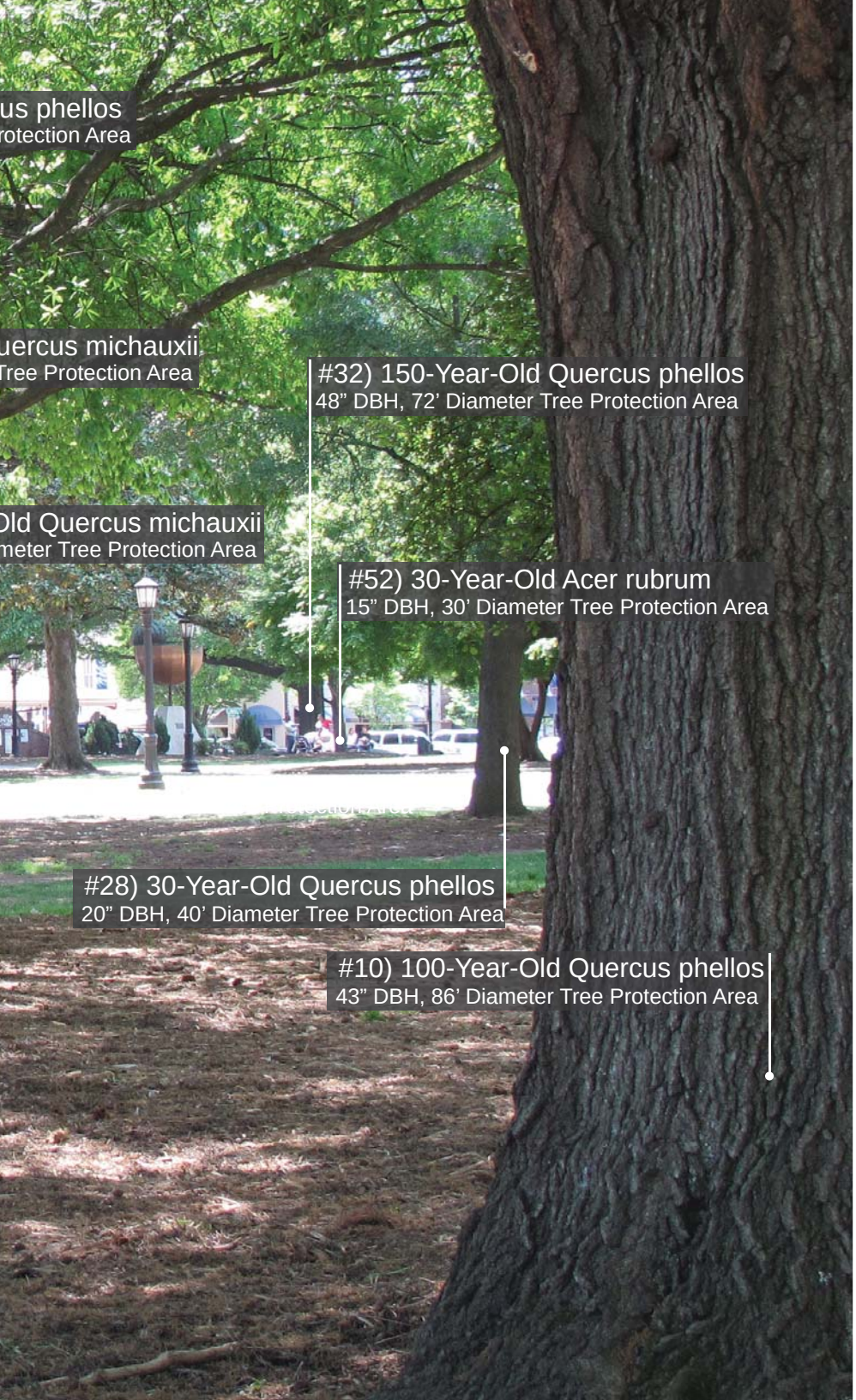
MOORE SQUARE COMPREHENSIVE TREE STRATEGY

Raleigh Parks and Recreation Department

April 2013


#25) 30-Year-Old Querc
17” DBH, 26’ Diameter Tree P
#2) 200-Year-Old Quercus phellos
65” DBH, 194’ Diameter Tree Protection Area
#26) 30-Year-Old Quercus phellos
17” DBH, 26’ Diameter Tree Protection Area
#3) 150-Year-Old Q
51” DBH, 152’ Diameter T
#45) 100-Year-Old Quercus phellos
44” DBH, 88’ Diameter Tree Protection Area
#48) 100-Year-Old Quercus phellos
34” DBH, 50’ Diameter Tree Protection Area
#36) 30-Year-Old Quercus phellos
10” DBH
#1) 150-Year-O
52” DBH, 104’ Dia
#46) 100-Year-Old Quercus prinus
43” DBH, 130’ Diameter Tree Protection Area
#27) 100 Year-Old-Quercus phellos
42” DBH, 84’ Diameter Tree Protection Area
#33) 100-Year-Old Quercus phellos
#34) 100-Year-Old Quercus phellos
34” DBH, 68’ Diameter Tree Protection Area
*DBH: Diameter at Breast Height



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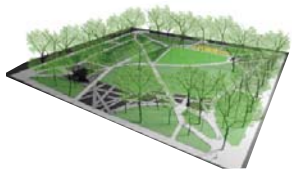
Public Input #1

Public input collected by the City of Raleigh before the Competition.

National Competition



2009
Winning Competition Concept

Public Input #2

Master Plan Public Participation Event 1

Public Input #3

Master Plan Public Participation Event 2

Master Plan

2010
Moore Square Master Plan

Comprehensive Tree Strategy
(3 Months)

Current Phase
Comprehensive Tree Strategy

Public Input #4

Public Input #5

Schematic Design* &
Design Development*
(8 Months)

Future Design Phases
Schematic Design
Design Development

Public Input #6

Construction Documents*
(8 Months)

Construction Documents

After the MSCTS complete in April 2013, there will be three additional public participation opportunities for the public to engage in and review the design process as the project continues.

Park Construction*
(12 Months)

Park Construction Documents

* Phases not currently funded.

PROJECT OBJECTIVES:

1. Develop tree preservation and enhancement goals to guide the future design of Moore Square improvements.

2. Conduct an intensive analysis of the existing trees, soils and topographic conditions in Moore Square before detailed design phases begin.

3. Summarize and synthesize findings through publicly accessible diagrams in addition to making recommendations for future design improvements of Moore Square.

MOORE SQUARE COMPREHENSIVE TREE STRATEGY OVERVIEW

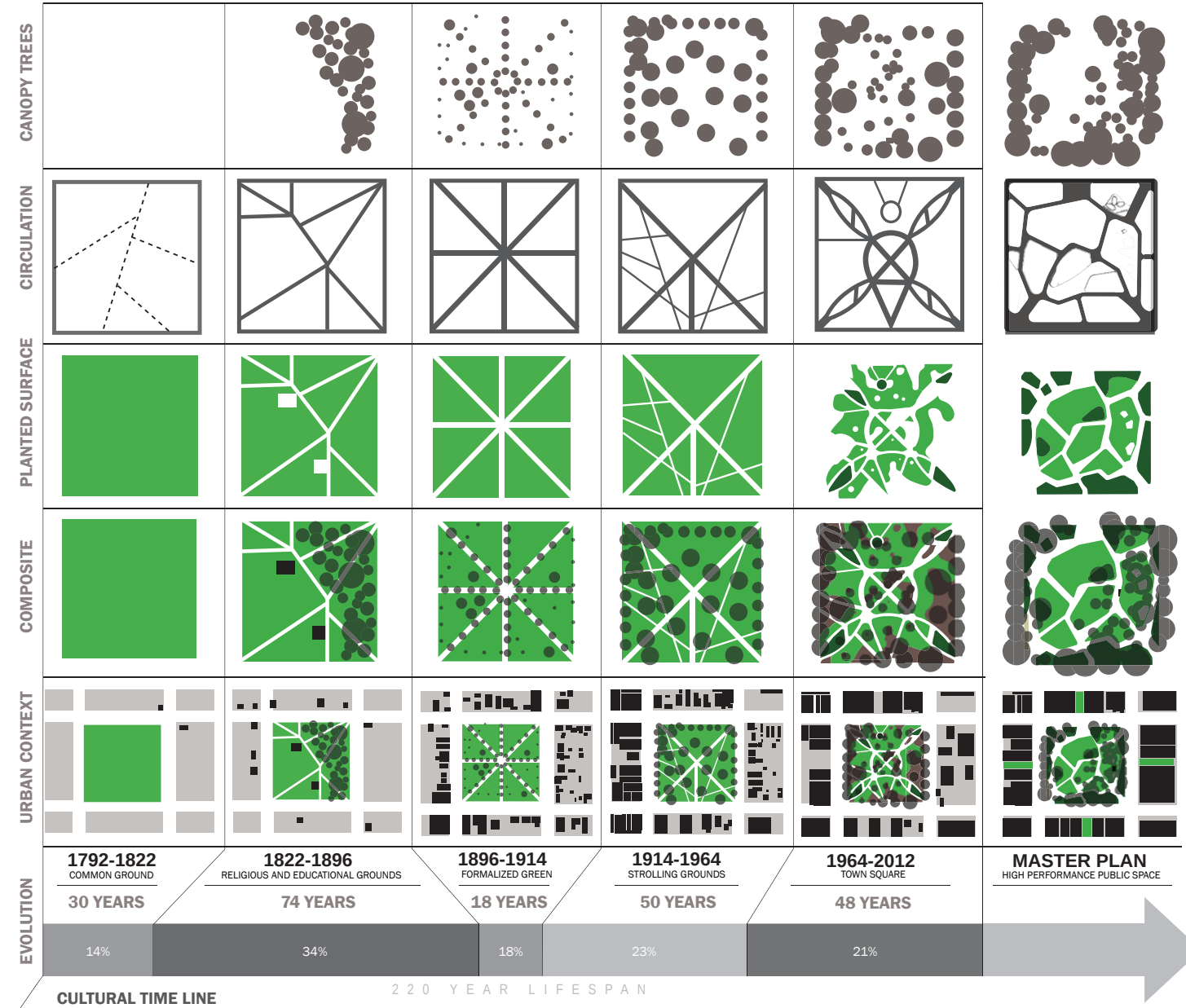
The conception of the Moore Square Comprehensive Tree Strategy (MSCTS) was proposed as a means to ensure that the long-term preservation and enhancement of the existing Oak Grove drives future design efforts. Traditionally, such a highly detailed existing analysis is undertaken late in the design process often associated with actual construction. However, given the importance of this project and the central role that tree preservation is to this project, the design team felt it critical that such a study be conducted before beginning the schematic design phase. Key to maintaining this commitment is securing all possible technical information on the existing trees and soils before the formal design process begins.

This preemptive body of research and analysis is intended to ensure that the aspirations of the Moore Square Master Plan are developed through a thoughtful and responsible framework in developing improvements for one of Raleigh's most important civic treasures. The project objectives can be broken into three separate phases reflected in this report: 1) developing tree preservation and enhancement goals to guide the future design; 2) conducting an intensive analysis of the existing trees and soils conditions; 3) summarizing and synthesizing findings through publicly accessible diagrams in addition to making future design improvements.

A key part of this recommendation involved retaining the services of James Urban of Urban Trees + Soils, an internationally recognized expert on urban trees and soils to join the design team for this critical phase of the project. Building off the nationally recognized Moore Square Master Plan (finalist in the ASLA National Award in Analysis and Planning 2011), this study offers insight and recommendations to ensure the proposed improvements to Moore Square will live up to their promise. In addition to the analysis of existing conditions, this study has produced rigorous 100-year growth and decline projections for the existing and proposed canopy trees that synthesize the Master Plan with the MSCTS. This modeling has led to a canopy management strategy that is innovative in its scope and comprehensive in its recommendations. This body of work is intended to help fulfill the commitment to the long-term vitality of the Grove and the improvement of Moore Square as a social space for the children and grandchildren of the City of Oaks.

DESIGN TEAM:

Prime Consultant	**CCSGC, P.C.**, Brooklyn, New York
Nationally Recognized Tree Expert	**Urban Trees + Soils** (James Urban FASLA, ISA), Annapolis, Maryland
Arborist	**Bartlett Tree Experts,** Raleigh, North Carolina
Consulting Landscape Architect	**Cynthia Rice Landscape Architecture and Planning, PLLC,** Raleigh, North Carolina



CULTURAL TIME LINE

TOWN PLAN
1792
Christmas completes survey and signs first official plat for Raleigh.

SQUARE NAMED FOR ALFRED E. MOORE
1792
The Square was named in honor of Alfred E. Moore, N.C. State Attorney General and U.S. Supreme Court Associate Justice, and Captain in the Continental Army.

SCHOOL GROUNDS
1842
Eastern Ward School built in southeast corner. In 1844 the School changed its name to the NC Classical, English and Mathematical School.

CHURCH GROUNDS
1822
A Church located across Person Street is moved to the Square.

MILITARY DRILLS
1844
Military drills held in open space adjacent to school due to Mexican War.

INTEGRATED CHURCH
1840-59
Square becomes home to area's first integrated Church when the Christian Chapel begins services for blacks and whites.

AFRICAN AMERICAN UNION SOLDIERS OCCUPY SQUARE
1865-71
African-American soldiers occupy the square to help enforce efforts at Reconstruction and prevent attempts at uprising.

EMPTY BUILDINGS
1861-65
The buildings on site sit empty.

FARMERS' MARKET
1868-1870
The Square is used as a temporary farmers market after the existing market located elsewhere is destroyed by fire.

PUBLIC SCHOOL
1866
A school opens in the old church building. Anyone with the funds to buy books may attend.

CHURCH MOVES
1896
State allows black former members of Baptist Grove Church to move the structure elsewhere for their use.

INTERIOR OAKS PLANTED
1871
The City is given authority by the State to beautify the Square and several stands of Oaks are planted.

PERIMETER OAKS PLANTED
1910
The Square becomes the City's most popular park and perimeter oaks are planted.

NEW PATHS + OAKS
1899
A state bill entrusts the Square's maintenance to the City of Raleigh. A more permanent path system, including islands with Oaks, is laid down.

BLACK BUSINESSES
1920's
An explosion in black owned businesses on Hargett St. and City Market results in strong use of the park for social events.

CITY MARKET OPENS
1914
The City Market opens across Martin Street from the Square.

LIBRARY OPENS
1935
The Richard B. Harrison Library opens facing the Square.

BLACK MAIN STREET
1930's
Black Main Street reaches its peak, bringing social and economic growth to the Square, despite the Depression.

EVENT VENUE
1970's
As decline bottoms out, the Square hosts occasional festivals in an attempt to renew interest in downtown.

DEPRESSED DOWNTOWN
1957
The Square finds itself surrounded by nearly half a million square feet of emptying space.

HISTORIC REGISTER
1983
Moore Square Historic District is listed in National Register of Historic Places.

ART DISTRICT
1980's
The Square attracts artists as the old City Market becomes home to Raleigh's art colony.

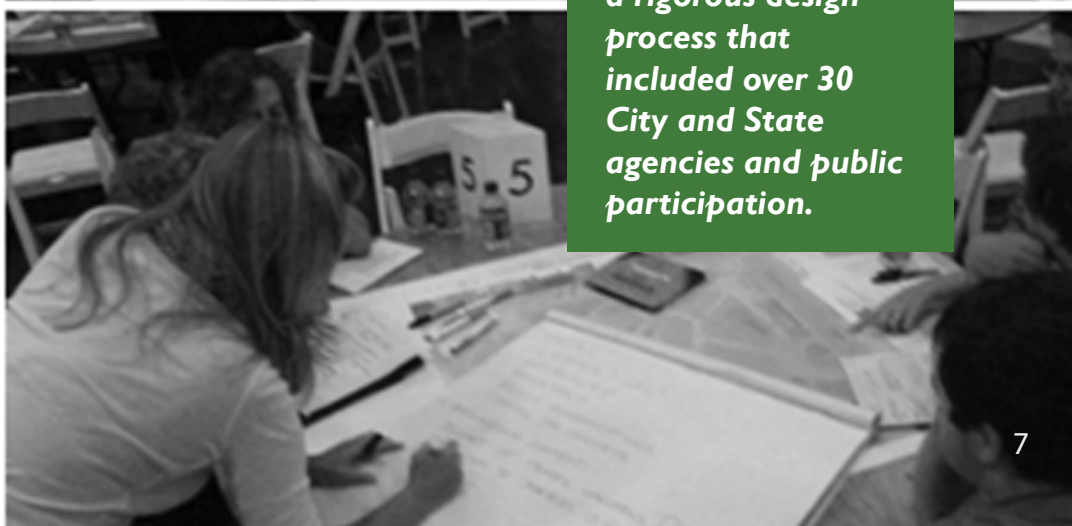
MOORE SQUARE MIDDLE SCHOOL
2002
Moore Square Middle School campus opens.

KIDS MUSEUM + IMAX
1999
Marbles Kids Museum and IMAX Premiere Opens

Although the natural and built conditions of Moore Square have changed dramatically over its 221-year history, its historical legacy lies in its evolving use as a social space.

CULTURAL AND PHYSICAL HISTORY OF MOORE SQUARE

The Moore Square Master Plan was developed through a rigorous design process that included over 30 City and State agencies and public participation.

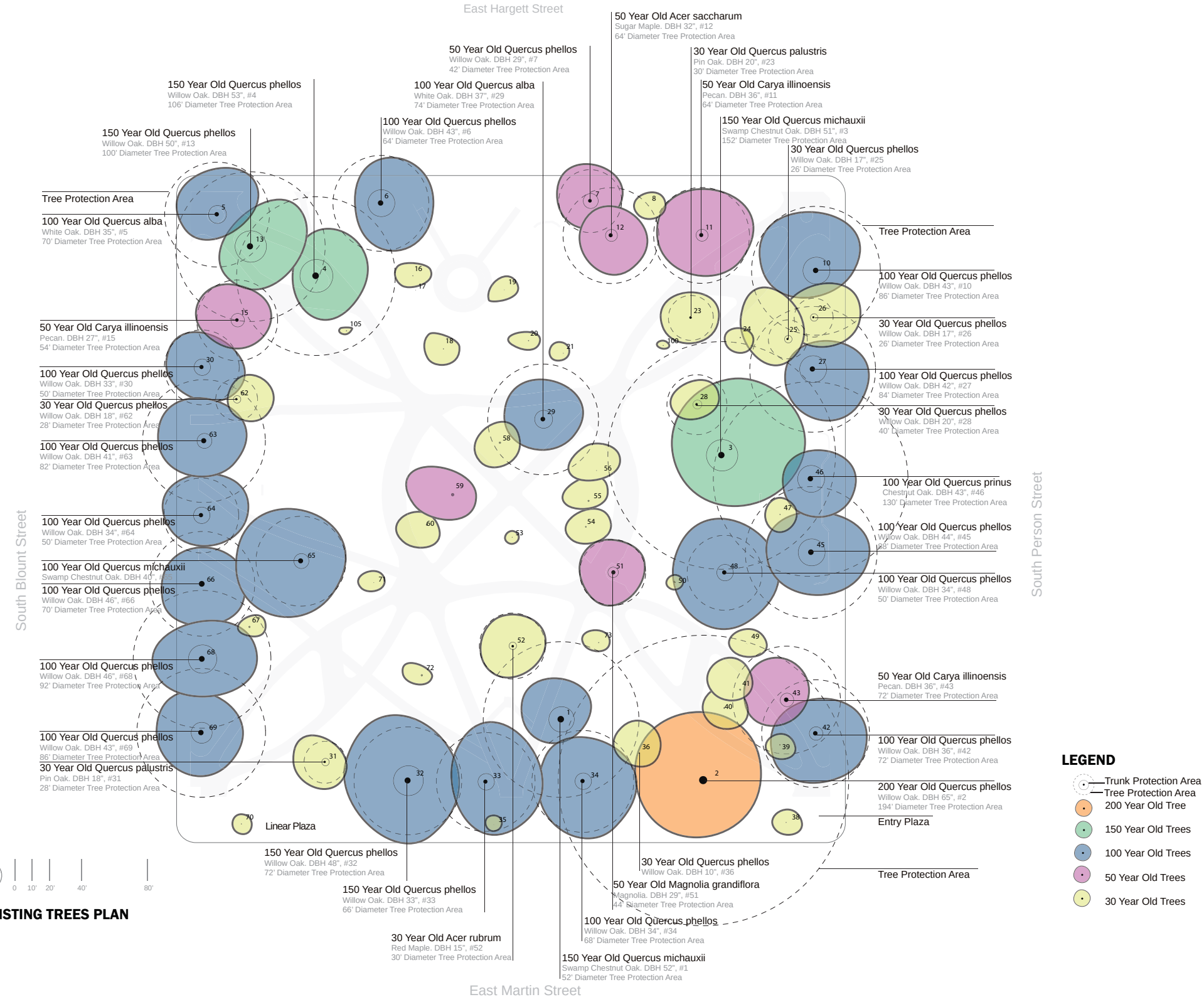



MOORE SQUARE CAFE


MOORE SQUARE CAFE

2010 MASTER PLAN CONCEPT

Moore Square is one of the two surviving squares of William Christmas' 1792 four-square town plan in the capital City of Raleigh, North Carolina. It is a public space with a rich history and a magnificent stand of mature oak trees, giving it tremendous potential to shape the new identity of Raleigh in the 21st Century. Like many cities throughout the United States, the City of Oaks is enjoying a resurgence of life in its downtown core. As an increasing number of young adults, empty nesters, and new residents move back to downtown for its amenities and urban lifestyle, improvement of the quality of Raleigh's public space is critical to its continued economic and cultural growth. This investment in improvements to Moore Square will distinguish Raleigh as a city with premier public spaces and act as a catalyst for downtown growth and economic development. As the City of Raleigh continues to draw new urban dwellers attracted to a burgeoning downtown lifestyle, the city will require beautiful civic spaces to sustain this flourishing urban activity and landmark cultural growth. The Moore Square Master Plan concept design honors the Square's historic heritage while establishing a forward looking vision for a 21st century urban space. The Master Plan seeks to elevate the status of the Square to its historical importance as one of the original four squares of the City of Raleigh, while giving physical expression to the progressive, contemporary and diverse aspirations of the citizens of Raleigh today.


East Hargett Street
South Blount Street
South Person Street
East Martin Street
50 Year Old Acer saccharum
Sugar Maple. DBH 32", #12
64' Diameter Tree Protection Area
50 Year Old Quercus phellos
Willow Oak. DBH 29", #7
42' Diameter Tree Protection Area
30 Year Old Quercus palustris
Pin Oak. DBH 20", #23
30' Diameter Tree Protection Area
150 Year Old Quercus phellos
Willow Oak. DBH 53", #4
106' Diameter Tree Protection Area
100 Year Old Quercus alba
White Oak. DBH 37", #29
74' Diameter Tree Protection Area
50 Year Old Carya illinoensis
Pecan. DBH 36", #11
64' Diameter Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 43", #6
64' Diameter Tree Protection Area
150 Year Old Quercus michauxii
Swamp Chestnut Oak. DBH 51", #3
152' Diameter Tree Protection Area
150 Year Old Quercus phellos
Willow Oak. DBH 50", #13
100' Diameter Tree Protection Area
30 Year Old Quercus phellos
Willow Oak. DBH 17", #25
26' Diameter Tree Protection Area
Tree Protection Area
100 Year Old Quercus alba
White Oak. DBH 35", #5
70' Diameter Tree Protection Area
Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 43", #10
86' Diameter Tree Protection Area
50 Year Old Carya illinoensis
Pecan. DBH 27", #15
54' Diameter Tree Protection Area
30 Year Old Quercus phellos
Willow Oak. DBH 17", #26
26' Diameter Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 33", #30
50' Diameter Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 42", #27
84' Diameter Tree Protection Area
30 Year Old Quercus phellos
Willow Oak. DBH 18", #62
28' Diameter Tree Protection Area
30 Year Old Quercus phellos
Willow Oak. DBH 20", #28
40' Diameter Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 41", #63
82' Diameter Tree Protection Area
100 Year Old Quercus prinus
Chestnut Oak. DBH 43", #46
130' Diameter Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 34", #64
50' Diameter Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 44", #45
85' Diameter Tree Protection Area
100 Year Old Quercus michauxii
Swamp Chestnut Oak. DBH 46", #66
100 Year Old Quercus phellos
Willow Oak. DBH 46", #66
70' Diameter Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 34", #48
50' Diameter Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 46", #68
92' Diameter Tree Protection Area
50 Year Old Carya illinoensis
Pecan. DBH 36", #43
72' Diameter Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 43", #69
86' Diameter Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 36", #42
72' Diameter Tree Protection Area
30 Year Old Quercus palustris
Pin Oak. DBH 18", #31
28' Diameter Tree Protection Area
200 Year Old Quercus phellos
Willow Oak. DBH 65", #2
194' Diameter Tree Protection Area
Linear Plaza
Entry Plaza
150 Year Old Quercus phellos
Willow Oak. DBH 48", #32
72' Diameter Tree Protection Area
30 Year Old Quercus phellos
Willow Oak. DBH 10", #36
Tree Protection Area
150 Year Old Quercus phellos
Willow Oak. DBH 33", #33
66' Diameter Tree Protection Area
50 Year Old Magnolia grandiflora
Magnolia. DBH 29", #51
44' Diameter Tree Protection Area
100 Year Old Quercus phellos
Willow Oak. DBH 34", #34
68' Diameter Tree Protection Area
30 Year Old Acer rubrum
Red Maple. DBH 15", #52
30' Diameter Tree Protection Area
150 Year Old Quercus michauxii
Swamp Chestnut Oak. DBH 52", #1
52' Diameter Tree Protection Area
0 10' 20' 40' 80'
EXISTING TREES PLAN
LEGEND
Trunk Protection Area
Tree Protection Area
200 Year Old Tree
150 Year Old Trees
100 Year Old Trees
50 Year Old Trees
30 Year Old Trees

EXISTING TREE ANALYSIS

TREE EVALUATIONS

There have been a number of tree evaluations undertaken for the trees in Moore Square. The City of Raleigh provided the design team with a tree evaluation at the beginning of the project. Jeffrey Kish of Bartlett Tree Experts, a consultant to the design team, made initial evaluations of each tree. These first two evaluations were focused on general tree health.

Urban Trees + Soils, the design team's soil and tree consultant, made an additional survey. This survey looked at the trees from the perspective of the tree's ability to survive construction and included looking at the tree's vigor, structure and the condition, relative to designing paving and other structures in close proximity to the tree. The goal of this survey was to obtain data to use in calculating the Tree Protection Area and the Trunk Base Protection Area, and to make recommendations on the tree's ability to withstand construction impacts.

Moore Square has nearly 70 trees, the majority of which are mature specimens. They are the soul of the park and treasured by the citizens of Raleigh for their green canopy at the perimeter of the park. Maintaining this canopy is critical to the park improvement plans. The current Master Plan concepts show places where proposed alterations are likely to fall within areas normally considered as part of the trees root zone. This report will set the limits of the Tree and Trunk Protection Areas, but also indicate what are the most critical things to-do and not-to-do within these areas.

Note that only the site's large, mature trees were evaluated for construction impact tolerance. There are 37 large mature trees out of a total of approximately 68 existing trees in Moore Square. The remaining smaller trees at the site will be relatively easy to work around where they are determined to be preserved.

TRUNK BASE EVALUATIONS AND TRUNK BASE PROTECTION AREAS

This evaluation determines the degree of difficulty in working near the base of the tree. The Trunk Base Evaluation is then used to set the Trunk Base Protection Area. This area, close to the base of the tree, is the area where even minor disturbance may severely injure the tree. The Trunk Base Protection Area is the distance new paving should be kept away from the trunk or where special construction is required to eliminate damage to roots and bark. This area must receive special protection treatment over and above the requirements of the larger Tree Protection Area. The size of the Trunk Base Protection Area is an initial recommendation. The distance may be decreased if special details such as flexible paving surfaces or bridging design are utilized, or may need to be larger due to topography or surface rooting conditions. These stand-off dimensions assume that no cut is required to construct the paving in this area. In areas where paving is already inside of the stand-off zone, as along Blount Street, new paving may be installed provided that the limit of paving is not brought closer to the tree or the paving section deeper than the existing paving.

TRUNK BASE TERMINOLOGY

Trunk Base Evaluation classifications, criteria, and limits of the Trunk Base Protection Area (TBPA) are:

Normal: Reasonably size trunk flair proportion with little damage or other problems. TBPA radius from center of trunk – 1.5 times trunk diameter.
Moderate: Larger size trunk flare, minor damage or other problem that may require special attention in the design. TBPA radius from center of trunk – 2 times trunk diameter.
Difficult: Extra large trunk flare or significant surface roots, existing trunk flare damage and other issue that may need additional investigation and response during the design process. Paving stand off radius from center of trunk – 2.5 times trunk diameter.

TREE STRUCTURE EVALUATION

This evaluation notes observed problems with branch structure or tree stability. Tree structure is critical to the long-term success of a tree and may be a significant factor in determining if a tree is a good candidate for tree preservation.

TREE STRUCTURE TERMINOLOGY

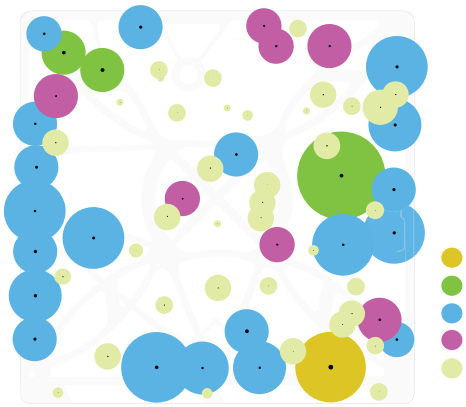
Good: No observed problems
Fair: Minor branch conflicts such as co-dominant leaders that are easily modified.
Poor: Significant branch conflicts such as co-dominant leaders that are not easily modified, dead portions of trees, asymmetrical canopies or trunk leans.

TREE VIGOR TERMINOLOGY

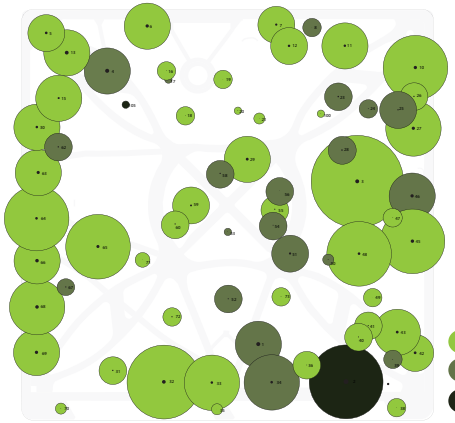
This evaluation records tree growth vigor as determined by leaf color, density and distribution in the canopy. A tree's vigor is a critical indicator of a tree's ability to survive root loss.

Good: Normal leaf color, size and distribution
Fair: Observable variation from normal leaf color, density and distribution in the canopy. Minor twig die back.
Poor: Significant variation form normal leaf color, density and distribution in the canopy. Significant twig die back.

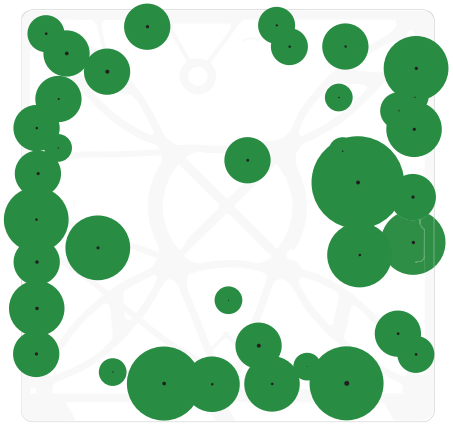
The key to preserving the perimeter canopy is ensuring that the trees that enhance the perimeter grove canopy receive the highest priority.



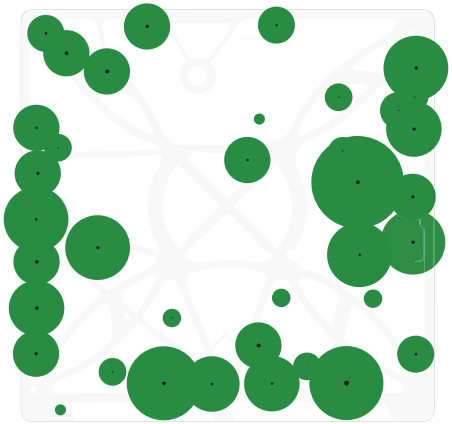
TREE AGE



TREE HEALTH



CANOPY TREES



OAK TREES

FINDINGS

The above diagrams illustrate information collected by Urban Trees + Soils that can be found on the following tree evaluation date matrix. Of the Square's 68 trees, 41% were found to roughly 30 years old, 10% roughly 50, 26% roughly 100 years old, 21% 150 years old, and the remaining 2% 200 years old. Roughly half of the Square's canopy trees (47%) are Oaks, and more than half (56%) are Canopy trees. The above charts graphically represent these findings and illustrate these distributions overlaid on the existing plan of the site. The following section on soils will help to illustrate the conditions in which each of these trees is growing in order to provide insight into why certain trees may be considered in better condition than others and as to how future steps can be taken to ensure healthy long-term strategies for Moore Square.

On the next page, several charts record the findings of additional tree health as reported in the Bartlett Tree Experts report based on condition, age class, diameter distribution, value, and those with conditions, defects and other structural issues. In addition, it was found that 24 of the 68 trees on the site are recommended for further investigation for a hazardous tree review by the City to ensure public safety for the site.

ID	Tree Name	DBH (In)	Canopy Radius (Ft)	Overall Condition	Hazard Evaluation Recommendation	Trunk Base	Structure	Vigor	Age Class
1	Quercus michau	52.0	25	fair	YES	Moderate	Poor	Fair	mature
2	Quercus phellos	65.0	40	good	YES	Difficult	Poor	Fair	over-mature
3	Quercus michau	51.0	50	good	YES	Difficult	Poor	Fair	over-mature
4	Quercus phellos	53.0	25	good	YES	Difficult	Fair	Fair	mature
5	Quercus alba	35.0	20	good	YES	Moderate	Fair	Fair	mature
6	Quercus phellos	43.0	25	good	YES	Difficult	Fair	Good	mature
7	Quercus phellos	29.0	20	good	YES	Moderate	Fair	Good	mature
8	Cornus florida	4.0	10	fair					Young
10	Quercus phellos	43.0	35	good	YES	Difficult	Poor	Fair	mature
11	Carya illinoens	32.0	25	good	YES	Normal	Fair	Good	mature
12	Acer saccharum	32.0	20	good	YES	Normal	Fair	Good	mature
13	Quercus phellos	50.0	25	good	YES	Difficult	Fair	Fair	mature
15	Carya illinoens	27.0	25	good	field check	Moderate	Fair	Good	mature
16	Acer palmatum	8.0	10	good					mature
17	Acer palmatum	4.0	4	fair					Yioung
18	Acer campestre	8.0	10	good					young
19	Magnolia x soul	5.0	10	good					mature
20	ILAT Ilex sp	9.0	4	good					mature
21	Quercus shumard	6.0	6	good					young
23	Quercus palustr	20.0	15	fair		Normal	Good	Fair	mature
24	Malus species	11.0	10	fair					mature
25	Quercus phellos	17.0	20	fair		Normal	Good	Fair	mature
26	Quercus phellos	17.0	15	good		Normal	Fair	Fair	mature
27	Quercus phellos	42.0	30	good	YES	Difficult	Fair	Fair	mature
28	Quercus phellos	20.0	15	fair	field check	Normal	Poor	Poor	mature
29	Quercus alba	37.0	25	good	YES	Moderate	Good	Fair	mature
30	Quercus phellos	33.0	25	good	YES	Moderate	Good	Fair	mature
31	Quercus palustr	18.0	15	good		Normal	Good	Good	mature
32	Quercus phellos	48.0	40	good	YES	Difficult	Good	Fair	mature
33	Quercus phellos	33.0	30	good	YES	Moderate	Poor	Fair	mature
34	Quercus phellos	34.0	30	fair	YES	Moderate	Fair	Poor	mature
35	Acer buergerian	3.0	6	good					young
36	Quercus phellos	10.0	15	good					young
38	Ulmus americana	7.0	10	good					young
39	Taxodium distic	10.0	10	fair					mature
40	Taxodium distic	13.0	15	good					mature
41	Taxodium distic	15.0	15	good					mature
42	Quercus phellos	36.0	20	good	YES	Normal	Fair	Poor	mature
43	Carya illinoens	36.0	25	good	YES	Normal	Poor	Fair	mature
45	Quercus phellos	44.0	35	good	YES	Difficult	Fair	Fair	mature
46	Quercus prinus	43.0	25	fair	field check	Difficult	Poor	Poor	mature
47	Ilex sp	4.0	10	good					Young
48	Quercus phellos	34.0	35	good	YES	Moderate	Good	Good	mature
49	Quercus shumard	3.0	10	good					young
50	Prunus x yedoen	11.0	6	fair					mature
51	Magnolia grandi	29.0	20	fair		Normal	Poor	Fair	mature
52	Acer rubrum	15.0	15	fair		Normal	Good	Good	mature
53	Picea pungens	7.0	4	fair					young
54	Acer palmatum	12.0	15	fair					mature
55	Acer palmatum	15.0	15	good					mature
56	Acer palmatum	6.0	15	fair					mature
58	Acer palmatum	17.0	15	fair					mature
59	Acer palmatum	25.0	20	good					over-mature
60	Acer palmatum	16.0	15	good					mature
62	Quercus phellos	18.0	15	fair	YES	Normal	Fair	Good	mature
63	Quercus phellos	41.0	25	good	YES	Normal	Fair	Fair	mature
64	Quercus phellos	34.0	35	good	YES	Moderate	Fair	Good	mature
65	Quercus michau	40.0	35	good	field check	Normal	Fair	Good	mature
66	Quercus phellos	46.0	25	good	field check	Difficult	Fair	Good	mature
67	Cedrus deodara	16.0	10	fair					mature
68	Quercus phellos	46.0	30	good	YES	Difficult	Fair	Fair	mature
69	Quercus phellos	43.0	25	good	field check	Moderate	Fair	Fair	mature
70	Quercus nuttall	4.0	6	good					young
71	Acer rubrum	5.0	8	good					young
72	Quercus michau	8.0	10	good					young
73	Quercus michau	8.0	10	good					young
00	unlisted	7.0	4	good					young
05	Acer palmatum	9.0	4	poor					mature

TREE EVALUATION DATA MATRIX:

The data above is a matrix that includes the field observations ratings for each of the large, mature trees as recorded by Urban Trees + Soils.

