CHARLOTTESVILLE MAIN STREET

Tree Assessment and Management Recommendations

Prepared for:
City of Charlottesville, Virginia

December 11, 2015

Prepared by:
James Urban, FASLA
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A. Executive Summary

The Charlottesville, Virginia, Main Street Mall is a nationally recognized streetscape, noted for the significant contribution of large healthy trees to the public space. Despite the good initial outward appearances of the tree planting, the stand of oak trees is in a fragile, declining state. The overly tight spacing of the trees and the insistence on paving right up to the base of the trunks of the trees has set in motion a series of biological factors that is beginning to push many of the trees to the point of failure. Fortunately there is time with the proper adjustments and modifications to save much of the fabric of this place.

An extensive set of data was collected by field observations for each tree detailing its condition. The summary of observations of this data discusses tree health, annual growth rates, tree/paving conflicts, tree to tree and tree to building canopy competition, the structural integrity of the tree bases, tree branch structure, previous pruning, root damage, water availability, insect and disease, health of the Shumard oaks and Maples, and tree/public use conflicts. These observations were the springboard for the recommendations of this analysis.

The recommendations in this report provide directions for management of the trees and related parts of the streetscape. ***The following is a summary of the most important recommendations.***

Tree base and paving conflict is the most serious and immediate threat to the long-term health of the trees. The tree grates must be eliminated and a new detail to resolve this transition from tree to paving is proposed.

The overly tight tree spacing of the original design is the primary cause of tree canopy decline. While there are some trees that need to be removed in the near future, with a different approach to pruning; the application of Tree Growth Regulators; and following other recommendations, most of the oak trees can be managed for long-term success.

Replacement of individual oak trees are not likely to be successful, unless the recommended canopy reduction pruning is implemented.

The maple trees particularly the remaining Red maples should be replaced.

All replacement trees should be planted following the recommended planting and repaving detail.

There is little that can be done to improve soil conditions except for replacement trees.

Insect and disease problems do not currently need control, however, there are insect threats to Willow oak that must be considered.

A public outreach program is critical to the success of the management plan.

Alternative recommendations for a simpler removal of the stressed trees and replacement of entire blocks of trees at one time are also proposed.

B. INTRODUCTION:

The Charlottesville, Virginia, Main Street Mall is a nationally recognized streetscape noted for the significant contribution of large healthy trees to the public space. Without question, the success of the trees is closely linked to the success of the retail environment and the sense of place. The Mall was designed by noted landscape architect Lawrence Halprin Associates in 1974 and planted in 1976. The original trees were mostly Willow oak – (*Quercus phellos*) with Red maples – (*Acer rubrum*) planted in a small plaza space at Second Street. The Oak trees were approximately 6 inches caliper at planting, as recorded in the book, "Central City Malls" by Harvey Robenstein, 1978. It is unknown how large the Maple trees were at the time of planting.

Despite the outward good appearances of the tree planting, overall the stand of trees, particularly the Oaks, is in a fragile state and many are on the verge of collapse. The overly tight spacing of the trees, and the insistence on paving right up to the base of the trunks of the trees has set in motion a series of biological factors that is pushing many of the trees to the point of failure. Fortunately there is time with the proper adjustments and modifications to save much of the fabric of this place.

In May of 1989 many of the trees were observed during a study of the Mall trees by James Urban and published in the proceedings of the Fourth Urban Forest Conference, October 15-19, 1989, in St Louis, Mo. At that time the Diameter at Breast Height, or DBH, of each tree was measured and a tree health score was assessed. The data at that time is included in this assessment as a growth reference point. It is extremely unusual to have data with this historical perspective in which to gauge growth, and it will be invaluable in making long-term management recommendations.

This report will be divided into three sections. Field observations where tree by tree data, recorded in 1989 and 2015, will be presented; Summary observations where trends and over all generalizations of the data combined with other influences on three conditions can be assessed; and finally a Recommendations section where specific proposals for short and long term management of the trees will be offered.

C. FIELD OBSERVATIONS:

Field observations methodology: The trees at the Charlottesville Main Street Mall were observed on October 26, 2015. James Urban and Keith Pitchford visited the Main Street Mall and recorded field data for tree health and condition. Observations and data include the following:

DBH 1976: The assumed DBH at planting is based on published report of the Mall planting of 6 inches caliper. DBH is the abbreviation for diameter of the trunk at breast height typically 4.5 feet above the ground. Tree trunks taper such that the DBH for these newly planted trees is assumed to be 80% of Caliper or in this case 4.8 inches. Caliper is a nursery grading term that describes the diameter of the trunk at 12 inches above the ground. Planting is assumed to have been in the spring 1976. Only the Oak trees observed in 1989 were assumed to have been planted in 1976. The use of 80% is based on information provided by Halka Nurseries for the difference between DBH and caliper.

Since all the trees were placed about one foot below the top of the tree grate, there will be a variation in the location of the DBH point in this studies, DBH was measured at 4.5 feet above the top of the tree grate. There is variation in the assumption of estimated planted tree size and the goal of the estimate was of relative not absolute tree growth. Since any error would be spread over 40 growing seasons, this variation is not considered significant.

Mall after completion, 1989 and 2015

DBH 1989: Field DBH measurements, May 1986, James Urban as part of a research project. Not all trees were measured in 1989. Trees were measured using a diameter tape at 4.5 feet above the top of the paving.

Notes 1989: Field notations, May 1989, by James Urban as part of a research project. Not all trees were assessed in 1989.

Health 1989: Assessment of tree health, May 1989, by James Urban as part of a research project, using the following system: Not all trees were assessed in 1989.

1. Excellent health.
2. Good health.
3. Fair health.
4. Poor health.
5. Dead.

DBH 2015 inches: Field measurements, October 26, 2015, by James Urban and Keith Pitchford. Trees were measured using a diameter tape at 4.5 feet above the top of the tree grate.

DBH Growth 1976- 2015 inches: Average DBH growth over 40 growing seasons from spring of 1976 to October of 2015.

DBH Growth 1989-2015 inches: Average DBH growth over 27 growing seasons from May of 2089 to October of 2015. Since the growth between 1989 and 2015 data was actual measurements, and at the same point on the tree (4.5 feet above the tree grate) this data is considered significantly more accurate than data of the growth over 40 years.

Vigor 2015: Assessment of tree vigor, October 2015, by James Urban and Keith Pitchford, using the following system. These observations were made from ground level. Vigor represents the appearance of new growth and leaves and indicated how healthy the tree may be.

1. Healthy
2. Early fall leaf drop
3. Some branch dieback
4. Significant branch dieback
5. Majority of the canopy dead
6. Very thin canopy, low vigor

Structure 2015: Assessment of tree structure, October 2015, by James Urban and Keith Pitchford, using the following keynotes. These observations were made from ground level. Structure is the accumulations structural defects that may shorten the life of a tree or contribute to hazardous conditions of possible future branch or tree failure

1. No structural defects
2. Significant weak branch attachments /co dominant leader(s)
3. Visible large rots or wounds
4. Significant visible structural weakness
5. Possible hazardous structure

Tip extension inches 2015: Estimate of branch tip extension in the 2015-growing season made October 2015, by James Urban and Keith Pitchford. These observations were made from ground level. Tip extension is considered to be a reliable indicator of tree health.

Trunk / paving interface code: The type of paving around the tree using the following keynotes.

1. Brick over metal grate close to trunk w/ thin metal plate to close space around trunk.
2. Metal tree grate. A thin metal plate was placed between the grate and trunk for newly planted trees. Grates or plates are periodically enlarged.

Tree grate to ground inches 2015: The distance for the top of the tree grate to the soil under the tree grate. One measurement per tree was made by pushing a tape measurer through the grate. The variation in this measurement varies significantly,

and is intended as a rough evaluation of the amount of space between the grate and the ground. The dimension is not considered to have a significant impact on tree health but may guide the descriptions of possible alternative solutions to supporting the pavement around the tree.

Health problem code 2015: Observed health problems and tree conditions made October 2015, by James Urban and Keith Pitchford. These observations were made from ground level using the following keynotes.

A. Old wound on trunk.
B. Thin metal plate removed around trunk.
C. Trunk flare in contact with metal grate or frame.
C1. Significant damage to trunk from contact with metal grate or frame.
D. Grate recently enlarged.
E. Thin metal plate constricting trunk.

Canopy quadrant code 2015: The portion of the canopy with branches made October 2015, by James Urban and Keith Pitchford. These observations were made from ground level using the following keynotes. The proportion of the canopy with branches is a strong indicator of future tree health, and is typically a result of light competition with adjacent trees and buildings. Canopy Quadrants shapes and sizes are drawn on the Key plans. Trees with very small canopies are significantly more stressed

Code	% canopy spread w/ branches
1	25%
2	50%
3	75%
4	100%

4 Quadrant tree

1 Quadrant tree

2 Quadrant tree

3 Quadrant tree

Notes 2015: Field notations, October 2015, by James Urban and Keith Pitchford. These are miscellaneous observations.

D. SUMMARY OBSERVATIONS:

Tree health and condition:

The majority of the trees assessed for this report are Willow oak (*Quercus phellos*). This is an exceptionally durable oak species known for its rapid growth and long life. Most of the Willow oaks were planted on the Mall in the spring of 1976, which means that they are approximately 40 growing seasons old. There are also a few groupings of maple and oak including a grouping of Shumard oak (*Quercus shumardii*) located near the Ntelos Pavilion at the Mall's eastern end, and a grouping of Norway maple (*Acer platanoides*) and Red maple (*Acer rubrum*) planted in the plaza area between 2nd and 3rd Streets, NE.

What is most impressive about the Willow oaks is the large size that they have attained given the limited rooting area. They are all growing within individual "tree boxes" that measure 8' by 8'. The City of Charlottesville is fortunate that the soil in the Mall area was actually reasonable good soil for growing trees even in paved areas. The soil along Main Street is a well-drained, weathered rock, loam soil that appears to have survived the development of the street with limited increase in compaction. The street was originally constructed prior to the use of heavy modern construction equipment and has retained sufficient pore space to support tree rooting even under pavement. Willow Oak has proven to thrive in other cities along the piedmont including Charlotte NC, Greenville SC and Atlanta GA where similar soils exist on the ridgelines along which these cities were built. Recent street repaving and utility work on Main Street has likely disturbed some of these historical soil conditions and the trees are responding with differing levels of decline depending on the amount and severity of the work.

While the pattern of vigor in this species is encouraging, this oak monoculture has its risks. The downside of monocultures is well documented. One only has to review the devastation of the American elm population east of the Mississippi River in the early- to mid-1900's to understand the pitfalls. The Dutch elm disease fungus essentially decimated entire tree populations. We are fortunate that, at this time, there are few serious pests associated with Willow oak that could rapidly weaken or eliminate the population on the Mall. However, with the introduction of new insects and diseases into the tree population of the United States, reliance on just one tree type remains a risk. This risk is important to understand when considering how long the oaks may survive. While there is little that can be done to address this problem right now, future replanting should resolve this issue.

Annual growth rates:

Annual growth rates were determined for tip elongation and trunk diameter. Tip elongation values in the Willow oak, and Red maple, were estimated from inspecting small branches found on the ground, and from visual inspection of branches using binoculars. The Norway maple was small enough to closely inspect the annual growth increments. In most of the Willow oak, the lower limbs have been elevated too high to reach the branches, so that determining exact measurements was difficult. Therefore, these estimates were estimates based upon many years of field experience, and our familiarity with this species.

For purposes of tip elongation, trees were grouped into categories of "normal" growth (which for this species is 8", or greater), "moderately slow" growth (3-8"), and "slow" growth (3" and less). Additionally, the accompanying spreadsheet details the annual trunk diameter growth rates of the Willow oak from 1976-2015, and 1989-2015. The

period of 1989 is reflective of when diameter measurements were last taken, by James Urban.

