Why Trees Matter:

Illustrations:
Canopied Street

Trees are among the most vital assets to the City of Madison. Consider your neighborhood without them. They are a foundation for community and ecosystem health, sustainability and resilience. Our urban forest, which cover about one-quarter of the city landmass, aides in s t o r m w a t e r m a n a g e m e n t, protects our drinking water, reduces energy costs and stress, as well as creating a sense of place in communities. But it is not commonly understood, and even less acknowledged in our actions, that much like the "built environment", our trees require ongoing care and stewardship.

With the necessary care for our trees and the expansion of their number on public and private land, they can continue make a difference in enhancing people's lives, property and quality of life. The return on investment for community forests is demonstrably high, yet we often place higher priority on other assets. However, without adequate investment and the attention and assistance of public officials and our residents, many will fail and the urban forest will slowly be diminished.

The most important aspect of trees to individuals and the community cannot be meaningfully quantified by any standard metric such as dollars, degrees and gallons. In an attempt to express their unique character, poets write elegies to trees, not stoplights and sidewalks. Photographers and artists attempt to capture the magical essence of trees, not office buildings or divided highways.

Nonetheless, in an attempt to document the "value" of trees we will look beyond the inexpressible qualities of our urban forest and look at the critical elements that are measurable.

Stormwater: Trees reduce stormwater runoff by capturing and storing rainfall in their canopy and the soils supporting their roots. Roots and leaf litter create conditions that promote the absorption of rainwater into soil.
Trees slow down and temporarily store runoff and reduce pollutants by nutrients, pollutants and water through their routes.
It is estimated that our current forest of street trees and parks intercepts 115 million gallons of rainfall in a year. This is equivalent to the additional (flood) water pumped by the Sewerage District on August 21-22, 2018 during the historic record rainfall.
(Illustration of flooded Madison.)

Energy: Trees reduce energy use by lowering air temperature by shading surfaces and when they transpire water through leaves. Trees shade buildings and streets in the summer and block winds in the winter. The shading of streets in the summer by a healthy tree canopy lowers temperatures by 5-10 degrees, reducing the effects of a heat island in

our downtown and densely paved areas. Heat islands further warm the surrounding buildings and if the heat is extreme (above 90) it also makes walking or simply being outside uncomfortable. The reduction of energy use by the cooling effect of trees will help Madison achieve its goal of becoming carbon-neutral and save money on utility bills.

Reducing Carbon Dioxide: Trees remove carbon dioxide from the atmosphere and in the process return oxygen. Urban forests "clean the air" by intercepting small particulate matter and absorbing harmful gases on their leaf surfaces. It is estimated that our public urban forest removes 15,000 tons of carbon each year. That's the equivalent carbon output of 4-6,000 cars each year.

Illustration of shaded trees and unshaded parking lot

Madison residents value and care about the trees around their home and neighborhood. They know that "trees cool my home in the summer" and that "having trees in a neighborhood makes it a better place to live." They also know by experience or intuition that trees on either private land or public property can substantially increase property value.
(Focus Group Summary Madison, Wis. Residential Property Owner Trees and Urban Green Space Survey. Thostenson, Knoot and Huff. USDA Forest Service, 2016

The State of our Forest

The Different Components of the City "Forests": Amidst the approximately 17 sq. miles that constitute the entire canopy of Madison's trees there are distinctive groups that help us understand the forest in its entirety.

"Private" Trees: These are the trees owned and maintained on private property. It's the tree in your front or backyard, in the parking lot at work, a small ornamental tree on the side of building or the trees in the UW's Arboretum. Most of the trees in the city are on private property

"Public" Trees: These trees are owned and cared for by the City. There are two general groups of public trees, "street trees" and "park trees." Although street trees comprise only a small percentage of the overall city forest, they are the most visible and as a result, strongly define the character of a street, a neighborhood and indeed, the city as a whole.

