MARKHAM

AECOM

MARKHAM TREES *for* TOMORROW

Streetscape Manual

June 2009

Design Guidelines
Selected Species
Technical Guidelines
Technical Details

DRAFT

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MARKHAM

TREES *for* TOMORROW

"*During this term of Council, we will plant more trees than we have planted in the last decade, making Markham a greener and better place to live and work.*" **~ Mayor Frank Scarpitti**

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1.0 Introduction

Research has shown that a healthy urban forest can reduce energy costs, sequester carbon, improve air and water quality and reduce storm runoff. When suitably integrated, urban trees are also a valuable 'green' infrastructure, providing tangible benefits that appreciate in value over time. As urban forests grow, their environmental, social and economic benefits increase. The urban landscape can be understood as an urban ecosystem, with each part relating to and affecting the whole. (Bell, R and Wheeler, J. November 2006)

As part of Mayor Scarpitti's commitment to planting a significant number of trees, the Trees for Tomorrow campaign was conceived, and officially launched in May 2008. Reviewing tree planting process in the Town of Markham as part of the Trees for Tomorrow program identified a need to update existing practices and standards relating to planting and maintenance. This exercise has resulted in the development of this manual.

This Streetscape Manual shall focus on Development applications for Site Plan and Subdivision as well as town boulevard tree planting. The development of this document is to make sure adequate replacement and increased number of new tree plantings occur in a sustainable manner. Providing specifications, details and education for staff, developers, contractors and residents will ensure this manual will be a significant resource and tool to ensure successful tree planting throughout the Town of Markam.

1.1 About Trees

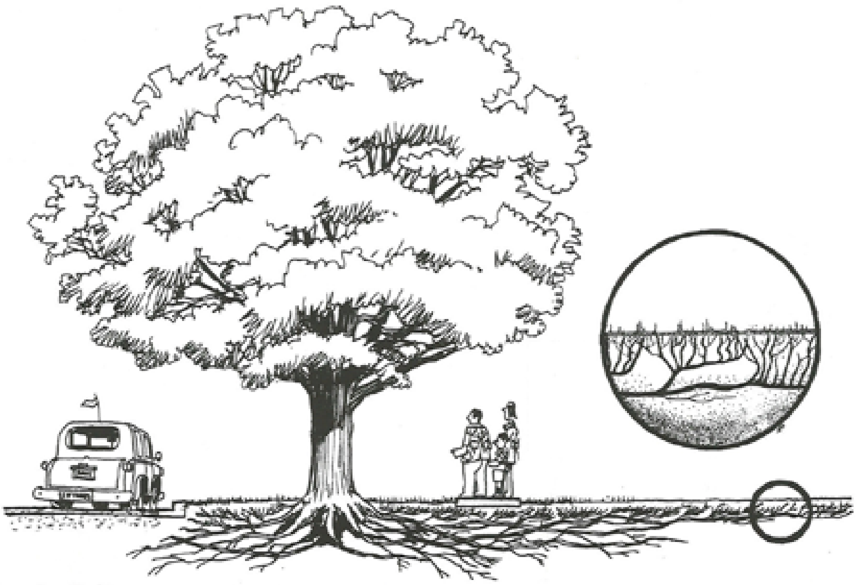
Trees, by most definitions, are woody plants that are large and have a single main trunk. A thorough understanding of how trees grow is fundamental to carrying out appropriate and accurate landscape design.

Tree Anatomy

Trees are generally made up of cells and tissues, wood, stems, leaves, and roots. **Wood** has four primary functions: conduction of water and dissolved minerals, support of the weight of the tree, storage of carbohydrate reserves and defence against the spread of disease and decay. Twigs are small stems that provide support structure for leaves, flowers and fruit. **Branches** support **twigs**, and the trunk supports the entire **crown**. **Buds** can occur along the twig, at the base of each leaf, just under the bark, or at the tip of each twig. **Leaves** are the food producers of the tree by trapping the energy of the sunlight in the chloroplast where it is converted to chemical energy in the form of sugar. This reaction is called photosynthesis. Leaves also control transpiration which helps cool the leaf and draw water up through the xylem. **Deciduous** trees loose their leaves every year and **coniferous** trees hold their leaves for more than one year. **Roots** serve four primary functions: anchorage, storage, absorption, and conduction. The main function of large roots are anchorage, storage and conduction. Absorbing roots are the small, fibrous, primary tissues that grow at the ends of the main, woody roots. Roots grow where moisture and oxygen are available and most absorbing roots are found in the upper 30cm of soil. Horizontal, lateral roots are usually near the soil surface. Vertical roots grow off the lateral roots within a few feet of the trunk, providing anchorage. The downward growing tap root of young trees is usually choked out as the root main system develops or is diverted horizontally once it meets unfavourable growing conditions. Roots may extend laterally for considerable distances, depending on the tree species and soil conditions. Roots of trees grown in open areas often extend two to three times the radius of the crown. (*International Society of Arboriculture, 2001*)

Growth Requirements

Trees require adequate space to develop both above ground and below ground. Above ground space controls the availability of sunlight for photosynthesis and crown development. Below ground space affects root development, nutrient availability, moisture and anchoring. The relationship between tree growth and soil volume requirements has been widely studied. Restricted root system growth negatively impacts the development and life expectancy of the whole tree.



(International Society of Arboriculture, 2001)

1.2 Benefits of Street Trees

Trees are not only important for their intrinsic value as wildlife habitat but also for a great number of environmental, social and economic benefits that include but are not limited to:

Environmental

- Active removal of carbon dioxide and other greenhouse gases from the air.
- Mitigation of air, dust, noise, heat and chemical pollution.
- Interception of rainwater, reduced runoff and improved stormwater runoff quality.
- Reduced soil erosion through interception of rainfall and increased soil stabilization.
- Increased infiltration of permeable land areas essential to stormwater management.
- Shade for impervious surfaces thereby reducing the ‘heat island’ effect.
- Shade and shelter for buildings, reducing energy associated with cooling and heating.
- Wildlife nesting, cover, shelter and food.
- Preservation, protection and appreciation of our Natural Heritage.

Social and Health

- Contribution to desirable environments to live, work and spend leisure time.
- Creating a buffer between moving vehicles and pedestrians
- Providing shade for pedestrians.
- Contributing to reduced stress and improved physical health.
- Creating a greater sense of meaningful connection between people and natural environment.
- Increased traffic safety due to the perception of road width, curves and speed relative to tree layout and spacing.
- A stronger sense of community and empowerment for residents to improve their neighbourhood conditions and promote environmental responsibility and ethics.

Economic

- Extended pavement surface life as a result of shade
- Lower utility costs as a result of increased energy savings.
- Attractive environment for business and consumers.
- Increased real estate values.
- Reduced healthcare costs associated with poor air quality.
- Reduced requirements for stormwater treatment and flood control costs.
- Economic return from urban forest products.
- Enhanced tourism values.

1.3 Challenges for Street Trees

The majority of Canadians live in urban centres. Threats to trees in the urban environment are due to both physical impacts and management and improper installation. They include:

Limited Room to Grow

In order for trees to sustain their health and growth potential, and consequently provide the most benefits, trees must have as much room to grow as possible. Trees are competing for available space within the boulevard. This space is crowded with:

- Infrastructure to accommodate pedestrian and vehicular traffic.
- Conflicts with utilities above and below ground
- Municipal Gas, water and hydro lines

All of these factors restrict the volume of soil available to support the canopy leaf growth and root growth balance.

Inadequate Soil Conditions

The successful growth and survivability of a tree is fundamentally linked to the quality of soil in which it grows. Current development practices leave sites bare of native soil and with high levels of compaction that create an inhospitable place for a tree to grow. Topsoil stripping and stockpiling introduces variability, modified pH, interrupted nutrient cycling, reduced soil organism activity, contamination with waste material and temperature extremes. All of these factors combined make it very difficult for a tree to put out roots and survive. Roots are unable to grow into soil with high bulk density that is compacted. Soil compaction is influenced by soil type and human activity. As pore space is eliminated, roots are not able to penetrate the soil and the plant has less access to water and oxygen.

Inappropriate Tree Selection

Each tree species has unique cultural requirements and the streetscape planting environment exposes trees to continual and unique stresses. Matching tree species selection with tolerance to site conditions gives the trees a better chance at survival. A great deal of thought needs to be incorporated into a planting plan. Consideration should be given to many factors, including:

- Variability in trees stock origin and quality, local gene conservation
- Age diversity and diversity of tolerant species to resist disease and insect impacts. (In many Canadian communities nearly half of all urban trees are non-native Norway maples.)
- Exotic pests, disease and invasive plants.
- Adaptation to changing climate

Poor Site Conditions

Physical challenges in the streetscape environment include water stress due to soil properties, microclimate and maintenance practices, increased drought, salt pollution, and air pollution. The streetscape environment creates microclimate extremes due to wind tunnelling, reflected heat from asphalt, concrete and light and shade from surrounding structures. Inadvertent damage caused by vehicles, snow plows, lawn equipment and vandalism threaten the health of trees and make them more susceptible to secondary stresses. Weakened and stressed trees are more susceptible to secondary insects and disease damage.

Limited Implementation Policies and Practices

The economic value that a tree provides to a development is not always considered along with other standard assets. Trees provide many immediate and long term benefits that need to be taken into account when planning for development and integrating tree planting. Improper tree installation too often results in high tree failure and loss of investment. Education for contractors, developers, Landscape Architects and Town staff is key to ensuring the success of our Urban Forest.

2.0 Tree Planting Context

Potential planting sites must be assessed to determine appropriate tree planting strategies. Opportunities for implementing high performance best management practices must be identified in the planning, design and construction of all projects.

2.1 Regional Context

The Town of Markham is located in the Regional Municipality of York, in the province of Ontario. It is directly north of Toronto. The unique soil and climate determine the types of vegetation which are found and can be grown in the area. Markham is located within Zone 5b of the 2000 Natural Resources Canada Plant Hardiness Zone Map, based on the region's average annual minimum temperature. The area can also be classified as the Great-Lakes - St.Lawrence Ecoregion characterized by warm summers and cold, snowy winters. York Region is located on the Lake Ontario Shore, South Slope region. The Town of Markham soil composition differs due to local environmental factors such as parent soil material, drainage, differences in land cover and human disturbance.

<u>Climate</u>

Markham's climate, like other portions of southern Ontario, is moderated by the Great Lakes. The area is influenced by warm, moist air masses from the south and Lake Ontario and cold, dry air masses from the north Oak Ridges Moraine. Markham is in the South Slope region where the topography is higher than the Lake Ontario Shore region with only moderate influence from the lake. Summer is characterized by high air temperatures reaching the mid to upper 20°C range and winter temperatures are cold and highly variable. Environment Canada monitoring stations in Stouffville and at the Toronto Zoo have recorded 37°C as the highest air temperature in August 1989 and -36°C as the lowest air temperature in January 1981. The mean temperature for the growing season is 17 degrees Celsius and the frost-free growing season is over 160 days. Based on Environment Canada climate stations, the average annual precipitation between 1986 and 2006 averaged 850mm/year. January and February tend to be the driest months with <60mm on average, while August and September are the wettest averaging >80mm. 15% of annual precipitation occurs as snow falls between December and March. (Environment Canada 2007)

The increase in greenhouse gases discharged to our atmosphere since the industrial revolution has created conditions that are precipitating change in our climate. This phenomena known as 'climate change' may have significant ramifications to the weather system affecting this area.

<u>Topography and Soils</u>

Markham has a smooth, moderately gentle sloping topography with imperfect drainage, bordered by the Oak Ridges Moraine to the north and dominated by the Peel Plain and South Slope physiographic regions. The Peel Plane region, overlying the central portion of Markham, is a generally flat topography where a thin veneer of silt and clay up to 5m thick was deposited over till during the most recent period of glaciation. Soils are predominantly clay with localized clay loam and loam with low infiltration. The South Slope region is a sloping plane with two bands through the Town that border between the south edge of the Oak Ridges Moraine and the north edge of the Peel Plain and between the south edge of the Peel Plain south to the Lake Iroquois shoreline in Toronto. The South Slope region is underlain by glacial till and the resulting soil types are predominantly clay with some clay loam and loam. Runoff is relatively high and infiltration is correspondingly low. Markham is predominantly in the Rouge River watershed under the Toronto and Region Conservation Authority emptying into Lake Ontario. Neighbouring watersheds draining into Lake Ontario include the Duffins Creek and Petticoat Creek to the east and the Highland Creek, Don River and Humber River to the west.

Agriculture followed by urban development has had a great impact on native soils in Markham. In many locations there have likely been several stages of soil disturbance over the last 200 years or more due to tree removal, agriculture, building, etc. The more disturbance, the more degraded the native soil becomes.

Demographics

The Town of Markham population was listed at 272,500 in 2006 with a projected increase of 151,000 from 2006-2013. 24% of Markham is covered by the Provincial Greenbelt Land where urbanization is restricted and agricultural and environmental lands are protected. This includes the major Rouge River tributaries and Federal and Provincial lands in eastern Markham. 60% of land use in Markham is urban settlement area and 16% is rural and agricultural.

Regional context, including climate and soil characteristics are important in considering planting sites and tree species selection. The regional context can help determine overall goals for preservation and enhancement of natural areas and identifying targets for increasing Markham's canopy cover and improving air quality. Each individual site will have unique characteristics that need to be studied and understood in addition to the regional context in order to make informed decisions and implement best management practices for tree planting.

2.2 Local Context

Local Context refers to the resources, methods, and policies that determine planning and development decision making. It is important to understand the expectations of the Town of Markham with regards to tree planting for development and the studies, planning, strategies and tools that determine these expectations.

Programs and Initiatives

- Trees for Tomorrow is a four year strategy aimed at increasing Markham's overall tree cover, providing plantings that will be sustainable and a positive living legacy for future generations and implementation through community and corporate involvement and programs to increase planting on private and public properties.
- Markham Green Print is a plan for a sustainable Markham striving to create a clean, safe environment, a vibrant community and a fair and inclusive community that welcomes creativity and culture. The Quest for the Best Markham is an interactive challenge that engages the community to define the vision for Markham's future as a sustainable community.
- The Celebrate our Environment Community Calendar is a three-season resource guide full of information about workshops, community cleanups, garden tours, planting events, plant sales, environmental celebrations and more.
- Commemorative Tree Planting partnership provides a creative and lasting way for individual residents, families, businesses, schools and community groups to honour friends and family or to celebrate special events. The Town will plan a mutually agreed upon, standard-sized tree in a park and will also provide regularly scheduled maintenance to the tree and surrounding area.
- The Markham Environmental Sustainability Fund is a Town program that funds innovative and leading environmental initiatives that contribute to the health of the natural environment.
- The Trees for Tomorrow Fund is a Town program to encourage Markham community groups, non-governmental organizations and other public agencies to conduct tree planting on public land.
- The Backyard Tree Planting Program is a partnership involving Markham, York Region and LEAF (Local Enhancement and Appreciation of Forests) subsidizing consultation with a qualified arborist, a tree and full planting services.

<u>Staff Resources</u>

Development Services Commission

- Planning & Urban Design Department
    - Urban Design Group
        - Design approval for subdivision and site plans
        - Determine species variety for boulevard trees
        - Determine design and % species make-up
        - Tree preservation
        - Streetscape design
        - Coordinate with York Region
        - Site Inspection
        - Release of Letters of Credit
        - Closure of Files

Fire and Community Services Commission

- Forestry

  Business and Technical Services
    - Maintain all trees on Town right of ways after subdivision assumption
    - Plant replacement trees.
    - Tree replacement for assumed subdivisions
    - Pruning on an as needed basis
    - Clearing of hazard trees on town property
- Operations Business and Technical Services
    - Review opportunities and coordinate plantings on Town and public lands
    - Work with government agencies, non-governmental organizations and community groups for ongoing partnerships of planting and stewardship

<u>Tools and Policies</u>

- Official Plan/Secondary Plan Amendment
- Zoning By-Law Amendment
- The Development Application and Approval Process
- Committee of Adjustment
- Environment and Open Space Policies
- Tree Preservation By-Law
- York Region Forest Conservation By-Law
- Growth Management Strategy
- Natural Heritage System
- Rouge Park Management Plans
- Province of Ontario Greenbelt Plan
- TRCA Special Policy Areas
- Federal Greenspace Master Plan
- Building Markham' s Future Together
- Province of Ontario Oakridge Moraine Plan

2.3 Site Context

Choosing potential tree planting areas must consider multiple factors including climate, soil characteristics, environmental conditions, planting space, site location, existing vegetation, visibility and accessibility, aesthetics, land use, ownership and regulations, social influences, and maintenance requirements.

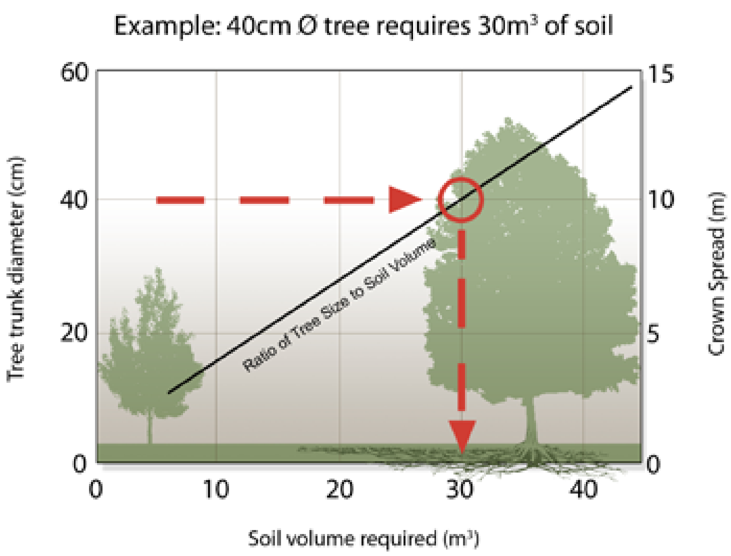
By fully understanding the site context, conflicts are minimized, maintenance needs are reduced, public safety is enhanced and long term costs are reduced. Planting strategies can be considered in the context of the specific site and prioritized to maximize canopy coverage for long term benefits.