Observations indicate that despite the apparent limited rooting areas afforded to the Willow oak, their overall vigor is good to fair. The majority (51%) had tip growth rates of 3-8", which is considered moderate for tip elongation. Only 10% of the population had growth rates that would be considered normal for the species, and 31% were growing at rates that would indicate a low level of vigor.

Although there is not enough long-term data on the trunk growth diameter increases to be statistically relevant in the two periods mentioned, it appears that the majority of the Willow oaks (70%) have trunk growth rates that are below normal for this species while only 30% are about normal. For this species, normal annual diameter growth rates would be .5-1.0 inch.

Tree / paving conflicts:
There are significant conflicts between the ever-expanding tree trunks and the paving. The original design set the tree root balls far below the paving elevation creating a deep space, typically 12 inches but as deep as 24 inches, below the paving. The original design was brick pavers set on a steel grating. This was gradually expanded at considerable effort. If the space between the tree and the grate was too large, people would occasionally trip or get their feet caught in the space. If the tree grew into the grate the trunk is damaged. The distance between too close and too far was only a few inches, and the trees expand at about 1/2 inch a year creating a constant management problem. In 2008/09 the Mall was repaved and cast iron tree grates were added. The grates had a similar set of problems with the trunk growing out to the grate. But, it was considered easier to enlarge the tree grates. The tree grate has a set diameter size for the hole in the middle of the grate. For any tree where the space between the trunk and this original grate edge was too large, steel plate was tack welded to the top of the grate to reduce the size of the space. This thin plate potentially causes greater damage to the trunk when the two come in contact. Trees east of 6th Street E have the brick paving close to the trunk with no surface grate. A thin steel plate is used to make up the space between the trunk and the bricks.

Under the tree grates is a steel beam support. Some of the faster growing trees are beginning to contact this support. This trunk to beam contact is of equal threat to the trees as the trunk to grate contact, but remains hidden from view. Fixing this problem will pose a greater challenge than presented by the grate as it involves a reconfiguration of the structure of the grate system.


Tree grate support beam


Beam in contact with trunk

The maintenance to enlarge the grates and plates are causing damage to the trees in many instances. It appears that the when the work to enlarge the holes is performed the grates and plates are left in place. When the plates are cut they appear to be cut with a cutting torch. This heats up the plate and there are many trees where the trunk bark is burned. In some cases it was clear that the cambium layer was damaged by this heating. In other trees it is not clear how much damage this process is causing. When the cast iron grates are cut the cutting appears to be done with some type of saw or grinder. In several instances the tool has cut into the trunk through the cambium layer. Some of the large oaks were also observed to have been burned during the enlargement process. **Trees, notably # 29, 36, 37, 38, 39, 50, 61, 62, and 65 are damaged.** These are noted on data sheets. **Significant wounding that has occurred on trees #29, 61, and 62, related to the expansion of the steel grates around these trees. This type of damage must be avoided.**

Trees damaged by burning during grate enlargement

Why is damage to the cambium layer a problem? The cambium layer of a tree is the critical growth region for the tree and the zone where water and carbohydrates (sugar) move through the tree. A thin layer of wood cells called the phloem just outside the cambium are the primary vessels that move sugar down to the roots. Inside the cambium layer is the xylem layer that move water up the tree. Damage to these layers is serious. Oaks are ring porous trees meaning that distinct sets of wood vessels in these layers connect specific sections of roots to specific limbs in the tree. Once these vessels are cut it is difficult for the tree to support those roots and branches.

It is too early to tell how much damage has been done by the cutting and heating of the cambium layers, but it is clear that in the future, plates and tree grates MUST be removed during the cutting process.

The conflict between the underlying grate frames and the trunk flare must also be resolved and the repairs to frames must be undertaken with methods that do not damage the living root tissue in contact with the steel support beams.

The conflict between the tree base and the paving is the most serious threat to the trees on the Mall and is the one thing that must be resolved quickly. It is strongly recommended that the grates be removed and replaced with a more suitable approach. See the Recommendations section below for an alternative idea.

Tree to tree canopy competition:
The trees in the original plan are placed too close together. The design may be a brilliant stoke of urban design but it defies the basic science and biology of growing trees. The design may have looked great as small clusters of trees for the first 20-30

years of its existence but the biologic necessity of how trees grow is now killing off the stand. After the conflicts created by the attempt to pave right up to the trunk, how to deal with the issue of trees too close is the second fundamental question to be solved.

Tree canopy competition in nature produces stress, primarily through shading. The results in this planting include asymmetric canopy shapes, and an associated low level of vigor. When several trees are growing in close proximity, typically one or two trees in the group will gain a slight height and spread advantage over the smaller neighbor. From that point it is simply impossible for the smaller tree to gain against the larger. Each year the stronger tree gets even stronger and the weaker tree gets even weaker. The weaker trees eventually die. Many of the Charlottesville Main Street Mall oaks are in the final, and terminal, phase of this competition.

Depending upon the shade tolerance of the tree in question, shading can reduce a tree's vigor to the point where it becomes the target of insect attack. The results of these insect attacks can be widespread and fatal. Rooting area competition is another consideration, but is much less significant than canopy competition. In fact, canopy competition is the ultimate limiting factor amongst trees in a forest condition.

It would be hard to find this level of stem density in nature, and with such large diameter sizes. In the forest the stands of trees are large and closely spaced trees are quickly killed off by neighboring trees. The Mall is a unique situation from the forest. First, each group of trees has open sides where the trees can get some light. Secondly individual trees do receive at least a baseline level of maintenance. These factors have prolonged the time where the trees may appear alive. Finally the untrained eye does not recognize the coming problem. However, there are many indications that some of the impacts of a high stem density, such as limb loss from shading and a decline in vigor are occurring. In particular, many of the trees are exhibiting low live crown ratios, and canopies limited to just one quadrant of the canopy. See a further discussion on live canopy ratio under then pruning discussion.

Tip growth variations and limitations on canopy spread in the Willow oak appear to be related to tree position within the groves. The largest growth increments are found on trees that obtain more sunlight, and have a greater area for canopy extension. These trees also have the largest numbers of canopy quadrants. This is directly related to the affects of shading on limbs from adjacent trees. Additionally, the affect of shading from the surrounding buildings is contributing to this tree form and condition.

Willow oak is considered to be intolerant of shade, with lower limbs shed as sunlight becomes limited. However, they DO respond well to being released from a heavy shade condition. They will produce epicormic, or adventitious, sprouts in stressful situations where growing conditions change suddenly. For example, if a nearby tree, or limb, is removed, it is likely that latent buds under the bark will be stimulated to form a new limb. This condition appears on many of the trees inventoried suggesting that most, if not all of these trees are under stress from shading, and are responding to any increase in available light. Limb loss typically occurs on the side of the tree next to a stronger tree thus the reduction of the canopy becoming asymmetrical. The tree looses some of its canopy quadrants.

Canopy quadrants were surveyed for each tree. These canopy sketches are on the key plan drawing. Each canopy was divided into quadrants and rated by the % of

the canopy remaining. A tree with a completely full symmetrical canopy has a rating of “4”, whereas a tree that is restricted on all sides with just one quadrant of canopy having a rating of “1.” This can be an important component of tree health because tree vigor is almost always directly related to the number of canopy quadrants. This is simply because more available leaf surface equals better health. In terms of a management strategy moving forward, this factor plays an important role. 58% of the large Willow oaks had a rating of 3 or 4; 24% were rated a 2 and 17% were rated with only one quadrant. The recommendations will attempt to improve the 1 and 2 rated trees by pruning back the stronger trees to force branching on the weaker trees.

Tree to building conflicts:
The oak trees are very large structures placed in close proximity to the relatively tall buildings. The buildings block light from reaching the lower parts of the tree and the tree branches brush onto the building surfaces, potentially causing damage to the building. The trees are then pruned away from the building reducing the canopy size of the tree. The leaves in the canopy supports the health of the tree. The decision to place large trees in these locations is a trade off between the type of landscape that has been created, and the management of this conflict.

A single tree near a building can successfully co-exist with this level of pruning, but these trees are also in fierce competition for light from the adjacent closely spaced trees. For some trees there is almost no place for the upper canopy to expand. This competition slows the trees growth and eventually will kill the tree. Pruning decisions on these confined trees will require strict adherence to the pruning recommendations and in some cases tree removal will eventually be required. All pruning decisions must balance trees health with other goals.

Structural integrity of the tree bases:
There were no indications that trunk rot, or root rot pathogens have invaded the bases of the Willow oak. Several did exhibit wounding at the root flares, which appears to be related to the expansion of the steel grates. However, no signs of wood decay pathogen infection were observed. This does not mean that infections are not ongoing, but only that there were no outward signs.

Another important consideration is the growth form of the trees relative to their stability. The intense canopy competition, and shading, in these sites is creating trees with a strongly single-stemmed form, but one with most of the branches on one side. Trees grown in a forest setting have ample rooting area in which to develop an appropriately large root plate to help compensated for reasonable asymmetry in the canopy, which is what helps to keep them upright. Still trees fall over in forest with great regularity. However, in the Mall, we assume that the root plate expansion is limited, and not necessarily in a direction that can compensate for the forces on the tree. This means that the root plate may not be expanding in a manner, and with the speed, that can support the tree.

Tree stability is further impacted by the loss of lateral limbs that act to dampen the wind loading as it is distributed down the main stem. The Mall trees are forming asymmetrical loading stresses as the canopy becomes one sided. This, in turn, increases the wind loading stresses on a root plate that may be too small for this tree form. In the end, the concern is that this pattern may lead to tree destabilization from excessive wind loading, a lean, and ultimately to whole tree failure. A few leaning trees were observed. The close tree spacing, and the adjacent building, which both

buffers wind loads do help individual tree to compensate for this increasing instability. However, the physics of tree fall, such as saturated soils combined with unusual wind speed or direction will at some point result in tree failures.

Structural integrity of the canopies:
There are several instances in the Willow oak where bark inclusions have developed between co-dominant stems. As a species, co-dominant branching in Willow oak is not an unusual growth form, and fortunately it is also not considered a high-risk defect. Bark inclusions that require mitigation through a structural support system were not identified.

Deadwood is always accumulating in the canopy, and where observed may represent an imminent threat. Because of the heavy use of the ground under the trees, the canopies should be constantly checked for deadwood and larger limbs. It should be removed as they are observed and at regular crown cleaning. Identification of specific dead branches was not included in the scope of this project.

Previous pruning:
The majority of the trees have had their lower and mid section limbs removed. This was likely done to remove dead limbs caused by excessive shading,

The City should avoid situations where pruning leads to trees with the live canopy concentrated in a small portion of the upper trunk. The measure of a tree's live canopy relative to its height is termed the "live crown ratio," or LCR. When a tree's LCR is 30%, or less, the trend is toward a tree that is inherently unstable. A low LCR will also result in a tree with smaller trunk taper. LCR has implications for tree vigor, structural integrity of the main stem, and stability at the base. Several of the Willow oak on the Mall are trending toward this condition.


Tree with low Live Crown Ratio

Previous root damage:
Significant root damage occurred within the area of the oaks at the western end of the Mall. These are trees #69-73. Excavation related to the installation of a new utility alignment occurred in close proximity to them, which has resulted in a noticeable decline in the live crown percentage, and vigor.

Fortunately, trees have redundancy in terms of the amount of roots and limbs that they need to survive. This redundancy varies between tree genus and species, and in the case of Willow oak it is generally quite high. This means that the species is tolerant of root and limb loss.


Stressed tree from root damage

At the time of this inspection, it was not possible to get a good sense of just how much live canopy exists because the leaves had been shed, and a close inspection of the viable buds was difficult from the ground. However, our initial evaluation of the tip extension indicates that they are growing slowly, and are in poor condition. Tree #71 is in the worst shape of the group, and likely represents a candidate for removal. However, the remainder may have enough live canopy to warrant retaining them, and providing chemical intervention in the form of a tree growth regulator treatment.