Street Trees: Madison has about 96,000 street trees- that's more than 100 trees per street mile. Although the street trees comprise only 15 % of the overall tree canopy, it has an out-sized influence on many critical features of city-life such as moderating the climate, stormwater control and enhancing the aesthetic quality of our streets.

Street trees are, as is the rest of the city forest, confronting numerous threats to their well-being most notably, Emerald Ash Borer and climate change. However, our street trees have additional significant threats of increased urbanization, winter salt and decreasing terraces in which to grow.
As we will later discuss, street trees as well as the entire urban forest must be continually maintained and grown or the canopy that helps sustain us will shrink with potentially disastrous results.

ii. Current and Upcoming Issues
Illustration: Pie graph of tree species with some grouping of species, particularly Ash.

Emerald Ash Borer: The Emerald Ash Borer is an invasive, wood boring beetle. It kills ash trees by eating the tissues under the bark, thus preventing water and nutrients from traveling from the roots to the branches.
The first noted infected Ash tree in Madison was found in Warner Park in 2013. An inter-department planning team was organized and developed the Ash Borer Plan. The purpose of the plan was to treat as many street trees as can be saved and remove those trees that were already unhealthy or would not benefit from chemical treatment.
Even given the enormous multi-year effort of City agencies, the impact of the EAB will be far greater than we can now imagine. Consider these facts:

- 20% of the 100,000 trees in our parks are Ash. None will be treated and almost all will be infected.
- Nearly one-third of the 100,000 + trees on private property are Ash and few are being treated to prevent infection.
- Half of the 22,000 Ash street trees are being treated and the remainder will be removed and replaced.
- That's a combined loss of about 60,000 mature trees.

The City is engaged in a vigorous program of tree replacement. From 2016 to 2019, the City will replace 10,000 street trees and an equivalent number of trees in Parks. Generally, there is a one year interim between the removal and replacement of a tree. However, the often discerning reality is that in almost all cases, a mature tree of 40-60 feet is "replaced" by a thin sapling that will take decades to reach the stature of it's predecessor.

Recommendations: When the Emerald Ash Borer "runs its course" as an invasive agent, the work of restoring the majority of our urban forest will not be done. More than 20,000 new saplings will need to be maintained through regular pruning, watering and other maintenance. This unprecedented project of caring for a forest of young sapling will require more trained staff than the previous project of tree removal. What is unknown is the longer-term effect of the Ash Borer on private properties. We estimate that 30,000 trees have died or will die off as a result of the pest during its most active phase. Will the City have to gear-up enforcement of removal of dead trees? Is there capacity of private arborists to accomplish this undertaking? Should the city establish programs to encourage replanting? These are important operational and policy issues that should be addressed before they become urgent.

Illustration: Picture of Healthy and Dying Ash Tree

Removal of dead Ash trees on private property. As noted above, up to 30,000 Ash trees on private property have or will die in the next few years. Many of the trees, due to their size and location near homes, should be removed. As is the case currently, it is often a neighbor that complains about a dead tree on the adjacent property.
Under current law, the Board of Parks Commissioners must authorize the removal of a tree. This is not practical when it is necessary to remove thousands of trees each year. This authority should be given to the City Forester.
Current staff is not adequate to assess private trees, issue orders for removals, ensure compliance and if necessary, have Forestry Division staff remove the tree. Removal of the tree and "grubbing" will in most instance be billable.

Replacing Ash Trees: Mature Ash trees grow up to 60 feet tall with a similar length in diameter. These canopy trees should be replaced by (other specie) canopy trees rather than ornamental trees that grow no taller than xx feet. Ornamental trees have the quality of ease of care and do not reach power lines. However, they provide few of the benefits of large canopy trees.
The City should make every effort to replace these canopy trees with other canopy trees.

Maintenance of new saplings: Care and pruning of thousands of new terrace trees will require additional arborists and support staff.

iii. Maintaining and Growing Our Urban Forest

The policies and programs of the City have a major effect on either maintaining and growing our trees or directly or indirectly facilitating their decline. Building and construction codes, street lights, sidewalk size and of course, power lines are a small sample of the many (non-Forestry) operations that influence the life and death of the 96,000 street trees of Madison.