Choosing an appropriate planting site must consider the following:

- Adequate soil volume and quality to support future healthy tree growth.
- User safety considering visibility and accessibility.
- Preventing compaction of planting area soils by construction and foot traffic
- Resolving conflicts between trees and utilities, pavement and lighting.
- Reducing impact of tree exposure to emissions, polluted runoff, wind and drought.
- Allowing for snow removal and storage and prevent salt damage, ice damage and trunk scour
- Preventing damage to trees from cars, vandalism and other conflicts
- Proximity to features that could reduce costs and/or impact of construction.

<u>Spatial Requirements</u>

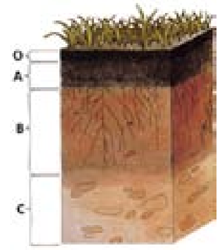
Within the limitations of the streetscape environment, materials and methods for tree planting can be determined and variations to the standard road cross section can be considered to accommodate tree growth and associated spatial requirements. In order for trees to sustain their health and growth potential, and consequently provide the most benefits, trees must have as much space as possible. There is a balance that a tree maintains between the surface leaf area for photosynthesis and the area of absorbing roots for water and nutrient uptake. A soil volume criterion is based on the expected size and stature of a particular tree species. Where soil volume space is limited, site specific enhanced planting strategies should be designed to extend the root zone under hard surfaces. Consideration should include but not be limited to techniques such as continuous planting trenches, structural soils, soil cells and permeable paving. Above ground tree parts must also be considered to reduce conflicts between trees and surrounding infrastructure to minimize maintenance and increase benefits and survivability.



TREE SIZE IN RELATION TO AVAILABLE SOIL VOLUME
(Urban, 2002)

<u>Soil Quality</u>
The functional relationship between tree roots and the characteristics of the soil in which they grow has the greatest influence on tree health. When poor soil quality limits growth it increases maintenance requirements and tree failure. The quality and quantity of soil are equally important criteria for improving control over soil specifications and testing. The quality and integrity of the subsoil is equally as important as the organic layer of topsoil.

An ideal medium for tree growth can be modelled after forest soils. Ideal soils are comprised of 45% mineral materials (sand, silt and clay), 50% open pore space, and 5% organic matter and organisms. The soil profile is normally made up of five major horizons developed as a result of rainfall, heating and cooling, chemical reactions and biological activity.



<u>Typical unaltered soil profile</u>
O – thin layer of decomposing organic material
A – contains most absorbing roots
B – fine textured material from A horizon and particles from parent material
C – subsoil composed of rocky parent material

Roots grow where soil conditions are favourable. Absorbing roots are most frequently in the upper 15-25cm of soil and tree roots are not usually found deeper than 1-1.5m. Soil texture (sand, silt, clay) affects the soils ability to hold water and provide oxygen to the roots. Bulk density measures the soil's porosity, or airspace between particles. Reduced bulk density resulting in compaction, restricts root growth, reduces water infiltration and availability and limits the movement of oxygen and carbon dioxide in the root zone. Soil pH affects which tree species will grow based on the availability of minerals. Soil pH is difficult to alter and therefore species should be selected based on existing soil. Soil is an ecosystem containing billions of organisms that live with tree roots. As trees grow, they absorb essential mineral elements from the soil.

TABLE 1 GENERAL ROOT GROWTH RESOURCE REQUIREMENTS (Dr. Kim Coder, 2000)

Root Resource	Minimum	Maximum
oxygen in soil atmosphere (for root survival)	3%	21%
air pore space in soil (for root growth)	12%	60%
soil bulk density restricting root growth (g/cc)		1.4clay 1.8 sand
penetration strength (water content dependent)	0.01kPa	3mPa
water content in soil	12%	40%
root initiation (02 in soil atmosphere)	12%	21%
root growth (02 in soil atmosphere)	5%	21%
progressive loss of element absorption in roots (O2 in soil atmosphere)	10%	21%
temperature limits to root growth	4°C	34°C
pH of soil (wet test)	pH 3.5	pH 8.2

The quality of organic soil throughout the Town of Markham varies and in development areas the consistency and quality of topsoil can be considered marginal to poor. Quality and compaction outside of the planting pit also limits root establishment and tree development. In the future, increased topsoil depth and quality will help in establishing suitable rooting zones in development areas.

Land Use

Different land use types provide both opportunities and constraints for street tree planting. The following table outlines some of those opportunities and constraints. Various tools can be used to implement successful planting as part of the development process.

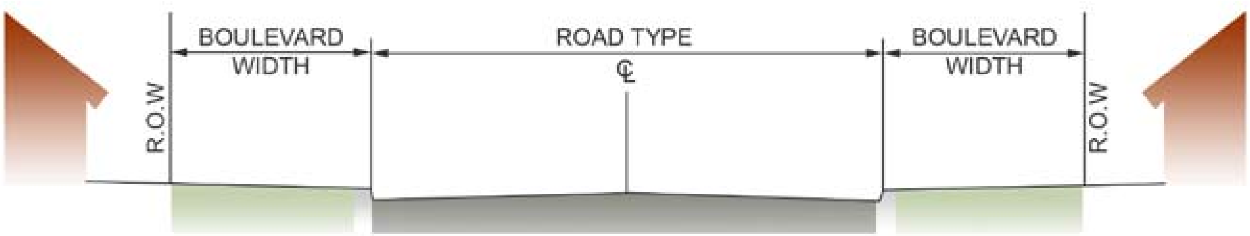
TABLE 2 LAND USE

Land Use	Opportunities	Constraints	Tools
Industrial Commercial Institutional Business Park	• median planting • windbreaks and shading • green roofs • reduce stormwater runoff using bioretention and bioinfiltration, tree check dams, and linear stormwater tree pits • establishment of larger trees on generous setbacks/ landscape areas • establish consent conditions to include additional rows of trees within private frontages	• overshadowing • wind tunnel effects • wind exposure • radian heat from pavement • high pollution levels from vehicle emissions • sign visibility (removals) • soil variability and construction contamination • limited soil volume • underground utilities • lack of irrigation • salt spray from roads	• Site Plan Application • Developer donations • Business Initiatives
Neighbourhood/ Commercial Centre	• bicycle racks to discourage use of trees • consolidated planting areas	• soil compaction due to foot traffic • soil volume • underground utilities • lack of maintenance	• Subdivision Plan • Site Plan Application
High Density Residential-Urban	• median and roundabout planting • corner lots • condominium maintenance	• tight setbacks • encroaching on house/ building façade • soil volume • underground utilities* • driveway widths	• Subdivision Plan • Site Plan Application
Low Density Residential - Rural	• homeowner maintenance • large boulevards • stormwater boulevard planters • planting on lot frontages • private plantings	• existing vegetation • homeowner preferences • limited alignment to doorways, windows and lot drainage channels • lack of maintenance	• Tree Preservation By-Law • Site Plan Application • Trees for Tomorrow program • L.E.A.F. program
Infill – Older retail and underdeveloped areas	• transplanting opportunities • native plant sources • preserving parent soils	• tree preservation • soil conditions • soil volume • unknown underground utilities	• Natural heritage • Site Plan Application • Town and community initiated plantings
Open Space & Walkways	• naturalization • open areas for planting	• limited budget • lack of maintenance • vandalism	

<u>Streetscape Framework</u>
Engineering standards for road cross sections set a specific framework for tree planting in the context of property lines, paved surfaces, utilities, site furniture and building frontage. These specific road types are determined by and determine the social context and pedestrian and motorist use patterns.

Traffic Roads (Major Collectors and Collectors) – Large scale, multiple-lane thoroughfares make up the skeleton of the roadway system. Travel streets provide critical transportation connections, major mass-transit links, and local truck routes; they also accommodate substantial pedestrian activity and contain commercial, cultural, institutional and occasionally residential building types. Travel streets should enhance connectivity between different neighbourhoods, destinations and other major streets.
Community Roads (Collectors and Local Roads) – Medium to large scale streets serve as 'town centres' for neighbourhoods and business districts, and are usually fronted by mixed commercial, institutional and residential uses. Community roads often link travel roads since they offer a range of destinations including shopping, entertainment, dining, services, cultural centre, mass-transit connections, parks and public spaces. Private vehicle travel is substantial, but truck travel should be minimal.
Living Roads (Local Roads and Laneways) – Narrow roads are primarily residential and are not intended as major transit routes. Quality of life and safety for pedestrians and residents is the major concern, and impact of motor vehicles should be kept to a minimum.

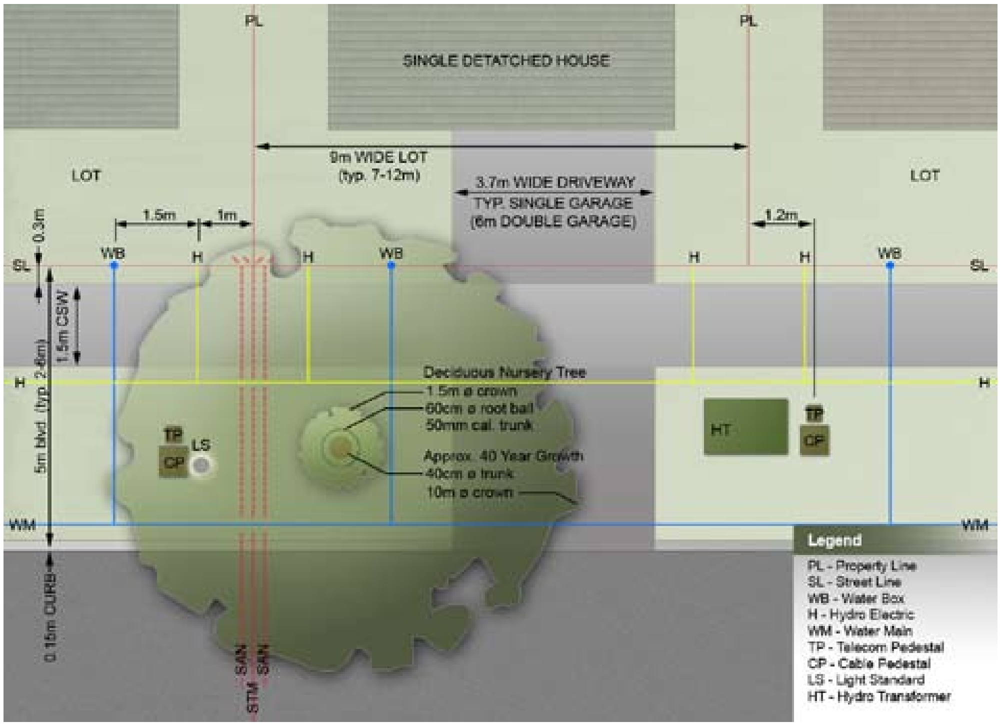
Increased traffic volume and pedestrian use results in an increase of negative impacts on all tree parts essential to growth and survival. In order to realize the many benefits of trees that are essential to human life, we must find ways to support tree growth and survival in dense urban streetscape environments where the majority of Markham's population resides.



LOCAL:	2.0m 3.5m 5.0m	15.5m - SINGLE LOADED 17.0m - STANDARD 18.5m - SIDEWALK BOTH SIDES	5.0m 5.5m 5.0m
COLLECTORS:	6.0m 6.0m 6.0m 6.0m 6.0m	21.5m - 1-SIDE PARKING 23.0m - 1-SIDE PARKING, SHARED BIKE 23.0m - INDUSTRIAL 23.5m - CENTRE TURNING LANE 24.5m - PARKING & BIKE LANES	6.0m 6.0m 6.0m 6.0m 6.0m
MAJOR COLLECTORS:	6.0m 6.0m	26.0m - WITHOUT CENTRAL MEDIAN 28.0m - WITH CENTRAL MEDIAN	6.0m 6.0m
LANEWAYS:	1.5m 1.75m	8.5m - RESIDENTIAL 10.5m - COMMERCIAL	1.5m 1.75m

DRAFT ROAD CROSS SECTION EXAMPLES

Infrastructure
Illustrating infrastructure requirements in the context of tree planting in the streetscape environment, illustrates the challenges for adequate root and canopy space.



INFRASTRUCTURE LAYOUT PLAN
(Developed from Markham Engineering Standard Drawings - 2008 Draft)

Underground spaces in developed areas are commonly crowded with the infrastructure needed to connect homes, offices, and other buildings to utility networks. Numerous pipes and cables for supply of water, gas, electricity and telecommunications may be buried beneath the boulevard and green areas along a right of way. The space occupied by these installations may severely reduce the space available for tree growth or prevent any tree planting at all.

Specific setback requirements between street trees and right of way infrastructure have been determined based on trial and experience to allow barrier free access, prevent hazards, conflicts and damage to both trees and infrastructure and to allow for access and service to infrastructure for maintenance and repair.

The table on the following page summarizes tree planting space requirements and right of way infrastructure.

TABLE 3 SPATIAL CONTEXT – TREE PLANTING

Tree Type	Crown Height	Crown Spread	Trunk Diameter	Average Rooting Depth	Soil Volume Requirements (Urban 1992)
large stature tree in park (sugar maple	25 - 35m	15m	up to 90cm	1-2m	minimum 6m(+) tree pit diameter
large stature tree in boulevard (hackberry)	20m	18m	up to 40cm (for avail. soil volume)	1-2m	30m3 (0.8-1.2m depth) 15m3 (shared root space)
medium stature tree in boulevard (linden)	15m	8m	up to 30cm (for avail. soil volume)	1-1.5m	23m3 (0.8-1m depth)
small stature tree (serviceberry standard)	3m	3m	up to 20cm	1m	15m3 (0.6 – 1m depth)

TABLE 4 SPATIAL CONTEXT – R.O.W. INFRASTRUCTURE

R.O.W. Infrastructure	Depth	Height	Setback/Offset Requirement	Restrictions/ Notes
house services (water, storm, sanitary)	1.75 - 2.75m		2m from trunk	maintenance access
watermain	1.75m		2m from trunk	maintenance access
street light (and utility base)		5-8m	4.6m from edge of canopy	maintenance access illumination safety
hydro/joint use trench	1.4m		1m from trunk	maintenance access
telecom. trench	1.4m		1m from trunk	maintenance access
transformer		1.2m	trunk 1.2m from sides trunk 3m from door	maintenance access
telecom. box		1.2m	1m from trunk	maintenance access
hydrant		1m	3m from trunk	maintenance access
gas main	1.2m		2m from trunk	maintenance access
property boundary			1m from trunk	maintenance disputes
pavement and sidewalk			1m from trunk	heaving, root conflict
curb			1.5m from trunk	snow storage vehicle overhang
driveway			trunk 1.2m residential trunk 3m commercial/ind.	visibility
structures (buildings)			4-6m from trunk	pruning (canopy specific)
signs			5m from trunk	visibility (canopy specific)
ditch (cl)			1m from trunk	maintenance
stop sign & intersection			9-15m from trunk	adhere to sight triangle
hydro pole		9-15m	3m from edge of canopy	maintenance access fire and power outages
overhead wires			canopy 3m below and adjacent crossarms	pruning harmful to trees fire and power outages

3.0 Design Process

3.1 Preservation and Protection of Existing Trees and Soil

Protection of our existing resources is critical to the success of our urban forest. Large, healthy trees are a valuable asset to the community. Most mature trees grow slowly over time and are not easily replaced. Damage to trees occurs as a result of development and construction from curbs and sidewalks, various types of paving, excavation of underground utilities, and road widening. The damage to trees includes root damage, trunk breakage, bark removal, branch scrapes and breakage, and total tree destruction. Such trees become public hazards which increase municipal liability.

Construction practices such as cutting and filling, installation of underground utilities, and backfilling against foundations can create great diversity in soil structure. This variability can change drastically with depth and between planting locations on the same property. Typically, construction techniques remove or stock-pile useful existing topsoil. However, the resulting compaction and construction vehicle traffic can reduce soil structure, with negative hydrologic and biodiversity impact. Consequences of soil compaction and loss of organic matter include reduced infiltration capacity, increased runoff, increased erosion, scouring and sediment load, reduced rate of groundwater recharge, reduced surface water availability for plants and increased runoff volume carries pollutants including pesticides, fertilizers, animal wastes and chemicals.

3.2 Design Principles

All landscape designs shall consider fundamental Design Elements and Design Principles such as: Colour, Line, Form, Texture and Scale; Unity, Balance, Transition, Proportion, Rhythm, Focalization, Repetition and Simplicity

The use of Plant Attributes such as form, texture and colour should be used to reinforce the landscape design vision.

Tree Form should be considered in site context for framing, accenting, screening, buffering, site design features, etc.