There are no other indications based on tree vigor within the oak population that this type of root damage has occurred elsewhere. But it is important to recognize what this type of root severing can do to these trees, and in such a short period of time. Once these roots are severed, the damage is often irreparable. It is difficult to bring a tree back to good health when this level of root loss has occurred. This has important implications to any future construction projects.

Water availability:
Water reaching these trees is in the form of rainfall, and perhaps from hoses used to clean the brick surface. There was also one instance of flooding from a leaking water feature at the base of tree #66. Willow oak does best in moist, well-drained soils. They will tolerate dry conditions, but will not tolerate flooded conditions. Therefore, providing these trees with a reliable form of water, especially during drought conditions, is an important management condition going forward. However, it cannot be so much that the soil itself losses its structural integrity. Given that there appear to be small root plates under these large trees, the worst situation would be where the soil in the tree pits becomes super saturated on a regular basis. This super saturated soil condition could lead to rotational failure of the root plate, and whole tree failure.

Insect and disease:
Two insects are presently affecting this tree population, but both are at low levels of infestation. Fall webworm (*Hyphantia cunea*) was evident on several of the Willow oaks. This insect is rarely damaging to the tree as a whole. It weaves a web around a small portion of the branch, and the larvae consume the leaves within the web. It is rarely stressful, or fatal. Our survey noted were infections are occurring, but did not find any situations that would require chemical control. Birds will often eat the larvae, or the webs can be pruned from the tree.

The second insect identified was oak lecanium scale (*Parthenolecanium quercifex*). This is a soft-shelled scale that feeds on the sap of deciduous trees, including Willow oak. In high concentrations, it can stress the host tree by feeding on the sap flowing through the phloem cells under the bark. Also, the excrement from the insect is a sticky, clear fluid termed “honeydew” that can rain down on surfaces below the tree including outdoor furniture, and visitors. When it dries, it hardens to a black finish, which is termed “sooty mold.” There were no suggestions in advance of this study that suggest a problem of this type on the Mall. However, it most certainly could become a problem in the event that these trees are increasingly infested.

The insects of greatest concern include woodborers and beetles. In particular, an infestation of granulate ambrosia beetle (*Xylosandrus crassiusculus*) could be devastating to this Willow oak population. This beetle is an Asian exotic that is expanding in the mid-Atlantic region. It is an aggressive and opportunistic insect. It can attack both weakened and healthy trees, and invades in large numbers that overwhelms a tree’s defense mechanisms. Its presence in any tree on the Mall

would necessitate immediate removal, and a chemical cover spray of insecticide on surrounding trees. Because of the increased occurrence of this insect, the Mall trees should be monitored twice per year for any signs of its presence. Research is showing that trees stressed by root loss, and then accompanied by excessive irrigation are prime targets for an invasion of the granulate ambrosia beetle. The arrival of this beetle has the potential to devastate the oak population, and is a good reason to find a way to change the oak monoculture design on the Mall.

At this time, there were no signs or symptoms in the Willow oaks related to these groups of insect pathogens.

Health of the Shumard oak, and maples
This study focuses on the oak stands but there are two other tree species that are included.

The choice of Shumard oak for the plaza near the outdoor pavilion is a good one. In general, this species shows good durability and drought tolerance in urban settings. However, the appearance of oak lecanium scale in these trees is a sign that the stresses related to the growing conditions are affecting the tree health and vigor. Note that any oak keeps the oak monoculture intact. In order to gain protection from the insects and diseases prevalent in Willow Oak, a genus other than Quercus should be chosen.

The choice of red and Norway maple in the plaza area is unfortunate. Both of these species are intolerant of limited rooting areas, and a high level of reflected sunlight and heat. All of these conditions apply to this setting. The poor condition of the trees is indicative of the harsh urban conditions, and the inability of these species to tolerate them. As these trees die, they should not be replaced with either of these species.

Tree / public space user conflicts:
The trees on the Mall are clearly a huge reason for the commercial and social success of Main Street. On the other hand they create conflicts with the users that must be managed. These conflicts include:

Leaves, flowers, pollen and minor debris falling from the trees: As living things there is a constant flow of organic debris that falls from a tree. People are generally accepting of this and normal maintenance is able to keep up with the clean up.

Larger branches: Trees naturally shed dead limbs. Lower branches and interior branches loose the competition for light and die. Other maintenance task such as pruning, and seasonal lighting will damage limbs and start the decline and loss process. An active squirrel population in the tree will also start the process of limb decline. Windstorms may partially break branches, which may take several years to die. These limbs can fall out of the tree and frequently will have sufficient size to damage property and injure or even kill people below. For this reason constant review of the canopy branches is needed to remove these branches before they simply fall out of the tree.

Outdoor dining management: The numerous outdoor eating spaces are a good use of the space, but there is always pressure to undertake operations that can harm the trees. Cleaning operations, attaching object to the trees, lighting, heating elements

can all impact tree health. It generally appears that the city is managing this conflict well.

User / tree management: Tree maintenance is often noisy, and requires large equipment and closing the fall zones during canopy work. Insect and disease control may require the use of chemicals that are in conflict with the use of the space. In the future enlarging the tree grates will require their removal, which will both lengthen the time of the operation and increase the space needed. Simple, but necessary maintenance task such as pruning and more complex task such as tree removal and replacement may be perceived negatively by some portion of the community. Tree removal to thin the stand of trees without replacement will be met with opposition. For these reasons a scientifically supported, constant and thoughtful public out reach program to educate the public will be required.

E. RECOMMENDATIONS:

Tree base/ paving conflicts:

As noted in the observations the current approach to paving up to the base of the tree is not a reasonable solution. **This issue is the most immediate threat to the long-term health of the trees.** What is needed is a more flexible system that can be enlarged with less damage to the tree. The biggest hurdle to overcome is the great distance between the soil and the paving. It is possible to accomplish this with easier to maintain materials if the space between the soil and the paving could be filled with a structural material. The suggested proposal is to fill the space immediately around the tree trunk with compressible foam with strength sufficient to hold up the paving near the tree but allow the growing tree to compress the foam.

Tom Smiley tested this concept in a study at the Bartlett research lab in Charlotte, NC, published as a joint paper with Jason Grabowski in 2011. This paper reports that a compressible material would need to be able to be deformed at about 0.35 MPa or 50 PSI. But this work looked at a round root of several inches in diameter, which is putting a point load on the material. In the case of the mall oak trees, the trunk of the tree is exerting pressure over a wide surface area. While the force might be greater, the increased surface area distributes the loading. Dow High Load EPS foam rated at 40 psi is capable of supporting vehicular weight when under pavers while still deforming from the tree pressure. Note that Dow makes several strengths of foam but this application requires 40-psi material. A sheet of Enka mat would be placed onto the trunk surface to keep water from being held onto the trunk surface as it transitions to a more moist environment. A sheet of geotextile fabric, Carthage 30%, should be placed over the Enka mat to keep stone fines from filling the voids in the Enka Mat. The Enka Mat will also serve as a space to insert the basal drench of the Tree Growth Regulator application

The area directly adjacent to the trunk is unlikely to experience the load of a vehicle. Further away for the tree where vehicle loading is possible, large diameter stone 1-3" diameter with no fine material could fill the space in the outer portion of the tree space. Virginal # 1 stone or ballast stone meets this criteria. This large stone would allow rapid flow of air to exchange with the soil gasses.

A geotextile fabric, Carthage 30%, would be placed on top of the large aggregate to allow a granular VA #8 aggregate setting bed, with brick pavers placed on top of the setting bed in a basket weave pattern. Pavers would be held 3-6 inches from the face of the trunk. The edge along the irregular base of the tree and void spaces between the foam and the Enka Mat would be filled with VA # 8 aggregate.

At four locations, a 6 inch diameter PVC stand pipe with a inlet grate top should extend from the surface of the brick to the soil below the large stones to allow inspection of the soil, watering, liquid fertilizer and aeration of the stone matrix below. The standpipe would be connected to a perforated pipe that runs around the perimeter of the tree space on top of the existing soil line for the distribution of water. NSD makes a suite of parts that can be used to make this riser and grating. (http://www.ndspro.com/images/stories/pdfs/general/catalogs/drainage-catalog.pdf) If the NDS 6" Speedy basin is used as the base of the riser, a 4' diameter hole must be cut into the bottom if each unit to allow a soil probe to access the soil under the basin.

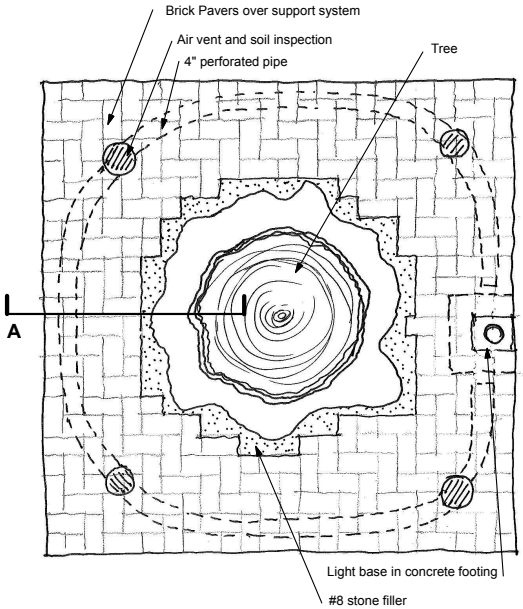
The tree light currently attached to the steel frame will be reset on a concrete base setting directly on top of the existing soil and utilize existing electrical connections

within the tree space. The concrete base must be designed to support the light without digging into the soil. Since the distance from the ground to the paving varies from tree to tree the concrete must be pored in place. See detail below.

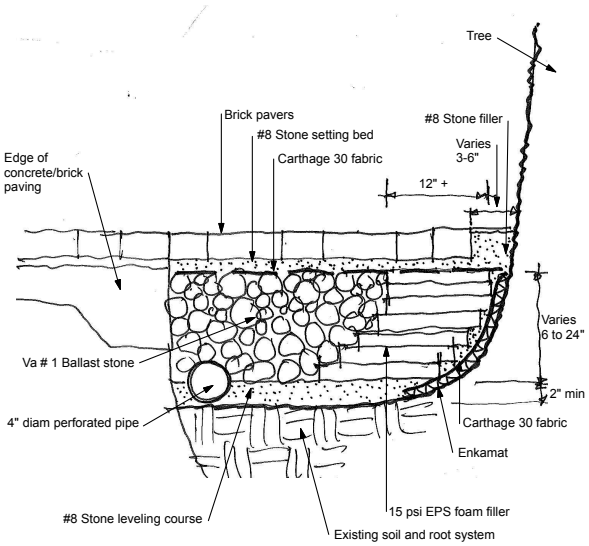
It is important not to allow substitutions to the products specified in this report. Enka mat 7018 or 7020 (http://www.colbond-geosynthetics.com/cms/projectdata/resources/data_sheets/EMT-001_7000_GB-A.pdf) is a unique material that forms void spaces due to its fiber design. There is no other material that is similar to this proprietary product. Carthage 30% (http://carthagemills.com/docs/new-mono/Carthage30Datasheet_04-17-14.pdf) is also a unique getotextile as it is a hybrid between traditional filter fabrics and structural geogrids. It has 30% of the surface area of relatively large holes that are sufficiently small enough to keep # 8 stone from dropping into the next layer while being sufficiently small enough to allow clogging fines from slowing the movement of water. The two stone sizes of VA # 1 and VA #8 are critical to the balance of the movement of both air and water through the system.

As the tree continues to grow, the tree may begin to slowly lift individual bricks along the edge of the paved area against the tree. Any of these bricks that lift to the point that they are considered a tipping hazard or are unattractive should be removed and replaced with the VA #8 stone. This is likely to be required maintenance every 4-5 years.