The Contested Terrain: Life on and Under the Sidewalk

Most Madisonians taking a walk down the street see a building on one side, the sidewalk before them and the terrace on the other side. They are happily unaware that each foot of space above and below ground have probably been negotiated and carefully planned and apportioned.

Illustration: Schematic of a 30 foot wide underground.

Let's start from the bottom and work our way up to the street. As you will note from Graphic X, it can get pretty crowded underground. There are lines to the home or business for water and waste water, gas and electrical power. Each of these lines are

spaced apart from each other and run from larger "mains" placed in the street. Trees must be place at least two feet from each utility line.
Obviously, trees cannot be place above these lines because of the dangers of digging and because if a line were to be replaced, it would then require the removal of the tree.

Illustration: Schematic of 120 foot block with street light, fire hydrant, electric poles and wires, three or four driveways.

The restrictions for tree placement aboveground and along the street terrace are greater than those below ground. As indicated in the Graphic Y, there are numerous restrictions on the placement of street trees on a city terrace:

- Trees must be six feet from driveways.
- Trees must be at least 20 feet from a street light
- Trees must be at least 10 feet from a fire hydrant.
- Trees must be at least 10 feet from a traffic sign
- Trees must generally be at least 20 feet from a corner to protect "line of sight."
- Height and design of trees must allow the placement of aerial ladders on buildings taller than 30 feet.
- Height and design of trees must take into consideration of utility poles and overhead cables. They must also be at least 10 feet from utility poles.

The final and perhaps greatest challenge for placement of a street tree is along the width of street from the edge of a building to the curb. This space comprising of the building "setback" (if any), the sidewalk, terrace and curb is vigorously negotiated by the interested parties.

Maintaining Madison's Forest

The Challenges: Most street trees grow and live in a hostile environment. In more intensively built environments, trees are often shadowed for much of the day by buildings. Trees along power lines are subject to loss of major limbs if they may touch or threaten the viability of a power line. They are subject to higher-than-normal temperatures in the summer and stronger winds in the winter (also without other trees to buffer the wind). During and after rainstorms they are subject to floods and in the winter they are covered by road salt and sand. They are also peed on by dogs.

Any one of the above-mentioned environmental conditions in and of itself could be sufficient to stunt the growth, misshape or kill a tree. However, often the most challenging condition we create for trees on street terraces is the insufficient space, soils, nutrients and water to grow. Trees must have rooting space to grow and stay healthy. Cramped spaces with little available soil will result in a tree with a short life-

span and a shrunken canopy. Highly compacted soil and impervious spaces deprive the tree of air and water. (Trees will sometimes heave pavement in an attempt to capture necessary air and water.

The size of the tree's crown (the measure of the tree's greatest width) is largely dependent on the available cubic feet of soil. For example, a tree planted in the standard six foot-wide terrace, three feet deep and 20 feet or 10 feet on each side would have 360 c.f. of space. We could expect a tree with a crown of about 15 feet with a shortened life. However, a substantially greater area is needed for a healthy canopy tree. A canopy tree with a crown of 30 feet in diameter would need a soil volume of 4 feet deep, an 8 foot wide terrace and 32 feet long space on the terrace.

Recommendations:

Terrace Size: Street trees live, thrive or die based on the capacity of their terrace to sustain them. A small terrace in compacted soil can only support an ornamental tree with a shortened life. It does not curtail stormwater, reduce carbon emissions or provide substantial needed shade.

Currently, there is no minimum width for street terraces. In some new developments of single-family homes on the city periphery terraces are fairly wide, e.g. eight feet wide. In addition to plantings from the home owner and a winter site for throwing snow from the sidewalk and snow spray from winter trucks, there is sufficient room for a viable canopy tree.

The pressure to minimize the size of a terrace is greatest in "infill" or new development on the Isthmus. If a new building is constructed to the sidewalk and the sidewalk is six to seven feet to allow for two pedestrians, it would leave about four feet for the terrace.

