Model Landscape Ordinance for a Municipal Zoning Code

Prepared by J. Michael Orange[1] for the GreenStep Cities Program, 4/1/17

Introduction

The following model ordinance focuses on the landscape requirements in a city's zoning ordinance that will regulate the review process for new developments.[2] City ordinances that incorporate state-of-the-art best practices improve the development review process. The City of Burnsville's zoning ordinance served as the primary base document for this model landscape ordinance to which information from several city ordinances were adapted and added.

The model ordinance strives to strike a balance between specificity and flexibility. Developers want clear rules. They want to know that everyone will get the same fair treatment and they are experts at building economically successful projects no matter whether they are at the low end or the high end of the quality spectrum. Since a city's code sets the minimum standards, more progressive standards will steer a project towards the higher quality end of what's economically feasible. Developers need to complete projects efficiently and earn a relatively quick return on their investment so that they can invest in another project. Without a state-of-the-art code, staff people, elected officials, or citizens concerned with the long-term health of the city might encourage higher quality (e.g. "greener," more sustainable development), but a developer can effectively argue it down to the minimum required to satisfy their demand for a short-term investment return. Also, a strong code makes the responsibilities of decision-making and enforcement much easier for city staff, planning commissioners, and elected officials. Being able to decisively tell a developer "it's the law" is a powerful enforcement tool.

Ordinances are, by design, difficult to change. Their clarity, relative permanence, and stability can generate investment confidence for developers and preserve existing property values. On the other hand, best management practices change as science evolves and circumstances vary, especially in response to the changing climate. Cities also need to accommodate unique site conditions and creative landscape designs not anticipated at the time of code adoption. It is not good policy to burden a city code with myriad detailed technicalities that may become obsolete and require periodic updating through the cumbersome code revision process. Rather, it is recommended that the city develop a separate document that includes a comprehensive compilation of best practices, technical requirements, etc. The working title for this document is the *Anycity Landscape Policy Guide* and a suggested version is included herein after the model ordinance. A city can easily keep this document up-to-date and posted on its website as a one-stop portal of important information for all of the actors in the development review process.

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[2] The Minnesota Municipal Planning Act grants the authority to cities to regulate land use. Cities within the seven-county metro area regulate land use through three basic tools—the comprehensive plan, the zoning ordinance, and the subdivision ordinance; and the latter two tools must be consistent with the comprehensive plan and implement its adopted policies. Stormwater management ordinances also play an important role in land developments.

Landscape Requirements

Intent: The purpose of these regulations is to implement orderly business development and the environmental goals from the Comprehensive Plan; to conserve higher quality existing site features during planning and construction; promote biodiversity and preserve the natural richness of the site; restore natural areas damaged by construction so the site can sustain its water, soil, and plant cover functions; and prevent construction and other developmental impacts from damaging off-site natural resources. General requirements shall apply to all zoning districts and include the following:

1. GENERAL LANDSCAPE REQUIREMENTS

A. Landscape Plan: When applicable and as a part of a project's permit review process, a landscape plan shall be submitted to the city providing all information required in the *Anycity Landscape Policy Guide*. The city shall base its permit decisions regarding the matters addressed in the landscape plan on the best practices described in the *Anycity Landscape Policy Guide*.

B. Areas Disturbed By Grading, Other Construction Activities, and Permanent Changes to the Site:

1. When a landscape plan is required for a development, it shall include the following information as regards on-and-off-site trees that may be affected by construction activities and permanent changes to the site:
   a. The location and species of on-site and off-site trees having a trunk diameter of at least 8 inches measured at breast height (diameter at breast height or *DBH*) that have any part of its tree root protection zone (as defined in the *Anycity Landscape Policy Guide*) within the subject site.
   b. The determination by a certified arborist whether the subject trees are classified as "Significant," "Desirable," or "Undesirable," based on generally acceptable arboriculture standards and as described in the *Anycity Landscape Policy Guide*.
   c. Demonstration that no land-disturbing activities or permanent changes to the site will have a deleterious effect upon the tree root protection zones of either on-site or off-site trees categorized as "Significant" or "Desirable."
2. All areas disturbed by grading that are not built upon, paved, or retained as a natural area shall contain sod, be seeded, or defined as a landscape planting bed with approved vegetation, ground covers, shrubbery and trees with a mulch cover, unless specifically approved as part of the overall landscape plan.
3. A minimum of 75% of total vegetated area on the site shall be native to the local area. In addition, a minimum of 75% of all trees and shrubs, by quantity, are to be native material. Native is defined as naturally growing within a 200-mile radius of the site. The removal of existing, non-invasive vegetation is not required in order to achieve this threshold.[3]

[3] Cities may choose to modify this language to accommodate the evolving practice of "managed relocation" or "assisted migration," which involves the intentional movement of flora and fauna into new areas where they are expected to thrive in response to climate change.

4. Maintain or supplement the tree trunk area of the site so that there is no net loss of tree trunk area (square inches) at diameter at breast height (4.5 ft.). The calculation of pre-project tree trunk area may disregard existing trees less than 8 inches in diameter. Replaced tree trunk area may include trees of any diameter.

C. Prohibited Species: Prohibited species that shall not be planted within the city are identified in the *Anycity Landscape Policy Guide*.

D. Compliance: If the applicant and the city manager cannot agree on the proposed landscaping design, the applicant shall be required to make an application for a conditional use permit to prove compatibility.

