tree species.

Determination of stock demand requires site information to determine the appropriate species and stock type. Once this information has been compiled, growers can be contracted to grow the stock to meet the future demands. Stock development usually takes 2 to 4 years before an acceptable seedling is ready for planting.

Growers acquire seed from a variety of sources including their own seed collectors, seed procurement and processing agencies (e.g. Ontario Tree Seed Plant) and sometimes from out of province suppliers.

Seed availability is unique to the species; some species provide seed annually and others provide seed periodically (e.g. silver maple can have annual crops; red pine seed crops can be as infrequent as every ten years). A coordinated effort to locate seed collection areas, forecast crops, hire collectors, harvest and in some cases store seed crops will help balance the supply with the expected demand for any one species.

Purpose and Objective of Project

The UFORE Plan measured existing urban forest canopy cover, models potential future cover, identifies the best tree planting sites for air pollution reduction and has created a "priority planting Index" which identifies the optimum locations in Oakville to plant trees. The Urban Forest Strategic Management Plan is expected to outline that approximately 3-5

hectares per year of Parkland will need to be converted under the TtT programme: this will necessitate securing the annual supply of approximately 7,500- 8,000 new trees

The Forestry Section of the Town of Oakville has identified that there is an issue with the lack of availability of locally sourced native plant material to fill this new demand. The Town of Oakville wants to ensure that restoration efforts are accomplished using appropriate stock.

To address this issue, Trees Ontario proposes to be accountable for sourcing suitable seeds and seedlings for planting in the Town for their restoration program.

Project Description

Phase I

Any stock planted over the next two to three years (2008 – 2011) will likely be coming from local nurseries that currently have stock growing that has originated from their own seed supplies. These seed sources may or may not be local to the Town. In addition, the Forestry Section also has access to approximately 10,000 red and white oak seedlings from seed it collected in 2005.

Therefore, to ensure that the appropriate native stock is used for the Town's restoration efforts, TOF will determine which nurseries will be providing stock for their program, visit the nurseries, and determine the seed source for the stock and report to the Town on its acceptability (i.e. native species, certified sources, genetic diversity, seed zone, stock type).

To ensure the future availability of appropriate seed past 2011, TOF will immediately develop a seed source registry that will involve the identification and documentation of appropriate seed collection areas for the Town. These areas will be assessed annually to forecast potential seed crops and this information will be used to coordinate seed collection, processing and storage for future planting efforts. Collected seed will be made available to nurseries with resulting stock ready for the spring 2011 planting season.

This seed source registry will include a web-based database that will allow field staff to report seed crop forecasts.

A seed inventory will be maintained for the Town at the Ontario Tree Seed Plant in Angus. The estimated cost for a seed inventory for the Town is $30,000. This fund will pay for the collection, processing and storage of Oakville seed. The seed will be sold to nurseries for Town planting at cost with the revenues being used to cover future seed collection and processing costs. The $30,000 is therefore a one-time cost.

Phase II

Beyond 2008, TOF proposes to continue to assist Town restoration activities through the administration and management of seed collection activities for the Town. This would include the updating of the seed source registry, updating stock demands from the local delivery agents and coordinating seed collection to meet stock demands.

Summary

The TOF will work with the Town of Oakville to achieve the objectives by:

1. Helping partners identify a range of species, seed sources and stock types required for priority site restoration.
2. Coordinating stock demand and appropriate supply for planting
3. Promoting the ecological value of native species and seed source identification (e.g. certification).
4. Identifying superior seed sources (forests) and working with owners to help ensure a long term supply of seed for Oakville.
5. Forecasting, collecting, documenting and tracking the use of high quality seed.
6. Partnering with the OMNR Ontario Tree Seed Plant to process and store seed dedicated to Oakville's restoration program.
7. Establishing a long-term program that will address seed source management, seed crop forecasting, collection and banking and seedling production in support of the Oakville Restoration Strategies.

TOF is a partnership of almost all the seed and tree planting experts in Ontario; therefore, we represent the best authority on these issues.

Expected Results

1. A seed source registry that will identify optimal locations for seed collecting across the Oakville.
2. Assurance that appropriate native stock is being used for restoration efforts in Oakville during the period 2008-2011 (assessment of Nursery stock)
3. A Seed Trust that gives assurance that appropriate native stock is available for future restoration efforts in Oakville beyond 2011
4. Centralized system that partners and clients can go to for any questions re Oakville forest restoration
5. Coordination and facilitation of ecologically and economically sound Oakville forest restoration practices
6. Increased capacity to deliver restoration on Oakville
7. Draft a "chain of supply" agreement that has the potential to certify Oakville's seed registry program.

Project Budget

Undertaking a TtT programme offers the best value to increase urban forest canopy cover as the cost is approximately one-tenth the cost of street tree planting.

The Community Foundation of Oakville has expressed its interest in financially supporting the TtT programme.