3.2 Design Considerations

Planting sites must be carefully and fully evaluated before the decision is made to plant a tree. Planting the “right tree in the right place” is essential to tree health and survivability and reduced conflicts with streetscape utilities and amenities. Prior to making the tree selection, the Landscape Architect must determine the overall design intention in partnership with the project Engineer. In order for the design to be successful, some key questions must be answered. The following checklist includes principal considerations for all designs:

- ☐ Is there sufficient soil volume and area to support a healthy tree to maturity?
- ☐ Is the soil suitable/capable of supporting a healthy tree or can it be modified sufficiently?
- ☐ Are there underground utilities in place which restrict or prevent a tree being planted?
- ☐ Is there sufficient horizontal and vertical space to allow the canopy to develop unimpeded and without extensive pruning requirements?
- ☐ What site lines must be maintained?
- ☐ What level of maintenance is required and can be expected?
- ☐ Is there potential for conflict with street maintenance or use? (snow loading, grass cutting, pedestrian access)

Utilities and Infrastructure

Design of right of way infrastructure to consider tree placement from the outset of development design will help to mitigate damage and reduce maintenance and replacement costs. In order to maximize space for successful tree planting, infrastructure should be consolidated wherever possible. Tree roots and underground lines can initially coexist without problems; however the installation, maintenance or renewal of underground services in existing streets usually necessitates digging a trench through the root zone resulting in significant root loss. The location and depth of existing utilities is often difficult to verify from a plan. When the wrong tree is planted in proximity to utilities, the ultimate result is damage and removal.

Provisions for underground root space must be considered in the community design stage. Coordinating the placement of utilities using common trenching and utility ducts can minimize the impact of installation and maintenance. This technique enables easy location and identification of utilities and enables utility entities to synchronize work and share expenses. Some 'dry' utilities such as telephone, electric and gas may be stacked in a trench to optimize space. Utility ducts are another technique that provide a below ground supporting structure that contain several adjacent utility systems and allows easy access for regular maintenance. The use of trenchless technology in areas with existing trees, allows for less invasive inspection, repair and installation of utility infrastructure to minimize cutting through root zones.

Utilities may also be shifted out of soft landscaping areas available for tree planting and into the street or under the paved pedestrian area. Maintenance costs can be a limiting factor in this alternative. Utilities can be located along the curb or in the bike lane to reduce traffic disruption and removable sidewalk panels ease utility access for maintenance and construction.

Tree Roots in the Built Environment, 2006

GreenLeaf www.greenleaf.org

Stormwater Management

Trees and vegetation provide benefits to stormwater management through rainfall interception, evapotranspiration, and infiltration. As part of stormwater management design, preservation of existing trees and should be a priority.

The road right-of-way has a number of opportunities to achieve Stormwater Management objectives in addition to its primarily circulation objectives of transportation, transit and utility servicing.

Alternative planting designs can reduce surface runoff and slow runoff water to the Municipal stormwater system. Water cycle management initiatives can be designed into the urban landscape in all scales of development from individual lots, streets, and neighbourhoods. Impervious areas directly connected to receiving water environments have a major detrimental impact on the ecosystem health. Bio-retention systems have been designed to treat parking lot runoff using sand filters and root-zone environments as stormwater treatment and conveyance systems. The re-design of street-tree root-zone environments as stormwater treatment systems is a further development of the bio-retention concept. Street trees can be grown in suitable permeable media with sub-surface drainage. Stormwater runoff is treated as it percolates through the root zone. Treatment is a combination of physical, chemical and biological processes.

Design to ensure successful stormwater management in the urban landscape context must be an integrated process involving developers, engineers, landscape architects, and others. The following design criteria should be considered in corridor tree planting:

Design bio-retention areas in the right-of-way to store excess runoff for extended detention time (24 to 48 hours) with ponding depth up to 0.25m. Specific design requirements for permeable soils and subsurface drainage are required.

Select plant material for bioretention areas which are drought and salt tolerant as well as tolerant of prolonged moisture.

Select plant material that will not damage drainage pipes.

Utilize curb extensions and bump-outs designed for traffic calming for stormwater management opportunities.

Refer to the following design standards:

Town of Markham’s Engineering Department SWM Guidelines

Toronto Region Conservation Authority’s “Low Impact Development (LID) Stormwater Management Manual (draft - November 2008) http://www.sustainabletechnologies.ca/

Groundcover

Groundcover involves replacing turfgrass with mulch, stone, ground covers, naturalized vegetation or low-maintenance grass.

Using groundcovers in place of turf can provide benefits such as reduced water consumption, reduced erosion, minimized need for chemical amendments, reduced need for supplemental irrigation, eliminating the need for regular mowing, reducing maintenance costs and emissions and damage to trees from mowing. Groundcover areas can also provide a buffer for protection around tree planting to preserve soil and reduce compaction.

Implementing groundcover planting into a streetscape environment requires adaption to landscape aesthetic expectations and can be used as a tool to promote education and public awareness. Installation costs are often higher than conventional turfgrass, but the long term maintenance costs are lower.

Design of groundcover areas can focus on areas which are shaded, steeply sloped, or hard to maintain. Groundcover areas can also be coordinated with drainage patterns to optimize stormwater filtration.

Rooftops and Structures

Planting over buildings and structures such as parking garages creates opportunities for green space and associated benefits. Landscaped areas on roof slabs and in contained planters are subject to more severe drying conditions, extreme elements and potential drainage issues. To address these issues, growing medium depth and type, drainage system, membrane layers, plant selection, amount of direct and reflected sunlight, watering/irrigation, water storage and maintenance all require special attention.

Weight is the primary limiting factor for planting on most roof structures. The weight of landscaped areas over structures must not be in excess of the design loading for the structure. Both the intended landscape design loading and loading during construction must be reviewed, approved and documented by a structural engineer. The minimum recommended depth for growing trees over structures is 450-900mm for small to medium trees and 900-1200mm for large trees (CMHC Roof Deck Design Guidelines). Designs should take into account the effect of on soil moisture-holding capacity of small depths and volumes through the selection of plant material, growing medium, drainage, irrigation and maintenance.

4.0 Tree Selection

All trees should fit the microclimate, soils, sun, moisture, budget, maintenance environment and design intentions for which they are planted. Specific site conditions must be fully analyzed and understood prior to plant selection.

The following considerations are critical for appropriate tree selection:

- Site assessment including microclimate and soil assessment.
- Understanding the physiological requirements of tree species to ensure health and longevity.
- Anticipation of potential conflicts with power lines, sidewalks, underground utilities to reduce future maintenance costs.
- Selection of large shade trees where space is available to provide the most long term benefits.
- Diversity of species for built in susceptibility to disease and insect infestation. This may also help to mitigate potential widespread mortality related to climate change.
- Native species that are best adapted to the local climate and provide natural wildlife habitats.
- Low maintenance species that require less pruning and are more adaptable to local climate and site conditions.
- Drought resistant species to reduce water consumption requirements. Use efficient irrigation systems and water recycling where appropriate.
- Location within polluted areas or heavily populated areas to maximize tree air quality benefits.
- Making use of evergreen trees for particulate matter reduction year round.
- Encourage ecological connectivity and habitat
- Biogenic VOC emissions of certain tree species should be considered near schools and hospitals.

4.1 Species Diversity

Diversity is an important element in the long term health of the urban forest. Proactive management of species and age composition will develop a built in tolerance for pests and disease. Diversity should also consider the species and age of existing trees in the community. In general there should be no more than 25% of any one genus for the Town as a whole.

TABLE 5 PREFERRED SPECIES DIVERSITY

Residential Sites (Subdivision Plan)	
Number of Trees on Site	**Maximum Percentage of Any one Genus**
1 - 15	100%
16 - 50	75%
51 - 100	50%
100 +	25%
Parks and Open Space (Site Plan)	
Number of Trees on Site	**Maximum Percentage of Any one Genus**
1 - 15	75%
16 - 50	50%
51 - 100	25%
100 +	20%

Note: Diversity Guidelines do not require each species to be evenly distributed throughout. Strong design using groupings and clusters at intersections and key mid-block locations should be implemented.

4.2 Spacing

Spacing between trees should reflect the species ultimate canopy size, the site conditions and design criteria. Tree spacing will affect the form and development of the tree over years of growth. Groups of trees can be mutually beneficial as a result of increased shading, reduced evapotranspiration, reduced soil compaction, shared soil volume and reduced reflective heat on single trees. Trees spaced closely develop a dense canopy and upright form. Trees spaced further develop an open canopy with lower branching.

4.3 Top Performing Species

Markham's unique climate and soils limit the variety of species which are recommended for street tree planting. Species listed in Appendix A are preferred for their dependability, low maintenance and drought resistance. Species attributes such as pollution tolerance, soil and moisture requirements, and growth characteristics must be considered together with spatial suitability. An acceptable species is not necessarily appropriate for all planting sites. Appendix A provides a detailed description of recommended species. The following images are examples of top performing street trees in the Town of Markham.

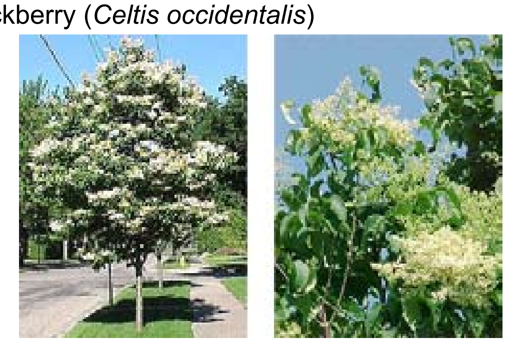
Hedge Maple (*Acer campestre*)

Autumn Blaze Maple (*Acer x freemanii*)

Serviceberry Tree (*Amelanchier canadensis*)

Hackberry (*Celtis occidentalis*)

Honeylocust (*Gleditsia triacanthos*)



Ivory Silk Lilac (*Syringa reticulata 'Ivory Silk'*)

5.0 Methods and Materials

Tree planting in the right of way is a long term initiative. Measures that are taken to ensure appropriate tree planting will have a lifetime impact on street tree maintenance.

5.1 Technical Guidelines

Appendix B provides guidelines for tree planting relative to development applications. The guidelines outline requirements for tree and soil preservation, layout and design, tree species selection, nursery stock selection, tree siting and location and inspection. The guidelines also define specific requirements for tree installation, warranty and maintenance.

<u>Watering</u>
Drought stress limits the growth of newly planted trees more than any other factor. The root ball soil is the primary source of water for the tree until the root system develops outside of it. During the first few years of establishment it is important to keep the root ball moist but not overwatered. The root ball dries out very quickly. A watering plan should be determined based on seasonal conditions detailing the frequency, quantity and method of watering. Moisture in the root ball should be monitored to avoid underwatering or overwatering. Organic mulches conserve soil moisture, buffer soil temperature extremes, control weeds and other competing vegetation and replenish organic matter and nutrients in the soil leading to improved root growth.

<u>Drainage</u>
Poor drainage accounts for substantial loss of new trees. When soil permeability is low, as is common in disturbed and compacted soils, the soil in the planting hole can remain saturated for long periods, driving out oxygen and effectively killing the tree roots. Irrigation systems designed for lawns, often over-irrigate trees. Subsoil must be inspected after excavation of the planting area to determine need for supplemental drainage. Improving drainage for individual trees can be done in several ways. Selecting species that are more tolerant of poor drainage can also improve performance. Perforated plastic pipe or products manufactured specifically to create drainage channels can be used to direct water from the bottom of the planting hole. Water must be drained away from the planting area and may be connected to a storm sewer system. Gravel at the bottom of the planting hole will not improve drainage.

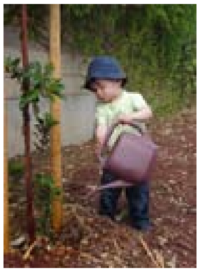
5.2 Enhanced Planting Strategies

Research is consistently being done to improve tree planting methods and opportunities. All planting strategies should be individually researched and designed for use on specific sites.

Water and Irrigation

Rainfall may not be sufficient to sustain tree growth, particularly in the urban area, where rainfall is not absorbed by the root zone soil. Water availability should consider sustainable water harvesting for rain that falls in the area. Porous pavement is a simplified and direct way to harvest rain water. In place of porous pavement, porous piping systems can be designed below the paving to collect water from an inlet which collects rain supplied water, or another external supply. Irrigation should be designed in accordance with soils, slope, plant material, microclimate, water source and local weather conditions. Water requirements of a tree will be reduced after establishment. Adding properly designed irrigation systems in dry environments will increase the soil's ability to support trees. Irrigation systems are often expensive and maintenance intensive. Drip irrigation systems reduce evaporation loss and to avoid applying unnecessary water on pavements. Water conserving irrigation management methods can be used such as check valves, pressure regulators, and moisture/rain/wind sensors. Sediment is a problem for water inlets and they must be designed with a method of clearing collected sediment. Surface water in boulevard environments will carry winter de-icing salts. In addition to planting salt tolerant trees in these environments, the soil must have adequate volume and drainage properties. All planting soils must drain properly to avoid overwatering.





Root Paths

Root paths are manufactured channels filled with soil to allow roots to grow out of confined spaces to access adjacent areas with better soil quality and quantity. Channels are laid radially from the root ball using trenches or pipes filled with good quality soil. Root paths are not intended to provide a significant soil volume within the paths. Root paths are typically 10cm wide, 30cm deep and spaced at 1.2m to retain the structural integrity of the existing sub-base.

(www.caseytrees.org)

Continuous Soil Zones

A continuous trench is a long, shared planting pit filled with quality soil to provide extra soil volume for root growth beneath paved surfaces. Pedestrian areas may also be designed to accommodate continuous open soil zones that are protected from compaction. A 1.5m wide trench could be spanned with an engineered reinforced structural concrete slab on footings either side of the trench. Trenches can also be used to connect roots to other soil zones. See **Appendix C** for detail. Coordinate placement of utilities, light poles, bus stops, driveways and hydrants to maximize continuity of trenches.

Soil Vaults
Soil vaults are engineered underground containers that keep roots separated from other infrastructure. Soil filled vaults can be engineered from plastic or concrete with drainage installed. The top of the vault is typically precast and the bottom of the vault is open. A footing is generally required under the vault. Vaults can be designed for volumes as large as 30 cubic metres, designed for vehicle loading. Drain boards are required along the edge of the vault similar to roof planters. Large vaults have the potential to conflict with other infrastructure such as underground utilities and drainage, especially in an already confined environment.

Aggregate Structural Soils
Structural soils provide a simplified pavement base and root medium to help support larger trees and pavement using a soil-earth mix that can be compacted. It withstands compaction caused by foot traffic, vehicle loads and vibration and reduces damage to sidewalks and pavements by encouraging deeper root growth. CU Structural Soil was developed by Cornell University with an approximate formula of 20% clay loam soil, 80% angular gravel with no fines and 0.03% polymer gel. Structural soil should ideally be used as a supplemental rooting area or for paths beneath paved areas.

Structural soil may be more costly than natural or manufactured topsoil as the uniform blending of soil components requires special equipment and careful monitoring. Pre-mixed soil cannot remain stockpiled for long periods of time or transported over long distances because the component parts will separate.

In order to implement this strategy, ensure adequate budget early in the project development process. Ensure that structural soils are used only at appropriate locations

Suspended Pavement and Structural Soil Cells
Soil cells are engineered frames installed below a pavement surface to provide a void for soil volume. DeepRoot have developed a modular, pre-engineered cell system to create large spaces under pavement. The cells are stacked to a designed depth with a deck secured on top of each stack. The system has an aggregate foundation on a compacted subgrade and requires supplemental drainage. Cells are designed for vehicular loading.

(www.deeproot.com)

Root Barriers
Root barriers are physical obstructions installed between the roots and infrastructure to prevent or delay conflicts between the two while channelling roots downward towards suitable soil.

Limitations of successful tree planting and maintenance often include time, cost, lack of knowledge regarding tree growth requirements, and lack of understanding of tree values. The maintenance costs should be built in to the development plan. Public tree education can help to promote community maintenance of newly planted trees. This can be achieved through signage, tours, workshops and publications.

5.3 Technical Details

Appendix C includes details for tree protection fencing, general deciduous tree planting, deciduous tree planting boulevard, deciduous tree planting in paved areas, deciduous tree planting in poor/confined soils, deciduous tree planting with ground covers, coniferous tree planting and trench in continuous soil zone.

SELECTED SPECIES LIST

SUMMARY TABLE – SEE APPENDING TABLE FOR SPECIES DESCRIPTIONS AND LIMITATIONS

The Town of Markham reserves the right to alter this list at any time.