However, there are yet additional competing uses. First, some building owners place bike racks on the terrace. Second, the City Parking Utility may require an extra wide curb to allow placement of a parking meter. Parking meters, bike racks and other structures on a terrace create foot traffic that will likely result in compacted soil, reducing tree roots access to vital water and nutrients.

A viable tree canopy is possible only with a sufficiently sized and undisturbed terrace.
When a full-sized tree is planted on the Isthmus, other contingent factors should defer to the goal of providing 600-1,000 cubic feet of soil to allow the full growth of a healthy canopy tree.
Requirements of the terrace width can be waived if the terrace site includes "Silva Cells" or similar deep, structured supports.
The immediate area (12 feet) around a tree should be free of bike racks and other objects that compact the soils. Low-fencing around the base of the tree may be required to protect the bark from erosion due to dog urine.

Challenges of Construction:

Role of the City: Many city agencies review, modify and oversee the implementation of proposed building plans. These agencies rely on city ordinances (Muni Code 107.13 (a-h), Standard Specifications for Public Works Projects) for guidance on tree protections and ANSI 300 standards for tree maintenance processes such as planting, pruning and removal.

Forestry (Parks Division) is responsible for the review of development proposals and related documents as they relate to protecting trees, new trees and post-construction inspection.

Planning and Zoning are responsible for review and approval of proposals in light of standards of MGO Chapter 28. Many of the standards do not directly address tree maintenance or protection, there are numerous design factors that indirectly affect tree survival such as shadowing by taller buildings, reduced terrace space and soils, etc.

Engineering reviews analysis completed by Forestry prior to construction approvals based on 107.13.

Traffic Engineering reviews plans based on distance requirements for trees from street intersections, street lights and traffic lights. Traffic Engineering also reviews plans for plantings based on review of line-of-sight measures.

Fire Department reviews plans to ensure that aerial ladders will be able to access buildings in excess of 30 feet. Specific advanced construction features may provide allowances and variability in tree placements and height.

Buildings: Construction of new buildings on sites that had been developed present one of the greatest challenges to the survival of terrace trees. Trees are often removed to create an entry for construction equipment. Those trees that are not initially removed may subsequently be killed by compaction of soils by heavy equipment and by the cutting of their roots in the course of construction.

The resulting building too often appears in stark contrast both with as the site appeared before construction and the architectural drawings. These drawings often include depictions of numerous large canopy trees while the final product may leave little more than a few scraggly ornamental trees.

Compounding the problems for staff review is that often the site plans submitted in the initial review and at times fairly late in the approval process does not include a detailed landscape plan. The absence of a landscape plan is rarely the basis for the rejection of a proposal.

Recommendations

In a 2016 memo, **Street Trees and the Development Process**, Planning Division and Forestry staff recommended changes in the review process that might enhance protections of street trees. Some of the recommendations were:

- Approval to remove street trees should be verified by Forestry staff.

- Improve project management by Planning staff to ensure coordination between Forestry and other agencies to minimize impacts on street trees.
- Require a 72-hour waiting period before a tree removal permit can be issued by Forestry.
- Create opportunities for new street trees associated with development.
  Early in the application process, Planning and Forestry should require consideration of new street trees through minor adjustments to the site, redesign of infrastructure, etc.
  Planning staff should include 1-2 meetings with applicants and Forestry on street tree issues.

In addition to these recommendations, consideration should be also given to:

- Provision of incentives to developers who plant canopy trees with sufficient soil volume, use of Silva Cells or other structured soils designs.
- Establish a construction barrier of 3 feet from tree drip line instead of the current rule of 5 feet from trunk.
- Create a penalty of $X per inch of tree circumference that provides sufficient disincentive to reduce substantial harm or loss during construction.
- Increase tree-planting in bio-swales and other stormwater retention and absorption structures.
- Incentives should be given for extra canopy trees on the same basis as extraordinary design.