(See Appendix A)

Respectfully Submitted,

Rob Keen

Project Manager

Trees Ontario Foundation

John McNeil

Manager of Forestry & Cemetery Services

Town of Oakville

Appendix A

Project Budget

A. Annual Operating Costs

(1) Annual Program Delivery Fee to TOF	**$60,000**
(2) Annual tending for the (TTS) programme	**$20,000**
(3) Forest Technician position to coordinate operational plans In the field	**$80,000**
(4) Overhead	**$10,000**
Subtotal	**$170,000**

B. Annual Capital Costs

(1) plant and site prepare the "Turn Turf to Trees (TtT) " Programme assuming

4 hectares per year (@ $20,000 per ha) $80,000

C. One time cost: a pick up truck for Forest Technician $35,000

D. One time cost: a seed inventory for the Town …… ……...$30,000

APPENDIX I

APPENDIX I: TREE PROTECTION INSPECTION IN THE TOWN OF OAKVILLE: DOCUMENTATION AND INSPECTION PROCESS[1]

Objective:
Protecting Town trees during construction through:

1. Documenting permit issuance process
2. Auditing activities in compliance with Town tree protection policies and by-laws
3. Monitoring hazards and damages to the Town trees due to construction
4. Recommending for any possible mitigation process
5. Funding the related costs through filing fines for infractions.

Inspection phases:
Tree Inspection is processed in three phases:

1. Pre-construction (design stage)
2. During construction
3. Post construction

Phase I: Pre-construction:
It is possible to preserve trees on construction sites, if the right measures are taken in the right time. The consideration to preserve trees cannot wait until the construction begins. The most important step is to be sure that the professional arborists get involved in planning stage.

During the design phase of a project, the design supervisor should identify all those trees that may be impacted by the construction activities. The design drawing and the tree protection plan prepared by a qualified arborist must be submitted to Forestry Section. Forestry Section will arrange a site inspection with the project arborist, design supervisor and construction supervisor of the project to decide upon the appropriate protective measures that maybe required for each tree.

Objectives and procedures:

1. Processing design drawing:
2. Reviewing "Tree Protection Plan" prepared by a Town approved qualified arborist.
3. Assessing construction standards and tree growing space
4. Tree appraisal
5. Tree Impact Evaluation checklist
6. Tree hazard assessment
7. Tree protection barrier installation
8. Security collection
9. Tree permits issuance: Forestry Section will issue a tree permit for every Town tree within or adjacent to construction area. For public utility projects, Town of Oakville capital projects and municipal consents tree permit will be issued where

[1] This is an exert from Tree Protection Inspection, Town of Oakville, 2005, Jalil Hashemi.

the minimum tree protection distance subject to table 1 article 3 of "Tree Protection Specifications for Construction near Trees" must be modified in order to operate an inevitable excavation inside TPZ. For driveway applicants, no excavation is allowed inside TPZ. Tree permit will be issued for all Town trees close to construction in the subject property.

References:
Following references may be used in order to process the pre-construction phase.

1. Design drawings and tree protection plans
2. Tree protection policies, guidelines and by-laws
3. Site inspections
4. ISA guide for plant appraisal 9th edition
5. ISA evaluation of hazard trees in urban areas and engineering based hazard tree assessment

Possible out comes:
The possible outcome of the pre-construction phase may include but not limited to:

1. TPZ avoidance: Recommendation for relocating infrastructure and design amendment
2. Regulating for pruning and preventative maintenance
3. Recommendation for soil mitigation (e.g. compaction avoidance, structural soil application, gridlock installation, etc.)
4. Recommendation for non-open trenching technology
5. Recommendation for hand digging and/or hydro-vac application
6. Public education through communication

Phase II: During construction:
Understanding how to minimize construction injury is based on the knowledge of tree physiology and the components needed for tree health, as well as understanding construction practices. The objective of site inspection at this phase is to ensure that the tree protection treatments and designs specified in pre-construction phase are implemented.

Objectives and Procedures:

1. Hoarding inspection
2. Construction compliance with the subject policies and by-laws
3. Auditing and documenting contravention from the tree protection plan
4. Documenting fines and penalties: The severity of the fines will be proportional to the amenity value of the tree and the potential damage to the trees. It will increase for multiple infractions.

References:

1. Project documents (drawings, Tree Protection Plan, etc.)
2. Project's arborist's report
3. Terms and conditions of Tree Permit

4. ISA literature (e.g. Best Management Practices, Integrated management of trees and shrubs in urban setting, etc.)
5. Inspectors' report

Possible outcomes:

1. Stop damaging Town trees order issuance
2. Recommendation for tree removal based on tree hazard assessment.
3. Recommendation for tree mitigation: soil aeration, vertical mulching, fertilizing, wound healing, bark tracing and corrective pruning

Phase III, Post construction:

The impact of physical injury on trees' health is permanent, even if they compartmentalized. If the injuries are extensive and the tree is stressed, the tree may never recover. Compaction of the soil and increase in grade both delete the oxygen supply to tree roots. Unless the damage is extreme, the tree may not die immediately, but could decline over several years. With this delay in symptom development, the loss of the tree may not be associated with the construction.

A Post construction report should be prepared by the project's qualified arborist for the specific projects where terms and conditions of related policies haven't been considered. This report provides Forestry with sufficient information to assess the mitigation process and the costs involved based on the severity of the impact and the amenity value of the tree. The distance of open excavation to the trees and the diameter of any severed structural roots bigger than one inch at cutting point should be recorded by the on-site arborist in his post construction damage project.