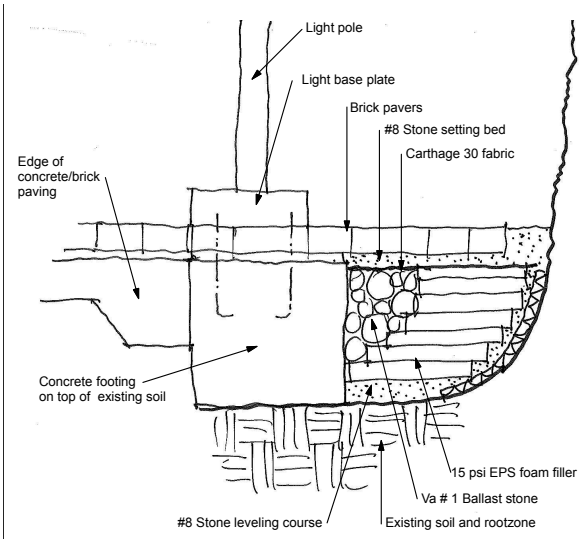
Plan and section drawings for this concept.



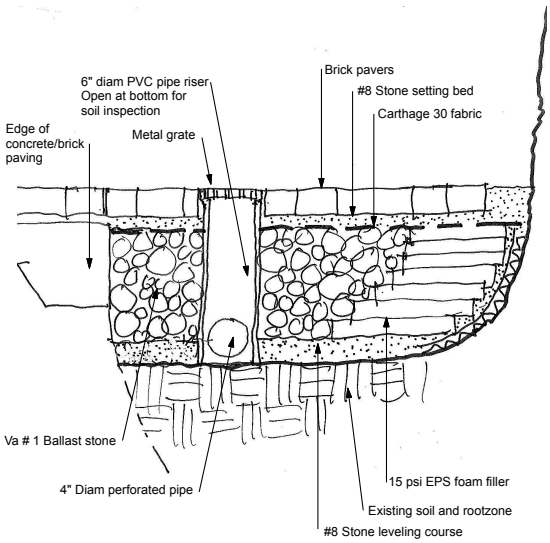
Brick Paving Around Tree to Replace Tree Grate
Typical Plan



Brick Paving Around Tree to Replace Tree Grate
Typical Section '**A**'



Light Base Detail



Air Vent and Soil Inspection Detail

Tree removal and replacement:

There are recommendations for stand management remediation including pruning, application of TGR and removal of the tree grates that can slow the process of tree decline and prolong the useful life of most of this tree. This report is recommending only the removal of a few trees in the short term, however, it will be likely that as time goes on many more trees will be removed. The tree data sheets ranks trees into four categories of overall condition and need for removal:

A Good condition – Recommendation: retention
B Fair condition with issues that can be remediated - Recommendation: retention w/ remediation
C Poor condition - Recommendation: Closely watch w/ remediation
D Very poor condition - Recommendation: Removal

Red maples have not faired well anywhere on Main Street and the few remaining are not contributing to the over all image of the space. It is recommended that they be replaced with a more suitable species.

Many of the oaks are suffering from the extreme close spacing where light competition has killed off large sections of the tree canopy. In particular, trees #12, 28, and 56 have so little canopy that they should be considered as potential early removals. Also, tree #71 has declined significantly from the utility work that it should also be considered as an early removal candidate. Additionally, all remaining trees with canopy branches in only one quadrant are considered to be in decline, and should be considered for removal at a later date. Remediation should also be considered, which involves significant pruning of the healthier trees on either side to give the weaker tree space to grow a larger more balanced crown.

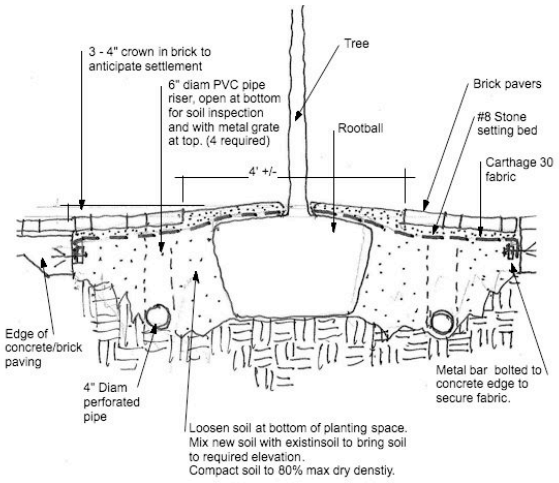
A few oaks have specific health issues such as trunk wounds or leans that suggest that future removal may be reasonable. Remediation options for these trees are not readily apparent.

Replacement of lost oaks is problematic. Since shade competition is the primary cause of tree decline, it is not anticipated that replacement trees will grow any better than the previous trees. Two oaks #16 and 31 are likely replacement and both trees are no growing well mostly due to shade competition. If replacement is chosen as an option, significant pruning of the adjacent tree canopies will be needed to promote better growth.

Replacement species selection:
The decision of what tree species to install is a difficult process and will need much more discussion than can be afforded in this study. Clearly Willow oak has performed well and the Red maples have not. A new species should be selected to replace the maples and Norway maple might not be the best option to replace the Red maple. If the City is intent on having maples because of the Halprin design, then an alternate species selection should be Trident maple (*Acer buergeranum*), Hedge maple (*A. campestre*), Amur maple (*A. ginnala*, tree form), or Tatarian maple (*A. tataricum*, tree form). These species can tolerate the harsh conditions that exist in the plaza.

The risks of continuing the oak monoculture inherent in this design are well documented. But the aesthetic down side of not continuing with the same tree is also recognized. Planting a different type of oak such as Shumard oak does not solve the monoculture question as any disease of oak may have a similar impact on both Willow oak and Shumard oak. White oak does not share some of the disease of Willow and Red oak but selecting a different genius, that is also shade tolerant, such as Beech, Fagus spp. or Linden, Tillia spp. would be preferred. Any discussion on an alternative species would require significant review and is beyond the scope of this assessment.

Replanting:
Any time a tree is to be replaced, the soil within the 8-foot square space must be modified as follows. Remove the stump and major roots of the old tree. If a stump grinder is used be sure to remove all the wood chips from the space. Remediate the soil within the tree space by breaking up compaction and add additional soil to the space to bring the soil level up to the bottom of the paving. Install brick paving. See sketch for replanting detail recommendation.



Replanting
Detail

Tree pruning:
Tree pruning done to date appears to be in reaction to dying limbs, or to provide clearance over pedestrian areas. The removal of dead, and dying limbs in some trees is trending toward a condition of LCR's that are approaching unsustainable levels.

Reduction pruning may also be considered as a means to selectively remove some limbs in order to decrease a tree's height or spread. Pruning for building clearance is well documented on the Mall, and has been a viable management option. However, pruning for height reduction has not be utilized, or perhaps even discussed. The usefulness of this treatment should be discussed as a means of lowering the risk of failure, balancing wind loading stresses, and to encourage new growth in the mid-level of the canopies. Regular reduction pruning would also reduce the rapid development of aggressive trunk base flares that lift pavement.

A more important benefit of crown reduction is to reduce the height and spread of the larger healthier trees that are shading the smaller suppressed trees. The pruning goal is to attain more even canopies on all trees with more balanced crown sizes and number of quadrants with branches. This level of canopy reduction would stimulate sprouting and branch development in the smaller 1 and 2 quadrant trees.

Willow oak is tolerant of reduction pruning, however attention must be paid to the appropriateness of the treatment given the age of the tree in question. The pruning proposed must be undertaken by a tree care firm with excellent experience in this type of work. Locally, the Bartlett Tree Company, for example, has such skills. The specification for this pruning must be carefully written to direct the trees to be pruned and goals of the pruning. A more standard and generalized instruction tree-pruning contract is not adequate

It is recommended that any additional pruning be limited to a dormant season crown cleaning of deadwood or to prune limbs away from buildings. Pruning paints are not to be used in any pruning operations. The tree must be left to its own to seal these wounds.

Tree Growth Regulators (TGR):
Tree Growth Regulators (TGR) applied to the tree base as a liquid drench would significantly slow the vegetative growth for a period of three growing seasons. These TGR's are often used to stimulate low vigor trees, and to extend the pruning cycles. Willow oaks respond quite well to the active ingredient, paclobutrazol, with no deleterious consequences or significant aesthetic affects. These products also act to enhance the root system as the starches from photosynthesis are redirected from vegetative growth to fibrous root growth. The result can be a renewing effect on stressed trees. If applying TGR to the entire planting is not phesible then starting with the western most grove would be an excellent starting point. TGR is most effective if applied in the early spring.

Tree growth regulators are typically applied to the base as a soil drench,o or injected into the soil with an injection needle. This is best done in March or April in order to see the effects in that year's growth. They are active for three growing seasons. Some trees have a higher sensitivity to TGR's so that the manufacturer's literature must be reviewed before applications are made. An excellent TGR is Cambistat

distributed by https://www.treecarescience.com/treecare-products/cambistat/

Tree/soil management:
There is little ability to modify the soil for these trees. The decision to pave right up to the tree or use tree grates that are difficult to remove makes it impossible to even take samples for soil testing. Soils can be modified with an Air spade whenever the tree grates are removed as was done to some trees during the installation of the grates. Biochar with bio-solids blended together should be considered as a soil amendment when ever the soil can be air spade loosened. When accessible, soil samples should be taken as well as digging a soil profile at least 36 inches deep with a Dutch auger to develop a better understanding of the soil. Leaf tissues can be used to check soil fertility levels but requires collecting leaves from high in the canopy. If indicated by the soil or leaf tissue testing apply fertilizers as recommended. These trees will likely benefit from occasional watering about once a month in summer. Watering should flood the tree space with at least 6 inches of water.

Insect and disease management:
At this time, there is no apparent need to control any existing insect infestation. The primary concern for the Willow oaks is the potential for a devastating infestation of granulate ambrosia beetle. Although there are no signs or symptoms of an infestation, it is prudent to monitor very closely for any signs of its appearance. Any confirmed infestation must be dealt with immediately by removing the infected tree, and applying a cover spray of insecticide on adjacent trees.

Tree growth regulators may also be a helpful as a means to increase the vigor of weaker Willow oaks. In particular, the trees that remain in the grove at the western end of the Mall may respond favorably to a TGR application. In this situation, the application of a TGR could be considered as an intermediate step before tree removal.

Public outreach:
Given the high visibility of these trees and strong public opinions about any changes, a public outreach and education process is needed before undertaking any of the recommendation that involve significant changes to the trees or the space. Various stake holders including the City Council; Planning Commission and the Tree Commission, Board of Architectural Review, the Place Design Task force, as well as neighborhood and business groups and faculty at the Landscape Architecture School at the University of Virginia are all likely to have strong opinions on any changes to the Mall. Any of these groups, if well briefed on the issues and remediation options can become a supporter of the proposed actions. Some of these recommendations have budget implications that need to be inserted into the maintenance budget of the city.

However, time is critical to preserve the more stressed trees. Tree canopy reduction recommendations and TGR applications should take place in late winter early spring and the sooner these are started, hopefully in the spring of 2016, the more effective the treatments. Each lost year decreases the chance of success.

Alternative recommendations:
The above recommendations are structured to make the least changes to the existing trees and to preserve these tree for as long as possible. But they are a

package of interrelated ideas. All the recommendations must be followed to have a good chance of success. Even with the best response it is likely that some trees will be lost over time. It is reasonable to ask what alternative are there to the above.

