Ottawa Forests & Greenspace Advisory Committee
COMMENTS ON PLANTING IN SENSITIVE CLAY SOILS
(March – April 2011)

These comments are intended to provide input to the review of the City of Ottawa Forestry Services' Tree Planting Guidelines (dated 2006), and also to make interim suggestions for applicable Development Application Reviews, Community Design Plans and any other planning activities involving urban landscapes, until such time as the City of Ottawa tree planting guidelines are revised in the direction of an overall tree canopy strategy.

THE PROBLEM

The City of Ottawa's current tree planting guidelines, particularly in areas of sensitive marine clay, which are widespread throughout the city, impose exceedingly restrictive limitations on what can be planted in most of Ottawa. This contributes to what will be a future deficit in the amount of tree canopy in the city.

"**Sensitive marine clay soils**" comprise an estimated 60% of soils in the remaining developable areas in Ottawa[1], and, per the city's guidelines, **only 5 tree species may be planted** (primarily small stature, non-native trees), on these soils, and these can only be planted if there is space left over after applying large distance setbacks from utilities, structures and pavement. In addition, these restrictive guidelines are applied across the spectrum to all soils which have been identified as having sensitive clay, with no regard for gradations of soil composition which might allow more leeway for other species to be planted, or where other measures can be implemented to mitigate potential building foundation issues. The cost of addressing foundation issues on clay soils could be more than offset by the value provided by the significant and measurable economic and social benefits provided by the urban tree canopy.

New development affected by Ottawa's tree planting guidelines for clay soils. Note the absence of street trees.
(from Google Streetview, 2011)

[1] As per the City of Ottawa's Request for Proposal for Study of Design Alternatives for Street Trees in Areas of Sensitive Marine Clay Soils, 2010.

It is important to expand the list of plantable tree species because we are losing trees in the city at an alarming rate. Our current experience with ash and elm trees alone also tells us that it is unwise to limit the selection of plantable species too severely since this can lead to large losses in a relatively short time period in the future with the introduction of potential new diseases and pests. The problem is compounded by the fact that many trees supplied by the landscaping industry have reduced genetic variability which may increase their susceptibility to diseases and pest problems, and, in addition, make them more vulnerable to climate change pressures.

The overall canopy deficit problem is compounded by other planning pressures that squeeze out available space for trees in urban and suburban Ottawa. Specifically:

- required setbacks and spacing distances as recommended by Hydro Ottawa, Enbridge, and other utility companies[2];
- location of utilities (underground and aboveground);
- shrinkage in average road allowances in new developments;
- trends toward larger homes and hard-surface front yards; and,
- overall city direction toward greater intensification.

The combination of the above, as well as the limited number of approved plantable species, a potential major reduction in the number of trees being planted by, or assisted by the City (because of the discontinuation of the TREE Program, and also possibly the Community Tree Planting Grant Program), and the continued loss of existing urban forest for various reasons, including disease, development pressures, etc., primarily in rural areas, will cause **serious problems** with a net loss of tree canopy in the near future if these issues are not quickly addressed and rectified through both policy development and effective implementation.

The Value of Trees

It is particularly important to expand the tree species list, as well as to plant more trees and retain as many of our existing trees as possible, because of the role trees play in contributing to community economic stability, health, safety and well-being, energy savings, managing stormwater runoff, and improving air quality. If only small trees are planted, the reduced canopy on these trees cannot fulfill these roles to the maximum extent possible because the size of the canopy must be larger to be maximally effective.

A recent City Green study done by city staff in 2008[3], found that Ottawa's existing forest cover removes about 630,000 kilograms of air pollutants per

[2] From Hydro Ottawa's Tree Planting Advice, at www.hydroottawa.com, and Enbridge at http://enbridge.com/Portal.aspx

[3] From Green Municipal Fund Case Study by the City of Ottawa.

year — a result valued at about $4 million. Ottawa's trees also store one million tonnes of carbon (in their structure) and through transpiration sequester a further 8,000 tonnes of carbon per year, helping to mitigate climate change. The urban forest also provides the equivalent of four million cubic metres of stormwater storage per year, saving the city about $19 million.[4] This is important as the cost of comparable built stormwater retention structures to replace the function of our current urban forest would be prohibitive.

