City of Duncan

Urban Forest Strategy

Submitted to:

City of Duncan
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SUMMARY OF RECOMMENDATIONS

Key recommendations from this report have been prioritized for implementation within the next 20 years. Priority A recommendations are to be implemented with the short-term (1 – 5 years), Priority B within the mid-term (6-10 years) and Priority C within the long-term (10-20 years).

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1.1 History of the City of Duncan

Coastal forests have played a vital role throughout the history of human settlement in the Cowichan Valley. The Coast Salish First Nations have inhabited the region since time immemorial, living off the region's rich forest, fish and wildlife resources. European settlement in the Cowichan Valley first began in 1862, marking a new era of land use. Forests were initially cleared for agriculture, but industrial logging soon became established around the Cowichan River which was used to transport logs downstream to the Strait of Georgia. Forest workers from Europe, China, Japan, and South Asia settled in the area. Duncan was founded in 1917, coinciding with construction of a new railway used to transport logs to port. Since then, forestry has remained an important industry for the region. Today, the City of Duncan has grown into a regionally important center and is known as the "City of Totems", which is an appropriate reminder of its vibrant past.

1.2 Defining the Urban Forest

The urban forest is more than just the individual trees growing in the urban landscape. It also includes the soil, water, vegetation, microbial communities and wildlife that together contribute to the health of forested ecosystems. The urban forest is not confined by jurisdictional boundaries. The interrelated nature of forest ecosystems means that land use activities within any one jurisdiction has the potential to affect forest health in another. Duncan is bordered by the Cowichan Valley Regional District (CVRD), District of North Cowichan and land owned by Cowichan Tribes. A majority of the trees in the City of Duncan are on privately owned land. Promoting responsible use of all forested land will provide residents and visitors continued opportunities to benefit from healthy, forest ecosystems. Effective management of the urban forest requires that all of these natural components be considered together as a system.

1.3 Why Manage the Urban Forest?

The dynamics of the urban forest are significantly influenced by human activity and natural events. Cumulative effects resulting from intensive land use and development can have potentially lasting and detrimental consequences on sensitive forest ecosystems. These pressures can quickly degrade trees, forests and other natural areas to a state that provides limited ecological benefits.

- Continued growth and development;
- Pollution;
- Increasing recreational use;
- Habitat fragmentation;
- Pest and disease incidence;
- Climate change;
- Introduction of non-native species;
- Unforeseen natural disasters (wildfire, pest outbreak or windstorm events)

One of the major challenges to managing the urban forest is protecting its diverse biological values while also providing opportunities to meet human settlement and development needs. Modern, sustainable cities recognize that the two need not be mutually exclusive. Intact, viable forest ecosystems provide many environmental, social and economic benefits. Street trees and planted boulevards can contribute to individual street character but also improve walkability and calm traffic. Trees in riparian areas and floodplains not only contribute to scenic beauty but also help to retain water to protect against floods. Trees in downtown shopping areas provide shade for pedestrians, improve overall urban design and character and are strongly associated with increased commercial activity for merchants. Treed corridors provide habitat but also reinforce greenways and provide connectivity as part of trail infrastructure and active transportation networks. Managing for these multiple values while taking

advantage of the free ecosystem services provided by the urban forest can significantly reduce a city's infrastructure, maintenance and health costs.

Risks associated with the urban forest must also be recognized and managed:

- Trees can fail, threatening public safety, property and infrastructure;
- As trees grow and age, they can become increasingly costly to manage;
- Over time, root systems can damage sidewalks and roadways, leaves and tree litter can clog drains and branches can interfere with overhead power and utility lines;
- Human/wildlife conflicts also pose a safety concern.

Tree failure

Wildlife conflicts (beaver damage)

Sidewalk damage

Responsible and appropriate management of the urban forest requires that these risks must be identified and managed according to an acceptable standard of care.

1.4 Value of the Urban Forest

1.4.1 Benefits of the Urban Forest

There are numerous social, environmental and economic benefits attributed to urban forests. Many of these benefits are often underappreciated or overlooked because they can be difficult to quantify and are not just simply aesthetic. Trees support important requisite life processes for a variety of organisms. They also provide us with a spiritual connection to our natural environment and improve the quality of life. It is important to recognize these benefits to fully appreciate the significant role that forest ecosystems play in the urban environment. The following lists of benefits are adapted from McPherson et al. (2002) and Benedict and McMahon (2002).

Environmental Benefits:

- Carbon sequestration and reduced CO2 emissions;
- Improved air quality (absorption of particulates);
- Improved water quality (filtration of overland and subsurface contaminants);
- Flood mitigation and stormwater management (rainwater interception and storage, reduced runoff volumes and delay of peak flows);
- Erosion protection, soil conservation, slope stability;
- Weather and climate moderation (shading, windbreaks, reduction of urban heat island effect); and
- Wildlife habitat (biodiversity).

Economic Benefits:

- Energy savings and reduced heating and cooling costs;
- Increased property values (1% increase in sales price per each large front-yard tree, 3-7% higher property value for home with significant tree cover compared to those without;
- Stormwater management (reduced treatment loads and infrastructure requirements);
- Wastewater management (natural filtration of overland and subsurface contaminants);
- Commercial activity (shoppers spend more time, take more trips and will spend more money in commercial districts with trees); and
- Increased tourism opportunities.

Social Benefits:

- Recreation and educational opportunities;
- Spiritual connections (trees, wildlife, nature);
- Sense of community stewardship and social bonding;
- Traffic calming and noise reduction;
- Work productivity (greater job satisfaction and lower incidences of work absences in offices with views of nature);
- Health benefits (reduced stress, reduced exposure to UV rays, improved outlook and less medication for hospital patients with views of nature);
- Increased public safety (treed spaces shown to have significantly more use);
- Aesthetic enhancement (beautification, privacy); and
- Spatial definition of public space, streetscapes and neighbourhood identity.

1.4.2 Costs of the Urban Forest

Management costs associated with the urban forest are not well documented within the City of Duncan. Tree management costs are embedded within department budgets. The City's Public Works Department manages street trees, parks and natural areas. Typical arboriculture costs include tree planting, irrigation, tree inspections, tree removal, maintenance, hazard tree abatement and administration. Other costs include repairs to pavement and underground sewer pipes resulting from tree roots. Conflicts with overhead powerlines or other infrastructure which require pruning or tree removal must also be managed. Tree litter (leaves and branches) from sidewalks, streets and storm drains must also be cleared and removed. Private land owners also bear some costs for tree management, including pruning, tree removal, clean-up and repairs for blocked water and damaged sewer lines associated with root conflicts.

1.4.3 The Urban Forest - An Analysis of Economic Benefits

Numerous studies have focused on measuring the economic value and benefits attributed to trees, ecosystems and the services they provide. However, affixing a dollar amount to the ecosystem services provided by trees can be challenging. Values such as biodiversity, community health and spiritual happiness are values that are difficult to quantify. Also, most current indices do not account for the benefits and liabilities associated with risk and public safety. Regardless, current valuations have clearly demonstrated the economic benefits attributed to trees and the significant returns on investment in urban forest management.

Generally, the economic value of an individual tree increases in relationship to its size. Large trees provide proportionally much higher net value as compared to small trees. In addition they have a greater aesthetic and spiritual impact on the community (Schroeder et al., 2009). This should be considered when removing and compensating for large trees.

Many cities, upon being convinced of the benefits, cost savings and return on investment associated with the Urban Forest, have invested significant amounts of money into tree management programs such as planting, maintenance and public education. Following a cost-benefit analysis of trees and the Urban Forest, New York City decided to invest $400 million over 10 years to plant one million trees beginning in 2007. Similarly, a 2006 study in Modesto, CA showed a return of $1.89 for each dollar spent which prompted a large increase in their annual budget for tree management (McIntyre, 2008).

The City of North Vancouver recently assessed its street tree inventory in 2004 as part of its Street Tree Master Plan. North Vancouver has approximately 5,350 municipal street trees. Over a period of 50 years, this study concluded that almost $25 million worth of benefits could be attributed to these trees (Maco et al., 2004). This equates to a benefit of $501,000 or $94 per tree annually. The City's annual tree management costs are approximately $94,000. These results show a benefit to cost ratio of 5:1, representing a significant return on the investment.

Carbon Benefits

An analysis conducted for Tree Canada (Roulet and Freedman, 1999) indicated that the average tree in Canada sequesters approximately 2 kg of Carbon annually, while the USDA Forest Service Climate Change Research Center reports average annual sequestration rates of approximately 10 kg per tree. These benefits are significant for communities such as Duncan, who have signed on to the Climate Action Charter (which commits signatories to becoming carbon neutral by 2012). Signatories are entitled to a carbon tax rebate as part of the province's Climate Action Revenue Incentive Program.

STRATUM Street Tree Analysis

An analysis of the environmental and aesthetic benefits of Duncan's street trees (using the 2006 GreenStreets inventory) was performed using STRATUM (Street Tree Management Tool for Urban Forest Managers). STRATUM was developed by the USDA's Centre for Urban Forest Research as a research tool to valuate the ecological services provided by urban street tree populations. This is the same type of analysis that has been performed in many cities throughout the United States, including New York City. Table 1 summarizes the economic benefits each of the five most common street trees in Duncan, in addition to a total for the entire street inventory.

Table 1. Benefits output from STRATUM for the City's five most common street trees

Species	Number	Energy	CO2	Air Quality	Stormwater	Aesthetic/ Other	Total ($)	% of Total
Cherry	339	$563	$85	$156	$2,543	$19,486	$22,833	15.2
Maple	192	$161	$35	$58	$735	$13,204	$14,193	9.5
Douglas-fir	172	$203	$45	$127	$1,929	$13,567	$15,871	10.6
Plum	164	$200	$46	$93	$961	$6,516	$7,816	5.2
Bigleaf Maple	161	$277	$79	$109	$1,122	$10,914	$12,501	8.3
Citywide Total	**2,310**	**$2,952**	**$603**	**$1,211**	**$15,290**	**$129,474**	**$150,160**	**100**

* Analysis assumes 2010 Residential Electricity Step 1 Rate: 6.27/kWh (BC Hydro); 2010 Natural Gas Residential Rate Schedule 1: $1.51/therm; Average residential home selling price: $350,000 (2009 Cowichan Valley); Duncan Population: 5,008 (2009 StatsCan estimate)

Creating awareness of the true net value of the Urban Forest is a critical component of this plan. Continued research to valuate the benefits and costs attributed to trees will encourage to the investment in the long term maintenance and enhancement of the Urban Forest. Management tools such as STRATUM and UFORE (Urban Forest Effects – a model which valuates Urban Forest structure, environmental effects and values) are invaluable to support these endeavours.

Rec 1 Periodically use tools and valuation protocols (STRATUM and UFORE) to quantify the benefits and costs of the urban forest

Rec 2 Promote and raise community awareness of the services and benefits provided by the urban forest

2 ROLE OF THE URBAN FOREST STRATEGY

The City of Duncan Urban Forest Strategy provides a vision and plan for long term sustainable urban forest management. It provides City staff with clear, meaningful and achievable management goals and operational directives to protect, maintain and enhance the urban forest. The consultative aspect of this Strategy will foster a sense of ownership and community stewardship for citizens by emphasizing the importance of trees, forested ecosystems and their associated values.

2.1 Policy Framework

All levels of government (Federal, Provincial and Municipal) play an important role in the management of the urban forest and its associated values (water, wildlife, etc). Management responsibilities can be shared or designated, but are often the sole responsibility of one level of government.

The Federal government of Canada has higher level constitutional powers which relate to only certain aspects of urban forest management. These include managing provisions within the Fisheries Act [RS 1985], the Species at Risk Act [2002], the Migratory Birds Convention Act [1994] and Indian Affairs, which deals with the transfer and control of land, resources and environmental responsibility to First Nations.

The Province of BC has constitutional rights that give it responsibility for natural resources and the environment, in addition to other powers related to property and civil rights. It enacts legislation outlining the regulatory framework and authorities for regional districts and municipalities. The Community Charter [SBC 2003], for example, grants specific powers to municipalities to address community needs. The Local Government Act [RSBC 1996] provides legal authorities related to land use planning and development within regional or municipal boundaries. In some cases, municipalities are required to take certain management actions, such as the preparation of Official Community Plans.

Local governments are responsible for managing growth and development within their boundaries. This includes development approvals, infrastructure planning and operations, engineering and public works, emergency response, recreational and park services, and protection of hazardous and/or environmentally sensitive lands. They have also been granted the power to enact local by-laws to support these directives.

2.1.1 Official Community Plan

Duncan encourages responsible stewardship of the environment and protection of its natural heritage. The current Official Community Plan, established in 2007, contains specific policies that relate to the urban forest. Examples include:

- Encourage development of formal and incentive-based protection for trees (7.1.8);
- Support protection of natural areas (7.1.18);
- Support 're-greening' of Duncan by promoting the planting of trees on public and private land (8.1.9);
- Integrate green space on streetscapes (7.1.10);
- "Green" streets with narrower lanes and landscaping for stormwater management (8.4.16).

Alternatively, urban forest initiatives can support other objectives of the OCP. Some examples include development of a more pedestrian friendly environment (8.4.5; 8.4.6), calming traffic (8.4.21), improving aesthetic appeal (8.4.15; 8.4.18), increasing connectivity (8.1.12; 9.6.1) and managing stormwater (10.3.3).

The City of Duncan has recently amended its OCP to address climate change. Primary targets (e.g. 33% reduction of GHGs from 2007 levels by 2010) have been established as part of an overall reduction strategy. Secondary targets have been established in specific sectors (such as natural resources) to support these endeavours. The updated OCP supports an increase in forest cover to 30% by 2020 and 40% by 2050 (from current level of 25.8%).

Development Permit Areas

Duncan has six Development Permit Areas and one Development Approval Information Area (which covers the entire City). These contain guidelines that relate to management of trees and the urban forest. The Multi Family (1) and Other Commercial DPA (4) focus on retention of natural vegetation and significant stands of trees. Use of drought resistant native plants and creation of landscaped screens is encouraged. The Downtown and Highway 1 Corridor DPAs (2 and 3) encourage planting of ecologically suitable, indigenous or compatible plant and tree species in landscaped areas. Choosing trees and locations that will provide benefits (e.g. shade), but not cause conflicts with infrastructure, is emphasized. The Natural Environment and Hazard Lands DPAs (5 and 6) emphasize protection of environmentally sensitive areas and features. These include floodplains, unstable slopes, aquifers, riparian areas and raptor habitat.

2.2 A Vision for Duncan's Urban Forest

Duncan's Official Community Plan (OCP) states that it will "encourage environmental sustainability by accommodating change and development in a manner that improves Duncan's environmental health and recognizes the City's interconnection with the ecology of the broader region".

As part of the community vision, the OCP emphasizes that

> "The City is green and takes pride in its sustainability practices: Streets are lined with trees, the River sparkles, commercial areas are well-landscaped, permeable surfaces have replaced pavement, community gardens are found throughout, natural areas are protected, clean air and water are vital community attributes, reduction, recycling and reuse are widely employed."

A vision statement for the Urban Forest Strategy was drafted in consultation with the City of Duncan. It supports the environmental goals of the OCP and forms a foundation for sustainable management of the urban forest. It should be reviewed on a regular basis to ensure that it continues to represent the community's principles and values.

> "The City of Duncan will be a community identified by its trees. The City will invest in its urban forest and actively encourage public participation in its protection and enhancement. The sustainable management of the urban forest will maximize its social, economic and environmental benefits for current residents and future generations."

Rec 3 Periodically review the vision statement for the Urban Forest Strategy to ensure it is consistent with the community's principals and values

2.3 Sustainable Urban Forest Management Goals

The vision of the Urban Forest Strategy is supported by achievable goals, which complement those of other higher-level plans. These goals are supported by the City and provide the framework for development of all subsequent objectives and recommendations.

The goals of the Duncan Urban Forest Strategy are to:

1. Provide a long term vision and planning framework for the urban forest, developed through effective consultation with City staff and stakeholders;
2. Protect existing trees and increase tree cover where possible;
3. Identify the species, sizes, and locations of trees to plant in the future;
4. Establish guidelines to protect and enhance the urban forest through sustainable practices.

2.4 A Living Document – Timing and Adaptive Management

Developing a management plan within the context of forest life cycles is challenging. Many trees take decades to grow to what would be considered a substantial size. Meanwhile, many forest ecosystems take centuries to develop fully. Many of the older trees in our remaining coastal old growth stands have lived for eight hundred years or longer. These timelines require that a long-term planning approach be adopted.

The rate of landscape change in urban environments must also be considered. Growing population will continue to put stress on local ecosystems as demand for land, water and resources increases. Future impacts to the landscape resulting from potential climate change scenarios, which are difficult to predict, will likely have a lasting, but as of yet undetermined, effect on the urban forest and the region in general.

A long term adaptive management approach should be implemented to integrate new management initiatives, scientific research, monitoring results and community input. The premise of adaptive management is continual learning. Specific management initiatives are monitored and the results are used to better inform and strengthen the plan by making necessary adjustments where appropriate. Periodic review and updating of the plan will facilitate integration of an adaptive management approach. This ensures that the plan continually follows current best management practices and reflects the current vision of the community. The Urban Forest Strategy is a living document with recommended plan updates every five (5) years.

Rec 4 Review and update the Urban Forest Strategy every five years

2.5 The Urban Forest Management Approach – Assessment Criteria and Performance Indicators

Urban forests require a healthy vegetation resource, community-wide support, and a comprehensive management approach to provide and maintain the highest possible level of environmental, social, and economic benefits over time (Clark et al. 1997). Adopting a foundation of assessment criteria and performance indicators can help achieve these objectives by providing a realistic view of where Duncan is currently positioned on a management spectrum. These can be used as part of a long-term monitoring approach to further guide implementation of adaptive management strategies and recommendations.

Communities vary in natural environments and societal desires; therefore, achieving management objectives for a particular component of the urban forest will depend on distinctive ecological, community and management factors, as defined below:

1) Ecological factors – ecological characteristics of the urban forest;
2) Community factors – the level of community awareness and involvement in urban forest management;
3) Management factors – the intent, goal, strategy, and objectives chosen for the management of the urban forest.

A rating of Duncan's current performance for selected ecological, community and management factors are summarized in the following tables (indicated by shaded cells). These tables are adapted from Kenney et al. (2008) and Clark et al. (1997). Some performance criteria have no measurable indicators and the status has been determined by City Staff. Generally, the City of Duncan is currently performing at a low to moderate capacity for all factors, based upon the key management objectives and assessment criteria selected.

2.5.1 Assessment Criteria and Performance Indicators (Ecological Factors)

Consideration and understanding of ecological factors is imperative to achieving a sustainable vision for the Urban Forest. The composition, vigour (growth and health), and pattern of existing plant communities will depend upon the ecosystems found in the urban forest. As each tree/plant species is adapted to a certain range of environmental conditions, it will grow and respond in ways that depend upon the ecosystem and site conditions. In unfavourable environments, the growth potential of both native and non-native species will not be realized. Trees will be more susceptible to damaging agencies, or more effort will be required to establish and grow the species. Knowledge of the environment, particularly its climate and soil, the ecological characteristics of plant species, and the influence of the environment on their growth, will permit selection of the most suitable plant species and appropriate treatments for different sites, green areas, and management objectives (Klinka and Feller, 1984).

Table 2. Ecological factors (Shaded areas indicate the current state of the City)

Key Objectives	Assessment Criteria	Performance Indicators			
		Low	Moderate	Good	Optimal
Maintain target crown closure	Canopy Cover	Existing canopy cover equals 0-25% of the target	Existing canopy cover equals 25-50% of the target	Existing canopy cover equals 50-75% of the target	Existing canopy cover equals 75-100% of the target
Establish a tree population suitable for the urban environment and adapted to the regional environment	Species suitability of street/park trees	Less than 50% of trees are of species considered suitable for the site	50% to 75% of trees are of species considered suitable for the site	More than 75% of trees are of species considered suitable for the site	All trees are of species considered suitable for the site
Establish a genetically diverse tree population city-wide and at neighbourhood and/or street segment level	Species distribution of street/park trees	Fewer than 5 species dominate the city wide tree population	No species represents more than 10% of the city wide tree population	No species represents more than 5% of the city wide tree population	No species represents more than 5% of the entire city wide tree population or at the neighbourhood/street segment level
Minimize degradation of natural areas and maintain healthy functioning ecosystems within the urban environment.	Ecological integrity of natural areas	More than 50% of natural areas significantly degraded with ecological functions impaired	25 – 50% of natural areas significantly degraded with ecological functions impaired	10 – 25% of natural areas significantly degraded with ecological functions impaired	Less than 10% of natural areas significantly degraded with ecological functions impaired
Maintain healthy, viable populations of wildlife species in natural areas	Wildlife indicator species (insects, herpetofauna, fish, birds, mammals)	Limited knowledge of the health of selected wildlife populations	Populations are stable or increasing in 25-50% of selected wildlife species	Populations stable or increasing in 50-75% of selected wildlife species	Populations stable or increasing in 75% of selected wildlife species
Preservation and enhancement of native plant species	Native vegetation	No program of integration	Voluntary use of native species on publicly owned lands where site appropriate	Use of native species is encouraged on a site appropriate basis	The use of native species is required on a site appropriate basis

2.5.2 Assessment Criteria and Performance Indicators (Community Factors)

Many (but not all) urban ecosystems have no capacity for self-renewal and maintenance; therefore, desired benefits from these ecosystems can only ensue when adequate and reasonable care is provided. In other words, urban forests require human intervention. The implication of this principle means that urban forests cannot be separated from the people who live in and around them (Clark et al.. 1997). As a consequence, the City must involve and share with the community the decisions and actions regarding the urban forest areas. Raising awareness of the urban forest and encouraging the general public (including green organizations, community groups, schools, institutions, developers, etc.) to become involved as important stewards in management of this shared resource will further support goals and objectives of the UFS.

Table 3. Community factors (Shaded areas indicate where the municipality currently sits)

Key Objectives	Assessment Criteria	Performance Indicators			
		Low	Moderate	Good	Optimal
City staff and general public understand the role of the urban forest	General awareness of the urban forest as a community resource	Urban forest seen as a problem, a drain on budgets	Urban forest seen as important to the community	Urban forest acknowledged as providing environmental, social and economic services	Urban forest recognized as vital to the communities environmental, social and economic well-being
Ensure all city departments cooperate with common goals and objectives	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
Private landholders embrace city-wide goals and objectives for urban forest management	Cooperation with private landholders	Ignorance of urban forest issues	Educational materials and advice available to private landholders	Incentives provided for voluntary stewardship on private land	Private landholders implement strategies to enhance urban forest
The green industry operates with high professional standards and commits to city-wide goals and objectives	Cooperation within Green industry (nurseries, soil providers, tree care companies, etc.)	No cooperation among segments of the green industry. No adherence to industry standards	General cooperation within green industry.	Specific cooperative arrangements	Shared vision and goals including the use of professional standards
At the neighbourhood level, citizens understand and cooperate in urban forest management	Neighbourhood action (stewardship groups, schools, scouts, etc)	No action	Isolated or limited number of active groups	City-wide coverage and interaction	All neighbourhoods organized and cooperating
All groups within the community interact for the benefit of the urban forest	Citizen-municipality-business interaction	Conflicting goals among different groups	No interaction between groups	Informal and/or general cooperation between groups	Formal interaction and cooperation between groups
Provide for cooperation and interaction among neighbouring communities and regional groups	Regional cooperation with adjacent municipalities	Communities cooperate independently	Communities share similar policy vehicles	Regional planning is in effect	Regional planning, coordination and /or management plans

2.5.3 Assessment Criteria and Performance Indicators (Management Factors)

The goal of managing urban forest areas appears to be manipulating natural environments for their present and potential contributions to the physiological, sociological, and economic well-being of the community (Jorgensen 1974). These contributions include the overall ameliorating effect of trees on their environment, and their recreational and general amenity value. Managing the urban forest to maximize its potential benefits, while minimizing associated costs and liability, requires a sound knowledge of its ecological components, values and risks. This knowledge can be developed over time through use of management tools such as comprehensive inventories, interdepartmental communication, risk assessment and results-based monitoring and evaluation. Above all, the essential staff, equipment and funding must be available to effectively support management initiatives.