E. Alternative compliance: The city manager may approve or recommend the city approve the substitution or reduction of landscaped plant materials, landscaped area, or other landscaping or screening standards upon finding any of the following:

1. The alternative meets the intent of this chapter and the site plan is similar in form, scale, and materials to existing features of the site and to surrounding development, and it includes amenities or improvements that address any adverse effects of the alternative. Site amenities may include but are not limited to additional open space, additional landscaping and screening, green roof, decorative or pervious pavers, state-of-the art stormwater management as described in the *Anycity Landscape Policy Guide*, ornamental metal fencing, architectural enhancements, transit facilities, bicycle facilities, preservation of natural features, restoration of previously damaged natural environment, and rehabilitation of existing structures and places that have been locally designated or have been determined to be eligible for local designation as having historic significance.
2. Strict adherence to the requirements is impractical because of site location or conditions and the proposed alternative meets the intent of this chapter.
3. Existing plant materials, walls, fences or the topography of the site and its surroundings make the required landscaping or screening less necessary.
4. The required landscaping or screening will hinder truck access and service necessary to the operation of the use.
5. The required landscaping and screening may obstruct views of traffic or reduce natural surveillance of the site.[4]

F. Alternative Landscape Options: The city encourages the use of special design features such as Xeriscaping, rain gardens/bio-retention systems, landscaping with native species, green rooftops, heat island reduction, and aesthetic design. All site development and redevelopment projects must include two (2) of the following alternative landscape options:

1. Xeriscaping: Xeriscaping is landscaping that uses plants that have low water requirements that make them able to withstand extended periods of drought.
2. Rain Gardens/Bio-retention Systems: Bio-retention systems are shallow, landscaped depressions commonly located in parking lot islands or within areas that receive stormwater runoff. For credit under this section, the rain garden/bio-retention system shall be aboveground and a visible part of the green or landscaped area. Stormwater flows into

[4] Refer to the Crime Prevention Through Environmental Design (CPTED) principles in the *Anycity Landscape Policy Guide*.

the bio-retention area, ponds on the surface, and gradually infiltrates into the soil bed. Pollutants are removed by a number of processes including absorption, filtration, volatilization, ion exchange, and decomposition. Filtered runoff can either be allowed to infiltrate into the surrounding soil (functioning as an infiltration basin or rainwater garden), or discharged to the storm sewer or directly to receiving waters (functioning like a surface filter). The use of under-drain systems is discouraged unless where infiltration is prohibited by the water resources management plan.

3. Lake-scaping to preserve or restore the natural buffer along a shoreline: The buffer shall be at least thirty feet (30') wide and be planted with grasses and species of plants included in the *Anycity Landscape Policy Guide*.
4. Green Rooftops: Green rooftops are veneers of living vegetation installed atop buildings, from small garages to large industrial structures. Green rooftops help manage stormwater by mimicking a variety of hydrologic processes normally associated with open space. Plants capture rainwater on their foliage and absorb it in their root zone, encouraging evapotranspiration and preventing much stormwater from ever entering runoff streams. What water does leave the roof is slowed and kept cooler, a benefit for downstream water bodies. Green roofs are especially effective in controlling intense, short duration storms and have been shown to reduce cumulative annual runoff by fifty percent (50%) in temperate climates.
5. Aesthetic Design: Sites shall be designed to include three (3) of the following: public art, fountains, plazas, perennial beds, entrance landscaping and walls or fences, or other amenities reviewed and approved by the city.

G. ***Anycity Landscape Policy Guide*****:** The city shall develop a document to be maintained by the city manager that will serve as a policy guide and a complement to the landscape regulations in the City Code. It shall describe best practices regarding all matters pertinent to permit decisions regarding landscaping including (but not limited to) technical requirements regarding the following:

1. Protection of trees and soils
2. Stormwater management and erosion control
3. Sun and wind orientation
4. Submission requirements for land use permits
5. Acceptable and unacceptable plants
6. Plant diversity definitions and goals
7. Crime Prevention Through Environmental Design
8. Contractor licensing requirements

2. LANDSCAPING REQUIREMENTS IN RESIDENTIAL DISTRICTS

A. Low-density Residential Districts:

1. Required Landscaping:
   a. All front yards, boulevards, and side yards to the rear of the structure shall have sod, hydroseeding, or landscaping with mulch cover properly installed within sixty (60) days, weather permitting, after the home is constructed upon the lot, but no later than one hundred eighty (180) days after issuance of a building permit. During winter conditions, when plants cannot be installed due to weather, the city will issue a

temporary certificate of occupancy and specify a date for landscaping to be installed during the growing season.

b. Silt fences shall be installed and maintained.

c. Each lot shall have not less than one overstory tree for each 500 square feet of lot area or fraction thereof not occupied by buildings. At minimum, two (2) trees per lot shall be installed, in the front yard and side yard if facing a street, concurrently with sodding requirements.

d. The lot shall have, at minimum, one overstory tree and either one ornamental tree or evergreen tree. The lot may have two (2) overstory trees as long as they are not identical species. This provision may be waived if existing trees meet the requirements of this subsection and are shown on the certificate of survey.

e. All trees shall be planted on private property at least five feet (5') from the property line unless the city manager approves an alternative spacing.

B. Medium Density and High Density Residential:

1. At least fifty percent (50%) of the total site area shall be landscaped. For the purpose of this subsection, landscaping may also include prairies, wetlands, woodlands, ponds, pervious outdoor play areas, outdoor recreational courts, and outdoor swimming and wading pools.
2. All maintained landscaped areas shall have in-ground irrigation systems consistent with the specifications in the *Anycity Landscape Policy Guide* unless the city manager approves an alternative method.