The drawing of this proposed building in the campus area, includes two trees of approximately 35 feet. The branches appear to touch the windows of the second and third floors. Also, the trees appear to have been planted in cement. Due to the height of the building, aerial fire ladders would not be able to reach either the middle or upper stories and thus, would likely be in violation of the Fire Code.

Picture of Bassett St. before reconstruction.
https://goo.gl/maps/9HeWUaCGpdE2

Construction in new areas:

Construction of low-density housing in the context of new developments continues apace. Since 2014, approximately 500 new single family homes have been platted each year. Most of these units were built on the city's periphery on the east and west-side on land that had previously been farmland. The farmland had often included large stands of trees as windbreaks on and between farms, stormwater retention and simply to retain some forested lands.

As these lands are cleared for single-family homes, substantial tree canopy is lost while the opportunities to restore new tree plantings are missed. It is all too common that the only remaining indication of the former area is the incorporation of the names of the tree species into the name of the development.

Given the open space available, developers have the opportunity to replant a tree canopy by plantings for each house as well as smaller tree stands on less developed areas such as next to playgrounds and stormwater retention ponds.

Currently, although the same restrictions apply in regard to avoiding underground infrastructure and other street uses such as fire hydrants and driveways, there are few requirements for new trees.

Recommendations:

- At a minimum, one canopy tree (defined) should be planted for each platted lot.
- Mature trees removed for construction should be replaced with trees with the potential of similar size.
- Provide incentives for planting stands of trees in allocated park lands.
- Terraces should be 8 feet wide to allow planting of canopy trees and allow narrowing of sidewalks to 4 feet.
- Provide census of existing trees prior to construction.

The Importance of Canopy Trees:

Canopy trees

Canopy trees, also called shade trees, are large trees with thick canopies or foliage coverings. Some common canopy trees in Madison include oaks, birches, elms, ashes and others.

Canopy branches and leaves both absorb and deflect sunlight that pours downward, allowing limited sunlight through the foliage. Although some canopy trees can be hundreds of feet, such as a redwood, canopy trees in our area are xx feet tall at the highest. In the Great Lakes region of the United State, canopy trees can live from 50 to 150 years or more. Older hardwood forest trees can have a lifespan of 200 to 400 years

Benefits: Because canopy trees have a high rate of photosynthesis, plants under canopy trees produce more seeds, fruits, leaves and flowers. This results in a wide range of animal life. Canopy trees help regulate both regional and global climate. A viable tree canopy reduces the urban heat island effect, reduces heating/cooling costs, reduces air pollution, increases property values, and provides aesthetic and improved quality of life.

The tree canopy provides an important stormwater management function by intercepting rainfall that would otherwise run off of paved surfaces and be transported into local waters though the storm drainage system, picking up various pollutants along the way.

Small and medium-sized trees provide most of these benefits, however, they do so at a fraction of the scope of their larger counterparts. While yearly maintenance costs of a large tree are greater than for a small tree, the immediate and long-term benefits of a large canopy tree are many multiples of the small tree.

Recommendations:

We recommend that the City prioritize the planting of large canopy trees where feasible. This should be reflected in the amendment of MGO 10.10

> 10.10 - INSTALLATION OF STREET TREES.
> (1) It shall be the policy of the City of Madison to promote and enhance the beauty and general welfare of the City through the planting and maintenance of trees or shrubs within the public right-of-way of any street, alley or highway. The City Forester shall direct, regulate and control the planting, care and removal of all public trees and shrubs within the City subject to the direction of the Superintendent of Parks and the Board of Public Works and the Board of Park Commissioners.
> (2) Diseased or destroyed street trees shall be replaced by the City, provided that adequate space for tree growth is available and subject to availability of funds. The replacement of diseased or destroyed trees shall not be assessed to the abutting property owner.
> **(3)It shall be the policy of the city to plant large canopy trees (greater than 40 feet) as new plantings and replacements for diseased or destroyed trees in parks or on terraces wherever practicable.**