Table 4. Management factors (Shaded areas indicate where the municipality currently sits)

Key Objectives	Assessment Criteria	Performance Indicators			
		Low	Moderate	Good	Optimal
Develop and implement an urban forest management plan	City-wide management plan for private and publicly-owned trees	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 accepted and implemented
Complete inventory of the tree resource to direct its management	Tree Inventory (canopy cover, age distribution, species mix, tree condition, risk assessment)	No inventory	Incomplete or sample-based inventory	Complete inventory and partial monitoring program	Complete inventory included in city-wide GIS with monitoring program
Complete inventory of the water resource to direct its management	Water resource inventory	No inventory	Incomplete or sample-based inventory	Complete inventory and partial monitoring program	Complete inventory in city-wide GIS with monitoring program
Complete inventory of the soil resource to direct its management	Soil resource inventory (soil productivity, type by location, risk assessment)	No inventory	Incomplete or sample-based inventory	Complete inventory and partial monitoring program	Complete inventory included in city-wide GIS with monitoring program
Complete inventory of ecosystem type to direct its management.	Ecosystem inventory (Biogeoclimatic Ecosystem Classification)	No inventory	Incomplete or sample-based inventory	Complete inventory	Complete inventory included in city-wide GIS system
Complete inventory, monitoring program and integrated management strategy	Pest, Disease and Invasive Species	No inventory or management program	Incomplete inventory with partial management program	Complete inventory and partial management program	Complete inventory included in city-wide GIS and pro-active management program
Maintenance of the amounts and proportions of different species, particularly those of ecological, economic, or cultural importance	Wildlife inventory and management	No inventory or management	Existing inventory limited in scope and little management. Population levels of selected forest-associated species are monitored	Limited wildlife inventory but some comprehensive management plans for selected species. Population levels of selected species from a variety of habitats are monitored	Ongoing inventory of selected species. Comprehensive plan for ALL selected species. Population levels of selected species from a variety of habitats are monitored

Key Objectives	Assessment Criteria	Performance Indicators			
		Low	Moderate	Good	Optimal
Develop and maintain adequate funding to implement a city-wide urban forest management plan	Municipality-wide funding	Funding for reactive management	Funding to optimize existing urban forest	Funding to provide for net increase in urban forest benefits	Adequate public funding to sustain maximum urban forest benefits
Employ and train adequate staff to implement city-wide urban forestry plan	City staffing	No staff	No training of existing staff	Qualified Environmental Professionals on staff with regular professional development	Multi-disciplinary team within the urban forestry unit
Urban Forest renewal is ensured through a comprehensive tree establishment program driven by canopy cover, species diversity, and species distribution objectives	Tree planting, planning and implementation	Tree planting is ad hoc	Tree planting occurs on an annual basis	Tree planting is directed by needs derived from a tree inventory	Tree planting is directed by needs derived from a tree inventory and is sufficient to meet canopy cover objectives
All privately-owned trees are maintained to maximize current and future benefits. Tree health/condition ensure maximum longevity	Maintenance of privately-owned trees	No education about or policy on how to maintain privately-owned trees	Education about and policy on the maintenance of private tree is done on a request/ reactive basis.	Limited education or policy guiding the maintenance of privately owned trees.	Extensive education and policy guiding the maintenance of privately owned trees
All publicly-owned trees are maintained to maximize current and future benefits. Tree health/condition ensure maximum longevity	Maintenance of publicly-owned trees (Street and Park trees)	No maintenance of publicly-owned trees	Publicly-owned trees are maintained on a request/ reactive basis. No systematic maintenance schedule	All publicly-owned trees are systematically maintained on an irregular or long-term cycle.	All publicly-owned trees are maintained on a regular cycle.
All trees are maintained to maximize current and future benefits. Tree health and condition ensure maximum longevity	Risk Management - Natural Resources (tree hazards, wildfire, flooding, windthrow, pest and disease, etc)	Many risks associated with natural features are not identified and there is little policy to address it.	Risks associated with natural resources are identified but there is little policy (26-50% of identified risks) for its management	Policy is produced to address some of the identified risks (51-75% of identified risks) associated with natural resources	Risk management is directed from policy derived from a natural resource risk management plan which meets objectives of risk reduction in >75% of the identified areas

Rec 5 Evaluate the City's performance based upon accepted ecological, community and management based criteria and performance indicators every five years

2.6 Public Consultation

A consultation program was designed to engage citizens, stakeholders and municipal workers as part of the Urban Forest Strategy. An important goal of the consultation was to raise awareness of the UFS and urban forest values. Another was to provide an opportunity for people to better inform and contribute to the process. Many of the management recommendations contained within the UFS are based upon information received during this consultation process. The recommendations reflect community values and consider municipal capacity. Facilitating shared ownership of the strategy will support future management initiatives to ensure long-term sustainability of the urban forest and community health. Following is a summary of the public consultation; the full detailed consultation report is attached in Appendix I.

A Citizen Survey, covering a variety of urban forest issues, was mailed to approximately 1700 households; it was also available online. 201 responses were received. A majority of respondents recognized the value of the urban forest, particularly for stormwater management, air and water filtration, flood protection, reduction of greenhouse gases and improving quality of life. Similarly, most respondents placed a high level of importance on protecting existing natural areas and wildlife habitat, and protecting, planting and replacing trees. Managing trees to protect tree health, protect public safety and to develop recreation opportunities was also considered important.

Most disagreement amongst citizens concerned management of trees on private land. Almost 100 percent of respondents considered management of street trees, parks, landscaped and natural areas important or somewhat important. However, only 80% considered private tree management as important (37%) or somewhat important (43%). City management of public street trees was considered good to excellent by 74%, but only 21% for trees on private land and 47% for natural areas. When asked about the introduction of policies and regulations, 73% were in favour for increasing tree canopy cover on public land. However, only 51% were in favour of regulating private trees, with 24% against and 25% unsure. 82% of respondents believed regulations and limits should be placed on development proposals to preserve trees.

Stakeholder groups representing a variety of interests were consulted. These included environmental stewardship groups, the business community, and individuals identified by the municipality. Generally, there were shared concerns directed at lack of protection and proper management of trees and natural processes. Tree retention and protection of natural areas and ecosystem processes was important. Inadequate policy, regulation and management capacity was an issue for all aspects of the urban forest. Recognizing urban forest benefits, including the importance of trees on private land, was important. The importance of managing street trees to enhance commercial areas, while addressing potential impacts to business, was highlighted.

A Municipal Survey was administered to relevant departments within the City of Duncan and the Comox Valley Regional District. This provided information regarding current urban forest management practices, needs and capacity within the City. Input from adjacent jurisdictions, relevant to their experience, was also used where appropriate. Responses indicate that there is currently little direction or support for urban forest management in the City of Duncan. Although managers recognize the value of the urban forest and the importance of tree maintenance and wish to pursue initiatives to capitalize upon the potential benefits of trees and natural areas, there are inadequate resources, policies and regulations to enable this. Management of private trees is a concern; however, effective policies are required in addition to the capacity to deal with expanded management responsibility.

3 TREE MANAGEMENT

Careful planning and management is required to ensure ongoing sustainability of the urban forest and its associated values. This requires efficient use of resources, particularly within a limited budget. Modern urban forest management practices focus not only on the management of single trees, but also canopy cover as a whole. This is a more efficient and effective means to achieve multiple objectives and benefits (e.g. water quality protection, slope stability, energy efficiency, stormwater management, habitat retention). The general process for managing trees has been divided into three sections:

1) Identify long term canopy cover targets;
2) Complete a detailed tree/stand inventory across the City;
3) Develop a framework for tree planting, protection, maintenance and replacement.

3.1 Canopy Cover

Canopy cover is a measure of the foliar area of trees within a specified area, often indicated as a percentage of the whole. Visually, it is generally represented as a two-dimensional, aerial view showing a broad distribution of trees across the landscape. Within many urban areas, canopy cover will typically appear as a heavily fragmented remnant forest interspersed with roads, buildings and related infrastructure development. Areas of low, medium and high tree density can be identified in addition to treed patches and corridors of varying sizes. The degree to which these patches and corridors are connected (or isolated from each other) is an indicator of the ecological integrity of the urban forest.

Most of Duncan's canopy cover is located on private land. Historically, this is where most tree loss within urban areas occurs. Clearing of larger lots for new development, in addition to individual tree removals by homeowners, has led to an incremental decline in forest cover which is difficult to offset on a limited amount of public land. An analysis of canopy cover is an important management tool that can quantify loss of tree cover both spatially and temporally. It can also be used to help plan future land use and development, establish greenways, or protect functional ecosystem processes.

The limitations associated with canopy cover analysis must be acknowledged. The analysis will not provide sufficient information with which to base all management decisions. Canopy cover gives an indication of foliar area, not carrying capacity. Important ecosystem components, such as soil moisture and nutrients, which determine the capability of a landbase to support specific tree cover, cannot be assessed properly through aerial interpretation.

3.1.1 Canopy Cover Targets

The concept of establishing canopy targets is recommended as a means to encourage the retention and expansion of urban forests. Much of this work has been advocated by American Forests, a non-profit organization founded in the United States in 1875 that is a world leader in urban forest conservation, research and education. American Forests recommends overall forest canopy cover of 40% for communities in the Pacific Northwest. However, because not every community is the same, an ideal target should be based upon an evaluation of existing land cover and land use with respect to local climate and geography.

Table 5 shows the current estimated cover within the City of Duncan by planning zone in comparison to the recommended canopy cover advocated by American Forests. Currently, Duncan's total canopy cover is estimated at 25.8%; however, this is considered generous. Residential zones are predominantly suburban with tree cover of 22.1% (roughly half of what is recommended). Commercial zones in Duncan currently have a tree cover of 8.5% (just over half the recommended amount). There is a significant proportion of forest cover found in natural areas which compensates for the lower cover in other zones.

Table 5. Estimated percent tree cover within the City of Duncan by planning zone

Zone	Area (ha)	Canopy Cover (ha)	Canopy Cover (%)	Recommended Canopy Cover by American Forests	Percentage Difference
Commercial – C	46.1	3.9	8.5	CBD - 15%	-6.5%
Institutional Properties and Active Parks - P1	13.7	3.0	22.0	N/A	-
Parks and Playgrounds - P2	22.2	11.6	52.5	N/A	-
Residential - R	124.1	34.6	27.9	Suburban - 50%	-22.1%
Total	**206.1**	**53.2**	**25.8**	**40**	**-14.2%**

(American Forests, 2009)

A City wide target of 40% tree cover, to be achieved by 2050, is recommended for adoption as a long term goal for Duncan. An interim goal of 30% by 2020 is also recommended to encourage proactive management. These goals should be supported by the Official Community Plan and address issues concerning community sustainability and climate change. The targets provided by American Forests for residential and commercial areas can serve as a general guide.

Targets for tree cover should be reviewed and updated every five years. Expected losses to urban development should be considered and offset by opportunities to enhance tree cover in other areas of the City, particularly on public land. Commercial centers and established residential neighbourhoods that have tree canopy levels below specified targets should be a priority for planting. Natural areas also provide significant opportunities for planting, particularly to address flood mitigation.

Increasing canopy cover requires not only replacing trees that are lost to mortality but improving the health of existing trees and finding suitable locations to plant additional trees. The number of trees required to raise canopy cover by even 1% can be substantial (approximately 261 based upon Duncan's current tree inventory). Of course, full canopy cover will not be realized until after many years of tree growth. This requires a realistic and long-term approach to achieving canopy cover targets.

Tree planting requires considerable resources and should not be relied upon solely to maintain and increase tree cover. Management strategies should be employed to reduce the mortality of existing trees. This includes improved planting, maintenance and protection practices. A public education campaign should also be pursued to demonstrate the benefits of trees and encourage planting, maintenance and protection of trees on private property.

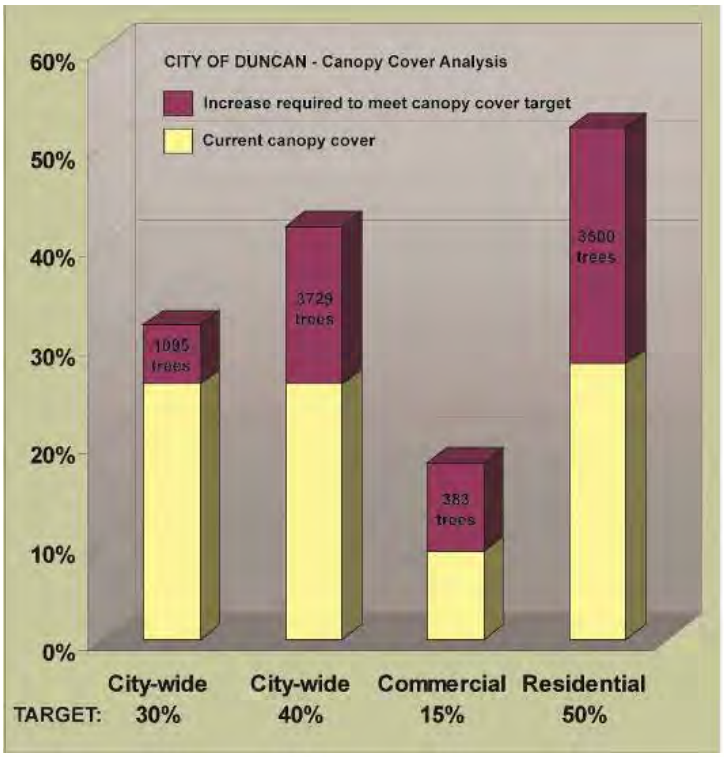
Table 6 provides an estimate of how many trees would be required to be planted to meet the 30% and 40% canopy targets, in addition to target canopy cover for commercial and residential areas. This analysis is based on the current baseline of existing trees and does not consider mortality or growth. It also assumes a crown area of a medium sized tree, which might normally take 15 or more years to achieve after planting. Growth rates often decline significantly in the second 15 year period. Although there is a correlation between tree diameter and crown diameter, individual tree species grow at different rates and crown shape and size vary.

Table 6. Planting requirements to achieve recommended tree canopy targets

Target	Current Canopy Cover (ha)	Target Canopy Cover (ha)	Percentage Increase Required	Additional Canopy Cover Required (ha)	Additional Trees Required
City-wide (30%)	53.2	61.8	16%	8.6	1095
City-wide (40%)		82.4	55%	29.2	3729
Commercial (15%)	3.9	6.9	77%	3.0	383
Residential (50%)	34.6	62.0	80%	27.4	3500

An additional 3729 trees (estimated) are required to meet the 40% canopy cover target (Table 6). This is based upon an average tree with a crown diameter of 10 meters and DBH of 30 cm (Peper et al, 2001). Existing tree cover in natural areas compensates somewhat for the lack of trees in residential and commercial neighbourhoods. 3500 (residential) and 383 (commercial) trees are required to meet recommended canopy cover sub-targets for these zones.

Meeting canopy cover targets will require a cooperative approach, including private landowners. Street tree planting alone will not be sufficient as costs and availability of plantable spots are too restrictive. Increasing canopy cover in parks and natural areas can help achieve city-wide targets; however, a strategy to protect existing trees and plant new ones must occur in residential and commercial zones to address those deficiencies. These initiatives are supported by the OCP (Policy 8.1.9) which promotes planting of trees on both public and private land to re-green neighbourhoods.



Rec 6 Adopt an average long-term (2050) City wide target of 40% tree cover

Rec 7 Establish tree canopy cover targets across the City for each planning area. Specify subtargets for tree cover on public land

Rec 8 Identify priority areas for maintaining and establishing tree canopy cover on public land

Rec 9 Educate the public on canopy cover targets and encourage tree retention, maintenance and planting on private lands

Rec 10 Review targets for cover every five years

3.2 Tree and Stand Inventory

Proper management of the urban forest requires a comprehensive inventory of the current tree resource. A tree inventory is the gathering of accurate information on the health and diversity of the trees within the City. This knowledge provides City staff with baseline information that will allow them to make informed management decisions, anticipate future needs and allocate appropriate resources. The location and condition of individual trees provides important information for the analysis of ecological conditions, canopy cover and trends in forest health. It can also be used to choose suitable sites for planting, identify potential conflicts with planned development or direct specific initiatives such as management of invasive species. Inventories can also be used as an educational tool to promote the stewardship of the urban forest and demonstrate the financial and environmental benefits of the urban forest.

Trees and natural forest ecosystems can be classified into categories which vary according to their management goals and intensity. These include:

1. Street trees;
2. Park trees;
3. Significant Trees;
4. Private Trees;
5. Natural areas trees; and
6. Volunteer, remnant or recruit trees.

3.2.1 Street Trees

Street trees are the publicly owned trees located within the traveled portion of a roadway, including the sidewalk, boulevards and medians, up to the property line. Street trees provide numerous environmental and health benefits and are considered fundamental to good urban design. Planting appropriate tree species can help enhance adjacent buildings and reinforce streetscape elements such as street corners, sidewalks, and benches (Philips, 1993). A well designed street tree plan improves streetscapes by providing shade, windbreaks and reducing the amount of hard surfaces. More planted area (trees and vegetation) increases rain interception and infiltration, reducing overland flow and stormwater.

Providing sufficient space to accommodate tree growth generally leads to narrower road widths and more sidewalk space for pedestrians. This has been shown to reduce the speed of vehicular traffic and increase pedestrian and bike activity. Presence of street trees has been demonstrated to increase property values and enhance commercial activity. Strategic planting of tree species also provides habitat for wildlife species.

No trees or accessory vegetation
*__Photo credit__: K. Wolf.

With trees, no accessory vegetation

With trees and accessory vegetation

Issues and Concerns

Although street trees provide numerous benefits, they can also be a liability if poorly managed. Above ground, they can block light, obscure signs and buildings, create windthrow and electrical hazards, and disrupt overhead utilities (Biddle, 1981). Significant maintenance costs are associated with removal of leaf litter in gutters, streets, and yards (Philips, 1993). Tree growth can damage infrastructure and buildings. Sidewalks, streets and foundations can heave and crack to accommodate root growth.

Planting street trees in commercial areas is sometimes viewed with some trepidation; perhaps that it could lead to a loss of business. There are often concerns that increased tree planting will reduce the available parking for customers and obstruct signage. However, research has shown that trees have a positive impact on the economy. People's perception of commercial districts is strongly correlated with the presence of trees and landscaped areas. Shoppers make more frequent visits and spend longer amounts of time in commercial areas with tree-lined streets. Often, people will travel farther distances (and spend more for parking) to shop there. In fact, shoppers in smaller cities are willing to spend up to 9 % more for goods and services in areas with high tree cover. These benefits are more pronounced in areas with well maintained, mature trees (Wolf, 2007). Developing distinct, enjoyable shopping environments can be a competitive advantage and help attract more commercial activity and economic opportunities.

A study of the positive effects of trees on consumer behaviour found that amenity and comfort ratings were about 80% higher for a tree lined sidewalk compared to a non-shaded street. Also, quality of products ratings were 30% higher in districts having trees over those with barren sidewalks. Interaction with merchants' items included customer service issues; ratings were about 15% higher for districts with trees (Wolf, 2007).

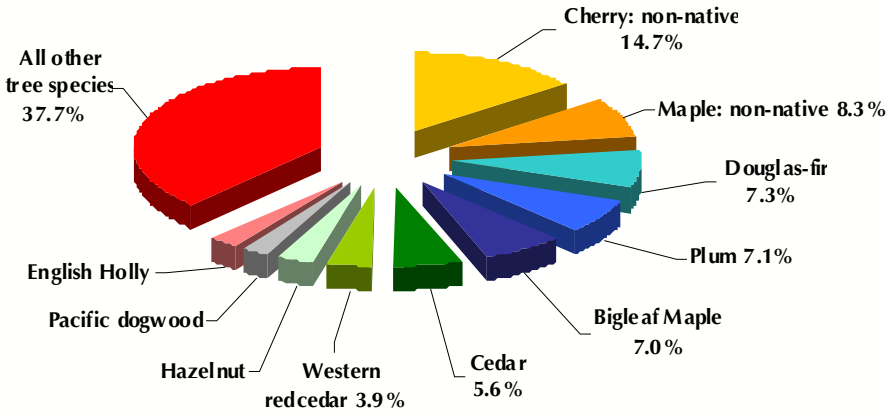
Many of the negative impacts of street trees can be attributed to improper planning and poor species and site selection. Likewise, many of the costs associated with street trees can be avoided through proper planning. Although there are costs associated with the development of well-designed treed streetscapes, it has been shown that over time these costs are absorbed by increases in street level activity, development and increased property values.

Street Tree Inventory

The Green Streets Canada Urban Tree Inventory Project was completed in 2006 as a coordinated effort between the City of Duncan and Cowichan Tribes. One objective was to develop an inventory of urban trees and green spaces. 2310 trees were identified within four meters of City streets. Property lines were sometimes unclear and it is unclear how many of these are growing on public land versus private land. This inventory provides excellent baseline information to initiate a long-term management program. Surveyed trees were located with GPS and separated into age and height classes. Tree health and condition was recorded in addition to any infrastructure conflicts. Table 7 contains a summary of the most common native and exotic street trees inventoried. Appendix C includes a more complete list.

Table 7. Summary of most common native and exotic street trees

Native Trees					
Coniferous trees	**Number**	**Percent**	**Deciduous trees**	**Number**	**Percent**
Douglas-fir	172	7.5	Bigleaf Maple	161	7.0
Western Redcedar	91	3.9	Beaked Hazelnut	73	3.2
Lodgepole (shore) Pine	25	1.1	Pacific Dogwood	59	2.6
Grand Fir	14	0.6	Cherry	42	1.8
			Garry Oak	25	1.1
Exotic Trees					
Coniferous	**Number**	**Percent**	**Deciduous**	**Number**	**Percent**
Cedar	130	5.6	Cherry	339	14.7
Blue Spruce	30	1.3	Maple	192	8.3
Deodor	22	1.0	Plum	164	7.1
			English Holly	57	2.5
			Magnolia	52	2.3



The current tree inventory should be updated on a regular basis to include more specific information. The location of the tree in relation to property lines to determine ownership is critical. In the absence of accurate survey information, an orthophoto with property lines delineated on it should be used to determine which trees are publicly owned. Attributes for all newly planted trees should be recorded and added to the inventory. Information for established trees can be updated on an interval basis during regular tree inspection and maintenance. The following information should be recorded and updated for each tree:

- GPS Location;
- Species;
- Planted date/Age;
- Diameter;
- Height;
- Live crown ratio;
- Crown diameter;
- Height to live crown;
- Damage/Pathological indicators;
- Current soil volume;
- Conflicts with infrastructure;
- Ownership.

Tree condition should be described including any damage, disease or insect concerns, conflicts with adjacent infrastructure and any maintenance procedure required. Service calls, inspections and completed maintenance should also be recorded. Similar inventories should be submitted for new street trees that are planted by private developers on public land as management responsibility will eventually transfer to the City. A valuation mechanism should be instituted for legal recourse. All tree information should be managed using an appropriate spatial software program.

3.2.2 Park Trees

Park trees are defined as those trees being actively managed in a landscaped area. Park trees generally stand alone or as groups and are located on active and passive park and institutional land (e.g. cemeteries, schools, etc). Remnant trees from natural areas may also be managed within landscaped areas. Park trees serve an aesthetic purpose, beautifying settings with their variety of forms, colours and flowers. They also provide other benefits such as shade and windbreaks for park users. Managed trees can sometimes act as a buffer or transition zone between landscaped grounds such as playfields and more natural areas. In these cases, trees can be seen as an ecological extension of the natural forest by providing some habitat values. Native species provide most ecological benefits due to their abundance and likelihood to be retained in groups. However, many non-native species provide food (nuts, fruit, and insects) and habitat for a variety of birds and wildlife.

Issues and Concerns

Many of the negative impacts and costs associated with park trees can be attributed to improper planning and poor species and site selection. Other issues arise from the nature of park use. Soil compaction and tree damage from park users can affect tree health and prevent establishment of new trees. Turf maintenance, including mowing and irrigation, can impact a trees rooting capacity. New parks are often established as even-aged "stands which can have implications down the road. Older parks often have significant trees that require specialized maintenance (California Urban Forest Council, 2010).