3. LANDSCAPING REQUIREMENTS IN MULTIPLE-FAMILY RESIDENTIAL, BUSINESS, MIXED USE, AND INDUSTRIAL DISTRICTS

A. General Requirements: General requirements that shall apply in all multiple-family residential, business, mixed use, and industrial districts include the following:

1. Minimum Tree and Shrub Requirements: The landscape plan shall, at a minimum, provide at least the following required numbers of trees and shrubs. The shrub requirement shall be in addition to any shrubs required for screening in subsections A.4 and B of this section:
   a. Two overstory trees per three thousand (3,000) square feet of the site not occupied by buildings.
   b. One ornamental tree per one thousand five hundred (1,500) square feet of the site not occupied by buildings.
   c. Two evergreen trees per three thousand (3,000) square feet of the site not occupied by buildings.
   d. One deciduous or evergreen shrub per one hundred (100) square feet of the site not occupied by buildings.
   e. A minimum of two (2) cubic feet of uncompacted, biologically healthy soil that allows healthy tree root growth shall be provided per one square foot of mature tree canopy.
   f. Since construction activities can make soil unable to support trees, the above tree root volume requirement must be satisfied with undisturbed soils.
2. Building Perimeter Landscaping: At least fifty percent (50%) of the total building perimeter shall be sodded or landscaped with approved ground cover, shrubbery, and trees in an area of no less than six feet (6') in width.

3. Heat-Island Reduction: To minimize impact on microclimate and on human and wildlife habitat, shading of parking lots is required. At least two overstory trees shall be planted for every five (5) parking stalls on site. To satisfy this requirement trees must be located at least four feet (4') and within ten feet (10') of a curb adjacent to any internal parking or drive area. Said trees shall count toward meeting the overall site green space and landscaping requirements identified by this chapter for the underlying zoning district.
4. Buffer Yards:
   a. Buffer Yard Location: Where any business, institutional, or industrial use (i.e., structure, parking, or storage) abuts a residential zone or use, such business or industry shall provide a buffer yard and screening along the boundary of the residential property. The buffer area and screening shall also be provided where a business, institution, or industry is across the street from a residential zone or use, but not on that side of a business, institution, or industry considered to be the front as defined by the city.
   b. Buffer Yard Design: Except in areas of steep slopes or where natural vegetation is acceptable, as approved by the city manager, buffer yards shall contain a combination of earth berms, plantings, or privacy fencing of a sufficient density to provide a minimum visual screen and a reasonable buffer to the following heights:
      (1) Plantings: All designated buffer yards must be seeded or sodded except in areas of steep slopes where natural vegetation is acceptable as approved by the city manager. All plantings within designated buffer yards shall adhere to the following:
         (a) Planting screens shall be fully irrigated, consist of healthy, hardy plants, at least six feet (6') in height and designed to provide a minimum year round opaqueness of eighty percent (80%) at the time of installation whenever screening or buffering is required.
         (b) Plant material centers shall not be located closer than five feet (5') from the fence line and property line, and shall not conflict with public plantings, sidewalks, trails, etc.
         (c) Landscape screen plant material shall be in two (2) or more rows. Plantings shall be staggered in rows unless otherwise approved by the city.
         (d) Shrubs shall be arranged to lessen the visual gaps between trees. Along arterial streets, all plantings of deciduous trees shall be supplemented with shrubs such that the buffer yard contains a continuous band of plants.
         (e) Deciduous shrubs shall not be planted more than four feet (4') on center, and/or evergreen shrubs shall not be planted more than three feet (3') on center.
         (f) Where parking or loading areas front on a public street or path, there shall be at least one canopy tree per 25 linear feet or fraction thereof of frontage. Deciduous trees intended for screening shall be planted not more than forty feet (40') apart. Evergreen trees intended for screening shall be planted not more than fifteen feet (15') apart.
      (2) Walls And Fences: All walls and fences erected within designated buffer yards shall meet the following conditions:
         (a) A screening fence or wall shall be constructed of attractive, permanent finished materials compatible with those used in construction of the permanent structure. Such screens shall be at least six feet (6') in height and provide a minimum opaqueness of eighty percent (80%).

(b) Fences may be exposed no more than a maximum length of twenty feet (20') between landscaping areas or clusters.

(c) For interior lots, a gate constructed of the same material as the fence shall be provided in the wall or fence to allow for maintenance of the street side boulevard.

(d) Fences and landscaping shall not be located within the traffic sight visibility (as defined by the National Association of City Transportation Officials or an approved equivalent).

(3) Earth Berms: Earth berms shall adhere to the following:

(a) Except in areas of steep slopes or where other topographic features or physical characteristics will not permit, as determined by the city engineer, an earth berm shall be installed in all designated buffer yards in accordance with the following requirements:

i. Berms shall be a minimum of four feet (4') in height.

ii. The slope of the earth berm shall not exceed a three to one (3:1) slope unless approved by the city engineer.

iii. The earth berm shall contain no less than four inches (4") of topsoil.

B. Parking Lot Landscaping Requirements: The following shall apply to all new development and redevelopment of parking lots for expansions creating five thousand (5,000) square feet or more of impervious surface or disturbance of one-half ($^1/_2$) acre or more of land.

1. Parking Lot Screening: Parking lot screening shall be designed to reduce the visual impact of surface parking lots; mitigate glare from headlights; improve the aesthetic quality of the area for users of the site, adjacent sites, roadways, and sidewalks; and define the perimeter of the parking lot as follows:

a. Off Street Parking Containing Six Or More Parking Spaces: Parking lot screening must be provided between those portions of an off street parking area containing six (6) or more parking spaces and a different zoning district or a public street.

c. Parking Lot Screening Standards:

(1) Parking lot screening must be provided within ten feet (10') of the perimeter of the parking lot to be screened, except for parking lots adjacent to rain gardens/bio-retention systems, other landscape features, or where screening may impact the traffic sight visibility triangle (as defined by the National Association of City Transportation Officials or an approved equivalent).

(2) Parking lot screening shall be not less than eighty percent (80%) opaque and be a minimum of three feet (3') and a maximum of four feet (4') in height as measured from the adjacent finished surface of the parking area. When shrubs are used to provide the screen, such shrubs must be at least two feet (2') tall at planting and anticipated to grow to at least three feet (3') tall at maturity.