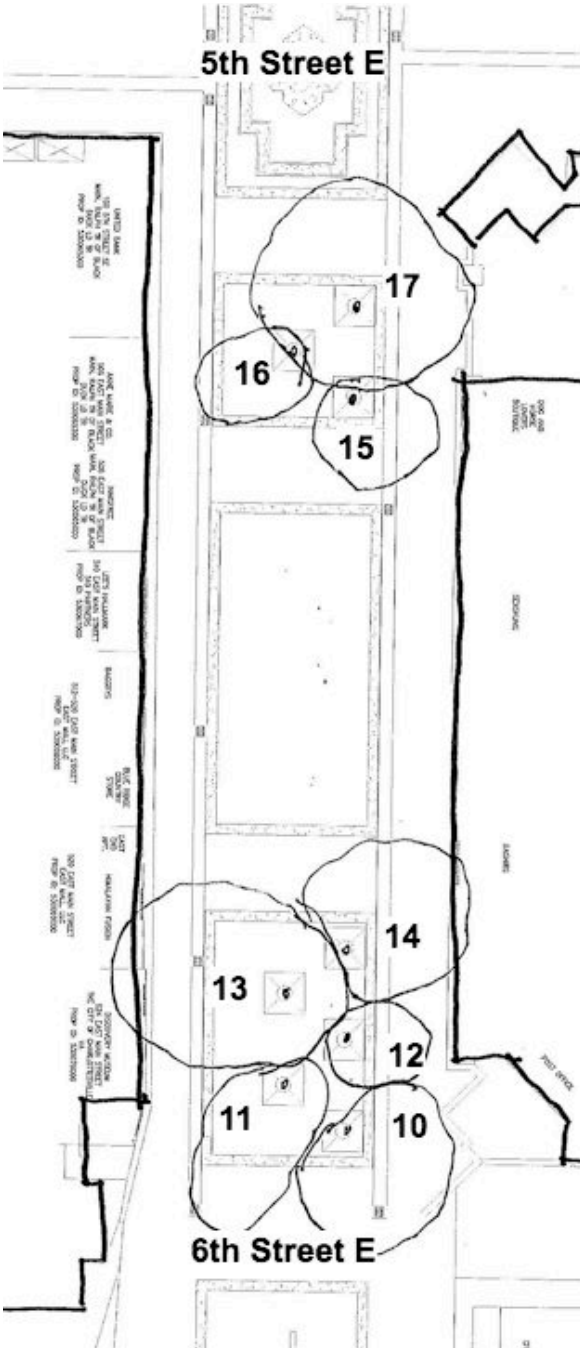
Alternative A. Given how difficult it will be to do restorative actions over many years it may be better to remove the stressed trees. This can be done one tree at a time when they are deemed hazardous. This will leave missing trunks but little impact on the canopy. As stated before, trying to replant trees in the very shaded conditions will not result in good tree growth. Empty planting spaces can be paved over until it is time to replace the entire stand or stand in one block.

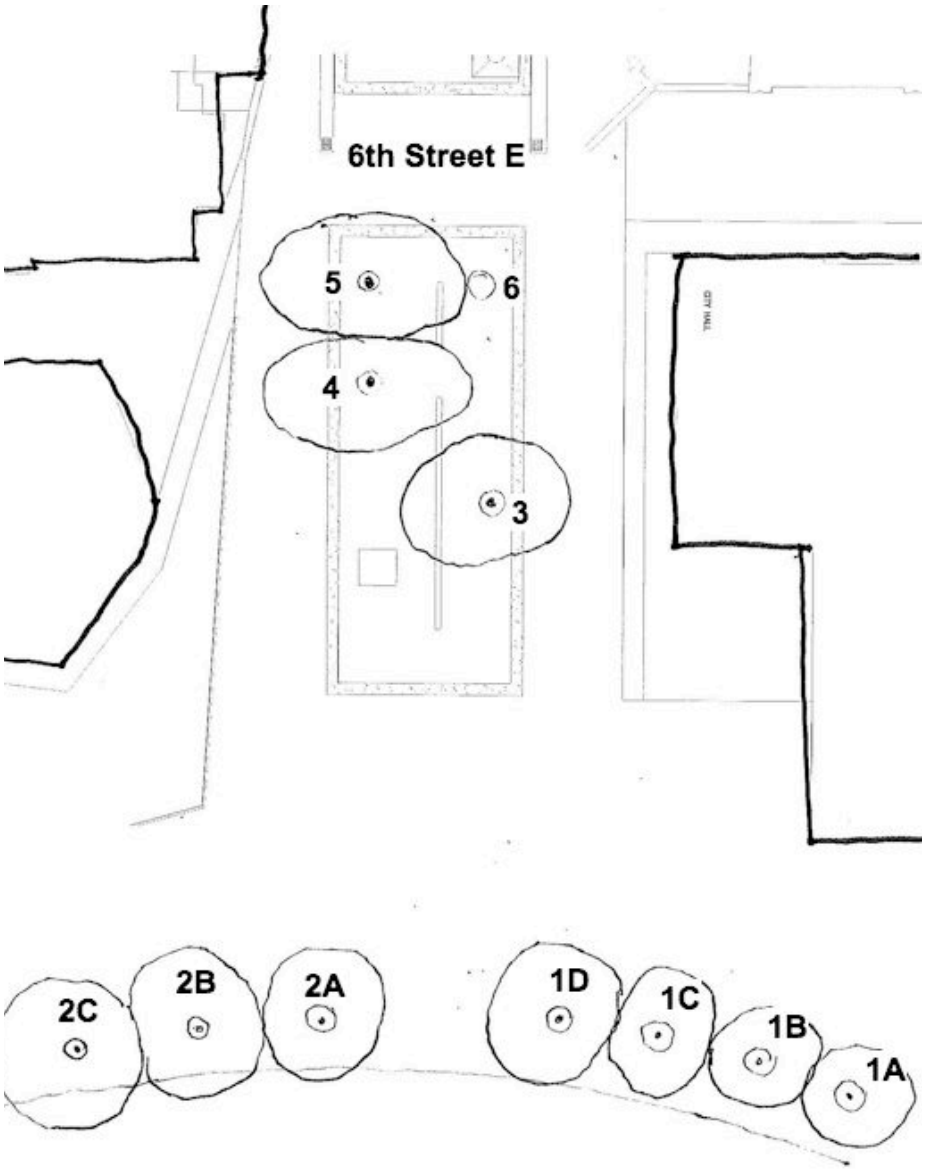
Alternative B. If an even stand of trees at the same spacing and species as the existing is desired, replacing all the trees at one time is preferred. But this solution may not be politically viable.

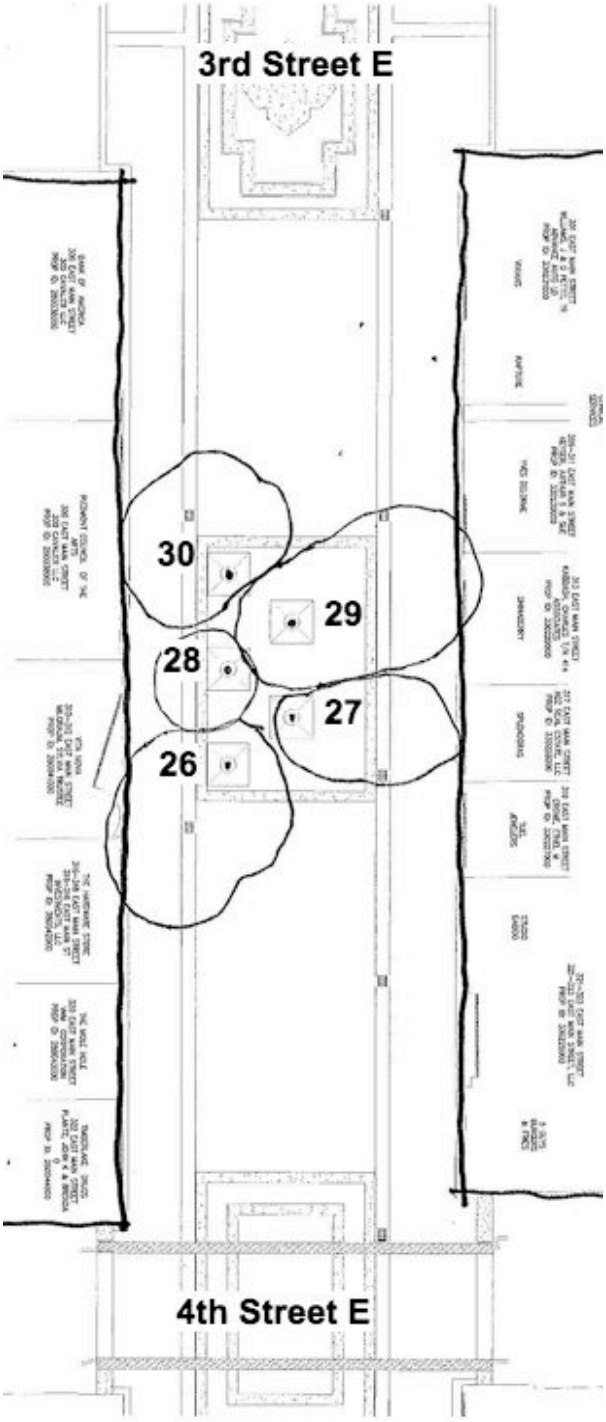
Alternative C. A final approach would be to change out one block at a time over about 15-20 years. The block at the west end of the Mall would be a good test case for this idea. New trees should be planted using the replanting detail shown in this report.

Alternative D. Ideally in Alternative B and C the soil around each tree might be improved using a suspended pavement system such as Silva Cells. That would involve significant increase in the amount of paving to be rebuilt which opens the door to consider an entirely new spacing and tree design to solve the extremely tight spacing that is the cause of the problem in the first place. A redesign also offers the opportunity to add more diversity in the species. Redesign of the mall is beyond the scope of this assessment, but this is a viable option to bring forth for consideration.