Photo: Trees planted at Rotary Park, with native recruitments to the left of the photo

Photo: Recently planted trees surround the playground at Centennial Park. Native forest cover dominates the slopes and riparian area in the natural area in the background

Park Tree Inventory

Duncan has a number of parks that provide a variety of experiences and uses. Following is a brief description of the major parks and condition of existing trees:

1. Charles Hoey - This park is centrally located within the downtown area. It has significant trees and historic buildings. The park's ornamental trees play an important role in defining the space and provide a link to the City's history. The train station provides a historic link to the City in addition to being an important transportation and tourism hub. Trees in this area require ongoing maintenance and inspection due to their historic significance and their proximity to people and facilities.

2. Centennial - This park has recently undergone a significant renovation. New tennis courts, a children's playground, rain garden, community garden, parking facilities and riparian plantings have been installed. The tree canopy in this park consists of recently planted ornamental trees and a small fringe of native forest cover dominated by deciduous species located near the creek. These recently planted trees and many of the existing non-native trees are too small to be much of a risk to the public. However, these trees will require maintenance to ensure they remain healthy and in good form.

3. McAdam - This park is located on the Cowichan River floodplain. It is has a small landscaped area located between two of Duncan's main sportsfields. There is a clubhouse, parking lot and a number of recently planted ornamental trees. Adjacent canopy cover is dominated by large black cottonwood trees. Park trees are generally too small to be considered a risk, but they will require regular, routine maintenance to ensure long-term tree health.

Rec 11 The current tree inventory must be updated as new trees are planted and following regular street/park tree inspections

Rec 12 Promote care, health and longevity of street/park trees

Rec 13 Increase the number of street/park trees and species diversity

Rec 14 Manage the risk of street/park trees to the public, property and infrastructure

Rec 15 Improve aesthetic values of street/park trees

Rec 16 Establish a street tree plan that can adapt to future climate change scenarios

Rec 17 Develop a park management plan for each park that considers tree planting and maintenance

3.2.3 Private Trees

Trees located on private property compose a significant percentage of a City's total forest cover. Private trees include a diversity of native and non-native species, many of which may be considered significant. Private trees perform valuable ecological services including stormwater management, carbon sequestration, energy reduction and provision of wildlife habitat. Property with large trees has also been shown to have higher values (an additional 3 to 7%) relative to those without.

Issues and Concerns

Trees on private land make a substantial contribution to the urban forest; however, the City has no jurisdiction to manage them. Regardless, it is important that private trees be accounted for when evaluating the urban forest. Annual removal of trees from private land, either through clearing associated with larger developments or removal of trees by private landholders, has led to a steady reduction in tree canopy over time. Uncontrolled tree

removal, resulting in inappropriate or indiscriminate loss of canopy cover, can affect tree health on adjacent public land and overall ecological function of the urban forest. For example, water quality may be affected as trees no longer filter contaminants before they enter aquifers. Flood risk can also increase as trees, which can absorb and store vast quantities of water, are removed from the landscape. Additionally, there are no assurances that these trees will be replaced.

Photo: An example of poor tree management on private property

Photo: An example of a mature tree growing on private property whose root growth is conflicting with sidewalk infrastructure

Introducing regulations to manage privately-owned trees can be contentious. In addition, management costs associated with administering new by-laws and permits for small jurisdictions like Duncan can be prohibitive. Striking an appropriate balance is critical to ensure long-term sustainability of the urban forest. This requires a cost-effective management framework that protects trees, while also allowing homeowners and developers the right to manage their tree resources responsibly. Section 3.7.1 provides recommendations for consideration when developing a tree protection policy.

Rec 18 Adopt a Tree Bylaw to regulate tree cutting on private land

Rec 19 Develop policy encouraging land developers to retain existing trees and/or replant new trees

Rec 20 Introduce tree replacement guidelines, including a green fund, for developers

Rec 21 Raise public awareness of the value and benefits of trees and the urban forest

Rec 22 Encourage planting and retention of trees on private land

Rec 23 Encourage naturescaping and planting of drought tolerant species

Rec 24 Encourage additional planting of ecologically suitable species to address flood risk in appropriate areas

3.2.4 Significant Trees

Significant trees have unique characteristics (e.g. size, age, species, rarity, aesthetic value, cultural significance, ecological importance) that provide considerable social, economic or environmental benefit to a neighbourhood or community.

Photo: An example of a significant tree in the City of Vancouver

Photo: Garry Oak trees identified as being significant in the City limits

Issues and Concerns

The City of Duncan has an incredible natural landscape that deserves recognition. Town character is in part defined by the trees, both native and exotic, within it. Raising awareness of significant trees is a key strategy to promote the urban forest and its values. Significant trees without specific protection are at risk of indiscriminate or inappropriate damage or removal, which can result in irreplaceable loss. The City of Duncan should recognize and promote its natural history by encouraging community groups, individuals and families to "get out" and experience their surroundings by nominating trees or a group of trees that are significant in terms of their age, size, character, rarity or historical significance.

Significant Tree Inventory

Nineteen (19) significant trees were identified during an informal survey of street trees in March, 2010. Trees include non-native and native species (e.g. Garry Oak), many of which are located on private land. This list was prepared so that staff could review their potential for inclusion as candidates as significant trees within its jurisdiction. However, it is important to involve the community in the process for nominating and finding significant trees in Duncan. This will help promote their protection and raise awareness of the benefits they provide to the City. A species list and location map is located in Appendix D.

Rec 25 Identify of all trees that have unique characteristics (size, age, species, rarity, aesthetic value, cultural significance, ecological importance)

Rec 26 Develop a public process for citizens to nominate significant trees as part of city-wide inventory

Rec 27 Develop policy relating to the management and maintenance of significant trees

Rec 28 Raise awareness of significant trees as part of urban forest education strategy

3.2.5 Natural Areas Trees

Trees that have germinated naturally in open areas or areas designated as parks are an integral component of functional ecosystems, including a variety of forested and non-forested communities in various ecological successional stages. The City of Duncan is responsible for managing approximately13.3 hectares of natural area. Many of these contain a high amount of forest cover and provide significant ecological benefits. For example, riparian ecosystems next to the Cowichan River are dominated by black cottonwood, a fast growing tree that is an extremely important provider of wildlife habitat in addition to stabilizing soil, filtering contaminants and absorbing significant quantities of water. Duncan's natural areas also provide recreational opportunities for walking, biking, and nature appreciation.

Issues and Concerns

One of the major issues associated with natural areas is maintaining ecological integrity. Continued development is increasingly fragmenting the landscape. Preserving natural areas large enough to support fully functional ecosystems is essential. Large, intact forests can provide additional benefits for the City of Duncan, including stabilizing slopes, moderating local temperatures, capturing and storing carbon dioxide, and mitigating flood impacts.

Photo: Rotary Park

Allowing natural processes to occur can reduce management costs; however, it does not imply that there should be no management. For example, natural regeneration avoids costly planting operations and allows for ecologically suitable and genetically strong trees to survive. The disadvantage of this strategy is that there is no control over species or density. A poor seed source may delay regeneration and allow for the establishment of invasive species.

The type and intensity of public use in natural areas is different than what occurs on streets and landscaped parks. This has implications for risk management and maintenance. Key issues relate to management of exposed treed edges (windthrow), forest fuels (fire) and public safety (hazard trees, non-sanctioned uses, and human-wildlife conflicts).

Natural Areas Inventory

Duncan's natural areas provide numerous benefits to the community. The Green Streets inventory classified natural areas within polygons that describe stand age, dominant tree species and/or species mix, and other characteristics including soil, slope and aspect. This information should be updated using additional standards outlined by the BC Resources Information Standards Committee (RISC). Recommended information to be compiled includes:

- Species composition by stand layer;
- Stand age;
- Average height and diameter;
- Stand density;
- Biogeoclimatic Ecosystem Classification (BEC) site series.

The City of Duncan is located in the Moist Maritime Coastal Douglas-fir Subzone, according to the Biogeoclimatic Ecosystem Classification system of BC. This Subzone is restricted to lower elevations (sea level to approximately 150 meters) along southeast Vancouver Island, the southern Gulf Islands and part of the Sunshine Coast. Climate is typified by warm, dry summers and mild, wet winters.

Following is a brief description of the two most common natural ecosystems found within the City.

1. Lowland floodplain and riparian forest community. This large area is located adjacent to the Cowichan River and includes Rotary Park. It provides important fish and wildlife habitat in addition to valuable ecological services such as flood attenuation for the community. Recreational trails, established on a protective dyke system, are popular and frequently used. The area is also used for picnicking and nature viewing particularly during the summer months. Forest cover is dominated by older black cottonwood trees that are approaching maturity. Tree risk assessments are required in the urban interface and along the trail system.

2. Upland terrestrial forest ecosystems. Smaller tracts of forested natural area exist in upland areas of Duncan. These are generally found on steeper slopes that are not suitable for development or as isolated patches in residential areas. One narrow, contiguous corridor bisects the city in a north-south direction. It incorporates a small creek and the forested component of Centennial Park. Dominant tree species include Douglas-fir, western redcedar, bigleaf maple, black cottonwood and red alder. These areas have some trails but they are used less frequently. .

Rec 29 Identify Environmentally sensitive areas relating to unique ecosystems, wildlife habitat, riparian habitat to help support tree retention

Rec 30 Manage natural areas to maintain ecological integrity and natural processes

Rec 31 Develop specific site prescriptions to manage natural stands in areas associated with risk (e.g. floodplains, slope instability, fire hazard, or invasive species)

Rec 32 Encourage preservation and restoration of natural forest ecosystems including Garry Oak, riparian and upland forest communities

3.2.6 Volunteer, Remnant and Recruit Trees

Volunteer specimens grow throughout the City. These typically include natural pioneer species that established from adjacent natural areas or trees that have been planted by residents without City approval. They are often located in road allowances, right-of-ways and undeveloped City-owned land.

Issues and Concerns

Currently, these trees do not receive any maintenance from the City. Volunteer trees may be suitable for long term retention if the species is appropriate for the growing space. Trees should be assessed and if they are not suitable and/or are expected to cause conflicts in the future, they should be removed. As compensation, replacement trees should be planted. Replacement trees may include different species that are appropriate for that particular site. They could also be planted in areas prioritized in the plantable spots inventory. Volunteer trees often grow in dense thickets; therefore, the number of replacement trees should reflect the canopy cover as opposed to the number of trees being removed.

Rec 33 Develop an inventory of volunteer trees on public land

Rec 34 Remove volunteer trees that are hazardous or not suitable for the growing space

3.3 Plantable Spots Inventory and Specifications

An inventory of possible planting locations for trees within the urban landscape (streets, parks and natural areas) provides a management framework to increase canopy cover. This provides a foundation for measuring potential mitigation measures to offset carbon emissions. Determination of plantable spots requires an analysis of the distribution of the existing tree inventory. Consideration should be given to both ecological and community values when determining suitability of potential planting locations. Potential benefits (e.g. shading) and planning and development objectives must be considered. Public consultation may be required to confirm suitable locations and garner community support.

An analysis of plantable spots within the City of Duncan was conducted for three broad planning zones:

1. Residential;
2. Commercial and Parking; and
3. Parks and Institutional.

The Parks and Institutional zone was further categorized depending on their use:

- Natural areas – native forest cover dominates and there is minimal human use within these areas in comparison to other park areas. Infill planting in many of these areas is recommended to fill gaps and replace declining forest cover;
- Institutional parks – green spaces or open areas that are associated with schools, government buildings or churches. Many of these areas have large open areas with turf that could be planted with additional trees along their edges;
- Active parks – recreation facilities exist. Limited areas exist to plant additional trees as they may conflict with the park objectives and/or decrease the amount of light at the site;
- Tourist dominated park – Charles Hoey Park is the only park with this classification. Tree planting should only be completed in conjunction with a master plan for this area;
- Sports field – there are two sports fields within City limits. It is assumed that no trees can be planted in these areas.

3.3.1 Street Trees

Street tree planting generally occurs within a landscaped strip (sometimes called the boulevard) dividing the sidewalk from the paved portion of the road. On wider streets, additional planting may occur in medians which divide opposing lanes. Space restrictions can sometimes limit street tree planting on the public portion of the roadway. As an alternative, some communities have implemented strategies to encourage planting on private land through use of tree easements or other agreements. In these cases, street trees are planted and maintained by the City on private land in exchange for an assurance the trees will not be cut down. This cooperative strategy improves neighbourhood walkability and aesthetics, in addition to increasing property values and providing other benefits (e.g. stormwater management).

Photo: Las Ramblas, Barcelona: Street trees can define a space in any sized city

There are many opportunities to plant street trees within the City of Duncan. Most streets within residential and commercial zones are typically underplanted. Some streets do have sufficient space in existing boulevards to plant trees directly. However, most streets do not currently have a designated (or wide enough) space for planting. Narrow utility corridors do exist; however, these do not provide sufficient soil volume

to sustain healthy tree growth. Tree conflicts with urban infrastructure (overhead lines, fences) are also a concern. Generally, private property tends to abut sidewalks which are separated by wide, paved roadways. However, most roads (particularly in residential areas) are wide enough to accommodate expanded boulevards for trees. This can achieve other objectives including traffic calming and improving walkability. Reducing the amount of paved surface can also reduce road maintenance and stormwater management costs.

Each municipal street within City limits was assessed for its suitability for planting additional trees. The analysis focuses on identifying opportunities to plant trees on publicly owned land. Available soil volume and potential for boulevard expansion are primary considerations. Infrastructure conflicts and other potential limitations for tree planting require a more detailed prescription and analysis. Individual streets were classified according to the above criteria. Each class provides a general assessment of current condition and potential plantabilty.

Stocking percentage is a term used to define the availability of potential planting spots in comparison to those that are currently occupied. One simple measure is to define the boulevard or median outside each lot as one plantable spot. The average stocking percentage in the United States is between 40 and 60% (Maco and McPherson, 2003); however, 75-80% is considered an achievable goal for smaller communities. This analysis uses a spacing distance of 5, 7 or 10 meters between trees to generate an inventory of plantable spots in Residential and Commercial zones in the City. A total of 4694 plantable spots (3513 Residential, 1181 Commercial) were identified. Based upon a 75% stocking percentage, 3520 new trees would be an ideal target. This compares to a current inventory of 2310 street trees (publicly and privately owned) based upon the Green Streets Canada Urban Tree Inventory completed for Duncan in 2006.

3.3.2 Residential

The Residential classification covers all streets within residential zones (e.g. single, multi-family). Typically, most private property abuts existing sidewalks. Some street trees do exist; however, many of these grow on private land. In many cases, ownership is unclear because property lines separating public and private land are sometimes difficult to distinguish. Public boulevards, if they do occur, are generally not wide enough to support healthy tree growth. Six classes for plantable spots were identified based upon an assessment of available space for additional trees:

R1 – No boulevard exists for planting of public trees without removing existing parking and/or taking space currently allocated to the road;

R2 - No boulevard exists for planting of public trees but there is abundant space allocated to the roadway, which can be reduced;

R3 - A boulevard exists for the planting of public trees;

R4 – No boulevard exists and there are trees already installed along the private property;

R5 - A boulevard exists and is currently planted;

R6 – A boulevard exists but is of insufficient size to plant public trees;

M1 - Medians located between lanes that currently have few to no trees. Plantable areas were determined considering traffic use, road width and professional judgment considering possible limitations including infrastructure conflict or lines of sight. Medians may not be restricted to residential zones, but are summarized in this section for simplicity.

Table 8 provides a summary of plantable spots according to Residential Class. Both sides of the roadway are included as part of the measure for linear distance. 3513 total plantable spots have been identified; however, there are approximately 1630 existing trees in R1, R2, R3 and M1 classes. This results in a net of 1932 plantable spots. Based upon a target of stocking level of 75%, approximately 1449 spots are currently available for residential street tree planting. A map showing the location of each Class is contained in Appendix E.

Table 8. Plantable spots for street trees identified in residential zones

Class	Linear Distance (m)	Spacing (m)	Total Plantable Spots	Existing Trees	Net Plantable Spots	Plantable Spots 75% Target
R1	1983	7.0	283	96	187	140
R2	8003	7.0	1143	465	678	508
R3	19476	10.0	1948	1017	931	698
R4	282	n/a	n/a	n/a	n/a	n/a
R5	298	n/a	n/a	n/a	n/a	n/a
R6	1017	n/a	n/a	n/a	n/a	n/a
M1	695	5.0	139	3	133	102
Total	**31754**	**-**	**3513**	**1630**	**1932**	**1449**

Many of Duncan's residential streets are (overly) wide with minimal to no boulevard (landscaped) area available for planting trees. Typical boulevard width, not including sidewalk, is between 0 and 1.5 meters. Most boulevard areas exist as narrow utility corridors (<0.5 meters wide) between the sidewalk and adjoining private property. Overhead lines are common on most streets and present a potential conflict for taller trees.

Providing enough room for tree growth (including roots and crowns) while avoiding infrastructure conflicts will be a challenge. R3 zones with sufficient boulevard widths (1 to 1.5 meters) are the best candidates for tree planting as the plantable spots already exist. Some site preparation may be required, as will an assessment of soil volume/conditions and existing infrastructure. R1 and R2 zones will require significant more preparation as boulevards would have to be created to accommodate new trees.

Photo: An example of R2 **-** No boulevard exists for planting of public trees but there is abundant space allocated to the roadway, which can be reduced.

Photo: An example of R3 - A boulevard exists for the planting of public trees

A reduction in road width, and in some cases (R1), removal of on-street parking, will be required to accommodate new street trees. There are many advantages, however. Treed boulevards would create a more pedestrian friendly environment by separating vehicles from the sidewalk. Narrower streets would also help to calm traffic and provide opportunities to develop designated bicycle lanes. Trees also tend to optically narrow streets, which add to the calming effect. Lane widths as narrow as 2.7 meters (9 ft.) have proven to be drivable, safe and effective at reducing car speed. Various boulevard configurations and street calming features can be used

to accommodate additional trees. These include roundabouts, raised medians, and intersection bulbs/chokers. Additional benefits of more street trees in residential areas include increased shade, improved street design and aesthetics, reduced stormwater management costs and higher property values.

Photo: An example of R2 - Private property abuts the existing sidewalk. Currently there are plantable spots on public land but there is abundant space allocated to the roadway, which can be reduced.

Photo: An example of R2 - No boulevard exists for planting of public trees but there is abundant space allocated to the roadway, which can be reduced.

The following photos depict some common residential streetscapes in East Vancouver. Trees are planted (generally at 10 meter spacing) in wide boulevards that can accommodate root and trunk growth. Lanes are reduced to accommodate on street parking in either direction with one travel lane. The reduced lane width acts to calm traffic and reduces the amount of paved surface to maintain. Stormwater is also reduced due to increased interception of rainwater by trees and ground infiltration. Other benefits include improved walkability for pedestrians (increased shade and aesthetic, wider boulevards and separation from traffic). Numerous species of wildlife also use treed streetscapes for habitat. Birds commonly use these areas to forage and nest, which provides an additional sense of life and vitality to urban streets. Home values have also been shown to increase with presence of large street trees.

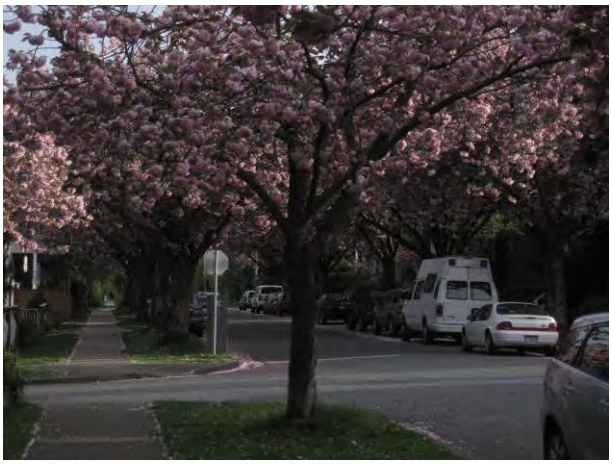


Photo: Cherry trees on Vancouver East Side streetscape.

Photo: Tree canopy provides shade for pedestrians and important habitat for birds and other wildlife.

The City of Vancouver manages its street trees; however, it is the responsibility of homeowners to maintain the boulevards. In most cases, this involves regular mowing of grass during the growing season. However, homeowners can also choose to landscape these areas with either native or non-native plant species. Naturescaping can often reduce the amount of maintenance required and limit noise associated with gas or electric lawnmowers. In addition, it improves overall aesthetics and provides valuable wildlife habitat. The City also may provide expanded boulevards to improve urban design. Some of these can accommodate small community gardens.

Photo: Small community garden at traffic intersection. Parking is set back to improve visibility and define pedestrian space.

Photo: Boulevard planted with both native and non-native species, which is an extension of the landscape theme for the property.

Rec 35 Initiate a tree planting program to prioritize and plant 75% of plantable spots by 2040

Rec 36 Educate the public regarding the possibilities for tree planting

3.3.3 Commercial and Parking

Infill development provides a good opportunity to 'green' existing areas of the City that generally have fewer trees. Traditionally, these include areas within the urban core (commercial districts) and industrial zones. Many cities are pursuing planning initiatives that provide more walkable space and reduced lane widths. The re-design of existing street configurations to achieve these objectives often creates more plantable space along sidewalks, parking lots, meridians and curbs.

The OCP encourages alternative street and parking designs to meet environmental protection and community sustainability objectives. Tree planting is an important component of this strategy. Policies for parking include 8.4.22 and 8.4.23 which encourage visual screening and reduction of permeable surfaces. Policies 8.4.16 and 8.4.21 support development of "green streets" with narrower lanes and traffic calming.

Commercial

The Commercial classification covers all streets within commercial zones. This includes a range of retail and office uses, restaurants and some public open spaces. Again, private property lines abut existing sidewalks in a majority of these areas, with no additional landscaped areas sufficiently large enough to support trees. Six classes were developed based upon an assessment of available space for additional trees:

C1 – Private property abuts the existing sidewalk. Currently there are no plantable spots on public land without removing existing parking and/or taking space currently allocated to the road;

C2 - Private property abuts the existing sidewalk. Currently there plantable spots on public land but there is abundant space allocated to the roadway, which can be reduced;

C3 - Private property does not extend all the way to the existing sidewalk or road, therefore there is room for the placement of trees before the sidewalk or room on the road side of the sidewalk;

C4 - Private property extends to the existing sidewalk or road and it is already planted;

C5 - Private property does not extend all the way to the existing sidewalk or road, and it is already planted;

C6 - Private property does not extend all the way to the existing sidewalk or road and there is no space available to install trees.

Table 9 provides a summary of plantable spots according to Commercial Class. Both sides of the roadway are included as part of the measure for linear distance. A map showing the location of each Class is contained in Appendix E.

Table 9. Plantable spots for street trees in commercial district

Class	Linear Distance (m)	Spacing (m)	Total Plantable Spots	Existing Trees	Net Plantable Spots	Plantable Spots 75% Target
C1	3473	7.0	496	86	410	308
C2	3364	7.0	481	121	360	270
C3	1428	7.0	204	34	170	127
C4	881	n/a	n/a	n/a	n/a	n/a
C5	1112	n/a	n/a	n/a	n/a	n/a
C6	1819	n/a	n/a	n/a	n/a	n/a
Total	**12077**	**-**	**1181**	**241**	**940**	**705**

Duncan's commercial areas have a current canopy cover of 8.5%, which is significantly below the recommended target of 15%. Approximately 383 trees would be required to reach this target. Due to space limitations typical of many commercial areas, most opportunities for tree planting occur on streets and parking lots. A total of 1181 plantable spots have been identified in C1, C2 and C3 classes. Existing trees occupy approximately 241 spots. This leaves approximately 705 plantable spots based upon a target stocking level of 75%.

Photo: Example of C2 designation

Photo: Station Street

Most commercial streets do not have boulevards wide enough to accommodate new trees (C3); however, there are significant opportunities to reduce road width while still accommodating on-street parking (C2). This would require work similar to what has been completed on Craig Street and Station Street, which expanded sidewalks and boulevards to accommodate new trees. Sidewalks on these two streets are wider and more pedestrian friendly (aesthetics, shade, etc). Trees with columnar shapes are recommended to address issues with obscuring signage and potential conflicts with adjacent buildings and infrastructure.