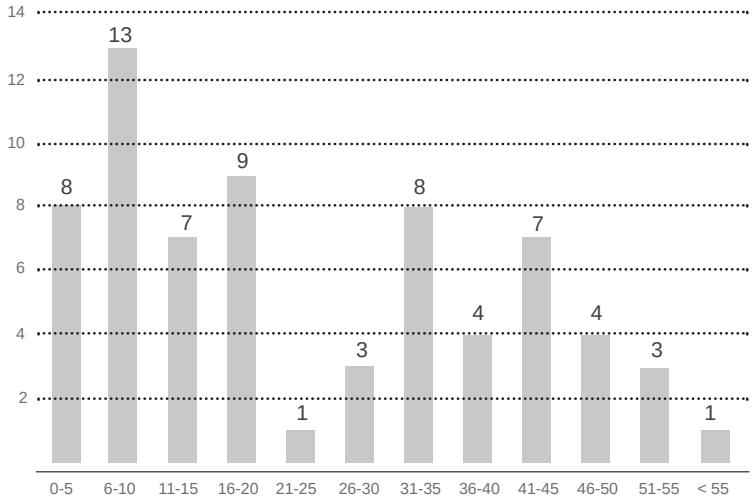
CONDITION CLASS BREAKDOWN

Condition Class	Quantity	% of Total
Good	33	49%
Fair	31	46%
Poor	4	6%
Dead	0	0%

AGE CLASS BREAKDOWN

Condition Class	Quantity	% of Total
Good	3	4%
Fair	43	63%
Poor	12	18%
Dead	10	15%

TREE DIAMETER DISTRIBUTION



HIGHEST ESTIMATED VALUE

Tree #	Common Name	DBH	Estimated Value
2	Willow Oak	65	$ 51,715.02
66	Willow Oak	45	$ 50,335.33
6	Willow Oak	43	$ 46,051.58
4	Willow Oak	53	$ 42,478.51
13	Willow Oak	50	$ 39,791.11
32	Willow Oak	48	$ 37,907.08
1	Swamp White Oak	52	$ 36,983.05
65	Swamp White Oak	40	$ 36,933.46
3	Swamp White Oak	51	$36,184.04
68	Willow Oak	46	$ 35,953.81

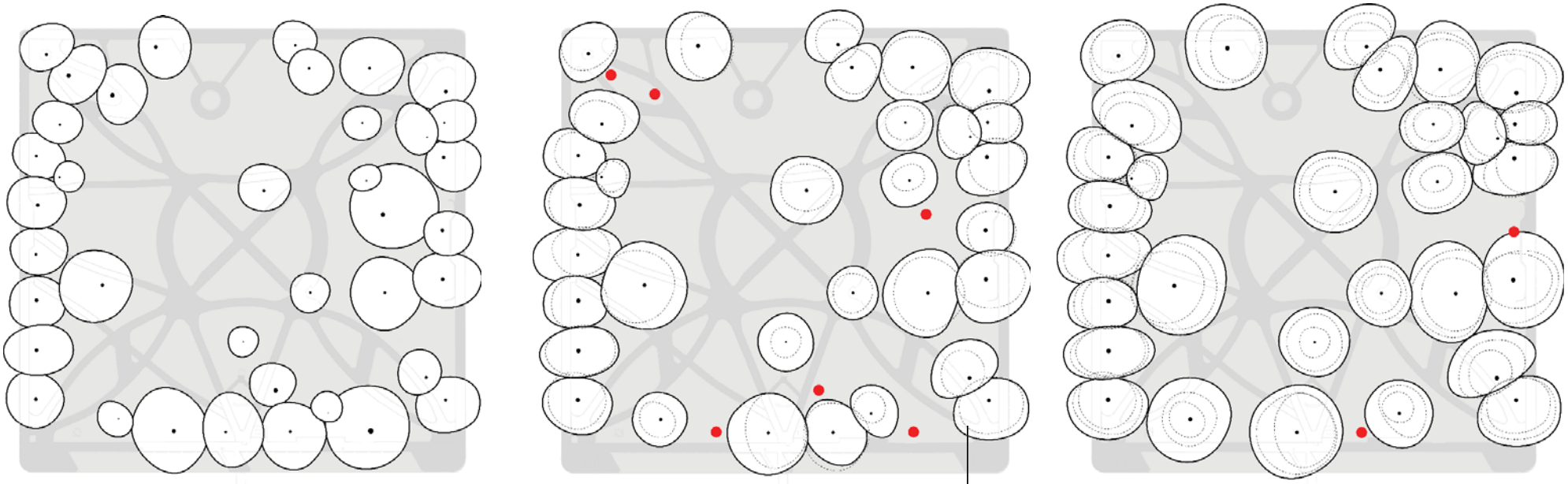
TREES WITH CONDITIONS, DEFECTS, OR OTHER STRUCTURAL ISSUES

Tree #	Common Name	DBH	Condition or Defect
2	Willow Oak	65	wound- branch, storm damage, lightning damage
3	Swamp White Oak	51	wound-stem, deadwood> 2
4	Willow Oak	53	deadwood<= 2
6	Willow Oak	43	deadwood<= 2
12	Sugar Maple	32	fungi/conks
16	Japanese Maple	8	deadwood<= 2
17	Japanese Maple	4	deadwood<= 2
18	Paperbark Maple	8	wound-stem
25	Willow Oak	17	suppressed
26	Willow Oak	17	codominant leaders
27	Willow Oak	42	lean
28	Willow Oak	20	poor branch structure
29	White Oak	37	fungi/conks
31	Pin Oak	18	girdling roots present
32	Willow Oak	48	wound-branch
34	Willow Oak	34	other, poor branch structure
39	Bald Cypress	10	suppressed
42	Willow Oak	36	uneven crown, wound-stem
43	Pecan	36	lean, over extended branch
50	Yoshino Cherry	11	wound-stem
51	Southern Magnolia	29	wound-stem
52	Red Maple	15	girdling roots present, cavity-stem
54	Japanese Maple	12	wound-stem
56	Japanese Maple	6	deadwood<2
58	Japanese Maple	17	cavity-stem
59	Japanese Maple	25	cavity-branch, codominant leaders
60	Japanese Maple	16	wound-stem, wound branches
71	Red Maple	5	wound-stem
72	Swamp White Oak	8	wound-stem

TREES RECOMMENDED FOR HAZARDOUS TREE REVIEW

Tree #	Botanical Name	DBH
1	Quercus michauxii	52
2	Quercus phellos	65
3	Quercus michauxii	51
4	Quercus phellos	53
5	Quercus alba	35
6	Quercus phellos	43
7	Quercus phellos	29
10	Quercus phellos	9
11	Carya illinoensis	32
12	Acer saccharum	32
13	Quercus phellos	50
27	Quercus phellos	42
29	Quercus alba	37

Tree #	Common Name	DBH
30	Quercus phellos	33
32	Quercus phellos	48
33	Quercus phellos	33
34	Quercus phellos	34
42	Quercus phellos	36
45	Quercus phellos	44
48	Quercus phellos	34
62	Quercus phellos	18
63	Quercus phellos	41
64	Quercus phellos	34
68	Quercus phellos	46



2014
EXISTING CONDITIONS

CURRENT CONDITIONS
36 existing canopy trees

2034
20 YEARS

15% LOSS

32 existing canopy trees remain
- One 200-year-old tree reaches maximum lifespan
- Five 150-year-old trees reach maximum lifespan

20 Year incremental Growth Rings

2054
40 YEARS

25% LOSS

30 existing canopy trees remain
- One 100-year-old fair vigor tree is lost
- One 30-year-old fair vigor trees is lost due to competition

100 YEAR EXISTING CANOPY TREE GROWTH AND DECLINE PROJECTIONS

EXISTING TREE GROWTH AND DECLINE PROJECTIONS

The existing tree analysis also included a 100-year growth and decline projections study to evaluate the viability of the existing grove. A detailed set of criteria for these studies was developed in close collaboration with Urban Trees + Soils that included canopy growth, trunk growth tree loss and parameters of declining trees. Although it is impossible to predict the exact future of tree growth and decline, this study was undertaken as a means to establish a reasonable understanding of the likely trends that will occur over the next 100 years.

For the purposes of this study, only canopy trees that have the potential to contribute to the enhancement of the perimeter grove were included in this study.

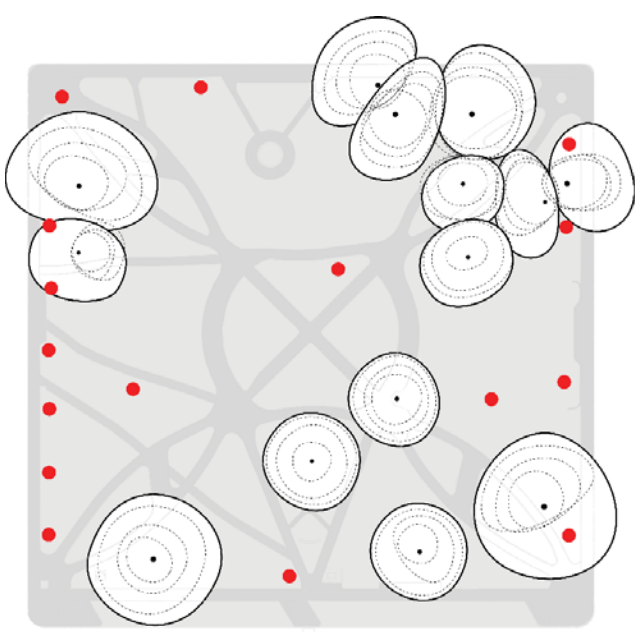
Without proper canopy tree management and planning, it is likely that 65% of the existing oaks will be lost over the next 50 years.

FINDINGS

The results from this analysis showed that over 60% of the existing trees will expire in the next 50 years and 90% in the next 100 years. It is critical that the Moore Square improvements anticipate these trends and begin a thoughtful plan to introduce new canopy trees in target areas to ensure that as the mature canopy trees naturally begin to decline and expire, there are new trees growing in to take their place. The study also found that the relatively low diversity of tree age is the primary reason for the two anticipated large waves of tree decline. When considering planting design strategies for Moore Square, it is recommended that a similar long-term approach be unitized to increase the age diversity of the grove.

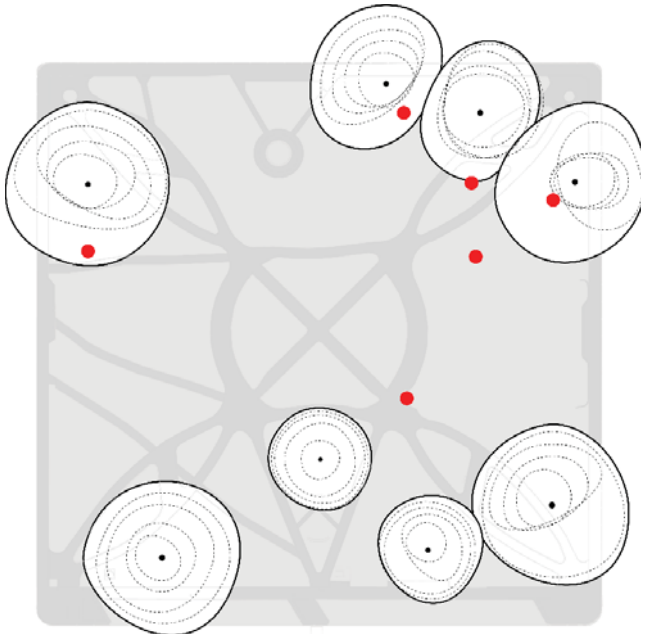
The Master Plan is not only working to preserve the significant trees, but to also respect their future growth, decline, death and replacement. Trees are living organisms that will grow and decline and die. In order to determine the impact of future changes in the canopy, it is necessary to make assumptions about this process. The following are the assumptions used to develop canopy growth studies over time. It is recognized that these assumptions are very general and that individual trees will not respond in this precise manner. However, the studies do assist in providing a basis for predicting park canopy changes and where and when new trees might be added to the park.

*Note trees represented as irregular forms rather than circles to indicate canopy competition over time.



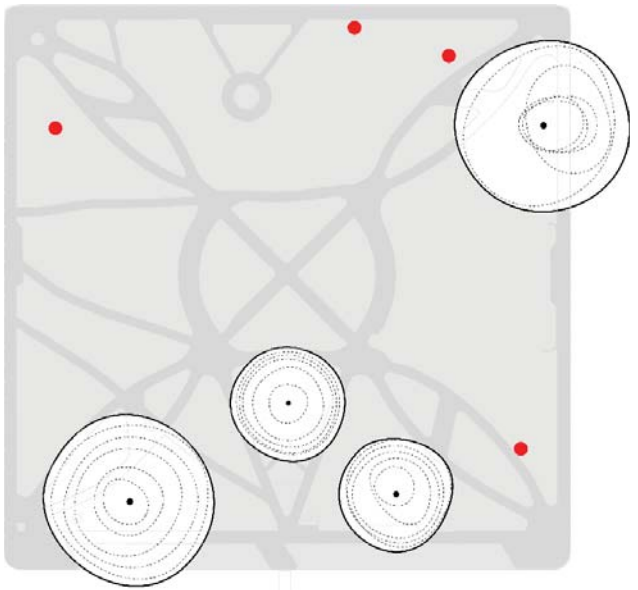
2074
60 YEARS
65% Loss

14 existing canopy trees remain
- 16 100-year-old trees reach maximum lifespan



2094
80 YEARS
80% LOSS

Eight existing canopy trees remain
- Two 50-year-old trees are lost
- Four 30-year-old fair vigor trees are lost



2114
100 YEARS
90 % LOSS

Four existing canopy trees remain
- Four 50-year-old trees reach maximum lifespan

100 YEAR EXISTING CANOPY TREE GROWTH AND DECLINE PROJECTIONS

PROJECTION CRITERIA

1. EXISTING CANOPY GROWTH
1.1) Canopy of good vigor trees expands 10” radius a year for the first 40 years
1.2) Canopy of good vigor trees expands 8” radius a year between 40 and 80 years old
1.3) Canopy of good vigor trees expands 6” radius after 80 years old and beyond
1.4) Canopy of fair vigor trees expands 8” radius a year for the first 40 years
1.5) Canopy of fair vigor trees expands 6” radius a year between 40 and 80 years old
1.6) Canopy of fair vigor trees expands 4” radius a year after 80 years old and beyond
1.7) Canopy of poor vigor trees expands 6” radius a year for the first 40 years
1.8) Canopy of poor vigor trees expands 4” radius a year between 40 and 80 years old
1.9) Canopy of poor vigor trees expands 2” radius a year after 80 years old and beyond

2. TRUNK GROWTH
2.1) Trunk of good vigor trees will expands 1/2” radius a year
2.2) Trunk of fair vigor trees expands 1/4” radius a year
2.3) Trunk of poor vigor trees expands 1/8” radius a year

3. CANOPY TREE LOSS
3.1) Canopy trees will have a lifespan of approximately 150 years
3.2) In 20 years 100% of the poor vigor trees will be lost
3.3) In 40 years 20% of the fair vigor trees will be lost
3.4) In 60 years 50% of the fair vigor and 10% of the good vigor trees will be lost
3.5) In 80 years 80% of the fair vigor trees and 30% of the good vigor trees will be lost
3.6)100 years 100% of the fair vigor trees and 70% of the good vigor trees will be lost

4. PARAMETERS OF IDENTIFYING DECLINING TREES
4.1) Canopy trees with lower structure rating and trunk sizes will decline faster
4.2) Older canopy trees will be lost before younger canopy trees
4.3) Trees experiencing excessive canopy competition will decline faster

5. NEW TREE GROWTH
5.1) Canopy trees will have a lifespan of approximately 150 years
5.2) New canopy trees will be planted at 3” caliper dbh
5.3) 100% of new canopy tress will be considered good vigor
5.4) Canopies with compress and elongate when in competition









EXISTING SOILS ANALYSIS

This report examines the soils from the perspective of existing and future plant growth. The findings are based on review of the site conditions on September 17 and 18, 2012, and the review of the planning documents for the proposed improvements to the park. All references to historical site conditions are taken from the Master Plan Report from 2010.

PAST TO PRESENT VIEW OF SOIL DISTURBANCE

Moore Square was part of the original 1772 Town Plan for the city. It likely evolved from either forest or farm land and developed directly into a public park. This would have resulted in minimum soil disturbance.

Only two structures of any significance were ever built in the park, those being before 1896. These structures fall in the central area of disturbance and were likely out of the current root zones of large existing trees. The small kiosk built on the south side of the park appears to have caused minimum soil disturbance compared to disturbances from walks, later grading and utility work.

The earliest representations of trees show the trees clustered on the east side of the park, possibly a remnant forest or second growth after logging. This edge is characterized by steeper slopes and may have been more irregular than currently sloped. The more formal designs of 1896 and 1914 would have likely smoothed grading on the east side of the park as well as removed the previously mentioned trees. The grading of the current plan appears to have pushed a layer of fill to the east of the center of the park.

The many alignments of walks over the park's history have caused soil disturbance along the edges. The center of the park and the four wider arms of the crossing diagonals have also introduced their share of soil disturbance.

The many different uses and events at the Square have ranged from pasture, civil war troop camp to a contemporary music festival venue. All functions have exacted a toll on soil quality. Hard layers of soil were encountered in many locations. Multiple rounds of park utility electric and water lines have also disturbed the soil.

Throughout the park, large areas of mulch beds cover the ground. These are areas where park maintenance has not been able to keep turf growing. Much of this turf problem is related to intense use during the many concerts and festivals staged in the park. These areas are also almost always within the canopy of the large trees. It is likely that people gather more in the shade during events contributing to turf damage.

While all these disturbances result in almost all areas of the park being disturbed to some degree, the soil disturbance in the large center space, its northern extension to Hargett Street and portions of the east side of the park are significant to the point of impacting existing and future tree growth.

SOIL PROFILE PITS

At 20 test pit locations, (marked TP #1-20), Urban Trees + Soils analyzed soils at various depths for a cross-section comparison looking at moisture, material composition and density. The 20 multi-layer profile pits were dug and recorded. The approximate locations of all profile pits are shown on the following "Soil Testing Pit Locations" plan. The following is the description of the soil profiles observed. Note the following gradations of terms for moisture and compaction are used in this report to describe soil conditions. Soil textures are USDA terminology as estimated during the digging process.

MOISTURE TERMINOLOGY

Description of soil moisture from dry to wet as determined by visual analysis and feel.

Dry – soil will not hold together after being crushed
Damp – soil will marginally hold together when crushed
Moist – soil can be formed into a ball
Wet – soil sticks together and will stick to the hand
Saturated – free water observed on the soil

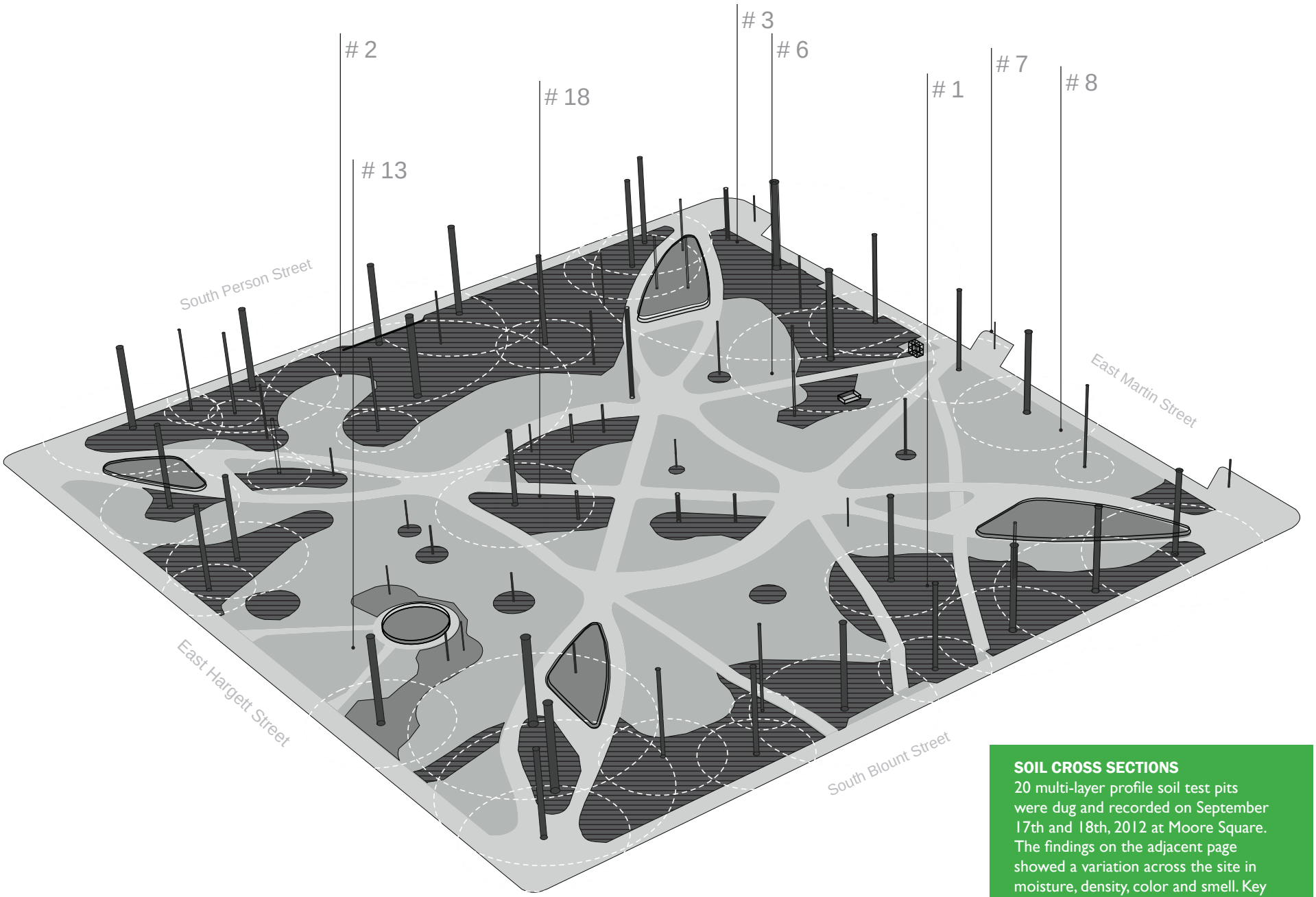
DENSITY TERMINOLOGY

The following are terms used to describe soil density from loose to solid as felt during the angering process. Note that dry soils that are not overly compacted can "feel' compacted, while compacted soil can "feel" soft when moist. The presence of roots is a better indication of compaction than the below root limiting levels. Root observations are noted when encountered.

Loose – auger easily penetrates the soil
Soft – auger penetrates the soil with moderate effort
Firm – auger requires strong push to penetrate the soil
Hard – auger requires maximum pressure to penetrate the soil
Refusal – auger refuses to penetrate the soil

SOIL NUTRIENT TESTING

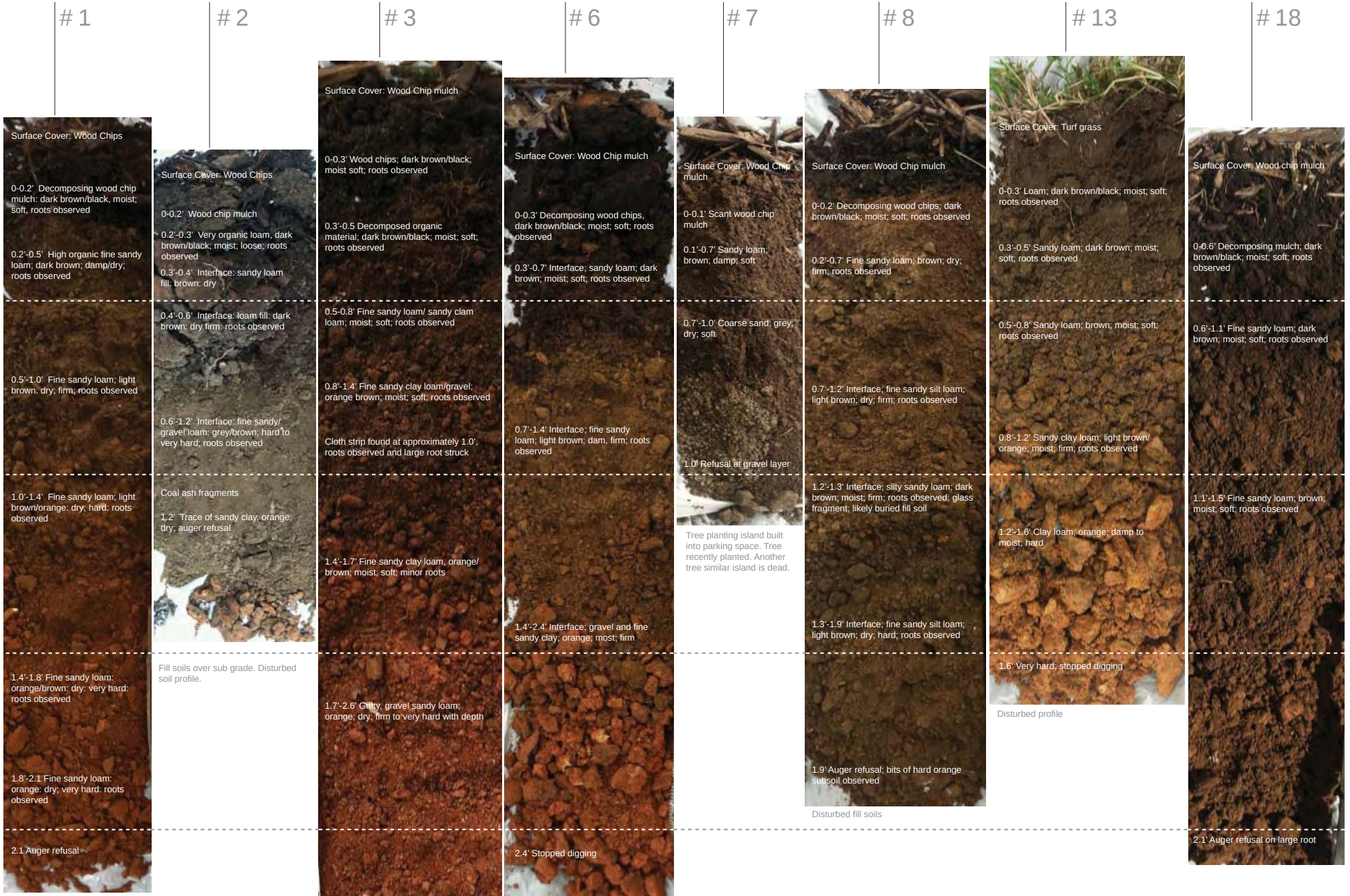
Separately from the soil profile pits, at 12 locations (marked 1-12, on the Soil Bulk Density and Nutrient Test, marked A-L, Location plan), nutrient tests were taken by Bartlett Trees Experts for an specific soil analysis of chemical makeup and bulk density.



EXISTING SITE AXON: SAMPLE TEST PIT LOCATIONS

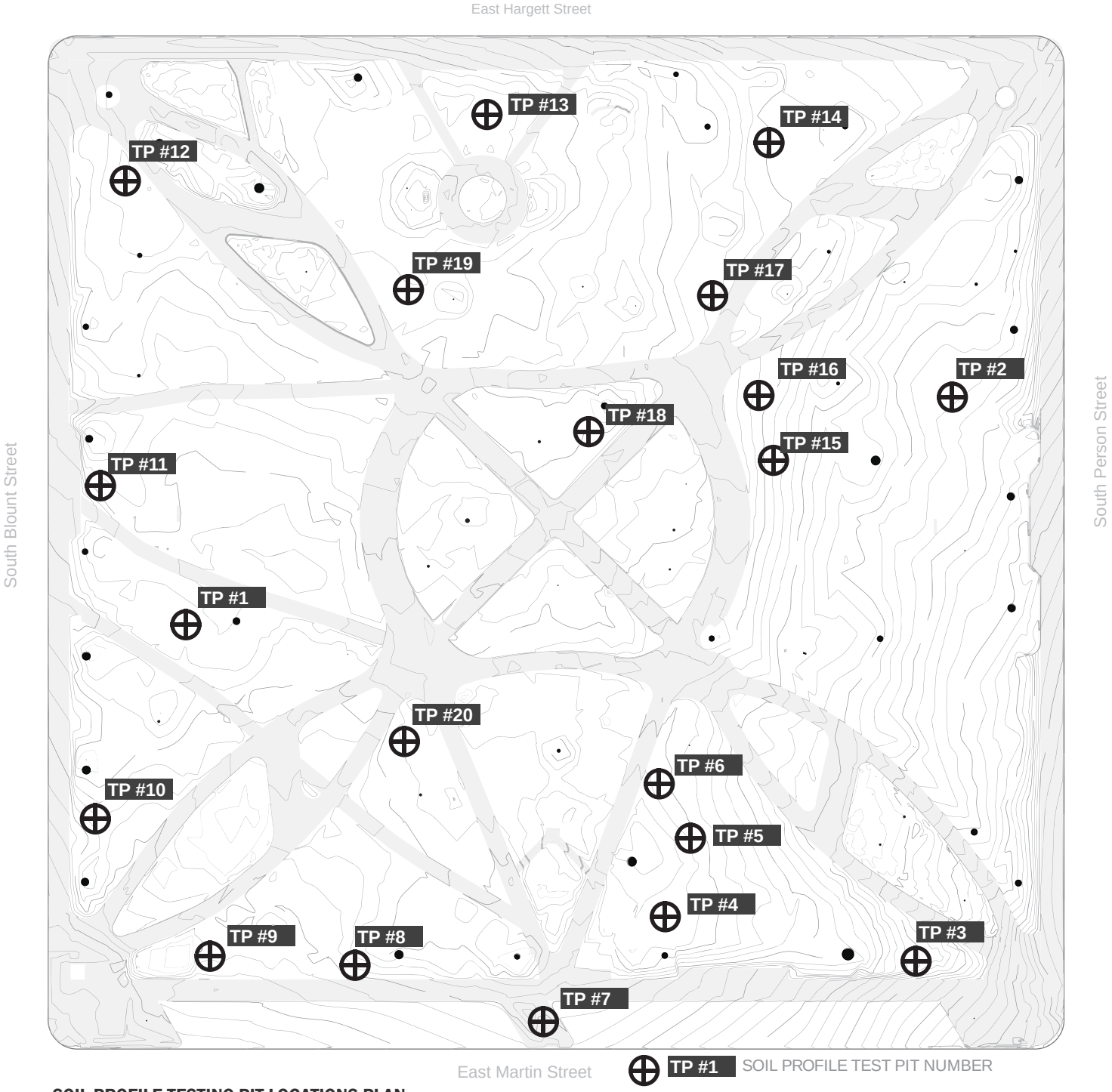
SOIL CROSS SECTIONS

20 multi-layer profile soil test pits were dug and recorded on September 17th and 18th, 2012 at Moore Square. The findings on the adjacent page showed a variation across the site in moisture, density, color and smell. Key difference are noted and pictured to help understand the cross section at various areas all over the site. Depending on the density, different depths in soil were reached. Refer to the Soil Modification Study found at the end of the Soils Analysis for a synthesis of these findings.



EXISTING SOILS PROFILES

SOIL PROFILE PITS
Soils ranging across the site at 20 different sites were tested using a methodology of test pit samples to understand not only the topography and amount of existing soils and types, but more specifically, the chemical makeup and cross section at various depths of the soils across the site.



SOIL PROFILE TESTING PIT LOCATIONS PLAN

*Test pit location and analysis by Urban Trees + Soils

TEST PIT SOIL ANALYSIS

LOCATION #1

Soil profile	Depth	Description
		Surface cover: Wood chip mulch
	0-0.2'	Decomposing wood chip mulch; dark brown/black; moist; soft; roots observed
	0.2'–0.5'	High organic fine sandy loam; dark brown; damp/dry; firm; roots observed
	0.5'-1.0'	Fine sandy loam; light brown, dry; firm; roots observed
	1.0'-1.4'	Fine sandy clay loam; light brown/orange; dry; hard; roots observed
	1.4'-1.8'	Fine sandy clay loam; orange/brown; dry; very hard; roots observed
	1.8'-2.1'	Fine sandy clay loam; orange; dry; very hard; roots observed
	2.1'	Auger refusal

Remarks: The soils below 0.5' are likely to be an undisturbed soil profile. Soil profile taken near one of the older and healthier trees in the park.

LOCATION #2

Soil profile	Depth	Description
		Surface cover: Wood chip mulch
	0-0.2'	Wood chip mulch
	0.2'-0.3'	Very organic loam, dark brown/black; moist; loose; roots observed
	0.3'-0.4'	Interface; sandy loam fill; brown; dry; firm; roots observed
	0.4'-0.6'	Interface; loam fill; dark brown; dry; firm; roots observed
	0.6'-1.2'	Interface; fine sandy/gravel loam; grey/brow; dry; hard to V hard; roots observed
		Coal ash fragments
	1.2'	Trace of sandy clay, orange; dry; auger refusal

Remarks: Fill soils over subgrade soils. Disturbed soil profile.

LOCATION #3

Soil profile	Depth	Description
		Surface cover: Wood chip mulch
	0-0.3'	Wood chips; dark brown/black; moist; soft; roots observed
	0.3'-0.5'	Decomposed organic material; dark brown/black; moist; soft; roots observed
	0.5'-0.8'	Fine sandy loam/ sandy clay loam; brown; moist; soft; roots observed
	0.8'-1.4'	Fine sandy clay loam/gravel; orange brown; moist; soft; roots observed;
		Cloth strip fond at approximately 1.0', roots observed and large root struck
	1.4'-1.7'	Fine sandy clay loam, orange/ brown; moist; soft; minor roots
	1.7'-2.6'	Gritty, gravel sandy clay loam; orange; dry; firm to very hard w/depth
	2.6'	Same as above; very dry; auger refusal

Remarks: Profile below 1.4 feet likely an undisturbed sub soil. Profile adjacent to largest (DBH) tree on site

LOCATION #4

Remarks: Profile similar to Location #3

LOCATION #5

Remarks: Profile similar to Location #3 except Orange soil starts at about 1.5'.

LOCATION #6

Soil profile	Depth	Description
		Surface cover: Wood chip mulch
	0-0.3'	Decomposing wood chips, dark brown/black; moist; soft; roots observed
	0.3-0.7'	Interface; sandy loam; dark brown; moist; soft; roots observed
	0.7-1.4'	Interface; fine sandy loam; light brown; damp, firm; roots observed
	1.4'-2.4'	Interface; gravel and fine sandy clay; orange; moist, firm
	2.4'	Stopped digging

Remarks: Highly disturbed soil near walk

LOCATION #7

Soil profile	Depth	Description
		Surface cover: Mulch
	0-0.1	Scant wood chip mulch
	0.1'-0.7'	Sandy loam; brown; damp; soft
	0.7'-1.0'	Coarse sand; grey; dry; soft
	1.0'	Refusal at gravel layer

Remarks: Tree planting island built into parking space. Tree recently planted. Another tree in similar island is dead.

LOCATION #8

Soil profile	Depth	Description
		Surface cover:
	0-0.2'	Decomposing wood chips; dark brown/black; moist; soft; roots observed
	0.2'-0.7'	Fine sandy loam; brown; dry; firm; roots observed
	0.7'-1.2'	Interface; fine sandy silt loam; light brown; dry; firm; roots observed
	1.2'-1.3'	Interface; silty sandy loam; dark brown; moist; firm; roots observed, glass fragment, likely buried fill soil
	1.3'-1.9'	Interface; fine sandy silt loam; light brown; dry; hard; roots observed
	1.9'	Auger refusal; bits of hard orange subsoil observed

Remarks: Disturbed fill soils

LOCATION #9

Soil profile	Depth	Description
Profile not photographed		Surface cover: Wood chip mulch
		Highly disturbed soil; multi layers; moist, one layer slightly anaerobic

Remarks: in bed next to electric vault

LOCATION #10

Soil profile	Depth	Description
Same as profile #1		Surface cover: Wood chip mulch

Remarks:

LOCATION #11

Soil profile	Depth	Description
Same as profile #1		Surface cover: Wood chip mulch

Remarks:

LOCATION #12

Soil profile	Depth	Description
Same as profile #1		Surface cover: Wood chip mulch Soil slightly wetter than other #1 profiles

LOCATION #13

Soil profile	Depth	Description
		Surface cover: Turf grass
	0-0.3'	Loam; dark brown/black; moist; soft; roots observed
	0.3'-0.5'	Sandy loam; dark brown; moist; soft; roots observed
	0.5'-0.8'	Sandy loam; brown; moist; soft; roots observed
	0.8'-1.2'	Sandy clay loam; light brown/orange; moist; firm; roots observed
	1.2'-1.6'	Clay loam; orange; damp to moist; hard
	1.6'	Very hard; Stopped digging

Remarks: Disturbed profile

LOCATION #14

Soil profile	Depth	Description
Same as profile #1		Surface cover: Wood chip mulch

Remarks:

LOCATION #15

Soil profile	Depth	Description
Profile not photographed		Surface cover: Turf grass
	0-0.7'	Loamy soil, dark brown; moist; soft
	0.7'	Fine sandy clay loam; orange, damp; firm

Remarks:

LOCATION #16

Soil profile	Depth	Description
Same as # 15		Surface cover:

Remarks:

LOCATION #17

Soil profile	Depth	Description
Same as # 1		Surface cover: Turf grass

Remarks:

Test pits at locations 15 -17 was an attempt to confirm the edge of the disturbed soil in this area of the site.

LOCATION #18

Soil profile	Depth	Description
		Surface cover: Wood chip mulch
	0-0.6'	Decomposing mulch; dark brown/black; moist; soft; roots observed
	0.6'-1.1'	Fine sandy loam; dark brown; moist; soft; roots observed
	1.1'-1.5'	Fine sandy loam; brown; moist; soft; roots observed
	1.5'-2.1'	Fine sandy clay loam; brown/ orange; moist; soft; roots observed
	2.1'	Auger refusal on large root

Remarks:

LOCATION #19

Soil profile	Depth	Description
Same as #13		Surface cover: Turf grass

Remarks:

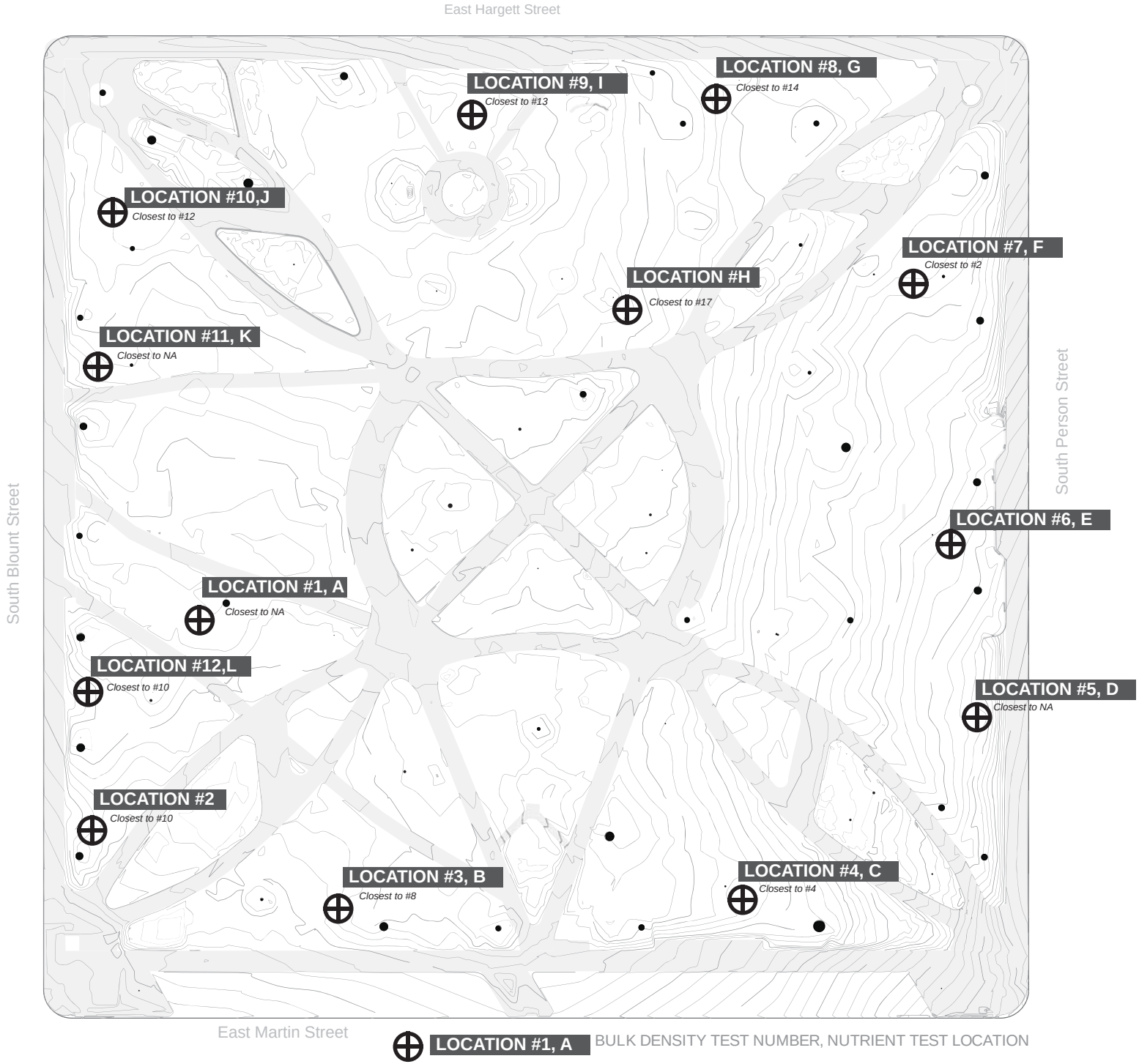
LOCATION #20

Soil profile	Depth	Description
Profile not photographed		Surface cover:
	0-1.5'	Sandy loam; brown; damp; firm
	1.5'	Interface; coarse sandy clay loam; red/orange; damp hard

Remarks: Fill soil over graded subsoil

*Test pit location and analysis by Urban Trees + Soils
Further information located in Appendix A of this report.