Forestry section will review and finalize the post construction report to manage hazard and health mitigation process and tree planting. The project will be responsible for the related costs.

Objectives and Procedures:

1. Project impact analysis:
2. Mechanical damage and soil compaction analysis
3. Calculating mitigation costs

References:

1. Arborist post construction report
2. Site inspection

Possible outcome:

1. Deposit release or retain
2. Fines and penalties proportional to the damage to the tree
3. Mitigation process and costs

APPENDIX J1

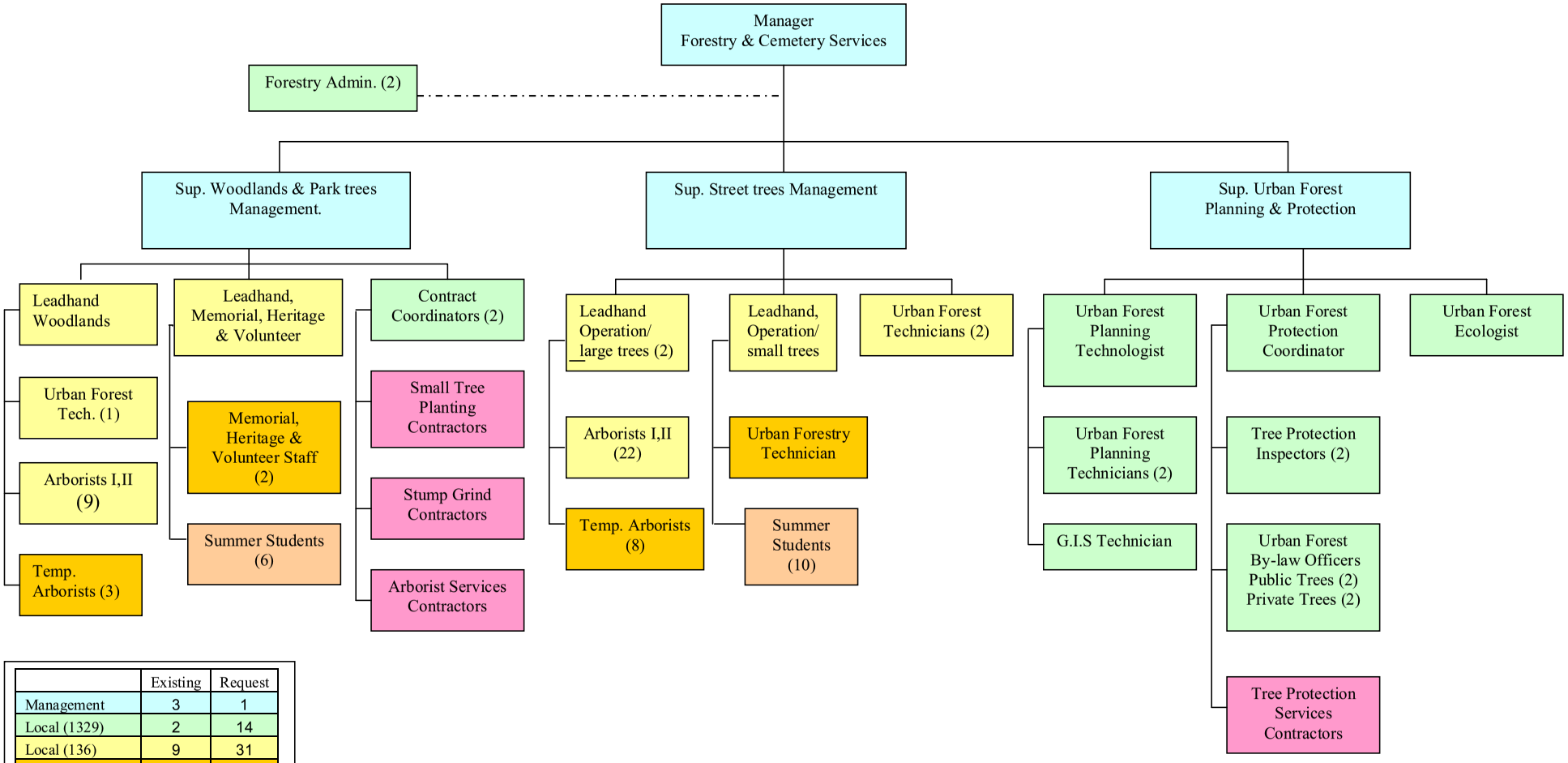
North Park Depot Master Plan Development Forestry Section Requirements