(3) No landscaping or screening shall interfere with driver or pedestrian visibility for vehicles entering or exiting the premises.

(4) Screening for a parking lot may be comprised of one hundred percent (100%) evergreen planting materials.

d. Content: Parking lot screening must consist of at least two (2) of the following:

(1) A compact hedge of evergreen or densely twigged deciduous shrubs spaced to ensure closure into a solid hedge at maturity.
(2) A berm with plantings as described above.
(3) Transit shelters, benches, bicycle racks, and similar features may be integrated as a part of the screen.
(4) Fencing may be integrated as part of the screen. All wood fencing shall be stained and sealed with a weatherproof product.

2. Parking Island Design: Off street parking areas with at least twenty-five (25) parking stalls shall contain interior landscaped islands. Such islands shall be bounded by a raised concrete curb, pervious curbing, or an approved equivalent, and shall contain mulch (as prescribed by the *Anycity Landscape Policy Guide*) to retain soil moisture. This provision shall not apply to parking structures. The standards for landscape islands are as follows:
   a. Landscape parking lot islands shall be required at the beginning and end of each parking row and shall contain a minimum of one hundred eighty (180) square feet and a minimum width of nine feet (9').
   b. A minimum of one overstory tree shall be provided for each island with soil volumes as prescribed in sections 3.a.1.e. and f. The design shall inhibit damage to the tree root protection zone as defined by the *Anycity Landscape Policy Guide*.
   c. Shrubs, perennials or ornamental grass shall be incorporated in each landscaped island that does not contain a tree.
   d. Islands shall be prepared with healthy topsoil to a depth of two feet (2') and improved to ensure adequate drainage, nutrient, and moisture retention levels for the establishment of plantings.
   e. All perimeter and interior landscaped areas in parking lots shall be equipped with a permanent irrigation system, unless drought tolerant plant materials are used exclusively. Where drought tolerant plant materials are used, irrigation shall be required only for the two (2) year period following plant installation and may be accomplished using hoses, water trucks, or other nonpermanent means.
3. Orientation: Where practical, tree plantings shall be grouped and oriented in response to the sun and wind consistent with the requirements in the *Anycity Landscape Policy Guide*.

Anycity Landscape Policy Guide

Introduction

Ordinances versus guidelines: Ordinances are, by design, difficult to change. Their clarity, relative permanence, and stability can generate investment confidence for developers and preserve existing property values. On the other hand, best management practices for landscaping must respond to unique site conditions and creative landscape designs and they must change as arboriculture science evolves and circumstances vary, especially in response to the changing climate. Rather than burden the Landscape Regulations in the Zoning Code with myriad detailed technicalities that may require periodic updating through the cumbersome code revision process, this *Anycity Landscape Policy Guide* includes a comprehensive compilation of best practices and technical requirements. It is intended to serve as a one-stop portal of important information for all of the actors in the development review process.

The City Code authorizes the city manager to develop the *Anycity Landscape Policy Guide*, keep it up-to-date, and use it to make permit decisions. It will serve in a quasi-judicial role and have a similar (but not identical) degree of authority as a regulation contained in the City Code. The city manager, Planning Commission, City Council, and other city officials will use the provisions in this guide as the legal bases for making decisions affecting a variety of permits and approvals.

Grey and green infrastructure: Everybody loves trees. We love how they beautify our yards, define our streets, shade our parks and trails, and provide aesthetic relief to our bleak parking lots. However, few people fully appreciate what it takes to develop and maintain an urban forest and the full spectrum of benefits such forests provide. Many urban disciplines also undervalue the urban forest; fostering the notion that grey public infrastructure (e.g. streets, sewers, sidewalks, and conduit) is significantly more important than green infrastructure (e.g. soils, plants, air, and water).

Cities should treat its green infrastructure on a par with its grey. While cities have legal and financial institutions, policies, plans, and best practices in place to ensure that public grey infrastructure performs as intended over the expected life of a particular system, similar safeguards are lacking when it comes to green infrastructure. If a city hired a private company to build a road designed to last twenty years and it started to fall apart after ten, the city could hold the company responsible for necessary repairs. Similarly, cities should ensure that development does not adversely affect green infrastructure. For example, zoning codes include specific landscape requirements for developments, but cities may not have prioritized their resources to inspect the sites years later to make certain that plants and trees are still alive and stormwater systems function as designed.

Tree inventories offer an excellent example of how this *green=grey* principle should also apply to city operations. Inventories that document public tree location, species, condition, and maintenance history are as essential to managing the urban forest as similar inventories of public grey infrastructure. Also, public tree inventories need to be continually updated in order to retain their value and effectiveness.

The value of mature trees: While it is easy to appreciate the aesthetic value of trees and other landscape elements, the scientifically quantifiable environmental, economic, and health benefits are not usually as easy to grasp. However, when these quantifiable benefits of trees are weighed against their purchase, planting, pruning, protection, and removal costs, the benefits outweigh the costs by a margin of about 3 to 1. For example, studies show that:

- An average mature tree will provide about $170 in benefits annually.[5]
- The net cooling effect of an average, healthy tree is equivalent to 10 room-size air conditioners that operate 20 hours a day.[6]
- One acre of urban forest absorbs 6 tons of carbon dioxide and emits 4 tons of oxygen annually.[7]
- Street trees even help extend the life of expensive asphalt by 40-60% by reducing daily heating and cooling of roads.[8]
- Storm water interception by trees reduces the peak-flow and flooding during intense storms, thereby reducing the amounts of pollutants that are washed into our rivers and lakes. An average mature tree will intercept over 1,800 gallons of stormwater annually.
- Tree roots have a profound effect on the soil environment. They will direct 40-73% of assimilated carbon below ground.[9]