Appendix A – Tree Location Key Plan and Canopy Quadrant Study



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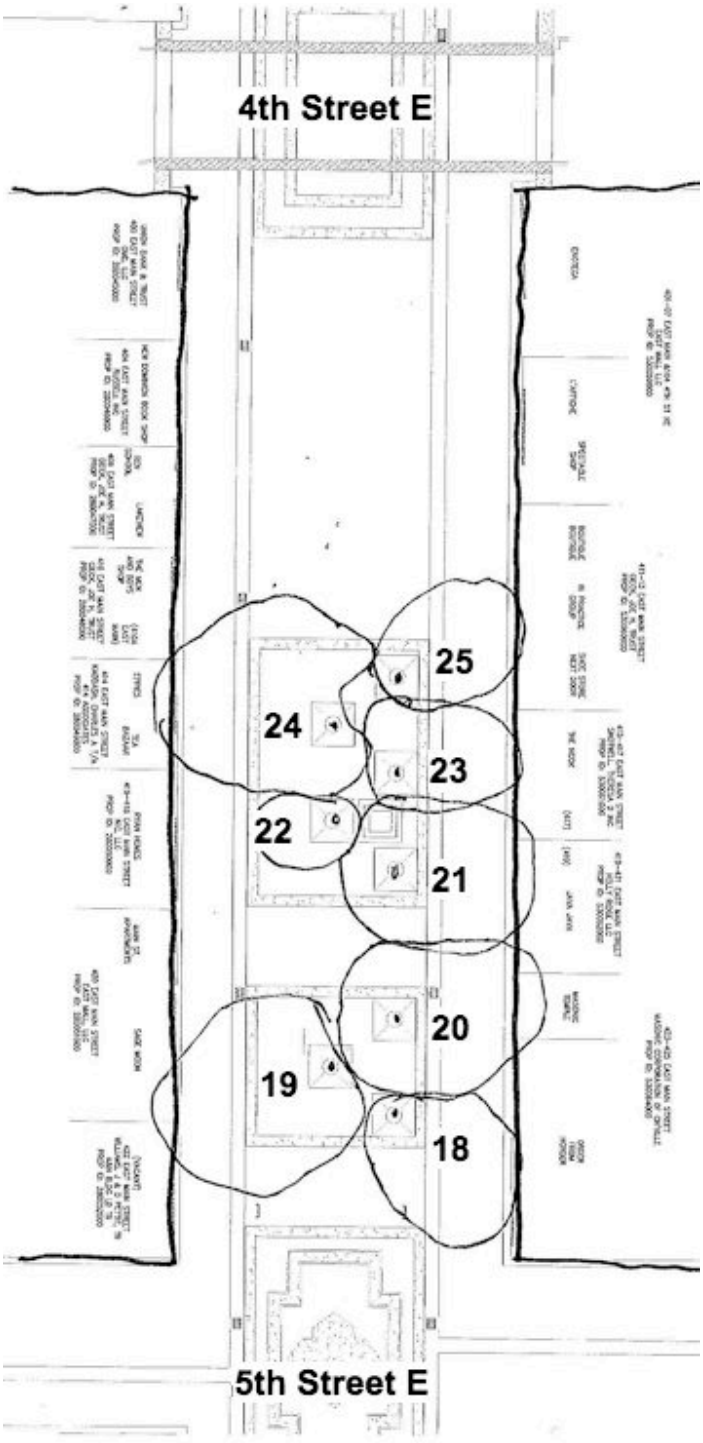
4th Street E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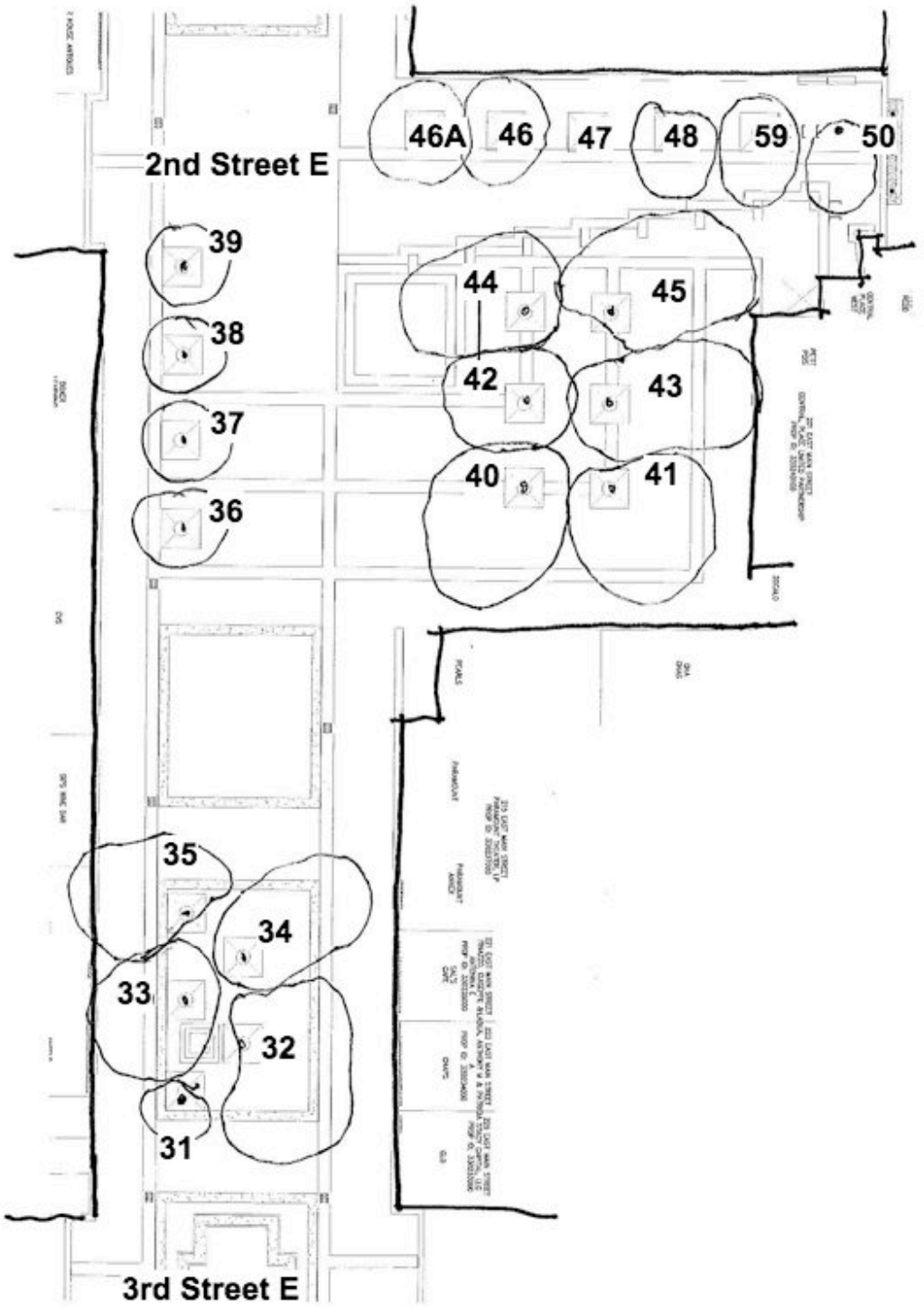
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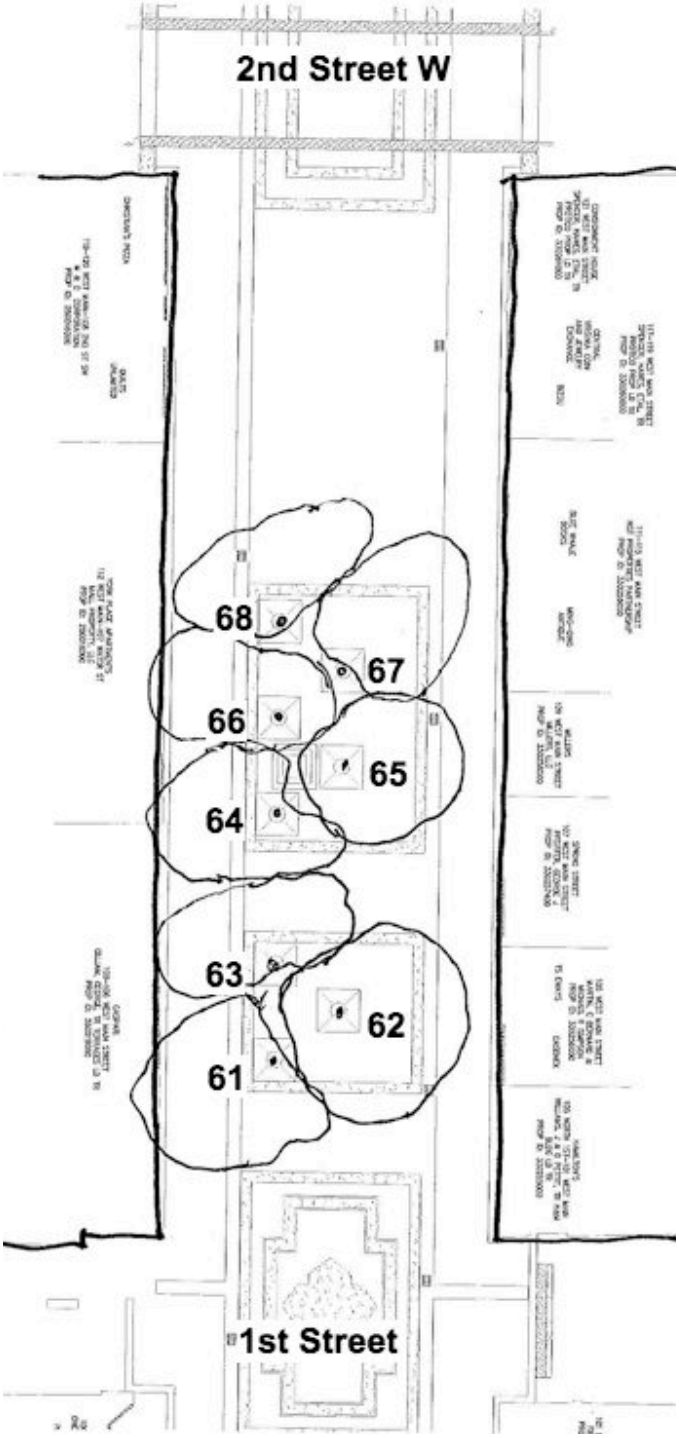
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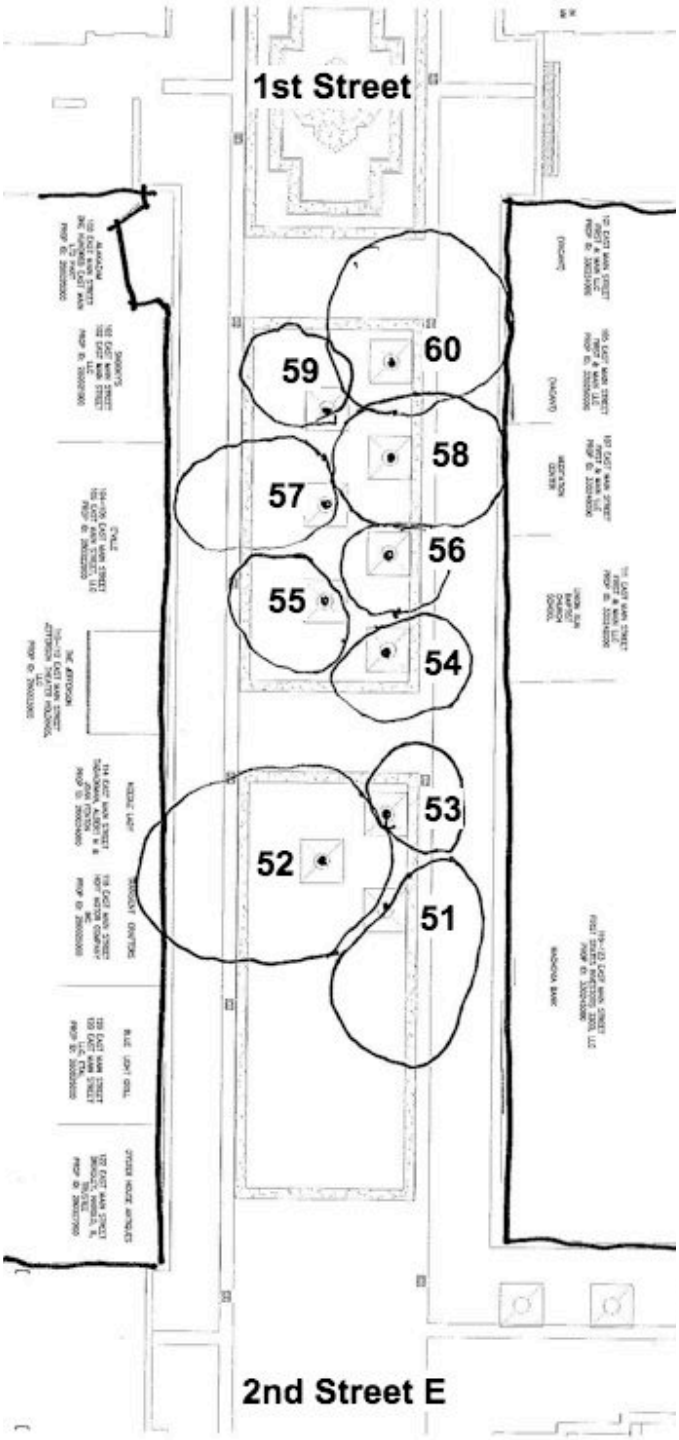
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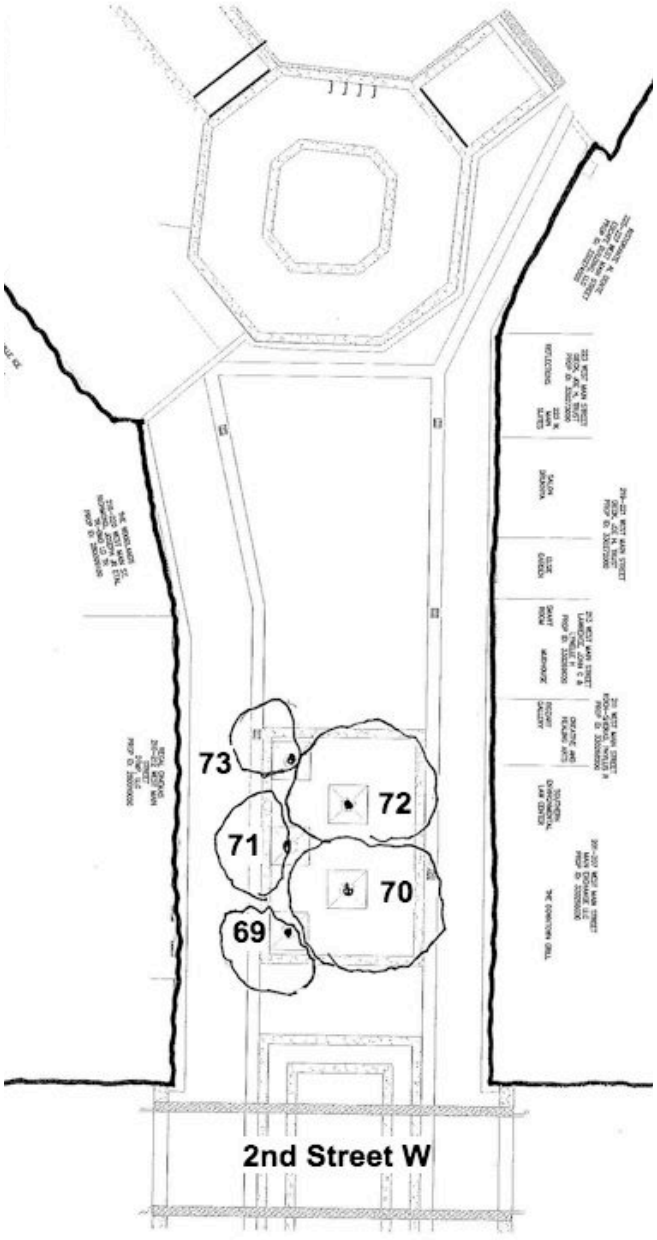
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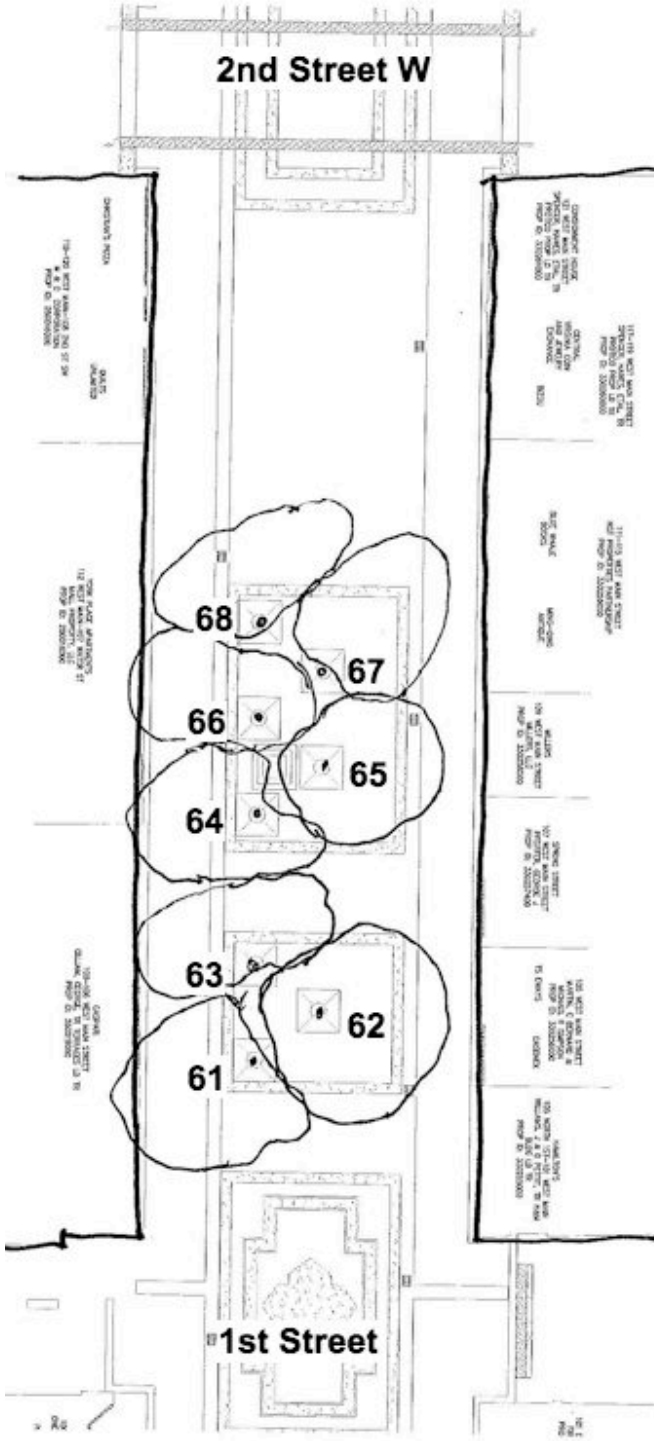
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Appendix B - Field Data Excel Work Sheet