Rec 37 Plant species-appropriate street trees in commercial areas according to plantable spots inventory

Rec 38 Implement urban design guidelines to enhance pedestrian environment in commercial districts, including larger sidewalks and boulevards to protect and maintain trees

Rec 39 Address business concerns related to planting of new trees, including development of commercial development and enhancement strategies and parking guidelines

Parking

Improperly designed parking lots can have negative impacts which should be considered:

- Large, impermeable surfaces do not allow rainwater to infiltrate into the ground;
- Water is redirected to stormwater management systems which are expensive and must be maintained;
- Temperatures in parking lots are often higher contributing to urban heat island and increased greenhouse gas emissions; and
- Presence of parking encourages vehicle use can contribute to less densification, fewer open spaces and a less pedestrian friendly environment.

There are opportunities to increase the amount of landscaping and trees in parking lots to mitigate these impacts. The City does provide some parking policy within the OCP but these provide few guidelines for planting trees. In addition, there are no incentives to encourage landscaping beyond bare minimum requirements.

Photo: A recently installed parking lot that incorporated tree planting along its edges.

Photo: an example of a well-planted parking lot

Parking lots with more than ten parking spots were classified to determine their potential for additional tree planting. An analysis of the number of plantable spots was not completed. Many of these parking lots are on private property so the municipality is limited in what can be done to encourage additional plantings. However, it is worth considering the total area of impervious cover and the lack of trees within these areas. There is a significant potential to increase canopy cover in the downtown core by addressing the lack of trees or vegetation in these lots. Parking lots were classified based upon the number of trees present compared to available planting spots. A map showing the location of each Parking Class is contained in Appendix E.

P1 - Parking lots that incorporate mature trees (if present) and has landscaping to provide a buffer between the asphalt and buildings. Plantable spots are limited;

P2 - Parking lots that have few trees. Plantable spots are available;

P3 - Parking lots that have very few to no trees. Plantable spots are abundant;

P4 - Parking lots that have few to no plantable spots possible;

P5 - Parking lots that are already planted with trees and no additional spots are available.

Photo: An example of a relatively recent development that incorporated mature trees and landscaping into its parking lot design

Photo: An example of where there is ample room for a vegetated buffer between parking stalls

Rec 40 Require that trees be incorporated into the design of all new parking lots

Rec 41 Provide incentives to redesign existing parking areas to incorporate trees and other vegetation

3.3.4 Parks and Institutional Grounds (Schools)

Parks and Institutional Grounds were classified according to their uses and management objectives. Plantable spots were estimated using professional judgment of forest cover and stocking levels for local ecosystems. A map showing the location of Parks and Institutional Grounds is contained in Appendix E.

Park Active (PA) – These park areas support active pursuits and facilities such as children playgrounds, tennis courts or community gardens;

Park Tourist (PT) – Hoey Park is the only one with this designation. It has historic significance and also acts as a hub for transportation and a downtown green space;

Sportfield (SF) – There are two sports fields located in McAdam and Rotary Park;

Park Institutional (PI) – These include school properties, churches, the municipal works yard and government owned properties.

Parks and Institutional grounds provide some opportunities for planting. However, there are specific issues that will influence how much planting can occur. Sportsfields (e.g. McAdam) require a significant amount of open space generally restricts planting to peripheries. Hazard tree and leaf maintenance can also be issues that tend to dissuade planting in close proximity to fields. Alternatively, opportunities do exist to strategically plant trees for shade and windbreaks.

Active Parks also require more light and room, resulting in lower stocking levels. Centennial Park does have strategic planting opportunities which can support other features and amenities. Riparian planting can enhance habitat values and ecological integrity of the creek. Also, additional planting can enhance the new rain garden by providing more diversity. Likewise, trees could be planted to complement the community garden.

Hoey Park is a prominent public space close to downtown with significant potential for additional tree planting. Overall design and functionality of the park can be improved by creating treed corridors to visually screen adjacent parking lots and provide definition for planned bike lanes. Reducing the number of parking lots should also be considered to create more linear green space.

Photo: Centennial Park

Photo: McAdam Park

3.3.5 Natural Areas

Natural areas should be identified that could be restored or enhanced by planting native tree species. This includes areas denuded of tree cover due to site disturbances such as windthrow, pest and disease outbreaks or human impacts. This could also include mature, even aged forests that have poor natural regeneration in the understory.

The classification for Natural Areas (NA) was based upon park spaces where native vegetation predominates. Six natural areas were identified. Two are of significant size, while the remainder are small remnant forest patches. Descriptions of the City's two major natural areas (found in Rotary and Centennial Parks) are provided below. The number of plantable spots was calculated using natural stocking densities for young and mature forests in this eco-region. A map showing the location of Natural Areas is contained in Appendix E.

NA2 – This 2.35 ha site is located on a moderately steep, west facing slope and incorporates part of Centennial Park. A creek flows along the toe of the slope; a residential area is located above the slope crest. Forest cover in this area provides additional benefits including slope stabilization and riparian habitat. Therefore, it is important to retain a healthy forest community over the long-term. Infill planting of western redcedar and a minor component of grand fir is recommended to replace dominant bigleaf maple and black cottonwood. These trees are approaching maturity and will eventually be in decline. A tree risk program should prioritize areas of native forest cover adjacent to homes for assessment.

NA6 – Rotary Park is an 8.4 hectare area located adjacent to the Cowichan River. It is predominantly a riparian area that is prone to flooding. Approximately ten percent of the total area can be planted at a density of 500 stems per hectare. Infill planting with western redcedar, sitka spruce and grand fir is suitable on the in higher areas where flooding is not expected. Pacific willow and black cottonwood trees should be planted in more open areas (where light is abundant) on floodplain benches. New plantings should be spaced no closer than 2.5 meters from existing trees.

Photo: Rotary Park – there is abundant space to increase the tree canopy while providing important flood attenuation services.

Photo: Centennial Park – opportunities to plant western redcedar and grand fir in understory to increase canopy cover

Rec 42 Identify and prioritize natural areas that provide opportunities for planting of native species

3.4 Tree Planting Specifications

Trees within the urban environment generally established one of two ways: either by planting or through natural germination. In nature, trees establish and develop on the landscape as part of a natural process known as natural succession. Many of the region's urban forests followed this process, having regenerated following historical logging and eventually growing into mature, secondary forests. Natural regeneration is generally not possible in intensively managed urban environments; therefore, managers will have to rely primarily upon planting for tree replacement, supported by a long-term maintenance program.

3.4.1 Green Neighbourhoods

The City of Duncan is relatively small in area and has several established neighbourhoods. These include Cairnsmore, Centennial Heights, Chesterfield, Coronation and Marchmont. In addition, there is the downtown commercial district. Although each of these neighbourhoods has specific issues, public consultations for the Official Community Plan have shown that preservation of green space, improving walkability and connectivity between neighbourhoods is a common theme (Section 8.1 of the OCP outlines policies for development of green neighbourhoods with distinct identities).

An assessment of neighbourhood streets, parks and natural areas should be completed prior to undertaking any specific management action on the ground. This will ensure that trees, neighbourhood objectives and other planning initiatives (e.g. trail or greenway development) are given proper consideration prior to any planting. Consideration should be given to both ecological and aesthetic suitability, urban design, and potential infrastructure conflicts. An assessment of street or neighbourhood character can help determine the types of trees and planting schemes that can enhance other features. Street trees, for example, can be used to emphasize boulevards, accentuate buildings, frame entrances, screen unsightly structures, and even create intimacy on sidewalks (Clouston and Novell, 1981). Tree planting strategies for natural areas may focus more on ecological benefits or providing connectivity between fragmented habitats. Community involvement is important to help shape this vision. Management considerations may include:

- Landscape character analysis;
- Street/park tree constraints;
- Tree planting opportunities;
- Tree species selection;
- Tree population/cover targets;
- Tree planting schedule;
- Tree maintenance schedule; and
- Operational budget.

Rec 43 Implement tree planting strategies that support community planning and sustainability objectives for green neighbourhoods

3.4.2 Site Ecology

Ecological conditions that influence tree and plant growth can vary significantly according to the topography, hydrology, soil properties and local (micro) climate associated with a site. In many forested areas, these conditions are a result of natural ecosystem processes that have occurred over a long time. In contrast, the ecological condition of disturbed areas (marked by human activity and development) has generally evolved within a relatively short period. This variability can have a significant influence on tree establishment due to differences in soil moisture and nutrient regimes and rooting conditions. Another consideration is future climate change which may alter current ecological (i.e. growing) conditions. Potential impacts include reduced rainfall and drought. This may affect current species composition and be a significant factor in determining what trees can best grow in the region.

The ecological conditions of a given site provide an indication of its ability to support tree growth. A healthy tree requires sufficient light, water and nutrients. These ecological requirements, in addition to a tree's tolerance to

their absence or deficiency, vary according to individual species. Selecting trees which are naturally adapted to a site's ecology increases the chances that they will remain healthy and vigorous over the long term. This strategy is also much more cost effective than altering a site to meet the tree's requirements (McPherson et al., 2002). Each site considered for planting should be evaluated to determine its ability to support vigorous long term growth for a selected species throughout its lifetime. Some site specific elements to consider include:

- Soil moisture and nutrient availability;
- Soil volume, texture, compaction, pH;
- Soil contamination;
- Drainage (well drained to standing water, stormwater runoff, irrigation);
- Shading (full, partial, none);
- Cold air ponding;
- Invasive species;
- Wind patterns;
- Existing ground cover (e.g. grass);
- Human and wildlife impacts;
- Changing conditions due to climate change; and
- Urban design objectives.

Figure 1 provides a guide for ensuring there is sufficient soil volume to support a tree through to its maturity. Information is based on data collected and published in the Journal of Arboriculture 18(2): March 1992. The Upper Limit Area (the area between the average line and the upper limit line) are values that should be used in the case of poor soil conditions such as compacted and/or degraded soils (i.e. street medians and roadside plantings). The soil volume selected should reflect the severity of compaction and grading at the planting site. The Lower Limit Area (the area between the average line and the lower limit line) show values that may only be used in ideal soil conditions (i.e. native, undisturbed soils). The soil volume selected should reflect the amount of construction activity at the planting site.

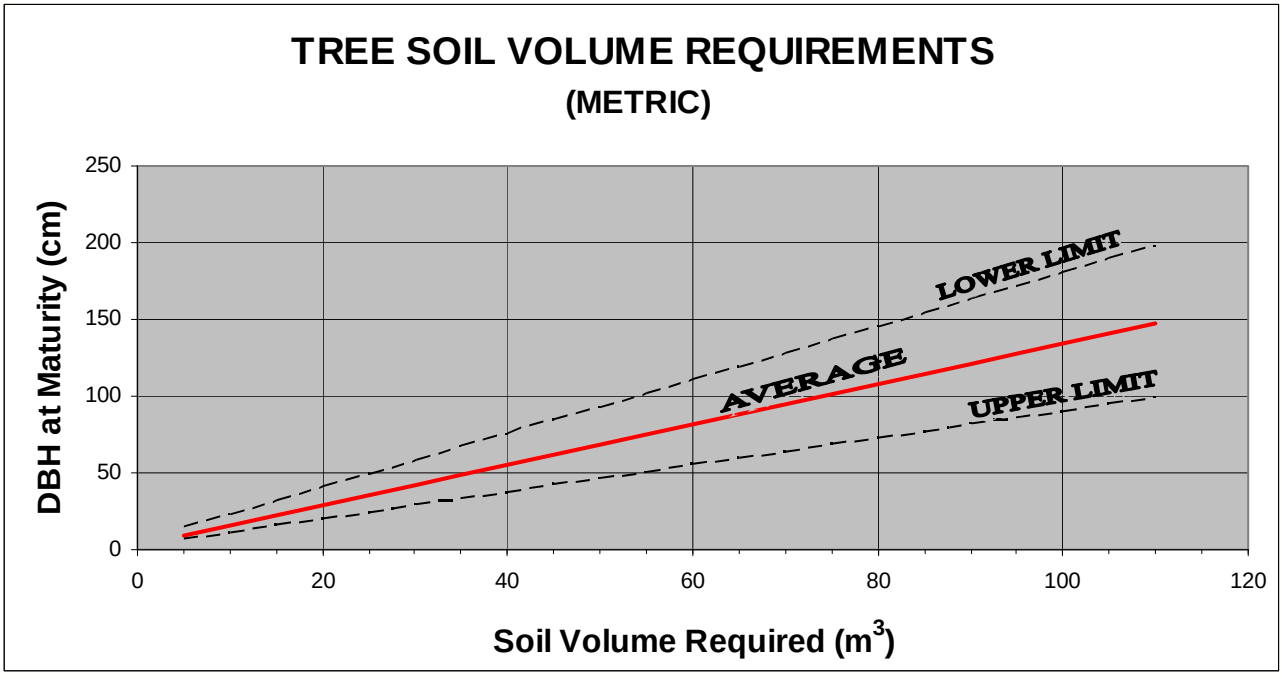


Figure 1. Ideal tree soil volume requirements given the diameter at breast height of the tree to be planted at maturity

3.4.3 Tree Species Selection

Tree species have specific characteristics that make them more or less suitable to particular site conditions, whether that is defined by the ecology or surrounding urban design. Aesthetic appeal has historically been a primary consideration when selecting street trees. Colour, form, canopy size, and year round visual appeal of trees contribute significantly to overall urban design and livability of our cities.

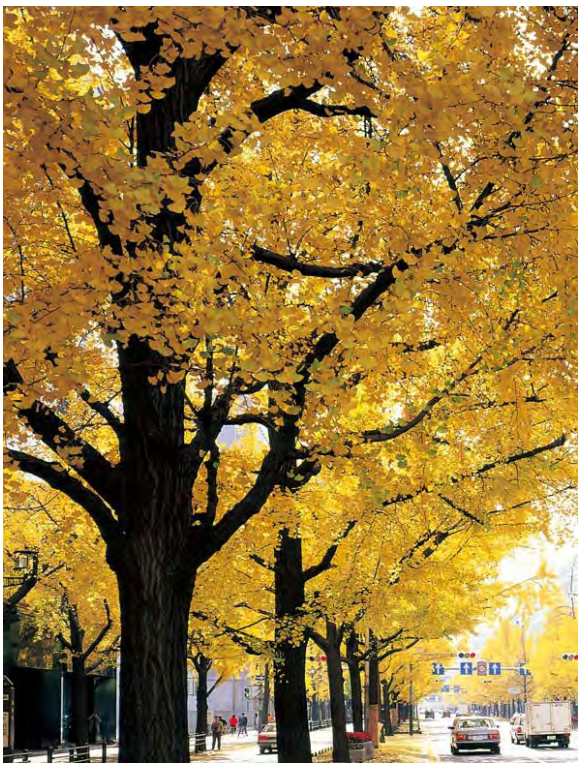


Photo: Gingko tree

Consideration of the physiological requirements of a tree species and the site's ecological conditions is equally important. Trees grow at a relatively slow rate and can live for hundreds of years. The mature size, ecological integrity and longevity of trees must be considered. Choice of species should reflect tolerance thresholds for rooting volume, temperature and moisture. Species distribution and diversity (native versus exotic) should reduce the risk of potential disease and insect outbreaks. Fruit-bearing potential is also becoming more important as urban agriculture expands; however, clean-up costs must be evaluated.

Many of the ecological benefits attributed to trees generally correlate with their size. Larger trees intercept more water, sequester more carbon, block more wind and provide more shade. Wherever possible, larger species which are ecologically and physically suitable for the growing space should be established.

A tree's ability to adapt to current and changing conditions will determine its long- term viability on a site, in addition to influencing the type of management actions that will be required to maintain it. Hardy tree species that are able to withstand the unique conditions found within the city (exposure to pollution, vehicles, confined growing spaces, etc.) will generally be more resilient over time. This reduces costs associated with maintenance and replacement of trees. Selecting tree species that can respond positively to future climate change is also advantageous. Drought tolerant species may be of particular interest in future years due to expected temperature increases and reduced water availability.

Photo: London Plane tree

Following is a summary of tree attributes that should be considered when determining site suitability:

- Consider predicted climate change (drier summers and cooler winters);
- Resistance to pests and disease and other damage agents;
- Habitat attributes (toxicity, seeds, nuts, berries, food trees);
- Rooting characteristics (depth and width);
- Foliage type (deciduous or coniferous);
- Water requirements and drought tolerance;
- Growth rates;
- Evergreen/deciduous;
- Suitable planting locations;
- Maintenance requirements - trainability/ prunability (e.g. for overhead power lines);
- Age (expected lifespan);
- Size (mature tree height and diameter);
- Root volume required;
- Sustainability;
- Disturbance history;
- Genetic variability (Cultivars);
- Crown shape and density;
- Ecological services provided (solar, wind, carbon storage etc);
- Urban design objectives for area.

Photo: Littleleaf Linden tree

A City-wide list of suitable street and park trees has been developed as part of the Planting Palette; however, it provides a limited diversity of trees to choose from. An additional list of acceptable (and unacceptable) species has been provided in Appendix F. These species are considered ecologically suitable for the local climate; however, the conditions of each micro-site must be determined before planting to ensure long-term tree health and longevity. This list should be regularly reviewed and amended as required to ensure that it addresses management needs and current climate and ecological conditions. Potential candidates should be evaluated based upon their ecological suitability, aesthetic appeal, longevity, growth rates, susceptibility to disease and pathogens, ecological benefits and maintenance requirements. In areas with more development (e.g. residential streets, commercial centers), site conditions and conflicts with buildings and infrastructure should be given more consideration. Lists should also indicate which species are suitable for solar shading, wind breaks or carbon sequestration. This inventory should be maintained and updated regularly, in addition to being consulted when more specific Neighbourhood Street Tree Plans are being developed.

The following priorities should be considered when selecting a tree:

- Prefer site suitable tree species that are underrepresented on the landscape;
- Increase species diversity to ensure that no non-native species occupies greater than 10% of street/park tree inventory;
- Prefer native species where site elements are appropriate; and
- Prefer the largest species feasible for the growing space.

Photo: Japanese Maple

Increasing tree diversity on the landscape reduces susceptibility to pest and disease incidence that can be associated with monocultures. In addition, it improves aesthetic variability on the urban landscape. Ensuring that no one species occupies more than 10% of canopy cover is a recommended strategy to reduce the potential for serious outbreaks that can be difficult and costly to manage. McPherson et al. (2002) recommend even more stringent criteria of 12% for a single genus and 5% for any one species. Cherry is currently the only tree species that is overrepresented in Duncan's street tree inventory at 14.7%. Exotic maple (8.3%), Douglas-fir (7.5%), plum (7.1%), Bigleaf maple (7.0%) and cedar (5.6%) are the next most common species.

Native tree species can be a good choice for planting due to their ecological suitability to local conditions; however, there are important considerations. Conifers such as Douglas-fir (*Pseudotsuga menziesii*) and western redcedar (*Thuja plicata*) require large rooting volumes and growing space and are not suitable for planting close to infrastructure. These species are considered good choices in natural areas to promote ecological connectivity across the City. Western hemlock (*Tsuga heterophylla*) poses particular management concerns due to its susceptible to windthrow, decay and structural defects. Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) and red alder (*Alnus rubra*) are native deciduous species that play important roles in natural areas but are generally associated with decay and other defects as they age, making them particularly onerous for management. Due to their relatively low aesthetic values, they are not a recommended tree species outside of natural areas. Garry oak (*Quercus garryana*) and bigleaf maple (*Acer macrophyllum*) can be a good choice (depending upon the site) due to their longevity and aesthetic value. Garry oak ecosystems are endangered on southern Vancouver Island and Gulf Islands; due to their uniqueness, opportunities to establish Garry Oak trees and groves in streets, parks and natural areas are encouraged. Pacific dogwood (*Cornus nuttallii*) is an ecologically suitable, low growing tree with good aesthetic value.

Photo: Garry Oak

Photo: Pacific Dogwood

Rec 44 Develop and update neighbourhood street tree plans based upon the expanded preferred and not preferred tree species selection list

3.4.4 Maximizing Ecological Benefits

A coordinated planting strategy can capitalize upon the ecological benefits provided by trees, resulting in reduced costs for residents, developers and the City. For example, expanding boulevards on residential and commercial streets to accommodate more trees reduces the amount of hard, impermeable surface that needs to be maintained. In addition, shading of sidewalks, streets and parking areas reduces the heat that is stored and reflected by paved surfaces which helps to counter the urban heat island effect. Additional trees intercept rainfall, slow overland flow and absorb water through their roots. This has implications for stormwater management, as the amount of infrastructure required to manage surface water is reduced.

Strategically planted trees can also reduce energy use. Deciduous trees planted on the south and west side of buildings can provide shade during the summer months and permit more sunlight in late autumn and winter when the leaves have dropped. This can dramatically reduce the cost of air conditioning and heating throughout the year. Some solar friendly deciduous species, such as ash and maple, are particularly well suited due to their branching structure (McPherson et al., 2002). Trees are effective at dissipating wind and their presence can significantly reduce heating requirements during the winter months. Where buildings or public spaces are highly exposed to wind, tree species such as dense conifers should be considered to help dissipate its force.

Rec 45 Recommend species and spatial locations that will maximize building energy saving throughout the year

3.4.5 Planting Criteria to Avoid Infrastructure Conflicts

As a tree grows and matures, it requires greater soil volume, nutrients and water to support its life functions. In natural environments, those tree species that are most suited to a site's ecological conditions become established and will compete with other trees for available growing space and resources. The urban environment poses unique challenges for tree establishment. Although the genetic and physical characteristics of a particular species determine a tree's potential size, its growth is most often limited by restrictions placed on it by urban infrastructure (e.g. buildings, roads, sidewalks, underground pipes, overhead lines, etc).

Available soil resources (potential rooting volume) and growing space can restrict a tree's ability to meet its long term growth potential. Conflicts occur when trees begin to outgrow this space. For example, many street trees are planted in sites that do not have sufficient soil volume. Over time, the roots of these trees naturally grow under adjacent infrastructure which can cause extensive damage to hard surfaces such as sidewalks, roads and curbs. Other common conflicts include trees growing into overhead lines and adjacent buildings and inhibiting important sight lines for driving. These types of conflicts can become costly to maintain and pose potential safety concerns to the public.

Photo: An example of a cherry tree roots in the City of Vancouver causing sidewalk damage

Photo: Trees help define the character of a neighbourhood.

Planting Guidelines

The most effective strategy for limiting potential conflicts between trees and urban infrastructure is to select the appropriate trees species for the growing site. Selecting a tree with root, size and form characteristics best suited to the soil volume and physical limitations of a particular site greatly reduces the costs associated with site preparation and future maintenance. Additional considerations include types of human activity, intensity of use and potential disturbance. Some tree species (for example, those with thicker bark) may be more resilient to mechanical damage while others might be extremely susceptible to pollution associated with busy streets. Specific guidelines specify for how trees should be planted, protected and maintained on public land are provided in Appendix G. For site specific advice on tree species and growing specifications, qualified professionals (ISA certified arborists) should be consulted.

Considerations for tree planting include:

- Tree species characteristics including mature crown size, spread, shape and rooting;
- Distance/spacing between trees;
- Infrastructure design including minimum distances from center of tree to buildings (1.5 to 3 meters), curbs, intersections, driveways and alleys;
- Minimum distance to infrastructure such as fire hydrants, poles, gas or water valves, manholes, stop signs etc;
- Maximum height of tree in relation to overhead conflicts such as powerlines;
- Engineering products such as porous surfaces, structural soils, root barriers, pavement characteristics;
- Planting requirements including tree stock standards, timing and soil preparation;
- Height, width, rooting depth and shape of a ***mature*** tree prior to planting;
- Appropriate setbacks from buildings and other infrastructure to reduce future conflicts;
- Strategic planting. For example, planting deciduous trees on the south and west facing sides of a building will provide shade in the summer and light during the winter;
- Location of underground utilities prior to digging;
- Use of continuous trenching for planting multiple trees in boulevards;
- Application of mulch (re-use of wood chips from regular pruning); and
- Appropriate time of year for planting.

Proper planning of newly planted trees will help to avoid future conflicts and reduce maintenance costs. However, there are many trees currently growing in urban environments that are causing infrastructure damage. Mitigation plans, based upon an assessment of tree and site conditions, should be developed on a priority basis to ensure that timely corrective action is undertaken and that the problem is not exacerbated. Tree removal should be considered as a last resort.