Then, consider that the average house price in Ottawa in 2010 was $325,000. It is generally accepted that a large, mature tree increases the real estate value by 5-20%, depending on circumstances. Thus, a tree is valued at a minimum average of $16,250 to the homeowner. With multiple large trees on a property, this can amount to a significant additional value. Add onto this the cooling effect that a tree provides through shade and creating air currents and there will be a decrease in cooling costs in summer for that house of another $50-100 per year. In fact, the collective urban tree canopy significantly reduces the energy needs of the whole city and accrues potentially substantial financial benefits through savings.

Desirable well-treed urban street near Merivale and Carling Avenue.
(from Google Streetview, 2011)

It is well-established that trees play a vital role in the psychological well-being of a city's population. Studies have shown that additional benefits of a well-treed city include reduced crime rates, slower traffic, increased community interactions, reduced health risks from skin cancer and respiratory diseases, increased feelings of well-being, and reduced levels of noise and light pollution. Ottawa benefits from all of these outcomes and residents value Ottawa for its greenspaces and trees.

The urban forest is also beneficial to taxpayers. On balance, it decreases current and future costly infrastructure needs, it reduces emergency and social services costs for crime and health, and it increases community economic stability.

The ecology of our urban forests will be substantially affected by a reduced tree canopy which will, in turn, limit the species dependant on it. Birds, pollinating insects, and other fauna and flora populations will be reduced as they lose their habitat for feeding, nesting, protection, shade, etc. Native

[4] Based on a Green Municipal Fund Case Study by the City of Ottawa.

tree species are also disadvantaged by invasive species such as Japanese knotweed and buckthorn, currently existing problems in the city.

Critical Planning Tools

In planning for the future, it is critical to provide sufficient new planting to compensate for the loss of existing and often mature urban forest through development, disease, old age, storm damage, and other causes, as well as the current restrictive tree planting species guidelines. Two important tools that would help with such planning are a detailed **Urban Tree Cover Assessment** which identifies how much tree canopy Ottawa currently has and how much it **could** have, and a comprehensive **city-wide Tree Inventory** which would provide a better and more complete picture of what exists now, what the species ratios are, how healthy the urban forest is, and what the threats are to its continued existence. The city's Forestry Services are undertaking an on-going tree inventory, but because of limited resources are not able to prioritize it.

All of these analyses and activities should contribute to an overall **Tree Canopy Master Plan** which would provide both a comprehensive short term and long term strategy for maintaining and enhancing the city's urban forest tree canopy.

A Framework for Solutions

The cost-benefit picture in terms of damage caused to buildings and infrastructure by trees in clay soils has not been quantified to our knowledge, and thus, the broad-scale application of the city's restrictive tree planting guidelines does not seem to be warranted. In contrast, it is instructive to consider studies that have shown that trees can provide an average net benefit of 42:1 for every dollar spent.[5]

There needs to be a serious effort to re-think the overall approach to layout, utilities and landscaping in new and redeveloped areas to ensure that urban trees are an "a priori" integral and valued part of the services provided. This will require some creative thinking and experimentation as shown in trials going on in other cities[6]. Trees should not be relegated to the category of "space left over after planning" – SLOAP. They are too important to our city.

The following recommendations and questions are provided to the city to suggest ways to begin resolving some of the current issues, and to work toward longer-term solutions.

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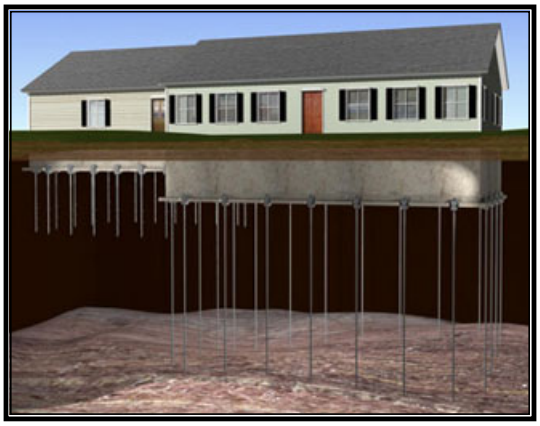
[5] According to the City of Regina (Saskatchewan, Canada) Urban Forest Management Strategy