Canopy Coverage

The term “canopy coverage” means the portion of the land that is covered by (the crown of) a tree canopy. The tree canopy in Madison covers **23%** of the land mass (excluding the lakes).
While this may, at first, seem like a large portion of the city, considering the size of the U.W. Arboretum, our extensive park system and the many single-family homes that have one or more large trees, it is relatively not

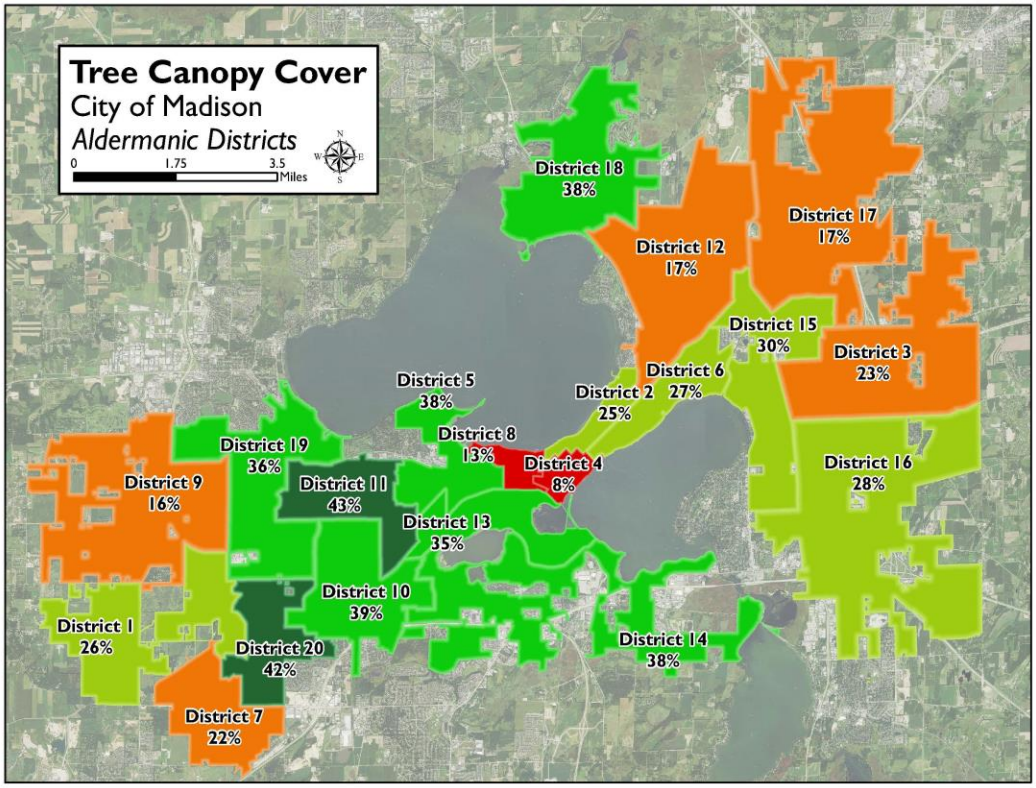
Researchers estimate that tree canopy cover in urban and metropolitan areas across the U.S. averages only 27% and 33% respectively. Because of the well-established relationship between higher tree populations and improved human and environmental health, advocates have generally recommended large increases in canopy.

For example, Pittsburgh has a tree canopy of 42% and seeks to increase it to 60%. Baltimore is committed to increasing its canopy from 28% to 40% by 2040. Arid Phoenix has set a goal of 30% by 2025 and Charlotte with a tree canopy of 32 % is working to increase its canopy to 50% by 2050. New York City has met a goal of planting 1,000,000 trees in the period of 2010-2015 and now has a canopy of 21%.

Some advocates have argued that the focus on increasing the overall percent of land covered by canopy to be misleading or beside the point. It may be misleading because some areas within the city may have a fairly dense canopy while other areas may lack trees. Also, the trees in some areas may serve as important stormwater control assets. Another factor, is if the trees population is sufficiently diversified. Given, the high percentage of ash trees in Madison, we can understand the importance of greater diversification.