3.4.6 Tree Easements

Sometimes, existing public right-of-ways do not have boulevards wide enough to plant street trees or there are obstacles such as overhead lines that may create a conflict. In these cases, many jurisdictions have pursued opportunities to plant public trees on adjoining private property. This strategy can be cost effective and provide benefits for both the City and the landholder.

Tree easements can be established, with consent of the property owner, to allow planting of trees within a designated area close to the boulevard. The City provides the trees and typically maintains them, although this responsibility can be shared (initial tree watering, for example). Alternatively, contracts or volunteer adopt-a-tree programs can be implemented that do much the same thing. In these cases, private landholders promise not to remove trees after they have been planted unless conditions change. If ownership changes, it is generally up to the new owner to determine whether or not the trees remain. However, in areas where these types of agreements have been implemented, most trees have been retained in these instances. A Tree Protection Covenant which runs with the land may also be registered by a landowner, generally ensuring that successive buyers are bound by the original conditions.

3.4.7 Funding

External funding opportunities exist to support urban forest initiatives. Duncan's Official Community Plan (Policy 8.1.9) encourages funding for green initiatives through provincial and federal funding programs and community sponsorship.

Tree Canada is a national organization which promotes tree planting to improve quality of life. It has two programs of interest. Green Streets is an urban forest initiative that provides over one million dollars annually to community environment and wildlife projects. The Greening Canada's School Grounds Program encourages

urban forestry projects on school grounds to promote cleaner, greener learning environments. Fifteen (15) schools have been selected in each of the past two years (2009 and 2010) for this initiative.

Evergreen is a national organization that provides funding for community and school greening programs. Several grants are offered. These include:

- Learning Grounds School Ground Greening Grant to create outdoor classrooms and food gardens(to $2000);
- Common Grounds Grant for community projects in partnership with municipalities that protect and restore urban green spaces on public land (e.g. parks);
- Evergreen Green Grant for community-based restoration and stewardship initiatives (to $10,000); and
- Rebuilding Nature Grant for community groups to cover plant and equipment costs and other related expenses for environmental stewardship projects.

Numerous other government organizations fund environmental stewardship programs. Environment Canada funds community projects through its EcoAction Program. Municipalities are not eligible as single applicants; however, they are encouraged to apply with eligible partners, including community, environmental, senior, youth, service and First Nations groups. BC Hydro has also been a significant funder of community tree planting programs in the past and continues to do so. Trees for Tomorrow was a provincial program (ending in 2009) which provided funding for restoration and planting projects in communities in an effort to reduce greenhouse gases. This program was discontinued due to the economic downturn, prior to fulfilling its mandate. It may be restarted in the future.

3.4.8 Nursery Establishment

It may be economical to develop a nursery to grow suitable tree and plant species for future planting within the City of Duncan. A cost benefit analysis should be completed to evaluate the feasibility of developing and maintaining a nursery that would provide trees for streets and open spaces and plants for landscaped and natural restoration areas. This analysis should consider the benefits of partnering with other municipalities to improve efficiencies.

Rec 46 Evaluate the feasibility of developing and maintaining a nursery to provide trees for streets and open spaces

3.5 Tree Maintenance

The unique conditions and values associated with the urban environment require that trees be managed throughout all of their life stages. Since many trees are long-lived, the management timeline for any one tree could potentially be multi-generational. Planning for long term and regular maintenance will improve tree health and reduce mortality rates. These measures can also serve to protect public safety and prevent damage to infrastructure, buildings, vehicles and other values associated with urban streetscapes.

Street trees generally require more intensive management due to their proximity to roads, buildings and other infrastructure such as overhead utility lines. Street trees also suffer significantly more damage and mortality; and therefore require more maintenance and replacement. Park trees often have high aesthetic, cultural or historic values and require additional management sensitivity. Trees in natural areas generally do not require the same level of maintenance due to reduced exposure to human agents and isolation from infrastructure.

3.5.1 Monitoring and Assessment of Tree Health

Monitoring is an essential component of a tree management program. It can be a valuable tool to assess tree growth and forest health in addition to providing important feedback regarding the effectiveness of any specific management actions being taken. As an early detection mechanism, monitoring can alert management of potential costly issues such as pest or disease incidence or hazards before they fail.

A proactive approach to tree maintenance will be cost-effective in the long term. A maintenance cycle should be established that includes regular detailed and systematic inspections of all street and park trees within an appropriate time frame. A block management approach is recommended to ensure that all trees are assessed in detail. This strategy, which involves the systematic inspection of all trees within specified zones (or blocks), has been shown to be considerably more efficient than on-request pruning protocols, where the City responds to public requests for tree maintenance on a case by case basis. (Halstead, 1999)

With the block management approach, the City is separated into individual management units or "blocks". These should be based upon existing neighbourhoods: Cairnsmore, Centennial Heights, Chesterfield, Coronation, Downtown and Marchmont. All trees within each block (or neighbourhood) are assessed prior to moving onto the next one. Often, blocks are assessed on an annualized basis within a set rotation. In this case, a six year rotation could be implemented based upon the six identified neighbourhoods or smaller neighbourhoods could be combined into a larger "block" to increase monitoring and maintenance frequency.

Inspection intervals should be short enough to ensure that any potential defects affecting a tree's health do not have time to develop and cause lasting harm or require costly mitigative actions. When a problem tree is identified, it should be carefully examined with consideration of its growing environment and potential options for mitigating the problem. Factors to be considered when assessing a tree include:

- The tree species, its long-term soil volume requirements, root system characteristics, crown shape and form.
- The health of the tree including any pests and diseases and the level of infestation;
- Structural defects and tree risk concerns;
- Site conditions including available soil volume, soil condition including compaction, water and nutrient availability; and
- The location, proximity and nature of adjacent infrastructure.

Potential mitigation options include modifications to the tree and/or the growing site. Tree removal should only be considered as a final resort. In all cases, qualified professionals, including an ISA Certified Arborist and/or a Professional Engineer, should be consulted.

Rec 47 Develop a long term street tree monitoring schedule using a block management approach

3.5.2 Hazard Tree Assessment

Although the block management approach provides a detailed assessment of all street trees on a regular basis, it focuses primarily upon tree health. A complementary system should be implemented to specifically manage risk. 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. The City of Duncan is responsible for a large number of trees and needs to consider the management of these trees to ensure they are safe for the public. In a legal sense, managers of large forests have a 'duty of care' to consider. 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."

It is neither possible nor feasible to anticipate and eliminate every risk associated with all trees in the City. The factors affecting tree morphology and forest dynamics are too unpredictable. It should be recognized that no trees can be considered completely safe. Continued growth and development in our cities, in addition to other environmental pressures such as climate change, are constantly changing the face of the Urban Forest. Therefore, a more focused approach to managing tree hazards and risk is required.

Photo: Hazard tree

Hazard and risk are terms which require clear understanding as effective tree management programs assess both. A hazard tree is defined as any tree that contains a structural defect that might cause it (or any part thereof) to fail *and* cause damage, personal injury or death. Using this definition, not every tree that has a defect is hazardous. There must be something (i.e. a target) for the tree to hit for it to be considered a hazard. Risk is defined as the likelihood of a failure to occur. It is preferable to use terms such as "low", "medium" or "high" risk to 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.

Tree risk inspection is a systematic process that reviews risk factors and ranks them into risk categories' (PNW Chapter ISA Release 1.1, 2000). The current standard of care for tree risk inspections in urban areas is the Tree Risk Assessment in Urban Areas (TRAUA) and the Urban/Rural Interface Course provided by WorkSafe BC and the Pacific Northwest Chapter of the International Society of Arboriculture. The standard of care for tree hazard inspections in large forested parks and natural areas is the Wildlife/Danger Tree Assessors Course provided by WorkSafe BC and the Ministries of Forests and Range and Environment. Certified Assessors who have completed these courses have a comprehensive understanding of tree biology, the properties of wood, theory of risk assessment and professional responsibilities.

Many cities manage hazard trees using a reactive approach. Trees that may be a risk are brought to the attention of the City by the public or City Staff. These are assessed, usually by a certified arborist employed by the City, and a decision is made on whether risk abatement is required. While this addresses immediate concerns, it does not show due diligence in recognizing the inherent risks associated with trees. It is important that tree risks are identified early in the inventory process and then prioritized for mitigation or removal. This will ensure that there is less chance for weaknesses or defects to become hazardous, resulting in potential damage or unwanted removal of the tree. Proper management will also lead to permanent reductions in liability.

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. All hazard tree inspections should be completed using the procedures outlined in the Tree Risk Assessment in Urban Areas and the Urban/Rural Interface Course. Inspections should be conducted by Tree Hazard Assessors who have passed this course and are certified by the International Society of Arboriculture.

Rec 48 Adopt the Tree Risk Assessment procedures outlines in the Tree Risk Assessment in Urban Areas and the Urban/Rural Interface Course as the standard of care for the City of Duncan

Rec 49 Tree risk inspection should only be conducted by people certified as 'Tree Risk Assessors'

The tree risk inspection procedure assigns a numeric ranking of risk based upon three factors: Probability of Failure (scale of 5); Size of Defective Part (3) and Target Area (4). Four risk categories (low to extreme) are assigned based upon the combined score of each factor. The TRAUA provides management recommendations based on these risk categories; however, these should be modified to reflect the risk management policy of the City.

The TRAUA provides general descriptions for target areas from 1 (Low) to 4 (High). These should be used to rank targets throughout the City based upon property value and/or frequency of human occupation. An abatement threshold should be established for each target area category. Targets areas that are low should require abatement only if the failure potential is high to avoid unnecessary removal of trees that provide wildlife habitat in natural areas. Removal thresholds should be more stringent for target areas with a higher value. Thresholds for abatement action should be developed by the City in consultation with their legal department and certified assessors that are familiar with the TRAUA system.

Rec 50 Develop thresholds for each target area over which risk abatement is required

Rec 51 Define the targets found throughout the City from 1 to 4 based upon the descriptions provided in the TRAUA

Tree Risk Inspection Schedule

The City of Duncan should adopt a management approach that identifies any foreseeable events/factors that could potentially cause harm to people or property in relation to tree hazards. A comprehensive hazard tree program requires that the risk associated with trees is mapped across the City. This includes the delineation of areas that have a moderate to high probability of failure and the related consequence. Establishing zones (red, orange, green) related to a specific hazard category (based upon target assessment) and frequency of traffic (vehicles, bus, bicycle, or pedestrian use) is an effective method to balance management costs and responsibility with risk and liability. This map can be used to plan appropriate timeframes and budgets for inspections and abatement of these risks.

Frequency of inspection is associated with the level of risk. Red zones that have the highest degree of use should be subject to more frequent and intensive inspections (e.g. annually using individual or visual inspections). Trees within Orange or Green zones, associated with less frequent use, could be inspected every 2 to 5 years using a combination of individual, visual or drive-by inspections. Severe weather events would necessitate a drive-by inspection within a specified period (5 days).

In addition to scheduled hazard tree inspections, the City should adopt procedures for responding to concerns of the public. When a member of the community calls the City with concerns regarding a specific tree, it is the City's responsibility to respond in a timely manner. All trees that are reported that appear to be an immediate hazard should be inspected within 24 hours while all other demand calls should be assessed within two weeks by a certified assessor in response to a concern by the community.

Rec 52 Delineate hazard tree polygons across the City with general risk ratings based on the conditions of trees and the targets at risk

Rec 53 Develop a schedule for regular hazard tree inspections of the hazard tree polygons

Rec 54 All trees of concern identified by the public should be assessed by a certified assessor within a target window of 24 hours for imminent hazards or two weeks in all other cases

Tree Risk Abatement

Standard of care for the abatement of tree risks relies on the timing of the risk abatement activities in relation to the inspection and how the abatement work is conducted. Trees that are identified as hazards and fall above the acceptable risk levels should be mitigated as quickly as possible. The period of time between the inspection of a hazard tree and its abatement is a concern for liability. It is recommended that the City attempt to mitigate tree hazards within two weeks of the inspection.

Risk abatement measures should be done to preserve as much ecological integrity of the tree as possible. Work should be conducted by an ISA Certified Arborist that is experienced and approved by the City. If possible, the tree should be pruned to mitigate the hazard. If pruning is not possible, or if the tree is in decline and not expected to recover, then it should be removed or converted to a wildlife trees at a safe height. Abatement measures such as cabling and bracing are not recommended as they require ongoing monitoring and maintenance.

Rec 55 All trees identified as hazards should be mitigated within two weeks

Rec 56 All work should be conducted by an ISA Certified Arborist that is experienced and approved by the City

Rec 57 Hazards should be mitigated by pruning if possible. Cabling and bracing are not recommended

3.5.3 Pruning

Pruning is considered to be one of the most important tree maintenance strategies, if conducted in an appropriate and timely manner. Pruning can have multiple objectives:

- Improving tree health, form and structure;
- Providing clearance for adjacent infrastructure (sidewalks, streets, utility lines, buildings);
- Removing or eliminating hazard and risk; and
- Protecting public safety and property.

A proactive approach to pruning is recommended. Immature trees should be inspected to assess deficiencies that can be mitigated through pruning or other corrective action before they develop into major structural problems as the tree grows and matures. It is important to recognize the variability amongst different tree species. Each tree should be managed with respect to its individual attributes and morphology and with respect to local site conditions. Preventative measures can prevent costly management and abate future risks.

A pruning schedule should be developed for street and park trees. Ideally, this would coincide with monitoring and follow the block management approach. The schedule should be based on the age and size (juvenile, intermediate and mature). Younger trees require more regular and intensive pruning. As these trees mature, the length of time between assessments will increase.

Standards of care for pruning should follow those of the International Society of Arborists and be completed by a certified arborist. General recommendations are provided below; more detailed tree pruning specifications are contained in Appendix H.

Maintenance Tips for Healthy Trees

Pruning is typically best performed during a tree's dormant period. In addition, pruning should be avoiding during periods of extreme heat or cold.

	J	F	M	A	M	J	J	A	S	O	N	D
Best Time	●	●										●
Worst Time				●	●							
Light Pruning	●	●	●			●	●	●	●	●	●	●

General pruning practices that should be observed include:

- Remove whole limbs or branches rather than shortening them. Cut back to the base of branch collar or cut just above the bud;
- Remove larger branches in a series of three cuts to avoid stripping away bark;
- Leave branch collars intact to reduce the wound size and limit decay;
- Limit pruning to a maximum of 25% of healthy, live trees within any one year, less on weak or declining trees;
- Topping is an outdated practice that is harmful to trees and can cause more maintenance problems down the road;
- Using spurs to climb trees is a poor practice. This can kill a tree over time, particularly those with thin bark;
- Prune trees when they are young to correct defects such as multiple leaders (forked tops);
- Remove lower tree branches gradually to develop a shade canopy.

Root Pruning and Barriers

The most common conflict with infrastructure involves root growth under adjacent pavement or other hard surfaces, which causes it to lift and/or break. Roots can be pruned at a suitable distance from the pavement. The extent of pruning and resulting injury to the tree should be carefully considered. Root barriers should be installed in combination with root pruning to prevent future problems. Numerous methods and materials are available for redirecting root growth. Barriers can be placed vertically in the soil to deflect roots down and away from hardscape features. Roots can also be directed using subsurface materials to areas that have additional soil volume to support tree growth.

Crown Pruning

Pruning should be considered when tree crowns conflict with overhead lines or adjacent structures. Structural pruning should be done by an ISA Certified Arborist. The amount of live tissue that should be removed depends on the tree size, species, and age. Limbs should be removed to a safe distance from the lines or structure and be cut back to an appropriate branch collar. Pruning should only be considered as a viable option if the tree is expected to recover and remain structurally stable.

Photos: Trees pruned to accommodate overhead lines

3.5.4 Infrastructure Design

Adjacent infrastructure can be redesigned to avoid future conflicts with a tree. This includes re-locating sidewalks and curbs further away from the tree and its root system. There are also engineering options available to provide for root growth under the pavement. These include the use of bridging pavement, installation of structural soils and the use of soil cells underneath hardscapes. Reinforcing pavement is also an option to resist breakage and displacement. Sidewalks can also be replaced with porous materials such as gravels or paving stones that allow for some surface movement and are cost effective to repair.

3.5.5 Recycling of Organic Debris

Disposal of debris resulting from pruning or replacement of street trees should be managed in a sustainable manner. All wood chips produced should be used as mulch, trail surfaces or for other landscaping or planting initiatives. Leaves, cones and small branches should be stored and processed at a compost facility and reused in landscaped areas. The City should establish and maintain a composing facility to reduce disposal costs and develop its own mulch for landscaped areas. Large woody debris that is too large to chip should be stored and made available for ecosystem and stream restoration projects.

Rec 58 Complete a cost-benefit analysis to evaluate the feasibility of establishing and maintaining a City-run composting facility to recycle organic debris

3.6 Tree Replacement

3.6.1 Recruitment and Replacement

Maintaining functional populations of mature street and park trees is important due to the numerous benefits they provide; however, replacing trees that have either died or require removal is often necessary. Generally, urban environments are much harsher than natural environments for trees. Dust and pollution, in addition to damage sustained from vehicle collisions and other human activity, can cause significant stress and shorten a street tree's lifespan significantly compared to a similar tree growing under natural conditions. Unplanned events can also occur which may have significant implications for management. Pest and disease outbreaks or windstorm events resulting in large-scale hazard tree mitigation are two relevant examples. Many jurisdictions are also faced with managing an aging tree population that was planted during the same time period. Eventually, these trees will reach an age where declining tree health will require large-scale replacement or intensified maintenance; both at significant cost. Many of the Cherry trees in Duncan are approaching this age of concern.

In general, tree removal should be considered as a last resort and only for the following reasons:

- The tree has health conditions that will continue to worsen;
- The tree has structural defects that pose a hazard and cannot be mitigated;
- The tree species and its growth characteristics are too large for the available space and the tree will continue to be a conflict;
- The tree interferes with overhead utility lines or structures and pruning is not a feasible option;
- The tree's roots interfere with adjacent pavement or other infrastructure and all available mitigation measures will not prevent future conflicts from reoccurring.

Successional planting strategies should be developed to ensure continual regeneration of trees over time. However, replacing mature trees with saplings will have significant implications upon the urban landscape. It takes many years for saplings to grow and achieve the ecological and aesthetic benefits that are derived from mature trees. Therefore, a variety of tree classes should be maintained to ensure sufficient recruitment levels and maintenance of tree cover over time. Although larger trees are favoured due to the increased benefits they provide, an even greater number of younger trees must be present to replace those in larger size classes after they die. The following table, based upon research provided by the Community Forestry Program Work Team at Cornell University, shows an ideal distribution of street trees across different size classes. Operational plans for planting over the next 40 years (to 2050) should aim to achieve this ideal diameter class distribution.

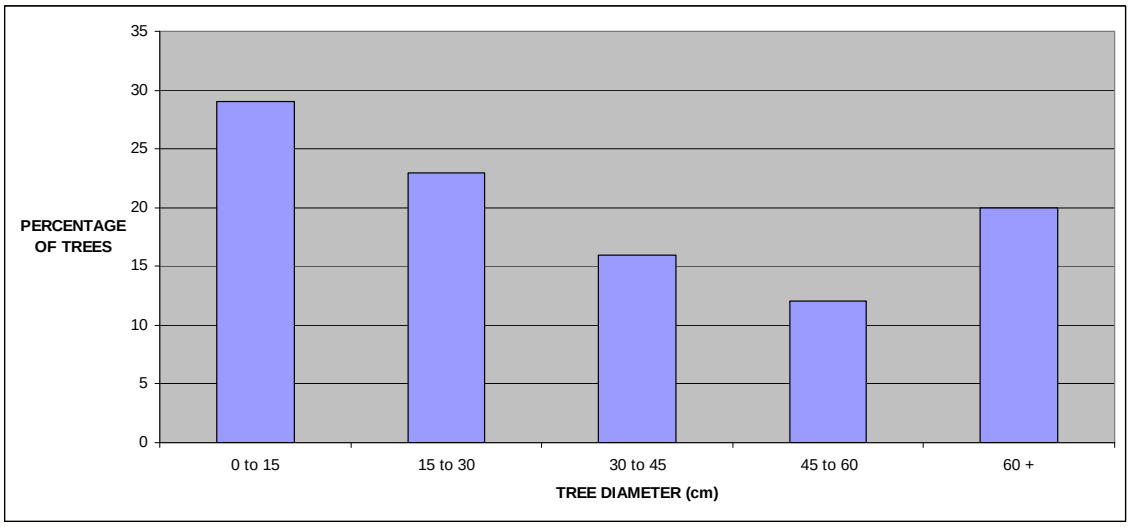


Figure 2. Ideal street tree composition by diameter class

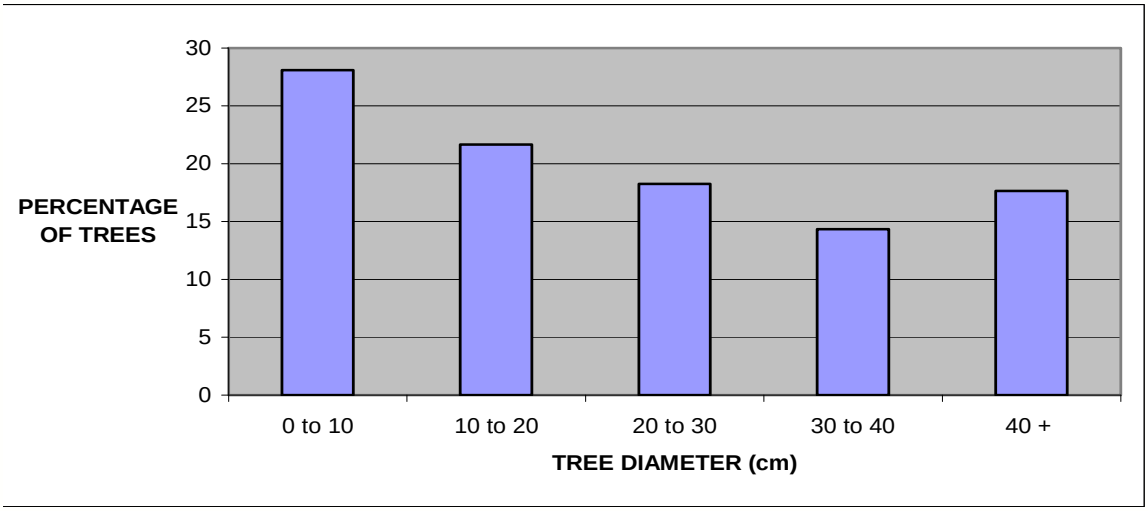


Figure 3. Duncan's current street tree composition by diameter class

Rec 59 Analyze the diameter class distribution of the updated street tree inventory. Develop a long term planting plan to achieve and maintain the recommended size class distribution

Standards should be established to ensure that equivalent or greater compensation is provided when trees are replaced (i.e. no net loss of canopy cover). Replacement trees should be ecologically suitable and/or meet the urban design objectives for the area. Depending upon the availability of plantable spots in the area, all trees lost to natural causes (including hazard abatement) should at minimum be replaced at a 1:1 ratio. However, consideration should be given to replacing larger trees at a greater ratio (2:1 or 3:1) to compensate for loss of benefits. For trees lost to unnatural causes such as vandalism or collision, a replacement ratio of 2:1 is recommended. Compensation should be received from the party at fault.

Specifications should be prepared to replace trees when they are cut down during the development process. Generally, a certain percentage of trees (e.g. 25%) could be removed without replacement. This could be based upon either the total number or total diameter of trees being removed. Any additional trees being removed beyond this limit would be replaced at a certain ratio. Replacement guidelines should take into consideration the size of tree being removed. One to one ratios may be sufficient for small trees, but a large oak, for example, might require two, three or five replacement trees.

Photo: European Hornbeam tree

An alternative approach is to require replacement based upon diameter. An example would be the loss of a 20 centimeter tree requiring a 1.5:1 replacement ratio (or 30 centimeters of new tree). Based upon a 2.5 centimeter caliper diameter for new trees, this could result in 12 replacement trees. Also, the guidelines should provide an option to pay into a development fund (certain dollar amount per tree) if no plantable spots are available on the property. Some jurisdictions state a cost per tree (e.g. $1000) or an amount per unit of diameter (e.g. $100 per every 5 centimeters) Criteria for the location of replacement trees should be flexible. If enough plantable spots are not available within the vicinity of any tree loss or the site is no longer suitable, additional trees should be planted elsewhere in the City following the plantable spots inventory. In natural settings, ecologically suitable trees should be planted to ensure there is a no net loss of tree cover. This is only required if natural regeneration has not already established.