[6] London UK's "Subsidence and Trees - a Soils Perspective, by Howorth and O'Sullivan, date unknown; A Risk Limitation Strategy for Tree Root Claims by London Tree officers Association, 2008;

1. Develop a cost-benefit framework that provides a strategic tool for making decisions about planting, maintenance and removal of trees in the City (part of a Tree Canopy Master Plan).
2. Develop a more extensive list of trees for planting on clay soils, integrated with other solutions, so that choices expand where other measures (such as developing lots with trees in mind, and geotechnical and engineering solutions) decrease the risk of adverse effects ("Tree Selection" list in the Appendix is just a start in this direction).
3. Re-think the overall approach to layout, utilities and landscaping in new developments to ensure that urban trees are an integral and valued part of the infrastructure and services provided (see "Planning and Space" in Appendix).
4. Provide more guidance to insurers, city staff, homeowners, engineers on identification and modification of soils (see "Soil Factors" in Appendix).
5. Reformulate minimum spacing distances so as to ensure that trees will be planted, rather than preventing trees from being planted ("Distance Measurements" in Appendix).
6. With the cost-benefit framework in place, make logical decisions on how and when to provide maintenance for selected trees to ensure they will not cause undue damage ("Pruning" in Appendix).
7. Recognize engineering solutions such as used in other jurisdictions ("Engineering Solutions" in Appendix).



Foundation built to levels below the influence of potential subsidence.
(from the Civil Engineer Group website)

Conclusion

The current City of Ottawa tree planting guidelines need to be updated, including a serious effort to re-think the overall approach to layout, utilities and landscaping to ensure that urban trees are an integral and valued part of the services provided. This will require some creative thinking and experimentation such as shown in trials going on in other cities.

The cost-benefit picture in terms of tree value versus damage caused to buildings by trees in clay soils has not been quantified to our knowledge. We would suggest developing an approach where the current and future value of services provided by trees is quantified (e.g. for low-, medium- and high-

value trees) and used as one tool to assess the risk vs. benefits to the City prior to determining the overall strategy for dealing with this issue. The Ottawa Forests and Greenspace Advisory Committee would like to work with the City to move in the direction of improved and expanded options and spaces for trees.

Appendix: ELEMENTS OF SOLUTIONS

Tree Selection

This section includes a list of some potential candidates for tree selection in sensitive clay areas. While some of the listed trees may not be suitable or available for various reasons, it should also be recognized that this is not a complete list, but intended merely as an example to illustrate additional possibilities to those already listed in the city's tree planting guidelines.

If trees are to be prescribed for sensitive clay conditions, what are the criteria for this selection? How are these criteria measured? Even for unmodified problematic soils, there should be a bigger list of acceptable tree species for planting, and a gradient of soils to which these apply. We offer the following examples of some trees and large shrubs (with average heights attained at maturity, which is typically more than 50 years) which may be used in their tree-form that tolerate poor drainage, clay, drought and salt to different extents:

Cedar [*Thuja occidentalis* or *orientalis*]: provides a screen, thrives in wet clay soil. 40' / 12 m (without pruning)

River birch [*Betula nigra*]: fast-growing, tolerates salt and poor drainage. . 40' / 12 m

Buckeye [*Aesculus glabra*]: can handle salt, poor drainage, drought. 25' / 7.5 m

Catalpa [*Catalpa speciosa*]: tolerates salt, poor drainage, drought. 60' / 18 m

Black cherry, or choke or pin cherry [*Prunus serotina, P. virginiana, P. pensylvanica*]: tolerates clay soils and drought, although sensitive to salt and poor drainage. 60' / 18 m, 25' / 7.5 m, 25' / 7.5 m

Eastern wahoo [*Euonymus atropurpureus*]: tolerates drought and poor clay soils; shade tolerant. 20' / 6 m

Tamarisk, salt cedar [*Tamarix sp.*]: very tolerant of salt, drought and clay soils. 25' / 7.5 m

Red elder [*Sambucus racemosa*]: tolerates moist heavy clay soils. 20' / 6 m

Hazelnut [*Corylus avellana*]: tolerates drought and poor heavy clay soils. 20' / 6 m