SOIL NUTRIENT TESTING
Soil was collected by the Bartlett Tree Experts from the top layer of the soil for nutrient testing. Samples were processed by Bartlett Tree Experts soil labs. The purpose of the testing was to gain a background chemical profile of the upper layer of the soil. The test results and lab recommendations for modifications to soil nutrients are included in this report.



NUTRIENT AND BULK DENSITY TEST LOCATIONS PLAN

*Test pit location and analysis by Bartlett Tree Experts

NUTRIENT ANALYSIS

LOCATION #A

Soil pH	6.3	Acceptable
Nitrogen (ENR)	113.0	
Phosphorous (P)	110.0	High
Potassium (K)	514.0	Very High
Magnesium (Mg)	618.0	Very High
Calcium (Ca)	4640.0	* Medium

Ideal pH range for Other: 5.5 to 6.5

Soil Organic Matter (OM) 4.4 Medium — Nutrient Retention Capacity 17.6 Very High

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	0.7	2.7
	38 - 0 - 0 gallons	5.0	2.4
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	0.0	0.0
Gypsum	pounds	100.0	48.0
Lime	pelletized	0.0	0.0
	powdered	0.0	0.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	0.0	0.0
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		32	130.0
Boost		16.0	65.0
Boost Granular		5.0	2.4
Organic Milorganite		10.0	4.8
Mulch or incorporate organic matter:		Yes	

LOCATION #B

Soil pH	5.6	Acceptable
Nitrogen (ENR)	86.0	
Phosphorous (P)	334.0	Very High
Potassium (K)	162.0	* Low
Magnesium (Mg)	270.0	* Medium
Calcium (Ca)	1954.0	* Medium

Ideal pH range for Other: 5.5 to 6.5

Molybdenum (Mo) 0.0

Soil Organic Matter (OM) 3.1 * Low — Nutrient Retention Capacity 8.4 High

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	0.7	2.7
	38 - 0 - 0 gallons	5.0	2.4
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	4.0	1.9
Gypsum	pounds	60.0	28.8
Lime	pelletized	0.0	0.0
	powdered	0.0	0.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	7.0	3.4
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		50	203.2
Boost		25.0	101.6
Boost Granular		10.0	4.8
Organic Milorganite		20.0	9.6
Mulch or incorporate organic matter:		Yes	

LOCATION #C

Soil pH	6.4	Acceptable
Nitrogen (ENR)	113.0	
Phosphorous (P)	168.0	Very High
Potassium (K)	704.0	Very High
Magnesium (Mg)	856.0	Very High
Calcium (Ca)	5756.0	* Medium

Ideal pH range for Other: 5.5 to 6.5

Soil Organic Matter (OM) 4.4 Medium — Nutrient Retention Capacity 22.5 Very High

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	0.7	2.7
	38 - 0 - 0 gallons	5.0	2.4
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	0.0	0.0
Gypsum	pounds	100.0	48.0
Lime	pelletized	0.0	0.0
	powdered	0.0	0.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	0.0	0.0
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		32	130.0
Boost		16.0	65.0
Boost Granular		5.0	2.4
Organic Milorganite		10.0	4.8
Mulch or incorporate organic matter:		Yes	

LOCATION #D

Soil pH	5.9	Acceptable
Nitrogen (ENR)	110.0	
Phosphorous (P)	138.0	Very High
Potassium (K)	438.0	High
Magnesium (Mg)	500.0	High
Calcium (Ca)	4006.0	* Medium

Ideal pH range for Other: 5.5 to 6.5

Soil Organic Matter (OM) 4.3 Medium — Nutrient Retention Capacity 15.2 Very High

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	0.7	2.7
	38 - 0 - 0 gallons	5.0	2.4
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	0.0	0.0
Gypsum	pounds	100.0	48.0
Lime	pelletized	0.0	0.0
	powdered	0.0	0.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	0.0	0.0
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		32	130.0
Boost		16.0	65.0
Boost Granular		5.0	2.4
Organic Milorganite		10.0	4.8
Mulch or incorporate organic matter:		Yes	

LOCATION #E

Soil pH	5.9	Acceptable
Nitrogen (ENR)	98.0	
Phosphorous (P)	348.0	Very High
Potassium (K)	374.0	Very High
Magnesium (Mg)	256.0	* Medium
Calcium (Ca)	1924.0	* Medium

Ideal pH range for Other: 5.5 to 6.5

Soil Organic Matter (OM) 3.7 Medium — Nutrient Retention Capacity 8.4 High

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	0.7	2.7
	38 - 0 - 0 gallons	5.0	2.4
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	0.0	0.0
Gypsum	pounds	60.0	28.8
Lime	pelletized	0.0	0.0
	powdered	0.0	0.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	7.0	3.4
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		32	130.0
Boost		16.0	65.0
Boost Granular		7.0	3.4
Organic Milorganite		20.0	9.6
Mulch or incorporate organic matter:		Yes	

LOCATION #F

Soil pH	5.7	Acceptable
Nitrogen (ENR)	106.0	
Phosphorous (P)	192.0	Very High
Potassium (K)	262.0	High
Magnesium (Mg)	254.0	* Medium
Calcium (Ca)	2004.0	* Medium

Ideal pH range for Other: 5.5 to 6.5

Soil Organic Matter (OM) 4.1 Medium — Nutrient Retention Capacity 8.7 High

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	0.7	2.7
	38 - 0 - 0 gallons	5.0	2.4
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	0.0	0.0
Gypsum	pounds	60.0	28.8
Lime	pelletized	0.0	0.0
	powdered	0.0	0.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	7.0	3.4
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		32	130.0
Boost		16.0	65.0
Boost Granular		5.0	2.4
Organic Milorganite		10.0	4.8
Mulch or incorporate organic matter:		Yes	

LOCATION #G

Soil pH	5.5	Acceptable
Nitrogen (ENR)	73.0	
Phosphorous (P)	576.0	Very High
Potassium (K)	314.0	High
Magnesium (Mg)	178.0	* Medium
Calcium (Ca)	1360.0	* Low

Ideal pH range for Other: 5.5 to 6.5

Molybdenum (Mo) 0.0

Soil Organic Matter (OM) 2.4 * Very Low — Nutrient Retention Capacity 6.9 Medium

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	1.0	4.1
	38 - 0 - 0 gallons	7.5	3.6
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	0.0	0.0
Gypsum	pounds	50.0	24.0
Lime	pelletized	0.0	0.0
	powdered	0.0	0.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	5.0	2.4
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		50	203.2
Boost		25.0	101.6
Boost Granular		10.0	4.8
Organic Milorganite		25.0	12.0
Mulch or incorporate organic matter:		Yes	

LOCATION #H

Soil pH	6.2	Acceptable
Nitrogen (ENR)	110.0	
Phosphorous (P)	116.0	High
Potassium (K)	418.0	High
Magnesium (Mg)	542.0	High
Calcium (Ca)	4520.0	* Medium

Ideal pH range for Other: 5.5 to 6.5

Soil Organic Matter (OM) 4.3 Medium — Nutrient Retention Capacity 17.2 Very High

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	0.7	2.7
	38 - 0 - 0 gallons	5.0	2.4
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	0.0	0.0
Gypsum	pounds	100.0	48.0
Lime	pelletized	0.0	0.0
	powdered	0.0	0.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	0.0	0.0
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		32	130.0
Boost		16.0	65.0
Boost Granular		5.0	2.4
Organic Milorganite		10.0	4.8
Mulch or incorporate organic matter:		Yes	

LOCATION #I

Soil pH	4.9	Too Acidic
Nitrogen (ENR)	76.0	
Phosphorous (P)	542.0	Very High
Potassium (K)	160.0	* Low
Magnesium (Mg)	106.0	* Low
Calcium (Ca)	980.0	* Low

Ideal pH range for Other: 5.5 to 6.5

Molybdenum (Mo) 0.0

Soil Organic Matter (OM) 2.6 * Low — Nutrient Retention Capacity 5.5 Medium

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	0.7	2.7
	38 - 0 - 0 gallons	5.0	2.4
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	2.0	1.0
Gypsum	pounds	0.0	0.0
Lime	pelletized	75.0	36.0
	powdered	50.0	24.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	0.0	0.0
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		50	203.2
Boost		25.0	101.6
Boost Granular		10.0	4.8
Organic Milorganite		20.0	9.6
Mulch or incorporate organic matter:		Yes	

LOCATION #J

Soil pH	6.1	Acceptable
Nitrogen (ENR)	110.0	
Phosphorous (P)	152.0	Very High
Potassium (K)	434.0	High
Magnesium (Mg)	594.0	High
Calcium (Ca)	4596.0	* Medium

Ideal pH range for Other: 5.5 to 6.5

Soil Organic Matter (OM) 4.3 Medium — Nutrient Retention Capacity 17.0 Very High

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	0.7	2.7
	38 - 0 - 0 gallons	5.0	2.4
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	0.0	0.0
Gypsum	pounds	100.0	48.0
Lime	pelletized	0.0	0.0
	powdered	0.0	0.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	0.0	0.0
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		32	130.0
Boost		16.0	65.0
Boost Granular		5.0	2.4
Organic Milorganite		10.0	4.8
Mulch or incorporate organic matter:		Yes	

LOCATION #K

Soil pH	5.9	Acceptable
Nitrogen (ENR)	110.0	
Phosphorous (P)	144.0	Very High
Potassium (K)	436.0	High
Magnesium (Mg)	674.0	Very High
Calcium (Ca)	5162.0	* Medium

Ideal pH range for Other: 5.5 to 6.5

Soil Organic Matter (OM) 4.3 Medium — Nutrient Retention Capacity 19.1 Very High

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	0.7	2.7
	38 - 0 - 0 gallons	5.0	2.4
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	0.0	0.0
Gypsum	pounds	100.0	48.0
Lime	pelletized	0.0	0.0
	powdered	0.0	0.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	0.0	0.0
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		32	130.0
Boost		16.0	65.0
Boost Granular		5.0	2.4
Organic Milorganite		10.0	4.8
Mulch or incorporate organic matter:		Yes	

LOCATION #L

Soil pH	5.9	Acceptable
Nitrogen (ENR)	110.0	
Phosphorous (P)	120.0	Very High
Potassium (K)	500.0	Very High
Magnesium (Mg)	516.0	High
Calcium (Ca)	4318.0	* Medium

Ideal pH range for Other: 5.5 to 6.5

Soil Organic Matter (OM) 4.3 Medium — Nutrient Retention Capacity 16.8 Very High

Recommendations

Prescription Fertilization		Pounds or Gallons per 1000 sq. ft.	Kg or Liters per 100 sq. m
Nitrogen	30 - 0 - 0 gallons	0.7	2.7
	38 - 0 - 0 gallons	5.0	2.4
Phosphorus	0 - 30 - 0 gallons	0.0	0.0
Potassium	0 - 0 - 52 pounds	0.0	0.0
Gypsum	pounds	100.0	48.0
Lime	pelletized	0.0	0.0
	powdered	0.0	0.0
Sulfur	pounds	0.0	0.0
Magnesium	pounds	0.0	0.0
Iron chelate	gallons	0.0	0.0
	pounds	0.0	0.0
Manganese	gallons	0.0	0.0
	pounds	0.0	0.0
Conventional Fertilization			
Boost Natural		32	130.0
Boost		16.0	65.0
Boost Granular		5.0	2.4
Organic Milorganite		10.0	4.8
Mulch or incorporate organic matter:		Yes	

BULK DENSITY ANALYSIS

LOCATION #1

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .454 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

LOCATION #2

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy Clay – 1.166 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

LOCATION #3

Diagnosis:
The texture and bulk density of your sample was as follows:

Loam / Sandy clay 1.308 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

LOCATION #4

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .384 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

LOCATION #5

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy Clay – 1.046 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

LOCATION #6

Diagnosis:
The texture and bulk density of your sample was as follows:

Loam / Sandy clay 1.414 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

LOCATION #7

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy Clay – 1.170 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

LOCATION #8

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy clay 1.382 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

LOCATION #9

Diagnosis:
The texture and bulk density of your sample was as follows:

Loam / Sandy clay 1.210 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

LOCATION #10

Diagnosis:
The texture and bulk density of your sample was as follows:

Sand / Loamy Sand – .929 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

LOCATION #11

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .590 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

LOCATION #12

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .441 g/cc

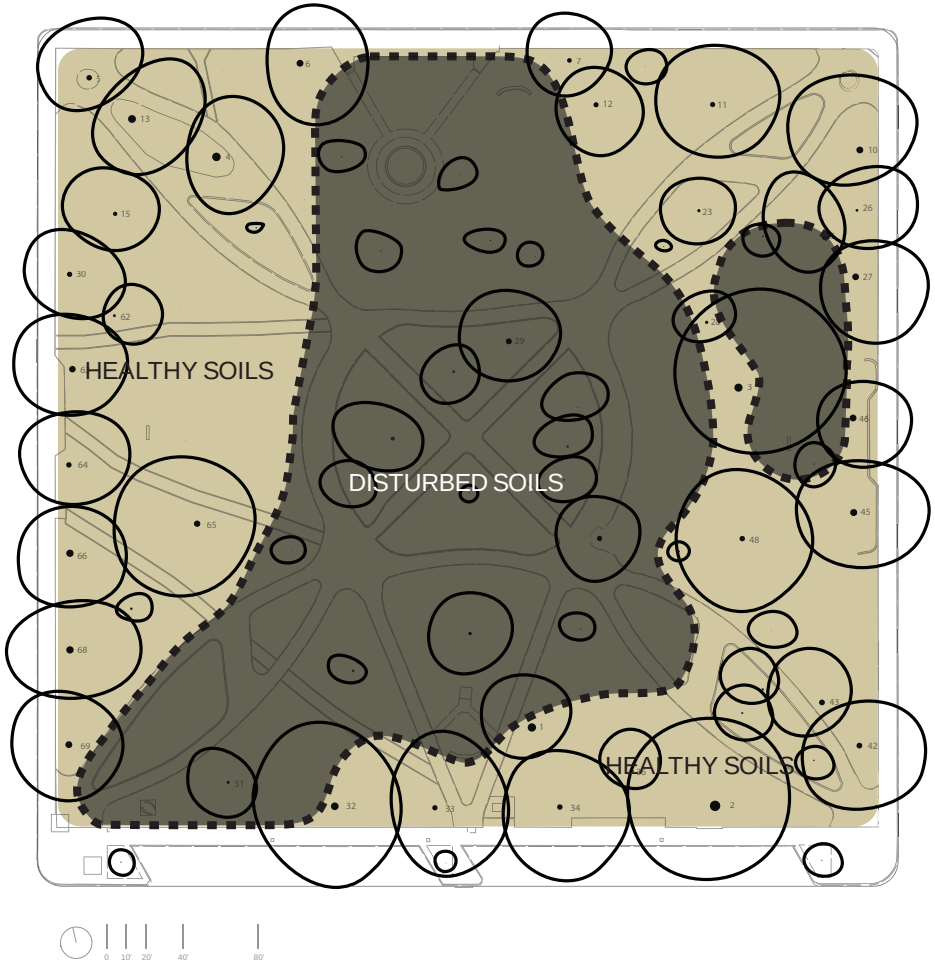
This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

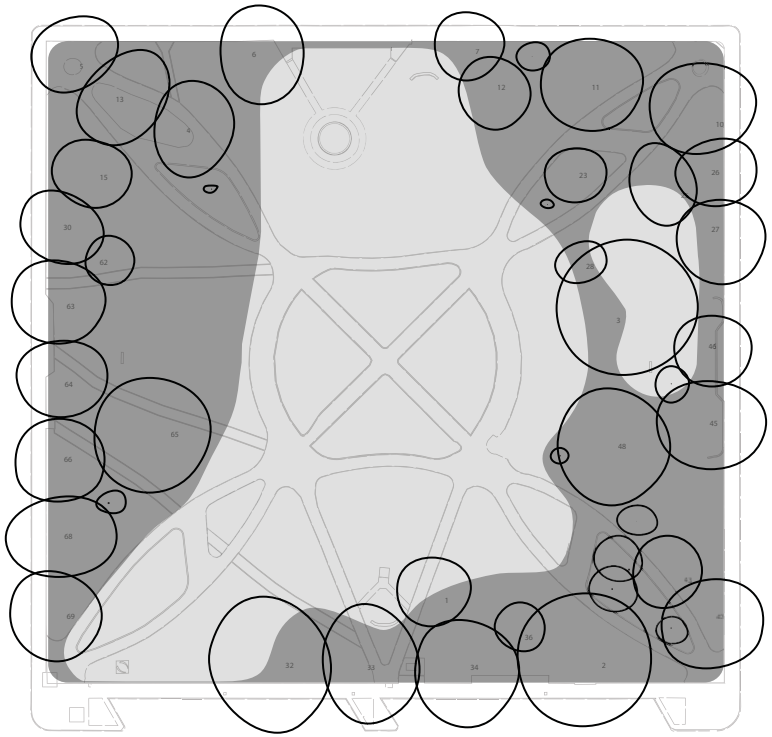
Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

*Test pit location and analysis by Bartlett Tree Experts. Further information located in Appendix B of this report.



EXISTING SOILS ANALYSIS



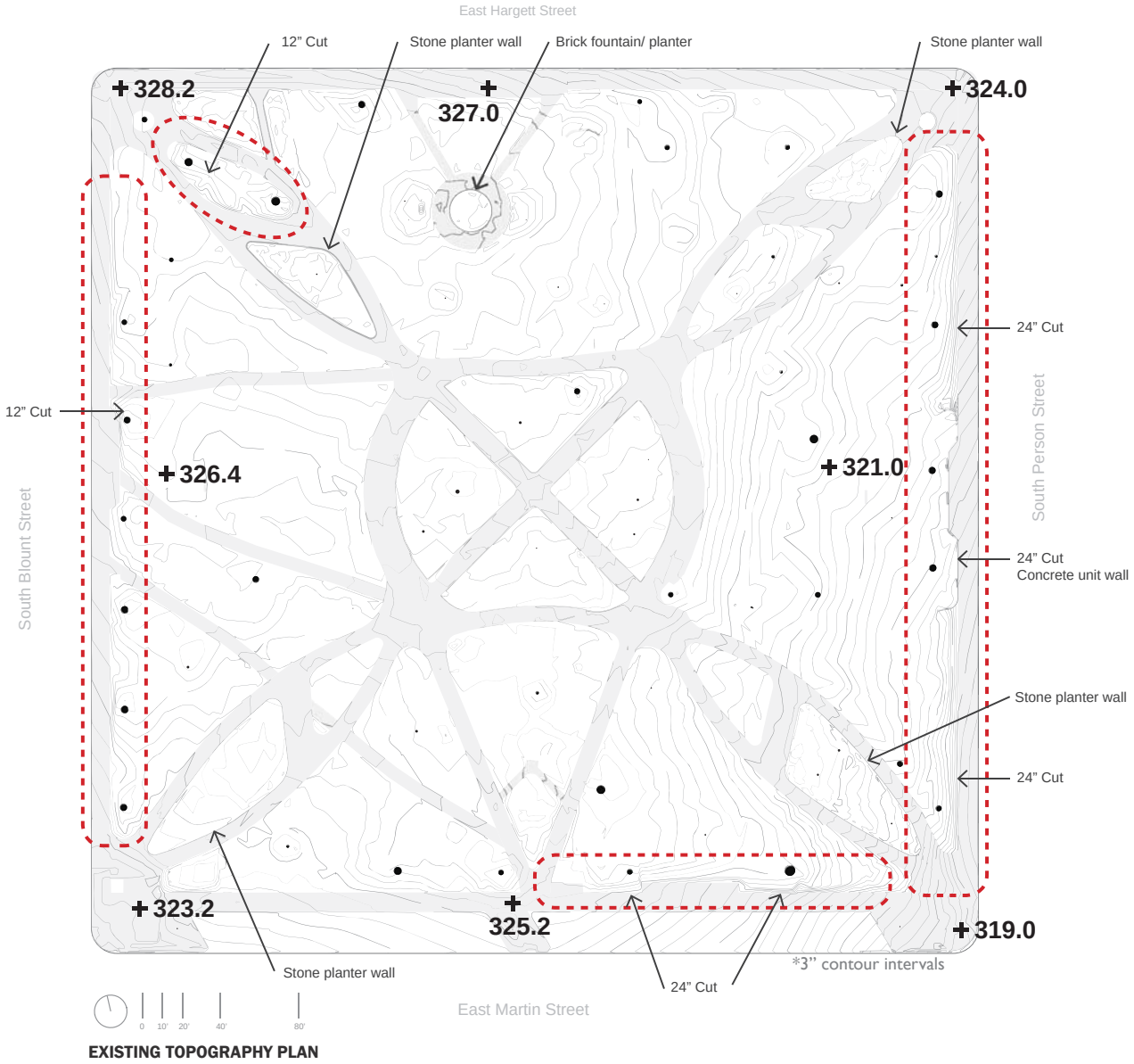
TREES WITHIN HEALTHY SOIL CONDITIONS

TREES WITHIN THE DISTURBED SOIL CONDITIONS

SOIL MODIFICATIONS STUDY

Soil lying outside the area in the above plan diagram not recommended for soil modification (represented in light tan) are found to be healthier soils, while soil within the disturbed area (represented in dark brown) is found to be disturbed and not as healthy for planting growth. By overlaying existing tree canopies with this information, it becomes evident that the older trees, most of which are oaks, are located within the healthier soil zones that are not disturbed while younger trees with less canopy are located in disturbed soils. We can use this information for preserving healthy soils and making suggestions for where soil modifications should be made for future design and to help ensure healthy and long-term canopy for the site.

The health and size of areas outside the disturbed soils illustrate the importance of healthy soil conditions.



EXISTING TOPOGRAPHY PLAN

EXISTING TOPOGRAPHIC CONDITIONS

CURRENT TOPOGRAPHY

Current topography can be read for soil disturbance. Cut and fill slopes appear associated with paving throughout the park. This is particularly true at the perimeter where the walks and grades meet the street sidewalk edges. It appears that the streets were generally cut into the existing pre development grades as part of a larger scale grading scheme to create smooth street grade transitions from the ridge line parallel to Fayetteville Street and the lower lands east of the downtown area. In the middle portion of the site, the contours are highly irregular with minimum organizing features. Only the slopes in the parks east side seem to reflect a pre-development contour pattern. But even here fill soils were discovered.

Careful attention should be devoted to addressing the past cuts within the tree and trunk protection areas.

EXCESSIVE MULCH

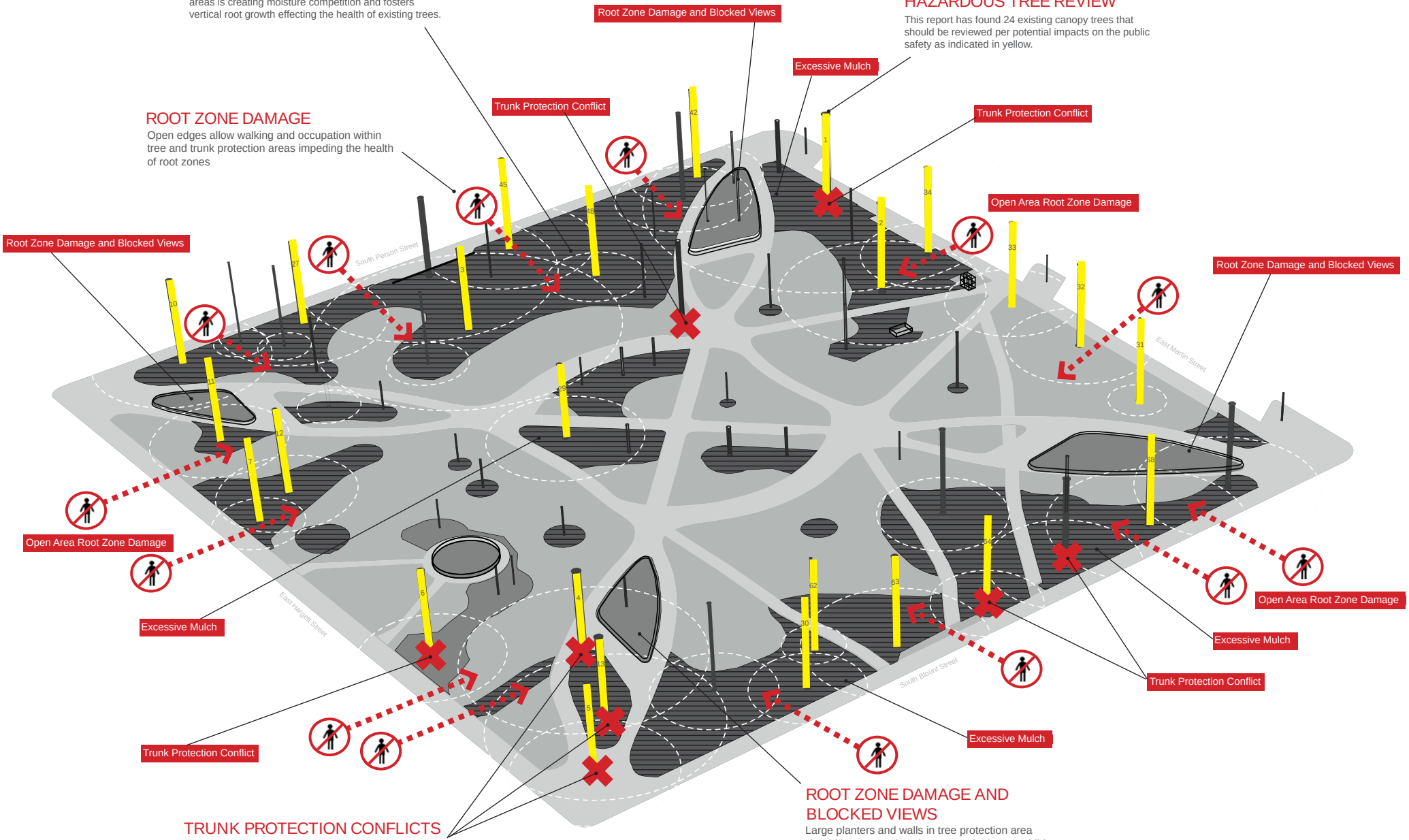
The existing thick mats of mulch in the tree protection areas is creating moisture competition and fosters vertical root growth effecting the health of existing trees.

ROOT ZONE DAMAGE

Open edges allow walking and occupation within tree and trunk protection areas impeding the health of root zones

HAZARDOUS TREE REVIEW

This report has found 24 existing canopy trees that should be reviewed per potential impacts on the public safety as indicated in yellow.

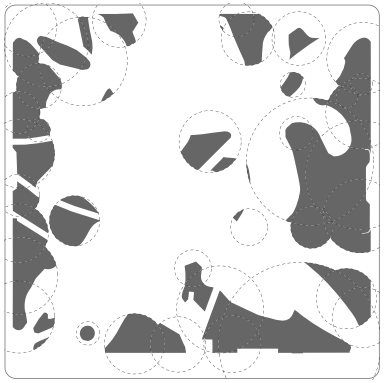


TRUNK PROTECTION CONFLICTS

There are six areas that currently exist in which paths were found to be aggressively cutting into the trunk protection areas. Existing trunk area conflicts should be improved and entrance paths improved.

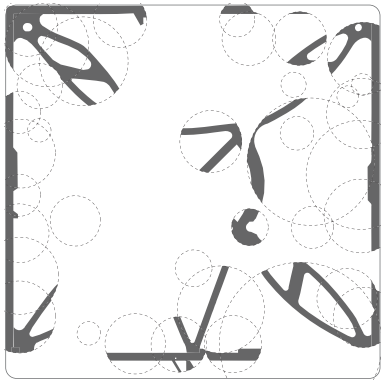
ROOT ZONE DAMAGE AND BLOCKED VIEWS

Large planters and walls in tree protection area should be removed as they currently do not exhibit low impact techniques for preventing root damage and block views into and out of the park.



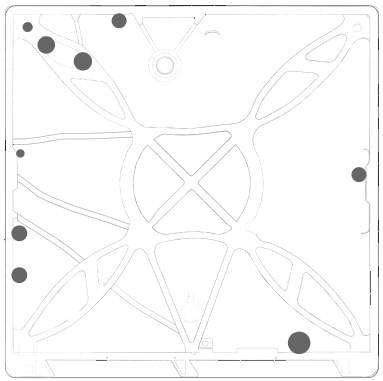
EXCESSIVE MULCH

The existing thick mats of mulch in the tree protection area is creating moisture competition and fosters vertical root growth effecting the health of the existing trees.



TREE / PATH CONFLICTS

Currently there are many existing paths within the tree protection areas. These traditionally built paths were created by cutting into the root zones.

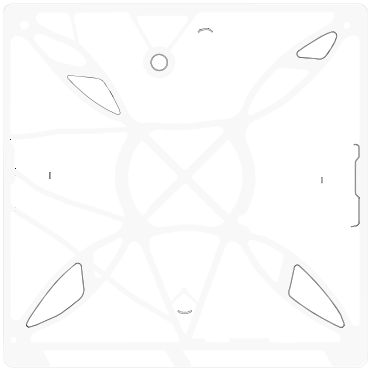


TRUNK PROTECTION CONFLICTS

There are six areas that currently exist in which new paths were aggressively cut into the trunk protection areas.

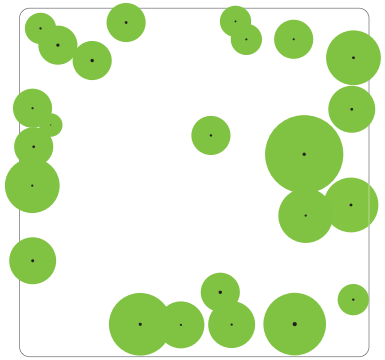
DISCONNECTED LAWN

The current small lawn panels have neither the size nor the soil structure to accommodate the intensity of current or anticipated urban use.



WALLS AND UTILITY STRUCTURES

A numerous collection of deep foundation walls, utility structures, and utility lines currently exist within the tree and trunk protection areas. Existing violations to tree protection areas should be removed.



TREES FOR HAZARDOUS TREE REVIEW

This report has found 24 existing canopy trees that should be reviewed per potential impacts on the public safety.

EXISTING CONDITIONS CONCERNS

A number of different concerns and considerations have been found with the current conditions of the site of Moore Square. For the trees in particular, problems exist within the root space of the existing trees that the report illustrates and recommends to address for future site design. Below are other areas that are of concern for the current site that have been discovered through the analysis of existing site conditions impacted by such current site features such as the current paving, walls, utilities, street curbs.

Paving (all types)– Previous paving resulting from park redesigns imposed additional compaction and reduced pervious areas of the site. By locating new paving over old areas of paving, the sub-base can be reused without adding to root damage. New paving can be more pervious. Air-spade (specialized excavation tool) vertical mulching under the paving can reduce soil compaction and improve root space.

Walls, foundations and other structures created significant root damage during excavation and installation of the structures. Removal of the structures can impose additional damage. Where possible, existing structures or their footings can be reused. If not, the footings should be left in place.

Utility structures – Excavation for wires and supporting utility structures created significant root damage and soil disruption. The trees have to a great extent recovered from this damage. To the extent possible, the locations of these structures and supporting conduits could be left in place.

Street curb and sidewalks – The street grid and most of the street infrastructure was installed either before the existing trees were planted or during a period when the trees were young enough to survive the damage. The grades, paving and curbing can remain or be renovated with limited damage to the existing tree root system, provided the work is performed using low impact means and methods that is well supervised by a tree expert with authority to control the work.

Existing grades – Changes in grades, particularly cutting grades lower, has a very significant negative health impact on tree health. The design grades can maintain existing grades or adopt a fill soil only approach to grading within the tree protection area.

EXISTING CONDITIONS STATISTICS

3,778 SF	ASPHALT
1,415 SF	STONE DUST
1,227 SF	WALLS & FOUNDATIONS
2000 LB	ACORN & STRUCTURE
29,265 SF	CONCRETE PAVEMENT
1,114 SF	GRANITE CURB
169 SF	UTILITY STRUCTURES
28 SF	KIOSK BUILDING

PATH CONFLICTS WITHIN THE TRUNK PROTECTION AREA SHOULD BE IMPROVED

STORM DAMAGE HAS AFFECTED THE SAFETY OF CERTAIN TREES WITHIN THE SITE

PATH CONFLICTS WITHIN THE TRUNK PROTECTION AREA SHOULD BE IMPROVED

PATH AND WALL CONFLICTS WITHIN THE TRUNK PROTECTION AREA SHOULD BE IMPROVED

STORM DAMAGE HAS AFFECTED THE SAFETY OF CERTAIN TREES WITHIN THE SITE

WALLS AND PLANTERS WITHIN TREE AND TRUNK PROTECTION AREAS SHOULD BE REMOVED

PATH CONFLICTS WITHIN THE TRUNK PROTECTION AREA SHOULD BE IMPROVED

PATH CONFLICTS WITHIN THE TRUNK PROTECTION AREA SHOULD BE IMPROVED

OVER MULCHING AND UTILITY STRUCTURES WITH-IN TREE PROTECTION AREAS CAN DAMAGE TREES

EVENTS WITHIN TREE PROTECTION AREAS CAN DAMAGE EXISTING TREES

EXISTING LAWN CANNOT SUPPORT URBAN USE

OPEN PERIMETER ALLOWS FOR USES THAT CAN DAMAGE ROOT ZONES OF EXISTING TREES

EXISTING PATHS AND UTILITY LINES VIOLATE TREE AND TRUNK PROTECTION AREAS

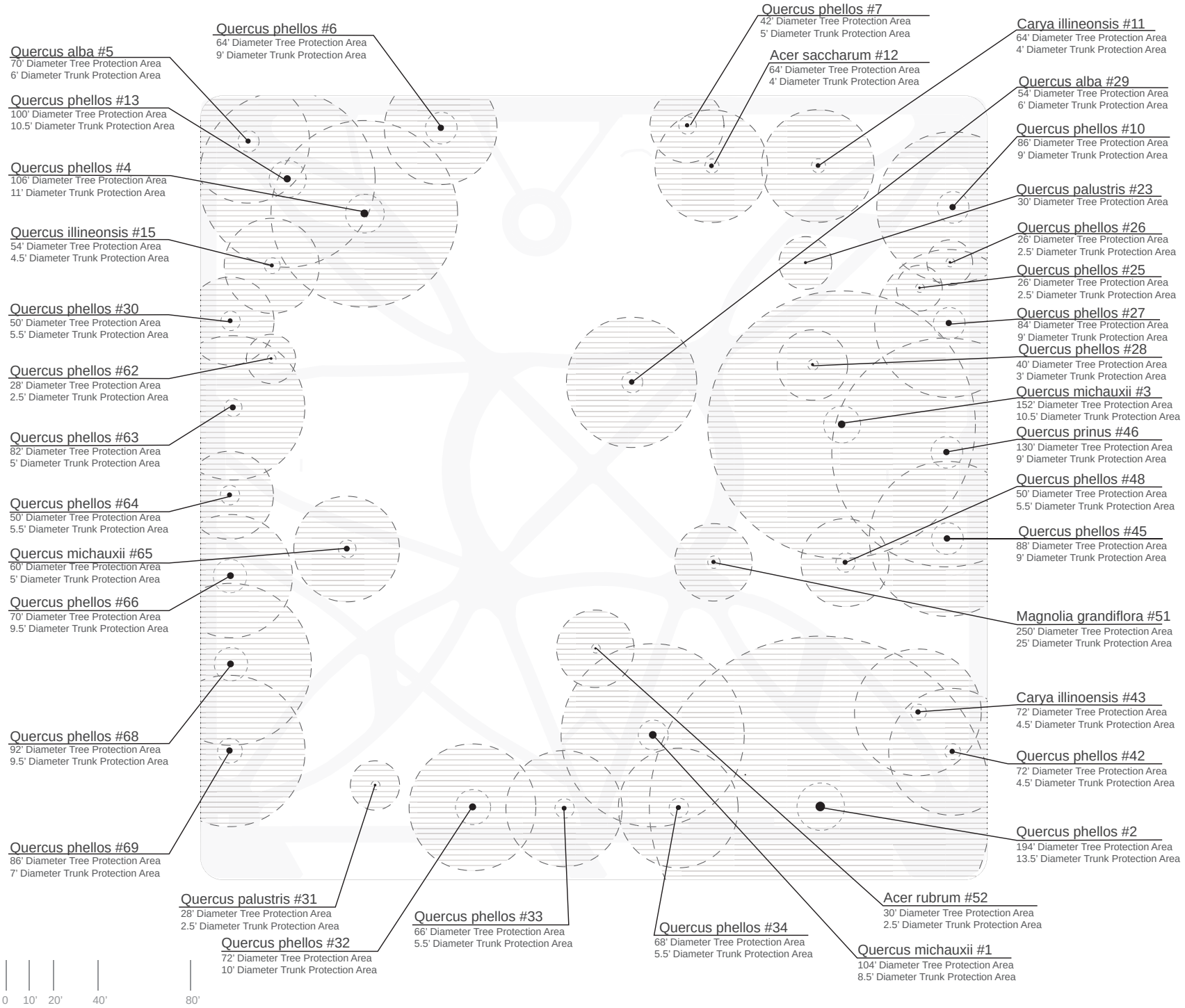
EXISTING PATHS AND UTILITY LINES VIOLATE TREE AND TRUNK PROTECTION AREAS

EVENTS WITHIN TREE PROTECTION AREAS CAN DAMAGE EXISTING TREES

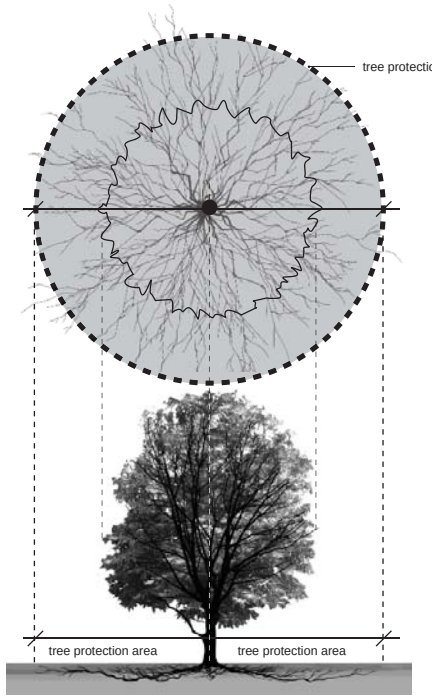
UTILITY STRUCTURES WITH TRADITIONAL FOUNDATIONS WITHIN TREE PROTECTION AREAS

OVER MULCHING AND UNRESTRICTED ACCESS TO SENSITIVE TREE PROTECTION AREAS

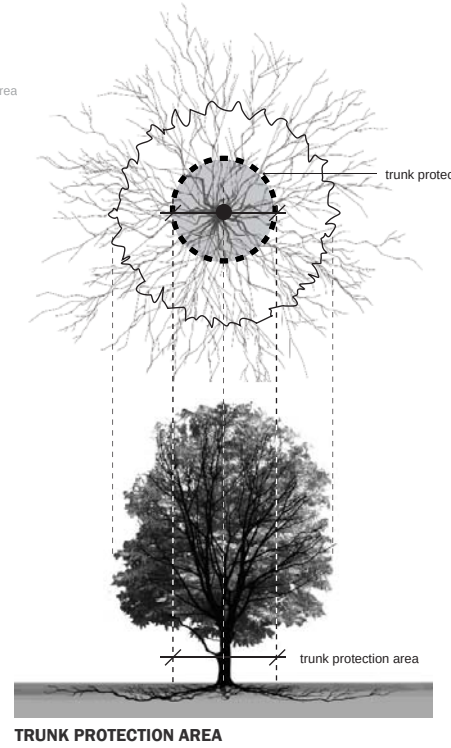
PATH CONFLICTS WITHIN THE TRUNK PROTECTION AREA SHOULD BE IMPROVED



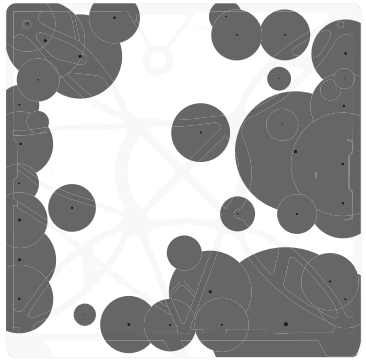
TREE PROTECTION AREA DIAGRAM



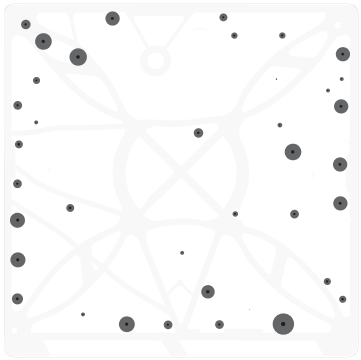
TREE PROTECTION AREA



TRUNK PROTECTION AREA



TREE AREA PROTECTION DIAGRAM
2.6 ACRES/ 57% OF SITE



TRUNK AREA PROTECTION DIAGRAM
.12 ACRES/ 2% OF SITE

Trunk Base Condition
Tree Structure
Tree Vigor
Age Class
Construction Tolerance
Hazard Evaluation
Size
Species

General Recommendations

Specific Recommendations Based on Different Aspects of the Tree Condition

TREE RECOMMENDATIONS

TREE PROTECTION AREA CALCULATIONS:

The City of Raleigh uses a formula of 1.5 feet of radius for each inch of trunk diameter to establish the Tree Protection Area. This approach is not necessary to successfully save every tree. It is an overly large protection area and assumes that nothing is done to modify normal construction or to mitigate damage. It does not take into account the differences in age of trees nor the differences species tolerance to withstand construction. The following section on tree recommendations uses a system of establishing tree and trunk protection areas to make recommendations for future preservation and modifications to enhance existing and plan for future tree plantings and design improvements.