As experts have underscored, healthy urban trees mean healthier city residents. A recent analysis by the World Health Organization confirmed that air pollution is now the world's single largest environmental health risk.[10] A recent analysis prepared by U.S. Forest Service scientists and collaborators provides the first broad-scale estimate of how trees reduce air pollution, protect our health, and reduce health care costs. The article describing the analysis quoted Michael T. Rains, Director of the Forest Service's Northern Research Station and the Forest Products Laboratory: "With more than 80 percent of Americans living in urban area, this research underscores how truly essential urban forests are to people across the nation."[11] The Forest Service study estimated that in 2010, trees in the urban areas of Minnesota removed 4,600 tons of pollutants from the air and that this resulted in $26.7 million in reduced health care costs.[12]

The following diagram is from a study published in 2013 in the *Journal of Environmental Science and Technology*, which measured the impact of boulevard trees on indoor air quality. Researches found a greater than 50% drop in traffic-derived indoor particulate matter when trees separated streets and homes.[13]

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[5] Based on a 17-inch ash tree. Source: National Tree Benefits Calculator, http://www.treebenefits.com/calculator/

[6] http://www.arborday.org/trees/benefits.cfm

[7] Ibid.

[8] Source: "City to Consider Special Funding for Trees," City of Madison Wisconsin, 7/31/14, http://www.cityofmadison.com/news/city-to-consider-special-funding-for-trees

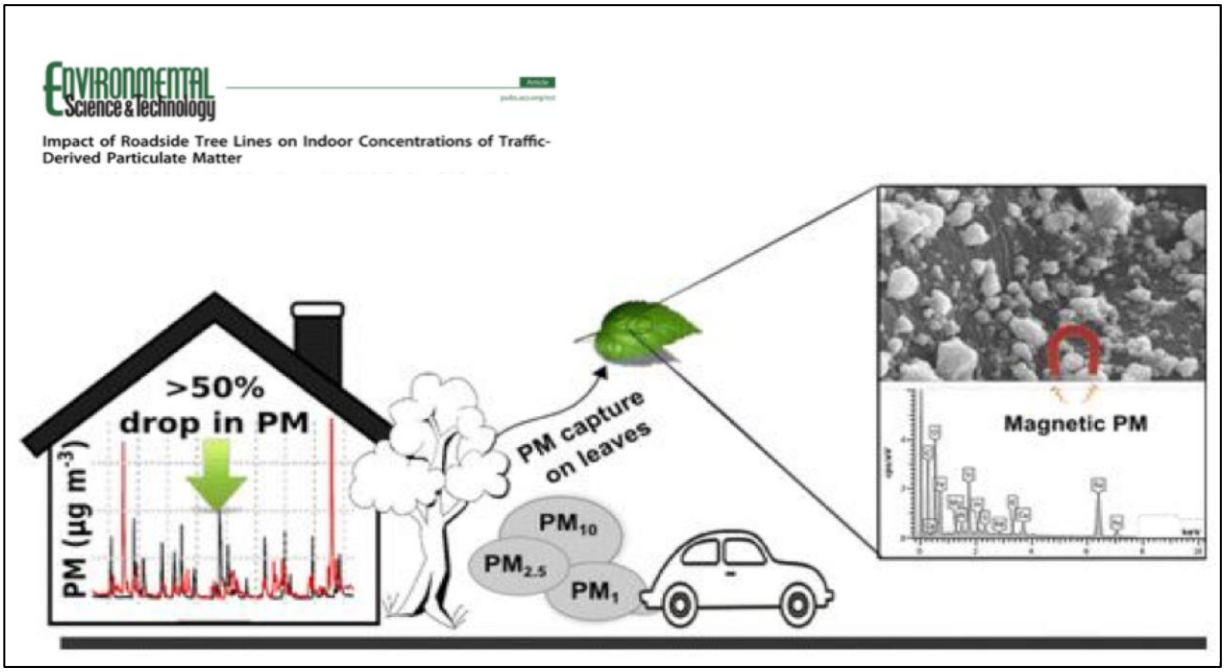
[9] Source: http://www.dailycamera.com/guest-opinions/ci_26131781/silent-environmental-devastation

[10] "7 million premature deaths annually linked to air pollution," World Health Organization press release, 3/25/14, www.who.int/mediacentre/news/releases/2014/air-pollution/en

[11] "Tree and forest effects on air quality and human health in the United States," Nowak, David, et al., *Environmental Pollution*, 7/25/14, http://www.nrs.fs.fed.us/pubs/46102

[12] The health impacts and their monetary values are based on the changes in NO_2, O_3, $PM_{2.5}$ and SO_2 concentrations using information from the U.S. EPA Environmental Benefits Mapping and Analysis Program model; http://www.epa.gov/air/benmap/.

[13] "Independently, the two approaches identify >50% reductions in measured [particulate matter] (PM) levels inside those houses screened by the temporary tree line. Electron microscopy analyses show that leaf-captured PM is



While the above studies quantify how trees benefit human health, another study demonstrates how tree deaths from the Emerald Ash Borer (EAB) infestation are associated with human deaths. An analysis by U.S. Forest Service scientists concluded that, "Poor air quality and stress are risk factors for [lower respiratory disease and cardiovascular disease], and trees can improve air quality and reduce stress. Their results showed that the spread of EAB across 15 states was associated with an additional 15,000 deaths from cardiovascular disease and an additional 6,000 deaths from lower respiratory disease."[14]

A key word in the above subheading refers to *mature* trees. Contrary to past assumptions, a recent study showed that the older the tree, the more quickly it grows. "Trees with trunks three feet in diameter generated three times as much biomass as trees that were only half as wide. … If we want to use forests as a weapon against climate change, then we must allow them to grow old…."[15]