Smoketree [*Cotinus sp.*]: tolerates moderate drought and heavy clay soils. 25' / 7.5 m

Wayfaring tree [*Viburnum lantana*]: tolerates heavy clay soils, shade tolerant, however not drought tolerant when planted in full sun. 10' / 3 m

Witchhazel [*Hamamelis virginiana*]: tolerates heavy clay soils, shade tolerant, however not drought tolerant when planted in full sun. 15' / 4.5 m

Smooth sumac [*Rhus glabra*]: tolerates poor saline soils, moderately drought tolerant, and tolerates clay soils. 15' / 4.5 m

Kentucky coffee tree [*Gymnocladus dioicus*]: tolerates drought, poor drainage, clay and salt. 60' / 18 m

Ginkgo [*Gingko biloba*]: tolerates drought, poor drainage, clay soil, and salt. 60' / 18 m

Hackberry [*Celtis occidentalis*]: tolerates drought, poor drainage, clay soil, but not salt. 40' / 12 m

Bitternut hickory [*Carya cordiformis*]: can tolerate drought, poor drainage, clay soil, and salt. 60' / 18 m

Honey locust [*Gleditsia triacanthos var. inermis*]: tolerates drought, poor drainage, clay soil, and salt. 40' / 12 m

Red maple (*Acer rubrum*): tolerant of urban conditions, drought and poor drainage tolerant. 60' / 18 m

Freeman maple [*Acer saccharinum x Acer rubrum*]: tolerant of urban conditions, fast growth, less invasive roots than red maple. 60' / 18 m

Basswood, or linden [*Tilia americana or cordata*]: tolerates drought, poor drainage, clay soil, but not salt. 60' / 18 m

Bur oak [*Quercus macrocarpa*]: tolerates drought, poor drainage, clay soil and salt. 60' / 18 m

Pin oak [Quercus palustris]: tolerant of clay, salt and poor drainage. 0' / 18 m

Black walnut [*Juglans nigra*]: tolerant of salt, clay, poor drainage and drought. 60' / 18 m

Various columnar trees [*Pyrus, Malus, Quercus, Cupressus, Fagus, Chamaecyparis, Juniperus, Carpinus*]: limited roots, tolerant of poor drainage.

We further recommend that in extreme cases where trees are considered inadvisable under any conditions, a list of suitable shrubs and groundcovers be developed. The current standard of primarily using grass lawns leads to a lower water infiltration rate, increased evaporation of stored soil moisture, and lower water-interception rate than more suitable shrubs and groundcovers. These problems all contribute to the drying out of sensitive clay soils, in turn creating and exacerbating foundation issues. There is a need to be more proactive in developing landscapes that mitigate and prevent these potential problems, and that are better for people and the environment.