This report recommends using the system developed by Nelda Metheny and James Clark in their book "Trees and Development: A technical Guide to Preservation of Trees During Land Development". This book, published by the International Society of Arboriculture (ISA), is recognized as the best source of tree preservation information.

TREE PROTECTION AREAS

The MSCTS Tree Protection Areas were established in a multi-variable system grounded in data from the International Society of Arboriculture (ISA) for each existing canopy tree on the site. Each individual tree was carefully inspected and reviewed for its trunk base condition, structure, vigor, age class, construction tolerance, hazard evaluation, size, and species. All of these factors are evaluated with historical and contextual information in the creation of tree-specific Tree Protection and Trunk Protection Areas.

ESTABLISHING THE TREE PROTECTION AREA:

The size of the Tree Protection Area for each tree is calculated to guide the design and help assure the survival of the tree. Tree Protection Areas are typically interpreted as being areas of no construction activity. However, if remedial work to improve growing conditions before, during, and/or after the construction are undertaken, responsible construction methods are under tight controls and design guidelines that will protect the tree's vital systems are employed, construction may take place within this area with little to no impact to the tree. Reasonable practices include those that prepare the tree, protect the tree and soil from damage and provide for after care that mitigates any soil or root damage. These reasonable practices will be further elaborated on in the section "Tree Protection Plan".

The MSCTS tree and trunk protection areas were determined by the team's nationally recognized tree expert through synthesis and analysis of multiple above and below-ground factors.

ISA

The ISA approach starts by determining the tree's tolerance to withstand construction. An extensive research questionnaire, sent to arborists all over the United States, ranked hundreds of different tree species. The results of this questionnaire were tabulated and published in "Trees and Development". The system uses a ranking of good, moderate and poor tolerance to construction. Fortunately, most of the large trees on this site are classified as having good tolerance to construction.

The second step is to determine the tree age with three levels proposed. They were as follows; young trees; considered at less than 20% of their life expectancy, mature trees; between 20 and 80% of their life expectancy, and over-mature trees; those with less than 80% of their life expectancy remaining. For the purpose of this report, the research findings from the Bartlett Tree Arborist report were used to make the determination of age classification.

The third step is to determine the requirement of the radius of the Tree Protection Area in feet per inch of trunk diameter. In the ISA system, the radius generally ranges from 0.5 feet per inch of caliper to 1.25 feet per inch of trunk diameter. In only one case, the most restrictive condition, does the ISA method use 1.5 inch per inch of trunk diameter. The ISA system is as follows;

Using the above system, a radius of Tree Protection Area has been calculated for each large tree. One variation was used to further refine this approach. The above ISA system assumes that the tree's health (vigor) is in a normal condition and does not account for other mitigating factors often found at urban sites such as trunk base conditions, soil problems, drainage, or adjacent structures. The ISA system does suggest that these conditions be factored into the final distance. In making the Tree Protection Area calculations for the trees at Moore Square, some of the tree distance requirements were increased 0.25 feet per inch of trunk diameter to factor for observed conditions that would make the tree preservation more difficult. These trees are noted with an asterisk in the Tree Protection Area Ft/Inch column on the tree evaluation chart.

The methodology used to determine that a tree should be given the extra 0.25' / Inch in the rating was as follows.

-Any tree that was rated as Vigor – Poor.
-Any tree that had two out of three categories (Tree Base, Structure, Vigor) in the lowest rating.
-Any tree that had three out of three categories in the medium or low rating.

Using the above methodology, the radius of the Tree Protection Area for the mature trees ranges from 0.5 ft / inch to 1.5 ft / inch with only three (3) trees indicated as needing 1.5 ft. / inch according to Urban Trees and Soils. We can use these measurements for construction protection, but will still use the 1.5 ft / inch DBH in order to establish the Tree Conservation Area (TCA) as required by the City.

HAZARD TREE INVESTIGATION RECOMMENDATION

Large mature trees in close proximity to people may pose the risk of structural tree failure that can injure people using the park. The City of Raleigh is responsible for the monitoring and mitigation of hazardous conditions in the park and has been doing a good job of removing dead branches and stabilizing trees. However, trees are dynamic organisms with constantly changing structural conditions as they grow, adding weight and wind loading in some areas, and at the same time decay and added stress from wind and gravity is weakening the tree in other areas. Finding tree conditions that might be dangerous is a constant task in a population of trees of the size and age of the trees in Moore Square.

The action of the proposed major renovation of this park causes the City to take on added liability for these trees. It is assumed that during a facility wide reconstruction, all systems will be made as safe as possible and that the entire park will meet current codes and safety concerns upon completion. This puts added requirements on the trees to be evaluated for defects and to mitigate these defects even to the point of removing hazardous trees.

For this reason, it is advised that the City conduct a hazard tree evaluation for any tree that may have indications of possible hazardous conditions. During the initial tree evaluation of the park, 24 trees were identified as being candidates for further hazard tree evaluation. These trees are noted in the Summary Tree Evaluation Data to follow.

The City has responded to the suggestion to evaluate these trees for hazardous conditions by undertaking an evaluation. They found that except for tree #2, a large Willow Oak in the south east corner of the site, all the trees recommended for evaluation can be retained with suggested mitigations. Tree #2 is recommended to be removed.

ISA RECOMMENDED:

Species Tolerance	Tree Age	Radius from the trunk in feet per inch of trunk diameter
Good	Young < 20% life expectancy	0.5'
	Mature 20-80% life expectancy	0.75'
	Over mature > 80% life expectancy	1.0'
Moderate	Young	0.75'
	Mature	1.0'
	Over mature	1.25'
Poor	Young	1.0'
	Mature	1.25'
	Over mature	1.5'

TREES RECOMMENDED FOR HAZARDOUS TREE REVIEW CHART

Tree #	Botanical Name	DBH
1	Quercus michauxii	52
2	Quercus phellos	65
3	Quercus michauxii	51
4	Quercus phellos	53
5	Quercus alba	35
6	Quercus phellos	43
7	Quercus phellos	29
10	Quercus phellos	9
11	Carya illinoensis	32
12	Acer saccharum	32
13	Quercus phellos	50
27	Quercus phellos	42
29	Quercus alba	37

Tree #	Common Name	DBH
30	Quercus phellos	33
32	Quercus phellos	48
33	Quercus phellos	33
34	Quercus phellos	34
42	Quercus phellos	36
45	Quercus phellos	44
48	Quercus phellos	34
62	Quercus phellos	18
63	Quercus phellos	41
64	Quercus phellos	34
68	Quercus phellos	46

TREE EVALUATION AND CONSTRUCTION PRECAUTIONS

Construction of many elements can be compatible with tree rooting areas if undertaken by skilled practitioners and contractors using techniques that are tree sensitive. It is important to note that the Master Plan Report is not a design document. It sets basic frameworks for design that now must be developed and refined to incorporate the many different site conditions and requirements that are typically left to the design development stage. This report is intended to guide the design development process from a tree preservation and soil health perspective.

Tree preservation during construction is essentially soil preservation. For this reason, tree preservation guidelines have focused on protecting large areas of ground surface around the tree. This area of protected ground is the Tree Protection Area.

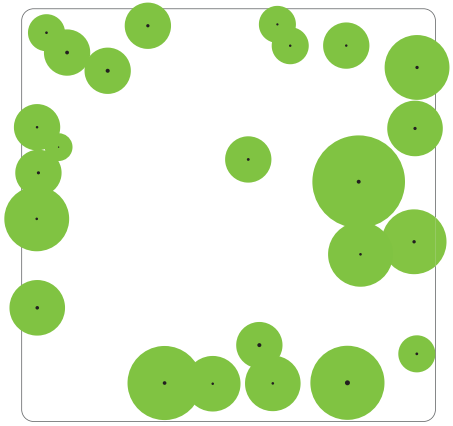
At the tree's trunk, there is typically a distinct trunk flair, an enlarged area of wood that supports the tree right at the ground line. Below the ground and trunk flare, large roots form to support the tree and further divide into smaller roots farther from the tree that collect the water and nutrients that the tree needs. The most important part of these roots are generally considered the area within the first 4-10 feet from the trunk called, the Zone of Rapid Taper roots. The Zone of Rapid Taper roots and the trunk flair together must receive special consideration to protect them from damage. (This area is also the place where most root / paving conflicts begin and paving within this area must take these conflict into consideration. This area is the Trunk Base Protection Area.)

Often the Tree Protection Area is interpreted as a place where no construction activity should take place. This is an incorrect interpretation. Construction of many types often occurs in this area with no consequences to the tree's long-term health. However, construction must be designed and executed by professionals who are expert in tree preservation and working around trees. It is analogous to having surgery by someone not trained in surgery. Even a trained general practitioner might not be the right person for particular procedures. The more technical the operation, the more likely you are to want to find a specialist. It is entirely possible to construct the elements of the Master Plan, with the appropriate design development refinements in their size, materials, elevations, and locations, and find the mature tree population in better condition that it is today if the guidelines set in this report are to be correctly appropriated.

TREE PROTECTION PLAN

Protecting a tree during construction requires multiple levels of approaches that go far beyond simply fencing the area of protection. A tree protection plan is required that begins prior to the start of construction and carries on well past the end of construction. The plan will have parts that must be implemented by the City. Parts of the plan will impact the design process and parts that will become a part of the construction documents. Portions of the plan will become part of the park's long-term management plan.

If properly developed and implemented, the result of the Tree Protection Plan reveals that within the lifespan of the existing mature trees on the site, their health is likely not only to be healthier after the construction than before, but also their life expectancy should increase. Each part of the plan not only protects the trees from damage, but also will improve growing conditions and mitigate existing conditions in ways that would likely not be possible under current park



TREES RECOMMENDED FOR HAZARDOUS ASSESSMENT PLAN DIAGRAM

management budgets.

The following is the outline for the tree protection plan, presented as a series of general concepts that will guide the development of specific recommendations for each tree as the details of the design and construction process develops. The plan has four parts. Pre-construction requirements; Design and construction documents requirements; Construction requirements; and Post construction requirements.

TREE CONSERVATION AREA

TCA will still be part of the design development phase. Information from this report and further design development will establish the locations of TCA as required by Raleigh Tree Conservation Ordinance.

PRE-CONSTRUCTION REQUIREMENTS:

1. Evaluate the existing tree conditions.
2. Establish Tree Protection Area and Trunk Base Protection Area for each tree.
3. Perform a Hazard Tree Evaluation for each mature tree and develop tree mitigation requirements for all conditions encountered. Implement the mitigation requirements.
4. Establish and fund a pre-construction tree management budget to implement the pre-construction portion of the Tree Protection Plan. This needs to be undertaken as soon as possible and is NOT part of the construction budget.
5. Identify the primary tree care manager within the Parks Department to oversee the Tree Protection Plan.
6. Develop and implement a tree health management contract with an Arborist to monitor and treat all disease and insect problems; prune trees to remove deadwood and structural defects.
7. Apply Cambistat to all mature trees. Cambistat shall be applied as a tree growth regulator that is proven highly effective in reducing growth rates and stimulating fine root production, and shall be used in preparation for construction. Note that Cambistat requires a minimum of one year to begin to have positive effects on the tree and needs to be applied every three years. Ongoing applications of Cambistat should remain a City responsibility during the construction to assure that consistent application requirements are followed.
8. Apply any nutrients recommended by the soil test to bring soils in the root zone to optimum nutrient levels before, during and after the construction. Ongoing soil testing and applications of nutrient should remain a City responsibility during the construction to assure that consistent application requirements are followed.
9. During periods of prolonged drought prior to construction, develop and implement a root zone watering program for all mature trees to remain to assure that they are not water stressed.
10. Establish TCA (Tree Conservation Area) to be reviewed by Raleigh Forestry Specialist.

DESIGN AND CONSTRUCTION DOCUMENTS REQUIREMENTS:

1. Insert into the design drawings the limits of the Tree Protection Area and Trunk Base Protection Area for each tree. These limits should be included in every site construction plan document of each of design discipline to assure that all design consultants understand the importance of these areas and when their work is impacting these zones.
2. Develop a Soils Improvement Plan, soil details and soil specifications for all areas of the park that retains good soils; protects root zone soils from damage; and improves soil within and outside the Tree Protection Area for future growth of each tree.
3. Develop Tree Protection Plans, details and specifications that detail specific requirements for tree protection including fencing, mulching/matting, operations allowed within the Tree protection Area, trenching/ grading techniques, watering requirements, disease and insect controls, pruning, and monitoring and mitigation of inadvertent damage.
4. Establish the cost to the contractor for various levels of tree damage including placing an ISA based value on each tree in the event that it is damaged to the point where the tree's long-term health is compromised by damage caused by the contractor.
5. Protect soil within the Tree Protection Area from compaction by fencing and mulch/geogrid matting.
6. Grading cuts should be minimized or when required made with an air spade and vactor equipment. Roots larger than 1 inch in diameter encountered during grading must be cut only with the approval of the project Arborist.
7. Grading fills must be preceded by removal of organic layers or turf. Undertake airspade invigoration of the existing soil that may include mixing existing organic layers with the sub-soil below and mixing with the new soil to be installed. Fill soil in the Tree Protection Area must be sandy loams place by low compaction impact procedures. New grades must continue to provide for drainage and aeration of the soil. If fills exceed 12 inches, deep aeration layers between the fill and existing grades must be included.
8. Utility line trenches within the Tree Protection Area should be avoided and lines redirected around the Tree Protection Area. Where unavoidable new utility lines shall be installed with directional boring technology; or the use of airspade / vactor equipment.
9. New paving should be placed on geogrid / aggregate bases. Walls and other structures should employ pier and beam bridging with designs that are flexible to move piers or beams to avoid large roots. All excavation must use airspade / vactor equipment. The Arborist must approve any roots to be cut over 1" in diameter.
10. All new planting within the Tree Protection Area must be performed using planting concepts that require the least amount of disturbance. Bare root planting and planting with airspade digging tool is preferred. Spacing of plants should be as wide as practical and allow plants to grow together. Tightly spaced plants to make instant effects of the planting must be avoided.
11. TCA plat approval.

CONSTRUCTION REQUIREMENTS:

1. Retain an independent Arborist to monitor all tree protection provisions during the extent of the work. The Arborist must have access to the site frequently enough to make reasonable and timely review of the work. The cost of this provision must be included in the project budget.
2. Implement the requirements in the Tree Protection Plan provisions.
3. Implement the requirements in the Soil Plan provisions
4. The provisions of the Tree Protection Plan must be flexible to accommodate all factors in the construction sequence. The project Arborist must approve all modifications to the plan.
5. Provide supplemental water to the root zone during the construction.

Post construction requirements:

1. Assure that there is a well documented and understood transfer point of tree maintenance responsibility from contractor to the City at the end of the construction.
2. Continue supplemental watering of the root zone as required for a minimum of 5 years.
3. Continue Cambistat and nutrient treatments as required for a minimum of 5 years after the end of construction.
4. Continue intensive tree health monitoring for a minimum of 10 years.

TREES RECOMMENDED FOR PRUNING

Tree #	Common Name	DBH	Tree Care Priority	Risk Rating	Clean	Thin	Structural
43	Pecan	36	1	low	yes	....	....
3	Swamp White Oak	51	1	....	yes	....	....
11	Pecan	32	....	....	yes	yes	yes
21	Shumard Oak	6	1	....	....	....	yes
36	Willow Oak	10	1	....	....	....	yes
38	Hybrid Elm	7	1	....	....	....	yes
45	Willow Oak	44	1	....	yes	....	....
49	Shumard Oak	3	1	....	....	....	yes
100	Palmetto	7	1	....	yes	....	....
4	Willow Oak	53	2	....	yes	....	.....
6	Willow Oak	43	2	....	yes	....	....
16	Japanese Maple	8	2	....	yes	....	....
17	Japanese Maple	4	2	....	yes	....	....
18	Paperbark Maple	8	2	....	yes	....	....
31	Pin Oak	18	2	....	....	yes	yes
73	Swamp White Oak	8	2	....	....	....	yes
56	Japanese Maple	6	3	....	yes	....	....
72	Swamp White Oak	8	3	....	....	....	yes

TREES RECOMMENDED FOR ROOT COLLAR EXCAVATIONS

Tree #	Common Name	DBH
4	Willow Oak	53
5	White Oak	35
6	Willow Oak	43
8	Flowering Dogwood	4
11	Pecan	32
12	Sugar Maple	32
13	Willow Oak	50
15	Pecan	27
16	Japanese Maple	8
17	Japanese Maple	4
18	Paperbark Maple	8
20	Holly	9
21	Shumard Oak	6
23	Pin Oak	20
30	Willow Oak	33

Tree #	Common Name	DBH
31	Pin Oak	18
35	Trident Maple	3
36	Willow Oak	10
49	Shumard Oak	3
50	Yoshino Cherry	11
52	Red Maple	15
53	Blue Spruce	7
59	Japanese Maple	25
62	Willow Oak	18
65	Swamp White Oak	40
67	Deodar Cedar	16
69	Willow Oak	43
70	Nuttall Oak	4
72	Swamp White Oak	8
30	Swamp White Oak	8

TREES RECOMMENDED FOR PLANT HEALTH CARE

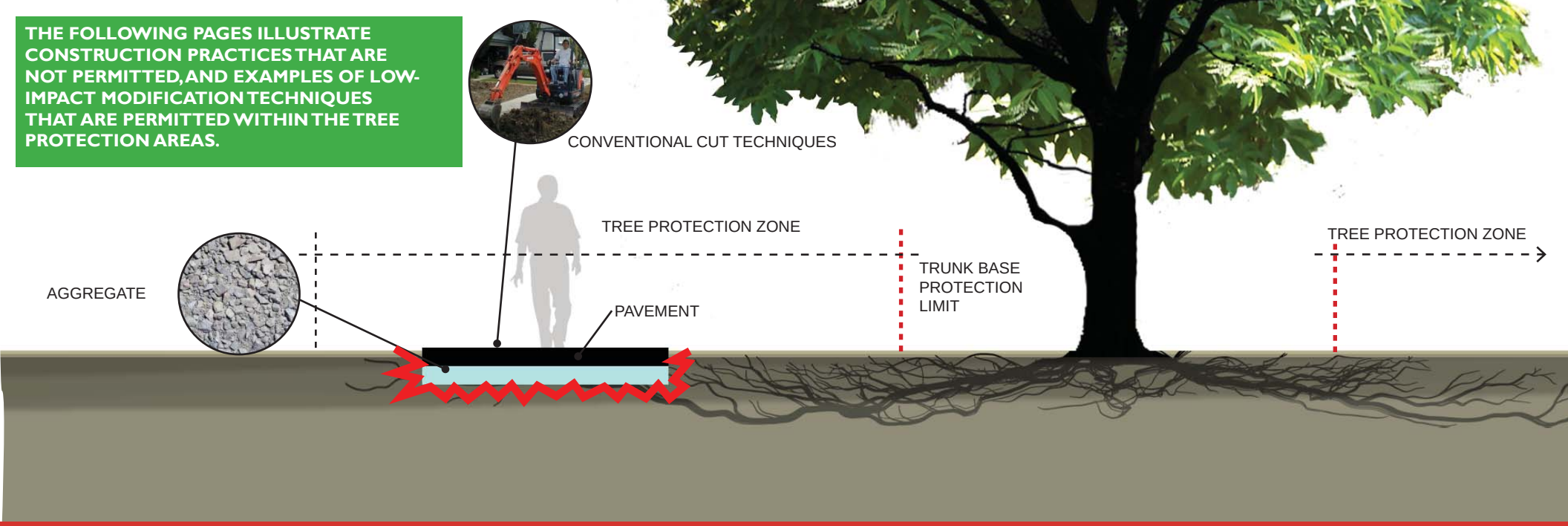
Tree #	Common Name	DBH	Pest or Disease
1	Swamp White Oak	52	cankers
23	Pin Oak	20	cankers
55	Japanese Maple	15	scale
66	Willow Oak	46	borers
67	Dodar Cedar	16	borers
70	Nuttal Oak	4	mites
71	Red Maple	5	cankers

Conventionally implemented and constructed tree disturbing activities should not be permitted within the tree protection and trunk protection areas.

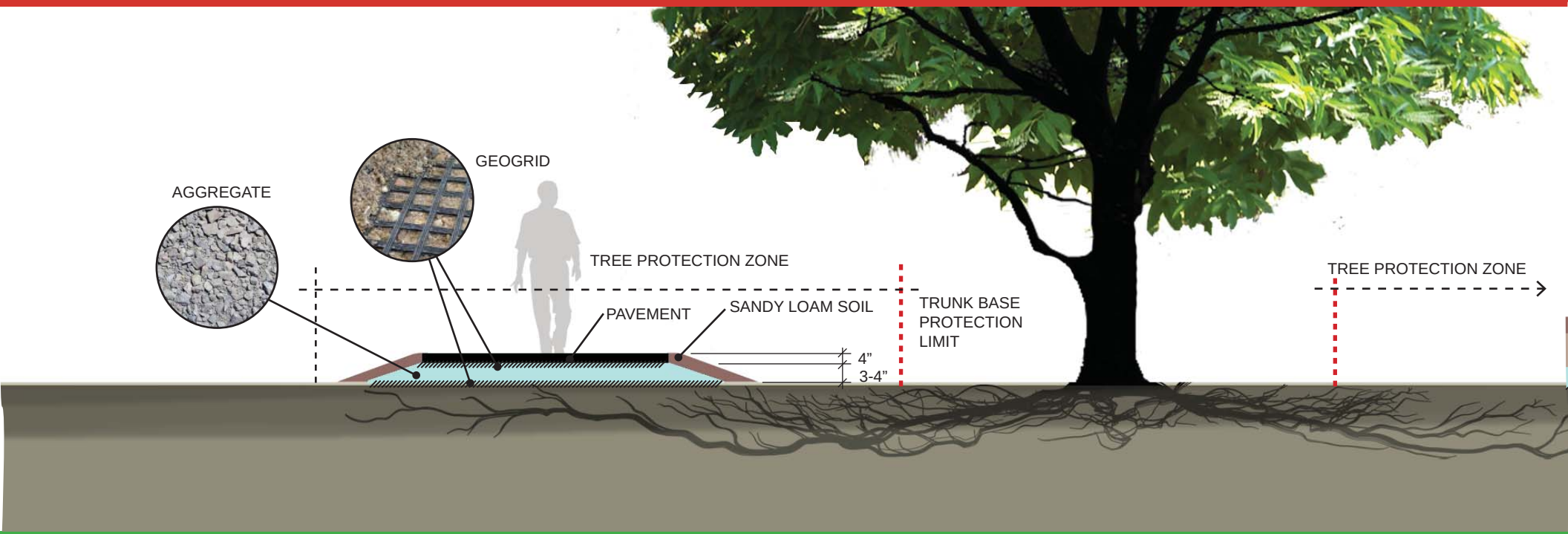
Design detailing, specifications, and construction observation involving modifications and improvements to the tree protection areas should be overseen by a nationally recognized tree expert and certified master Arborist.

Any modifications within the tree protection area should be reviewed on a tree by tree basis and every effort should be taken to minimize the impact to the existing root zones.

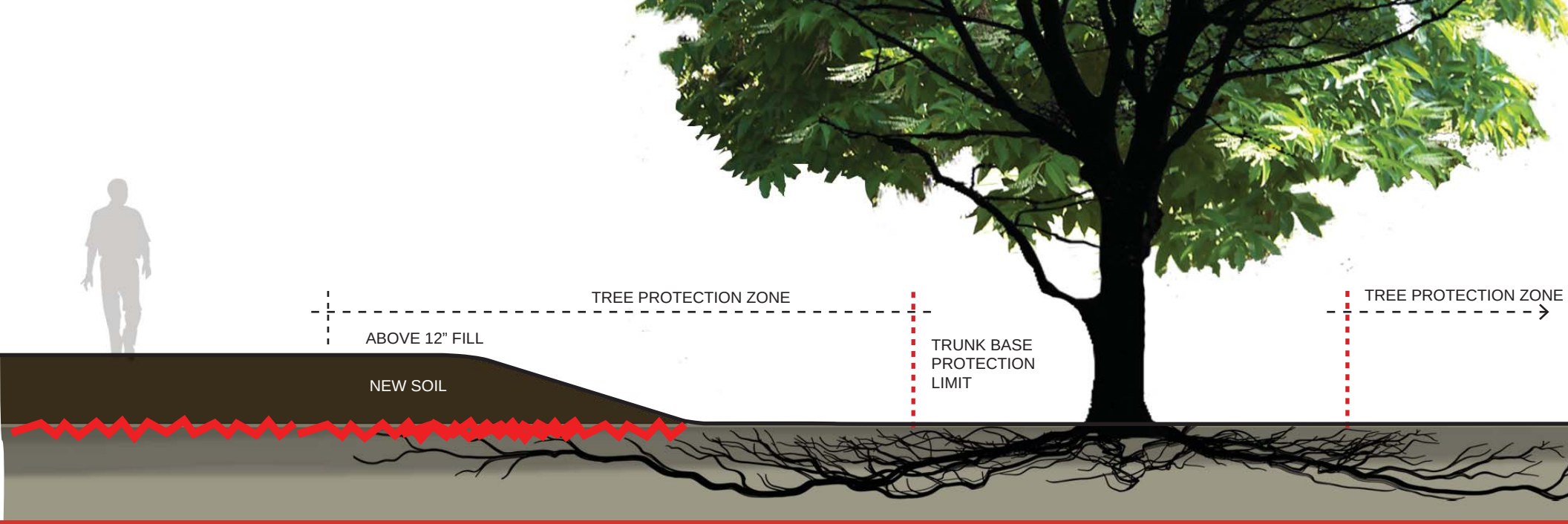
THE FOLLOWING PAGES ILLUSTRATE CONSTRUCTION PRACTICES THAT ARE NOT PERMITTED, AND EXAMPLES OF LOW-IMPACT MODIFICATION TECHNIQUES THAT ARE PERMITTED WITHIN THE TREE PROTECTION AREAS.



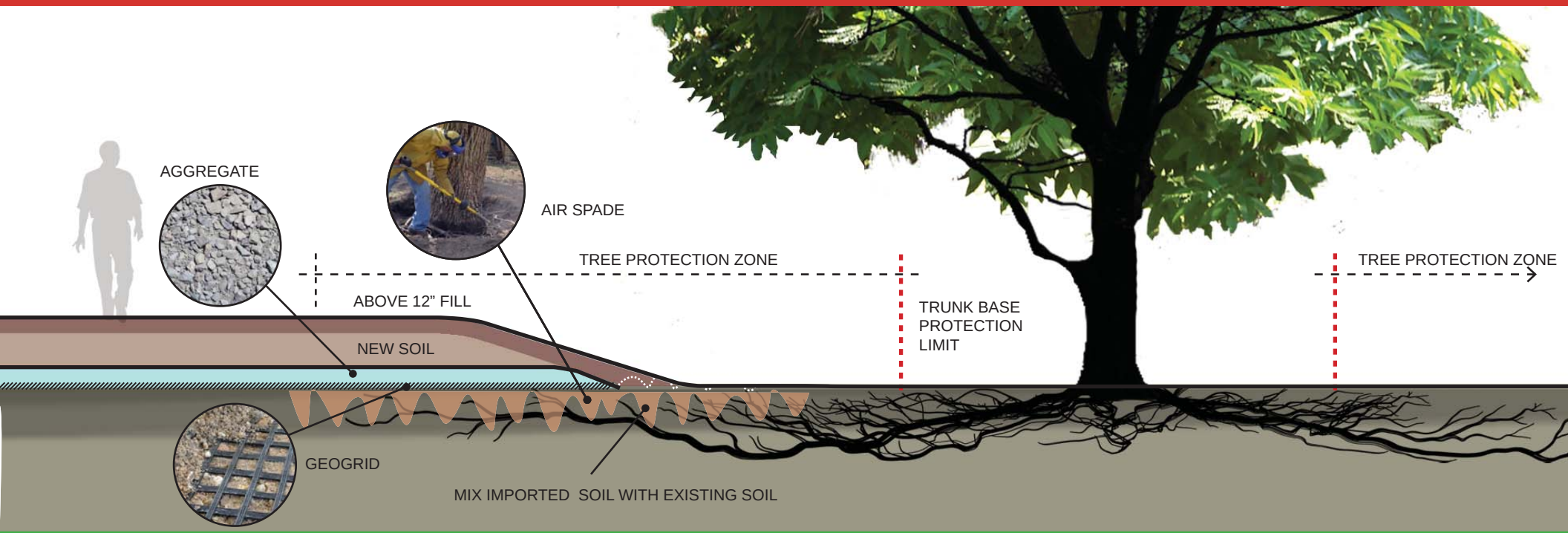
UNAPPROVED HIGH - IMPACT PATH SYSTEM



APPROVED LOW - IMPACT PATH SYSTEM

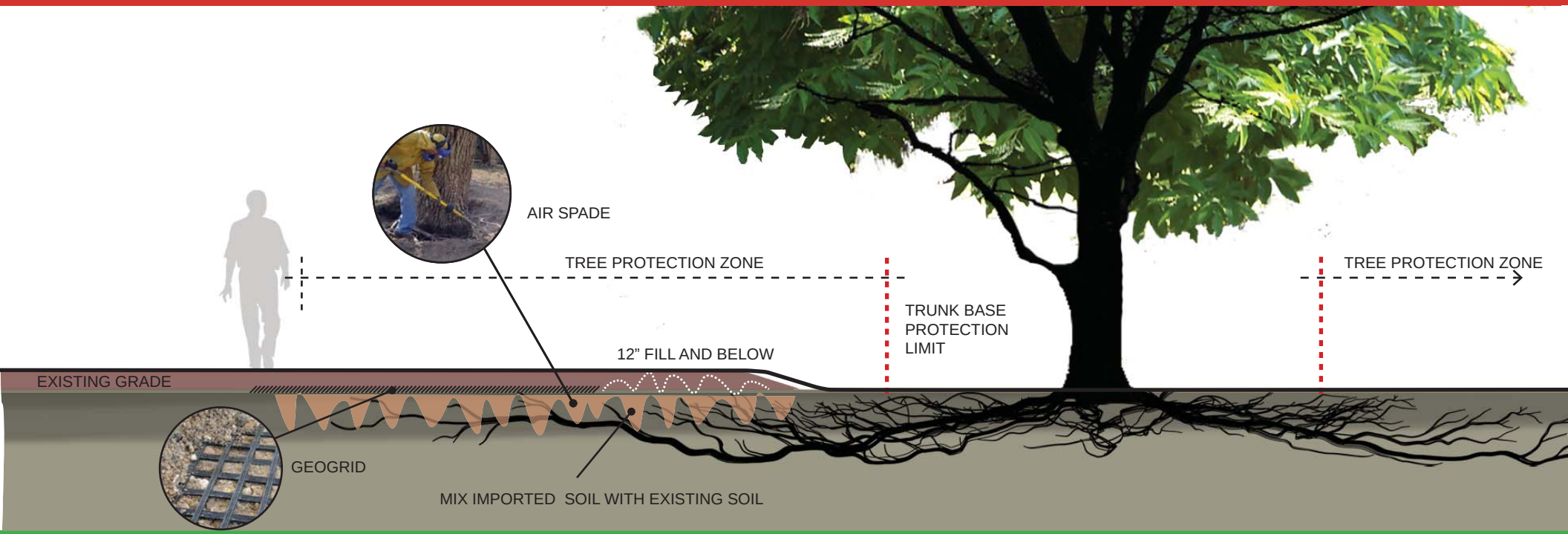


UNAPPROVED HIGH - IMPACT ABOVE 12” FILL TECHNIQUE

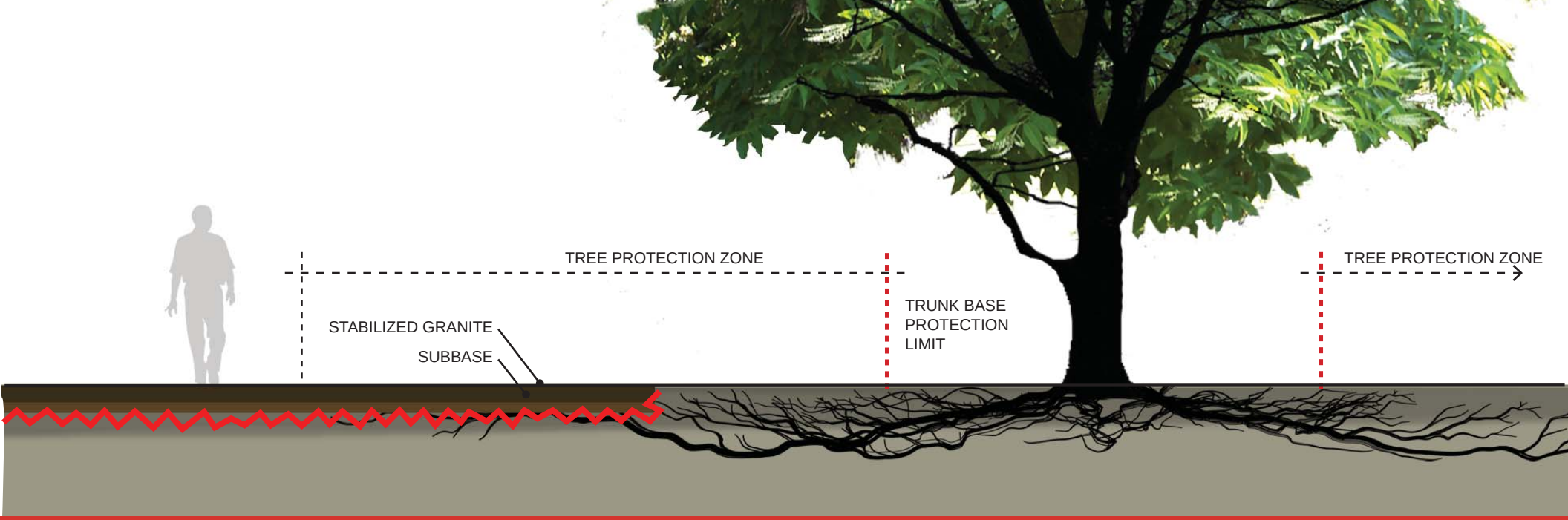


APPROVED LOW - IMPACT ABOVE 12” FILL TECHNIQUE

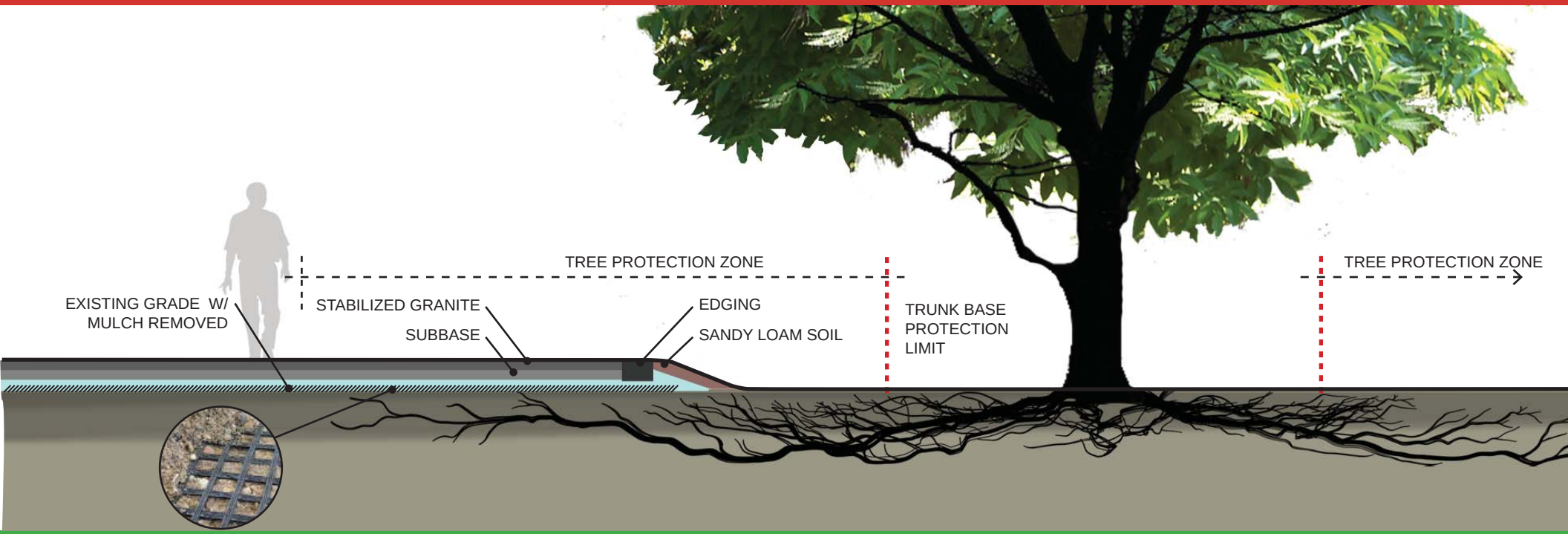
UNAPPROVED CONVENTIONAL FILL BELOW 12”