The value of soils: There is a similar argument for preserving soils. Our soils are alive. They play key roles in the cycle of life and they are absolutely crucial to climate change and the hydrologic and carbon cycles. The structures of healthy soil rely on carbon, which is a key element of all living things. These soil structures are interspersed with small air pockets that absorb precipitation and snow melt. This is especially important in times of drought and

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concentrated in agglomerations around leaf hairs and within the leaf microtopography. … The efficacy of roadside trees for mitigation of PM health hazard might be seriously underestimated in some current atmospheric models." Source: http://pubs.acs.org/doi/abs/10.1021/es404363m

[14] "Exploring Connections Between Trees and Human Health," *Science Findings*, Pacific Northwest Research Station, U.S. Forest Service, Jan./Feb. 2014, http://www.fs.fed.us/pnw/sciencef/scifi158.pdf

[15] Wohlleben, Peter, *The Hidden Life of Trees: What The Feel, How They Communicate*; Greystone Books, 2015, pp. 97-98.

flooding.[16] Compaction destroys this stormwater management benefit and the ability to absorb carbon.

To stay fertile, soil needs a steady diet of carbon from organic matter and it needs protection from temperature extremes and erosion by keeping it covered.[17] Climate change reflects a human-caused disruption in the natural processes where carbon cycles through the environment as a liquid, solid, or gas. "Another way of looking at the problem is that too much of the carbon that was once in a solid phase in the soil is now a gas."[18] The Earth's soils store 2,500 billion tons of carbon—more carbon than the atmosphere (780 billion tons) and plants (560 billion tons) combined.[19]

Plant photosynthesis evolved to utilize atmospheric carbon dioxide and convert it into sugars. The waste product, oxygen, is, of course, essential for higher forms of life. Plant sugars produce the above ground growth we see such as leaves and stems, but plants release up to 40% of the captured carbon dioxide through its roots to feed soil microbes, which in turn assist the plant in acquiring nutrients.[20] As scientist, Peter Wohlleben writes, "There are more life forms in a handful of soil than people on the planet. A mere teaspoon contains many miles of fungal filaments. All of these work the soil, transform it, and make it so valuable for the trees."[21]

Do it right the first time: There are common misperceptions that there is little difference between soil and dirt, and between a mature tree and a new tree (even though it takes up to 3 decades for a new tree to provide benefits comparable to a mature tree). It is crucial during the development process to preserve as much as possible all healthy soils and mature trees. As for new trees, the National Arbor Day Foundation urges putting the "right tree in the right place."[22] Furthermore, it's much more efficient to do it right the first time. A fuller appreciation of the importance of our green infrastructure can lead to urban forests that deliver the substantial benefits that were the long-range hope of those who planted the saplings.

Best Practices and Technical Requirements

1. **Protection of trees and soils:** Mother Nature ignores property lines. The city's developmental controls (zoning, subdivision, and stormwater ordinances) must account for both on and off-site impacts. For example, construction activities like heavy

[16] "Soil and Carbon: Soil Solutions to Climate Problems," Diana Donlon, Center for Food Safety, 2015. Downloaded from: http://www.centerforfoodsafety.org/reports/3846/soil-and-carbon-soil-solutions-to-climate-problems#
[17] Grubinger, Vern. "Soil Microbiology: A Primer." University of Vermont Extension. University of Vermont, Nov. 2004. Web. 9 Apr. 2015.
[18] Jones, Christine. "SOS: Save Our Soils." Interview by Tracy Frisch. Acres USA Mar. 2015. Web. 9 Apr. 2015.
[19] Lal, Rattan. "Managing Soils and Ecosystems for Mitigating Anthropogenic Carbon Emissions and Advancing Global Food Security." *BioScience* 60.9 (2010): 708-21. Oxford Journals. Web. 9 Apr. 2015. 708.
[20] Dilkes, Nigel B., David L. Jones, and John Farrar. "Temporal Dynamics of Carbon Partitioning and Rhizodeposition in Wheat." Plant Physiology 134.2 (2004): 706–715. PMC. Web. 9 Apr. 2015.
[21] Wohlleben, Peter, *The Hidden Life of Trees*, p. 86.
[22] Source: https://www.arborday.org/trees/righttreeandplace/

equipment movements, materials storage, excavations, and changes to drainage can damage on and off-site trees and destroy living soils.

The Minnesota Department of Natural Resources, the Minnesota Pollution Control Agency, the Minnesota Tree Trust, and the University of Minnesota have developed comprehensive guides of best management practices for the protection of trees and soils in developments (MnDNR BMPs for developments, Minnesota Stormwater Manual, *City Trees: Sustainability Guidelines & Best Practices*, and "SULIS: Sustainable Urban Landscape Information Series" (http://www.extension.umn.edu/garden/landscaping/). Rather than replicate these best practices in this report, the city manager should apply the standards described in these websites and reports in the evaluation of developments as if they were incorporated in total in the zoning code. The alternative compliance provisions in the Model Landscape Ordinance provide sufficient flexibility to vary these more specific criteria where appropriate.

1.1. Tree Root Protection Zone: A tree's Root Protection Zone is defined as a circle on the ground defined by either a) the drip line of the tree or b) a radius that equals one foot for every inch of diameter at breast height (DBH). Damage to a tree's roots can be caused by any disturbance inside this zone including nearby trenching, paving, vehicular movements, materials storage, soil replacement, or altering drainage patterns.[23]

1.2. Process for designating the tree root protection zones of on-site and off-site trees: The following describes a two-stage process whereby city staff can determine if a development under review by the city is likely to have an effect on existing trees on the site and on adjacent properties, and on new trees proposed for the development.