Management Question / Issue	Forestry Section - Current Standard	Additional Equipment/Staff Required by 2009 Assumptions: 1. Remain @ Central Opps Centre 2.		Additional Equipment/ Staff Required by 2009 Assumptions: Remain at Central Opps 2. Apply the (new)
What equipment, material, fleet and staff resources (type and numbers, both contracted and owned) do we need to mobilize from north site initially (2009)?	3 Bucket Trucks (1 is a Rental)	2 Chip Truck (2008 Budget Request)		1 Kabota Tractor - Woodlands
	1 Hiab	2 Chipper (2008 Budget Request)		1 Bucket Truck (Rental) - Woodlands
	2 Chip Trucks	1 Mem. / Heritage / Volunt. Coord. Truck (2008 Budget Request)		1 Trail Skidder - Woodlands
	1 Gator	2 Mem. / Heritage / Volunt. Temp Staff Rental Trucks (2008 Budget Request)		3 Mem. / Heritage / Volunt. Temp Staff Rental Trucks
	5 Water Trailers	3 Student Rental trucks - Mem. / Heritage / Volunt. (2008 Budget Request)		2 Student Rental trucks - Mem. / Heritage / Volunt.
	1 16' Trailer (arriving shortly)	3 Water Trailers (2008 - 2009 Budget Request)		2 Water Trailers
	5 Summer Student Rental Trucks	1 Hybrid Car for Forest Ecologist (2008 Budget Request)		1 Trail Truck
	1 Temp Tree Tech Truck	1 Tree Protection Inspector Truck (2008 Budget Request)		1 Tree Protection Inspector Truck
	2 Leadhand Trucks	1 Hybrid Car for UF Plannning Technologist (2008 Budget Request)		1 Bucket Truck - Heritage Tree
	1 Tree Protection Inspector Truck	5 70' aerial bucket truck (1 for Wdld. BU) 2008 Budget Request		1 Large Chip Truck - Heritage Tree
	2 Supervisor Trucks	4 Pick up truck:Leadhand Heritage Tree Leadhands(2008 Budget Request)		3 Chippers (2 Heritage Tree, 1 Woodlands)
		5 Chipper (2008 Budget Request)		1 Blocker Truck - Heritage Tree
	24 TOTAL	**30 TOTAL**		**18 TOTAL**
		54 GRAND TOTAL		**72 GRAND TOTAL**

North Park Depot Master Plan Development Forestry Section Requirements

Management Question / Issue	Forestry Section - Current Standard	Additional Equipment/Staff Required by 2009 Assumptions: 1. Remain @ Central Opps Centre 2.		Additional Equipment/ Staff Required by 2009 Assumptions: Remain at Central Opps 2. Apply the (new)
Staffing Resources	1 Manager	7 Woodlands (Arborist I or II) (2008 Budget Request)		3 Temp Mem. / Heritage / Volunt. Staff - 8 month
	2 Supervisors	1 Memorial / Heritage and Volunteer Coordinator (2008 Budget Request)		4 Summer Student - Mem. / Heritage / Volunt. (5 to 6 month)
	1 Tree Protection Inspector	2 Temp Mem. / Heritage / Volunt. Staff - 8 month (2008 Budget Request)		1 Tree Protection Inspector
	2 Leadhands	6 Contract Arborist - Mem. / Heritage / Volunt. (5 to 6 month) (2008 Budget Request)		6 Heritage Tree (Arborist I & II)
	1 Temp. Urban Forestry Tech (6 to 8 months)	1 Ecologist (2008 Budget Request)		
	6 Heritage Tree (Arborist I & II)	1 Tree Protection Inspector (2008 Budget Request)		
	2 Woodlands (Arborist I & II)	1 UF Plannning Technologist (2008 Budget Request)		
	1 Temp Tree Tech (Arborist II)	3 Forestry Clerical		
	10 Summer Students (5 to 6 months)	1 Director		
		8 Arborist 1 or 11(Heritage Tree) 1 Leadhand (Heritage Tree) 1 Supervisor Tree Protection 2 Manager 3 Inspector		
	26 TOTAL	**38 TOTAL**		**14 TOTAL**
		64 GRAND TOTAL		**78 GRAND TOTAL**

APPENDIX J2



	Existing	Request
Management	3	1
Local (1329)	2	14
Local (136)	9	31
Temp. Local 136	2	11
Non-Union Temp.	10	6
Outsourced	N/A	N/A
Total	26	63

Strategic Urban Forest Management Plan
Master Plan Development Forestry Section Requirements by 2009
Organizational Chart

APPENDIX K

APPENDIX K: TREE ATTRIBUTES TO BE COLLECTED DURING THE TREE INVENTORY
(Source: ESRI Canada. 2007. Street Tree Inventory and Tree Asset Maintenance Management System Requirements Analysis. Prepared for the Town of Oakville)

1. Tree Id. (unique value ranging 1-999,999). This may be called FACILITYID.
2. Survey Date:
3. Surveyor's name:
4. Tree X, Y Coordinates:
5. Street name and Number:
6. Zone:
7. Town Managed (Ownership), DDM
1= Town tree
2= Regional tree
3= Not Town tree
8. Landuse (the same as existing landuse in Town's G.I.S.), DDM
9. Site Location (LocSite): DDM
1=Front yard
2=Planting strip (e.g. BLVD.)
3=Cutout (tree root growth restricted on four sides by hardscape within dripline)
4=Median
5=other maintained locations
6=other un-maintained locations
7=Backyard
10. Species, DDM Dropdown menu (will be adapted from Stratum)
11. DBH
12. Height
13. Condition Wood (CondWood): DDM
Branch attachment, included bark and V crotches, decay and cavities, loose and cracked bark, lean, scar, conks and fungus, crack type and size, etc.. will be considered to classify CondWood into following four classes.
1=Dead or dying- extreme problem
2= Poor- major problem
3= Fair- minor problem
4= Good- No apparent problems
14. Crown Condition (CondLvs): DDM
weak colour, chlorotioc, defoliation, small leaves, etc.. will be considered to classify CondLvs in to following four classes.
1=Dead or dying- extreme problem
2= Poor- major problem
3= Fair- minor problem
4= Good- No apparent problems
15. Reduced Height: DDM
1= Topping
2= Pollarding
3= Vandalism
4= Blank space: [50 characters]
16. Wire Conflict, DDM (default to 1)
1= No lines