Legend: Keynotes descriptions that apply to the following data tables

DBH 1976: Assumed DBH size at planting based on published report of the mall planting of 6 inches caliper. DBH is assumed to be 80% of Caliper or 4.8 inches. Planting assumed to be spring 1976.

DBH 1989: Field DBH measurements, May 1986, James Urban as part of a research project.

Notes 1989: Field notations, May 1989, by James Urban as part of a research project.

Health 1989: Assessment of tree health, May 1989, by James Urban as part of a research project, using the following key notes:

1. Excellent health.
2. Good health.
3. Fair health.
4. Poor health.
5. Dead.

DBH 2015 inches: Field measurements, October 26, 2015, by James Urban

DBH Growth 1976- 2015 inches: Average DBH growth over 40 growing seasons from spring of 1976 to October of 2015.

DBH Growth 1989-2015 inches: Average DBH growth over 27 growing seasons from May of 2089 to October of 2015.

Vigor 2015: Assessment of tree vigor, October 2015, by James Urban, using the following key notes.

1. Healthy
2. Early fall leaf drop
3. Some branch dieback
4. Significant branch dieback
5. Majority of the canopy dead
6. Very thin canopy, low vigor

Structure 2015: Assessment of tree structure, October 2015, by James Urban, using the following key notes.

1. No structural defects
2. Significant weak branch attachments /co dominant leader(s)
3. Visible large rots or wounds
4. Significant visible structural weakness
5. Possible hazardous structure

Tip extension inches 2015: Estimate of branch tip extension in the 2015 growing season made from the ground.

Trunk / paving interface code: The type of paving around the tree using the following key notes.

1. Brick over metal grate close to trunk w/ thin metal plate to close space around trunk
2. Metal tree grate. Thin metal plate between the grate and trunk for newly planted trees. Grate or plate periodically enlarged.

Tree grate to ground inches 2015: The distance for the top of the tree grate to the soil under the tree grate.

Health problem code 2015: Observed health problems using the following key notes.

A. Old wound on trunk.
B. Thin metal plate removed around trunk.
C. Trunk flare in contact with metal grate or frame.
C1. Significant damage from trunk flare in contact with metal grate or frame.
D. Grate recently enlarged.
E. Thin metal plate constricting trunk.

Canopy quadrant code 2015: The portion of the canopy with branches due to light compitition using the following key notes.

1. 25%
2. 50%
3. 75%
4. 100%

Notes 2015: Field notations, October 2015, by James Urban.

Over all condition: Tree ranking into four categories of overall condition and need for removal:

A Good condition – Recommendation: retention
B Fair condition with issues that can be remediated - Recommendation: retention w/ remediation
C Poor condition - Recommendation: Closely watch w/ remediation
D Very poor condition - Recommendation: Removal

Charlottesville, VA - Main Street Mall																	Data from October 26, 2015
Tree #	Species	DBH 1976 inches (80% of caliper	DBH 1989 inches	Health 1989	Notes 1989	DBH 2015 inches	DBH Growth 1976-2015 inches	DBH Growth 1989-2015 inches	Vigor 2015	Structure 2015	Tip extension inches 2015	Trunk/ paving interface code 2015	Tree Grate to ground inches 2015	Health Problem code 2015	Canopy quadrant code 2015	**Overall condition**	Notes 2015
6th Etreet to the Park																	
1A	Shumard oak Q. shumardii	NA	NA	NA	NA	5.1	NA	NA	3	2	5	1	NA	A	4	**A**	Scale; paving depressed@truck access; Fall web worm
1B	ShumardoOak Q. shumardii	NA	NA	NA	NA	10.9	NA	NA	1 2	2	8 10	1	NA	B/C	4	**B**	Scale; Girdling root; Burn ring trunk base
1C	Shumard oak Q. shumardii	NA	NA	NA	NA	9.3	NA	NA	1	1	8 10	1	NA	A	4	**A**	Scale
1D	Shumard oak Q. shumardii	NA	NA	NA	NA	7.6	NA	NA	1	1	8 10	1	NA	A	4	**A**	Scale
2A	Shumard oak Q. shumardii	NA	NA	NA	NA	7.2	NA	NA	6	1	3 4	1	NA		4	**A**	Flush cut pruning; scale
2B	Shumard oak Q. shumardii	NA	NA	NA	NA	7.1	NA	NA	1 2	2	6 8	1	NA		4	**A**	scale
2C	Shumard oak Q. shumardii	NA	NA	NA	NA	9.4	NA	NA	1	1	10 12	1	NA	C	4	**A**	Flush cut pruning
3	Willow oak Q. phellos	NA	NA	NA	NA	11.6	NA	NA	1	2	12	1	NA	B/C1	4	**B**	Web worm; aphids; scale
4	Willow oak Q. phellos	NA	NA	NA	NA	11.6	NA	NA	1	1	12	1	NA	C	4	**A**	
5	Willow oak Q. phellos	NA	NA	NA	NA	11.9	NA	NA	1 2	1	12	1	NA	C1	4	**B**	
6	XXX																Tree missing
6th Street E to 5th Street E																	
10	Willow oak Q. phellos	4.8	13.7	2		22.2	0.4	0.3	6 2 3	2	3 6	2	10	D	2	**C**	Web worm
11	Willow oak Q. phellos	4.8	13	1		19.1	0.4	0.2	2	2	3 6	2	12	D	1	**C**	
12	Willow oak Q. phellos	4.8	12.2	2		17.8	0.3	0.2	4	2	3 6	2	9	C1 B	1	**D**	Web worm
13	Willow oak Q. phellos	4.8	15.7	4	Gall; tip dieback	35.6	0.8	0.7	1	1	6 8	2	11	C1 B	4	**A**	Topped over by tree 14
14	Willow oak Q. phellos	4.8	16.2	4	Gall; tip dieback	33	0.7	0.6	6 4	1	3 6	2	9	D	3	**C**	Topping over tree 13
15	Willow oak Q. phellos	4.8	12.7	3	Gall	18.5	0.3	0.2	6 2 3	2	3 6	2	16	D	1	**D**	very limited branching quadrant
16	Willow oak Q. phellos	4.8	14.7	3	Gall	11.2	0.2	-0.1	4 2 6 5	2 5	3	2	11	A D	1	**C**	Many large high branches and no terminal leader; probably a replacement since 1989
17	Willow oak Q. phellos	4.8	16.2	3	Gall	31.7	0.7	0.6	4		3	2	13	A C1 D	4	**A**	Wood 2x2 embedded in trunk at grate