1.2.1. Stage 1 screening procedure by city staff: The city will develop a simple and clear Tree Screening Procedure that can be used by the city's permit review staff to determine if a development under review is likely to have an effect on existing trees on the site and on adjacent properties, and on new trees proposed for the development. This Tree Screening Procedure will help the staff person estimate tree size and location relative to land disturbing activities and to define the preliminary tree root protection zone. The Tree Screening Procedure will incorporate relatively low thresholds to identify a project's potential threats to on and off-site trees, and it will guide the staff decision whether to require the developer to prepare a Tree Plan, which is part of the second stage of the landscape review process.

[23] The following article provides helpful information: https://www.cnu.org/publicsquare/2017/03/10/root-zone-tips-healthy-street-trees?utm_source=Public+Square&utm_campaign=676289d244-EMAIL_CAMPAIGN_2017_03_23&utm_medium=email&utm_term=0_a565e9d234-676289d244-36264433

1.2.2. Stage 2 Tree Plan review completed by arborist: If city staff determine a project has land disturbing activities within the staff-defined, preliminary root protection zone, staff should require the developer to submit a Tree Plan and to notify the property owners of adjacent sites with trees that may be adversely affected by the project. Similar to the landscape plan that is an integral part of the Site Plan Review process, the Tree Plan will identify the information critical to determining a project's potential risk to on and off-site trees including the species, measured trunk diameter, canopy size, and the tree's classification as young, mature, or over-mature. The city should employ the services of a certified arborist who will review the developer's Tree Plan, make on-site inspections, categorize specific trees as "Significant," "Desirable," or "Undesirable," delineate tree root protection zones, and identify potential hazards. The city's arborist may recommend possible alternative solutions such as the redesign of paved areas and excavations, alternative locations accessible for construction equipment and materials storage, the use of tunnel trenching and air spades, and modifications to the site contours and drainage plan.

1.2.3. Tree fund: In the event site constraints prohibit the reasonable protection of on-site or off-site Significant and Desirable trees, the city could establish a Tree Fund and require developers to pay the equivalent costs for the city to buy, plant, and maintain trees on public or private property in the same watershed as the site.

1.3. Mulch: Mulch must be placed around plants (or covering the ground in lieu of plants) to prevent the growth of weeds, reduce erosion and water loss, regulate soil temperature, and, upon decomposition, serve as a soil amendment. Rocks are not acceptable mulch and the use of weed mats are prohibited because they limit the ability of the mulch to amend the soil.

1.4. Perc Test: Developments that call for extensive grading or new planting areas may require per tests to determine if soil amendments will be needed.[24] Tests should be conducted prior to the start of development and post construction. The development permit could define a limit to the allowable percent change in the soil absorption rate. The percentage change could be based on the grey infrastructure capacity surrounding the site, or the requirement to keep all stormwater (including from more severe storms) on site.

2. Stormwater management and erosion control: Until the turn of the century, design and engineering professionals focused on moving every drop of water that fell or melted as quickly and efficiently to the Mississippi River as soon as possible. We now know the huge environmental damage that practice has caused, e.g. periodic flooding along much of the river's trip to the Gulf of Mexico and the creation of a "dead zone" there the size of

[24] A perc test evaluates how well soil absorbs liquid. They are typically required to get a permit to install a new septic system or a drainage system (like French drains) that is dependent on the soil absorption rate. Simple perc tests may also be used to determine what will grow well on a specific site.

New Jersey every year in the Mississippi River delta.[25] Over the last decade, civil engineers, architects, and city planners now face the opposite challenge, trying to treat 100% of the stormwater on site.

2.1. Best practices for stormwater management and erosion control: The Minnesota Pollution Control Agency (MPCA) has developed a report that describes best practices for stormwater management, "Protecting Water Quality in Urban Areas: Best Management Practices for Dealing with Storm Water Runoff from Urban, Suburban and Developing Areas of Minnesota," (https://www.pca.state.mn.us/water/stormwater-best-management-practices-manual). The report includes policy guides, not mandates, that can guide the city manager's review of the landscape plan for a development. The following are selected policies of the MPCA report that address parking lots, which are often the most critical part of a development's landscape plan:

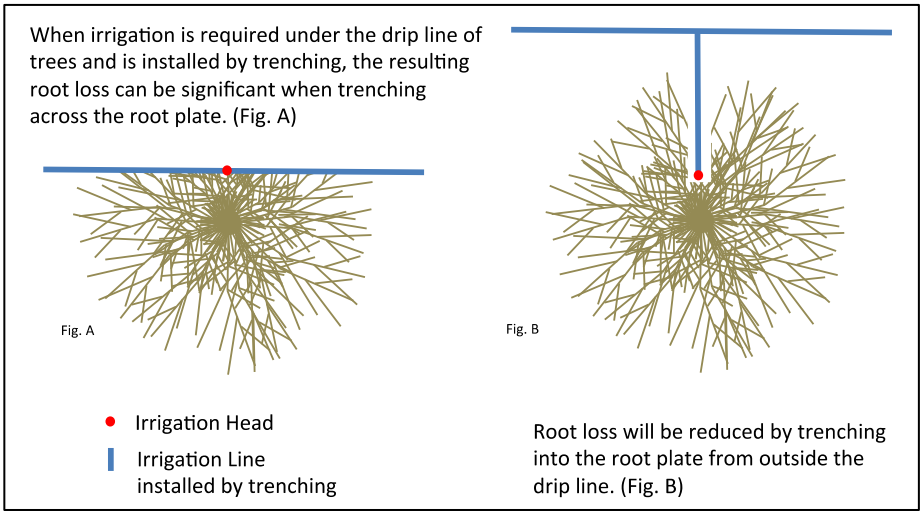
> 6. The required parking ratio governing a particular land use or activity should be enforced as both a maximum and a minimum in order to curb excess parking space construction. . . .
>
> 7. Parking codes should be revised to lower parking requirements where mass transit is available or enforceable shared parking arrangements are made.
>
> 8. Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes and using pervious materials in spillover parking areas. . . .
>
> 10. Wherever possible, provide stormwater treatment for parking lot runoff using bioretention areas, filter strips or other practices that can be integrated into required landscaping areas and traffic islands.