2= Present and not conflicting
3= present and conflicting

17. Management Recommendation: DDM

1= None
2= Small tree routine
3= Small tree immediate
4= Large Tree routine
5= Large tree immediate
6= Critical concern (public safety)
7= Plantable space
8= Blank space: [50 characters]

18. Task: DDM

1= None
2= Stake
3= Remove stake
4= Train
5= Aerate
6=Fertilize
7= Woodchip
8= Deadwood
9= Line clearing
10= Raise
11= Reduce
12= Cabling
13= Remove
14= Treat pest/disease
15= Stand improvement/shelterwood cutting
16= Stand improvement/group selection
17= Stand improvement/single selection
18= Stand improvement/prescribed burn
19= Stand improvement/site preparation
20=Stand improvement/reforestation
21=Stand improvement/invasive species control
22= Staff training
23= Blank space: [50 characters]

19. Canopy Cover

a. Crown width (in metres)
b. Crown height (in metres)

20. Warranty date: default to blank

21. M-plan:

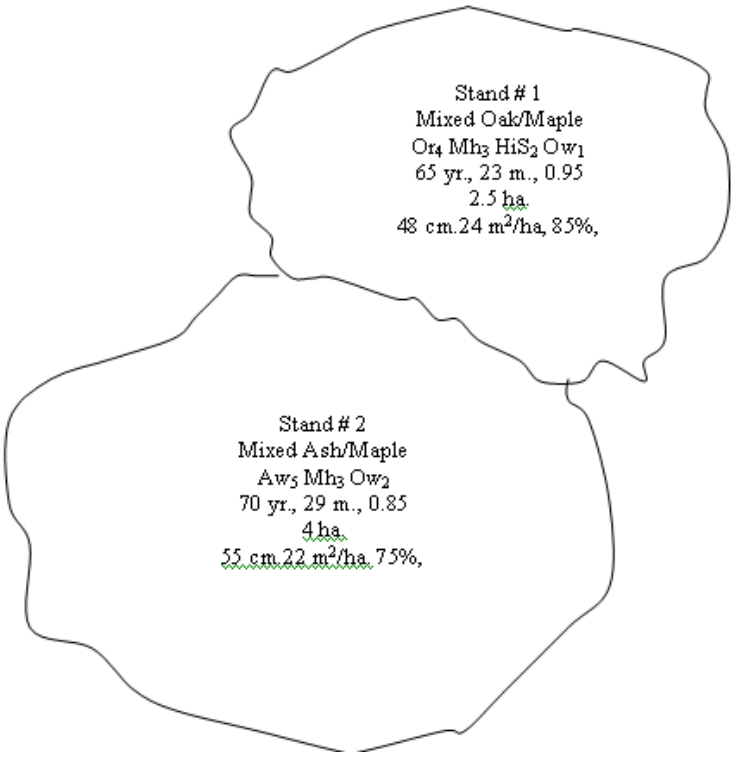
22. Heritage tree: Y/N (default to N)

23. Sidewalk damage (SwDamag): DDM (default to 1)

1= None
2= Low
3= Medium
4= High

FOREST STAND ATTRIBUTES

Title: (Woodland's name): e.g. Bayshire Woods Park
Address: e.g. 1234 Bayshire Drive
Survey Date: e.g. July 12, 2007
Forest Stand #: e.g. Forest Stand # 1
Forest Stand's name: e.g. Mixed Oak/Maple
Species name and composition of Forest Stand, e.g. Or_4 Mh_3 HiS_2 Ow_1 (red oak=40%, sugar maple=30%, shagbark hickory=20%, white oak=10%)
Average age: e.g. 65 yr.
Average height (m.) e.g. 23 m.
Stocking: e.g. 0.95
Forest Stand's area: e.g. 2.5 ha.
Average DBH (cm.) e.g. 48 cm.
Basal area (m^2/ha) e.g. 24 m^2/ha
Crown closure (%) e.g. 85%



APPENDIX L

APPENDIX L: OBJECTIVES FOR ACHIEVING OAKVILLE'S EDUCATION GOALS

Short Term Objectives – 1-5 Years for completion:

Objective 1. Create and distribute information pamphlet for council & city staff.

Task 1. Research existing educational materials aimed at council and city staff.

Indicator: Library of materials.

Task 2. Research pertinent information specifically for Oakville to add to existing materials.

Indicator: Up-to-date book of current issues in Oakville.

Task 3. Create and distribute pamphlet.

Indicator: Pamphlet designed for Oakville's council and city staff.

Indicator: All councilors and relevant staff members have received a copy.

Objective 2. Create and distribute information pamphlet for private landowners.

Task 1. Research existing educational materials aimed at private landowners.

Indicator: Library of materials.

Task 2. Research pertinent information specifically for Oakville to add to existing materials.

Indicator: Up-to-date book of current issues for Oakville's landowners.