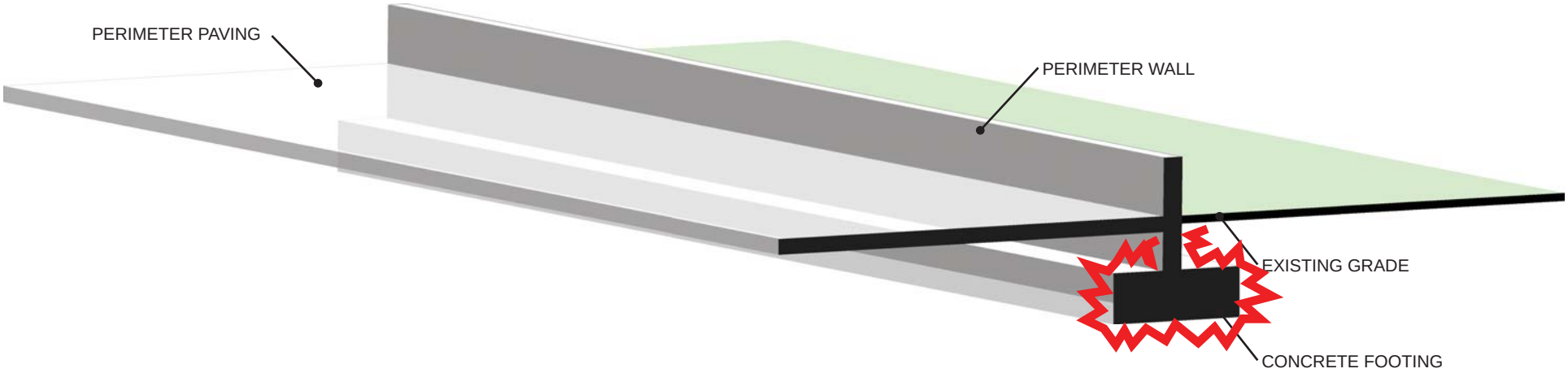
APPROVED LOW - IMPACT FILL BELOW 12”



UNAPPROVED CONVENTIONAL GRANULAR PAVEMENT

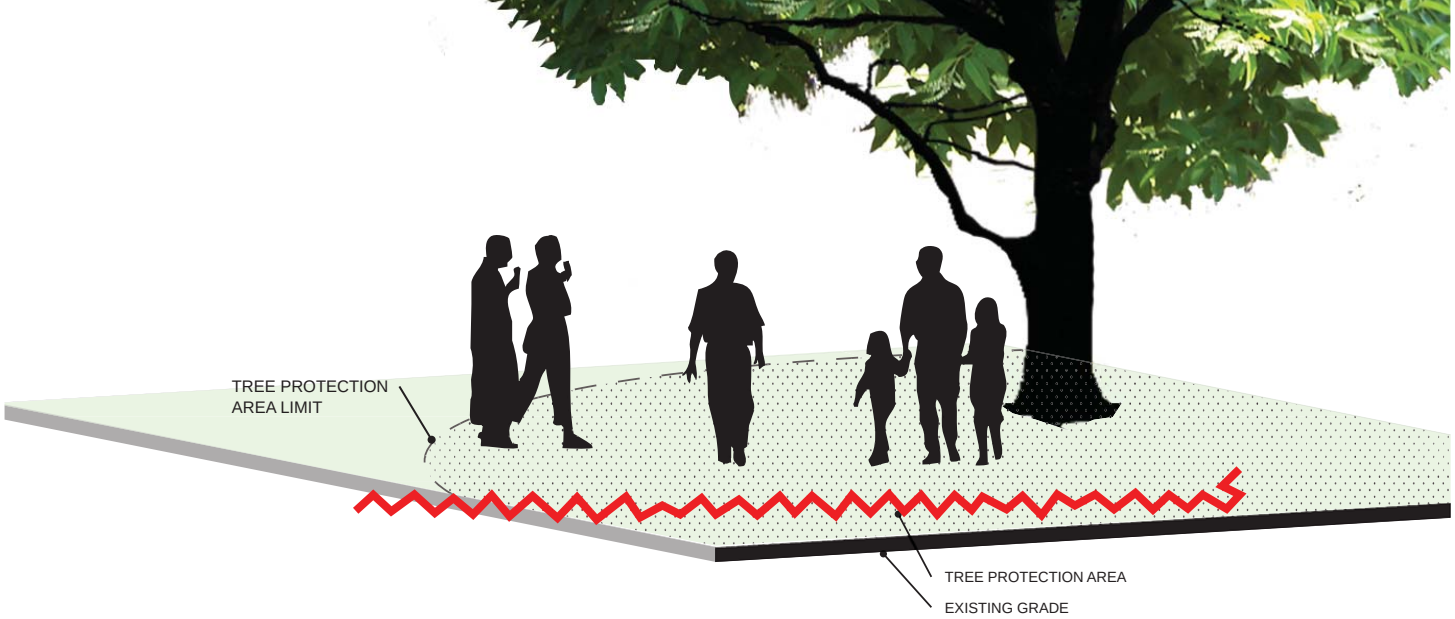


APPROVED LOW - IMPACT GRANULAR PAVEMENT

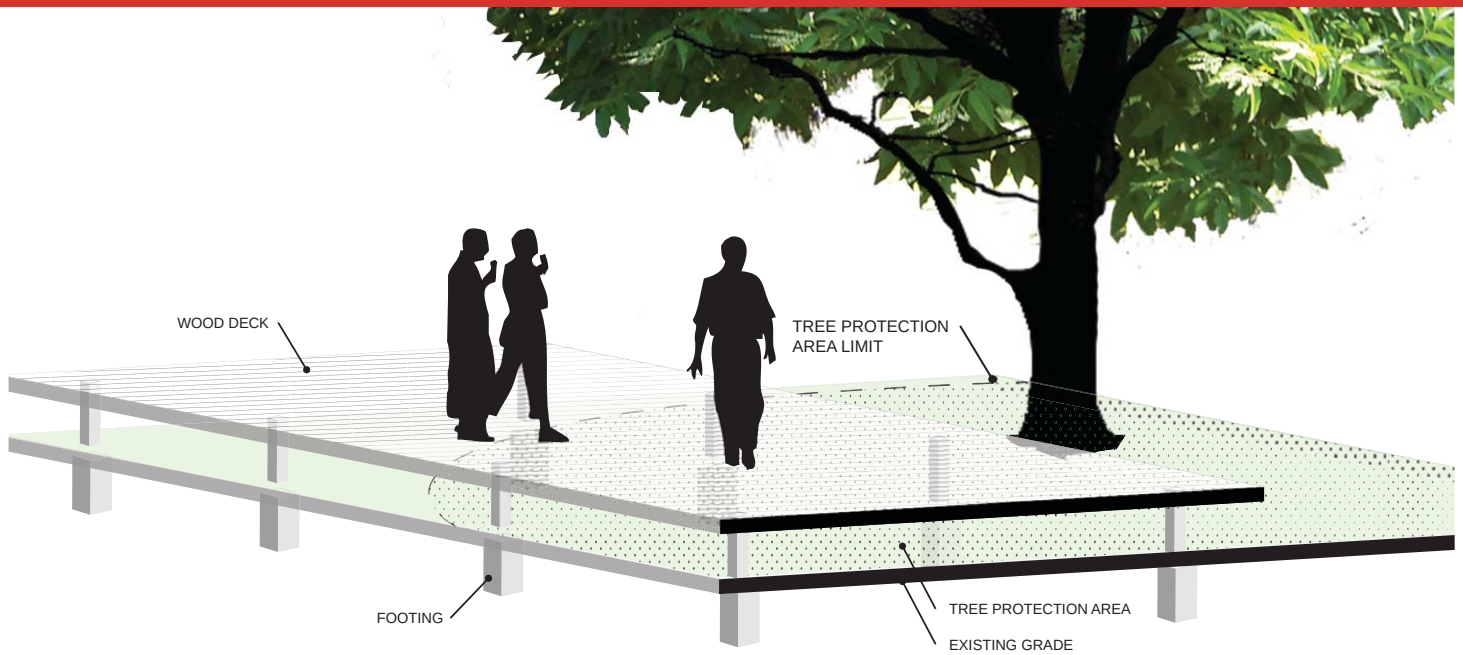


UNAPPROVED CONVENTIONAL WALL CONSTRUCTION

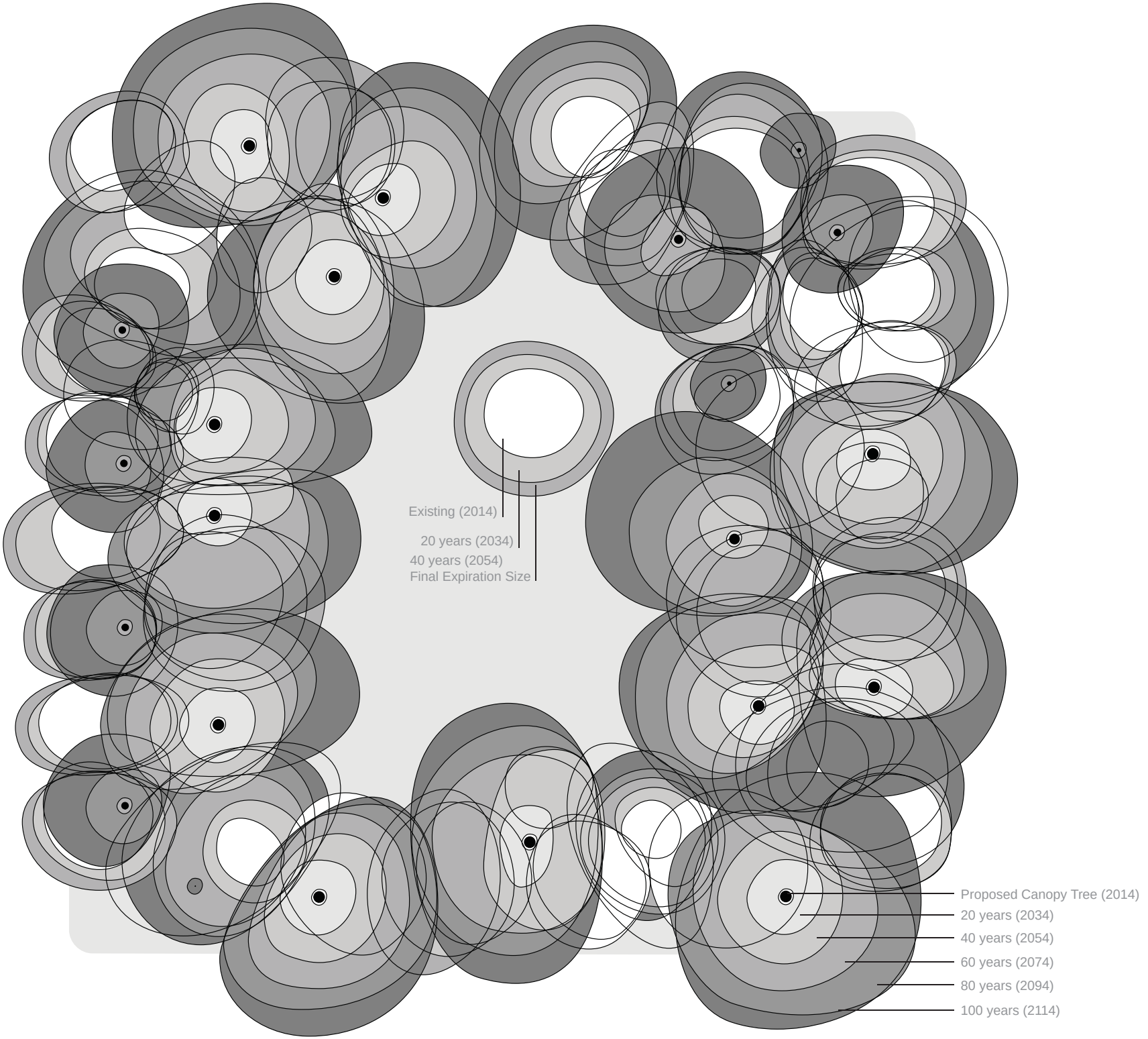
APPROVED LOW - IMPACT WALL CONCEPT



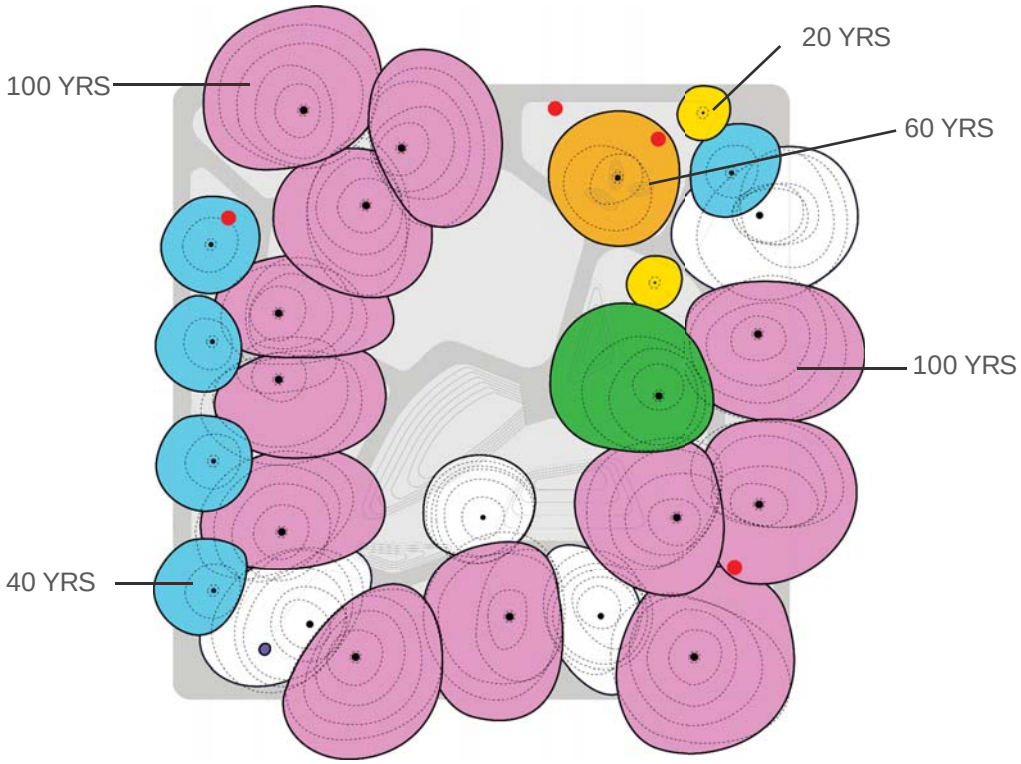
UNAPPROVED IMPACT TO TREE PROTECTION AREA



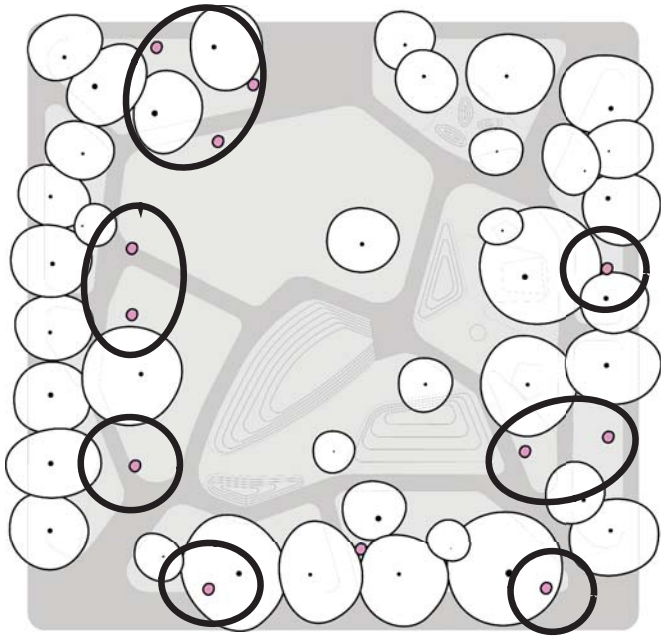
APPROVED LOW - IMPACT ELEVATED WOODEN DECK CONCEPT



100 YEAR COMPOSITE PROJECTION



AGE DIVERSITY GOAL



TARGET AREAS FOR PLANTING NEW CANOPY TREES

Long-term CANOPY MANAGEMENT

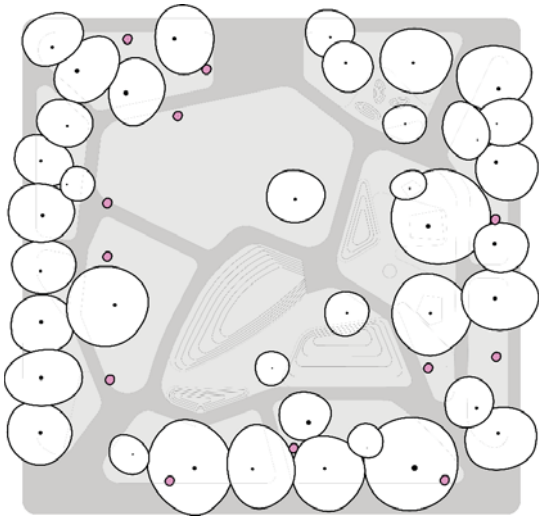
In addition to existing tree analysis, a 100-year growth and decline projection study was undertaken to evaluate the viability of the existing grove. A detailed set of criteria for these studies was developed in close collaboration with Urban Trees + Soils that included canopy growth, trunk growth tree loss and parameters of declining trees. Although it is impossible to predict the exact future of tree growth and decline, this study was undertaken as a means to establish a reasonable understanding of the likely trends that will occur over the next 100 years. The results from this analysis showed that over 60% of the existing trees will expire in the next 50 years and 90% in the next 100 years. It is critical that the Moore Square improvements anticipate these trends and begin a thoughtful plan to introduce new canopy trees in target areas to ensure that, as the mature canopy trees naturally begin to decline and expire, there are new trees growing in to take their place. The study also found that the relative low diversity of tree age is the primary reason for the two anticipated large waves of tree decline. When considering planting design strategies for Moore Square, it is recommended that a similar long-term approach be utilized to increase the age diversity of the grove.

The Master Plan is not only working to preserve the significant trees, but to also respect their future growth, decline, death and replacement. Trees are living organisms that will grow and decline and die. In order to determine the impact of future changes in the canopy, it is necessary to make assumptions about this process. The following are the assumptions used to develop canopy growth studies over time. It is recognized that these assumptions are very general and that individual trees will not respond in this precise manner. However, the studies do assist in providing a basis for predicting park canopy changes and where and when new trees might be added to the park.

For the purposes of this study, only canopy trees that have the potential to contribute to the enhancement of the perimeter grove were included in this study.

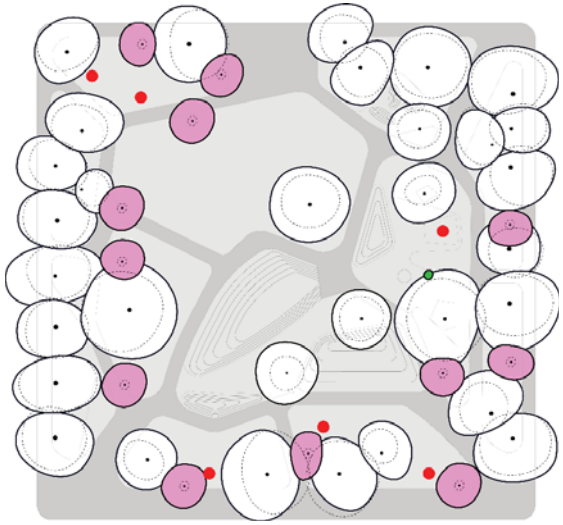
The long-term management of any the perimeter grove of canopy trees should be a central driver of a new planting strategy.

Increasing the age diversity of the Grove should be a long-term goal of the long-term canopy management for Moore Square.



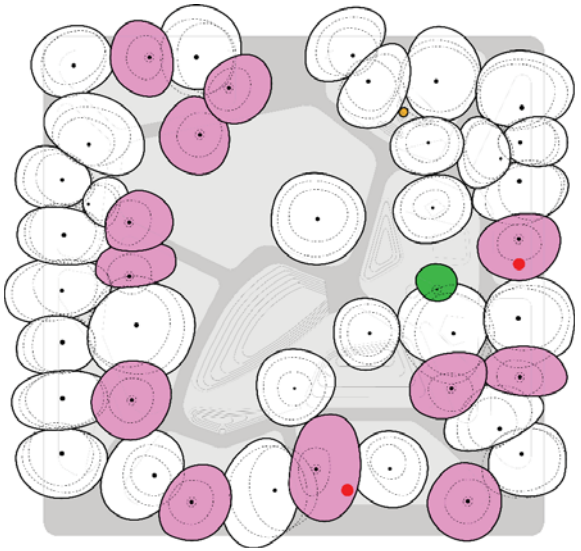
2014
INITIAL PLANTING

38 existing canopy trees
12 new canopy trees planted at 3” DBH



2034
20 YEAR PLANTING

32 existing canopy trees remain
One new canopy tree planted at 3” DBH
Six trees reach maximum lifespan
Initial planting reaches 20 years old



2054
40 YEAR PLANTING

30 existing canopy trees remain
One new canopy tree planted at 3” DBH
One 100-year-old fair vigor tree is lost
One 30-year-old fair vigor tree is lost due to competition
Initial planting reaches 40 years old

100 YEAR TREE PLANTING STRATEGY

2014 Canopy Tree Planting

2034 Canopy Tree Planting

2054 Canopy Tree Planting

2074 Canopy Tree Planting

2094 Canopy Tree Planting

2114 Canopy Tree Planting

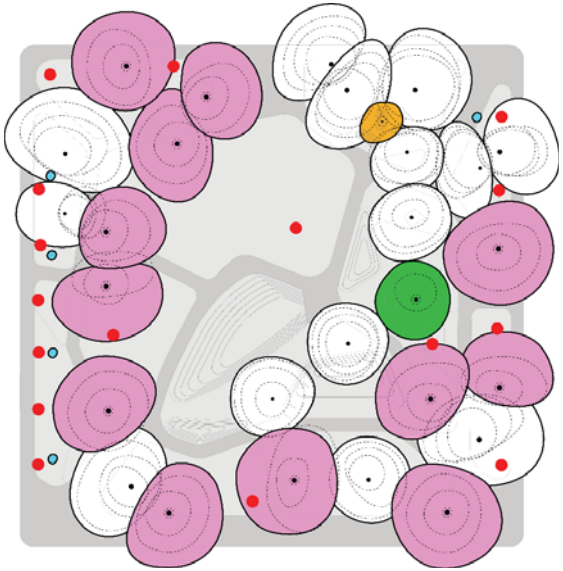
LONG-TERM GROWTH PROJECTIONS AND RECOMMENDATIONS

The results from the tree analysis of existing conditions and future projections showed that over 60% of the existing trees will expire in the next 50 years and 90% in the next 100 years. It is critical that the Moore Square improvements anticipate these trends and begin a thoughtful plan to introduce new canopy trees in target areas to ensure that as the mature canopy trees naturally begin to decline and expire, there are new trees growing in to take their place. The study also found that the relatively low diversity of tree age is the primary reason for the two anticipated large waves of tree decline. When considering planting design strategies for Moore Square, it is recommended that a similar long-term approach be unitized to increase the age diversity of the Grove.

The Master Plan is not only working to preserve the significant trees, but to also respect their future growth, decline, death and replacement. Trees are living organisms that will grow and decline and die. In order to determine the impact of future changes in the canopy, it is necessary to make assumptions about this process. The following are the assumptions used to develop canopy growth studies over time. It is recognized that these assumptions are very general and that individual trees will not respond in this precise manner. However, the studies do assist in providing a basis for predicting park canopy changes and where and when new trees might be added to the park.

The past growing performance and geographic location suggest that oak trees should be considered for new canopy tree planting.

Canopy growth and decline should be reviewed every five years to update and revise the management strategy.

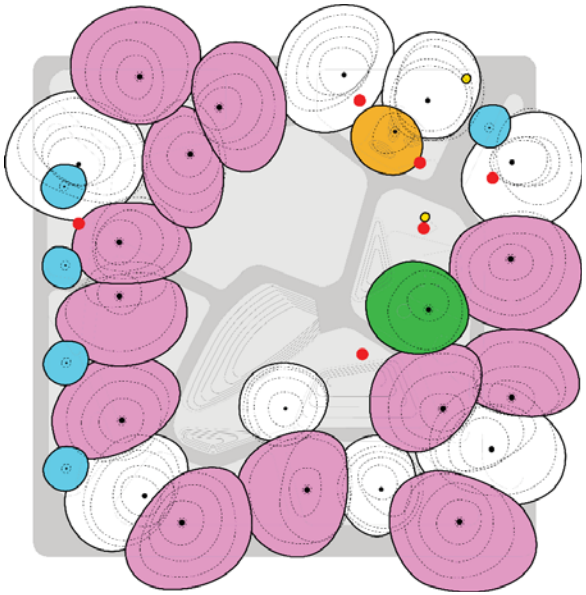


2074

60 YEAR PLANTING

14 existing canopy trees remain
- 15 trees reach maximum lifespan
- Five new canopy trees planted at 3” DBH

Initial planting reaches 60 years old

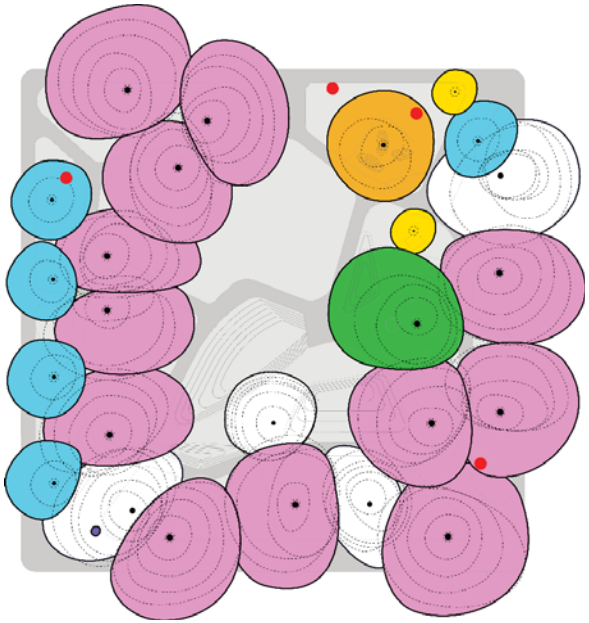


2094

80 YEAR PLANTING

Eight existing canopy trees remain
- Two new canopy tree planted at 3” DBH
- One 50-year-old tree is lost
- Three 30-year old fair vigor trees are lost

Initial planting reaches 80 years old



2114

100 YEAR PLANTING

Four existing canopy trees remain
- One new canopy tree planted at 3” DBH
- Four trees reach maximum lifespan

Initial planting reaches 100 years old

100 YEAR TREE PLANTING STRATEGY

PROJECTION CRITERIA

1. EXISTING CANOPY GROWTH

1.1) Canopy of good vigor trees expands 10” radius a year for the first 40 years
1.2) Canopy of good vigor trees expands 8” radius a year between 40 and 80 years old
1.3) Canopy of good vigor trees expands 6” radius after 80 years old and beyond
1.4) Canopy of fair vigor trees expands 8” radius a year for the first 40 years
1.5) Canopy of fair vigor trees expands 6” radius a year between 40 and 80 years old
1.6) Canopy of fair vigor trees expands 4” radius a year after 80 years old and beyond
1.7) Canopy of poor vigor trees expands 6” radius a year for the first 40 years
1.8) Canopy of poor vigor trees expands 4” radius a year between 40 and 80 years old
1.9) Canopy of poor vigor trees expands 2” radius a year after 80 years old and beyond

2. TRUNK GROWTH

2.1) Trunk of good vigor trees will expands 1/2” radius a year
2.2) Trunk of fair vigor trees expands 1/4” radius a year
2.3) Trunk of poor vigor trees expands 1/8” radius a year

3. CANOPY TREE LOSS

3.1) Canopy trees will have a lifespan of approximately 150 years
3.2) In 20 years 100% of the poor vigor trees will be lost
3.3) In 40 years 20% of the fair vigor trees will be lost
3.4) In 60 years 50% of the fair vigor and 10% of the good vigor trees will be lost
3.5) In 80 years 80% of the fair vigor trees and 30% of the good vigor trees will be lost
3.6)100 years 100% of the fair vigor trees and 70% of the good vigor trees will be lost

4. PARAMETERS OF IDENTIFYING DECLINING TREES

4.1) Canopy trees with lower structure rating and trunk sizes will decline faster
4.2) Older canopy trees will be lost before younger canopy trees
4.3) Trees experiencing excessive canopy competition will decline faster

5. NEW TREE GROWTH

5.1) Canopy trees will have a lifespan of approximately 150 years
5.2) New canopy trees will be planted at 3” caliper dbh
5.3) 100% of new canopy tress will be considered good vigor
5.4) Canopies with compress and elongate when in competition

SOIL RECOMMENDATIONS

HIGH PERFORMANCE LAWN

The creation of a high performance lawn is recommended for the central lawn area, which will improve the Square's ability to absorb reasonable levels of high intensity use without damaging the lawn. A new soil profile will be established in the central lawn area that includes a higher percentage of sand, less organics, and a subsurface drainage system. The new central lawn is located in an area that is largely outside of the Tree Protection Area minimizing the impact to existing root zones through soil re mediation and drainage lines. The new higher performance central lawn will require organic fertilization several times a year. As the design develops and the future Moore Square event program is established, the lawn management plan may include resting periods. This is a common practice employed by high use urban landscapes such as Central Park and Battery Park City in New York. This technique involves temporarily fencing off the lawn areas for prescribed time periods, often in the winter and wet seasons to allow the lawn to naturally recover and prevent damage of wet and dormant lawns. To ensure the highest performance the lawn will require yearly aeration from a standard core aerator.

The number and timing of events must be carefully regulated. For example, at Central Park's "Great Lawn" the number of large events is limited to 5 events a year and includes a winter long rest period. The lawn is further closed to use when the turf manager deems that turf stress requires additional rest periods.

NATIVE PERIMETER (UNDERSTORY AND SHRUB PLANTING AREAS)

Careful attention should be made to the selection of shrubs, understory trees, and ground covers for the perimeter native planting areas. Minimizing impact to existing root zones and

PLANTING RECOMMENDATIONS

moisture competition should be a major driver of plant selection in these areas. Bare root planting with an air spade installation of new shrubs and trees is highly recommended when planting in Tree Protection Areas. Air spade installation involves digging and loosening the soil for planting by using an air spade rather than a shovel. This technique offers the best possible establishment for growing conditions and minimizes damage to existing root zones. Permanent irrigation in these areas is not recommended. However, surface distribution systems should be considered during establishment periods. The enhanced growing conditions accomplished by the removal of moisture competition from the existing mulch beds and soil amendments are designed to be largely a self-maintaining system. However, a one inch +/- topdressing of compost should be considered once a year to enhance proper growing vigor in these areas.

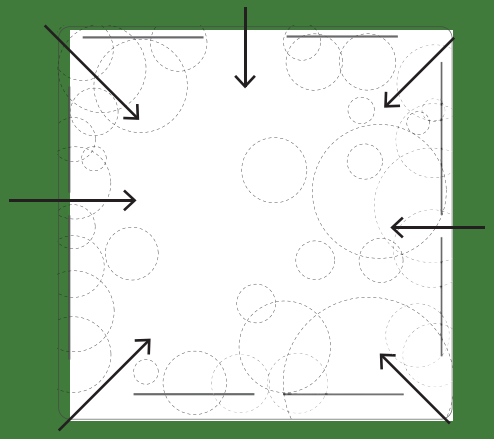
NEW CANOPY TREE PLANTING

A new canopy tree planting strategy was developed out of multiple 100-year growth and decline projections from multi-criteria modeling. The criteria for the projections included tree vigor, age, structure, competition, trunk size, structure, spacing, and historical research. The findings of these studies identified strategic areas to target canopy replacement.

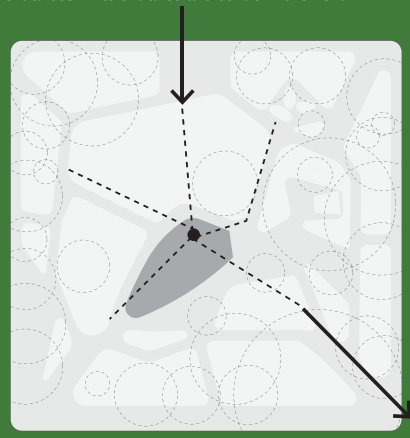
TURF MANAGEMENT

Trees and turf are also difficult partners, and problems increase with the added compaction of people. Serious consideration on solving the shade, event, and turf conflicts must accompany any park redesign. Recent study of the national Mall turf in Washington D.C. indicates that event structures, turf abrasion, and events on saturated soil contribute the majority of turf damage rather than compaction from park users.

SOIL ADJUSTMENTS
Recommended soil adjustments include minor perimeter enhancement, a new high performance turf profile, and central soil modifications.



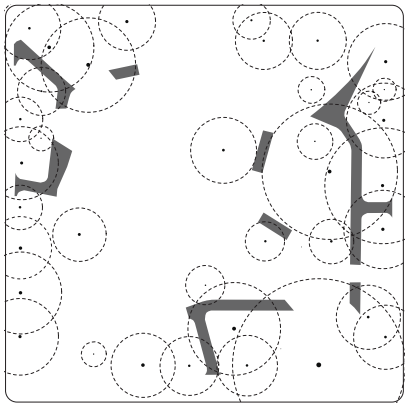
MANAGING ACCESS
The new perimeter edge discourages occupation and trespassing over sensitive root zones. Proper dignified entrances invite entrance and control movement.



NEW INFRASTRUCTURE
It is of critical importance that new infrastructure needed for park improvements respect the tree and trunk protection areas and avoid excavation of new utility lines whenever possible.

RECYCLE EXISTING PATHS

New paths should re-use existing path layout areas, especially when crossing tree and trunk protection areas.

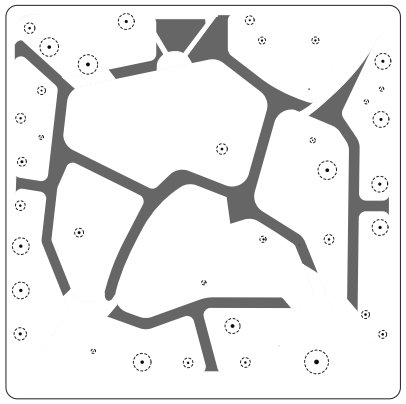


UTILIZE LOW-IMPACT PATH SYSTEMS

Low-impact above ground path systems as described in this report should be used when paths enter tree protection areas.

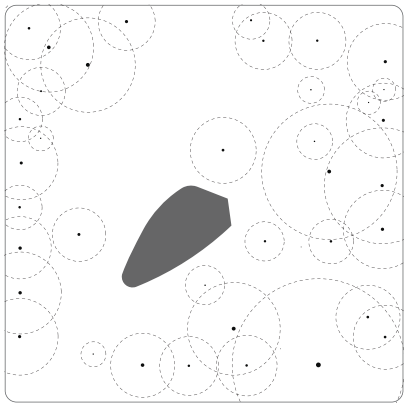
NATIVE PERIMETER PLANTING

The native perimeter low shrub and understory planting around the perimeter should incorporate bare root planting with an air spade. Low competition species should be planted within the tree protection areas.



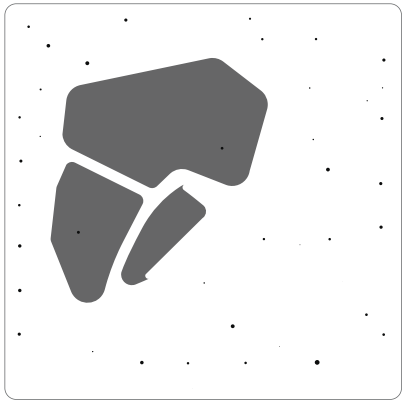
AVOID TRUNK PROTECTION AREAS

New path layouts should maximize distance from tree protection areas.



LOCATE LANDFORM OUTSIDE OF TPA

The central landform and utility core should be constructed above existing grade and located outside of the tree and trunk protection areas.



INTRODUCE HIGH PERFORMANCE LAWN

A high performance turf system should be introduced in the central lawn area to accommodate a higher intensity of use and events.

DESIGN RECOMMENDATIONS

PAVING, STRUCTURES AND DETAILING

An important goal of proper tree preservation strategies is acknowledging and anticipating the movement and change that occurs within the root zones of large trees. This inevitable movement should be taken into consideration during the development of the design and detailing. When possible, new design elements should re-use existing areas of impact to Tree Protection Areas. Areas of existing impact within the Tree Protection Areas include existing path, walls, buildings, and raised planters. This practice will minimize impact to existing root zones.

UTILITIES

New utility lines should be located outside of the Tree Protection Areas when possible. In areas that require new utility lines in Tree Protection Areas, all care should be taken to minimize impact to these sensitive areas. Locating utilities above the existing grade within low-impact walkway systems is recommended where possible. This study also strongly approves the suggested above-ground utility core located within the tilted lawn landform proposed by the 2010 Moore Square Master Plan. This concept centrally locates the utilities in an area out of the Tree Protection Areas and prevents the need for excavation by locating the core above the existing grade within the landform. By centrally locating the utility core in the center of the site, the utility plans can employ a radial system that minimizes the cross cutting of root zones. New utility lines should enter the site through the northern mid-block plaza area, the southeast corner, and the southwest corner if needed. Wet utilities will exit the site through the southeast corner which is also the low point of the site.