ACCEPTABLE STREET TREES		ACCEPTABLE SITE PLAN TREES (Including Street Trees)	
Native Deciduous Trees	**Non-Native Deciduous Trees**	**Native Deciduous Trees**	**Non-Native Deciduous Trees**
Acer x freemanii 'Autumn Blaze' (Autumn Blaze Maple)	Acer campestre (Hedge Maple) **H**	Aesculus glabra (Ohio Buckeye)	Aesculus hippocastanum (Horse Chestnut)
Acer nigrum 'Green Column' (Green Column Black Maple)	Acer ginnala (Amur Maple) **H**	Acer saccharinum (Silver Maple)	Malus spp. (Crabapple varieties) **H**
Acer rubrum (Red Maple)	Acer platanoides spp. (Norway Maple)	Alnus incana (Speckled Alder)	Prunus spp. (Ornamental Cherry) **H**
Acer saccharum (Sugar Maple)	Acer tataricum (Tatarian Maple) **H**	Betula papyrifera (Paper Birch)	Quercus robur 'Fastigiata' (Pyramidal English Oak)
Acer saccharum 'Green Mountain' (Green Mountain Maple)	Corylus colurna (Turkish Hazel) **H**	Carpinus caroliniana (Blue Beech)	Sorbus spp. **H**
Amelanchier canadensis Std. (Serviceberry Tree) **H**	Crataegus crus-galli 'inermis' Thornless Cockspur Hawthorn)	Ostrya virginiana (Ironwood)	**Native Coniferous Trees**
Celtis occidentalis (Hackberry)	Ginkgo biloba (Maidenhair Tree)	Populus spp. (Poplar/Aspen)	Abies balsamea (Balsam Fir)
Cornus racemosa Std. (Gray Dogwood Tree) **H**	Gleditsia triacanthos 'Skyline' (Skyline Honeylocust)	Quercus macrocarpa (Bur Oak)	Larix laricina (Tamarack)
Gymnoclaudus dioicus (Kentucky Coffee Tree)	Phellodendron amurense (Amur Corktree)	Quercus palustrls (Pin Oak)	Picea glauca (White Spruce)
Platanus occidentalis (Sycamore)	Pyrus calleryana 'Chanticleer' (Ornamental Pear) **H**	Quercus rubra (Red Oak)	Pinus resinosa (Red Pine)
Tilia Americana (Basswood)	Syringa reticulate 'Ivory Silk' (Ivory Silk Tree Lilac) **H**	**Non-Native Coniferous Trees**	Pinus strobus (White Pine)
	Tilia cordata 'Greenspire' (Little Leaf Linden)	Abies concolor (Silver Fir)	Thuja occidentalis (White Cedar)
	Ulmus spp. (Elm)	Juniperus spp. (Juniper)	Tsuga Canadensis (Hemlock)
		Picea abies (Norway Spruce)	
		Picea pungens (Colorado Spruce)	
		Taxus spp. (Yew)	

H – acceptable under hydro wires

SELECTED SPECIES LIST

Botanical Name	Common Name	Species Attributes	Mature Height	Location	Species Limitations
Native Deciduous Trees					
Acer x freemanii 'Autumn Blaze'	Autumn Blaze Maple	Cross between red and silver maple. Fast growing. Fall colour.	16m	S	Shallow root system. Thin bark. Moderate salt tolerance.
Acer nigrum 'Green Column'	Green Column Black Maple	Narrow and upright. Tolerant of hot, dry conditions.	15m	'x', W	Prefers moist soil and partial to full shade.
Acer rubrum	Red Maple	Fall colour. Transplants well. Hardy cultivars.	15m	N/W/S*	Spring planting. Prefers moist acidic soil.
Acer saccharinum	Silver Maple	Fast growing. Very hardy.	18m	N*/W	Aggressive roots. Surface roots tripping hazard. Requires large space. Increased liability with age. Spring planting.
Acer saccharum	Sugar Maple	Fall colour. Hardy cultivars.	20m	N/S*	Requires large root space. Prefers good drainage. Not tolerant of high heat, pollution or road salt.
Acer saccharum 'Green Mountain'	Green Mountain Maple	Uniform growth. Hardy.	18m	'x'/S	Leaf scorch in restricted soils.
Aesculus glabra	Ohio Buckeye	Hardy. Fragrant flowers.	12m	N*	Low branching. Fruit litter. Leaf scorch and leaf drop.
Alnus incana	Speckled Alder	Attracts birds.	18m	N/W*	Spring planting.
Amelanchier Canadensis (Std.)	Serviceberry (Tree Form)	Flowers and edible fruit. Transplants easily.	8m	S/N/W/P	Susceptible to defoliation. Prefers wet sites.
Betula papyrifera	Paper Birch	Attractive bark. Hardy. Fast growing when young.	13m	N*/P	Prefers spring planting. Not tolerant of pollution. Bronze birch borer threat in mature trees. Birch leaf miner threat.
Carpinus caroliniana	Blue Beech	Withstands shade.	9m	N/W	Slow growth rate. Difficult to transplant.
Celtis occidentalis	Hackberry	Very hardy. Interesting bark.	20m	S	Dense shade. Surface and girdling roots. Pruning for witches' broom. Spring planting.
Cornus racemosa (Std.)	Gray Dogwood (Tree Form)	Flowers and edible fruit.	5m	S/H/N/P	Low branches can block drivers view.

Location Codes:
H – under hydro wires, B - buffer planting/screening, S – streetscape, N – natural areas, W – requires moist soils, 'x' – cultivars for certain characteristics, P – container or raised planter, * - limited use

SELECTED SPECIES LIST

Botanical Name	Common Name	Species Attributes	Mature Height	Location	Species Limitations
Fraxinus spp.	Ash	Very adaptable to different soils.	15-20m	*	Prohibited use due to threat of emerald ash borer.
Gymnocladudus dioicus	Kentucky Coffee Tree	Deep furrowed bark. Open spreading. Drought and pollution tolerant.	16m	S* (rare southern ON native)	Litter potential from large fruit pods and leaves.
Ostrya virginiana	Ironwood	Slow growing. Does well in deep shade.	12m	N*	Trunk suckering and borer problems. Spring planting.
Platanus occidentalis	Sycamore	Interesting bark. Tolerates wet and compacted soil.	20m	N/S/W (southern ON native)	Requires large space.
Populus spp.	Poplar/Trembling Aspen	Attractive bark and leaves. Rapid growth.	15-25m	N*	Weak wood. Invasive potential.
Quercus macrocarpa	Bur Oak	Very hardy. Corky bark. Wide range of soil.	20m	S/N*	Prefers acidic soil. Difficult to transplant. Requires large spaces. Spring planting.
Quercus palustris	Pin Oak	Fall colour.	18m	S/N*	Prefers acidic soil. Chlorotic. Difficult to transplant. Slow growing. Spring planting.
Quercus rubra	Red Oak	Fast growing oak. Fall colour.	18m	S/N*	Not tolerant of high pH and drought. Difficult to transplant. Spring planting
Tilia Americana	Basswood	Varieties for form and urban tolerance	20m	S/N*	Requires large areas. Suckers from base. Limited use.
Viburnum lentago (Std.)	Nannyberry (Tree Form)	Flowers and fruit.	6m	S/H/N/P	Low branches block drivers view.
Native Coniferous Trees					
Abies balsamea	Balsam Fir	Shade tolerant. Slender conical shape and fine texture.	20m	B	Not tolerant of drought or heat.
Juniperus virginiana	Eastern Red Cedar	Mass planting and wind breaks. Little maintenance required.	12m	N/B	Alternate host to cedar apple rust. Insect and blight problems.
Larix laricina	Tamarack	Small cones.	20m	N/W	Needles drop in fall.

Location Codes:

H – under hydro wires, B - buffer planting/screening, S – streetscape, N – natural areas, W – requires moist soils, 'x' – cultivars for certain characteristics, P – container or raised planter, * - limited use

SELECTED SPECIES LIST

Botanical Name	Common Name	Species Attributes	Mature Height	Location	Species Limitations
Picea glauca	White Spruce	Very hardy. Specimen or mass planting.	25m	B	Susceptible to winter dehydration.
Pinus resinosa	Red Pine	Very hardy. Mass planting. Little maintenance required.	20m	B	Low wide branching. Not tolerant of wind or salt.
Pinus strobus	White Pine	Dense canopy. Fine texture. Fast growing.	25m	B	Requires large space.
Thuja occidentalis	White Cedar	Hedging and wind breaks	15m	B/W	Weak wood. Susceptible to salt and air pollution.
Tsuga Canadensis	Hemlock	Prefers cool, moist envt. Fine texture.	20m	W/*	Not tolerant of pollution, salt or drought.
Non-Native Deciduous Trees					
Aesculus hippocastanum	Horse Chestnut	Large white flowers and chestnuts.	18m		Requires large areas. Leaf scorch and blotch in hot dry locations. Messy fruit.
Acer campestre	Hedge Maple	Corky bark. Upright branching.	10m	S/H/P	Tends to sucker.
Acer ginnala 'Flame'	Amur Maple	Hardy. Round form. Fall colour.	6m	S/H/P	Tends to sucker. Lots of seeds.
Acer platanoides 'Crimson King'	Crimson King Maple	Copper-purple leaves. Hardy.	12m	S*	Girdling roots, powdery milder, tar spot, dense canopy.
Acer platanoides 'Superform'	Superform Maple	Uniform growth. Hardy.	12m	S*	Girdling surface roots, dense canopy.
Acer tataricum	Tatarian Maple	Oval form. Dry soils.	8m	S/H/P	Tends to sucker. Lots of seeds.
Corylus columa	Turkish Hazel	Pyramidal form. Dry soils.	14m	S	Spring planting. Difficult to transplant. Low branching block drivers views.
Crataegus crus-galli 'inermis'	Thornless Cockspur Hawthorn	Thornless. Drought tolerant.	8m	S/H/P	Do not plant near apples or pears. Messy persistent fruit maintenance. Spring planting.
Ginkgo biloba	Maidenhair Tree	Tolerant of drought, salt and high pH	16m	S	Male only – does not bear fruit. Spring planting.

Location Codes:
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SELECTED SPECIES LIST

Botanical Name	Common Name	Species Attributes	Mature Height	Location	Species Limitations
Gleditsia triacanthos	Honeylocust	Tolerant of wet and dry soil, salt and high pH. Filtered shade.	16m	S	Overuse in urban monocultures. Defoliation.
Malus spp.	Crabapple varieties	Flowers and fruit. Leaf colour and form variety.	6-10m	S*/P	Choose varieties that are resistant to insect and disease. Fruit maintenance.
Phellodendron amurense	Amur Corktree	Fast growing. Broad spreading. Tolerant of many soils, pests, drought and pollution.	12m	S*	Seedless varieties – fruit litter. Invasive tendencies.
Prunus spp.	Ornamental Cherry	Flowers and fruit.	5-10m	S*/P	Tend to sucker. Choose varieties that are resistant to insect and disease. Susceptible to black knot and cankers. Spring planting.
Pyrus calleryana 'Chanticleer'	Ornamental Pear	Flowers and fall colour.	10m	S*/P	Tend to sucker. Choose varieties that are resistant to insects and disease. Increased liability with age. Aggressive root system. Spring planting.
Quercus robur 'Fastigiata'	Pyramidal English Oak	Fast growing. Columnar form. Persistent leaves.	15m	S*/P	Low branching. Spring planting.
Sorbus aucuparia	Mountain Ash	Flowers and orange berries.	12m	S*	Low branching. Prefers acidic soils. Not tolerant of drought, heat, compacted soil or pollution. Predisposed to disease and pests. Short lived.
Sorbus thuringiaca 'Fastigiata'	Oakleaf Mountain Ash	Pyramidal form. Oak like leaves. Orange berries.	7m	S*/H/P	
Syringa reticulate 'Ivory Silk'	Ivory Silk Tree Lilac	Compact form. Flowers.	7m	S/H/P	Overuse in urban monocultures. Prefers well drained acidic soil.

Location Codes:
H – under hydro wires, B - buffer planting/screening, S – streetscape, N – natural areas, W – requires moist soils, 'x' – cultivars for certain characteristics, P – container or raised planter, * - limited use

Botanical Name	Common Name	Species Attributes	Mature Height	Location	Species Limitations
Tilia cordata 'Greenspire'	Little Leaf Linden	Large pyramidal shape	15m	S	Suckers from base. Aphid and borer problems.
Ulmus 'Accolade'	Accolade Elm	Vase shape, vigorous growth, drought tolerant	18m	S	Dutch Elm Disease Resistant cultivar. Susceptible to storm damage.
Ulmus 'Frontier'	Frontier Elm	Fast growing.	13m	S	Dutch Elm Disease Resistant cultivar. Susceptible to storm damage.
Ulmus 'Pioneer'	Pioneer Elm	Fast growing.	13m	S	Dutch Elm Disease Resistant cultivar. Susceptible to storm damage.
Zelkova serrata	Japanese Zelkova	Vase shape, upright branching.	18m	S, 'x'/P	Ensure stock with well spaced branches.

Location Codes:
H – under hydro wires, B - buffer planting/screening, S – streetscape, N – natural areas, W – requires moist soils, 'x' – cultivars for certain characteristics, P – container or raised planter, * - limited use

HARDY WOODY GROUNDCOVERS

As with tree planting, the planting site must be carefully assessed prior to choosing a species. Consider among other microclimate and soil factors the exposure and shade tolerance under trees, salt and pollution exposure and tolerance along roadways, water availability and drought tolerace. Additional maintenance may be required for watering and weed control during establishment. Using smaller plants, spaced closesly will provide quick cover for less money and help with weed supression. Spacing must also consider ultimate plant size to prevent crowding and thinning. Consider planting at 0.3-1m spacing based on plant characteristics. Many cultivar varieties of shrubs and perennials are commercially available for specific qualities.

Botanical Name	Common Name	Species Attributes	Mature Height	Species Limitations
DECIDUOUS SHRUBS				
Arctostaphylos uva ursi	Bearberry	Native. Broadleaf evergreen. Salt and drought tolerant.	15cm	Difficult to establish. Winter burn. Not heat tolerant.
Cotoneaster dammeri	Bearberry Cotoneaster	Broadleaf evergreen. Drought tolerant.	20cm	May become untidy and require pruning.
Cotoneaster horizontalis	Rockspray Cotoneaster	Broadleaf evergreen. Drought tolerant.	50cm	May become untidy and require pruning.
Deutzia gracilis 'Nikko'	Nikko Deutzia	Drought tolerant once established. Will tolerate poor drainage. Full sun.	30cm	Not tolerant of poor drainage.
Euonymus fortunei 'Coloratus'	Coloured Leaf Wintercreeper	Forms dense carpet.	40cm	May require pruning.
Hypericum kalmianum 'Ames'	Kalm St. Johnswort	Native. Bright yellow flowers July to August. Tolerates hot sun and poor soil.	60cm	May require pruning.
Potentilla fruticosa 'abbotswood'	Abbotswood Potentilla	White flowers May to September	50cm	Prefers moist soil.
Rosa rugosa	Rugosa Rose	Vigorous growth. Repeat bloom. Many varieties.	90cm	Prickly canes.
Spiraea bumalda 'Goldmound'	Goldmound Spirea	Flowers in july.	60cm	May require pruning.
Stephanandra incisa 'crispa'	Cutleaf Stefanandra	Fine textured foliage. Easily grown in average soil and full sun.	60cm	Prefers moist, acidic soil.
Symphoricarpos x chenaultii 'Hancock'	Hancock Snowberry	Vigorous growth with arching stems. Full sun to part shade.	60-90cm	Requires pruning to rejuvenate every few years.
CONIFEROUS SHRUBS				
Juniperus horizontalis 'x'	Spreading Juniper cultivars		20-40cm	

Location Codes:
H – under hydro wires, B - buffer planting/screening, S – streetscape, N – natural areas, W – requires moist soils, 'x' – cultivars for certain characteristics, P – container or raised planter, * - limited use

TECHNICAL GUIDELINES

Table of Contents

1.0 INTRODUCTION

The following document has been created to outline the expectations of the Town of Markham with regards to tree planting for development. Attractive and functional design for tree planting and landscaping is a critical component to any development. Any detailed submission should be preceded by a review of this document with other relevant policy sources and preliminary consultation with staff.

The following document has been compiled to assist applicants in preparation of landscape plans in new developments and redevelopment projects. It is not intended to remove or replace established or approved processes or regulatory framework, but rather to enhance the environment through quality, well planned landscaping in conjunction with the development application process. It has been assembled to assist the landscape professional, developers and contractors in the preparation and execution of effective tree planting plans.

Applicants may contact the following departments regarding requirements for application submissions:

Planning and Urban Design
Forestry and Operations
Parks & Open Space Development

Note: Please contact York Region for Design Guidelines and Technical Guidelines for Regional Road Allowances.

Applicable By-Laws, Guidelines and Templates

- Preconsultation By-Law (for all development applications)
- Tree Inventory and Preservation Plan Requirements Details – **Appendix G**
- Application to Permit the Injury or Destruction of Trees
- Tree Preservation By-Law (2008-96) to Regulate or Prohibit the Injury or Destruction of Trees Within the Town of Markham (with a DBH of 20cm or greater)
- Regional Municipality of York Forest Conservation By-Law No.TR-0004-2005-036
- By-Law (2008-97) to Impose Fees or Charges for Services or Activities Provided or Done by the Town of Markham (Tree Preservation By-Law Permit Fees)
- Certification of Completion Letter –Template – **Appendix E**
- Maintenance Report – Template – **Appendix F**
- Soil Requirements Checklist - Template

2.0 TREE PRESERVATION

In order to reduce the risk of damaging trees and better preserving existing trees, the following fundamental of tree growth and survival are to be considered to ensure preservation:

- Tree roots are vital for tree survival and stability
- Tree roots can extend two to three times the radius of the crown
- The critical structural root zone extends directly from the trunk
- Fine roots are entirely responsible for water and nutrient uptake
- 90% of the feeder roots exist in the top 30cm of soil
- Roots are easily killed by soil compaction and changes in grade
- Water and nutrients are conducted in the tissue just under the bark
- Broken branches and torn bark allow pathways for insects and decay
- Damage to leaves and overall canopy reduces the capacity for photosynthesis and limits availability of required energy

Implementing tree protection measures including details and specifications from project initiation increases the chances of tree survival. Based on these considerations the following tree preservation measures are required:

Inventory, Assessment and Preservation Plan

- During initial site analysis tree tagging and inventory shall be undertaken by an Arborist certified with the International Society of Arboriculture in conjunction with a Landscape Architect in good standing with the Ontario Association of Landscape Architects. The inventory shall include a legal survey tie-in of all trees within **6m** of the subject property and to the road right-of-way where construction has the potential to directly or indirectly impact trees.
- Using the results of the tree inventory the designer should attempt to incorporate design alternatives to minimize the impact to existing vegetation.
- Tree Inventory and Preservation Plan Requirements including Specifications and details are included in **Appendix G.**

Transplanting, Compensation and Vegetation Removal

- For all development applications, no net loss of trees or canopy is to be achieved within the Town of Markham.
- Approved tree and vegetation removal shall be compensated with <u>approved replacement</u> and <u>enhancement planting</u>. Penalties for tree removal shall be based on By-Law 2008-96.
- Transplanting existing vegetation should be considered for trees in good condition to a maximum size that can be successfully transplanted as determined by a certified Arborist.