Task 3. Create and distribute pamphlet.

Indicator: Pamphlet designed for Oakville's private landowners.

Indicator: Once an appropriate property size has been determined, all landowners with property have received a copy.

Indicator: Pamphlet advertised on Oakville web site for other interested landowners.

Objective 3. Create and distribute information pamphlet for developers & landscape architects.

Task 1. Research existing educational materials aimed at developers and landscape architects.

Indicator: Library of materials.

Task 2. Research pertinent information specifically for Oakville to add to existing materials.

Indicator: Up-to-date book of current issues for Oakville's developers and landscape architects.

Task 3. Create and distribute pamphlet.

Indicator: Pamphlet designed for developers and landscape architects working in Oakville.

Indicator: All major development / landscape architecture companies have received a copy.

Indicator: Pamphlet advertised on Oakville Web site for other interested developers and landscape architects.

Objective 4. Create support infrastructure for private landowners to develop stewardship plans.

Task 1. Research existing private land stewardship guidebooks.

Indicator: Library of guidebooks / other materials.

Task 2. Research pertinent information specifically for Oakville to add to existing materials.

Indicator: Up-to-date book of current issues in Oakville for private land stewardship.

Task 3. Create hotline to field questions / provide information regarding development and implementation of stewardship plan.

Indicator: Hotline fully running with knowledgeable staff.

Indicator: Hotline advertised in guidebook in Task 4 and on Oakville's Web site.

Task 4. Create and distribute guidebook.

Indicator: Guidebook designed for Oakville's private landowners to develop stewardship plans.

Indicator: All landowners with at least XXXX sized property have received a copy.

Indicator: Guidebook advertised on Oakville's Web site for other interested landowners.

Objective 5. Develop campaigns specifically for invasive species problems and extreme weather events.

Task 1. Research existing materials to educate people regarding invasive species problems and what to do before and after extreme weather.

Indicator: Library of existing materials.

Task 2. Research potential threats to Oakville regarding these specific problems.

Indicator: Continuously updated database of potential threats.

Task 3. Create and distribute Oakville-specific educational materials for imminent threats.

Indicator: Library of Oakville-specific materials.

Indicator: Map of areas under threat that should receive relevant materials.

Indicator: Database of addresses that have received relevant materials.

Objective 6. Create a temporary staff position to promote Oakville's urban forest by using media such as television, radio, newspaper, and events. This position should be created early on and dismantled when the long-term objectives are nearly complete.

Task 1. Decide on details of job and number of hours required.

Indicator: Specific job description.

Task 2. Advertise and fill position.

Indicator: New position filled by qualified person.

Long Term Objectives – Completed Within 20 Years:

Objective 7. Develop and implement a community-based social marketing strategy to aid in meeting the education goals.

Task 1. Discover barriers to the desired behaviour towards Oakville's urban forest.

Indicator: Literature review that details pertinent issues for further exploration in focus groups.

Indicator: Several small focus groups to narrow down list of possible common barriers and concerns. Be sure that multicultural and marginalised communities are fairly represented.

Indicator: Analysis of a survey from a random sample of residents that pinpoints relevant segments of Oakville's population and the barriers that each group identifies.

Task 2. Design social marketing strategy, making sure to include multicultural and marginalised communities.

Indicator: Collection of behaviour change methods that match the priority barriers to overcome.

Indicator: A programme to implement these methods.

Indicator: Feedback from several focus groups that indicate areas that need to be redesigned.

Indicator: Pilot tests that verify whether the strategy successfully alters behaviours or needs to be revised.

Task 3. Implement and evaluate the strategy.

Indicator: Baseline information on involvement before implementation.

Indicator: Community-wide implementation of the fully revised, successful strategy.

Indicator: Information at several points after implementation to evaluate the success of the strategy.

Objective 8. Create an Urban Forest Centre with satellite kiosks in major parks. The Centre will provide a space for events, workshops, and displays for current issues, new technologies, and innovative ideas. The kiosks should independently run their own events and workshops tailored to local neighbourhoods, making sure to consider multicultural and marginalised communities. Together, these centres will help to foster sustainable behaviour in all residents towards the urban forest.

Task 1. Secure partnerships with community organisations, non-governmental agencies, and private businesses.

Indicator: Database of partners, with details on specific areas of interest and level of involvement.

Task 2. Define criteria for locations of Centre and kiosks, as well as number of kiosks. These should include issues such as size of parks, density of surrounding neighbourhoods, and representation of multicultural and marginalised communities.

Indicator: Set of criteria and rationalisation.

Task 3. Identify potential locations for Centre and kiosks using pre-defined set of criteria.

Indicator: Map of potential locations with order of preference.

Task 4. Design Centre and kiosks through an open competition and panel of judges. The kiosks may be designed differently depending on the location of each.

Indicator: Open competition held.

Indicator: Panel of judges selected winning design.

Task 5. Build Centre and kiosks within proposed timeline and open them to the public.

Indicator: Completed Centre and kiosks open for public enjoyment.

Objective 9. Create volunteer networks that aid in planting and caring for trees, updating inventory, and staffing the Urban Forest Centre and kiosks. Networks should reflect multicultural and marginalised communities and can work with existing groups.

Task 1. Identify existing community groups, non-governmental organisations, and private businesses that can contribute to the volunteer network.