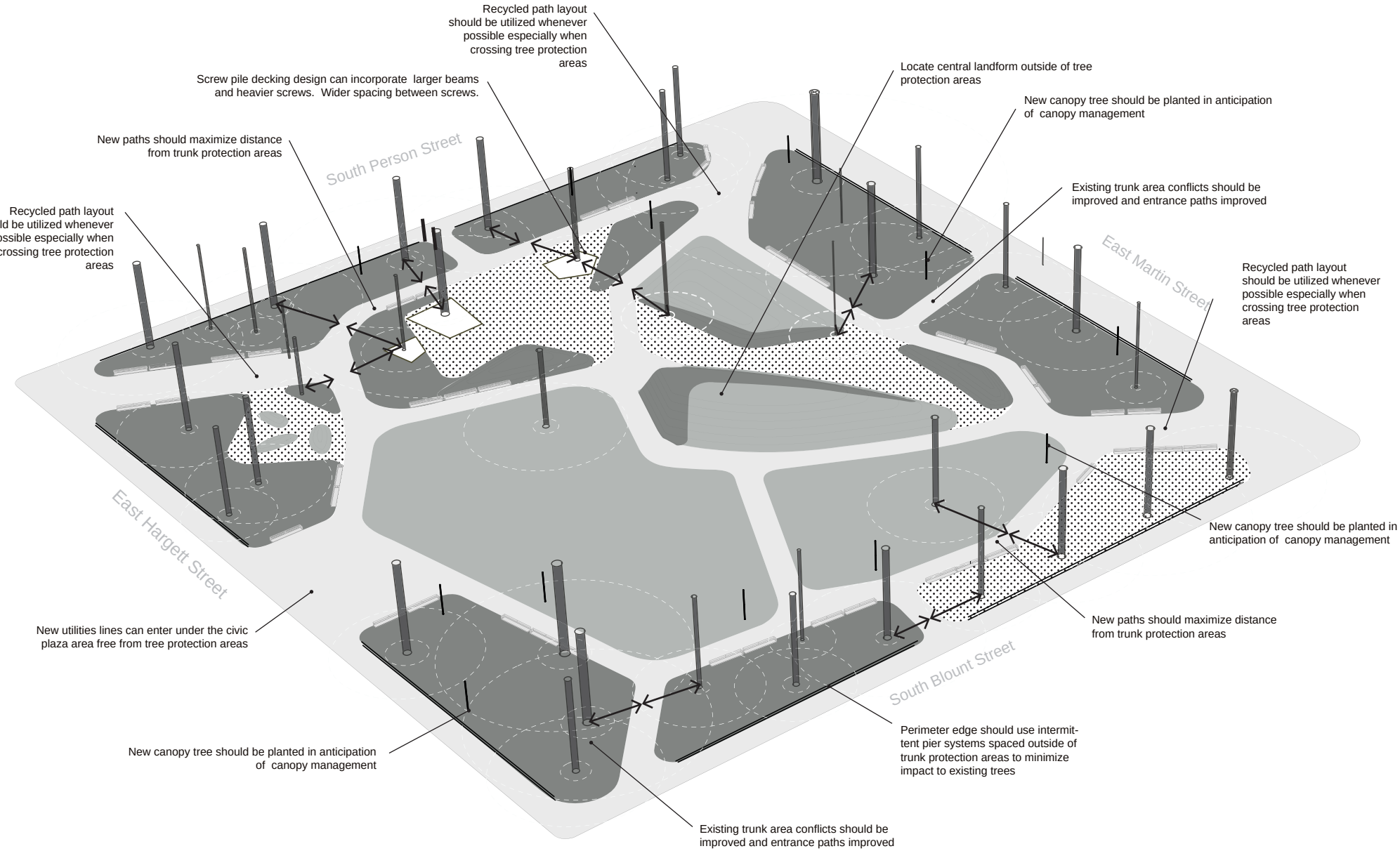
MSCTS DESIGN PRINCIPLES

1. The long-term preservation and enhancement of the perimeter canopy trees should be a top priority for future design improvements to Moore Square.

2. The revitalization of Moore Square should leave the growing conditions of the trees in better condition than what currently exists.

2. All improvements to Moore Square should follow the MSCTS design parameters.

3. Future design development for Moore Square should synthesize the approved Master Plan concept and the MSCTS.



EXISTING SITE AXON: DESIGN RECOMMENDATIONS DIAGRAM

*arrows indicate space from trunk protection area to path.

CONCLUSION AND NEXT STEPS

The conception of the Moore Square Comprehensive Tree Strategy (MSCTS) was proposed as a means to ensure that the long-term preservation and enhancement of the existing Oak Grove drives future design efforts. Traditionally, such a highly detailed existing analysis is undertaken late in the design process often associated with actual construction. However, given the importance of this project and the central role that tree preservation is to this project, the design team felt it critical that such a study be conducted before beginning the schematic design phase. Key to maintaining this commitment is securing all possible technical information on the existing trees and soils before the formal design process begins.

Through an intensive analysis of existing conditions, trees, soils, topography and carefully examined to produce a set of criteria for projecting into the future and providing design parameters to preserve and enhance the Square well into the future. With more than have of the trees as oaks and a strong character defining perimeter, maintaining the tree canopy is critical to the park improvement plans. This report sets the limits of the Tree and Trunk Protection areas and through projections studies of future tree growth and expirations, recommends a strategy for planting. Over the next 100 years. The results from the analysis showed that over 60% of the existing trees will expire in the next 50 years and 90% in the next 100 years. It is critical that the Moore Square improvements anticipate these trends and begin a thoughtful plan to introduce new canopy trees in target areas to ensure that as the mature canopy trees naturally begin to decline and expire, there are new trees growing in to take their place. The study also found that the relatively low diversity of tree age is the primary reason for the two anticipated large waves of tree decline. When considering planting design strategies for Moore Square, it is recommended that a similar long-term approach be unitized to increase the age diversity of the grove.

Through an in-depth series of studies and analysis done of soils, combined with overlaying existing tree canopies with this information, it becomes evident that the older trees, most of which are oaks, are located within the healthier soil zone that is not disturbed while younger trees with less canopy are located in disturbed soils. This information for preserving healthy soils leads to suggesting making soil modifications in the center of the site. The creation of a high performance lawn is recommended for the central lawn area, which will improve the Square's ability to absorb reasonable levels of high intensity use without damaging the lawn. A new soil profile will be established in the central lawn area that includes a higher percentage of sand, less organics, and a subsurface drainage system. The new central lawn is located in an area that is largely outside of the Tree Protection Area minimizing the impact to existing root zones through soil re mediation and drainage lines among other considerations. Relative to topography, several areas outlined in the report indicate areas for consideration.

After detailed analysis this study has found that with minor adjustments the 2010 Master Plan is an entirely feasible concept in regards to the protection and enhancement of the existing trees. It is assumed that when detailed design begins that the design team will build off the recommendations of the MSCTS to learn and develop further techniques that ensure the preservation and health of the existing grove is a major driver of all design decisions. Please see the following set of general recommendations and each section for more specific recommendations for moving forward.

GENERAL RECOMMENDATIONS

1. Conventionally implemented tree disturbing activities should not be permitted within the tree protection area.
2. Limited modifications within the tree protection area that employ low-impact construction techniques are permitted.
3. Detailing, specifications, and construction that involves modifications within the tree protection area should be overseen by nationally recognized tree expert and certified master Arborist.
4. Existing violations of the tree protection area, tree disturbing uses, and problematic site arrangement should be corrected with through improvements to Moore Square.
5. Oaks should be considered for new canopy tree planting.
6. New tree planting should be informed by the long-term canopy management strategy and reviewed every five years after construction.
7. Increasing the age diversity of the canopy should be a priority of long-term canopy management.
8. Strict low-impact tree preservation specifications must be properly outlined and tree preservation manager should be identified in all areas of the construction and given top authority to enforce proper implementation of specifications.
9. City of Raleigh tree conservation parameters requiring conservation of 10% of the site should be followed.
10. Excessive mulch and open vehicular and pedestrian access within the tree protection area should be reduced.
11. Pre-construction tree preparation should be implemented according to the MSCTS.
12. When possible, new paths should re-use existing path locations to reduce disturbance within the tree protection area except when paths are within the trunk protection area.
13. A high-performance lawn system and engineered soils should be considered to improve lawn health.
14. Trees that contribute to the perimeter grove canopy should be given the highest priority for preservation, enhancement, and new planting.

APPENDIX A
MOORE SQUARE TREE AND SOIL EVALUATIONS
URBAN TREES + SOILS

Moore Square Tree Evaluation

Raleigh, North Carolina October 29, 2012

Moore Square, Raleigh, North Carolina
Tree Evaluations and Recommendations

Draft 10 25 12
Urban Trees + Soils

Introduction

Moore Square has nearly 70 trees, the majority of which are mature specimens. They are the soul of the park and treasured by the citizens of Raleigh for their green canopy at the perimeter of the park. Maintaining this canopy is critical to the park improvement plans.

The current master plan concepts show places where alterations are proposed in areas that are likely to fall within areas normally considered as part of the trees root zone. This report will set the limits of the Tree Protection Areas, but also indicate what are the most critical things to do and not to do within this area.

Construction of many elements can be compatible with tree rooting areas if undertaken by skilled practitioners and contractors using techniques that are tree sensitive. It is important to note that the Master Plan Report is not a design document. It sets basic frameworks for design that now must be developed and refined to incorporate the many different site conditions and requirements that are typically left to the design development stage. This report is intended to guide the design development process from a tree preservation perspective.

Tree preservation during construction is essentially soil preservation. For this reason, tree preservation guidelines have focused on protecting large areas of ground surface around the tree. This area of protected ground is the **Tree Protection Area**.

At the tree's trunk, there is typically a distinct trunk flair, an enlarged area of wood that supports the tree right at the ground line. Below the ground and trunk flare, large roots form to support the tree and further divide into smaller roots further from the tree that collect the water and nutrients that the tree needs. The most important part of these roots are generally considered the area within the first 4-10 feet from the trunk called the Zone of Rapid Taper roots. The zone of rapid taper roots and the trunk flair together are must receive special consideration to protect them from damage. This area is also the place where most root / paving conflicts begin and paving within this area must take these conflict into consideration. This area is the **Trunk Base Protection Area**.

Often the Tree Protection Area is interpreted as a place where no construction activity should take place. This is an incorrect interpretation. Construction of many types often occurs in this area with no consequences to the tree's long-term health. However, construction must be designed and executed by professionals who are expert in tree preservation and working around trees. It is analogous to having surgery by some one not trained in surgery. Even a trained General practitioner might not be the right person for particular procedures. The more technical the operation the more likely you are to want to find a specialist. It is entirely possible to construct the elements of the Master Plan, with of course appropriate design development refinements in their size, materials, elevations, and locations, and find the mature tree population in better condition that it is today.

Tree evaluations

There have been a number of tree evaluations undertaken for the trees in Moore Square. The City of Raleigh provided the design team with a tree evaluation at the beginning of the project. Jeff Kish of Bartlett Tree Experts, a consultant to the design team made initial evaluations of each tree. These first two evaluations were focused on general tree health.

Urban Trees + Soils, the design team's soil and tree consultant made an additional survey. This survey looked at the trees from the perspective of the trees ability to survive construction, including the trees vigor, structure and the condition of the trees base relative to designing paving and other structures in close proximity to the tree. The goal of this survey was to obtain data to use in calculating the Tree Protection Area and the Trunk Base Protection Area; and to make recommendations on the trees ability to withstand construction impacts.

Note that only the sites large, mature trees were evaluated for construction impact tolerance. There are 37 large mature trees out of a total of approximately 68 existing trees in Moore Square. The remaining smaller trees at the site will be relatively easy to work around where they are determined to be preserved.

The following is the methodology for the Urban Trees + Soils evaluations:

Trunk base evaluation:
This evaluation determines the degree of difficulty in working near the base of the tree. The Trunk Base evaluation is then used to set the **Trunk Base Protection Area**. This area, close to the base of the tree is the area where even minor disturbance may severely injure the tree.

Trunk Base Protection Area: The distance new paving should be kept away from the trunk or where special construction is required to eliminate damage to roots and bark. This area must receive special protection treatment over and above the requirements of the larger Tree Protection Area. The size of the Trunk Base Protection Area is an initial recommendation. The distance may be decreased if special details such as flexible paving surfaces or bridging design are utilized, or may need to be larger due to topography or surface rooting conditions. These stand off dimensions assume that no cut is required to construct the paving in this area. In areas where paving is already inside of the stand off zone, such as along Blount Street, new paving may be installed

provided that the limit of paving is not brought closer to the tree or the paving section deeper than the existing paving.

Trunk base evaluation classifications, criteria, and limits of the Trunk Base Protection Area (**TBPA**) are:

Normal: Reasonably size trunk flair proportion with little damage or other problems. **TBPA *radius*** *from center of trunk –* ***1.5 times trunk diameter****.*

Moderate: Larger size trunk flare, minor damage or other problem that may require special attention in the design. **TBPA *radius*** *from center of trunk* ***– 2 times trunk diameter.***

Difficult: Extra large trunk flare or significant surface roots, existing trunk flare damage and other issue that may need additional investigation and response during the design process. ***Paving stand off radius*** *from center of trunk –* ***2.5 times trunk diameter****.*

Tree Structure evaluation:
This evaluation notes observed problems with branch structure or tree stability. Tree structure is critical to the long-term success of a tree and may be a significant factor in determining if a tree is a good candidate for tree preservation.

Tree structure evaluation criteria and classifications are:

Good: No observed problems

Fair: Minor branch conflicts such as co-dominant leaders that are easily modified.

Poor: Significant branch conflicts such as co-dominant leaders that are not easily modified, dead portions of trees, asymmetrical canopies or trunk leans.

Tree Vigor evaluation:
This evaluation records tree growth vigor as determined by leaf color, density and distribution in the canopy. A trees vigor is a critical indicator of a trees ability to survive root loss.

Good: Normal leaf color, size and distribution

Fair: Observable variation from normal leaf color, density and distribution in the canopy. Minor twig dieback.

Poor: Significant variation form normal leaf color, density and distribution in the canopy. Significant twig dieback.

Hazard tree investigation recommendation:
Large mature trees in close proximity to people may pose the risk of structural tree failure that can injure people using the park. The City of Raleigh is responsible for the monitoring and mitigation of hazardous conditions in the park and has been doing a good job of removing dead branches and stabilizing trees. However, trees are dynamic organisms who's structural conditions change constantly as the tree grows and adds weight and wind loading in some areas while at the same time decay and added stress from wind and gravity is weakening the tree in other areas. Finding tree conditions that might be dangerous is a constant task in a population of trees of the size and age of the trees in Moore Square.

The action of the proposed major renovation of this park causes the city to take on added liability for these trees. It is assumed, that during a facility wide reconstruction, all systems will be made as safe as possible and that the entire park will meet current codes and safety concerns upon completion. This puts added requirements on the trees to be evaluated for defects and to mitigate these defects even to the point of removing hazardous trees.

For this reason, it is advised that the city conduct a hazard tree evaluation for any tree that may have indications of possible hazardous conditions. During the initial tree evaluation of the park 24 trees were identified as being candidates for further hazard tree evaluation. These trees are noted in the Summary tree Evaluation Data.

Apparently the City does not have a person on staff who is ISA certified in hazard tree evaluation to evaluate the trees using the ISA Hazard Tree Evaluation method. They do have an alternative method to evaluate trees which is apparently has proven effective to reasonably identify most hazardous trees**.** However, the ISA Hazard Tree Evaluation system is the best available methodology to determine safety concerns for trees in public landscapes and the City should consider having the evaluations performed by some one trained in the ISA system. The City, as the owner of the property, will make the decision on this important matter, determining what system to use, and the qualifications of the review person. They will make the final determination of which trees are considered hazardous and approve mitigation requirements to reduce dangerous conditions including tree removal if needed.

Summary Tree Evaluation Data:
The data collected is summarized on the attached tree evaluation and recommendations spreadsheet. This matrix includes the field observations ratings for each of the large, mature trees.

Establishing the Tree Protection Area

The size of the Tree Protection Area for each tree is calculated to guide the design and help assure the survival of the tree. Tree Protection Areas are typically interpreted as being areas of no construction activity. However, if remedial work to improve growing conditions before, during, and after the construction are undertaken and responsible construction methods under tight controls and design guidelines that will protect the tree's vital systems are employed' construction may take place within this area with little to no impact on the tree. Reasonable practices include those that prepare the tree, protect the tree and soil from damage and provide for after care that mitigates any soil or root damage. These reasonable practices will be further elaborated in the section "Tree Protection Plan".

Tree Protection Area Calculations:

The City of Raleigh uses a formula of 1.5 feet of radius for each inch of trunk diameter to establish the Tree Protection Area. This approach is not supported in the literature as being necessary to successfully save every tree. It is an overly large protection area and assumes that nothing is done to modify normal construction or to mitigate damage. It dos not take into account the differences in age of trees nor the differences species tolerance to withstand construction.

This report recommends using the system developed Nelda Metheny and James Clark in their book "Trees and Development: A technical Guide to Preservation of Trees During Land development". This book, published by the International Society of Arboriculture (ISA), is recognized as the best source of tree preservation information. It was peer reviewed by 15 arborist and tree professionals for its accuracy. The ISA is a serious professional and scientific organization with a long history of improving the care and preservation of trees.

The ISA approach starts by determining the trees tolerance to withstand construction. An extensive research questioner, sent to arborist all over the United Stated, ranked hundreds of different tree species. The results of this questioner were tabulated and published in "Trees and Development". The system uses a ranking of good, moderate and poor tolerance to construction. Fortunately most of the large trees on this site are classified as having good tolerance to construction.

The second step is to determine the tree age with three levels proposed. Young trees, considered at less than 20% of their life expectancy; Mature trees between 20 and 80% of their life expectancy; and Over-mature trees, those with less than 80 % of their life expectancy. For the purpose of this report the Bartlett Tree arborist report was used to make the determination of age classification.

The third step is to determine the requirement of the radius of the Tree Protection Area in feet per inch of trunk diameter. In the ISA system, the radius generally ranges from 0.5 feet per inch of caliper to 1.25 feet per inch of trunk diameter.

In only one case, the most restrictive condition, does the ISA method use 1.5 inch per inch of trunk diameter. The ISA system is as follows:

ISA Recommended

Species Tolerance	**Tree Age**	**Radius from the trunk in feet per inch of trunk diameter**
Good	Young < 20% life expectancy	0.5'
	Mature 20-80% life expectancy	0.75'
	Over mature > 80% life expectancy	1.0'
Moderate	Young	0.75'
	Mature	1.0'
	Over mature	1.25'
Poor	Young	1.0'
	Mature	1.25'
	Over mature	1.5'

Using the above system, a radius of Tree Protection Area has been calculated for each large tree. One variation was used to further refine this approach. The above ISA system assumes that the trees health (vigor) is in a normal condition and does not account for other mitigating factors often found at urban sites such as trunk base conditions, soil problems, drainage, or adjacent structures. The ISA system does suggest that these conditions be factored into the final distance. In making the Tree Protection Area calculations for the trees at Moore Square, some of the tree distance requirements were increase 0.25 feet per inch of trunk diameter to factor for observed conditions that would make the tree preservation more difficult. These trees are noted with an asterisk in the Tree Protection Area Ft/Inch column on the tree evaluation chart.

The methodology used to determine that a tree should be given the extra 0.25' / Inch in the rating was as follows.

Any tree that was rated as Vigor – Poor.
Any tree that had two out of three categories (Tree Base, Structure, Vigor) in the lowest rating.
Any tree that had three out of three categories in the medium or low rating.

Using the above methodology, the radius of the Tree Protection Area for the mature trees ranges from 0.5 ft / inch to 1.5 ft / inch with only 3 trees indicated as needing 1.5 ft / inch.

Construction disturbance within the Tree Protection Area:

The Tree Protection Area is not to be considered a place where no construction disturbance is permitted. There are many types of activities including minor grading, paving and small structures that can be successfully implemented provided that proper approaches are taken. Some soil disturbances such as soil invigoration have been shown to improve tree health. These concepts are outlined in the following Tree Protection Plan section. But it should not be assumed that construction disturbances such as paving, grading and the inclusion of structures do not cause any harm to the tree. The construction techniques in the Tree Protection Plan should be limited in their area of impact to the greatest extent possible.

A good rule of thumb is to make the following limitations and requirements on the inclusion of construction impacts in the Tree Protection Area.

0-30% of the Tree Protection Area

Design impacts to one side of the area avoid circling the tree with different impacts.
No Impacts within the Trunk Base Protection Area
Avoid work in the summer.
Apply water to mitigate impact.
Restore fencing and geogrid/mulch matting after the completing of the work.

30-50% of the Tree Protection Area

Design impacts to one side of the area – No impacts on the opposite side. Increase the size of the Tree Protection Area on the side of the tree that is not being disturbed
No Impacts within the Trunk Base Protection Area
Undertake work during the season most favorable for root development and in periods of low plant stress.
Apply water to mitigate impact and continue to apply water as needed over the following year.
Restore fencing and geogrid/mulch matting after the completing of the work.
Increase frequency of monitoring of tree vigor, disease and insect over the following 5 years

Following these guidelines will significantly reduce the impacts on the trees.

Tree Protection Plan

Protecting a tree during construction requires multiple levels of approaches that go far beyond simply fencing the area of protection. A Tree Protection Plan is required that begins prior to the start of construction and carries on well past the end of construction. The plan will have parts that must be implemented by the City. Parts of the plan will impact the design process and parts that will become a part of the construction documents. Portions of the plan will become part of the park's long-term management plan.

If properly developed and implemented, the result of the Tree Protection Plan over the long term of the life of the tree is that the mature trees in Moore Square will likely be healthier after the construction than before and their life expectancy should increase. Each part of the plan not only protects the trees from damage, but also will improve growing conditions and mitigate existing conditions in ways that would likely not be possible under current park management budgets.

The following is the outline for the Tree Protection Plan, presented as a series of general concepts that will guide the development of specific recommendations for each tree as the details of the design and construction process develops. The plan has four parts. Pre-construction requirements; Design and construction documents requirements; Construction requirements; and Post construction requirements.

Pre-construction requirements:

1. Evaluate the existing tree conditions.
2. Establish Tree Protection Area and Trunk Base Protection Area for each tree.
3. Perform a Hazard Tree Evaluation for each mature tree and develop tree mitigation requirements for all conditions encountered. Implement the mitigation requirements.
4. Establish and fund a preconstruction tree management budget to implement the preconstruction portion of the Tree Protection Plan. This needs to be undertaken as soon as possible and is NOT part of the construction budget.
5. Identify the primary tree care manager within the Parks Department to oversee the Tree Protection Plan.
6. Develop and implement a tree health management contract with an arborist to monitor and treat all disease and insect problems; prune trees to remove deadwood and structural defects.
7. Apply Cambistat tree growth regulator to all mature trees to reduce growth rates and stimulate fine root production. Note that Cambistat requires a minimum of one year to begin to have positive effects on the tree and needs to be applied every three years. Ongoing applications of Cambistat should remain a City responsibility during the construction to assure that consistent application requirements are followed.
8. Apply any nutrients recommended by the soil test to bring soils in the root zone to optimum nutrient levels before, during and after the construction. Ongoing soil testing and applications of nutrient should remain a City

responsibility during the construction to assure that consistent application requirements are followed.
9. During periods of prolonged drought prior to construction, develop and implement a root zone watering program for all mature trees to remain to assure that they are not water stressed.

Design and construction documents requirements:
1. Insert into the design drawings the limits of the Tree Protection Area and Trunk Base Protection Area for each tree. These limits should be included in every site construction plan document of each of design disciplines to assure that all design consultants understand the importance of these areas and when their work is impacting these zones.
2. Develop a Soils Improvement Plan, soil details and soil specifications for all areas of the park that retains good soils; protects root zone soils from damage; and improves soil within and outside the Tree Protection Area for future growth of each tree.
3. Develop Tree Protection Plans, details and specifications that detail specific requirements for tree protection including fencing, mulching/matting, operations allowed within the Tree Protection Area, trenching/ grading techniques, watering requirements, disease and insect controls, pruning, and monitoring and mitigation of inadvertent damage.
4. Establish the cost to the contractor for various levels of tree damage including placing an ISA based value on each tree in the event that it is damaged to the point where the tree's long-term health is compromised by damage caused by the contractor.
5. Protect soil within the Tree Protection Area from compaction by fencing and mulch/geogrid matting.
6. Grading cuts should be minimized or when required made with an air spade and vactor equipment. Roots larger than 1 inch in diameter encountered during grading must be cut only with the approval of the project arborist.
7. Grading fills must be preceded by removal of organic layers or turf. Undertake airspade invigoration of the existing soil that may include mixing existing organic layers with the sub soil below and mixing with the new soil to be installed. Fill soil in the Tree Protection Area must be sandy loams place by low compaction impact procedures. New grades must continue to provide for drainage and aeration of the soil. If fills exceed 12 inched deep aeration layers between the fill and existing grades must be included.
8. Utility line trenches within the Tree Protection Area should be avoided and lines redirected around the Tree Protection Area. Where unavoidable new utility lines shall be installed with directional boring technology; or the use of airspade /vactor equipment.
9. New paving should be placed on geogrid/ aggregate bases. Walls and other structures should employ pier and beam bridging with designs that are flexible to move piers or beams to avoid large roots. All excavation must use airspade / vactor equipment. The arborist must approve any roots to be cut over 1" in diameter.
10. All new planting within the Tree Protection Area must be performed using planting concepts that require the least amount of disturbance. Bare root planting and planting with airspade digging tool is preferred. Spacing of plants should be as wide as practical and allow plants to grow together. Tightly spaced plants to make instant effects of the planting must be avoided.

Construction requirements:
1. Retain an independent arborist to monitor all tree protection provisions during the extent of the work. The arborist must have access to the site frequently enough to make reasonable and timely review of the work. The cost of this provision must be included in the project budget.
2. Implement the requirements in the Tree Protection Plan provisions.
3. Implement the requirements in the Soil Plan provisions
4. The provisions of the Tree Protection Plan must be flexible to accommodate all factors in the construction sequence. The project arborist must approve all modifications to the plan.
5. Provide supplemental water to the root zone during the construction.

Post construction requirements:
1. Assure that there is a well documented and understood transfer point of tree maintenance responsibility from contractor to the City at the end of the construction.
2. Continue supplemental watering of the root zone as required for a minimum of 5 years.
3. Continue Cambistat and nutrient treatments as required for a minimum of 5 years after the end of construction.
4. Continue intensive tree health monitoring for a minimum of 10 years.

Introduction
The following is the report of findings of the soil conditions at Moore Square in Raleigh, North Carolina. This report examines the soil from the perspective of existing and future plant growth. The findings are based on review of the site conditions on September 17 and 18, 2012, and the review of the planning documents for the proposed improvements to the park. All references to historical site conditions are taken from the master plan reports.

Historical overview of soil disturbance:
Moore Square was part of the original 1772 Town Plan for the city. It likely evolved from either forest or farm land directly into a public park. This would have resulted in minimum soil disturbance.

Only two structures of any significance were ever built in the park, those being before 1896. These structures fall in the central area of disturbance and were likely out of the current root zones of large existing trees. The small kiosk built on the south side of the park appears to have caused minimum soil disturbance compared to disturbances from walks, later grading and utility work.

The earliest representations of trees show the trees clustered on the east side of the park, possibly a remnant forest or second growth after logging. This edge is characterized by steeper slopes and may have been more irregular than currently sloped. The more formal designs of 1896 and 1914 would have likely smoothed grading on the east side of the park as well as removing the previously mentioned trees. The grading of the current plan appears to have pushed a layer of fill to the east of the center of the park.

The many alignments of walks over the parks history have caused soil disturbance along the edges of the alignments. The center of the park and the four widen arms of the crossing diagonals have also introduced their share of soil disturbance.

The many different uses and events at the square from pasture, civil war troop camp to contemporary music festivals, all extracted a toll on soil quality. Hard layers of soil were encountered in many locations. Multiple rounds of park utility electric and water lines also have disturbed the soil.

Throughout the park, large areas of mulch beds cover the ground. These are areas where park maintenance has not been able to keep turf growing. Much of this turf problem is related to intense use during the many concerts and festivals staged in the park. These areas are also almost always within the canopy of the large trees. It is likely that people gather more in the shade during events contributing to turf damage. Trees and turf are also difficult partners, and problems are increase with the added compaction of people. Serious consideration on solving the shade, event, and turf conflicts must accompany any park redesign. Recent study of the national Mall turf in Washington DC indicates that event structures, turf abrasion, and events on saturated soil contribute the majority of turf damage rather than compaction from park users.

While all these disturbances result in almost all areas of the park being disturbed to some degree, the soil disturbance in the large center space, its northern extension to Hargett Street and portions of the east side of the park are significant to the point of impacting existing and future tree growth.

Current topography and soil disturbance:
Current topography can be read for soil disturbance. Cut and fill slopes appear associated with paving throughout the park. This is particularly true at the perimeter where the walks and grades meet the street sidewalk edges. It appears that the streets were generally cut into the existing predevelopment grades as part of a larger scale grading scheme to create smooth street grade transitions from the ridge line parallel to Fayetteville Street and the lower lands east of the downtown area. In the middle portion of the site the contours are highly irregular with minimum organizing features, characteristic of continuous changes from different construction efforts. Only the slopes in the parks east side seem to reflect a pre development contour pattern. But even here fill soils were discovered.

Soil profile pit descriptions:
20 multi layer profile pits were dug and recorded. Soil profile descriptions are in the following section. A general review and interrelationship of the soil profiles follows later in a later section "**Interpretation of the soils information."**

The approximate locations of all profile pits are shown on the attached "Soil Profile Pits Location Plan. The following are the description of the soil profiles observed.

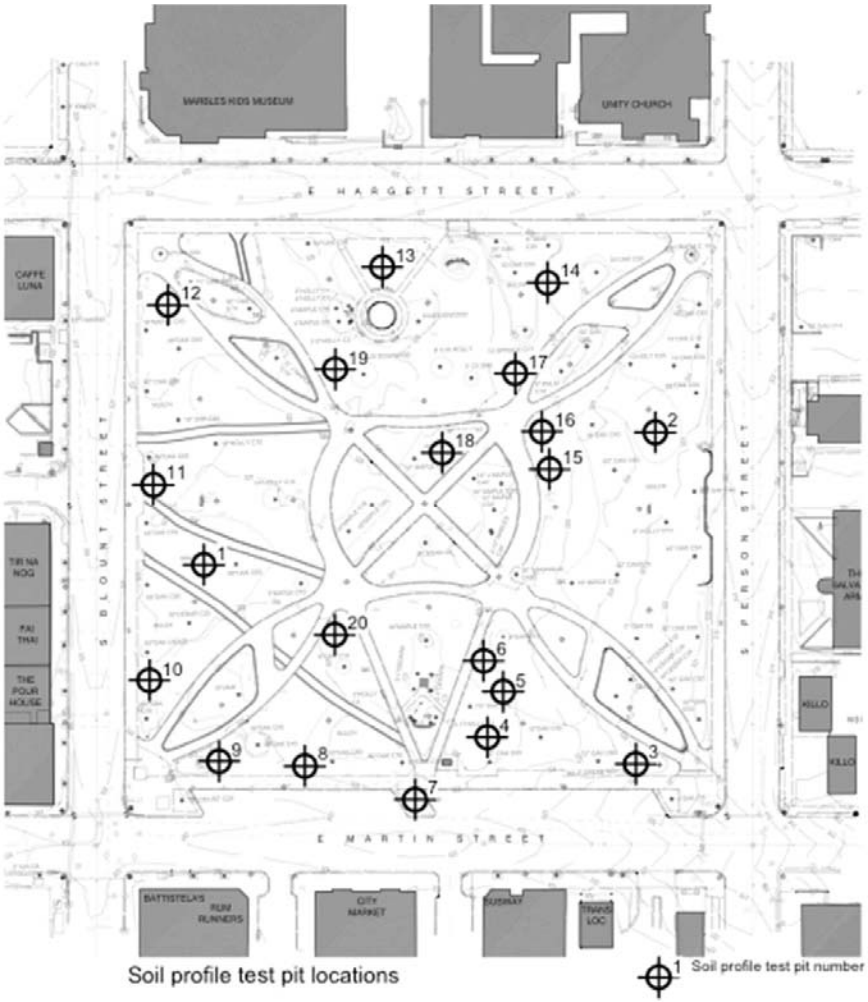
Note the following gradations of terms for moisture and compaction are used in this report to describe soil conditions. Soil textures are USDA terminology as estimated during the digging process.

Moisture: terminology for soil moisture from dry to wet as determined by visual analysis and feel.
Dry – soil will not hold together after being crushed
Damp – soil will marginally hold together when crushed
Moist – soil can be formed into a ball
Wet – soil sticks together and will stick to the hand
Saturated – free water observed on the soil

Density: terminology for soil density from loose to solid as felt during the angering process. *Note that dry soils can "feel' compacted, while compacted soil can "feel" soft when moist. The presence of roots is a better indication of compaction below root limiting levels.*

Loose – auger easily penetrates the soil
Soft – auger penetrates the soil with moderate effort

Firm – auger requires strong push to penetrate the soil
Hard – auger requires maximum pressure to penetrate the soil
Refusal – auger refuses to penetrate the soil



Location 1:

Soil profile	Depth	Description
		Surface cover: Wood chip mulch
	0-0.2’	Decomposing wood chip mulch; dark brown/black; moist; soft; roots observed
	0.2’–0.5’	High organic fine sandy loam; dark brown; damp/dry; firm; roots observed
	0.5’-1.0’	Fine sandy loam; light brown, dry; firm; roots observed
	1.0’-1.4’	Fine sandy clay loam; light brown/orange; dry; hard; roots observed
	1.4’-1.8’	Fine sandy clay loam; orange/brown; dry; very hard; roots observed
	1.8’-2.1’	Fine sandy clay loam; orange; dry; very hard; roots observed
	2.1’	Auger refusal

Remarks: The soils below 0.5’ are likely to be an undisturbed soil profile. Soil profile taken near one of the older and healthier trees in the park.

Location 2:

Soil profile	Depth	Description Surface cover: Wood chip mulch
	0-0.2’	Wood chip mulch
	0.2’-0.3’	Very organic loam, dark brown/black; moist; loose; roots observed
	0.3’-0.4’	Interface; sandy loam fill; brown; dry; firm; roots observed
	0.4’-0.6’	Interface; loam fill; dark brown; dry; firm; roots observed
	0.6’-1.2’	Interface; fine sandy/gravel loam; grey/brow; dry; hard to V hard; roots observed
		Coal ash fragments
	1.2’	Trace of sandy clay, orange; dry; auger refusal

Remarks: Fill soils over subgrade soils. Disturbed soil profile.

Location 3:

Soil profile	Depth	Description Surface cover: Wood chip mulch
	0-0.3’	Wood chips; dark brown/black; moist; soft; roots observed
	0.3’-0.5’	Decomposed organic material; dark brown/black; moist; soft; roots observed
	0.5’-0.8’	Fine sandy loam/ sandy clay loam; brown; moist; soft; roots observed
	0.8’-1.4’	Fine sandy clay loam/gravel; orange brown; moist; soft; roots observed;
		Cloth strip fond at approximately 1.0’, roots observed and large root struck
	1.4’-1.7’	Fine sandy clay loam, orange/ brown; moist; soft; minor roots
	1.7’-2.6’	Gritty, gravel sandy clay loam; orange; dry; firm to very hard w/depth
	2.6’	Same as above; very dry; auger refusal

Remarks: Profile below 1.4 feet likely an undisturbed sub soil. Profile adjacent to largest (DBH) tree on site

Location 4:

Remarks: Profile similar to Location #3

Location 5:

Remarks: Profile similar to Location #3 except Orange soil starts at about 1.5'.

Location 6:

Soil profile	Depth	Description Surface cover: Wood chip mulch
	0-0.3'	Decomposing wood chips, dark brown/black; moist; soft; roots observed
	0.3-0.7'	Interface; sandy loam; dark brown; moist; soft; roots observed
	0.7-1.4'	Interface; fine sandy loam; light brown; damp, firm; roots observed
	1.4'-2.4'	Interface; gravel and fine sandy clay; orange; moist, firm
	2.4'	Stopped digging

Remarks: Highly disturbed soil near walk

Location 7:

Soil profile	Depth	Description Surface cover: Mulch
	0-0.1	Scant wood chip mulch
	0.1'-0.7'	Sandy loam; brown; damp; soft
	0.7'-1.0'	Coarse sand; grey; dry; soft
	1.0'	Refusal at gravel layer

Remarks: Tree planting island built into parking space. Tree recently planted. Another tree in similar island is dead.

Location 8:

Soil profile	Depth	Description
		Surface cover:
	0-0.2’	Decomposing wood chips; dark brown/black; moist; soft; roots observed
	0.2’-0.7’	Fine sandy loam; brown; dry; firm; roots observed
	0.7’-1.2’	Interface; fine sandy silt loam; light brown; dry; firm; roots observed
	1.2’-1.3’	Interface; silty sandy loam; dark brown; moist; firm; roots observed, glass fragment, likely buried fill soil
	1.3’-1.9’	Interface; fine sandy silt loam; light brown; dry; hard; roots observed
	1.9’	Auger refusal; bits of hard orange subsoil observed

Remarks: Disturbed fill soils

Location 9:

Soil profile	Depth	Description
Profile not photographed		Surface cover: Wood chip mulch Highly disturbed soil; multi layers; moist, one layer slightly anaerobic

Remarks: in bed next to electric vault

Location 10:

Soil profile	Depth	Description
Same as profile #1		Surface cover: Wood chip mulch

Remarks:

Location 11:

Soil profile	Depth	Description
Same as profile #1		Surface cover: Wood chip mulch

Remarks:

Location 12:

Soil profile	Depth	Description
Same as profile #1		Surface cover: Wood chip mulch Soil slightly wetter than other #1 profiles

Remarks:

Location 13:

Soil profile	Depth	Description Surface cover: Turf grass
	0-0.3’	Loam; dark brown/black; moist; soft; roots observed
	0.3’-0.5’	Sandy loam; dark brown; moist; soft; roots observed
	0.5’-0.8’	Sandy loam; brown; moist; soft; roots observed
	0.8’-1.2’	Sandy clay loam; light brown/orange; moist; firm; roots observed
	1.2’-1.6’	Clay loam; orange; damp to moist; hard
	1.6’	Very hard; Stopped digging

Remarks: Disturbed profile

Location 14:

Soil profile	Depth	Description Surface cover: Wood chip mulch
Same as profile #1		

Remarks:

Location 15:

Soil profile	Depth	Description Surface cover: Turf grass
Profile not photographed	0-0.7’	Loamy soil, dark brown; moist; soft
	0.7’	Fine sandy clay loam; orange, damp; firm

Remarks:

Location 16:

Soil profile	Depth	Description Surface cover:
Same as # 15		

Remarks:

Location 17:

Soil profile	Depth	Description Surface cover: Turf grass
Same as # 1		

Remarks:

Test pits at locations 15 -17 was an attempt to confirm the edge of the disturbed soil in this area of the site.