3.0 SOIL PRESERVATION

Protection of native soils in addition to vegetation is one of the most important considerations in development. Wherever reasonable, based on quality, existing on-site soil should be used for planting rather than importing foreign topsoil and exporting waste soil. Soil should be tested and amended on-site to compensate for poor organic or physical properties, or to improve soil infiltration rate. Soil health can be regained by using compost, forest product residuals, and other renewable organic substances to increase the porosity of soil and return nutrients to the earth. Soil Preservation Plans are outlined in **Appendix D**.

<u>Soil Preservation Plan</u>

- Identify areas where native soil and/or vegetation will be retained
- Identify areas where topsoil and subsoil will be amended in place
- Identify areas where topsoil will be stripped and stockpiled prior to grading for reapplication
- Identify areas where imported topsoil will be applied
- Do not permit delivery or installation of amendments prior to approval for test results

- Do not permit heavy equipment to encroach on in-place soils or within protected zones or use low ground pressure operating equipment.
- Take erosion and sediment control measures such as siltation barriers and temporary cover

See **Appendix D** for Site Alteration Permit requirements for Soil Preservation.

4.0 GENERAL DESIGN REQUIREMENTS

The Developer is responsible to plant trees along all road allowances, open spaces, walkway blocks, buffer blocks, valleylands, and within the development site in accordance with the specifications established pursuant to the Site Plan Control Application, Official Plan Amendment Application, Plan of Subdivision Application, Zoning Amendment Application or any other applicable regulation.

The Developer is required to retain a landscape architect, who is a member in good standing with the Ontario Association of Landscape Architects for all design submissions.

Trees shall be planted within the road allowance to the satisfaction of the Town and in accordance with the following guidelines:

- Trees shall be planted at a maximum interval of **10m**. Large shade trees are preferred.
- Minimum tree spacing shall be determined by mature canopy size for acceptable ornamental varieties.
- At least one tree shall be planted in front of each residential lot.
- Where lot frontage is restricted to prevent the planting of ornamental trees, consolidated planting areas shall be implemented elsewhere in the development.
- Trees shall be placed along the flankage of all lots at the same spacing interval required for the frontages. A minimum of two trees shall be placed along the side of each corner lot.
- Where no sidewalks exist or where sidewalk construction is not planned, trees are to be 1m outside the private property line on Town property
- Trees are not to be planted in boulevards which are less than 1.5m wide.
- Where a boulevard between the curb and sidewalk is 1.5 – 2m wide, ornamental or medium sized shade trees are to be planted, ensuring that the minimum soil volume of 15m^3 is met (1.5m width x 10m length x 0.9m depth). Trees shall be centred in the boulevard in this case, assuming no utility conflicts.
- Surface parking lots shall be planted around the perimeter offset at least 1.5m from the curb or edge.
- Surface parking lots exceeding two lanes of stalls shall have consolidated planting areas to enhance tree growing conditions, maximize canopy benefits and break up the expanse of paved area.
- Surface parking lots shall have interior trees planted at a ratio of one tree for every five parking spaces. Distribute the internal planting so that no parking space is more than 30m from a tree.
- The minimum soil volume for tree planting in a parking lot island is 15m^3.
- The Town of Markham reserves the right to adjust the quantity of trees planted based on availability of space

Once the planting design has been finalized the next step is to ensure the best quality trees are selected.

5.0 TREE SELECTION AND SITING

Selection of the best quality tree and the most appropriate location to plant are key factors in the long term success of a tree. This section provides guidelines and requirements for tree selection from the Nursery, appropriate design location for the tree species chosen, spacing and layout and installation specifications. These guidelines and specifications provide guidance for the Landscape Architect and Contract Administrator to be able to choose the best tree for the right location. The success of tree planting relies on:

- Choosing the right species for the site
- Creating as much rooting space as possible
- Preserving and establishing good soil quality
- Controlling water availability and drainage
- Planting at the proper depth
- Protecting the ground area around the trunk
- Making allowances for proper maintenance

Tree Species Selection

Tree species shall be selected from the approved tree list in **Appendix A** to be chosen based on site characteristics and design. Use of native tree species is encouraged, especially in proximity to natural areas where the potential for invasion by non-native species is high.

Tree Siting and Location

The next step in ensuring long term success is to ensure the tree has as much space as possible to grow roots and crown. In order to ensure minimal conflict with utilities, driveways, curbs, sidewalks and other trees, the following setbacks shall be incorporated with the Landscape Architect's Planting Plan:

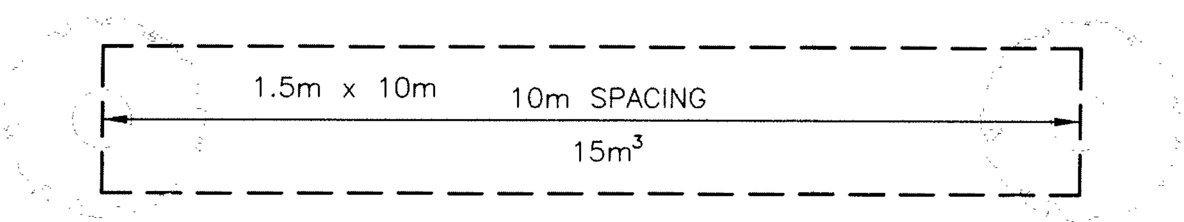
- Trees to be planted a **maximum** of **10m** apart in accordance with:
  - Safety and accessibility regulations
  - Design parameters
  - Site conditions
  - Tree species
    - Refer to tree list for species size and cultural requirements
    - Ornamental alternatives may be allowed for small lot frontages
- The **minimum** boulevard width to accommodate a tree is:
  - 3m on high speed traffic roads (≥60km/hr)
  - 1.5m on low speed traffic roads without parking lane (≤50km/hr)
  - Planting area in a narrow boulevard shall be compensated along the length of the prepared planting area to achieve minimum required soil volumes for intended tree size.
  - Large stature trees require a soil volume of 30 m^2 at a depth of 0.9-1.2m.
- The **minimum** distance to plant from the centreline of the trunk is:
  - Watermain – 2m
  - Gas Main – 2m
  - Utility & Telecomm. trench – 1m
  - Underground services – 2m
  - Street Light – 5-8m (edge of canopy)
  - Transformer – 1.2m sides, 3m door
  - Telecomm. box – 2m
  - Fire hydrant – 3m
  - Residential Driveway – 1.5m (in conformance with sight triangle)
  - Commercial/Industrial Driveway – 3m (in conformance with sight triangle)
  - Stop Sign & Intersections – 9-15m (in conformance with sight triangle and canopy size)
  - No trees shall be planted in front of building entrances
  - No trees shall be planted on easements, property lines or drainage swales
  - No trees shall be planted under overhead wires or directly over underground services

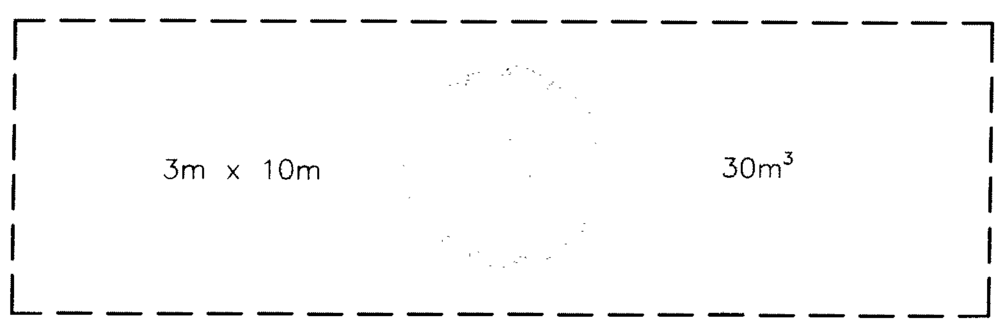
Soil Volume

Soil volume is one essential factor for tree growth along with good drainage, adequate water and nutrients in the soil. The soil volume available for rooting must be large enough to support the expected tree size.

- Based on tree size to soil volume relationships (Urban, 1992) a minimum soil volume of $30m^3$ is required for healthy growth to an ultimate trunk diameter of 40cm.
- A minimum soil volume of $15m^3$ is recommended for smaller stature trees or shared root areas.
- Shared root areas are
- The planting hole shall be of sufficient size for rapid initial root development during establishment.
- Tree pits shall be as large as possible to allow for ample growing space for tree.
- The planting hole shape should not restrict root spread beyond the planting hole.
- On sites with high quality soil, the planting hole needs to be wide enough to facilitate planting and a minimum of 2m diameter or 3 times the root ball diameter.
- On sites with poor quality soil (compacted, clay or poorly drained), trees benefit from larger planting holes and cultivation of surrounding soil to a depth of 300mm.
- The minimum allowable soil volume for planting small stature trees is $15m^3$
- A wide hole with sloped or stepped sides uses the majority of the digging effort to excavate the surface soil where the roots will grow most vigorously.
- The overall boulevard width between the sidewalk and curb or the overall width of the sidewalk may limit the size of the tree pit.
- Consolidate planting areas are more effective than individual tree pits with insufficient resources.
- Planting in restricted environments should incorporate site specific design using enhanced planting strategies such as root paths, continuous soil zones, structural soils, structural soil cells, etc.

SOIL VOLUMES (BASED ON 0.9m DEPTH)
$30m^3$ MINIMUM FOR LARGE TREES
$15m^3$ MINIMUM FOR SMALL TREES and
SHARED ROOT AREAS
LAYOUT EXAMPLES
1.5m BED WIDTH @ 20m LENGTH ≈ $30m^3$
1.5m BED WIDTH @ 10m LENGTH ≈ $15m^3$
3.0m BED WIDTH @ 10m LENGTH ≈ $30m^3$
3.0m BED WIDTH @ 5m LENGTH ≈ $15m^3$





Soil Depth

- A minimum topsoil depth of 900mm should be specified for tree planting areas, providing that the root ball is placed on a compacted base where the root collar is flush with finished grade.
- A topsoil depth of 300mm should be specified for all sod boulevard areas.
- Due to the organic nature of topsoil, increased depth may compromise the structural integrity of grading and drainage patterns and generate settlement. The addition of sand can help alleviate the compaction from maintenance and vibrations.

Soil Quality and Testing

Existing soil should be analyzed for suitability and preserved and protected from compaction, contamination and degradation and re-used for planting. Topsoil may become further degraded through handling and stockpiling. The addition of soil amendments shall be based on recommendations from a soil test done by a laboratory accredited by the Ontario Ministry of Agriculture and Food. Soil amendments may be required to improve drainage and aeration and reduce soil compaction. Amendments may be addition of organic matter or sand to change the physical nature of the soil or specific nutrient fertilizers. Chemical composition is difficult to change, therefore plant selection should match existing soil fertility and pH. The following basic requirements for root growth must be considered:

- 50-60% sand, 20-40% silt, 6-10% clay with adequate pore space for air and water holding capacity
- 2- 5% organic content for nutrients
- pH between 6.5-7.0
- Bulk density not to exceed 1.3g/cubic centimetre

Nursery Stock Selection

- Only high quality nursery grown trees which conform to the most recent version of the Canadian Nursery Landscape Association's *Canadian Standards for Nursery Stock* are acceptable.
- Plants shall be nursery grown under climatic conditions similar to those of the planting location for at least 2 years. The Contractor shall provide a written list, to the Landscape Architect, of the proposed sources of nursery stock. Geographic origin of seed or cuttings used to produce the trees shall be made available upon request.
- Plant material may not be dug or collected from native stands or established woodlands.
- Trees shall be sound, healthy, vigorous, well branched and densely foliated when in leaf and free of disease and insects of any stage. They shall have healthy, well-developed root systems and shall be free from physical damage or other conditions that would prevent thriving growth.
- Trees with multiple leaders, unless specified, shall be rejected. Trees with damaged, cut or crooked leaders, included bark, abrasion of bark, sunscald, cuts of limbs over 2cm diameter that are not completely callused shall be rejected.
- Stock Type:
  - Balled and burlapped trees shall be dug with solid balls of standard size, the balls securely wrapped with non-synthetic, untreated, biodegradable burlap, and tightly bound with non-synthetic, biodegradable rope or twine. **Root collar shall be apparent on the surface of the soil ball.**
  - Container grown trees shall be well established in the container with a root system sufficiently developed to retain its shape and hold together when removed from the container. Plants shall not be pot bound, nor have kinked, circling, or bent roots. **Root collar shall be apparent at the surface of the soil ball.**
  - Bare root trees shall have a healthy, well branched root system characteristic of the species and with adequate spread. Bare root trees must be dug and planted when dormant and the ground is not frozen.
- Selection and Inspection:
  - Trees shall have the north side of the trunk tagged in the nursery so that they can be planted in the same orientation to reduce bark splitting.

  - The Developer's Landscape Architect is responsible for assuring the quality of all plant material meeting the Contract specifications.
  - All trees must meet the requirements of the specifications at the time of planting and throughout warranty and final inspection.
  - The Developer's Landscape Architect should inspect plant material at their place of growth or holding yard to confirm conformance with specification requirements. All plants shall be selected and tagged by the Contract Administrator at their place of growth. Trees should be inspected at the nursery to ensure root flare is visible or exposed prior to digging.
  - The Developer's Landscape Architect and the Town's Landscape Inspector reserve the right to reject any plants upon delivery that do not meet the standards or that have been damaged during shipment. Approval does not impair the right of inspection and rejection during progress of the work.
  - A Contractor's representative shall be present at all inspections.
- Type & Size:
  - All deciduous trees shall be at least 50mm in caliper, measured at 15cm above the root collar.
  - Coordinate caliper with branching height to achieve proper clearance for pedestrians and vehicles. Select only trees which have clear stems to at least 1m height on ornamental varieties and 1.5m height on large growing varieties.
  - Root ball shall be in accordance with table
- Transportation and Storage:
  - Only material dug fresh during the season of planting is allowed.
  - Branches shall be tied with rope or twine only, and in such a manner that no damage will occur to the bark or branches.
  - During transportation of plant material, the Contractor shall exercise care to prevent injury and drying out of trees. Damaged or dried out trees may be rejected.
  - Roots of bare root stock shall be adequately covered with acceptable moisture holding medium.
  - Plants must be protected at all times from sun and drying winds; those that cannot be planted immediately on delivery shall be kept in the shade, well protected with soil covered with mulch and kept well watered. Plants shall not remain unplanted any longer than 3 days after delivery.
  - Plants shall be lifted and handled with suitable support of the soil ball to avoid damage. Plants shall not be handled by the trunk or foliage parts in a manner that will damage the tree or loosen the roots in the ball.
  - Roots and root ball must be kept moist during and after shipping.

Layout Inspection

- All locates for underground utilities shall be secured prior to mobilization.
- The Landscape Architect shall request an appointment with a Town of Markham representative to stake out all tree locations on the site. Minimum 5 business days notice to the Town of Markham is required for all inspection appointments.
- Possible conflicts between trees and streetlights and other utilities may be addressed upon this stakeout and adjusted accordingly.
- Final tree planting locations to be verified and approved by the landscape architect and Town of Markham representative to ensure sight and accessibility clearances.
- Tree locations shall be marked with a painted 'dot' on the curb or sidewalk.
- Prior to carrying out any excavation or planting, The Town's Landscape Inspector shall provide sign off on approved layout.
- The Contractor shall be responsible for all costs associated with transplanting plant material that that is deemed to be planted in conflict with utilities or setback requirements.

6.0 TREE INSTALLATION

Careful selection of a tree species that is well matched to the site and the use of vigorous, healthy nursery stock with a well-developed root system are essential, but do not compensate for poor or improper planting procedures.

Timing of Planting

- Acceptable planting times depend on plant species, type of stock, climate and weather.
- Spring, after the ground thaws and before the tree buds break, is the best time to plant most species. With care and proper techniques, planting may also be feasible in the summer.
- Trees are planted throughout the year unless the soil is frozen. Some species favour spring planting such as oaks. Trees dug in the dormant season and container grown trees can be held for planting throughout the growing season with proper care.
- Bare root trees are dug and planted when trees are dormant and water stress is lowest.
- The following recommendations are the optimal planting times. Weather and other circumstances may require variance from these dates.
- Planting shall be done within the following dates:
  - Deciduous: May 1 to June 31 or September 1 to November 1
  - Coniferous: May 1 to June 31
  - Exceptions: seasons may be shorter than expected depending on weather conditions
- If special conditions exist that warrant a variance from the recommended planting dates, a written request shall be submitted by the Contractor to the Contract Administrator stating the special conditions and the proposed variance.
- Relative to operations and road construction

On-Site Storage and Handling

- Plants must be protected at all times from sun and drying winds; those that cannot be planted immediately on delivery shall be kept in the shade, well protected with soil covered with mulch and kept well watered. Plants shall not remain unplanted any longer than 3 days after delivery.
- Plants shall be lifted and handled with suitable support of the soil ball to avoid damage. Plants shall not be handled by the trunk or foliage parts in a manner that will damage the tree or loosen the roots in the ball.

Planting Hole Preparation

- The Contractor shall ensure that the layout has been reviewed by the Landscape Architect and the Town. The Contractor shall be responsible for all costs associated with transplanting plant material that is deemed to be planted in conflict with utilities or setback requirements.
- The Contractor shall ensure that all utility locates are complete. The Contractor shall be responsible for all damage resulting from neglect or failure to comply with this requirement.
- Excavation may be done by shovel, backhoe or stump grinder. **Note: a soil auger or tree spade may not be used.**
- The planting pit edges must be sufficiently scarified to allow for roots to penetrate parent soil. Surrounding clay soil may restrict root transition from an amended planting pit to the, effectively limiting their growth to the amended area.
- Research has shown that a wider planting hole improves establishment, particularly in heavy soils.
  - Option 1 – the planting hole shall be at least 3 times the diameter of the soil ball and the soil shall be loosened beyond the edge of the planting hole.
  - Option 2 – The planting hole shall be at least 2 times the diameter of the soil ball and the soil shall be loosened at least one ball diameter's distance beyond the hole to a depth of 20-30cm using a rotary tiller.