Volunteer specimens are common throughout the City. These trees are typically natural pioneer species that established from adjacent natural areas or those that have been planted by residents. Volunteers should be considered for retention if they meet appropriate standards for management, particularly in areas where natural species are a priority and there are few conflicts with urban infrastructure.

Rec 60 Develop replacement ratios for street trees based upon their size, condition and cause of mortality

3.7 Tree Protection

Trees on public and private land are a community resource; they provide benefits that can extend far beyond property lines. Therefore, a balanced approach to tree protection is required to meet urban forest objectives. The intent of any tree protection measure is to ensure that trees are not needlessly removed or damaged. They should not be intended as a tool to prevent responsible development; rather, they should support initiatives that strengthen the urban forest as a whole and contribute to community health and sustainability. Rules and regulations must provide clear, balanced framework for people working with and around trees.

Tree protection measures must also be realistic and sensitive to Duncan's fiscal and management realities. Municipal resources (time, money, manpower) are limited. Any tree protection regulations that are implemented should make optimum use of available resources while not detracting from other work that is required. Administration should not be onerous. Use of fees should be considered. Implementing tree management strategies that meet multiple objectives would also improve operational and management efficiencies. Public education is also essential to better inform the community of tree benefits and help create "buy-in" for tree protection.

3.7.1 Developing Tree Protection Policy

Regulation of trees on private property is contentious. However, proper management of all trees is required to ensure long-term sustainability of the urban forest. The Citizen Survey that was prepared as part of the Duncan Urban Forest Strategy provided community members an opportunity to voice their opinion regarding protection of privately-owned trees. One question asked whether the City should introduce regulations to preserve and manage trees on private land. 50.8% of respondents were in favour of introducing regulations to manage private trees, while 24.4% were opposed. Another 24.9% were undecided. A second question asked citizens whether the City should introduce regulations and limits for development proposals to preserve trees. 82.4% of respondents were in favour, 7% were opposed and 10.6% had no opinion.

The City of Duncan does not have a Tree Protection Bylaw but it is supported by the OCP. Policy 7.1.8 states:

> "Consider the formal protection of significant trees, wildlife trees and treed areas through the creation of a Tree Protection Bylaw. Alternatively, establish an incentive-based tree protection and planting initiative, by offering density bonusing or modified development standards as part of the rezoning, subdivision and development approvals process."

There are several important components to a tree protection bylaw. A tree bylaw should:

- Ensure that trees are not needlessly or recklessly damaged or destroyed;
- Help manage the urban forest to achieve and maintain an appropriate condition while maximizing community benefits;
- Encourage retention and proper maintenance of trees;
- Respect the rights of private property owners to manage and develop their land in a sustainable manner.

A bylaw cannot prevent a private landholder from developing to the density and permitted uses set out in the zoning bylaw. Therefore, education and awareness are key components of implementing a tree bylaw. Another important consideration is the municipality's capacity to enforce bylaws and process applications. Council support of tree enforcement is important. Following are some considerations for development of a tree protection bylaw:

- Require permits prior to cutting and removal of trees;
- Create a user-friendly application process;
- Develop guidelines for regulated trees (e.g. diameter limits, significant trees, number of trees that can be removed per year);
- Permit minor exceptions for special circumstances (e.g. hazard trees or emergency removals);
- Ensure flexibility for replacement criteria, recognizing site constraints and unique circumstances (see Section 3.6 for different criteria);
- Provide options to contribute to a development fund in lieu of planting a tree on site;
- Identify important areas where special protection is warranted (e.g. floodplains, corridors, significant stands of trees, Environmentally Sensitive Areas);
- Develop a list of acceptable replacement trees;
- Simplify enforcement mechanisms (e.g. grant authority to ticket, stop work, replant); and
- Consider changes to zoning bylaw to allow flexibility to retain trees (setbacks and lot configuration).

The policy also encourages offering incentives to developers to protect trees. Conditions for tree removal on new developments should be established. In addition to permitting density bonusing and modified development standards, tree replacement strategies discussed in Section 3.6 should also be considered.

Tree bylaws have become more common in recent years as communities realize the benefits of trees. They are more prevalent in larger municipalities, but they do exist in smaller communities. The intent and applicability can vary considerably by jurisdiction. Similarly, administration costs are variable. Following are some examples of tree bylaws developed in similar sized communities (to Duncan) in British Columbia.

- Village of Anmore (pop. 1800) implemented Tree Management Bylaw No.430, 2007 to manage cutting and retention of trees on private land. Requirements for minimum vegetation cover and replacement trees are included.
- The Village of Lions Bay (pop. 1500) implemented Tree Bylaw No. 393, 2007. The bylaw applies to all municipal land. Replacement trees are required when contravening the conditions of the bylaw.
- Parksville (pop. 12,000) implemented Tree Management Bylaw No. 1415, 2006 which applies to all properties within the City. There are no requirements for replacement trees.
- Powell River (pop. 13,000) implemented Tree Bylaw 2174, 2008. The bylaw applies to all City-owned land and on private land where certain conditions are met. Requirements for tree management plans and replacement trees are provided.

3.7.2 Construction, Excavation and Paving Adjacent to Trees

Construction of buildings and services often requires that excavation and work must take place within close proximity to trees. Prior to any excavation on a site, tree protection zones (TPZ) should be established using orange snow fencing and 2x4 lumber. Minimum distance from a tree trunk should be a minimum of 1m for every 10 cm of tree diameter at breast height. This protection zone is required to retain the trees in good health and vigor.

Following are guidelines and standards for the TPZ:

- No soil disturbance or stripping is permitted within the TPZ;
- The natural grade shall be maintained;
- No storage, dumping of materials, parking, underground utilities or fires are permitted;
- Utilities should be routed around the TPZ;
- Site drainage improvements should be designed to maintain the natural water table levels within the TPZ.

Photo: Tree protection fencing

Respecting these guidelines will prevent changes to the soil and rooting condition, minimize the risk of wounding or damaging trees and help avoid potential contamination due to spills and waste. The following design and construction guidelines are provided if work must take place within a TPZ.

- All excavation activities within a TPZ should be monitored by an ISA Certified Arborist;
- Excavation should remove and disturb as little of the rooting zone as possible and all roots greater than 2cm should be hand pruned;
- The natural grade of the rooting zone should be maintained. If the grade is altered it should be raised and not reduced in height;
- Tree roots can often be exposed and worked around. The use of air spades and hydro-vac systems should be considered to retain the roots of trees;
- During construction, soil moisture conditions adjacent to the tree should be monitored. When soil moisture conditions are dry, supplemental irrigation should be provided; and
- Any planned changes to the surface grades within the TPZ of trees including the placement of mulch should be designed so that the water will flow away from the trunk of the trees.

Avoiding Damage to Tree Crowns

All operators of heavy machinery (excavators, cranes, dump trucks, etc.) working adjacent to trees should be aware of their proximity to the tree crowns. If there is to be a sustained period of machinery working within five meters of the crowns of these trees, a line with colored flags should be suspended at the height of the crowns along the length of the protected trees. If there are concerns regarding the clearance required for machinery and workers within the TPZ or just outside it, an ISA Certified Arborist should be consulted so that a pruning prescription can be developed or a zone surrounding the crowns can be established. All pruning should be performed by a Certified Arborist and be in accordance with the *ANSI Tree Pruning Guidelines* (ISA). Any wounds incurred to the subject trees during construction should be reported to the City.

Planting within TPZs

If there are plans to landscape the ground cover within the TPZ of any trees, measures should be taken to minimize potential impacts. Grass should not be stripped, as this will damage the surface roots. The grass layer should be covered with mulch at the start of the project, which will gradually kill the grass while moderating soil moisture and temperatures. Topsoil should be mixed with mulch prior to planting of shrubs; however, the depth of this new topsoil layer should not exceed 20 cm. Planting should take place within the newly placed topsoil mixture and should not disturb the original rooting zone of the trees. Two meters around the base of each tree should be left free and covered in mulch.

Monitoring During Construction

When construction is planned within close proximity to significant trees, regular monitoring should be provided by an ISA Certified Arborist. Site visits should be more frequent during activities that are most likely to damage the trees. This includes the first stages of the construction process when excavation occurs adjacent to trees. Site visits will ensure contractors are respecting the recommended tree protection measures and identify any new concerns that may arise from construction activities.

During each site visit the following measures should be assessed and reported on:

- The integrity of the Tree Protection Zone (TPZ) and fencing;
- Any changes to the TPZ limits including: overall maintenance, parking on roots, and storing or dumping of materials within the TPZ;
- Review and confirmation of recommended tree maintenance including: root and branch pruning, irrigation, and mulching;
- The health and condition of the trees;
- Any damages to the trees that may have resulted from construction activities and recommendations for remediation; and
- Changes to soil moisture levels and drainage patterns.

4 CLIMATE CHANGE

Climate change is more than global warming - it is defined as any measurable change in global climate attributable to either natural or man-made causes. The Intergovernmental Panel on Climate Change is an independent scientific group set up by the United Nations Environment Program (UNEP) and the World Meteorological Association (WMO) to assess the latest scientific information related to climate change. In its 2007 report, the IPCC stated that the evidence supporting climate change is "unequivocal", noting that 11 of the 12 warmest years on instrumental record occurred between 1995 and 2006. Although the exact nature of future climate change is somewhat hard to predict (due to global variability), climate change models for this region generally point to warmer, drier summers and warmer, wetter winters. Temperature increases between 2 and 4 degrees Celsius (Hebda, 2009) have been predicted for British Columbia by the end of this century. However, due to the City of Duncan's proximity to the ocean (which acts to moderate temperature extremes), it is expected that these increases will be on the lesser end of the scale.

Climate change will have profound impacts on the landscape, including its trees, natural areas and ecological processes. Some of these can be quite negative while others may be beneficial. Drought, heat, fire, insect outbreaks, and increased CO_2 are just some of the climate change impacts that could affect the urban forest and its associated ecosystems. It is expected that the frequency and severity of extreme weather events (much like the devastating windstorms that hit the Lower Mainland in the winter of 2006/2007) will also increase. These impacts must also be considered within the context of the urban landscape; many trees (particularly street trees) already grow in a much harsher environment. Pollution, compacted root zones, limited rooting volume, hard surfaces, soil moisture and nutrient deficiencies, and the urban heat island effect can further exacerbate the potential impacts of climate change.

Cities must adapt to these changing conditions or risk the significant environmental, social and economic consequences that may result from waiting until it is too late. Effective management strategies will mitigate the risks and capitalize on potential opportunities. Developing plans (such as the UFS) that can anticipate and adapt to potential climate change scenarios will increase the chances for long-term health and sustainability of the City of Duncan and the urban forest. Some important questions to consider include:

- How will native and specimen trees, which have certain moisture and nutrient requirements, respond (tolerate/adapt) to potential changes in local climate and growing conditions?
- Are the species being planted now suitable for a future climate that may be markedly different than the one now (i.e. should more drought tolerant species be planted?)
- Should risk and liability in terms of certain climate change scenarios (e.g. windstorms) be considered when selecting and managing tree species?
- How can the urban forest be best managed to reduce potential climate change impacts (i.e. planting to reduce energy consumption and increase carbon sequestration)?

4.1.1 Potential Benefits of Climate Change

Cities in traditionally cooler, northern latitudes (i.e. most of Canada) are expected to benefit more from a warming climate relative to regions in the southern and western United States, which are already facing significant water shortages and higher year-round temperatures. The Lower Mainland, which has high annual precipitation and ample water resources, may be in a better position to adapt to (and benefit from) a warmer climate. Rising temperatures will likely result in an increased growing season with fewer frost days. This trend has been evident over the past century, generally resulting in more frost free days now than the beginning of the 20th century. Night time temperatures are expected to rise relatively more than day-time temperatures. Increased temperatures will provide a longer growing season. However, actual plant growth is somewhat dependent upon the amount of nutrients (nitrogen primarily) and water available to support growth. Higher soil temperatures may also occur which could encourage active root growth earlier in the season and increase nutrient availability (Johnson, 2004).

These potential benefits may be limited by factors associated with the urban environment (soil compaction, soil volume, moisture availability). Eventually, the local climate may warm sufficiently to support tree species that can not currently be sustained, including a variety of fruit-bearing species.

4.1.2 Potential Adverse Impacts of Climate Change

Climate change may have numerous adverse impacts on the local environment, particularly its urban forests. Generally these relate to temperature and precipitation. Higher temperatures, for example, can increase a tree's susceptibility to winter mortality. Warmer weather during the winter may activate normal root uptake processes which are usually dormant; making the tree susceptible to a sudden cold snap. Summer rainfall is generally predicted to remain much as it is now; however, hotter temperatures may actually increase evapotranspiration and reduce available soil moisture considerably over the summer. This can cause heat stress on trees and their root systems. There is some evidence to indicate that these 'summer drought' conditions may already be affecting native tree species. Some western redcedar, for example, are showing signs (dead or dying tops, reddening branchlets) that may indicate a negative response to drier summers and autumns (Richard Hebda, pers.com). It is possible that this species may eventually be replaced by Douglas-fir or other drought-tolerant species such as Garry Oak (Johnston, 2004).

Climate change models indicate that precipitation increase will be most noticeable over the winter and spring. Significant rainfall events and/or snowmelt could increase flood risks in depressional areas or floodplains. Tree roots can be stressed if these types of conditions last for longer periods. Increased snowload over the winter could also cause significant tree damage (breaking branches, etc). Over time, current warming trends may eventually reduce or eliminate winter snow pack in local mountains, which could have significant implications for hydrological processes and water storage (Johnston, 2004).

A decline in cold weather, particularly over the winter months, will adversely affect efforts to control insects. This is particularly evident in the battle to control the pine bark beetle in British Columbia's interior forests. Warmer temperatures mean that more insects survive overwinter, which compounds the seriousness of outbreaks in subsequent years as more insect populations become established. Warmer and drier trends may also provide opportunities for other pests to establish. This may include insects, diseases as well as invasive wildlife and plant species.

Much of the attention paid to climate change has focused on global warming and increased emissions of CO_2. Vehicles in urban areas are a major source of these pollutants. More CO_2 in the atmosphere could potentially lead to increased growth in trees and plants over the short-term. However, growth increases resulting from increased uptake in CO_2 have been shown to subside over time (within 3-5 years) as trees acclimatize to new conditions. Also, research into tree growth response to ozone, another common urban pollutant, show that growth attributed to CO_2 is often counterbalanced by losses due to ozone (Johnston, 2004). In addition, there is some question whether any photosynthetic gains (carbon sequestration) outweigh losses due to related increases in respiration (carbon loss).

4.1.3 Mitigating and Adapting to Climate Change

Climate change mitigation generally refers to reducing the amount of greenhouse gases in the atmosphere. Greenhouse gases, such as water vapour, Carbon Dioxide and Methane, help regulate the earth's temperature by selectively absorbing and emitting infrared radiation within the atmosphere. Considerable increases in anthropogenic (human created) greenhouse gases (principally CO_2) within the past century have altered this balance, which has contributed to the dramatic rise in temperatures that have been recorded

One of the major benefits attributed to trees and forests is their ability to capture and store (sequester) carbon dioxide, the primary gas responsible for the "greenhouse effect". Even considering the release of carbon that results from tree respiration and mortality and the carbon emissions associated with tree maintenance, the net amount of carbon sequestered by live trees is significant. The longer growing season in the Lower Mainland

region further enhances the ability of trees to store more carbon. In general, larger and fast growing trees sequester more carbon from the atmosphere. Planting certain species, such as oak and ash, will result in still greater reductions of carbon over time due to their increased capacity to sequester CO_2 (McPherson, 2005).

Identifying areas to maintain and establish tree cover is a key strategy to capitalize upon potential climate benefits of the urban forest. Maximizing the cooling and shading benefits provided by trees in urban environments will become increasingly important as temperatures rise and the urban heat island effect becomes more pronounced. The shading benefit of trees reduces energy consumption in buildings and the amount of evaporative hydrocarbons from parked cars, which indirectly reduces CO_2 emissions and saves on energy costs (McPherson, 2005). Increased transpiration associated with more trees is also of significant benefit due to the atmospheric cooling effects that result.

Due to the uncertainties surrounding future climate change scenarios, it is important to engage in proactive and adaptive management practices. Arboriculture, engineering and land use standards should be researched and implemented that will help existing trees adapt to future climate changes.

Rec 61 Identify opportunities to increase canopy cover as a means of mitigating the impacts of climate change and maximizing carbon absorption

Rec 62 Select tree species that are appropriate for the expected changes in climate

5 PUBLIC EDUCATION AND COMMUNITY ENGAGEMENT

Many Urban Forest management initiatives require significant time, money and resources. These can be limited in small jurisdictions like Duncan. Education and involvement of the public is critical for a successful Urban Forestry program. The goal of a public education program is to engage the public and instill a sense of "ownership and stewardship" of the Urban Forest.

Volunteers of all ages can make a huge difference to achieving community goals. For example, New York City has a goal of planting one million trees over ten years (to 2017). The City has asked for volunteers to plant, water, and register new trees. Donations to assist in tree planting are accepted. The City also donates trees to be planted in private yards and provides educational workshops. Initiatives such as Adopt-a-Tree and Parks Reforestation Day (where volunteers planted 20, 000 trees in one day) have also helped NYC towards its goal.

Developing strategies to engage and communicate with the public to familiarize them with the goals and objectives of the Urban Forest Strategy, while also providing opportunities to comment and participate in its ongoing development and implementation, is part of the adaptive management process. Following is a list of strategies for public education and engagement:

- Relate Urban Forest goals and strategies with improved livability, community sustainability and significant cost savings;
- Raise awareness by clearly illustrating the economic benefits of trees in the urban environment in terms that are easily understood by the general public, land managers, developers and municipal policy makers;
- Engage youth and seniors as part of a public education strategy;
- Create an Urban Forestry page (that is updated regularly) for the City website. The webpage will function as a virtual open house giving residents information, and the flexibility to participate when they want;
- Inform public of all upcoming tree management initiatives within their neighbourhood. If possible, they should be invited to participate at some level;
- Consider a block volunteer approach where neighbours can pool their labour to assist with Urban Forest management initiatives (such as planting of trees). This collaborative approach is designed to reduce costs and foster a sense of community stewardship;
- Promote voluntary private stewardship initiatives, such as tree planting and naturescaping. This can be a cost-effective strategy to enhance the Urban Forest. Public natural areas, particularly smaller parks and riparian corridors, are often not large enough to support fully functional ecosystem processes or provide sufficient wildlife habitat. Planting of trees and shrubs in backyards and other privately held property can help bridge these gaps by expanding the size of a corridor or linking patches of public land.

There are numerous environmental stewardship groups in the Duncan area that are committed to maintaining the urban forest. Some are involved in restoration efforts; others advocate for policy and regulations. The Nature Conservancy of Canada has indicated a willingness to donate trees as part of the reforestation effort. The City of Duncan must capitalize upon this community spirit and engage more citizens in the management of its urban forest.

Rec 63 Develop a public stewardship program to maintain street trees

APPENDIX A - REFERENCES

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APPENDIX B – REGULATIONS AND POLICY

Federal and Provincial Acts and Regulations

Following is a summary list of Federal and Provincial Acts and Regulations relating to the protection of aquatic and terrestrial resources:

Federal

- Canada Fisheries Act
- Canada Migratory Birds Convention Act
- Canadian Environmental Protection Act
- Federal Species at Risk Act

Provincial

- Local Government Act
- B.C. Wildlife Act
- B.C. Water Act and Water Act Regulation
- B.C. Fish Protection Act
- B.C. Environmental Management Act and Spill Reporting Regulation
- B.C. Transportation of Dangerous Goods Act
- B.C. Fire Code and National Fire Code
- B.C. Forest and Range Practices Act
- B.C. Occupational Health & Safety Regulation
- B.C. Regulation 296/97
- B.C. Weed Control Act
- B.C. Riparian Areas Regulation
- B.C. Pesticide Control Act

A more detailed description of the Acts and Regulations most likely to be applicable within the context of urban forest management has been provided below:

Canada Fisheries Act - Federal

- Prohibits harmful alteration, disruption or destruction of fish habitat;
- Prohibits the deposit of deleterious substances into water frequented by fish;
- Penalty: up to $1,000,000 and prison time; and
- Requires approvals and notification.

Migratory Birds Convention Act and Regulations - Federal

- Protect various species of migratory birds, as well as their habitats;
- Prohibits the killing or capturing of migratory birds, as well as any damage, destruction, removal or disturbance of active nests;
- Prohibits pollution (defined as the deposit of oil, oil wastes or any other substance harmful to migratory birds) in any waters or any area frequented by migratory birds; and
- No permits issued for the destruction of nests in the case of industrial or construction activities.

Species at Risk Act – Federal

- Conserves biological biodiversity, prevents wildlife species from becoming extinct, and secures the necessary actions for their recovery;
- Creates prohibitions to protect listed threatened and endangered species and their critical habitat; and
- Recognizes that compensation may be needed to ensure fairness following the imposition of critical habitat prohibitions.

Wildlife Act and Regulations - Provincial

- Provisions for protecting, managing and purchasing habitat areas as well as protecting endangered and threatened species;
- Establishes and protects wildlife management and critical wildlife areas;
- Regulates work impacting beaver dams, birds and their nests and eggs, and transportation and possession of carcasses; and
- Prohibits the taking of birds, eggs, or nests. In addition, the nests of an eagle, peregrine falcon, gyrfalcon, osprey, heron, or burrowing owl, are specifically protected whether or not it is active.

Fish Protection Act - Provincial

- Provides legislative authority for water managers to consider impacts on fish and fish habitat before approving new licenses, amendments to licenses or issuing approvals for work in or near streams. and
- Focuses on four major objectives: ensuring sufficient water for fish; protecting and restoring fish habitat; improved riparian protection and enhancement; and stronger local government powers in environmental planning.

Riparian Areas Regulation (RAR) – Provincial

- Enacted under Section 12 of the *Fish Protection Act*, protects Riparian Areas during residential, commercial, and industrial development by ensuring that proposed activities are subject to a science based assessment conducted by a Qualified Environmental Professional;
- Provides protection for the features, functions and conditions that are vital in the natural maintenance of stream health and productivity;
- Disturbance within 30m of the top of the bank usually require an assessment to determine the necessary steps to be taken to avoid causing deleterious impacts to fish habitat; and
- Requires notification.

Weed Control Act – Provincial

- Regulates the management of noxious weeds & prohibits the dispersal of weeds and their seeds;
- Private landowners, private companies, utility companies, regional districts and municipalities, and provincial government agencies or anyone in physical possession of land all have a responsibility to manage weeds in the province; and
- Designates 48 plant species as noxious weeds (non-native plants that create problems in agriculture and/or natural habitats).

Environmental Management Act – Provincial

- Replaced Waste Management Act;
- Requires preparation of plans for flood control, drainage, soil conservation, water resource management, fisheries and aquatic life management, wildlife management, waste management, and air management; and

Water Act – Provincial

- Specifies requirements that assure that work being done in and about a stream does not compromise water quality, fish and wildlife habitat and the rights of other water users;
- Activities requiring a formal approval under are typically significant works that permanently alter the direction, pattern or flow of a stream's path; and
- Requires approvals and notification.

Local Government Act – Provincial

- Provides a legal framework and foundation for the establishment and continuation of local governments to represent the interests and respond to the needs of their communities; and
- Grants legal authority from the province to municipalities for disposition of land, creation of municipal forest reserves, planning and land use management, and acquisition and reclamation of land for parks.

Municipal Documents

The City has developed policies, bylaws, plans, ecological inventories, studies and best management practices that direct and facilitate management of the urban forest. More detailed descriptions are provided for selected documents.