Indicator: Database of partners, with details on specific areas of interest and level of involvement.

Task 2. Research successful volunteer networks for information and ideas on creating them in Oakville.

Indicator: Library of reference materials and database of organisations willing to help.

Task 3. Develop and implement volunteer networks using resources identified in Tasks 1 and 2.

Indicator: Volunteer networks fully running.

Objective 10. Reinstate Tree Committee composed of interested residents, making sure that multicultural and marginalised communities are fairly represented. The Committee should bridge the gap between council and voters with regards urban forest issues.

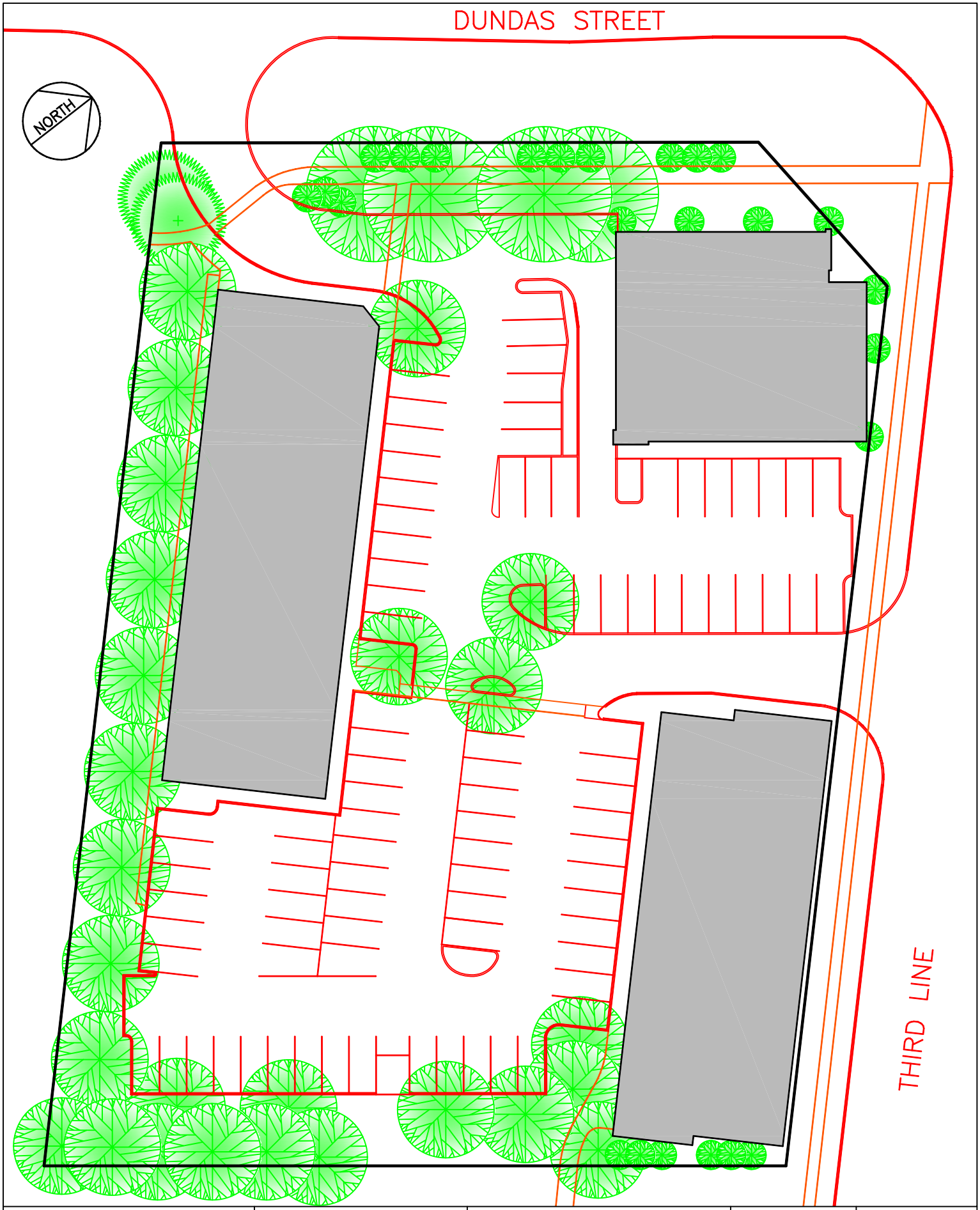
Task 1. Decide on details of Committee responsibilities and number of positions required.

Indicator: Specific description of the Tree Committee.

Task 2. Fill positions with interested and representative residents.

Indicator: Tree Committee fully established.