- Planting depth shall result in the top of the root collar is even with or a maximum of 50mm above the surrounding grade after planting.
- Holes shall be dug at the time of planting. Excavation holes shall not be left unattended or open over night.
- Proper water drainage must be assured. The Contractor shall notify the Contract Administrator, in writing, of any soil conditions or other obstructions that the Contractor considers detrimental to tree growth. Such conditions shall be described, as well as suggestions for correcting them.
- Where soil conditions or below ground obstructions which cannot be remedied are encountered, the Contract Administrator shall designate alternate planting locations. The Contract Administrator shall bear any costs associated with such relocation.

Soil Preparation

- Existing soil shall be used to backfill planting holes wherever possible. Backfilled soil shall be cultivated, removing any large clods or extraneous material.
- Amendment may be required on sites with poor quality soil or lack of sufficient parent soils.
- Test pits shall be conducted in 5% of the planting locations for topsoil depth, soil structure, bulk density, and subsoil drainage.
- Existing topsoil and all imported soils shall be tested for pH, Organic Matter, Nutrient Levels, % Sand, % Silt, %Slay, Cation Exchange Capacity (CEC) and sodium absorption ratio (SAR).
- Suggested amendments for clay soil are coarse sand and coarse organic matter such as compost or aged manure. Finer sands may compound soil structure problems.
- Avoid fine-textured material such as peat moss or the packaged manures.

Planting

- Plants must be centred and plumb in the hole.
- Plant in the same orientation as marked in the nursery.
- Plant so that the top of the root collar is even with or a maximum of 50mm above finished grade. Plants shall be set so that they will be at the same depth 1 year after planting. Planting too deep may result in trunk disease or girdling roots. If the root collar is deep in the ball, excess soil may be removed from the trunk using hands, not tools.
- Bare root plants shall have their roots spread into a natural position, free of bunching, kinking, or circling. No root pruning shall be done.
- Plants in containers shall have containers removed completely before planting. If roots are crowded or coiled on the bottom, sides or surface of the root ball, they shall be gently separated from the edges or surface. The plant material is rejectable if excessively girdled or pot bound.
- For plants moved with tree spades, all holes and cavities between the ball and the surrounding soil shall be filled. The planting hole surfaces shall be sufficiently roughened prior to backfilling.
- Cut and remove all material from the top ½ of the rootball.
- All plastic ties, ropes, strings, wire baskets, burlap and other wrappings must be removed from the tree and hole. The ball shall be in the hole and well supported before the material is removed.
- Planting holes shall be backfilled with cultivated excavated soil, tamped in 150mm lifts. When holes are approximately two-thirds full, they shall be watered thoroughly.
- Backfill soil to the top of the root ball and form a 10cm soil ring to direct water to the rootball. Backfill shall not filled around the trunk or above the root flare.
- Remove all trunk wrap immediately after planting.

Support Systems

- Tree support may be required to provide anchorage for roots while they become established, to maintain trunk in a vertical position, provide support for trunk and crown and provide protection to the trunk.

- Should trees move 10% or more from vertical plane throughout the guarantee period, the contractor shall stake within one week of notification at their own expense.
- Where required, trees shall be staked using two 1.8m long 50mm x 50mm (2"x2") wood stakes. Ensure that stakes are driven into undisturbed soil and never driven through the root ball.
- Tree tie to be ArborTie or approved equivalent material that is a minimum of 25mm wide and will remain soft and pliable under all weather conditions.
- Tree supports shall be monitored and maintained throughout the guarantee period.

Mulching

- Mulch shall consist of aged or composted wood chips or shredded bark with no pieces larger than 25mm in length and shall be free of material injurious to plant growth.
- Place mulch to a consolidated depth of 15cm throughout the entire planting pit area and kept back no less than 5cm and no more than 10cm from the trunk.

Watering (Performance Standard)

- The Contractor shall submit a watering plan for approval by the Town prior to installation of any plant material detailing the water source, method of application, quantity and frequency of watering for the first two growing seasons.
- The contractor shall surface water each tree immediately following planting with 40 litres of water.
- Water shall be free of contaminants which could adversely affect the trees survival and growth.

Trunk Protection

- Trunk protection may be required to protect from sunscald, frost crack, animal and maintenance equipment damage. Trunk protection may also be required to protect trees during establishment in densely populated and high traffic areas.
- Tree guards shall be made using a 15cm diameter white corrugated PVC pipe to 50cm above grade. The guard shall be loose around the tree trunk in order to allow for air circulation. Mulch shall not be trapped between the guard and trunk. Tree guards must be monitored for damage and interference with tree growth.
- Tree grates may be used to protect soil and increase pedestrian right of way. Tree grates are only appropriate when they are easily removable and their condition is monitored to allow for tree growth. Tree grate opening shall be adjustable and removable to allow for trunk growth.

7.0 GUARANTEE, INSPECTION AND ACCEPTANCE

Acceptance

- All planting shall include a full maintenance program to ensure success. The Contractor shall submit a maintenance plan including watering plan prior to installation of all plant material. The maintenance plan should include identified watering cycles, mulching, weed removal and stake removal.
- Prior to or during of tree planting, the Contractor shall provide door hangers to all residents in subdivision planting.
- The Developer shall notify the Town of Markham of installed and complete tree planting by way of a Certificate of Completion letter. See **Appendix E** for letter template.
- Upon receipt and acceptance of the Certificate of Completion letter, the Town will undertake an inspection of the tree planting.
- Upon inspection and acceptance of tree planting, the Town will release 75% of the Letter of Credit.

Guarantee Period

- A minimum two year guarantee period is required for all tree planting from the date of acceptance.
- The Developer's Landscape Architect shall carry out inspections of the planting at least once per month during the growing season from June 1 to October 31.
- The Town can request replacements at any time based on periodic inspections or inspections of citizen complaints.
- Defects and deficiencies shall include, but not be limited to; dieback, disease or lack of vigour in 50% or greater of originally specified crown
- The guarantee does not include vandalism, storm damage, animal damage or mechanical damage unrelated to the Contractor's activities.
- The Contractor shall remove and replace, without costs, and as soon as weather conditions permit, and within a specified planting period, all plants not in a healthy and flourishing condition as determined by the Developer's Landscape Architect and/or Town of Markham any time during the guarantee period. Replacement shall be subject to all requirements in the original specifications.
- The guarantee of all replacement plants shall be for the greater of the remainder of the guarantee period or an additional period of one year from the date of acceptance after replacement.

Final Inspection and Acceptance

- At the end of the two year guarantee period, the Developer shall contact the Town's Landscape Inspector for a final inspection. In order for an inspection to be scheduled, the Developer shall provide to the Landscape Inspector a Record of Inspection and Maintenance for the 2 year warranty period. See **Appendix F** for report template.
- Prior to providing the inspection for both completion and acceptance, the following conditions shall be in place:
  - All tree pits shall be freshly cultivated, free of weeds, leaves, broken branches and debris
  - All tree wrap shall be removed by the Contractor
  - All stakes and wires shall be removed by the contractor prior to inspection for acceptance
  - Leaves shall be on the tree
- Any inspection required in addition to the initial and final inspection shall be an additional charge as noted in the Fee By-Law.
- After acceptance, by the Town of Markham, the Town will release the final Letter of Credit and will assume responsibility for the trees.

8.0 MAINTENANCE DURING ESTABLISHMENT

Trees that are properly maintained in the critical early growth years improve the overall appearance of the neighbourhood and significantly help reduce replacement costs. A healthy urban forest maintains benefits and services over the long term and is managed to maximize return on investment. Each site will have specific maintenance requirements associated with the use, design and external influences.

Maintenance during establishment shall be ongoing throughout the guarantee period and is the responsibility of the Contractor and Landscape Architect under supervision and inspection of the Developer. Maintenance of newly planted trees should focus on producing healthy plant growth toward desired mature form and increased size.

- Inspections shall be undertaken by the Developer's Landscape Architect at least once per month during the growing season from June 1 to October 31.
- Records should be filed using a standardized format including the date of inspection, inspector's name, tree location, size, species and condition, action required and urgency of action. Records should include photos, drawings, defect descriptions, utilities, target location and description.
- **Watering** shall reflect soil conditions, plant requirements, microclimate and supplement natural rainfall. New plantings will require more frequent watering and should be monitored regularly throughout the growing season for signs of drought and overwatering. During the establishment period it is recommended that new plants are watered (according to conditions) at minimally every seven (7) to ten (10) days between May and August 30, and minimally every fourteen (14) to twenty-one (21) days between September 1 and November 15. Watering shall be such that the water penetrates the full depth of the growing medium. Frequency of watering shall be increased when plant materials are showing signs of drought stress. Scheduled applications of water shall be skipped only when rainfall has penetrated the soil fully as required.
- **Fertilizing** should only be done to supplement nutrient deficiencies determined by soil tests, observation of leaf growth and tissue testing. Trees shall be fertilized only as required to correct symptoms of nutrient deficiency, except where otherwise recommended on the basis of soil or tissue test results
- **Mulching** shall be maintained to reduce weed growth, improve water retention in soil, moderate soil temperature and improve the appearance of the planting areas. Maintenance requirements may include litter removal, replacing displaced much and addition of mulch to maintain specified settled depth.
- **Weed Control:** All areas shall have all weeds removed at least once per month during the growing season by hoeing, cultivation to a maximum depth of 100 mm, (varying the depth to prevent a soil pan) hand pulling or, if absolutely necessary by the use of herbicides. Ground covers and shallow rooted plant material should have the weeds manually removed.
- **Pruning** should be done by a certified arborist at the appropriate time according to individual species requirements. Pruning should be limited to cuts that are necessary to remove dead, damaged, diseased, crossing and rubbing branches, direct growth and correct structural weakness **and for Sucker Removal.** Proper pruning during establishment is critical to strong and safe tree growth.
- **Stabilization** of trees should be inspected regularly to ensure that the ties are not damaging the trunk. Stakes, guy wires and ties shall be maintained for one full growing season. Ties shall be checked minimally every three months to ensure that they are not rubbing against the bark, and shall be loosened, repaired or replaced as necessary. After one full growing season, the Contractor shall remove all staking and associated ties. Trees shall be inspected to ensure that they are secure in the ground. Trees that cannot sufficiently support themselves without stakes after one full growing season shall be checked to confirm adequate soil consolidation around the root ball and be re-staked for an additional growing season. Stabilization material shall be removed no later than the end of the guarantee period.
- **Pest and Disease Control:** All planted areas shall be inspected for pests and diseases at least once a month throughout the growing season from May to October. The principles and methods of Integrated Pest Management (IPM) and Plant Health Care (PHC) should be applied in controlling pests and diseases.

TECHNICAL DETAILS

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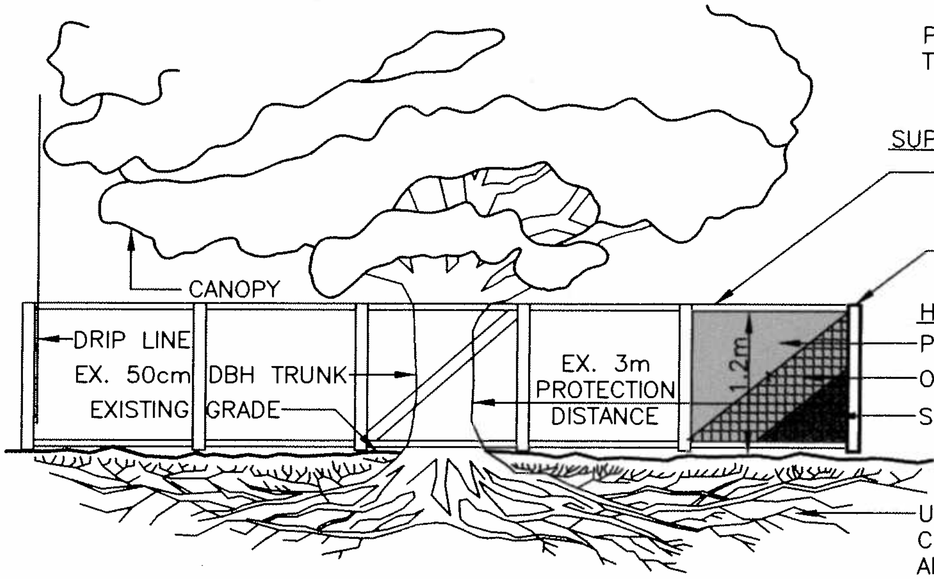
APPENDIX C



MINIMUM TREE PROTECTION DISTANCE FROM TRUNK:

< 10cm DBH	1.2m
10–29cm DBH	1.8m
30–40cm DBH	2.4m
41–50cm DBH	3.0m
51–60cm DBH	3.6m
61–70cm DBH	4.2m
71–80cm DBH	4.8m
81–90cm DBH	5.4m
91–100cm DBH	6.0m
> 100cm DBH	6cm/1cmø

(DIAMETER AT BREAST HEIGHT) DBH = TRUNK DIAMETER AT 1.4m HEIGHT

40cmx60cm SIGN MOUNTED ON ALL SIDES OF BARRIER

MARKHAM

TREE PROTECTION ZONE

NO WORK IS PERMITTED WITHIN THE TREE PROTECTION ZONE INCLUDING GRADING, CONSTRUCTION ACCESS AND MATERIAL STORAGE.

BREACH OF TREE PROTECTION ZONE IS SUBJECT TO A FINE OF $________

CONTACT TOWN OF MARKHAM FOR MORE INFORMATION: 905–477–5530

TREE PROTECTION NOTES:

1. ALL TREE PROTECTION BARRIERS SHALL BE IN PLACE AND APPROVED BY THE TOWN PRIOR TO CONSTRUCTION ACCESS.

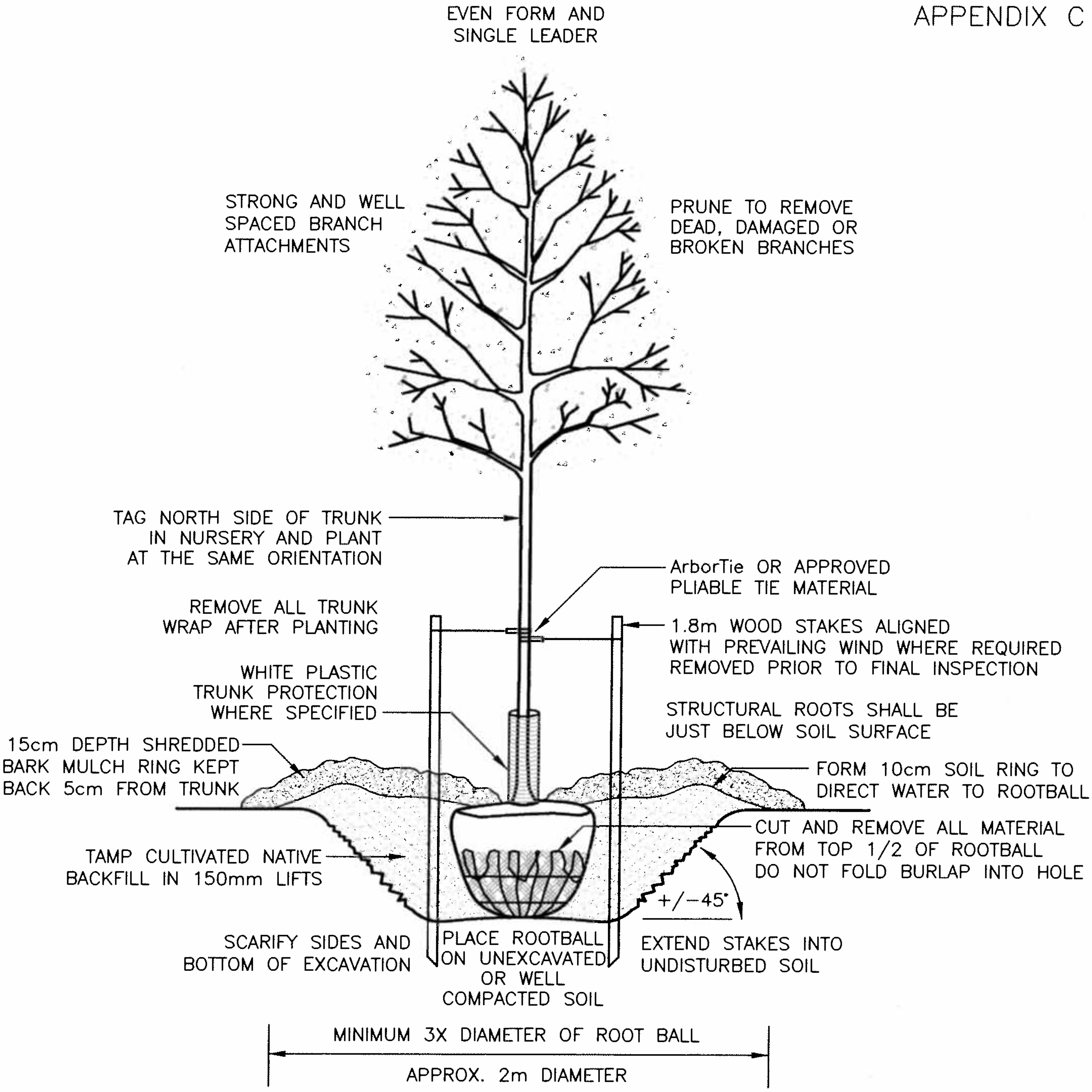
2. ALL SUPPORTS AND STAKES SHALL BE OUTSIDE THE TREE PROTECTION ZONE AND SHALL MINIMIZE ROOT DAMAGE.