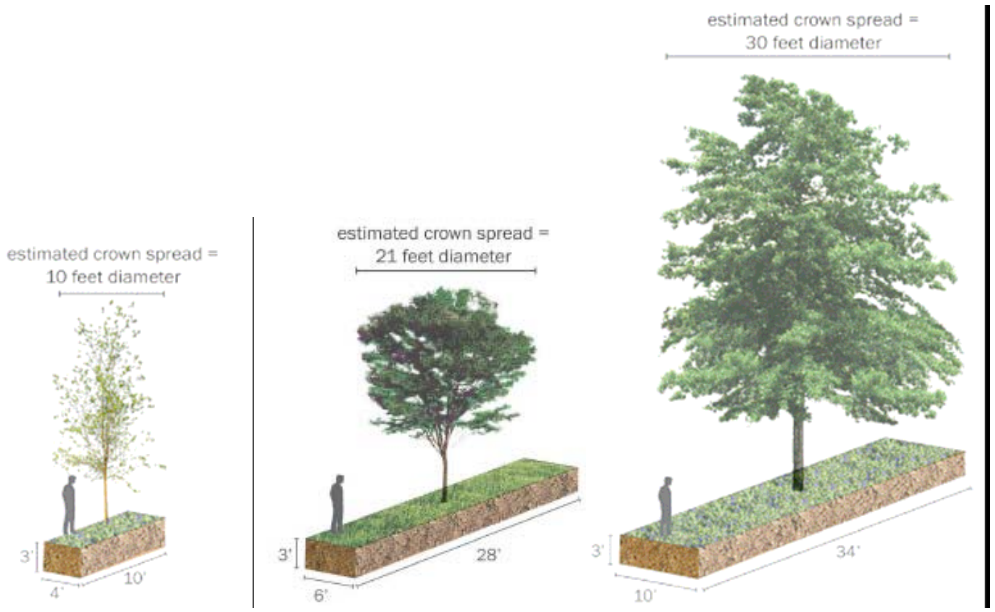
Planning and Space

Apart from the restrictions on species, the distance limits in the tree planting guidelines place prohibitive restrictions on the possible placement and potential number of trees that can be planted. It is estimated that tree planting in the affected streetscape areas, mostly new developments, will be reduced by 75% from normal planting regimens (pers. comm. Heather Martin, MLA, B.Sc (Env), ERPD, Landscape Architectural Intern, OALA). This is taking Ottawa in the opposite direction from that laid out in its planning documents (Greenspace Master Plan, Official Plan).

Some additional examples of concerns in the tree planting guidelines which have a severely limiting effect on the ability to plant or maintain street trees include the following:

- The 4.5 m distance from any private walkway or driveway for conifers is excessive for some types such as columnar-shaped trees or hybrids;
- A 7 m distance for planting a new tree near an existing one also seems excessive, considering someone may want to plant a tree in advance of the death and/or removal of an existing tree so it can get a 'head start';
- Large-sized trees under Hydro lines – while there are obvious risks of conflict, through proper and judicious pruning, trees and Hydro lines should have few conflicts where managed properly *(Please note: The Hydro Ottawa "Tree Planting Advice" guidelines are also currently overly restrictive and need to be reevaluated and revised)*;
- Minimum spacing of 3m between two existing driveways – this doesn't appear to have anything at all to do with trees and should be removed from the tree planting guidelines; and,

- In the guidelines, the wording 'wherever possible' is used in reference to a minimum grass or open earth area of 9m^2 and an acceptable soil depth of 1m and quality soil (no sensitive marine clay). This needs to be changed to a minimum requirement to allow for larger tree canopies to develop as demonstrated in the figures below[7].



Soil Volume = 3.3 m^2 | Soil Volume = 14 m^2 | Soil Volume = 28 m^2

Minimum Soil Volume requirements based on Tree Canopy Diameter. From "Tree Space Design" produced by Casey Trees, in Washington D.C.

An interesting trial (http://actrees.org/files/Newsroom/lgc_ucf.pdf) in Seattle replaced paved street edges with tree-planted vegetated areas to keep stormwater from being channeled directly into local waterways. Runoff was reduced by 98% over a two-block wide area over the first two years, with a similar reduction in pollutants. Natural drainage was 25% cheaper to build, and the effectiveness increased as the trees and plants grew and, an added bonus, the increased soil moisture results in less drying of clay soils. Other approaches have been discussed by Urban[8] and others.

[7] From Tree Space Design: Growing the Tree out of the Box, Casey Trees, Washington, D.C., USA. 2008 found at http://www.caseytrees.org/planning/design-resources/for-designers/tree-space/documents/TreeSpaceDesignReport.pdf

[8] Up by Roots, 2008. James Urban.

Soil Factors The sensitive marine clay conditions around much of Ottawa have been identified as the trigger for the tree planting guideline restrictions. These soil conditions are not necessarily homogeneous or unchangeable, but they have been known to be problematic in a number of ways related to trees and buildings.

Part of the problem in sensitive clay soils is the tendency for trees to remove water from the soil, causing shrinkage adjacent to and underneath nearby structures. It should be noted that trees are not always the only, or even the primary factor in damage to structures; in some cases, the structures are poorly designed or built. How many damaged structures in Ottawa have been reported? How many of these are main buildings (as opposed to porches or add-ons)? How many can be conclusively shown to be the direct result of tree root damage?

It should also be noted that certain types of structures are more sensitive to building movement problems, whatever the cause, including the drying out of sensitive clay soils. Brittle building materials are more susceptible to cracking, and heavy or poorly-built porches are more likely to show signs of distress. This is an aspect that should be addressed in requirements for building and construction permits. Covering front lawns with impermeable surfaces can also lead to drying problems. Often trees are incorrectly blamed for these problems and part of the chosen solution is the current restrictive tree species planting guidelines. However, other aspects of the situation need to be addressed.