Charlottesville, VA - Main Street Mall — Data from October 26, 2015

Tree #	Species	DBH 1976 inches (80% of caliper	DBH 1989 inches	Health 1989	Notes 1989	DBH 2015 inches	DBH Growth 1976-2015 inches	DBH Growth 1989-2015 inches	Vigor 2015	Structure 2015	Tip extension inches 2015	Trunk/ paving interface code 2015	Tree Grate to ground inches 2015	Health Problem code 2015	Canopy quadrant code 2015	**Overall condition**	Notes 2015
5th Street E to 4th Street E																	
18	Willow oak Q. phellos	4.8	13.7	2		25.6	0.5	0.4	3	1	3	2	15	C D	2	**C**	Slight lean; over topped by tree 19 and 20
19	Willow oak Q. phellos	4.8	16.5	2		30.5	0.6	0.5	4 6	3	2	1	4		2	**C**	
20	Willow oak Q. phellos	4.8	15.5	1		28.5	0.6	0.5	1 2	1	3 6	2	12	D	4	**A**	fall Web Worm
21	Willow oak Q. phellos	4.8	13.7	1		24.5	0.5	0.4	2	1	6 8	2	12	D	4	**A**	
22	Willow oak Q. phellos	4.8	13	1		21	0.4	0.3	3	1	3	2	18	D	1	**C**	
23	Willow oak Q. phellos	4.8	12.7	1		21.7	0.4	0.3	1 2	1	3 6	2	13	D	2	**B**	
24	Willow oak Q. phellos	4.8	17.7	1	Gall	38.2	0.8	0.8	1	2	6 8	2	9	C D	3	**A**	Co -dominant leader
25	Willow oak Q. phellos	4.8	12.5	1	Gall	24.5	0.5	0.4	1	1	6 8	2	10	C D	1	**C**	
4th Street E to 3rd Street E																	
26	Willow oak Q. phellos	4.8	16.5	2	Cable in tree	35.6	0.8	0.7	1	1	3 6	2	9	D C1	3	**A**	Small wound on south side of trunk flare
27	Willow oak Q. phellos	4.8	12.5	2		21.2	0.4	0.3	4	2	3 6	2	15	D	2	**C**	Remove dead terminal leader
28	Willow oak Q. phellos	4.8	10.2	1		15	0.3	0.2	1	1	3 6	2	12	D	2	**C**	
29	Willow oak Q. phellos	4.8	15	1		34.1	0.7	0.7	4	1	3 6	2	9	A C1 D	4	**A**	Burned trunk from grate enlargement; Trunk sawed on NW side; remove dead wood
30	Willow oak Q. phellos	4.8	12	2	Gall	24.2	0.5	0.5	1	1	6 8	2	10	D	3	**A**	Dead branch on W side
3th Street E to 2nd Street E																	
31	Willow oak Q. phellos	4.8	13.5	2	Leaning, gall	4.8	0.0	-0.3	6 4	1 2	3 6	2	15	D	3	**B**	Likely replacement tree about 8 years ago;dead lower banches;thin tree grate plate conflict; Co-dominat leader could be removed.
32	Willow oak Q. phellos	4.8	14	2	Gall	22.8	0.5	0.3	3	1	3 6	2	12	D	3	**B**	Lean to N
33	Willow oak Q. phellos	4.8	12.7	2	Gall	19	0.4	0.2	3	1	3 6	2	18	D	3	**C**	
34	Willow oak Q. phellos	4.8	12.2	2		18	0.3	0.2	4	1	3	2	18	D	2	**C**	Significant lean to the N. Not self-correcting.
35	Willow oak Q. phellos	4.8	10	1		35.2	0.8	0.9	1	1	3 6	2	13	A C D	3	**A**	

Charlottesville, VA - Main Street Mall																	Data from October 26, 2015
Tree #	Species	DBH 1976 inches (80% of caliper	DBH 1989 inches	Health 1989	Notes 1989	DBH 2015 inches	DBH Growth 1976-2015 inches	DBH Growth 1989-2015 inches	Vigor 2015	Structure 2015	Tip extension inches 2015	Trunk/ paving interface code 2015	Tree Grate to ground inches 2015	Health Problem code 2015	Canopy quadrant code 2015	**Overall condition**	Notes 2015
2nd Street E to 3rd Street E - Plaza trees																	
36	Acer platanoides Norway Maple	NA	7	5	Much lower in planting pit, Smaller leaves that other maples.	5.4	NA	NA	6	2	2	2	14	E	4	**C**	Originally Red maple A. rubrum; leaf scorch; burned base
37	Acer platanoides Norway Maple	NA	8.5	4	Branch crotch at 4'; multiple branch removals	5.1	NA	NA	6	2	2	2	15	E	4	**C**	Originally Red maple A. rubrum; leaf scorch; burned base
38	Acer platanoides Norway Maple	NA	6.7	5		5.1	NA	NA	6	2	2	2	11	E	4	**C**	Originally Red maple A. rubrum; leaf scorch; burned base and bleeding sap at wound
39	Acer platanoides Norway Maple	NA	6.2	5		4.8	NA	NA	6+	1	>1	2	11	E	4	**D**	Originally Red maple A. rubrum; leaf scorch; burned base and bleeding sap at wound
40	Willow oak Q. phellos	4.8	12	3	Gall; chlorotic leaves	22.3	0.4	0.4	1	1	6 8	2	15	A D	2	**B**	
41	Willow oak Q. phellos	4.8	13	2	Gall	20.4	0.4	0.3	1	1 3	6 8	2	13	D	4	**A**	NW side decay;Green moss and black lesions; lost upper terminal leader and many branches
42	Willow oak Q. phellos	4.8	11.5	3	Gall; chlorotic leaves	20.6	0.4	0.3	4	2	6 8	2	13	D	4	**A**	
43	Willow oak Q. phellos	4.8	13	3	Gall; chlorotic leaves; branch dieback	16.5	0.3	0.1	1	1	3 6	2	15	E	4	**B**	Grate needs enlarging constriction root plate
44	Willow oak Q. phellos	4.8	10.2	1	Chlorotic leaves	23.7	0.5	0.5	3 6	1	3	2	13	C D	3	**B**	
45	Willow oak Q. phellos	4.8	13.2	2	Gall	19.8	0.4	0.2	2 3 6	2 3	3	2	14	D	2	**C**	Significant trunk scar 25% of trunk or 15" of trunk circumference
46A	Acer platanoides Norway Maple	NA	11.7	4	Lost major branch; leans to E 20 deg	6.6	NA	NA	1	1	6 12	2	NA	A D	4	**C**	Scorch; Wound 50% of trunk circumference
46	Acer platanoides Norway Maple	NA	7.2	4	Leans to E 10 deg; Branch crotch at 3.5 feet.	11.5	NA	NA	1	1	18	2	16	A E	4	**A**	
47	Red Maple A. rubrum	NA	8.2	4	Leans to E 10 deg;	NA	NA	NA	NA	NA	NA	2	22	NA	NA	**NA**	Dead; ganoderma conk
48	Red Maple A. rubrum	NA	9	4	Leans to E 10 deg;	12.8	NA	0.1	2 3	2 3	1 2	2	24	D	3	**D**	Basal wound; flush pruning cuts
49	Red Maple A. rubrum	NA	9.5	4	Leans to E 10 deg;	14.3	NA	0.2	2	2 3	1 2	2	18	D	4	**D**	Correctiing lean; few buds
50	Red Maple A. rubrum	NA	8.7	4	Leans to E 10 deg;	19.7	NA	0.4	1	2	8 12	2	16	D	3-	**D**	Correcting lean; very large space between plate and trunk; burned trunk

Charlottesville, VA - Main Street Mall — Data from October 26, 2015

Tree #	Species	DBH 1976 inches (80% of caliper	DBH 1989 inches	Health 1989	Notes 1989	DBH 2015 inches	DBH Growth 1976-2015 inches	DBH Growth 1989-2015 inches	Vigor 2015	Structure 2015	Tip extension inches 2015	Trunk/ paving interface code 2015	Tree Grate to ground inches 2015	Health Problem code 2015	Canopy quadrant code 2015	**Overall condition**	Notes 2015
2nd Street E to 1st Street																	
51	Willow oak Q. phellos	4.8	15.5	2	Group with the thinnest canopy	26.2	0.5	0.4	1	1	3 6	2	15	C D	3	**A**	
52	Willow oak Q. phellos	4.8	15.2	2	Group with the thinnest canopy	28.4	0.6	0.5	1	1	3 6	2	10	C D	4	**A**	
53	Willow oak Q. phellos	4.8	12.5	1	Group with the thinnest canopy	16.3	0.3	0.1	2 4 6	2	3	2	16	D	1	**D**	
54	Willow oak Q. phellos	4.8	12.2	2	Group with the thinnest canopy	17.7	0.3	0.2	2 4 6	1	3	2	17	D	2	**C**	
55	Willow oak Q. phellos	4.8	13.7	2	Group with the thinnest canopy	18.6	0.3	0.2	2 4 6	2	3	2	16	D	2	**C**	
56	Willow oak Q. phellos	4.8	10.7	1	Group with the thinnest canopy	15.3	0.3	0.2	2	2	3 6	2	20	D	4	**C**	Slight lean to N
57	Willow oak Q. phellos	4.8	12.2	3	Gall	20	0.4	0.3	2 4 6	1	3	2	18	D	1	**C**	Slight correcting lean to S
58	Willow oak Q. phellos	4.8	13	1	Aphids	19.9	0.4	0.3	1	1	3 6	2	20	D	4	**A**	
59	Willow oak Q. phellos	4.8	13.7	4	Aphids	18.2	0.3	0.2	2 4 6	2	3	2	19	D	1	**D**	Slight correcting lean to S
60	Willow oak Q. phellos	4.8	15.2	3	Aphids	27.6	0.6	0.5	2 4 6	1	3	2	13	C D	4	**C**	Swelling at trunk base above trunk flare
1st Street to 2nd Street W																	
		Note Trees part of a Phase two extension of the Main Street Mall. No data collected in 1989. Year and size of planting not known.															
61	Willow oak Q. phellos	NA	NA	NA	NA	22	NA	NA	2	1	3 6	2	9	A C D	2	**C**	Burned w/ wound at base
62	Willow oak Q. phellos	NA	NA	NA	NA	24.5	NA	NA	1	2	3	2	11	A D	4	**B**	Burned w saw cuts at base; co dominat leader with included bark
63	Willow oak Q. phellos	NA	NA	NA	NA	24.4	NA	NA	2	1	3 6	2	12	A C	2	**B**	
64	Willow oak Q. phellos	NA	NA	NA	NA	30	NA	NA	1	1	3 6	2	10	C1 D	3	**B**	
65	Willow oak Q. phellos	NA	NA	NA	NA	26.7	NA	NA	1	1	3 6	2	10	C1 D	4	**A**	Burned at base
66	Willow oak Q. phellos	NA	NA	NA	NA	16.1	NA	NA	1	1	3 6	2	12	D	4	**A**	Very green fall color, warter standing in tree space possibly from fountain
67	Willow oak Q. phellos	NA	NA	NA	NA	23.9	NA	NA	1	1	3 6	2	11	A C D	3	**A**	Water stain on E face of trunk; canopy supressed growth with many epcormic branches
68	Willow oak Q. phellos	NA	NA	NA	NA	26.5	NA	NA	1	1	6 10	2	8	A C D	3	**A**	Grate needs to be enlarged

Charlottesville, VA - Main Street Mall — Data from October 26, 2015

Tree #	Species	DBH 1976 inches (80% of caliper	DBH 1989 inches	Health 1989	Notes 1989	DBH 2015 inches	DBH Growth 1976-2015 inches	DBH Growth 1989-2015 inches	Vigor 2015	Structure 2015	Tip extension inches 2015	Trunk/ paving interface code 2015	Tree Grate to ground inches 2015	Health Problem code 2015	Canopy quadrant code 2015	**Overall condition**	Notes 2015
2nd Street W to Mall end																	
Note Trees part of a Phase two extension of the Main Street Mall. No data collected in 1989. Year and size of planting not known.																	
69	Willow oak	NA	NA	NA	NA	19.3	NA	NA	4 6	1	3	2	9	C D	2	**C**	Lost terminal leader
70	Willow oak Q. phellos	NA	NA	NA	NA	28.5	NA	NA	4 6	2	3	2	10	C D	4	**C**	Lost terminal leader
71	Willow oak Q. phellos	NA	NA	NA	NA	15.1	NA	NA	2	1	3 6	2	17	D	2	**D**	Lost terminal leader
72	Willow oak Q. phellos	NA	NA	NA	NA	24.2	NA	NA	5 6	1	3	2	9	C D	4	**C**	
73	Willow oak Q. phellos	NA	NA	NA	NA	17.7	NA	NA	4 6	1	3 6	2	12	C D	1	**C**	