Bylaws and Planning Documents

Official Community Plan Bylaw No. 2030, 2007
Floodplain Designation Bylaw No. 1975, 2004
Screening and Landscaping Bylaw No. 1580, 1989
Revitalizing Downtown Duncan's Neighbourhood, 2002

Design Guidelines

City-wide Planting Plan, 2006
Planting Palette, 2006

Studies/Inventories

Green Streets Canada Urban Tree Inventory, 2006

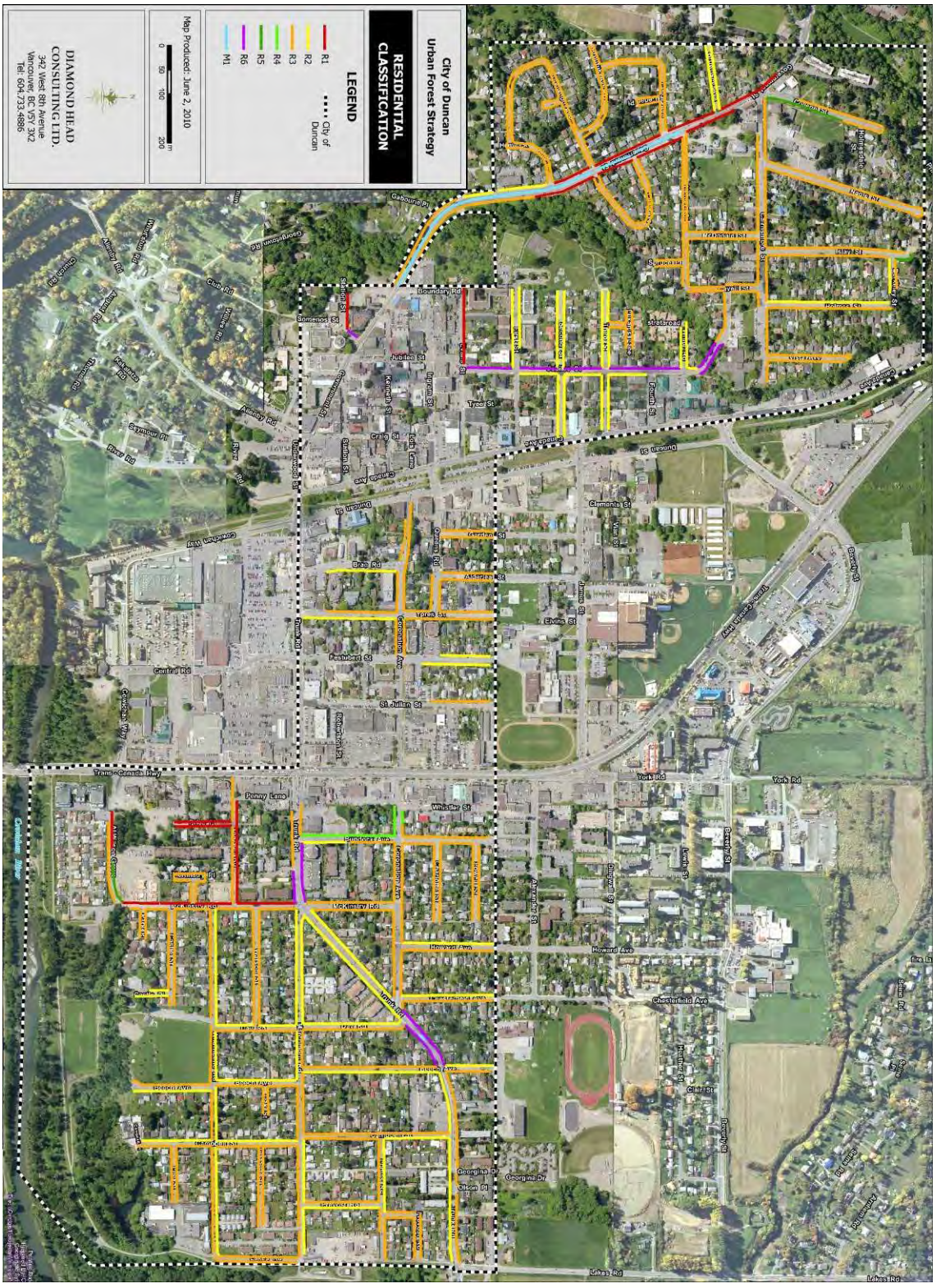
APPENDIX C – COMMON STREET TREES IN CITY OF DUNCAN

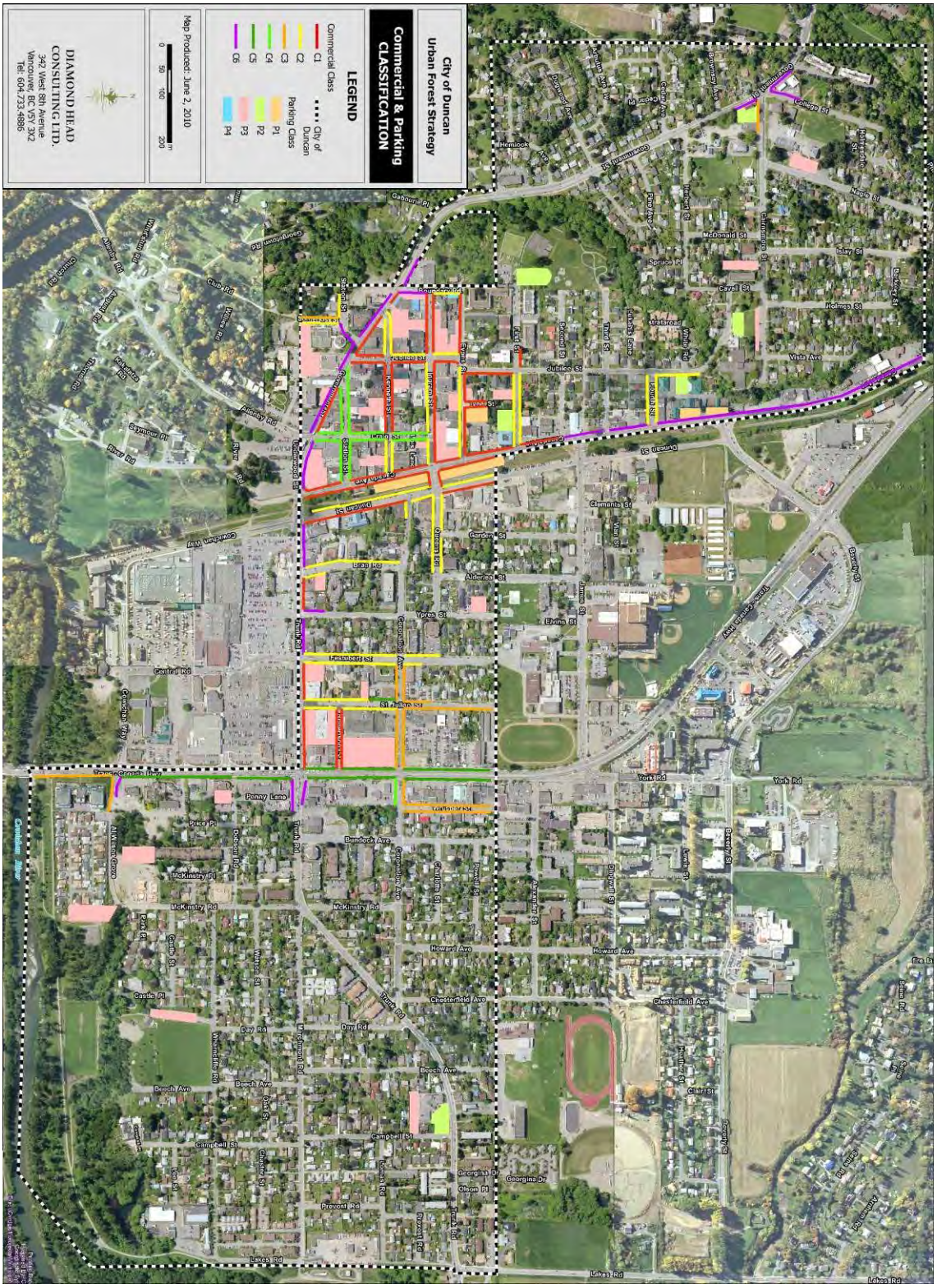
Rank	Common Name	#	%	Rank	Common Name	#	%
1	Cherry - exotic	339	14.7	21	Blue Spruce	30	1.3
2	Maple - exotic	192	8.3	22	Red Oak	27	1.2
3	Douglas-fir	172	7.5	23	Cottonwood	26	1.1
4	Plum	164	7.1	24	Lodgepole Pine	25	1.1
5	Bigleaf Maple	161	7.0	25	Garry Oak	25	1.1
6	Cedar	130	5.6	26	Red Alder	23	1.0
7	Western Redcedar	91	3.9	27	Deodor	22	1.0
8	Hazelnut	73	3.2	28	Chestnut	20	0.9
9	Dogwood	59	2.6	29	Crab Apple	17	0.7
10	Birch	58	2.5	30	Locust	17	0.7
11	Holly	57	2.5	31	Grand Fir	14	0.6
12	Apple	55	2.4	32	Pine – white	13	0.6
13	Magnolia	52	2.3	33	Japanese Smoke	11	0.5
14	English Hawthorne	51	2.2	34	Pear	10	0.4
15	Acacia	44	1.9	35	Beech	9	0.4
16	English Laurel	42	1.8	36	Fir	9	0.4
17	Cherry – native	42	1.8	37	Elm	8	0.3
18	Poplar	32	1.4	38	Juniper	8	0.3
19	Mountain Ash	32	1.4	39	Walnut	8	0.3
20	Pine	32	1.4	40	Weeping Willow	8	0.3

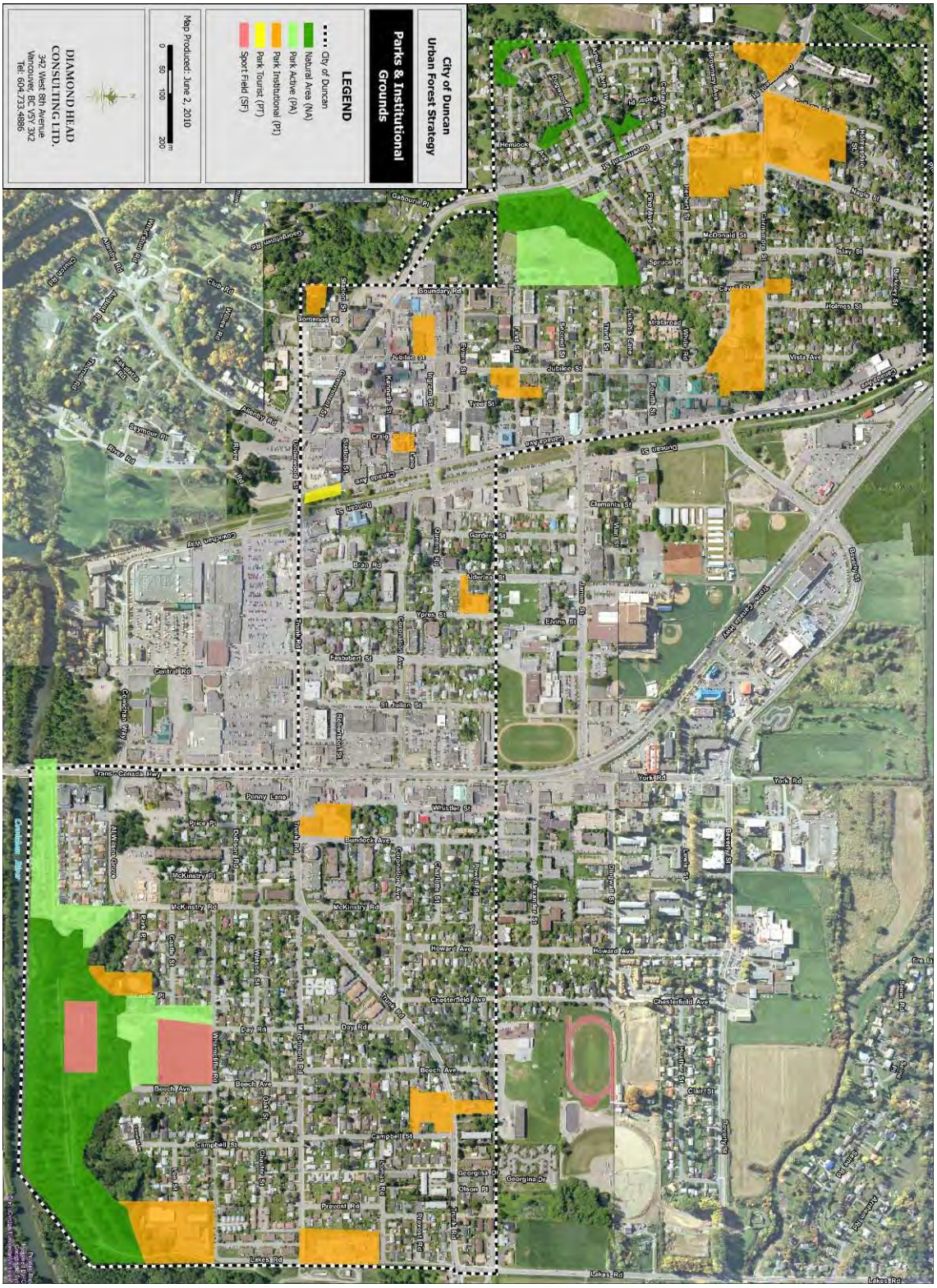
APPENDIX D – SIGNIFICANT TREES

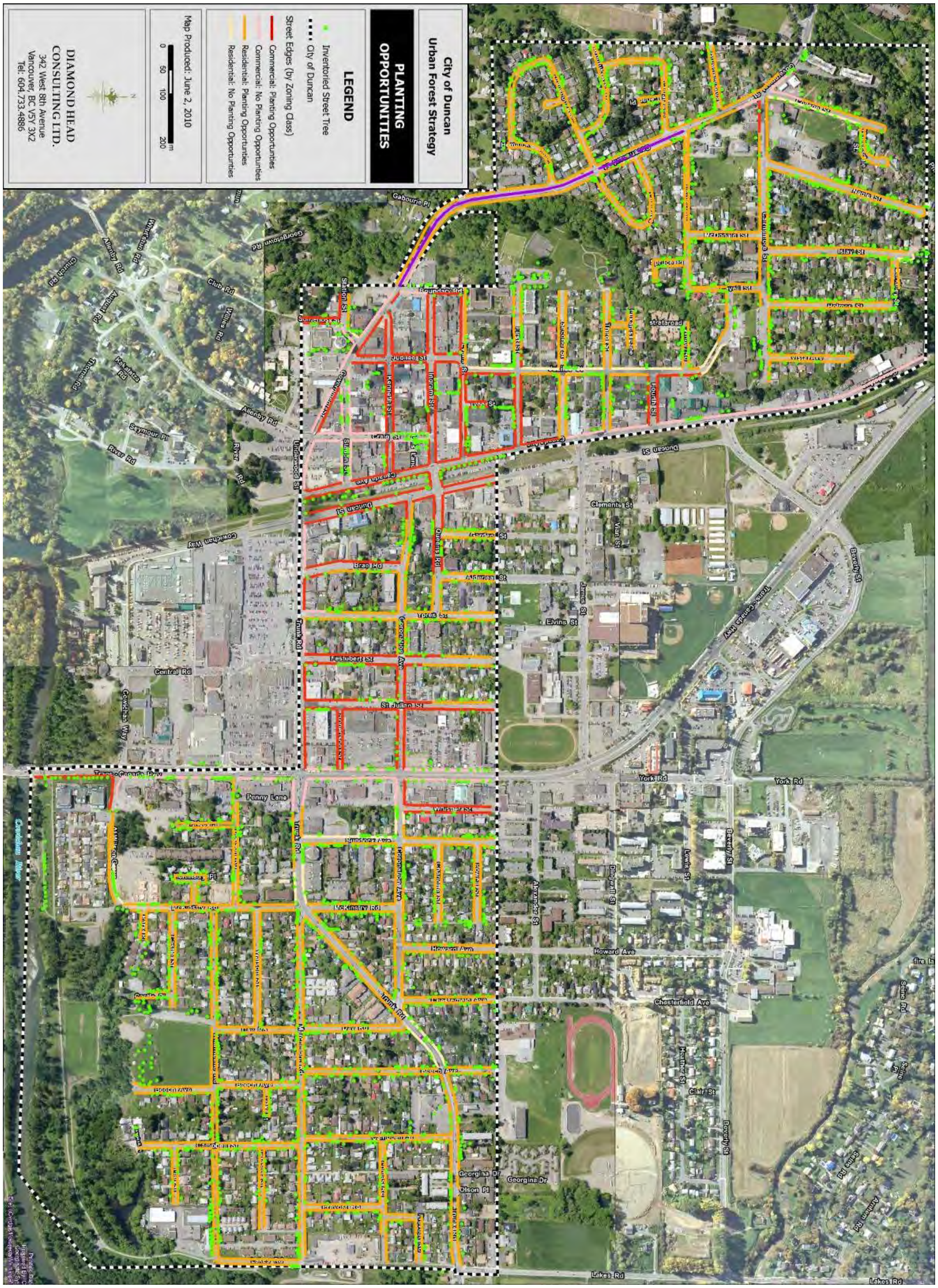
Label	Common Name	Botanical Name	Dbh (cm)	Ht (m)	Overall Condition	Comments	Minimum Root Protection Zone (m)
A	Garry Oak	*Quercus garryana*	65, 70	19	Good	**Two** trees located in a recently completed commercial development. They have both been pruned for overhead powerlines and it appears their roots were managed for the parking nearby. Mulch has been placed around their bases. These are significant trees for the area due to their size, species and condition.	4.0
B	Beech	*Fagus Sylvatica*	60	12	Good	Located in commercial development. A healthy young specimen. Mulch has been applied at its base - a little too deep.	4.0
C	London Plane	*Platanus x acerifolia*	84	17	Good	Beside powerlines, pruned on east side. Pavement is surrounding its base. Large diameter tree in the downtown core.	5.0
D	London Plane	*Platanus x acerifolia*	84	17	Good	Beside powerlines, pruned on east side. Pavement is surrounding its base. Large diameter tree in the downtown core.	5.0
E	Bigleaf Maple	*Acer macrophyllum*	84	22	Good	Adjacent to what appears to be a historic building. Likely has historic significance.	5.0
F	London Plane	*Platanus x acerifolia*	48	18	Excellent	Large open crown, good rooting zone.	3.0
G	Red oak	*Quercus rubra*	70	18	Good	Near train station. Existing heritage tree. Abundant soil available for rooting	4.5
H	Red oak	*Quercus rubra*	72	16	Good	Near train station. Existing heritage tree. Abundant soil available for rooting	4.5
I	Red oak	*Quercus rubra*	58	15	Good	Near train station. Existing heritage tree. Abundant soil available for rooting	4.0
J	Red oak	*Quercus rubra*	70	16	Good	Main stem has pruning wounds that have not completely closed over. Existing heritage tree. Abundant soil available for rooting	4.5
K	Red oak	*Quercus rubra*	45	15	Good	Younger tree than neighbouring oaks. Near train station. Likely has historic significance. Abundant soil available for rooting	3.0
L	Black Locust	*Robinia pseudoacacia*	65	12	Good	Ivy growing at the base.	4.0
M	Black Locust	*Robinia pseudoacacia*	95	13	Fair	Tree has been topped in the past.	5.0
N	Red Maple	*Acer rubrum*	72	27	Fair	Tree has good form. Roots were cut on the north side near the powerlines.	4.5
O	Bigleaf Maple	*Acer macrophyllum*	66	19	Good	An open grown, well formed tree. Tree has a 2.5m rooting zone.	4.0
P	English Oak	*Quercus rubra*	67	15	Good	Tree has good form and health. Base abuts sidewalk.	4.0
Q	Garry Oak	*Quercus garryana*	67	21	Good	A tall specimen with good form and vigour. Evidence of large pruning cuts due to adjacency to powerlines.	4.0
R	English Oak	*Quercus rubra*	85	17	Good	Tree shows good form and vigour. Asphalt for parking has been laid over roots.	5.0
S	Douglas-fir	*Pseudotsuga menziesii*	74	32	Good	The base of the tree has begun to grow over the sidewalk and near powerlines creating infrastructure conflict.	4.5

APPENDIX E – MAPS




City of Duncan
Urban Forest Strategy
Commercial & Parking
CLASSIFICATION
LEGEND
Commercial Class
C1
C2
C3
C4
C5
C6
City of Duncan
Parking Class
P1
P2
P3
P4
Map Produced: June 2, 2010
0
50
100
200
m
DIAMOND HEAD
CONSULTING LTD.
342 West 8th Avenue
Vancouver, BC V5Y 1N2
Tel: 604.733.4886


City of Duncan
Urban Forest Strategy
Parks & Institutional Grounds
LEGEND
City of Duncan
Natural Area (NA)
Park Active (PA)
Park Institutional (PI)
Park Tourist (PT)
Sport Field (SF)
Map Produced: June 2, 2010
0 50 100 200 m
DIAMOND HEAD CONSULTING LTD.
342 West 6th Avenue
Vancouver, BC V5Y 1K2
Tel: 604.733.4886


City of Duncan
Urban Forest Strategy
PLANTING OPPORTUNITIES
LEGEND
Inventoried Street Tree
City of Duncan
Street Edges (by Zoning Class)
Commercial: Planting Opportunities
Commercial: No Planting Opportunities
Residential: Planting Opportunities
Residential: No Planting Opportunities
Map Produced: June 2, 2010
0 50 100 200 m
DIAMOND HEAD CONSULTING LTD.
342 West 8th Avenue
Vancouver, BC V5Y 3X2
Tel: 604.733.4886

APPENDIX F – PLANTING LIST

Table 10. Preferred Tree Species for Streets, Parks and Natural Areas

Species	Common Name	Location	Height (m)	Spread (m)	Comments
Abies concolor	White Fir	Park	25-40	5-7	
Abies grandis	Grand Fir	Natural	25-60	5-8	Native
Acer buergeranum	Trident Maple	Street	10	8	
Acer campestre	Hedge Maple	Street	8-11	8-11	
Acer campestre 'Red Shine'	Field Maple	Street	8-11	8-11	
Acer cappadocicum	Cappadocian Maple	Street/Park	20	15	
Acer x freemanii 'Autumn Blaze'	Freeman Maple	Street/Park	15	12	
Acer ginalla	Amur Maple	Street	10	8	
Acer griseum	Paperbark Maple	Street	10	10	
Acer macrophyllum	Bigleaf Maple	Park/Natural	35	20	Native
Acer palmatum	Japanese Maple	Street	8	10	
Acer platanoides 'Atropurpureum'	Norway Maple	Park	11	10	
Acer platanoides 'Columnare'	Norway Maple	Park	20	6	
Acer platanoides 'Crimson King'	Norway Maple	Park	10	8	
Acer platanoides 'Crimson Sentry'	Norway Maple	Park	12	5	
Acer platanoides 'Deborah'	Norway Maple	Park	15	13	
Acer platanoides 'Drummondii'	Norway Maple	Park	10-12	10-12	
Acer platanoides 'Globosum'	Norway Maple	Park	6	8	
Acer platanoides 'Emerald Lustre'	Norway Maple	Park	13	12	
Acer platanoides 'Fairview'	Norway Maple	Park	13	12	
Acer platanoides 'Princeton Gold'	Norway Maple	Park	12	10	
Acer platanoides 'Royal Red'	Norway Maple	Park	13	10	
Acer pseudoplatanus	Sycamore Maple	Street	30	25	
Acer rubrum 'Bowhall'	Red Maple	Street	15	5	
Acer rubrum 'Morgan'	Red Maple	Street/Park	13	11	
Acer rubrum 'Scanlon'	Red Maple	Street	15	5	
Acer rubrum 'Scarlet Sentinel'	Red Maple	Street/Park	12	6	
Acer saccharinum	Silver Maple	Street	20	12	
Acer truncatum 'Pacific Sunset'	Purple-blow/Shantung Maple	Street	9	8	
Acer truncatum 'Norwegian Sunset'	Purple-blow/Shantung Maple	Street	8	10	
Aesculus carnea "Briotii"	Ruby Red Horsechestnut	Street/Park	20	15	
Aesculus hippocastanum	Common Horsechestnut	Street	25	20	
Alnus rubra	Red Alder	Natural	25	10	Native
Arbutus menziesii	Arbutus	Natural	20	15	Native
Betula jacquemontii	Himalayan White Birch	Park	18	10	
Calocedrus decurrens	California Incense-cedar	Park	20-40	2-9	
Carpinus betulus	European Hornbeam, Ironwood	Street/Park	25	20	
Carpinus betulus 'Fastigiata'	European Hornbeam, Ironwood	Street/Park	15	12	
Carpinus betulus 'Frans Fontaine'	European Hornbeam, Ironwood	Street/Park	15	6	
Carpinus japonica	Japanese Hornbeam	Street	15	10	
Cedrus atlantica 'Glauca'	Atlas Cedar	Park	40	10	
Cedrus deodora	Deodor Cedar	Park	40	10	
Cercidiphyllum japonicum	Katsura	Street/Park	20	15	
Cercis canadensis	Eastern Redbud	Street/Park	10	10	
Cercis canadensis 'Forest Pansy'	Eastern Redbud	Street/Park	10	10	
Chamaecyparis nootkatensis pendula	Nootka Cypress	Park	30	8	
Chamaecyparis obtusa	Hinoka Cypress	Park	20	6	
Cornus kousa 'Satomi'	Japanese Flowering Dogwood	Park	7	5	
Cornus nuttallii	Pacific Dogwood	Park/Natural	20	8	Native
Cornus rutgan 'Aurora'	Dogwood	Park	6-8	6-8	
Cornus rutgan 'Stellars Pink'	Dogwood	Park	5-9	6	
Crataegus douglasii	Black Hawthorn	Natural	10	6	Native
Crataegus x lavallei	Lavalle Hawthorn	Park	7	10	
Cratagus phaenopyrum	Washington Hawthorn	Park	10	10	