3. TREE PROTECTION BARRIERS SHALL REMAIN IN PLACE AND IN GOOD CONDITION UNTIL ALL CONSTRUCTION IS COMPLETE AND APPROVED BY THE TOWN.

4. ALL ARBORICULTURE WORK SUCH AS PRUNING OF BRANCHES AND ROOTS, SHALL BE DONE BY A QUALIFIED TREE WORKER CERTIFIED WITH THE INTERNATIONAL SOCIETY OF ARBORICULTRE APPROVED BY THE TOWN.

TREE PRESERVATION DETAILS

MARKHAM THE CORPORATION OF THE TOWN OF MARKHAM	SCALE: N.T.S.	DATE: ARPIL 2009	DRAWING No. T-1



SOAK THE ROOTBALL AND BACKFILL AREA WITH 40 LITRES OF WATER AT TIME OF PLANTING

ALL PROPOSED PLANTING AREAS SHALL BE TESTED FOR DRAINAGE, SOIL QUALITY AND pH. POOR DRAINAGE SHALL INCORPORATE DESIGN OF A DRAINAGE SYSTEM CONNECTED TO APPROVED OUTLET. AMENDMENTS TO POOR QUALITY SOIL SHALL BE DESIGNED USING COARSE SAND, AND COARSE ORGANIC MATERIAL WITH ≤ 7.5pH.

DECIDUOUS TREE PLANTING IN *GOOD QUALITY SOIL*

	SCALE:	DATE:	DRAWING No.
MARKHAM THE CORPORATION OF THE TOWN OF MARKHAM	N.T.S.	ARPIL 2009	T-2

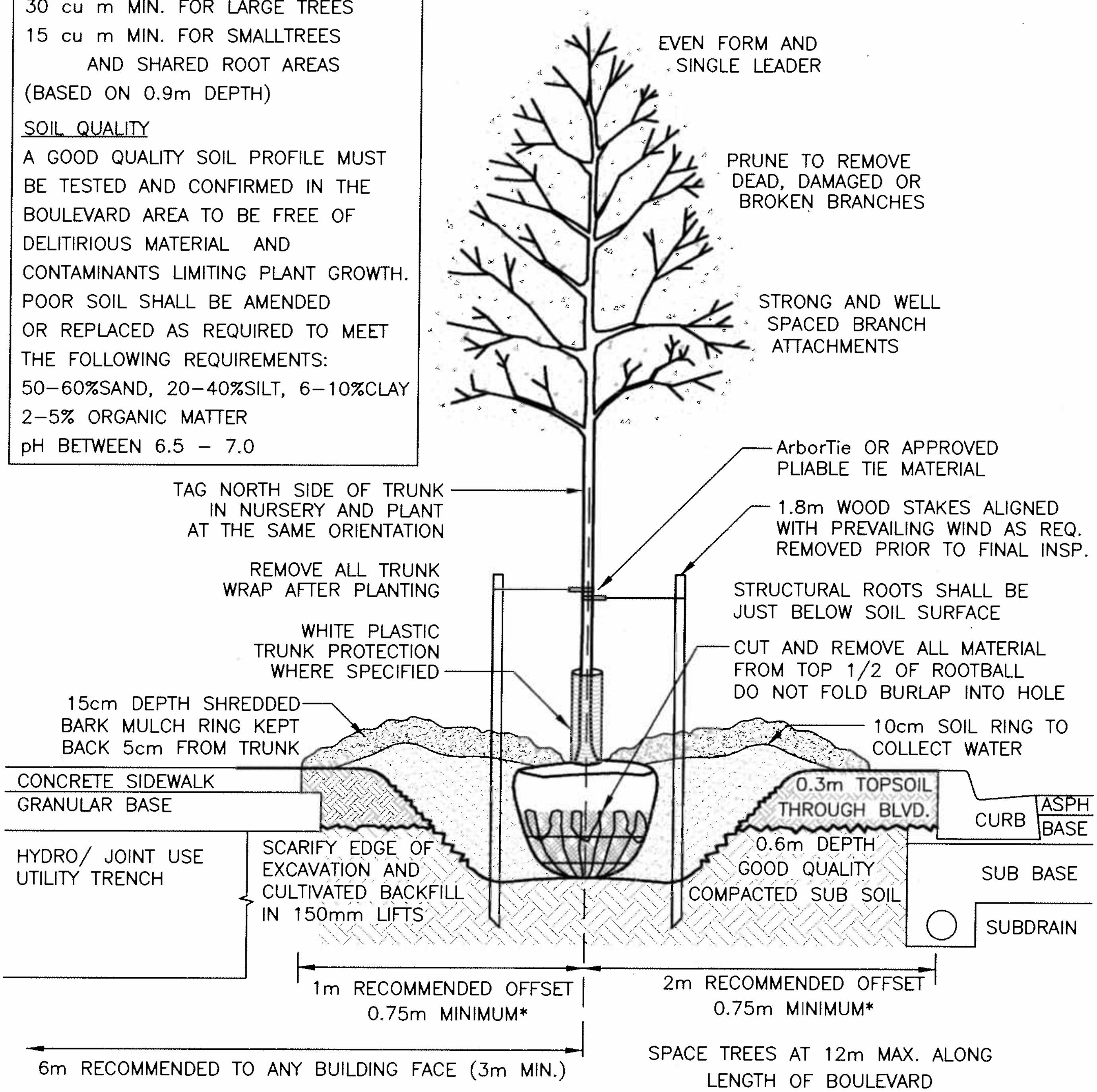
APPENDIX C

SOIL VOLUME

30 cu m MIN. FOR LARGE TREES
15 cu m MIN. FOR SMALLTREES
AND SHARED ROOT AREAS
(BASED ON 0.9m DEPTH)

SOIL QUALITY

A GOOD QUALITY SOIL PROFILE MUST BE TESTED AND CONFIRMED IN THE BOULEVARD AREA TO BE FREE OF DELITIRIOUS MATERIAL AND CONTAMINANTS LIMITING PLANT GROWTH. POOR SOIL SHALL BE AMENDED OR REPLACED AS REQUIRED TO MEET THE FOLLOWING REQUIREMENTS:
50–60%SAND, 20–40%SILT, 6–10%CLAY
2–5% ORGANIC MATTER
pH BETWEEN 6.5 – 7.0



* MINIMUM SPACING IS BASED ON SMALL STATURE TREE SPECIES AND LOW TRAFFIC SPEED ROADS REDUCED SPACING MAY BE CONSIDERED WITH PROVISIONS OF ADEQUATE SNOW STORAGE AND ENHANCING ROOTING AREA THROUGH BRIDGING, SOIL CELLS, STRUCTURAL SOIL OR OTHER APPROVED TECHNIQUES

BOULEVARD TREE PLANTING DETAIL

MARKHAM

THE CORPORATION OF THE TOWN OF MARKHAM

SCALE:	DATE:	DRAWING No.
N.T.S.	ARPIL 2009	T-3

APPENDIX C

SOIL VOLUME (BASED ON 0.9m DEPTH)

30 cu m MIN. FOR LARGE TREES

15 cu m MIN. FOR SMALL TREES
AND SHARED ROOT AREAS

LAYOUT EXAMPLES

1.5m BED WIDTH @ 20m LENGTH ≃ $30m^3$

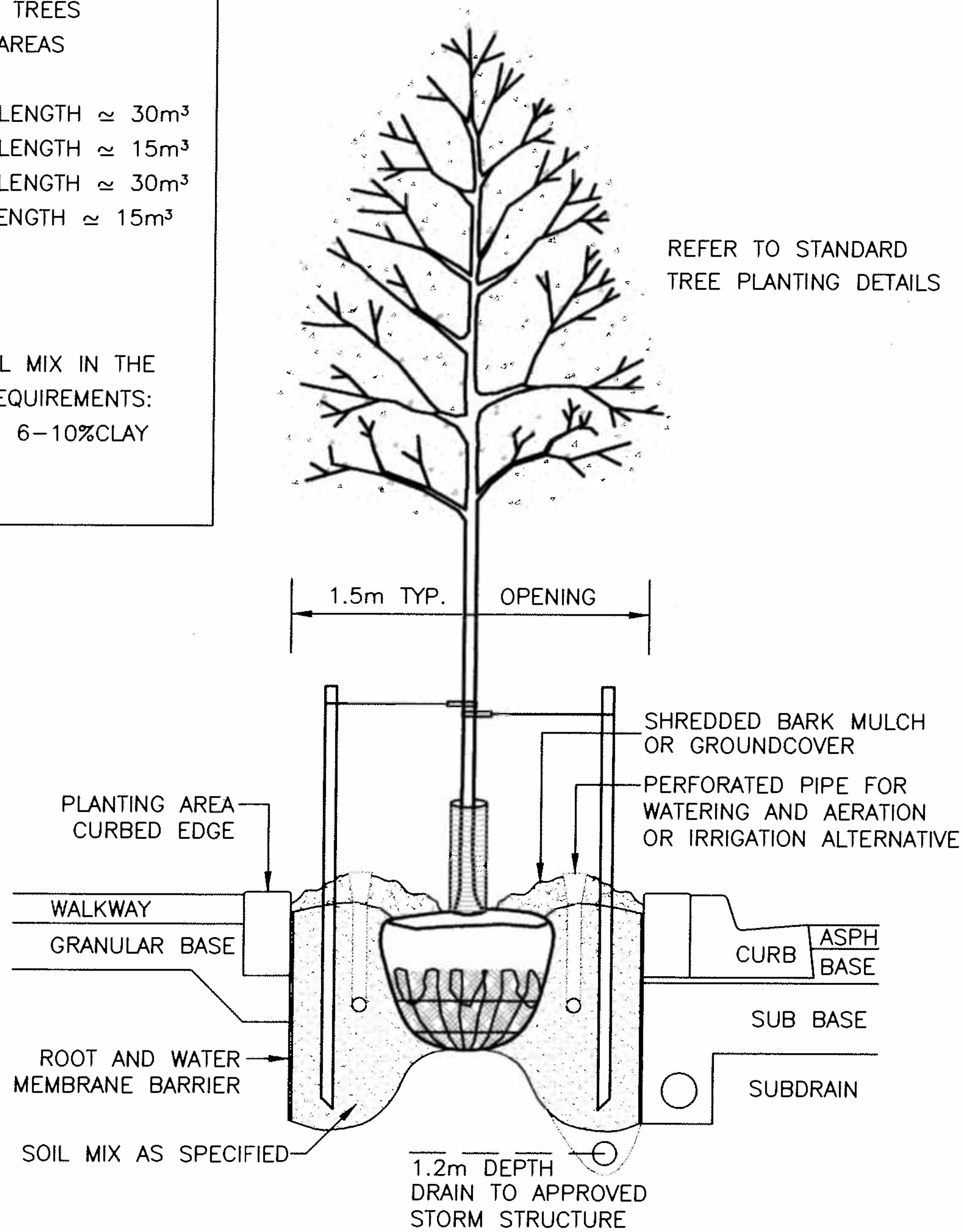
1.5m BED WIDTH @ 10m LENGTH ≃ $15m^3$

3.0m BED WIDTH @ 10m LENGTH ≃ $30m^3$

3.0m BED WIDTH @ 5m LENGTH ≃ $15m^3$

SOIL MIX

INSTALL GOOD QUALITY SOIL MIX IN THE BED TO THE FOLLOWING REQUIREMENTS:
50–60%SAND, 20–40%SILT, 6–10%CLAY
2–5% ORGANIC MATTER
pH BETWEEN 6.5 – 7.0



NOTE: REQUIREMENTS FOR ENHANCED PLANTING STRATEGIES AS DETERMINED BY THE TOWN MAY INCLUDE:

- IRRIGATION
- ROOT PATHS
- CONTINUOUS TRENCH
- SOIL VAULTS
- STRUCTURAL SOILS
- STRUCTURAL SOIL CELLS
- ROOT BARRIERS
- ETC.