APPENDIX M



GHENT PLANNING SERVICES
1408 Kathleen Crescent
Oakville, ON L6H 2G7
tel: 905-844-8749
gps@ghent.ca

TOWN OF OAKVILLE
URBAN FOREST PROJECT
ENHANCED FOREST COVER

FOREST COVER FOR COMMERCIAL PLAZA

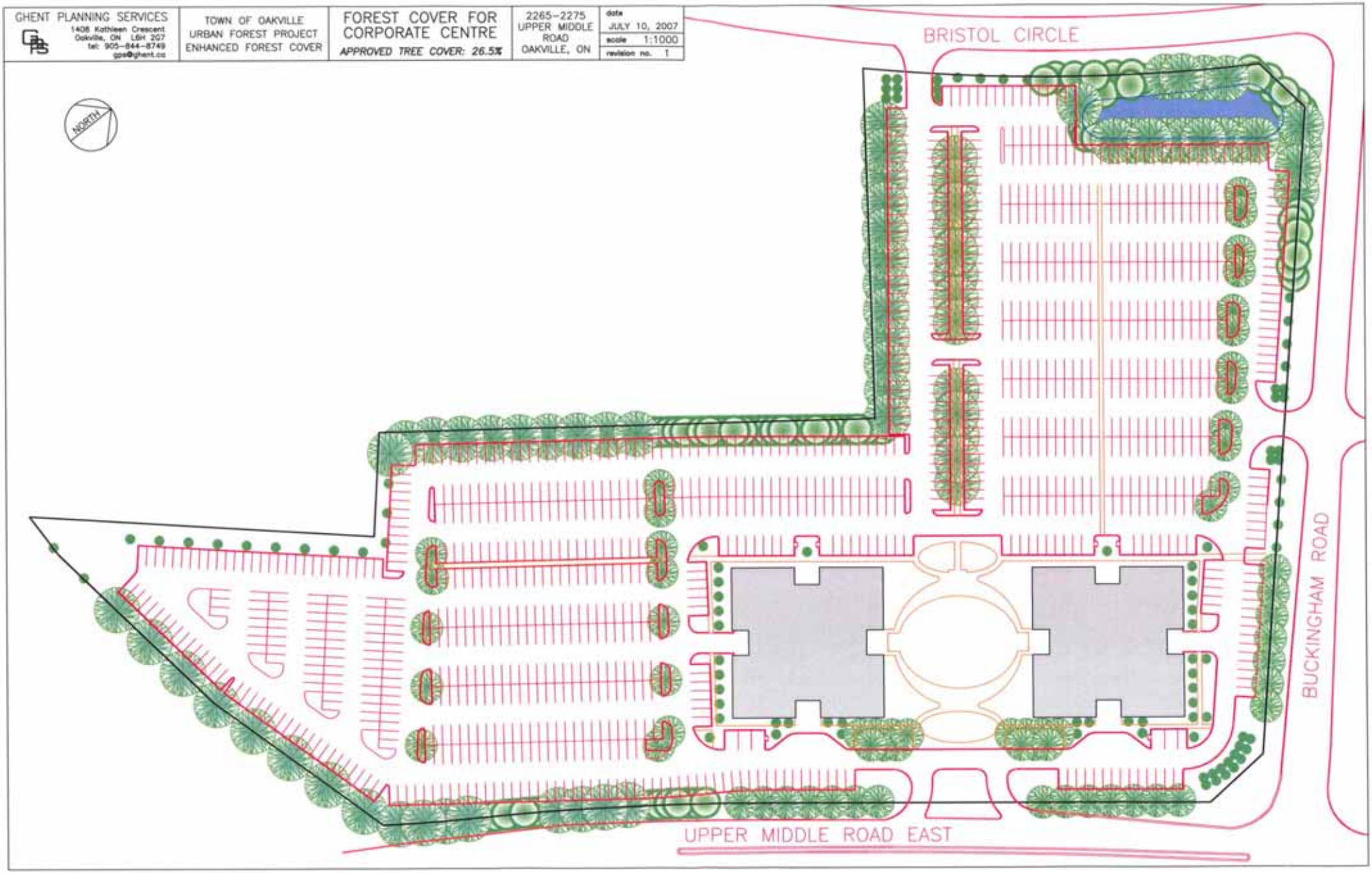
APPROVED TREE COVER: 28.6%

2012 DUNDAS STREET WEST
OAKVILLE, ON

date	JUNE 26, 2007
scale	1:500
revision no.	1

GHENT PLANNING SERVICES 1408 Kathleen Crescent Oakville, ON L6H 2G7 tel: 905-844-8749 gps@ghent.ca	TOWN OF OAKVILLE URBAN FOREST PROJECT ENHANCED FOREST COVER	FOREST COVER FOR COMMERCIAL PLAZA *TREE COVER AT 40.5%*	2012 DUNDAS STREET WEST OAKVILLE, ON	date JUNE 26, 2007 scale 1:500 revision no. 1

GHENT PLANNING SERVICES	TOWN OF OAKVILLE	FOREST COVER FOR CORPORATE CENTRE	2265–2275 UPPER MIDDLE ROAD OAKVILLE, ON	date JULY 10, 2007
1408 Kathleen Crescent Oakville, ON L6H 2G7 tel: 905–844–8749 gps@ghent.ca	URBAN FOREST PROJECT ENHANCED FOREST COVER	*APPROVED TREE COVER: 26.5%*		scale 1:1000
				revision no. 1



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TOWN OF OAKVILLE
URBAN FOREST PROJECT
ENHANCED FOREST COVER

FOREST COVER FOR CORPORATE CENTRE

TREE COVER AT 40%

2265-2275
UPPER MIDDLE
ROAD
OAKVILLE, ON

data	JULY 10, 2007
scale	1:1000
revision no.	1