2.2. Tree islands and stormwater management: For trees in commercial areas, conventional tree islands (or "tree coffins" as they are often called) are designed for failure. Trees rarely last beyond 5 years and rarely grow of sufficient size to serve their primary purposes of providing environmental, economic, and health benefits, as well as shade and aesthetic relief from the view of vehicles. However, alternative methods exist. Structural soil (e.g. Cornell University structural soil) and Silva Cells allow trees to be planted almost anywhere because they allow tree roots to grow under paved areas without disrupting the pavement as they grow. Adequately sized and placed islands designed as rain gardens with structural soils can eliminate the need for stormwater ponds and allow long-lived, large canopy trees to thrive for 50+ years. Construction documents and specifications for a wide

[25] "Each year a swath of the Gulf of Mexico becomes so devoid of shrimp, fish, and other marine life that it is known as the dead zone." "Gulf of Mexico 'Dead Zone' Is Size of New Jersey," John Roach, National Geographic News, May 25, 2005.

range of soil cell applications can be found on the manufacturers' websites (Deeproot Green Infrastructure and Citygreen Systems).

2.3. Tree root irrigation: Installation design for the irrigation of established trees should allow for root protection as shown in the plan-view drawings in Fig. A and B below:



3. Summer sun and wind orientation: During the summer months when shade and cooling breezes are most important, the sun will cast lengthening shadows to the east during the late afternoon when parking demand will be the highest (peak retail time is after 5:30 pm). Since the predominant wind directions in Minnesota are generally from the south in July and August, a north-south orientation of tree islands and rain gardens offers the best shade for cars on the eastern sides while not blocking southern breezes.

4. Submission Requirements for Land Use Permits: The following outlines the primary components of an adequate landscape plan:

4.1. Who must submit a landscape plan: Landscape plans are required for applicants for development permits that involve land disturbing activities that may have an adverse impact on trees that might be classified as "Significant" or "Desirable." This means that those staff members who review permit requests must be aware of the two-stage Tree Screening Procedure described in Section 1 and that even the most basic site plans must include an inventory of on-site mature trees. City staff can also use the readily available satellite imagery to help them determine if a complete landscape plan is also warranted (refer to the resources listed in Section 9).

4.2. Components of a landscape plan submission: Landscape plan submissions must include at least the following information:

- Site survey showing current conditions including natural features and topography.

- Post-development natural features and topography.
- On-site shrubs and trees that are proposed or will be preserved: Type, size (diameter at breast height for trees), and overall amounts.
- Existing trees adjacent to the site with at least an 8-inch diameter at breast height located within 12 feet of on-site, land-disturbing activities: Type, size, and number.
- Areas of land disturbing activities during construction including excavations and trenching, grading and filling areas, material storage areas, and areas where vehicles and equipment will operate.
- Mitigating measures to minimize soil removal and compaction.
- Snow storage areas or propose a snow removal plan.
- Walls, screens, and fences (show location, type, opacity, and height).
- Fire hydrants, transit stops, public plazas, trash enclosures, trees in the public right-of-way (type and size).
- Directions of water drainage from the site and buildings (downspouts, roof drains, etc.).

5. **Acceptable and unacceptable plants:** In order to determine the acceptability of new plantings, the city shall utilize the information available on the website: "SULIS: Sustainable Urban Landscape Information Series (http://www.extension.umn.edu/garden/landscaping/). Cultivars may be used if they do not appear on the Minnesota Native Plant Society or University of Minnesota Extension Service "Invasive" or "Species of Concern" lists.

6. **Plant diversity definitions and goals:** The city shall utilize the 5-10-15 rule to increase species diversity in development projects. The rule suggests an urban tree population should include no more than 5% of any one species, 10% of any one genus, or 15% of any family. [26] The city manager shall determine how to apply the rule on a development site under consideration.

7. **Crime Prevention Through Environmental Design:** Landscape designs should take into account the principles of Crime Prevention Through Environmental Design (CPTED).[27] The principles include natural surveillance through "eyes on the street," natural access control (e.g. thorny bushes beneath first floor windows and no hidden access to upper story windows and balconies), and natural territorial reinforcement through the public/private access stages: Public (e.g. sidewalk), semi-public (e.g. alley, driveway, private sidewalk to front door), semi-private (e.g. front porch), and private (e.g. inside).

8. **Contractor licensing requirements:** (To be developed by each city)

[26] The general rule used to be 10-20-30 but it implies the acceptability of suffering the loss of 20% of our urban canopy since both of the commonly planted ash species are highly susceptible to the Emerald Ash Borer infestation.
[27] Useful summary of CPTED principles:
http://en.wikipedia.org/wiki/Crime_prevention_through_environmental_design

9. Additional resources:

- *Design Guidelines for 'Greening' Surface Parking Lots* (City of Toronto: 2013)
- *Green Parking Lot Resource Guide* (U.S. EPA: 2008)
- Free i-Tree canopy calculation using Google Maps at: https://landscape.itreetools.org
- Statewide LiDAR coverage at 3.3-foot horizontal resolution available from the MN Geospatial Information Office (MnGeo) at http://www.mngeo.state.mn.us
- The University of Minnesota's Remote Sensing and Geospatial Analysis Laboratory at http://land.umn.edu provides satellite imagery for land cover and impervious surface datasets for several time periods for the state of Minnesota, and for more time periods for the Twin Cities Metropolitan Area.
- The Global Land Cover Facility of the University of Maryland at http://www.landcover.org develops and distributes remotely sensed satellite data that includes forest inventories.