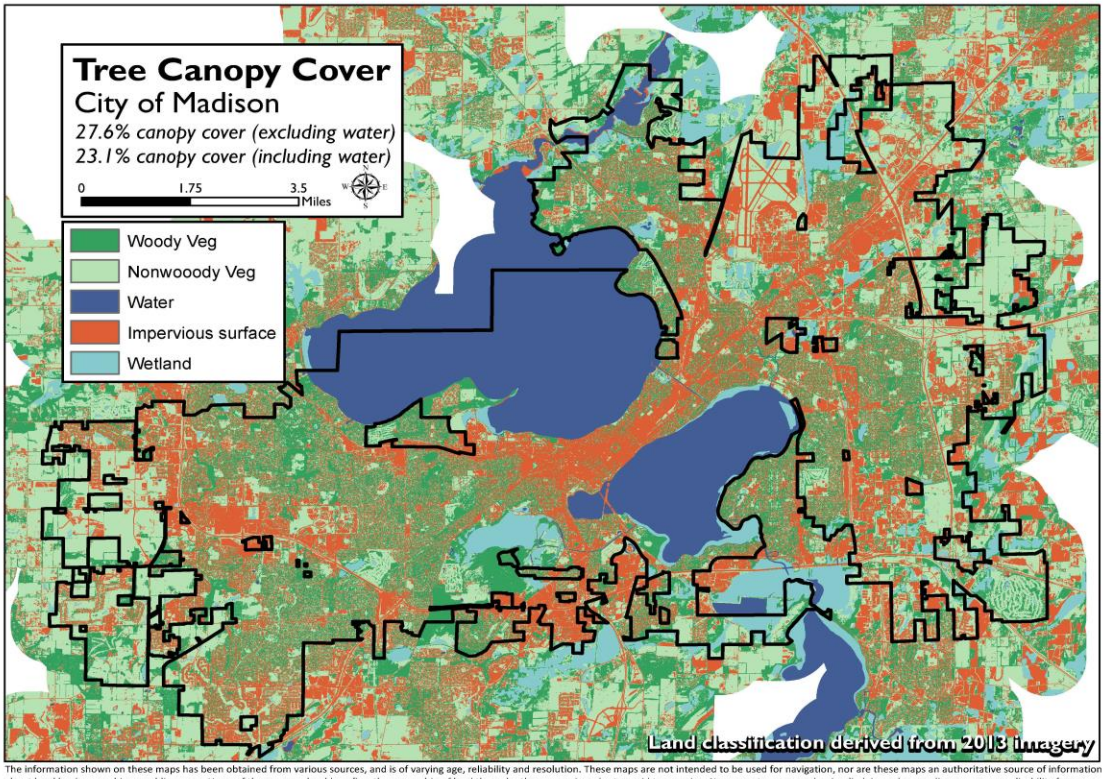
The issue of major importance however are the substantial differences in tree canopy by area. As we can see in the map below, the downtown and UW areas have between 8-13% of canopy. Also, contrary to expectations about the environment on the city’s periphery, areas on the far east (District17) have only 17% canopy and far west (District 9) have 16% canopy. These two areas also have the two largest malls along with numerous “satellite” smaller but still substantial shopping centers and parking lots.

Given the continued growth in housing and commercial buildings in areas that had been farmland or undeveloped and covered in vegetation buildings replace green spaces but also streets, sidewalks, parking lots. These impervious surfaces do not absorb rain. Without changes in public policy the tree canopy will continue to decline and the city will be subject to greater threats of flooding.



While the map of Alder Districts provides a “macro” perspective of major areas, it doesn’t illustrate areas within each district that have many trees such as parks or that don’t such as East Washington.

As is indicated in illustration XX, the downtown area is depicted as nearly completely impervious as are large areas of the malls, airport and UW.



Recommendations on Canopy:

The Challenges of Climate Change

Public Outreach and Education

Funding Forestry