Location 18:

Soil profile	Depth	Description
		Surface cover: Wood chip mulch
	0-0.6’	Decomposing mulch; dark brown/black; moist; soft; roots observed
	0.6’-1.1’	Fine sandy loam; dark brown; moist; soft; roots observed
	1.1’-1.5’	Fine sandy loam; brown; moist; soft; roots observed
	1.5’-2.1’	Fine sandy clay loam; brown/ orange; moist; soft; roots observed
	2.1’	Auger refusal on large root

Remarks:

Location 19:

Soil profile	Depth	Description
Same as #13		Surface cover: Turf grass

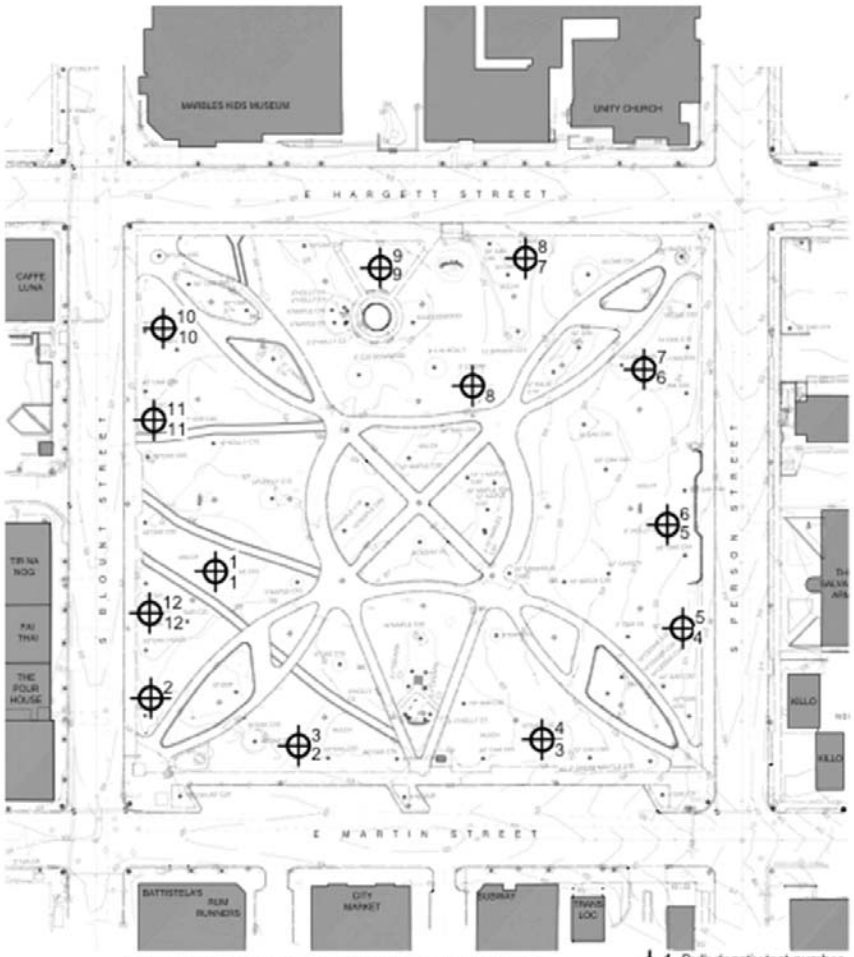
Remarks:

Location 20:

Soil profile	Depth	Description
		Surface cover:
Profile not photographed	0-1.5’	Sandy loam; brown; damp; firm
	1.5’	Interface; coarse sandy clay loam; red/orange; damp hard

Remarks: Fill soil over graded subsoil

Soil nutrient testing:
At 12 locations, marked 1 thru 2, on the Soil Bulk Density and Nutrient Test Location plan, soil was collected by the Bartlett Tree Experts from the top layer of the soil for nutrient testing. Samples were processed by Bartlett Tree Expert soil labs. The purpose of the testing was to gain a background chemical profile of the upper layer of the soil. The following are the test results and lab recommendations for modifications to soil nutrients. A general review of the soil testing results and recommendations follows later in section **Interpretation of the soils information.**



Soil bulk density and nutrient test locations

Nutrient Test Location 1:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #1 under tree 65
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131905
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	6.3	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	113.0		
Phosphorous (P)	110.0	High	
Potassium (K)	514.0	Very High	
Magnesium (Mg)	618.0	Very High	
Calcium (Ca)	4646.0	* Medium	
Soil Organic Matter (OM)	4.4	Medium	Nutrient Retention Capacity 17.6 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 2:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #2 common area between trees 31 and 32
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131915
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.6	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	86.0		
Phosphorous (P)	334.0	Very High	
Potassium (K)	182.0	* Low	
Magnesium (Mg)	270.0	* Medium	
Calcium (Ca)	1954.0	* Medium	
			Molybdenum (Mo) 0.0
Soil Organic Matter (OM)	3.1	* Low	Nutrient Retention Capacity 8.4 High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate	1.1 L	4.6	1.2		1.9 Kg	4.0
Gypsum	pelletized	22.2 L			5.9	28.8 Kg	60.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt	2.8 L	11.7	2.9		3.4 Kg	7.0
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		189.5 L			50.0		
Boost		94.7 L			25.0		
Boost Granular		5.0 L	21.0	5.3	1.3	4.8 Kg	10.0
Organic Milorganite		14.2 L			3.8	9.6 Kg	20.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 3:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #3 under tree 36
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131904
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	6.4	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	113.0		
Phosphorous (P)	168.0	Very High	
Potassium (K)	704.0	Very High	
Magnesium (Mg)	856.0	Very High	
Calcium (Ca)	5756.0	* Medium	
Soil Organic Matter (OM)	4.4	Medium	Nutrient Retention Capacity 22.5 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 4:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #4 Adjacent to tree #44
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131907
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.9	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	110.0		
Phosphorous (P)	138.0	Very High	
Potassium (K)	438.0	High	
Magnesium (Mg)	500.0	High	
Calcium (Ca)	4006.0	* Medium	

Soil Organic Matter (OM)	4.3	Medium	Nutrient Retention Capacity	15.2 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 5:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: Adjacent to tree #47
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131919
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.9	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	98.0		
Phosphorous (P)	348.0	Very High	
Potassium (K)	374.0	Very High	
Magnesium (Mg)	256.0	* Medium	
Calcium (Ca)	1924.0	* Medium	

Soil Organic Matter (OM)	3.7	Medium	Nutrient Retention Capacity	8.4 High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

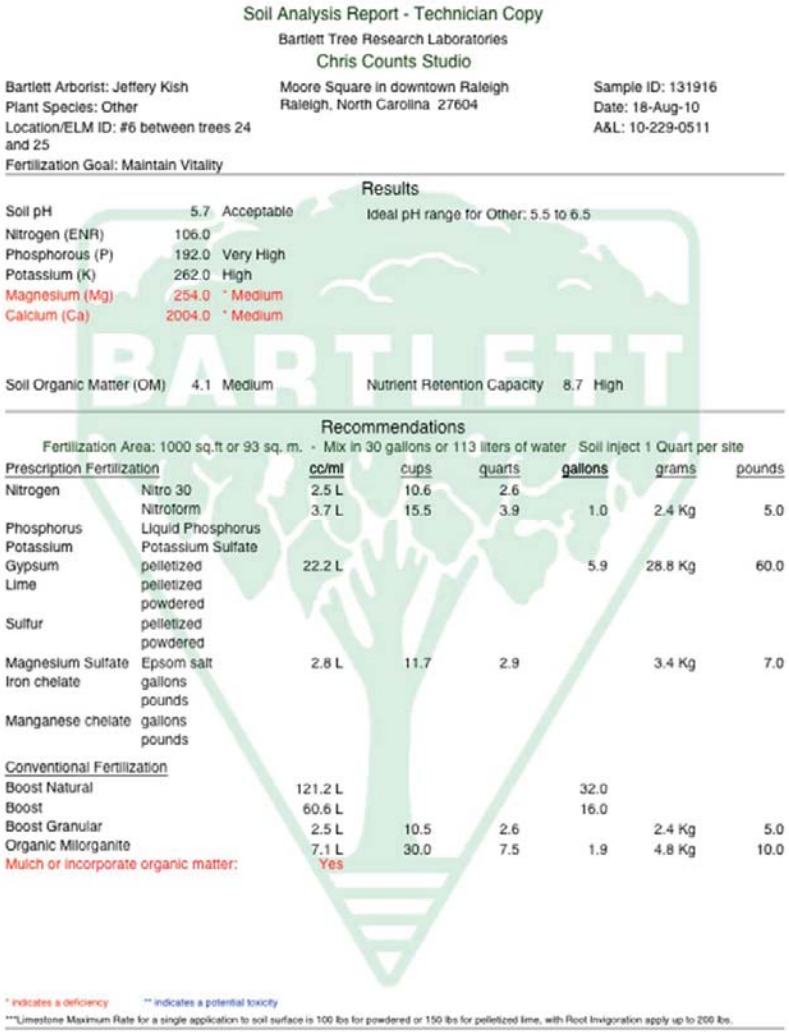
Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	22.2 L			5.9	28.8 Kg	60.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt	2.8 L	11.7	2.9		3.4 Kg	7.0
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		3.5 L	14.7	3.7		3.4 Kg	7.0
Organic Milorganite		14.2 L			3.8	9.6 Kg	20.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 6:



Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #6 between trees 24 and 25
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131916
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.7	Acceptable	Ideal pH range for Other: 5.5 to 6.5	
Nitrogen (ENR)	106.0			
Phosphorous (P)	192.0	Very High		
Potassium (K)	262.0	High		
Magnesium (Mg)	254.0	* Medium		
Calcium (Ca)	2004.0	* Medium		
Soil Organic Matter (OM)	4.1	Medium	Nutrient Retention Capacity	8.7 High

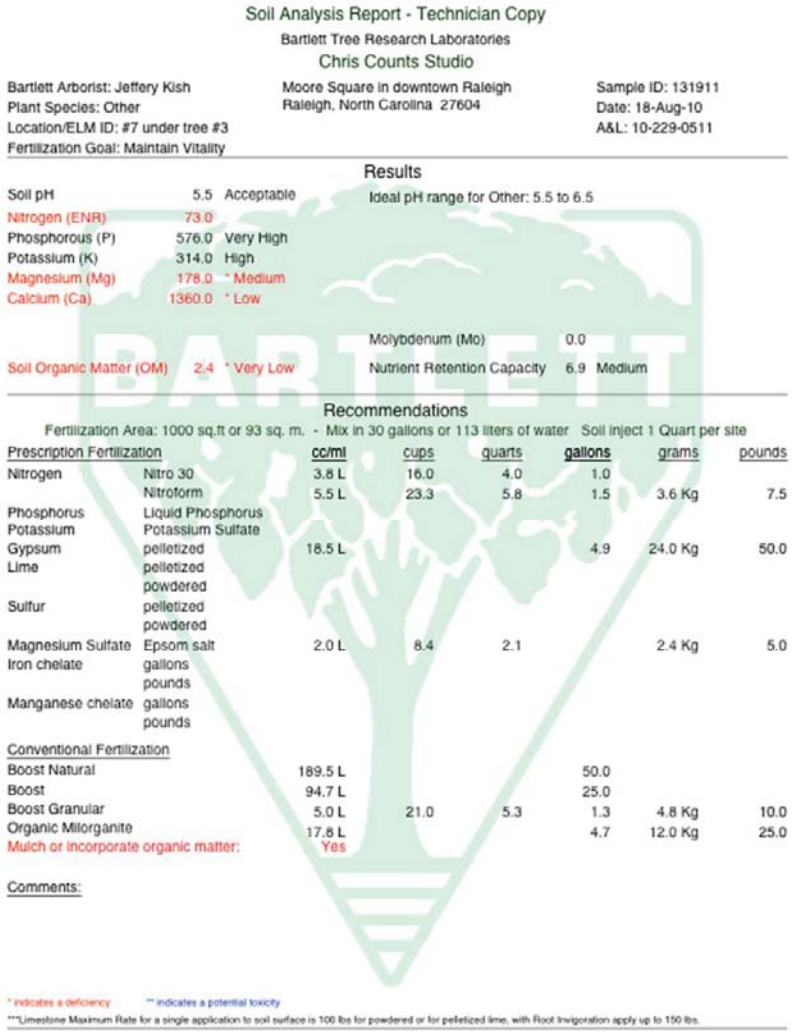
Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	22.2 L			5.9	28.8 Kg	60.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt	2.8 L	11.7	2.9		3.4 Kg	7.0
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.



Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #7 under tree #3
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131911
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.5	Acceptable	Ideal pH range for Other: 5.5 to 6.5	
Nitrogen (ENR)	73.0			
Phosphorous (P)	576.0	Very High		
Potassium (K)	314.0	High		
Magnesium (Mg)	178.0	* Medium		
Calcium (Ca)	1360.0	* Low		
			Molybdenum (Mo)	0.0
Soil Organic Matter (OM)	2.4	* Very Low	Nutrient Retention Capacity	6.9 Medium

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	3.8 L	16.0	4.0	1.0		
	Nitroform	5.5 L	23.3	5.8	1.5	3.6 Kg	7.5
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	18.5 L			4.9	24.0 Kg	50.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt	2.0 L	8.4	2.1		2.4 Kg	5.0
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		189.5 L			50.0		
Boost		94.7 L			25.0		
Boost Granular		5.0 L	21.0	5.3	1.3	4.8 Kg	10.0
Organic Milorganite		17.8 L			4.7	12.0 Kg	25.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or for pelletized lime, with Root Invigoration apply up to 150 lbs.

Nutrient Test Location 7:

Nutrient Test Location 8:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #8 under tree #21
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131920
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	6.2	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	110.0		
Phosphorous (P)	116.0	High	
Potassium (K)	418.0	High	
Magnesium (Mg)	542.0	High	
Calcium (Ca)	4820.0	* Medium	
Soil Organic Matter (OM)	4.3	Medium	Nutrient Retention Capacity 17.2 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 9:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #9 Gathering area at Hargett
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131906
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	4.9	Too Acidic	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	76.0		
Phosphorous (P)	542.0	Very High	
Potassium (K)	160.0	* Low	
Magnesium (Mg)	106.0	* Low	
Calcium (Ca)	980.0	* Low	
			Molybdenum (Mo) 0.0
Soil Organic Matter (OM)	2.6	* Low	Nutrient Retention Capacity 5.5 Medium

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate	549.4	2.3			960.0	2.0
Gypsum	pelletized						
Lime	pelletized	21.3 L			5.6	36.0 Kg	75.0
	powdered	14.2 L			3.8	24.0 Kg	50.0
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		189.5 L			50.0		
Boost		94.7 L			25.0		
Boost Granular		5.0 L	21.0	5.3	1.3	4.8 Kg	10.0
Organic Milorganite		14.2 L			3.8	9.6 Kg	20.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or for pelletized lime, with Root Invigoration apply up to 150 lbs.

Nutrient Test Location 10:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: Along Blount between trees 5 and 30
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131914
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	6.1	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	110.0		
Phosphorous (P)	152.0	Very High	
Potassium (K)	434.0	High	
Magnesium (Mg)	594.0	High	
Calcium (Ca)	4596.0	* Medium	
Soil Organic Matter (OM)	4.3	Medium	Nutrient Retention Capacity 17.0 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 11:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: Along Blount between trees 30 and 63
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131913
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.9	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	110.0		
Phosphorous (P)	144.0	Very High	
Potassium (K)	436.0	High	
Magnesium (Mg)	674.0	Very High	
Calcium (Ca)	5162.0	* Medium	
Soil Organic Matter (OM)	4.3	Medium	Nutrient Retention Capacity 19.1 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 12:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: between trees 66 and 68
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131918
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.9	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	110.0		
Phosphorous (P)	120.0	Very High	
Potassium (K)	500.0	Very High	
Magnesium (Mg)	516.0	High	
Calcium (Ca)	4318.0	* Medium	
Soil Organic Matter (OM)	4.3	Medium	Nutrient Retention Capacity 16.8 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Soil Bulk Density testing:

At 12 locations, marked 1 thru 12, on the Soil Bulk Density and Nutrient Test Location plan, soil was collected by the Bartlett Tree Experts from the top layer of the soil for bulk density testing. Samples were processed by Bartlett Tree Expert soil labs. The purpose of the testing was to gain an understanding of background bulk density level profile of the upper layer of the soil. The following are the test results and lab recommendations for modifications to soil bulk density. A general review of the soil testing results and recommendations follows later in section **Interpretation of the soils information.**

Bulk Density Test Location 1:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131896	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#1 under tree 65	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .454 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

Bulk Density Test Location 2:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131899	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#2 adjacent to #69	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy Clay – 1.166 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

Bulk Density Test Location 3:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131895	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#3 common are between trees 31 and 32	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Loam / Sandy clay 1.308 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

Diagnostician:
George Palmer

Bulk Density Test Location 4:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131898	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#4 under tree 36	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .384 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

Bulk Density Test Location 5:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131897	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#5 adjacent to tree #44	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy Clay – 1.046 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

Bulk Density Test Location 6:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131900	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	Adjacent to tree #47	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Loam / Sandy clay 1.414 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

Diagnostician:
George Palmer

Bulk Density Test Location 7:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131901	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#7 between trees 24 and 25	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy Clay – 1.170 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

Bulk Density Test Location 8:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131894	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#8 under tree #3	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy clay 1.382 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

Diagnostician:
George Palmer

Bulk Density Test Location 9:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131891	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#9 gathering area at Hargett	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Loam / Sandy clay 1.210 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

Diagnostician:
George Palmer

Bulk Density Test Location 10:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131893	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#10 between 5 and 30	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Sand / Loamy Sand – .929 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

Bulk Density Test Location 11:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131890	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	Along Blount between trees 30 and 63	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .590 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

Bulk Density Test Location 12:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131889	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	Along Blount between trees 66 and 68	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .441 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

Plant / soil observations:
The general quality of trees and other plantings indicate that the soil in Moore Square is very good and supporting long-term tree growth in almost all areas of the park. Even the disturbed soils are supporting reasonable tree and plant growth. The exceptions are the trees in planting islands at the parking spaces on the south edge of the park and in the central portion of the park. Turf decline appears to be more a problem with abrasion, shade and event use competition than compaction.

Interpretation of the soils information:
Soil Testing: Both the nutrient testing and bulk density testing indicate that few problems exist in the top layer of the soil, however, much of the testing sites only examined the decomposing mulch layer common throughout much of the park. The testing also focused on soils under the canopies of the largest healthiest trees where good soils would have been expected.

The nutrient testing indicates that pH is around 5.5 to 6.4 in almost all areas of the park. This is a good range of pH for all the existing tree types. This pH is low for turf. One test site, #9, has a pH of 4.9. this is one of the few places where soil was tested in the center space where poor soils are observed. Chemical testing for phosphorus and potassium and often also Magnesium is high to very high. This may indicate that large amounts of fertilizer have been applied over the many years this ground has been managed as a public park.

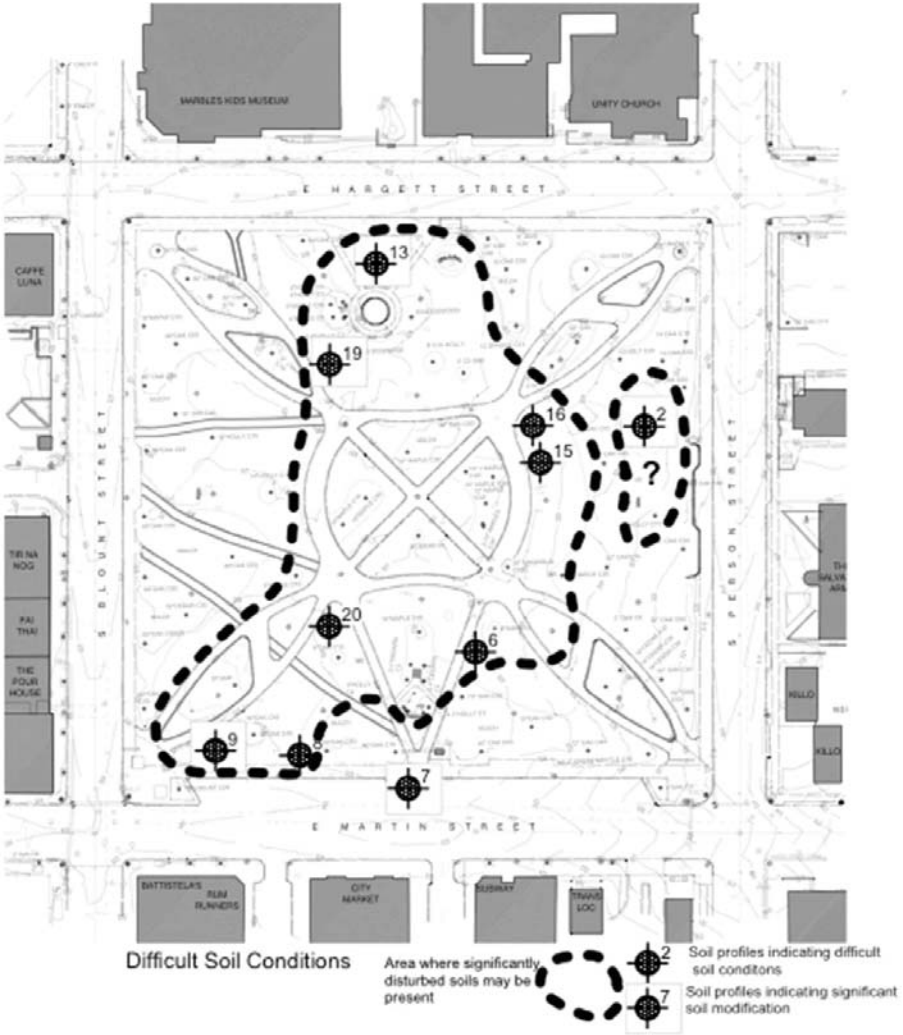
Soil Organic Matter (SOM) is normally around 4.0%. However, since much of the testing was in soil that is decomposing wood chip mulch, this high organic matter content is likely misleading to actual SOM. However the large amounts of brown soils encountered would indicate that SOM in the profile is likely adequate for most plants. SOM in the few soil test outside of the mulch beds were relatively low in SOM but not to an unreasonable level. The presence of roots in the brown soils and the healthy trees indicates that SOM is at a reasonable level even if 'low".

Soil Profiles: The soil profiles reveal that much of the soils around the perimeter of the site have seen only limited disturbance over the life of the soil. Relatively deep brown upper layer soils that included root observation are indicative of soils that support the high quality trees. Soil profiles in locations 2, 6, 7, 8, 9, 13, 15, 16, 19, and 20 are areas where soil improvement is likely to be warranted. This improvement would be reduction in bulk density, and increases in Soil Organic Matter, or blending of the decomposing organic matter into the lower soil layer. Five of these soil profiles 2, 7, 9, 13, and 19 suggest that soil replacement or other significant soil modification may be needed to assure long-term tree growth.

Problem soil location are plotted on the attached Difficult Soil Conditions plan. This plan also indicates a delineation of areas where difficult soil conditions may be present based on all factors including: the soil test and profile review; site surface features; topography; site history; and plant performance. Work within

this delineated area should consider additional soil modification requirements. The delineated area on eh east portion of the site with a question mark indicates that soil conditions may change rapidly over short distances and that generalizations may need further refinement in the design development portion of the project. Soils outside these delineated zones should be considered for soil protection or utilized design methodologies that tend to favor less grading and soil disturbance where possible.

Summary soil recommendations:



The following are recommendations for modifications to soils related to the proposed improvements in Moore Square. They are intended to guide design development of the concepts in the Master Plan.

Grading: Grading whether within or outside Tree Protection Areas is the most significant operation impacting soil quality. Grading may remove or bury important existing upper level soil profiles. It damages or destroys soil structure and modifies site hydrology. Moving soil releases organic matter. Grading, particularly cut, can damage tree root systems.

Most of these damaging impacts can be mitigated easily outside the Tree Protection Area. Within the Tree Protection Area construction strategies should focus on avoiding damage and using low impact techniques such as air spade soil tools, low ground pressure machines, and hand grading. Work areas prior to and after grading must be protected with geogrid / mulch mats and fencing.

Grading design should follow these requirements where possible.

1. Wherever existing soils are of good quality limiting the grading particularly cuts.

2. Limit cuts and fills in areas of tree protection root zones. See special provision in report “Tree Evaluations and Recommendations” for protection requirements.

3. Remove and stock pile A and B horizon soils and loosen subgrade soils before the start of any grading. Note that A and B horizon soils are those soils that are noted as being brown in color on the soil profiles. Protect soil stockpiles with breathable filter fabric.

4. In Tree Protection Area fill zones, create new A and B horizon soils and place fill using techniques that reduce the amount of compaction.

5. Respect existing site hydrology. Avoid channeling water in significantly different directions, particularly the concentration of water into small areas of the site.

6. Segregate A and B horizon soils from sub soils and restore soil profiles. See soil improvement section below.

Tree Protection: Tree protection is essentially soil protection. However, It is understood that building within the root zone of existing trees is possible if great care is taken within the root zone. Both construction and limited grading can be permissible in Tree Protection Area provided that specialized equipment and methods are utilized. Successful tree protection happens when lots of small decisions are made to fine tune the design in ways that respect the tree. A

detailed discussion on tree protection is found in the second part of this report "Tree Evaluations and Recommendations".

Soil Protection: The majority of the soil has been subjected to only minimum soil disturbances. Protecting this resource should be a critical goal of the project design. Following the grading and tree protection recommendation is an important first step.

Soil protection is similar to tree protection except prohibitions that are designed to protect existing roots are no longer critical. Larger equipment can be utilized to move soil. Cut and fill grades may be designed provided that the soils are segregated, protected, and restored.

Decomposing Mulch Layers: Across much of the site, large areas of thick mats of decomposing wood chip mulch are found. These layers were generally moist as they tend to hold too much water and not release it into the dryer soils below. Modifying these soils will be critical to long-term soil management.

1. Within tree root zone area, utilize an air spade to mix the decomposing mulch layer into the soil layer below to depths of 12 inches where possible.

2. Outside the Tree Protection Area, rip through the decomposing wood chip soil into the soil to depths of 18 inches. The ripping should mix sub soils and organic soils. Following the ripping, roto till the surface 6-8 inches of the soil and grade smooth the resulting material. Alternatively perform back hoe tilling to depths of 18 inches to mix the soil layers and fracture the lower soil profile.

Soil Improvements: in areas identified as difficult soils develop soil improvements strategies.

1. Within Tree Protection Area, loosen the soil with air spade and add compost to depths of 8-12 inches. Follow the requirements in the second part of this report under Tree Protection Plan.

2. In shrub and tree planting bed areas, outside the Tree Protection Area, utilize backhoe tilling with 4-6" of compost to depths of 18-24 inches. Apply an additional 4 inches of compost over the tilled soil and roto till the compost into the top 6-8 inches of the final grades.

3. In lawn areas develop a sand / soil / compost mix, specialized for high use turf 10" deep. Install sand choker layers and drainage. Grade soils with a minimum of 2% slopes.

APPENDIX B
MOORE SQUARE TREE INVENTORY & MANAGEMENT PLAN
THE BARTLETT INVENTORY SOLUTIONS TEAM

Moore Square
Tree Inventory & Management Plan | 2012

Prepared for
CCSGC, P.C.

Submitted by
The Bartlett Inventory Solutions Team

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ISA Board Certified Master Arborist & Municipal Specialist #SO-1845BM, ASCA RCA#524

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SCIENTIFIC TREE CARE SINCE 1907

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MAKING THE MOST OF YOUR INVENTORY MANAGEMENT PLAN

Those who operate a large business or institution understand how inventory impacts operations and budgeting. One must know what's there, how much or how many, and where it all is. But the task doesn't end there. To obtain the greatest benefit from inventory, owners or their designees must *manage* it. Are a company's tools, for example, old and defective, in need of repair, in short supply, or useless and taking up space that could be better occupied?

A good management plan will address these issues and keep the inventory current, in good condition, and functioning for the benefit and safety of those involved.

Managing trees on a large property can seem like an overwhelming task, but the same principles of inventory management apply. This inventory and management plan should provide managers the data they need to develop realistic budgets for their tree maintenance needs, and it will help make Moore Square a safer and more beautiful environment.

The following tips will assist you in making the most of this document:

Who's Who

Those who conducted the inventory and prepared this document are members of the Bartlett Inventory Solutions (BIS) team. They are also employees of Bartlett Tree Experts and operate from the Bartlett Tree Research Laboratories in Charlotte, North Carolina. Readers may interpret the terms "Bartlett Tree Experts," "Bartlett," "the BIS team," "the team," "we," and "our" as the Bartlett company and those who conducted the inventory and prepared this management plan.

Subject Trees

In this document, the term "subject trees" refers (depending on context) to some or all of the 68 trees included in the inventory.

Definitions & Bolded Terms

Some definitions or specifications are detailed within a given section to explain how readers should interpret certain terms or classifications. We have also appended a Glossary for other terms that appear throughout the document. The first reference to each of these terms appears in bold for the reader's convenience.

How This Document is Organized

As usual, the Table of Contents provides an effective road map to document contents, but following it are a List of Tables and List of Maps that users will find helpful in locating specific findings, recommendations, or tree locations. Also, a handy outline appears on page 7 that introduces the order in which results, recommendations, and the Entire Inventory will appear. All tables, photos, maps, and diagrams have numbered captions for quick reference. Starting with the Introduction, pages are numbered consecutively up to the "Entire Inventory" at the back. So that it can stand alone as a main inventory document, the Entire Inventory starts over with page -1-.

EXECUTIVE SUMMARY

In October, 2012, the Bartlett Inventory Solutions (BIS) Team from Bartlett Tree Experts was retained by CCSGC, P.C. to conduct an inventory of trees on the Moore Square. We identified 68 trees or groupings of trees that included 46 different species. The attributes that we collected include tree latitude and longitude, size, age and condition class, and a visual assessment of tree structure, health, and **vigor**.

We conducted the attribute collection using a sub-meter accuracy Global Positioning Satellite Receiver (GPSr) device with an error-in-location potential of not greater than three meters. Our recommendations for the subject trees over the next three-year period include:

Pruning
Prune 17 trees (25 for safety, health, structure, and appearance. Pruning will comply with American National Standards Institute (ANSI) A300 for pruning and ANSI Z133.1 for safety.

Advanced Tree Risk Assessments (Level 3)
Provide an andvanced tree risk assessment for 5 trees (7%) to evaluate the impact of wood decay in **stems** and **buttress roots** that show potential for failure.

Cabling, Bracing & Ground Support
Install new structural support systems in 1 trees (1%) to reduce risk of branch or whole tree failure.

Root Collar Excavations
Perform **root collar** excavations to 31 trees (46%) to lower risk of damaging conditions such as **girdling roots**, basal cankers, masking of root decay and lower-stem decay, and predisposing trees to various insect and disease pests.

Plant Health Care (PHC)
Implement Bartlett's PHC program to monitor pests and diseases on the subject trees. Treatments are therapeutic and preventive, and treatment timing is based on pest life cycle.

Soil Samples
Collect soil samples throughout the landscape and submit them for analysis that includes presence of soil nutrients, pH, organic matter, and **cation exchange capacity**.

Bulk Density Samples
Collect bulk density samples throughout the landscape to determine the extent of **soil compaction**.

Root Invigoration
Perform Bartlett's patented Root Invigoration program on trees affected by construction activities to improve aeration and promote more efficient root growth, especially for high-value trees in disturbed areas.

INTRODUCTION

In October, 2012, CCSGC, P.C. retained Bartlett Tree Experts to perform an inventory of trees in Moore Square, Raliegh, NC. Team member Michael Sherwood visited the site on October 9th to work with Jeff Kish to conduct the inventory.

The inventory included:

- identifying trees
- identifying the trees' condition, health, and vigor;
- recommending risk evaluations and removals of appropriate trees;
- recommending pruning, soil care, and plant health care treatments to promote tree safety, health, appearance, and longevity; and
- mapping the trees using GPSr hardware and Geographic Information System (GIS) software.

The methods and procedures we used to make the above determinations and recommendations are detailed in the following sections.

GOALS & OBJECTIVES

An effective management plan communicates clear goals and the specific objectives designed to carry out those goals. We intend "goal" to mean the overall aim or result we expect to achieve for the client in producing the inventory and management plan. The objectives are the specific actions taken or recommended to support goal completion. Table 1 below describes each goal and its corresponding objective(s).

Table 1: GOALS & OBJECTIVES

GOAL	OBJECTIVES TO ACCOMPLISH GOAL
Establish the tree inventory (per numbers agreed) at Moore Square.	Using Trimble GeoXT GPSr hardware and ArgGIS 9.3 software, collect data such as tree name, location, size, age class, and condition class.
	Use existing tree id #'s provided by CCSGC, P.C.
Provide mechanism for managing inventory, recommendations, and related budget planning.	Provide map or maps of the inventoried trees and tree grouping to assist the client in managing property areas.
	Submit a comprehensive management plan that documents and organizes findings and provides other resources to assist the client in efficient use of the information.
Maximize client understanding and implementation of management plan.	Include in management plan specific explanations and visuals related to plan recommendations.
	Provide appended resources that address health, procedures, and preservation standards related to tree care.
	Make periodic contact with client to follow up and answer any questions about the management plan's contents.
Maximize immediate and long-term tree health and aesthetics.	Implement recommended plant-health-care program that uses • plant health care • soil care • maintenance pruning
Manage immediate and long-term risk associated with trees in high-use areas.	Implement recommended risk-management measures that include • risk-reduction pruning • required removals • tree structure evaluations

DATA COLLECTION & TREE INSPECTION METHODOLOGY

In conducting the inventory, we used specialized equipment and software and followed specific procedures to determine tree characteristics, risk evaluations, and recommendations. The following explanation will assist the reader in interpreting the findings of this management plan.

Data Collection Equipment & Attribute Data

The BIS team used the Trimble GeoXT global positioning system receiver (GPSr) hardware unit and accompanying ArgGIS 9.3 software. The attribute data we collected on site are listed below.

- botanical name and regional common name according to local ISA Chapter Tree Species List
- tree location based on GPS coordinate system
- tag number
- diameter at breast height (**DBH**)
- canopy radius
- age class
- height class

- condition class
- root zone infringement, based on **dripline** and estimated **grayscape** (e.g., sidewalks) impact on root zone
- infrastructure interaction (between trees and grayscape that may cause an undesirable condition
- priority of tree care (based on 3-year management plan)
- pruning
- need for and inspection of existing cables and braces
- need for and inspection of existing lightning protection
- need for advanced tree risk assessments (Level 3)
- tree removals
- soil care recommendations
- plant health care recommendations

Specifications/Definitions

Age Class

New Planting	Tree not yet established
Young	Established tree but not in the landscape for many years
Semi-mature	Established tree but has not yet reached full growth potential
Mature	Tree within its full growth potential
Over-mature	Tree that is declining or beginning to decline due to its age

Height Class

Small	Less than 15 feet
Medium	15 to 40 feet
Large	Greater than 40 feet

Condition Class

Dead	
Poor	Most of the canopy displays dieback and undesirable leaf color, inappropriate leaf size or inadequate new growth. Tree or parts of tree are in the process of failure.
Fair	Parts of canopy display undesirable leaf color, inappropriate leaf size, and inadequate new growth. Parts of the tree are likely to fail.
Good	Tree health and condition are acceptable.

Priority of Tree Care

Priority class recommendations are based on a three-year management plan that takes into consideration tree species, condition, location, age, and proximity to infrastructure. We intend that this rating system assist decision makers in prioritizing tree pruning, cabling and bracing, and tree lightning protection recommendations. *Trees with a priority of 1 and an Overall Risk Rating of Extreme or High (see definitions in the next section) should be addressed immediately.* Prioritization does not take into account any budgetary or financial considerations.

Recommendations for Priorities 1, 2, and 3 are all based on observations by the inventory arborist. The following additional information clarifies each priority class:

Priority 1 To be addressed in years 1 or 2 of the management cycle. Priority 1 may include trees with large dead wood, structural defects, located in exposed sites, high aesthetic value, and/or parts that are currently negatively interacting with infrastructure, such as branches that touch buildings, interfere with signage or lighting, or obstruct pathways.

Priority 2 To be addressed in years 2 or 3 of the management cycle. Priority 2 may include trees with small dead wood, developing structural defects, located in semi-exposed sites, moderate esthetic value, and/or parts that are anticipated to negatively interact with infrastructure, such as branches that touch buildings, interfere with signage or lighting, or obstruct pathways.

Priority 3 To be addressed in year 3 of the management cycle. Priority 3 may include trees with small dead wood, developing structural defects, located in lesser used sites, and/or parts that are anticipated to negatively interact with infrastructure, such as branches that rub on buildings, interfere with signage or lighting, or obstruct pathways.

Pruning

Each of the following is a selective pruning technique to achieve the pruning goal described:

Clean Remove one or more of dead, diseased, and/or broken branches

Raise Provide vertical clearance

Thin Reduce density of live branches

Reduce Reduce height or spread

Structure Select live branches and stems to influence orientation, spacing, growth rate, strength of attachment, and ultimate size of branches and stems

ISA Tree Risk Assessment & Risk Rating System

The International Society of Arborculture (ISA) developed a Tree Risk Assessment Protocol and Risk Rating System that Bartlett employs while conducting tree inventories. The BIS team conducts a basic tree risk assessment (Level 2) for each tree. When catergorizing tree risk the factors considered are the Likelihood of Tree Failure Impacting a **Target** and the Consequence of the Failure (Smiley *et al*. 2011). Examples of targets are people, vehicles, buildings, and other valuable objects. After assessing any targets the BIS team looks for any defects or conditions in the roots, stem, and crown that may impact a target. The team then estimates the Likelihood of a Tree Failure Impacting a Specified Target. The Consequence of Failure is then catergorized. An Overall Risk Rating is then estimated by entering the Liklihood of Failure and Impact and Consequences into the Risk Rating matrix.

The categories for Liklihood of Failure and Impact are: *Unlikely, Somewhat likely, Likely, and Very likely.*

The categories for Consequence of Failure are: *Negligible, Minor, Significant, and Severe.*

The categories for the Overall Risk Rating are: *Low, Moderate, High, and Extreme.*

The following tables describe the Overall Risk Rating in more detail:

Table 2: CONSEQUENCES OF FAILURE DEFINITIONS

Consequences of Failure	
Negligible	Low value property damage that can be replaced or repaired, and do not involve personal injury.
Minor	Low to moderate property damage, small disruptions to traffic and communications or very minor injury.
Significant	Moderate to high value property damage, considerable disruption, or personal injury.
Severe	Involves serious personal injury or death, high value property damage, or disruption of important activities.

*(Smiley *et al.* 2011)

Table 3: OVERALL RISK RATING DEFINITIONS

Overall Risk Rating	
Low	Some trees with level of risk may benefit from mitigation or maintenance measures, but immediate action is not usually required.
Moderate	Mitigation and/or retaining and monitoring may be recommended. The decision for mitigation and timing of treatment depends upon the risk tolerance of the tree owner or manager.
High	Mitigation measures should be taken. The decision for mitigation and timing of treatment depends upon the risk tolerance of the tree owner or risk manager.
Extreme	Failure is imminent and there is a high likelihood of impacting the target. Mitigation measures should be taken as soon as possible which may include immediate restriction or access to the target zone area to avoid injury to people.