Species	Common Name	Location	Height (m)	Spread (m)	Comments
Davidia involucrate	Dove Tree	Park	15	10	
Fagus sylvatica	European Beech	Street/Park	25	15	
Fagus sylvatica 'Dawyck'	European Beech	Street/Park	25	7	
Fagus sylvatica 'Dawyck Gold'	European Beech	Street/Park	18	7	
Fagus sylvatica 'Dawyck Purple'	European Beech	Street/Park	20	5	
Fraxinus Americana	White Ash	Park	16-21	17-21	
Fraxinus Americana 'Autumn Applause'	White Ash	Park	18	10	
Fraxinus Americana 'Autumn Purple'	White Ash	Park	18	12	
Fraxinus Americana 'Empire'	White Ash	Park	16	12	
Fraxinus excelsior 'Westholf's Glory'	European Ash	Park	15	15	
Fraxinus latifolia	Oregon Ash	Park	25	15	
Fraxinus ornus	Manna Ash	Street/Park	15	15	
Fraxinus pennsylvanica 'Patmore'	Green Ash	Street/Park	14	11	
Fraxinus pennsylvanica 'Summit'	Green Ash	Street/Park	14	8	
Fraxinus pennsylvanica 'Urbanite'	Green Ash	Street/Park	15	12	
Ginkgo biloba	Gingko	Street/Park	30	8	
Gleditsia triacanthos 'Halka'	Honey Locust	Park	12-18	12-18	
Gymnocladus dioica	Kentucky Coffeetree	Park	20	15	
Koelreuteria paniculata	Goldenrain Tree	Park	10-13	10-13	
Liquidambar styraciflua 'Worplesdon'	American Sweetgum	Park	13	8	
Liriodendron tulipifera	Tulip Tree	Street/Park	30	15	
Magnolia acuminata 'Yellowbird'	Cucumber Tree	Street	10	6	
Magnolia denudata	Yulan Magnolia	Street	10	10	
Magnolia x 'Elizabeth'	Magnolia hybrid	Street	10	6	
Magnolia x 'Forrest's Pink'	Magnolia hybrid	Street	12	12	
Magnolia x 'Galaxy'	Magnolia hybrid	Street	12	8	
Magnolia x 'Kobus'	Magnolia hybrid	Street	12	10	
Magnolia sieiboldii	Siebold's Magnolia	Street	8	12	
Magnolia x 'Vulcan'	Magnolia hybrid	Street	8	6	
Malus fusca	Pacific Crab Apple	Park/Natural	12	6	Native
Metasequoia glyptostroboides	Dawn Redwood	Street/Park	20-40	5-8	
Nothofagus Antarctica	Antarctic Beech	Street/Park	15	10	
Nyssa Sylvatica	Black tupelo	Street/Park	20	10	
Oxydendrum arboreum	Sourwood	Park	10-15	8	
Parrotia persica	Persian Ironwood	Park	8	10	
Paulownia tomentosa	Empress Tree	Park	12	10	
Phellodendron amurense	Amur Cork Tree	Street/Park	14	15	
Picea omorika	Serbian Spruce	Park	20	2-3	
Picea sitchensis	Sitka Spruce	Natural	25-50	6-12	Native
Pinus contorta var. *Contorta*	Shore Pine	Natural	25	8	Native
Pinus monticola	Western White Pine	Natural	25-40	6-8	Native
Pinus nigra	European Black Pine	Park	30	6-8	
Pinus thunbergii	Japanese Black Pine	Park	15-25	6-8	
Platanus x acerifolia	London Plane Tree	Park	30	20	
Platanus x hispanica	London Plane	Park	30	20	
Platanus occidentalis	American Sycamore	Park	25	20	
Populus balsamifera var. *trichocarpa*	Black Cottonwood	Natural	35	8	Native
Prunus emarginata	Bitter Cherry	Natural	12	8	Native
Pseudotsuga menziesii	Douglas-fir	Natural/Park	25-50	6-10	Native
Quercus acutissima	Sawtooth Oak	Street/Park	15-20	15-20	
Quercus coccinea	Scarlet Oak	Street/Park	20	15	
Quercus garryana	Garry Oak	Park/Natural	25	10	Native
Quercus palustris	Pin Oak	Street	20	12	
Quercus phellos	Willow Oak	Street/Park	20	15	

Species	Common Name	Location	Height (m)	Spread (m)	Comments
Quercus rubra	Red Oak	Street/Park	25	20	
Rhamnus purshiana	Cascara	Natural	12	7	Native
Robinia pseudoacacia 'Inermis'	Locust	Street/Park	6	6	
Salix balylonica	Babylon Willow	Park	12	12	
Salix hookeriana	Hooker's Willow	Natural	6	2-3	Native
Salix lasiandra	Pacific Willow	Natural	12	5	Native
Salix scouleriana	Scouler's Willow	Natural	2-12	1-3	Native
Salix sitchensis	Sitka Willow	Natural	1-8	1-4	Native
Sequoiadendron giganteum	Giant Sequoia	Street/Park	25-80	7-10	
Sorbus aucuparia	European Mountain Ash	Park	15	7	
Stewartia pseudocamellia	Japanese Stewartia	Park	20	8	
Styrax japonicus	Japanese Snowbell	Street	10	8	
Styrax obassia	Fragrant Styrax	Street	12	7	
Taxus brevifolia	Pacific Yew	Natural	5-12	7	Native
Thuja plicata	Western Redcedar	Street/Park	20-50	6-9	Native
Thujopsis dolabrata	Hiba Tree	Park	20	6-9	
Tilia americana	Basswood	Street	25	15	
Tilia cordata 'Chancellor'	Littleleaf Linden	Street/Park	15	6	
Tilia tomentosa	Silver Linden	Street/Park	30	20	
Tsuga heterophylla	Western Hemlock	Natural	20-40	6-10	Native
Zelkova serrata 'Green Vase'	Japanese Zelkova	Street/Park	18	15	

Table 11. List of Non-preferred Tree Species

Species	Common Name	Rationale
Acer negundo	(Box Elder, Manitoba Maple)	Poor aesthetics; not tolerant to salt; susceptible to pests
Acer platanoides	Norway Maple	Acceptable in parks; aggressive roots; susceptible to pests
Acer rubrum	Red Maple	Acceptable in some situations; high risk associated with pest incidence and disease.
Acer sacharum	Sugar Maple	Not tolerant to drought, pollution, salt
Aesculus glabra	Ohio Buckeye	Not tolerant to drought, salt; produces nuts; susceptible to pests
Ailanthus altissima	Tree-of-heaven	Weak wood; aggressive seedlings
Albizia julibrissin.	(Silk Tree, Mimosa)	Susceptible to canker attack
Alnus rubra	Red Alder	Short-lived; weak wood; susceptible to tent caterpiller
Betula spp.	Birch	Short-lived; weak wood; susceptible to leaf miner, aphids and other pests; requires high soil moisture
Castanea dentata	American Chestnut	Susceptible to disease
Catalpa speciosa Warder	Western Catalpa	Weak wood; aggressive roots
Celtis occidentalis	Hackberry	Susceptible to disease and pests
Crataegus oxyacantha	English Hawthorne	Susceptible to black spot fungus; aphids
Crataegus mordenensis	Morden Hawthorne	Thorny
Eleagnus angustifolia	Russian Olive	Weak wood; drainage issues
Fraxinus spp.	(Black ash, Patmore ash)	Acceptable in some situations; susceptible to pests
Gleditsia triacanthos	Honey Locust	Acceptable in parks; thorny
Ilex quifolium	European Holly	Invasive species – will spread into natural areas
Juglans cinera	Butternut	Susceptible to fungus; produces nuts
Juglans nigra	Black Walnut	Produces large fruit; restricts plants from growing around it
Juglans regia	English Walnut	Aggressive roots; produces fruit
Liriodendron tulipifera	American Tulip tree, Yellow Poplar	Acceptable in some situations; higher risk associated with pest incidence and disease
Liquidambar styraciflua.	Sweetgum	Acceptable in parks; aggressive roots
Malus spp.	Apple	Acceptable in some situations; produces fruit
Morus alba	White Mulberry	Produces fruit; aggressive seedlings
Platanus spp.	London Plane, Sycamore	Acceptable in parks; aggressive roots; susceptible to pests; drops seeds, twigs, bark
Populus spp.	Poplar	Short-lived; weak wood; cotton seeds
Prunus spp.	Cherry	Overplanted in City. Susceptible to blight, frost; produces fruit; prone to disease

Species	Common Name	Rationale
Quercus macrocarpa	Burr Oak	Large size; requires significant pruning maintenance
Quercus robur	English Oak	Invasive species – will spread into natural areas
Rhamnus cathartica	Common Buckthorn	Aggressive
Robina pseudoacacia	Black Locust	Accceptable in some situations; susceptible to insect damage
Salix spp.	Willow	Aggressive roots; susceptible to pests
Sophora japonica	Pagoda Tree	Susceptible to canker attack
Sorbus spp.	Mountain Ash	Weak wood; susceptible to pests and disease
Tilia americana 'Redmond'	Redmond Linden	Acceptable in some situations; large size
Ulmus americana	American Elm	Susceptible to Dutch elm disease; aggressive roots; large size
Ulmus parvifolia	Chinese Elm	Weak wood
Ulmus pumila	Siberia Elm	Weak wood; susceptible to pests
Conifers*		Appropriate in some locations such as parks and wide meridians; however, lower branches can act as visual screen

Table 12. List of Lower Shrub Species (Native)

Species	Common Name	Species	Common Name
Amerlanchier alnifolia	Saskatoon	*Polystichum munitum*	Sword Fern
Arctostaphylos uva-ursi	Kinnikinnick	*Rubus spectabilis*	Salmonberry
Cornus sericea	Red-Osier Dogwood	*Rosa gymnocarpa*	Baldhip Rose
Corylus cornuta	Beaked Hazelnut	*Sambucus racemosa*	Red Elderberry
Gaultheria shalon	Salal	*Sorbus sitchensis*	Sitka Mountain-Ash
Holodiscus discolor	Oceanspray	*Symphoricarpus albus*	Snowberry
Mahonia nervosa	Dull Oregon Grape	*Vaccinium ovalifolium*	Oval-leafed Blueberry
Oemleria cerasiformis	Indian Plum	*Vaccinium parviolium*	Red Huckleberry
Paxistima myrsinites	Falsebox	*Vaccinium ovatum*	Evergreen Huckleberry

Table 13. List of Plants Suitable for Landscape Buffers

Species	Common Name	Species	Common Name
Amelanchier alnifolia	Saskatoonberry	*Lonicera korolkowii*	Zabel's Honeysuckle
Arbutus unedo	Strawberry Tree	*Lonicera tartarica*	Tartarian Honeysuckle
Camellia japonica (var.)	Camellia	*Malus fusca*	Crabapple
Caragana arborescens	Siberian Peashrub	*Osmanthus armatus*	Chinese Osmanthus
Chamaecyparis lawsoniana	Ellwood Cypress	*Philadelphus x virginalis*	Mock Orange
Choisya ternata	Mexican Orange Blossom	*Photinia x fraseri*	Photinia
Clethra alnifolia	Summersweet	*Pieris japonica*	Japanese Andromeda
Cornus alba	Tartarian Dogwood	*Prunus laurocerasus* 'Reynvaanii'	Russian Laurel
Cornus sericea	Red Osier Dogwood	*Prunus lusitanica*	Portugal Laurel
Corylus cornuta var. *californica*	Hazelnuts	*Prunus triloba*	Chinese Flowering Almond
Cotinus coggygria 'Royal Purple'	Smoke Tree	Rhododendron varieties	Rhododendron
Cotoneaster acutifolius	Peking Cotoneaster	*Ribes laxiflorum*	Wild Black Currant
Cryptomeria japonica	Plume Cryptomeria	*Syringa vulgaris (cult.)*	French Lilac
Cupressus macrocarpa	Monterey Cypress	*Taxus x media* 'Hatfieldii'	Hatfield Yew
Elaeagnus commutata	Silver Berry	*Taxus x media* 'Hicksii'	Hick's Yew
Elaeagnus x ebbingei	Silverberry	*Thuja occidentalis* 'Aureospicata'	Cedar
Elaeagnus pungens 'Maculata'	Thorny Elaeagnus	*Thuja occidentalis* 'Fastigiata'	Pyramidal Cedar
Euonymus alata	Winged Burning Bush	*Tsuga canadensis*	Eastern Hemlock
Escallonia rubra	Escallonia	*Vaccinium corymbosum*	Commercial Blueberry
Hippophae rhamnoides	Sea Buckthorn	*Vaccinium ovatum*	Evergreen huckleberry
Hydrangea paniculata 'Grandiflora'	P.G. Hydrangea	*Viburnum x burkwoodii*	Burkwood Viburnum
Kolkwitzia amabilis	Beauty Bush	*Viburnum cassinoides*	Witherod
Laurus nobilis	Sweet Bay	*Viburnum dentatum*	Arrow Wood
Ligustrum japonicum	Japanese Privet	*Viburnum opulus* 'Roseum'	Common Snowball
Ligustrum ovalifolium	California Privet	*Viburnum tinus* 'Robustum'	Laurustinus
		Weigelia x 'Centennial'	Weigelia

* This list is adapted from Landscaped Buffer Specifications (1998) produced by the Agricultural Land Commission and the City of Vancouver, Food Policy (2009).

APPENDIX G – PLANTING SPECIFICATIONS

The following tree pruning specifications have been adapted from the City of Surrey Planning, Tree and Landscape Division.

Choosing Planting Stock:

- All tree's root balls and pots to be free of noxious weeds;
- All trees to be of BCSLA/BCLNA Landscape Standard, and the CNTA Nursery Stock Standard;
- All trees of ex-current genera to have single leaders (no trees with co-dominant stems permitted);
- All trees to have encircling/girdling roots removed at the time of planting;
- All tree species to be approved by Parks, Recreation & Culture and to be a minimum of 5 cm caliper, branched at or above 1.3 meters if deciduous, or 3 meters in height if coniferous. No pruning of the scaffold branches or leader should be undertaken; only broken branches should be pruned; and
- Lower branches may be retained for taper development, provided that they are shortened so as not to compete with the leader; leave a minimum of three buds on branches and prune to laterals.

Planting Specifications:

- Underground service locations (i.e., B.C. Gas, B.C. Hydro, B.C. Tel, Water, Sewer) to be determined prior to planting; tree locations shall avoid underground services and utilities;
- Edges of the planting hole shall not be vertical, but rather should be shallowly angled, to avoid girdling roots. All holes should be dug a minimum of twice the diameter of the root ball of the tree. Soil at the sides of the planting hole shall not be glazed, but should be scored to facilitate root penetration;
- Backfill for the tree should be of the soil taken from the planting hole, unless soil tests have shown the soil to be unsuitable for tree growth. (Soil tests should be conducted if there is any doubt about the quality of the existing soil). Backfill should be carefully tamped so as to remove air pockets. All extraneous materials are to be removed (e.g., wood, metal, etc);
- Fertilizer is not to be introduced at the time of planting, unless it is a minimum of 270 day slow release formulation (e.g. Nutricote 16-10-10, 270 day), or unless soil tests have shown the soils to be deficient in nutrients. (Some planting sites are of compacted glacial till or road base material; developers should conduct soil nutrient tests when soils are suspect);
- The finished planting height of the root collar of the tree relative to the covering soil shall be at the height as grown in the nursery and the trees planted height should be approximately 5 cm above existing grade on the site to allow for subsidence and to prevent drowning of the tree within the hole;
- On B&B trees, burlap should be rolled down to the bottom of the planting hole or preferably, be cut off;
- The top two layers of wires in the baskets should be cut and folded into the bottom of planting hole;
- All single stem trees to be staked with a minimum 10 cm diameter, pressure-treated 2.5 meter wooden stake, with soft strapping applied loosely with a figure eight around the stem, at a height no greater than two-thirds of the height of the tree. 5 cm-wide fabric belting is an ideal material for tree strapping (e.g. Arbortie or approved equal). Care should be taken to ensure that the stake does not damage the roots of the tree as it is being pounded into place (place stake outside root ball);
- A tree well of minimum diameter of 1.5 m is to be established around the tree. The tree well is to be filled with good quality mulch to a minimum depth of 8 cm. Mulch must be kept 15 cm away from the stem of the tree. Cedar mulch must not be used.
- Care should be taken to avoid damaging the bark of the tree during planting. Roots should not be exposed to sun or frost and should be kept moist.

Tree Spacing:

Spacing between trees shall reflect the chosen tree species' ultimate width, its conditions, and design criteria. Spacing shall be chosen to maximize the number of trees on the streetscape, while allowing for the development of a full crown. Within this rationale, fastigiate trees could be planted closer together than trees with spreading crowns, and more small trees could be planted than larger trees. Following are recommended spacing for trees in the size classes described in the list below.

- Small/fastigiate trees 6 – 9 meters
- Medium trees 10 – 14 meters
- Large trees 12 – 15 meters

Planting trees at fixed distances along the boulevard should be avoided, as doing so can lead to conflicts with underground utilities and above ground structures. Planting at irregular intervals will create a less formal appearance of the streetscape and will make gaps due to site constraints and removal of dead or vandalized trees less conspicuous. Avoid planting directly in front of main entrances to homes and large windows.

Table 14. Distance from Utilities

Steel or wooden poles	5 meter minimum (species dependent)
Driveways	2 meter minimum (small trees) 3 meter minimum (medium trees) 5 meter minimum (larger trees)
Catch basins	3 meter minimum
Manholes, valve boxes, service kiosks	3 meter minimum
Sewer services	2 meter minimum
Hydrants	3 meter minimum
Corners	In line with 8 meter site triangle
Sidewalk	1 meter
Back of curb	1 meter for local roads. Consult Public Works department for collector and arterial roads

Tree Species Selection:

In most residential situations, medium-sized trees should be chosen for planting. However, for many sites with larger lots with significant setbacks to the homes, large trees should be selected to maximize the urban forest impact and fit the scale of the neighbourhood. Conversely, many sites should be planted with small trees because of smaller lot size, reduced setback to the homes or in cul-de-sacs, because the frontage of the lot near the street is narrower than the rest of the lot. Avoid planting larger trees on the north side of east-west streets and on the east side of north-south streets, as this often results in excessive shade for the homes located behind the trees. In all cases, Public Works should visit the site prior to picking the size of trees to be planted to avoid incompatibility in mature tree size relative to neighbourhood scale. Avoid selecting trees with fruit where sidewalks will run beneath the mature tree's canopies.

Mixing two or more types of trees along non-arterial City streets promotes tree health through the lowering of the incidence of common pests and diseases. If only two different tree types are used, the chosen trees should be of similar size and form. When three or more tree types of similar size and form are chosen, the planting pattern can be random, provided that the same species is not placed adjacent to one another for more than three trees in a row.

APPENDIX H – PRUNING SPECIFICATIONS

The following tree pruning specifications have been adapted from the City of Surrey Planning, Tree and Landscape Division.

References for Pruning:

- ANSI A300 Standards for Tree Care Operations (Part 1 – Pruning);
- BCSLA/BCLNA Landscape Standard (current edition).

Qualifications of those to conduct pruning work:

- International Society of Arboriculture certification or BC Trades qualification in Landscape Horticulture or Arboriculture.
- British Columbia trades qualification as Utility Arborist where trees to be pruned within 3 meters of overhead energized conductors.

Products:

- Disinfectant for chains or saws - 20% solution of sodium hypochlorite, 70% solution of ethyl alcohol, or 5% Lysol.

General Pruning Specifications:

1. Prune in accordance with ANSI A300 pruning standard and as directed by Owner's Representative. Where discrepancies occur between standard and specifications, specifications govern.
2. Tool maintenance:
    a. Ensure that tools are clean and sharp throughout pruning operation. Do not use tools which crush or tear bark.
    b. Disinfect tools before each tree is pruned.
    c. On diseased plant material, disinfect tools before each cut.
3. Notify Owner's Representative immediately of conditions detrimental to health of plant material or operations.
4. Prune during plant dormant period or after leaves have matured. Avoid pruning during leaf formation, at time of leaf fall, or when seasonal temperature drops below minus 10 degrees Celsius.
5. Prune each species when in full leaf.
6. Retain natural form and shape of plant species.
7. Do not:
    a. Flush cut branches.
    b. Leave stubs.
    c. Crush or tear bark.
    d. Cut behind branch bark ridge.
    e. Damage branch collars.
    f. Damage branches to remain.
    g. Climb trees to be retained with spurs.
    h. Do not drain, fill, or seal cavities.

Pruning:

1. Remove dead, dying, diseased and weak growth to promote healthy growth.
2. Remove live branches that:
    a. Interfere with healthy development and structural strength including branches crossed or rubbing more important branches.
    b. Are of weak structure including narrow crotches.
    c. Obstruct development of more important branches.
    d. Are broken.
    e. Are infected at least 15 mm below infected area.
3. Remove live branches to re-establish natural species form including:
    a. One or more developing leaders.

   b. Multiple growth due to previous topping.
   c. Branches extending outward from natural form.
   d. Undesirable sucker growth.
4. Remove loose branches, twigs and other debris lodged in trees.
5. Remove vines, nails, wire, rope, signs and stakes.
6. For branches under 50 mm in diameter:
   a. Locate branch bark ridge and make cuts smooth and flush with outer edge of branch collar to ensure retention of branch collar. Cut target area to bottom of branch collar at an angle equal to that formed by line opposite to branch bark ridge.
   b. Make cuts on dead branches smooth and flush with swollen callus collar. Do not injure or remove callus collar.
   c. Do not cut lead branches unless directed by Owner's Representative.
7. For branches greater than 50 mm in diameter:
   a. Make first cut on lower side of branch 300 mm from trunk, one-third diameter of branch.
   b. Make second cut on upper side of ranch 500 mm from trunk until branch falls off.
   c. Make final cut adjacent to and outside branch collar.
8. Ensure that trunk bark and branch collar are not damaged or torn during limb removal. Repair areas which are damaged, or remove damaged area back to next branch collar.
9. Remove additional growth designated by Owner's Representative.

Root Girdling:

1. For girdling roots one-quarter size of trunk diameter or larger, V-cut girdling root one-half way through at point where root is crossing.
2. Remove exposed portion of girdling root as directed by Owner's Representative after cleanly cutting root flush with grade on each side of parent root. Do not injure bark or parent root.

Care of Wounds:

1. Clean dead bark around wound ensuring minimal increase in wound size. Retain peninsulas of existing live bark and do not damage callus tissue.
2. Do not apply wound dressing.

Clean-up:

1. Collect and dispose of pruned material daily and remove off site, to location approved by Owner's Representative.

APPENDIX I – CONSULTATION REPORT