CONTINUOUS PLANTING BED IN PAVING/PLAZA DETAIL

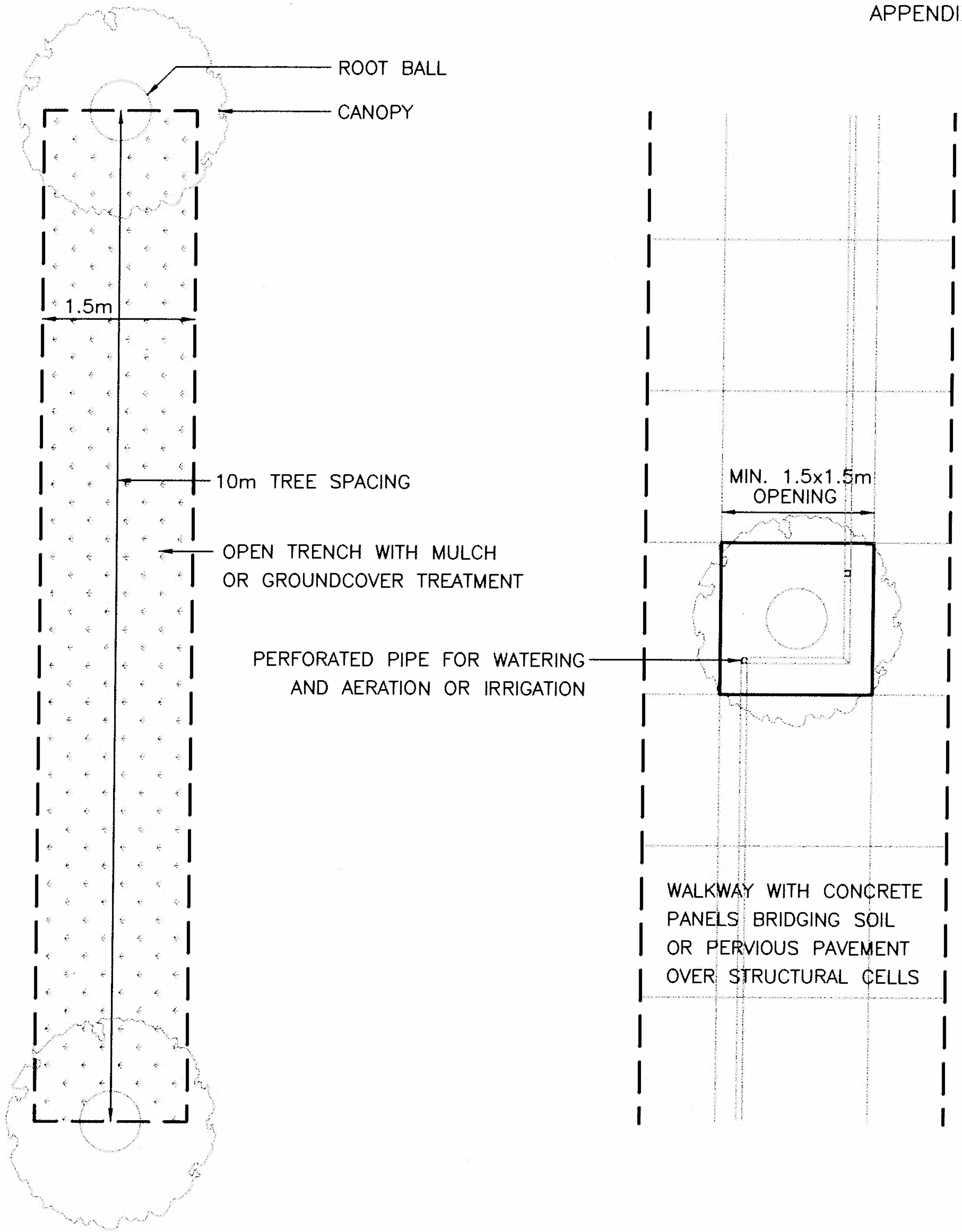
*GUIDELINE ONLY - SPECIFIC DETAILS TO BE DEVELOPED FOR EACH PROJECT

MARKHAM

THE CORPORATION OF THE TOWN OF MARKHAM

SCALE:	DATE:	DRAWING No.
N.T.S.	ARPIL 2009	T-4a

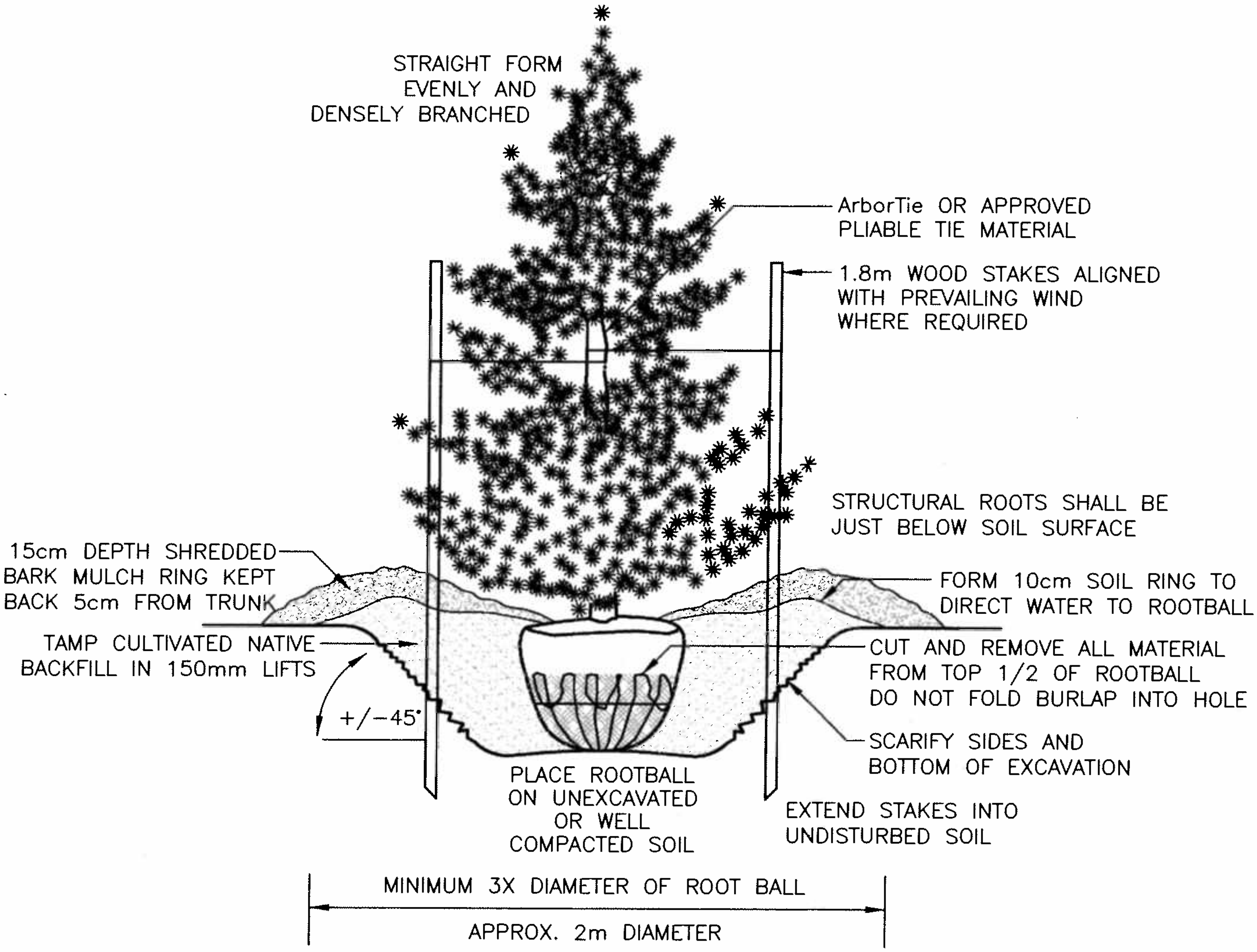
APPENDIX C



CONTINUOUS PLANTING TRENCH PLANS

*GUIDELINE ONLY - SPECIFIC DETAILS TO BE DEVELOPED FOR EACH PROJECT

MARKHAM THE CORPORATION OF THE TOWN OF MARKHAM	SCALE: N.T.S.	DATE: ARPIL 2009	DRAWING No. T-4b



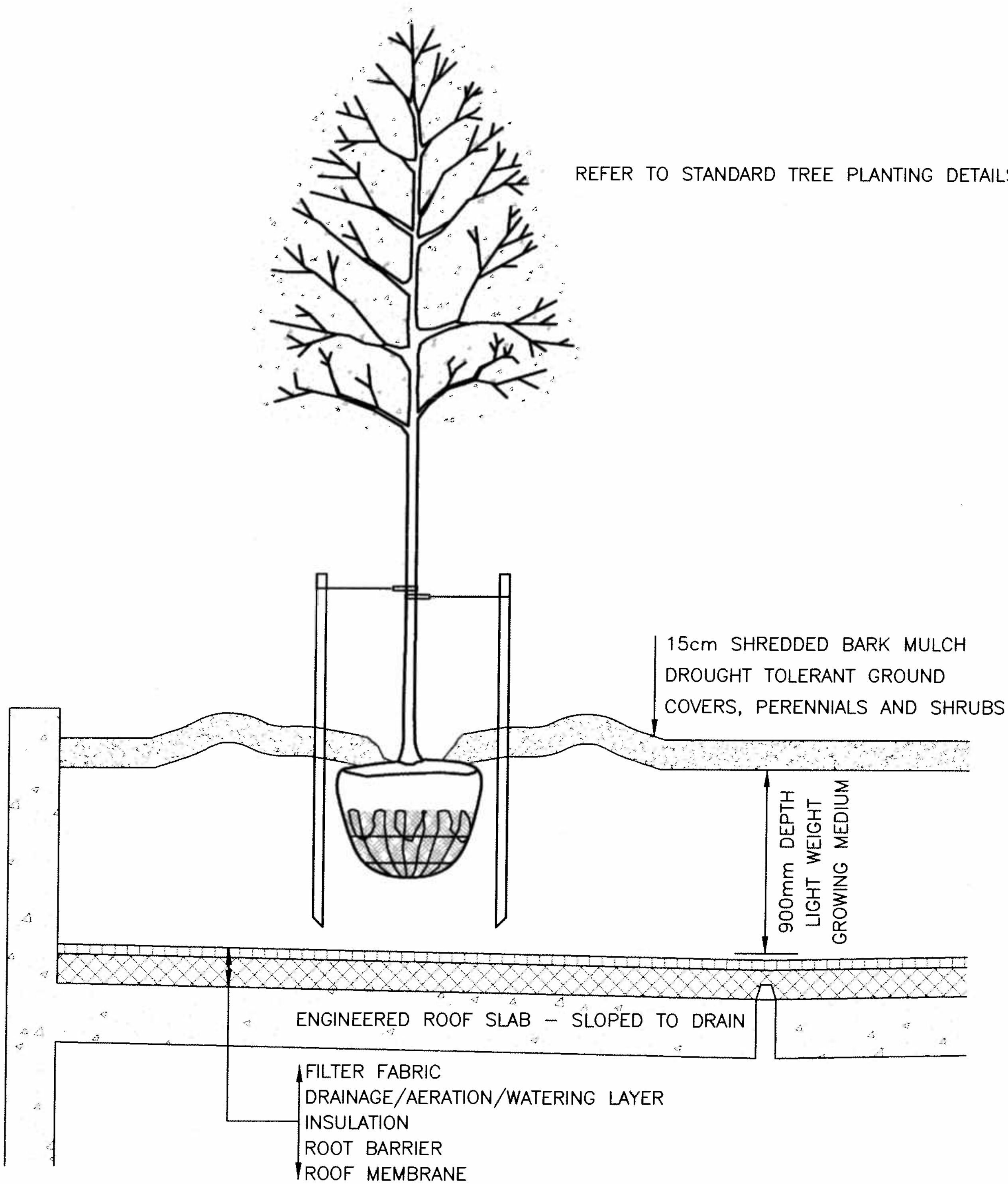
SOAK THE ROOTBALL AND BACKFILL AREA WITH 40 LITRES OF WATER AT TIME OF PLANTING

ALL PROPOSED PLANTING AREAS SHALL BE TESTED FOR DRAINAGE, SOIL QUALITY AND pH. POOR DRAINAGE SHALL INCORPORATE DESIGN OF A DRAINAGE SYSTEM CONNECTED TO APPROVED OUTLET. AMENDMENTS TO POOR QUALITY SOIL SHALL BE DESIGNED USING COARSE SAND, AND COARSE ORGANIC MATERIAL WITH ≤ 7.5pH.

CONIFEROUS TREE PLANTING DETAIL

MARKHAM THE CORPORATION OF THE TOWN OF MARKHAM	SCALE: N.T.S.	DATE: ARPIL 2009	DRAWING No. T-5

APPENDIX C



TREE PLANTING ON ROOF/STRUCTURE

*GUIDELINE ONLY - SPECIFIC DETAILS TO BE DEVELOPED FOR EACH PROJECT

MARKHAM THE CORPORATION OF THE TOWN OF MARKHAM	SCALE: N.T.S.	DATE: ARPIL 2009	DRAWING No. T-6

Date

Planning and Urban Design
Town of Markham,
101 Town Centre Blvd.,
Markham, Ontario,
L3R 9W3

Attention: Urban Design Senior Planner

RE: Certificate of Completion
Town Project File Number
Address
Reference Name/Developer

Inspection Date:

Attendees:

Weather Conditions:

Changes: Please attach written approval from the Town regarding any changes

Deficiencies: If necessary, provide an additional sheet attached for deficiencies

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I certify that the landscape design for XXXX is complete in accordance with approved plans dated XXXXX and approved XXXXXX.

Sincerely,

Landscape Architect, provide stamp and sign

Date

Planning and Urban Design
Town of Markham,
101 Town Centre Blvd.,
Markham, Ontario,
L3R 9W3

Attention: Urban Design Senior Planner

RE: Maintenance and Inspection Report
2 Year Warranty Period
Town Project File Number
Address
Reference Name/Developer

Year 1

Inspection Dates:

Inspector and any other Attendees:

Weather Conditions:

Watering Dates:

Weeding Dates:

Deficiencies: Note any deficiencies at the time of the inspection. If necessary attach an additional sheet for deficiencies. Include the timing for replacement and warranty for replacement trees. Note timing and completion of stake removal.

Year 2

Inspection Dates:

Inspector and any other attendees:

Weather Conditions:

Watering Dates:

Weeding Dates:

Deficiencies: Note any deficiencies at the time of the inspection. If necessary attach an additional sheet for deficiencies. Include the timing for replacement and warranty for replacement trees. Note timing and completion of stake removal.

I certify that the above noted inspections and maintenance have been completed over the 2 year warranty period for XXXX project and request the scheduling of a final inspection.
Sincerely,

Landscape Architect, provide stamp and sign

MARKHAM

TREE PRESERVATION REQUIREMENTS, SPECIFICATIONS AND DETAILS

In an effort to take an application through the process to Site Plan and Subdivision Approval and project completion, Urban Design staff will work with the Applicant to advance and finalize the Tree Inventory, Analysis and Preservation Plan. The initial stages of a successful design process should include an approved Tree Inventory and Analysis. This information should be used to make appropriate decisions and inform the final design.

In order to achieve these goals and finalize the documents and plans, the applicant will need to provide the following information relevant to their application.

TREE INVENTORY and ANALYSIS

If there is no existing vegetation on the proposed development site, a letter must be provided by the arborist or Landscape Architect, as well a statement to that effect must be made on the draft plan. The plan will be prepared by a qualified Landscape Architect in good standing with the O.A.L.A., in partnership with a certified arborist who will prepare the vegetation analysis. The inventory should indicate all existing vegetation within **6.0m** of the subject property on adjacent lands.

The inventory and analysis should describe the existing vegetation as follows:

- Designation of species types
- Size, general health and quality of vegetation
- An opinion as to the retention value considering future development
- An appraisal of the economic value of the trees (trunk formula) to be preserved as set out in the *International Society of Arboriculture Guide for Plant Appraisal.*

TREE INVENTORY and ANALYSIS PLAN REQUIREMENTS

- Surveyed location of all existing woodlots, trees, valleys and natural features
- Surveyed location of all trees and shrubs on the development site
- Surveyed location of all trees and shrubs within **6.0**m of the property line
- Scaled drawing at 1:500
- Title Block to include Town File number SC XX XXXXX.
- Title Block to include area for Town's approval stamp
- Provide a Key Map
- Property lines incl. dimensions
- Existing elevations at the base of trees
- All trees greater than 20 cm individually identified
- Corresponding identification chart with the tag number, species, size, general health and recommendations

Note: for small scale developments or developments with limited number of trees to be preserved the Inventory, Analysis and Preservation can be included together on one plan.

TREE PRESERVATON

Once the Inventory and Analysis has been approved by staff, the Tree Preservation Plan can be prepared. The plan will be prepared by a qualified Landscape Architect in good standing with the O.A.L.A., in partnership with a certified arborist who will prepare the vegetation analysis. The preservation plan should indicate all existing vegetation within **6.0m** of the subject property on adjacent lands. In order to finalize this plan the following requirements apply:

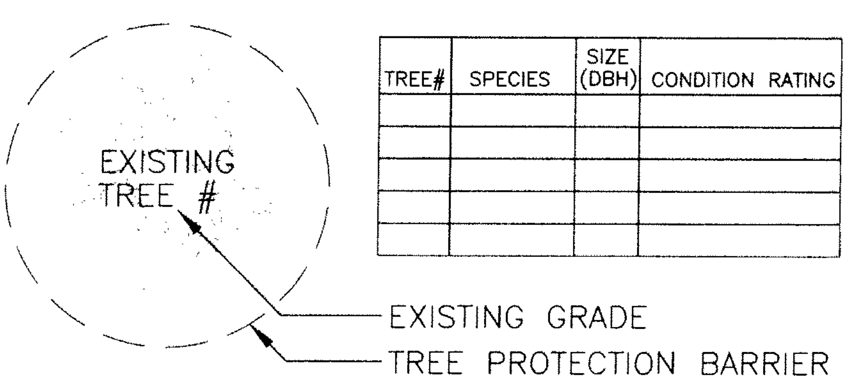
The tree preservation plan must include Preservation Plan information, Tree Preservation Requirements, Specifications and a Tree Preservation Detail.

Preservation Plan Requirements:

- Designation of species types
- Location of all trees and shrubs on the development site
- Existing and proposed elevations at the base of trees to be preserved
- Size, general health and quality of this vegetation
- An opinion as the retention value considering future development
- An appraisal of the economic value of the trees (trunk formula) to be preserved as set out in the *International Society of Arboriculture Guide for Plant Appraisal.*
- Report or drawings to include photographs of trees

Tree Preservation Plan Requirements:

- Scaled drawing at 1:500;
- Title Block to include Town File number SC XX XXXXX.
- Title Block to include area for Town's approval stamp
- Provide a Key Map
- Property lines incl. dimensions
- Dimensions shown of all existing and proposed buildings
- Site context including adjacent property building setbacks and all adjacent trees within **6.0** metres of the property line;
- Surveyed location of all existing woodlots, trees, valleys and natural features
- Appropriate Tree Protection Zone – based on Table 1



TREE#	SPECIES	SIZE (DBH)	CONDITION RATING

Table 1 – Tree Protection Zones (TPZ)

Trunk Diameter (DBH)[1]	Minimum Protection Distances Required [2] Town Owned and Private Trees	Minimum Protection Distances Required
< 10 cm	1.2 m	Whichever of the two is greater:
10 – 29 cm	1.8 m	The drip line[4] or 1.2 m
30 – 40 cm	2.4 m	The drip line or 3.6 m
41 – 50 cm	3.0 m	The drip line or 4.8 m
51 – 60 cm	3.6 m	The drip line or 6.0 m
61 – 70 cm	4.2 m	The drip line or 7.2 m
71 – 80 cm	4.8 m	The drip line or 8.4 m
81 – 90 cm	5.4 m	The drip line or 9.6 m
91 – 100 cm	6.0 m	The drip line or 10.8 m
> 100 cm	6 cm protection for each 1 cm diameter	The drip line or 12.0 m
		12 cm protection for each 1 cm diameter or the drip line[5]

1 Diameter at breast height (DBH) measurement of tree stem taken at 1.4 metres above the ground.
2 Tree Protection Zone distances are to be measured from the outside edge of the tree base.
3 Diameter (**30** cm) at which trees qualify for protection under the private tree by-law.
4 The drip line is defined as the area beneath the outer most branch tips of a tree.
5 Converted from ISA Arborists' Certification Study Guide, general guideline for tree protection barriers of 1 foot of diameter from the stem for each inch of stem diameter.

The following requirements for an area designated as a TPZ shall apply to both inside the zone and outside the zone in areas where tree roots are located. The roots of a tree can extend from the trunk to approximately 2-3 times the distance of the dripline.

No storage of construction materials, equipment, soil, construction waste or debris
No construction
No parking of vehicles or machinery of any kind
No movement of vehicles, equipment or pedestrians
No altering of grades
No fill, excavating, trenching, dumping or disturbing or any kind

Tree Preservation Specification Requirements

The following SPECIFICATIONS NOTES FOR THE PROTECTION AND PRESERVATION OF EXISTING TREES are to be included as part of the Tree Preservation Plan

1. All existing trees which are to remain shall be fully protected with fencing erected beyond the "drip line". The fencing will be located 360^0 around and at a minimum distance of 1.5 times the crown radius from the drip line of the tree. Groups of trees and other existing plantings to be protected, shall be done in a like manner with fencing around the entire clump(s).
2. Areas within the protective fencing shall remain undisturbed and shall not be used for the storage of building materials or equipment.
3. This work shall be completed, to the satisfaction of the Commissioner of Development Services, prior to the issuance of Building Permits for the site development. The developer or his/her agent shall take every precaution necessary to prevent damage to trees or shrubs to be retained.

4. No rigging cables shall be wrapped around or installed in trees; and surplus soil, equipment, debris or materials shall not be placed over root systems of the trees within the protective fencing. No contaminants will be dumped or flushed where feeder roots of trees exist.
5. Where limbs or portions of trees are removed to accommodate construction work, they will be carefully removed by a qualified arborist.
6. Where root systems of protected trees are exposed directly adjacent to or damaged by construction work, they shall be trimmed nearly and the area back filled with appropriate material to prevent desiccation.
7. Where necessary, the trees will be given an overall pruning to restore the balance between roots and top growth or to restore the appearance of the tree.
8. If grades around trees to be preserved are likely to change, the developer shall be required to take such precaution as dry welling and root feeding to the satisfaction of the Commissioner of Development Services.
9. Trees to be preserved that have died or have been damaged beyond repair, shall be replaced by the developer at his own expense with trees of a size and species as approved by the Commissioner of Development Services.
10. **See attached tree preservation detail** to be included on the drawing as part of the tree preservation plan

Security and Release of Letter Requirements

Tree Preservation Letters of Credit will be held for a minimum of 5 years. The length of time will be determined on a case by case situation regarding the type of tree, location, type of development

For all development applications, no net loss of trees or canopy cover is to be achieved within the Town of Markham. A permit from the Town of Markham is required to injure or destroy a tree subject to penalties in accordance with By-Law 2008-96.

Acceptable replacement and enhancement planting shall be determined by the Town of Markham based on review and approval of landscape submissions for development.