*(Smiley *et al.* 2011)

Table 4: ISA MATRIX USED TO ESTIMATE THE OVERALL RISK RATING

Likelihood of Failure and Impact	Consequences			
	Negligible	**Minor**	**Significant**	**Severe**
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

*(Smiley *et al.* 2011)

Pruning and structural support system procedures can reduce the risk of branch and leader failure to an acceptable level. We emphasize, however, that *all large trees pose a certain degree of inherent risk and this evaluation does not preclude all possibility of failure especially during severe storms*.

For those trees that the client considers hazardous and representing an immediate safety concern, we recommend placing a sign, tape, or other warning indicator near those trees until such time as the hazard can be remedied.

Trees inherently pose a certain degree of risk from breakage, failure, or other causes and conditions. Recommendations that are made by the Bartlett Tree Experts Company are intended to minimize or reduce hazardous conditions that may be associated with trees. However, there is and there can be no guaranty or certainty that efforts to correct unsafe conditions will prevent breakage or failure of a tree. Our recommendations should reduce risk of tree failure but they cannot eliminate such risk, especially in the event of a storm or any other act of God. Some hazardous conditions in landscapes are apparent while others require detailed inspection and evaluation. While a detailed inspection and evaluation should and normally does result in the detection of potentially hazardous conditions, there can be no guaranty or certainty that all hazardous conditions will be detected.

RESULTS & RECOMMENDATIONS

In reviewing the results and recommendations, the reader will find useful the specifications and definitions detailed on pages 3-4 above. We used the following categories to organize the results and recommendations, which are displayed in tables:

- **Results**
  - Stand Dynamics – This characterizes the subject trees according to
    - Condition Class
    - Age Class
    - Tree Groupings
    - Tree Species Identified
    - Tree Size per DBH
    - Estimated Value
  - Conditions or Defects Observed
- **Recommendations**
  - Advanced Tree Risk Assessments (Level 3) and Tree Removal
  - Pruning and Structural Support Systems by ISA Risk Rating and Priority
  - Lightning Protection Systems
  - Soil Care
  - Plant Health Care
- **Entire Inventory**
  Due to the length and detail of this table, we placed it last, under a major heading, for handy reference.

Where appropriate, we have included explanations, photos, drawings, or other information to illuminate the table contents.

Stand Dynamics

Condition Class

The breakdown of tree condition follows:

Table 5: CONDITION CLASS BREAKDOWN

Condition Class	Quantity	% of Total
Good	33	49%
Fair	31	46%
Poor	4	6%
Dead	0	0%

Age Class

The breakdown of tree age class follows:

Table 6: AGE CLASS BREAKDOWN

Age Class	Quantity	% of Total
Over-mature	3	4%
Mature	43	63%
Semi-mature	12	18%
Young	10	15%

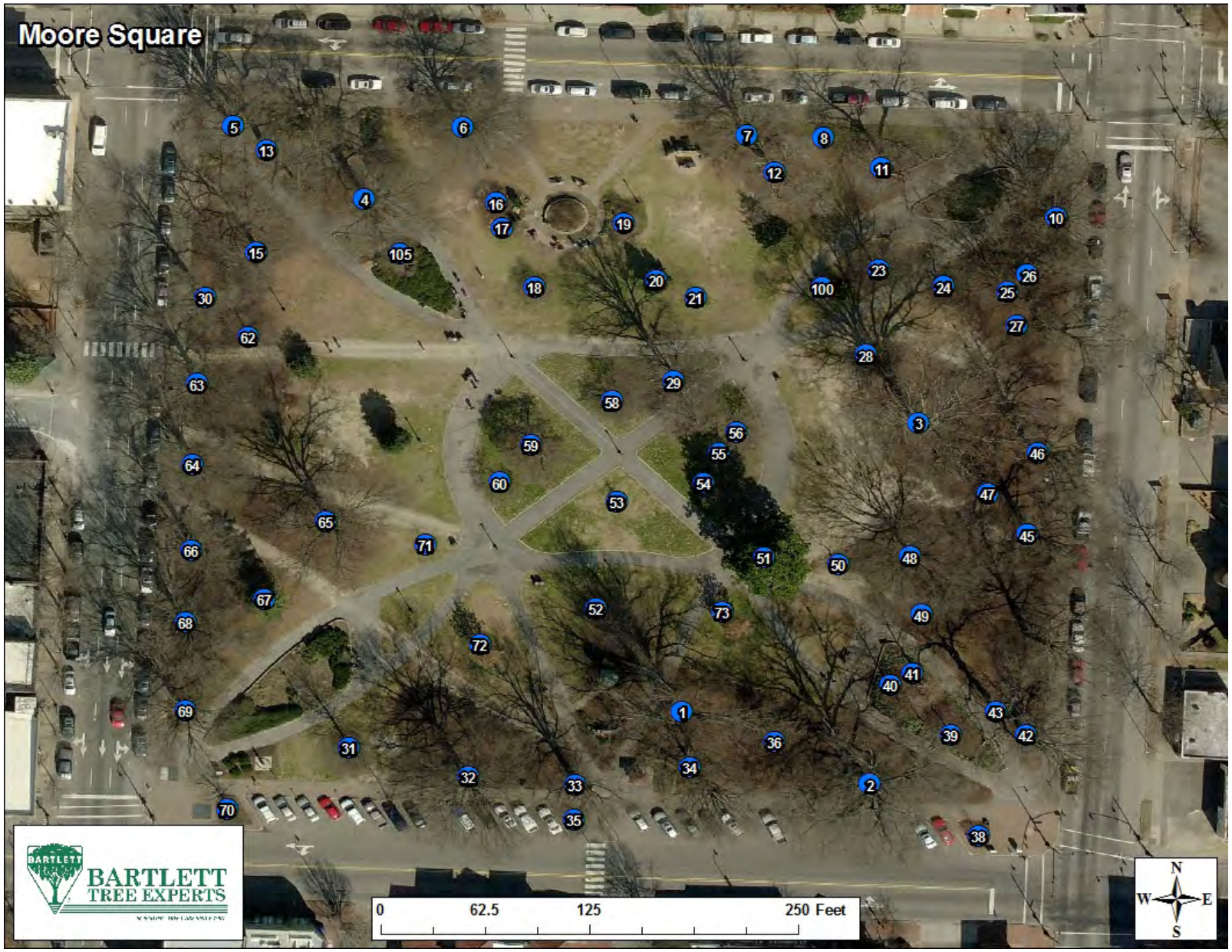
Tree Species Identified

Our inventory revealed 46 different species of trees, as detailed in the following table:

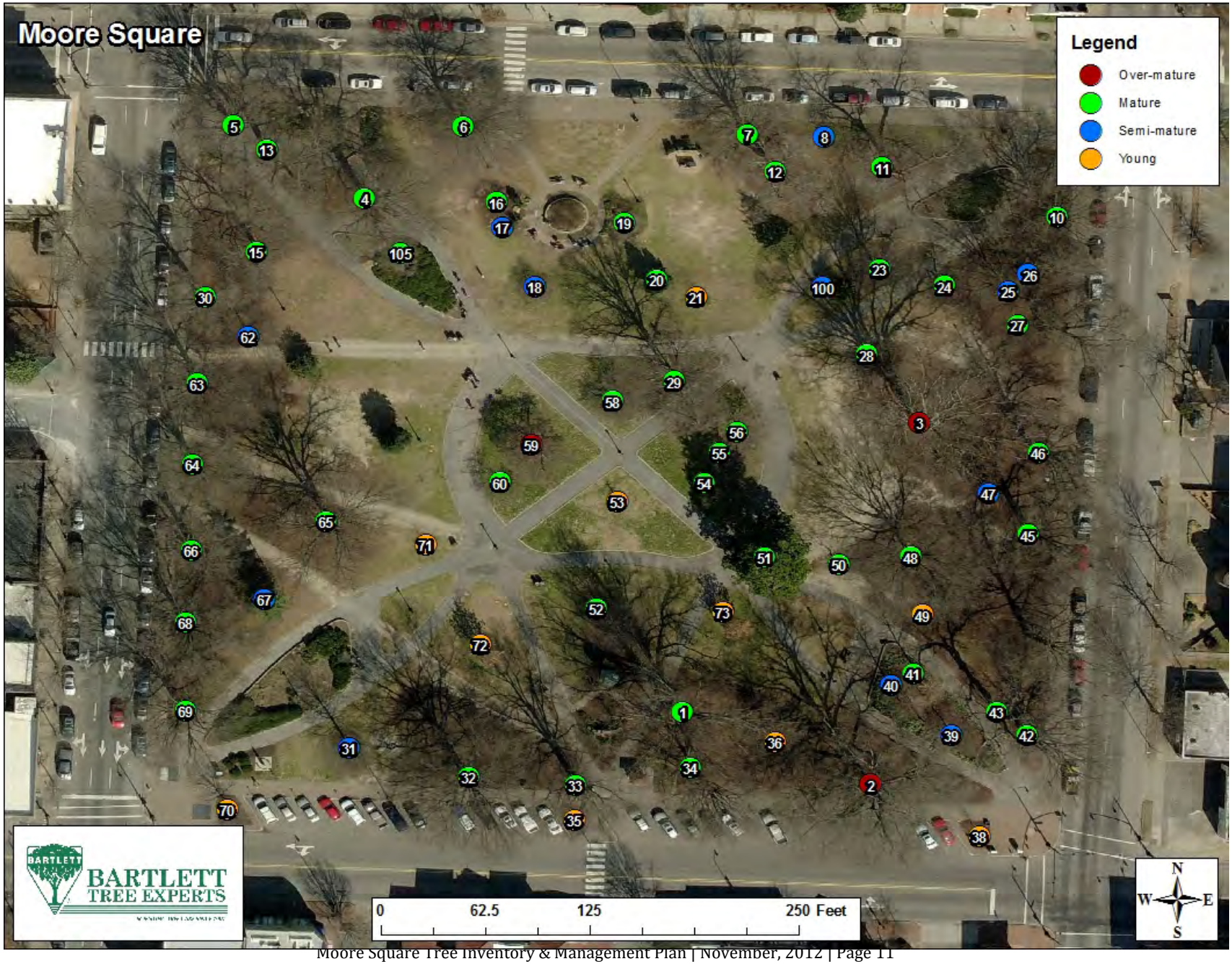
Table 7: TREE SPECIES IDENTIFIED

Genus	Species	Common Name	Count	% Distribution of Total
Acer	buergerianum	trident maple	1	1%
	campestre	hedge maple	1	1%
	palmatum	Japanese maple	9	13%
	rubrum	red maple	2	3%
	saccharum	sugar maple	1	1%
Acer Total			**14**	**21%**
Carya	illinoinensis	pecan	3	4%
Cedrus	deodara	Deodar cedar	1	1%
Cornus	florida	flowering dogwood	1	1%
Ilex	spp.	holly	2	3%
Magnolia	grandiflora	southern magnolia	1	1%
	x soulangiana	saucer magnolia	1	1%
Magnolia Total			**2**	**3%**
Malus	spp.	crabapple	1	1%
Picea	pungens	Colorado blue spruce	1	1%
Prunus	x yedoensis	Yoshino cherry	1	1%
Quercus	alba	white oak	2	3%
	michauxii	swamp white oak	5	7%
	nuttallii	Nuttall oak	1	1%
	palustris	pin oak	2	3%
	phellos	willow oak	24	35%
	prinus	chestnut oak	1	1%
	shumardii	shumard oak	2	3%
Quercus Total			**37**	**54%**
Sabal	minor	palmetto	1	1%
Taxodium	distichum	common baldcypress	3	4%
Ulmus	americana	hybrid elm	1	1%
Grand Total			**68**	**100%**

Map 1: 2012 TREE INVENTORY



Map 2: TREES BY AGE CLASS

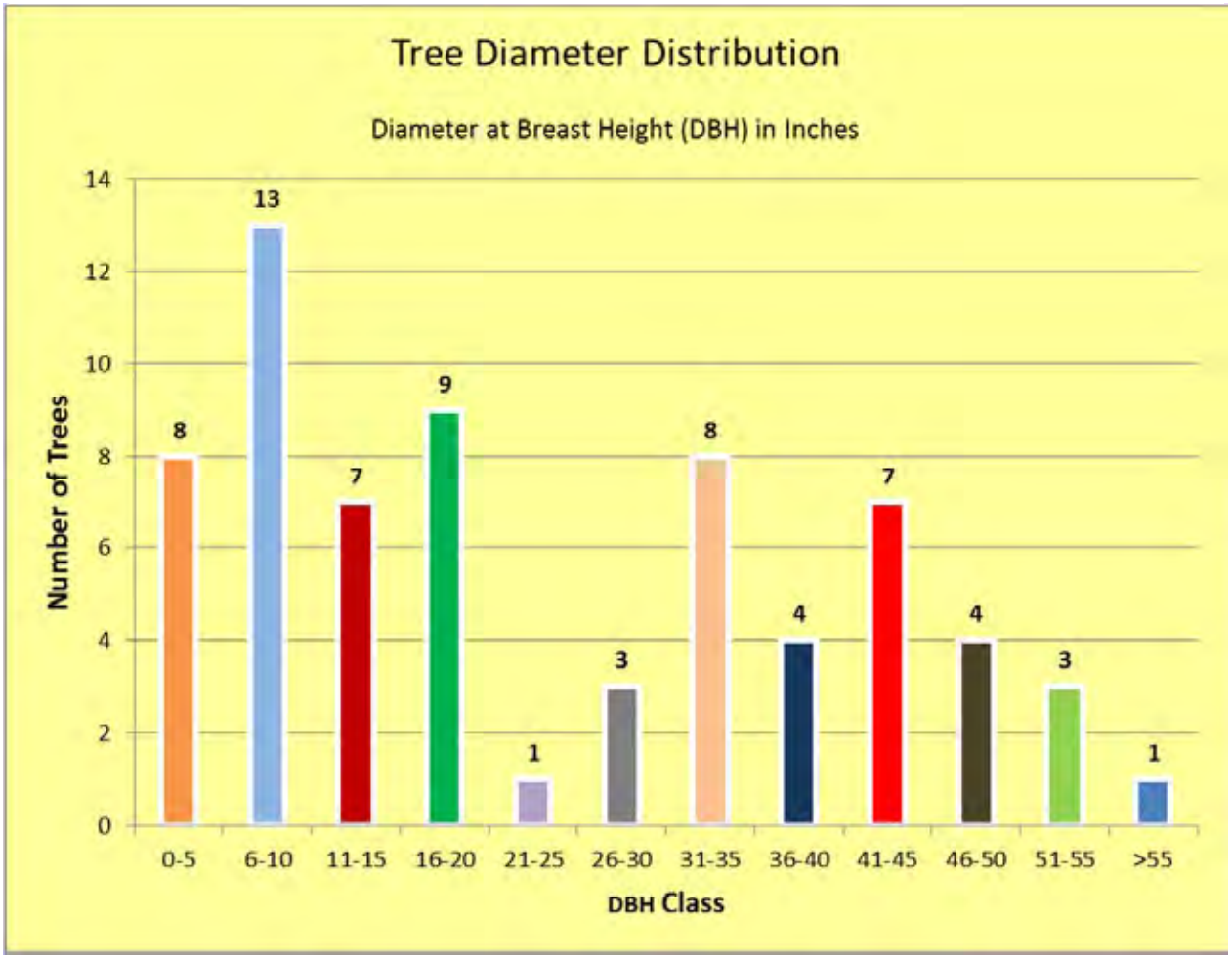


Map 3: TREES BY CONDITION CLASS

Tree Size (DBH)

The following chart illustrates numbers of trees according to size per DBH:

Table 8: TREE SIZE ACCORDING TO DBH



Estimated Value

As part of the Bartlett inventory process, we have included an estimated value for each tree and a cumulative total for all trees inventoried. To calculate the estimated value, we use a modified version[1] of the Trunk Formula Method published by the Council of Tree and Landscape Appraisers in *The Guide for Plant Appraisal,* 9th Edition.

[1] This version does not consider cost of purchase and installation of the largest available "like tree."

The following data fields are used in this formula:

Table 9: DATA FIELDS FOR DETERMINING ESTIMATED TREE VALUE

Estimated Value	Size, species factor, condition factor, and location value
Size	Based on tree DBH (4.5 feet above grade)
Species Factor	Relative species desirability based on 100% for the tree in that geographical location. In most cases, species desirability ratings, published by the International Society of Arboriculture, are used for adjustment.
Condition Factor	Rating of the tree's structure and health based on 100%
Location Factor	Average rating for the site and the tree's contribution and placement, based on 100%

The cumulative total value[2] for all trees inventoried is **$1,052,307.93.** The following table lists the eleven trees with the highest estimated values:

Table 10: TOP TEN TREES - HIGHEST ESTIMATED VALUE

Tree ID #	Common Name	DBH	Estimated Value
2	willow oak	65	$51,715.02
66	willow oak	46	$50,335.33
6	willow oak	4g3	$46,051.58
4	willow oak	53	$42,487.51
13	willow oak	50	$39,791.11
32	willow oak	48	$37,907.08
1	swamp white oak	52	$36,983.05
65	swamp white oak	40	$36,933.46
3	swamp white oak	51	$36,184.04
68	willow oak	46	$35,953.81

Map 4: TOP 10 TREES - HIGHEST ESTIMATED VALUE

Conditions or Defects Observed

Finally, in this (results) section, we list in Table 14 trees on which we observed conditions, defects, or other structural issues. Figure 1 provides an example of a tree with branch wound..

Figure 1: Tree #32 with a branch wound present.

Table 11: LIST OF TREES WITH CONDITIONS, DEFECTS, OR OTHER STRUCTURAL ISSUES

Tree ID #	Common Name	DBH	Condition or Defect	Condition or Defect	Condition or Defect
2	willow oak	65	wound-branch	storm damage	lightning damage
3	swamp white oak	51	wound-stem	deadwood >2	...
4	willow oak	53	deadwood <=2	...	...
6	willow oak	43	deadwood <=2	...	...
12	sugar maple	32	fungi/conks	...	...
16	Japanese maple	8	deadwood <=2	...	...
17	Japanese maple	4	deadwood <=2	...	...
18	paperbark maple	8	wound-stem	...	...
25	willow oak	17	supressed	...	...
26	willow oak	17	codominant leaders	...	...
27	willow oak	42	lean	...	...
28	willow oak	20	poor branch structure	...	...
29	white oak	37	fungi/conks	...	...
31	pin oak	18	girdling roots present	...	...
32	willow oak	48	wound-branch	...	...
34	willow oak	34	other	poor branch structure	...
39	common baldcypress	10	supressed	...	...
42	willow oak	36	uneven crown	wound-stem	...
43	pecan	36	lean	overextended branch	...
50	Yoshino cherry	11	wound-stem	...	...
51	southern magnolia	29	wound-stem	...	...
52	red maple	15	girdling roots present	cavity-stem	...
54	Japanese maple	12	wound-stem	...	...
56	Japanese maple	6	deadwood >2	...	...
58	Japanese maple	17	cavity-stem	...	...
59	Japanese maple	25	cavity-branch	codominant leaders	...
60	Japanese maple	16	wound-stem	wound-branch	...
71	red maple	5	wound-stem	...	...
72	swamp white oak	8	wound-stem	...	...

Advanced Tree Risk Assessments (Level 3) & Tree Removal

This section begins our coverage of recommendations. As part of the inventory process, the BIS team conducts a basic assessment (Level 2) from the ground. In this type of examination, the inspector can determine whether some aspect of tree structure or health indicates that a more comprehensive tree structure evaluation (Level 3) is needed to more thoroughly evaluate tree condition and risk of failure. Figure 2 provides an example of a tree defect that merits further evaluation.

Figure 2: The presence of fungal conks on Tree #29 necessitates an advanced tree risk assessment to more thoroughly assess internal decay and risk of failure.

In such cases, we may recommend advanced assessments of the roots, stem, or crown. These assessments may include climbing inspections, examination of the root system using a compressed-air tool (that avoids damage to roots and underground utilities), and one or more of the following: resistance drilling; the IML Resistograph, a precision drilling instrument that provides graphical output (preferred drilling method); or sound-wave examinations that produce estimates of decay percentages in targeted areas. The goal is to use the appropriate method to evaluate impact of wood decay in stems and buttress roots that show potential for failure and to determine presence and condition of the root system.

Once we complete such advanced assessments, we can then recommend appropriate measures, such as remediation, maintenance, or removal. (A technical report on tree structure evaluation appears in the Appendix.)

The trees listed in Table 12 below met the conditions for advanced assessments (Level 3).

Table 12: TREE RECOMMENDED FOR ADVANCED ASSESSMENTS (LEVEL 3)

Tree ID #	Common Name	DBH	Roots	Stem	Crown	Condition or Defect	Condition or Defect	Condition or Defect
2	willow oak	65	...	...	yes	wound-branch	storm damage	lightning damage
3	swamp white oak	51	...	...	yes	wound-stem	deadwood >2	...
11	pecan	32	...	...	yes	...	...	...
12	sugar maple	32	yes	yes	...	fungi/conks	...	...
29	white oak	37	yes	yes	...	fungi/conks	...	...

Map 5: TREES RECOMMENDED FOR ADVANCED ASSESSMENTS (LEVEL 3)

Pruning & Structural Support Systems

A commonly offered service among tree companies, pruning trees is one of the most poorly executed practices by tree workers who lack training in the basics of tree biology. "Lion's tailing," topping, and flush cuts are a few examples, and these can lead to hazardous conditions over time.

Because this practice is so misunderstood, and because specific standards exist to perform pruning correctly, the BIS team decided to include some explanation in the main body of this management plan.

Tree owners and tree-care practitioners should always keep in mind that *any pruning cut is a wound*. Informed tree-care professionals have learned to manage that wounding to preserve the health, safety, and integrity of the tree.

Improper Pruning Practices

A few of the most common pruning abuses are

- Lion's Tailing – pruning that removes interior branches along the stem and scaffold branches. This encourages poor branch taper, poor wind load distribution, and risk of branch failure. It also deprives the tree of foliage it needs to produce **photosynthates**. See Figure 4.
- Topping – pruning cuts that reduce a tree's size by using heading cuts that shorten branches to a predetermined size. This also deprives the tree of adequate foliage. See Figure 5.
- Flush Cuts – pruning cut through the **branch collar**, flush against the trunk or parent stem, causing unnecessary injury. See Figure 6.
- Using Climbing Spikes Inappropriately – Using climbing spikes on a healthy tree, for example, wounds healthy stem tissues and can lead to infection by fungal pathogens.

Figure 3: Black oval indicates general area of excessive foliage removal.

Figure 4: Examples of topping

Figure 5: Examples of flush cuts

Correct Pruning Practices

For specific standards on pruning practices, readers will find ANSI Standards on this topic in the Appendix. We have, however, included below some key pruning categories and diagrams to illuminate the goal of each.

Cleaning

Selective pruning to remove one or more of the following parts: dead, diseased, and/or broken branches.

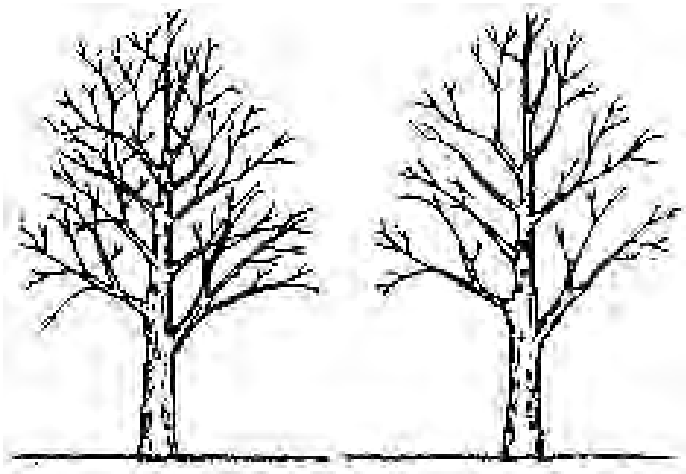


Figure 6: Illustration of crown cleaning

Raising

Selectively pruning to provide vertical clearance.

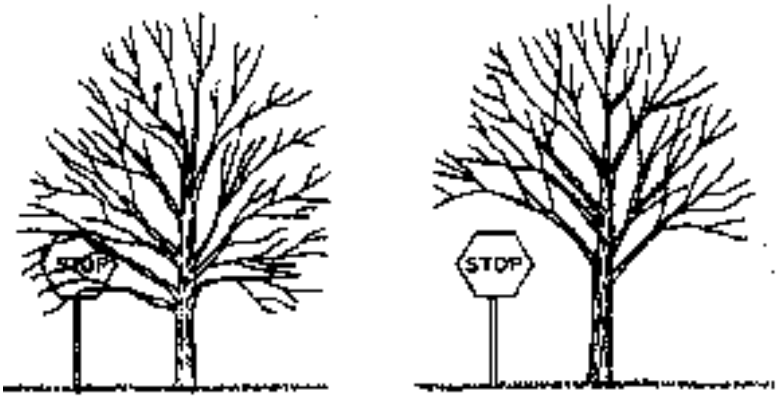


Figure 7: Illustration of crown raising

Thinning

Selective pruning to reduce density of live branches.

Figure 8: Illustration of thinning

Reducing (Reduction Pruning)

Selective pruning to reduce height or spread.

Figure 9: Illustration of reduction pruning

Structural

Selective pruning of live branches and stems to influence orientation, spacing, growth rate, strength of attachment, and ultimate size of branches and stems.

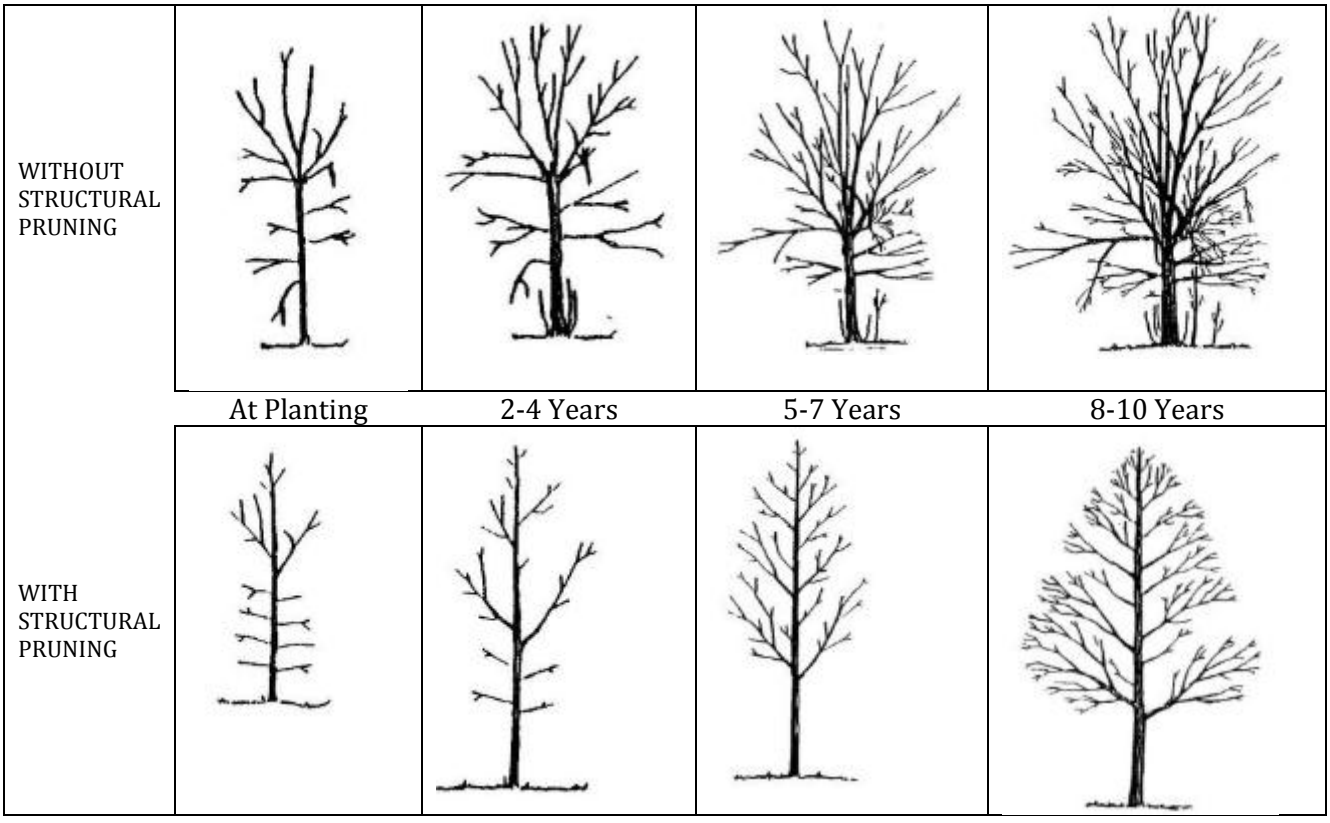


Figure 10: Illustration of structural pruning

We recommended pruning on the following trees:

Table 13: TREES RECOMMENDED FOR PRUNING

Tree ID #	Common Name	DBH	Tree Care Priority	Risk Rating	Clean	Thin	Structural
43	pecan	36	1	low	yes	...	...
3	swamp white oak	51	1	...	yes	...	...
21	Shumard oak	6	1	...	...	...	yes
36	willow oak	10	1	...	...	...	yes
38	hybrid elm	7	1	...	...	...	yes
45	willow oak	44	1	...	yes	...	...
49	Shumard oak	3	1	...	...	...	yes
100	palmetto	7	1	...	yes	...	...
4	willow oak	53	2	...	yes	...	...
6	willow oak	43	2	...	yes	...	...
16	Japanese maple	8	2	...	yes	...	...
17	Japanese maple	4	2	...	yes	...	...
18	paperbark maple	8	2	...	yes	...	...
31	pin oak	18	2	...	...	yes	yes
73	swamp white oak	8	2	...	...	...	yes
56	Japanese maple	6	3	...	yes	...	...
72	swamp white oak	8	3	...	...	...	yes

Map 6: TREES BY TREE CARE PRIORITY

Structural Support Systems

Cabling, bracing, and guying are structural support systems that can reduce risk of failure by limiting movement of stems or branches in certain situations. Examples include co-dominant stems or overextended branches with heavy foliage loads. Often cabling and bracing are combined with pruning to lighten the load on these branches or stems. Figure 12 illustrates a tree that could benefit from cabling.

We recommend that the following trees have new support systems installed:

Table 14: TREE RECOMMENDED FOR STRUCTURAL SUPPORT SYSTEMS

Tree ID #	Common Name	DBH	Tree Care Priority	Support System	Support System Details
43	pecan	36	1	yes	New 1

Map 7: TREES RECOMMENDED FOR STRUCTURAL SUPPORT SYSTEMS

Soil Care

Urban soils (as opposed to forest soils) are often mixed with the byproducts of construction activities that build our foundations, driveways, streets, parking lots, and other structures and grayscapes. This material compromises the physical, chemical, and biological properties that create healthy soils. Bartlett Tree Experts recommends several procedures and treatments that address soil quality. We address some of these below.

Soil Testing

Collecting soil samples and having them tested helps determine nutrients that may be lacking, unfavorable soil pH values, and adequacy of soil organic matter. Following laboratory test results, we can implement a prescription fertilization program to balance soil chemistry and optimize conditions for plant growth.

Mulch Application

Proper mulching provides many benefits to trees and shrubs. It moderates soil temperatures, reduces soil moisture loss, reduces soil compaction, provides nutrients, and improves soil structure. This practice results in more root growth and healthier plants. Mulch is frequently applied incorrectly, so we recommend that readers inspect the technical report on mulch application guidelines that appears in the Appendix. Figure 13 illustrates root growth density under grass versus mulch.

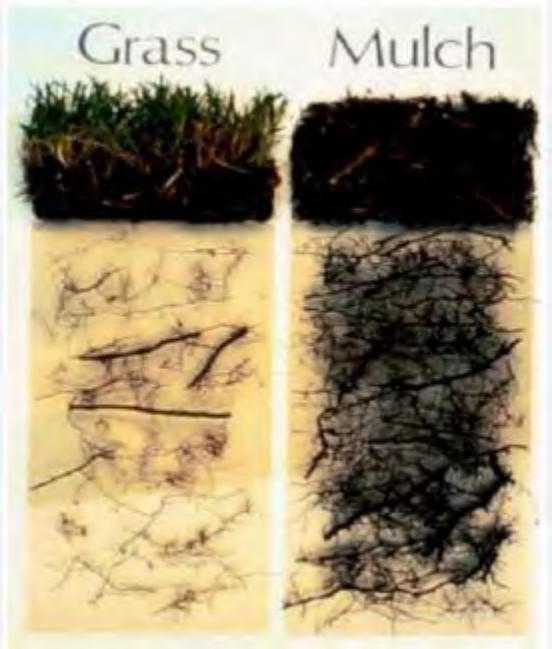


Figure 11: Example of root density under grass versus mulch

Bulk Density

Compacted soils are regrettably common in the urban setting. A bulk density test, which requires an undisturbed core sample, measures the level of soil compaction. Arborists can use the results to diagnose problems or to determine what size holes to dig for planting. If soil density exceeds a measured threshold for a given soil type and tree species, we recommend Bartlett's Root Invigoration program.

Root Invigoration

The aim of Bartlett's patented Root Invigoration Program is to improve soil conditions by addressing soil compaction and promoting efficient root growth, especially for high-value trees in disturbed areas. The process includes taking soil samples to determine what nutrients are deficient, performing a root collar excavation, "air-tilling" a portion of the root zone to find fine roots, incorporating organic matter, fertilizing (based on soil sample), and applying mulch. The area of the root system treated can vary by tree. For the Root Invigoration Program to be successful, proper watering techniques must be employed after the process is complete.

Root Collar Excavation

Excavating the root collar is necessary for trees whose buttress roots are covered by excess soil or mulch. Buried root collars can contribute to tree health problems, including girdling roots, basal cankers, and masking root and lower stem decay.

Figures 14, 15, and 16 provide examples of some of the above issues.

Figure 12: No root flare is visible at this tree's base. The root collar is buried.

Figure 13: Example of exposed root collar.

Figure 14: Example of improper mulch application, known as "volcano mulch."

The following trees are recommended for root collar excavations:

Table 15: TREES RECOMMENDED FOR ROOT COLLAR EXCAVATIONS

Tree ID #	Common Name	DBH
4	willow oak	53
5	white oak	35
6	willow oak	43
8	flowering dogwood	4
11	pecan	32
12	sugar maple	32
13	willow oak	50
15	pecan	27
16	Japanese maple	8
17	Japanese maple	4
18	paperbark maple	8
20	holly	9
21	Shumard oak	6
23	pin oak	20
30	willow oak	33
31	pin oak	18
35	trident maple	3
36	willow oak	10
49	Shumard oak	3
50	Yoshino cherry	11
52	red maple	15
53	Colorado blue spruce	7
59	Japanese maple	25
62	willow oak	18
65	swamp white oak	40
67	Deodar cedar	16
69	willow oak	43
70	Nuttall oak	4
71	red maple	5
72	swamp white oak	8
73	swamp white oak	8

Map 8: TREES RECOMMENDED FOR ROOT COLLAR EXCAVATION

Plant Health Care

The BIS team also recommends a Plant Health Care (PHC) Program for trees in the formal landscape. A PHC program monitors for potentially damaging insects, diseases and cultural problems that are often seasonal and were not evident during our inventory visits. These pests include, but are not limited to, the following:

- Anthracnose – on flowering dogwood
- Boring Insects – on a variety of tree species
- Caterpillar Defoliators – on a variety of tree species, especially oak
- Suspected Phytophthora Root Rot and Canker – on a variety of tree species, especially beech species
- Scab and Rust Fungi – on crabapple and apple species.
- Scale Insects – on a variety of tree species, especially oak
- Spider Mites – on a variety of tree species

We identified the following trees for a PHC program at this time:

Table 16: TREES RECOMMENDED FOR PHC PROGRAM

Tree ID #	Common Name	DBH	Pest or Disease
1	swamp white oak	52	cankers
23	pin oak	20	cankers
55	Japanese maple	15	scale
66	willow oak	46	borers
67	Deodar cedar	16	borers
70	Nuttall oak	4	mites
71	red maple	5	cankers

Map 9: TREES RECOMMENDED FOR PHC PROGRAM

ENTIRE INVENTORY

Table 17: ENTIRE INVENTORY

Tree ID #	Genus	Species	Common Name	DBH	Age Class	Height Class	Tree Care Priority	Estimated Value
1	Quercus	michauxii	swamp white oak	52	mature	large	...	$36,983.05
2	Quercus	phellos	willow oak	65	over-mature	large	...	$51,715.02
3	Quercus	michauxii	swamp white oak	51	over-mature	large	1	$36,184.04
4	Quercus	phellos	willow oak	53	mature	large	2	$42,487.51
5	Quercus	alba	white oak	35	mature	large	...	$24,772.58
6	Quercus	phellos	willow oak	43	mature	large	2	$46,051.58
7	Quercus	phellos	willow oak	29	mature	large	...	$23,873.61
8	Cornus	florida	flowering dogwood	4	semi-mature	small	...	$324.42
10	Quercus	phellos	willow oak	43	mature	large	...	$32,893.99
11	Carya	illinoinensis	pecan	32	mature	large	...	$25,315.33
12	Acer	saccharum	sugar maple	32	mature	large	...	$20,568.70
13	Quercus	phellos	willow oak	50	mature	large	...	$39,791.11
15	Carya	illinoinensis	pecan	27	mature	large	...	$18,394.89
16	Acer	palmatum	Japanese maple	8	mature	small	2	$1,816.78
17	Acer	palmatum	Japanese maple	4	semi-mature	small	2	$324.42
18	Acer	campestre	paperbark maple	8	semi-mature	small	2	$1,614.91
19	Magnolia	x soulangiana	saucer magnolia	5	mature	small	...	$551.97
20	Ilex	sp.	holly	9	mature	small	...	$2,120.52
21	Quercus	shumardii	Shumard oak	6	young	medium	1	$851.62
23	Quercus	palustris	pin oak	20	mature	large	...	$4,505.90
24	Malus	sp.	flowering crabapple	11	mature	medium	...	$1,908.25
25	Quercus	phellos	willow oak	17	semi-mature	large	...	$5,859.92
26	Quercus	phellos	willow oak	17	semi-mature	large	...	$5,859.92
27	Quercus	phellos	willow oak	42	mature	large	...	$31,839.61
28	Quercus	phellos	willow oak	20	mature	large	...	$4,866.37
29	Quercus	alba	white oak	37	mature	large	...	$27,184.25
30	Quercus	phellos	willow oak	33	mature	large	...	$21,570.24
31	Quercus	palustris	pin oak	18	semi-mature	large	2	$5,109.69
32	Quercus	phellos	willow oak	48	mature	large	...	$37,907.08
33	Quercus	phellos	willow oak	33	mature	large	...	$30,198.34
34	Quercus	phellos	willow oak	34	mature	large	...	$13,668.31
35	Acer	buergerianum	trident maple	3	young	small	...	$249.81
36	Quercus	phellos	willow oak	10	young	medium	1	$2,838.72
38	Ulmus	sp.	hybrid elm	7	young	medium	1	$540.93