Another part of the problem stems from the poor growing conditions in the typically over-compacted, structure-less clay soils found on development sites. If unmodified or over-compacted, the soil may not drain enough to allow the trees to grow; or the groundwater table may be lowered through dewatering and site loading with fill, or due to other site alterations. Many trees die because of these inhospitable and poor growing conditions. Also, the volume of soil may not be adequate in confined locations, and needs to be large enough to allow the tree to grow and remain healthy (an excellent resource on this can be found at http://www.caseytrees.org/planning/design-resources/for-designers/tree-space/documents/TreeSpaceDesignReport.pdf).

Soil Identification The designer/builder must find out what kind of soils he is dealing with at the site, including the infiltration rate and moisture storage capacity. How much sensitive clay presence is required before the site is so designated? How are sensitive clays differentiated from "mixed" soil conditions? Which tests are used (e.g., trial pits, control boreholes, soil moisture content, soil suction, liquid limit test, plastic limit test, soil plasticity, assessment of desiccation, shear strength tests)? What guidelines are provided for this classification? Is there a gradient to which the approved species are recommended?

Soil Modification

If, however, the soil around the tree is modified and adequate for its growth, both parts of the problem may be addressed to some extent. The tree grows, and adjacent structures remain intact. Also, there is a much larger list of trees for selection.

How much and what type of soil modification is required? That depends on the size of the mature tree and the proximity to structures, as well as the nature of the existing soil on the site. We would like to see some guidelines that address this issue in more detail.

Maintenance

It may be prudent to adopt a policy of periodic pruning and selective removal in areas that are deemed to be particularly susceptible to building movement or other root-related issues. Pruning will limit the growth and effects of the tree roots, as well as the canopy. This has been an effective way of mitigating damage and responding to concerns in specific cases. As well, if city trees are well watered they will be less prone to becoming foundation problems.

Engineering Solutions

There are several other possible options for accommodating trees in problem soils. Examples include using a Vermeer trencher to trench down the area where a sidewalk would be built from tree to tree, then installing a drain board and filling it with top soil and building the sidewalk over the top. Tree pits can be used above trenches (1.5 by 2.5m pits). Depending on the depth and width of the trench, this can provide significant non-sensitive rooting space.

Vermeer trencher. (from the Vermeer Rocks Website)

As well, allowing site drainage to infiltrate on-site soils will counteract the shrinkage caused by soils drying out. This can be accomplished through proper site design and grading, and increasing the moisture storage of soils through soil de-compaction and amendments. A modified approach to house construction may be possible through proper planning and a change in standard practices. For example, the developer/construction crew could ensure that fill soil is only compacted in areas required for heavy equipment approaches and for foundations (to a distance half the depth of the foundation - not the entire site). Continued heavy equipment access routes could be restricted to the location of the future driveways and roads.

The use of "structural soils" may also reduce impacts on adjacent structures.

Structural Soils (from "Tree Space Design" produced by Casey Trees, in Washington D.C.)

It is recognized that tree roots tend to develop in areas of soil that are less compacted and with a good supply of moisture and oxygen, and there are some concerns about roots growing in and around drains or service lines.

A vertical barrier is sometimes used beside or around the trench. Likewise, flexible vertical barriers can be used next to buildings, potentially reducing shrinkage stress on foundations. The barriers need to be flexible, because water and/or top soil will percolate around the face of a rigid root barrier allowing roots to eventually go underneath. Where a flexible root barrier is used to bisect existing underground services it can be cut and effectively resealed to fit around these services.

Commercial below-ground tree grids (e.g., Silvacells) are another option.

Silvacells (from the Built Green Canada Website)

Finally, the design and construction of new foundations has to be such that they can withstand more than minor droughts, and with the expectation that trees and other vegetation will be on the property within 3 m of the foundation. Some of these solutions can be found in the "*Foundations in Expansive Soils*" Technical Manual published by the United States Army in 1983 found at http://www.geotechnicalinfo.com/usace_foundations_in_expansive_soils.pdf.