Southern Methodist University

Campus Tree Inventory &

Ecosystem Services Benefits Report

Submitted by:

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SMU

Texas Trees Foundation

CREATING HEALTHY COMMUNITIES

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Executive Summary

The campus of Southern Methodist University (SMU) is located in a highly developed and urbanized area of Dallas, Texas. Surrounded by concrete, large buildings, and major transportation corridors the SMU campus is an oasis of green comprised of 2,236 trees. To better understand the role trees play on campus, a partnership between Southern Methodist University and Texas Trees Foundation was created to inventory and study the shade and ornamental tree species growing on the campus grounds. This study is an effort to:

1. Determine the actual size and scope of the urban forest on the campus of SMU
2. Catalogue each campus tree based on species, size and location
3. Asses the current health and management needs of the trees on campus
4. Determine the ecosystem service benefits and replacement value which the trees provide to the SMU community

Using state of the art technology, Texas Trees Foundation assessed each tree on campus during the summer of 2013. Tree species, total tree height, condition, and many other attributes of each tree were assessed and catalogued using a data storage and management system specifically created for tree inventories, called ArborPro. This software program allows Facility Services and other SMU departments to accurately place trees on aerial imagery, record and display critical tree characteristics and recommend maintenance for public safety and/or tree health.

After all trees were assessed and inventoried the data were uploaded to a program called i-Tree. i-Tree is a robust program developed by the USDA Forest Service and Davey Resource Group. This program allows us to economically and ecologically monetize the benefits of trees for carbon sequestration, energy savings, stromwater mitigation and other factors that are important to our community. From this program we are able to quantify and report the value these trees provide to the SMU campus and the urban forest of Dallas. One visit to SMU and you immediately know that trees add significantly to the beauty of the university campus and the quality of life for students, faculty and visitors from throughout the community. With its abundance of trees and beautiful landscaping, the university has excelled in building a Green Infrastructure for which it can be proud. Now, by utilizing state of the art technology, SMU is in a position to better manage this urban oasis and help ensure a sustainable, healthy, well-treed campus for decades to come.

This report describes, in detail, the work that was done to assess the current condition and value of the trees on the SMU campus. The report provides the results of the inventory and offers recommendations for the care and maintenance of the campus forest and landscape through the use of Green Infrastructure Best Management Practices.

The Importance of Trees

Trees are essential to our world and offer a wide range of benefits to our environment. The list of benefits that trees provide is long. Pollution reduction, energy savings, heat island mitigation, storm water management, erosion control, wildlife habitat, and an enhanced sense of self and place are all well known, long term benefits of our Urban Forest.

Trees are one of the most effective ways to bring about widespread improvement in the environment and the quality of life of an area. Even in a vast metropolitan area like Dallas, where the *grey* infrastructure far out weights the *green*, trees play a colossal role in regulating temperature, improving air and water quality and increasing energy savings.

The Impact of Campus Trees

By understanding the structure, function and value of an urban forest, Facility Services, the Office of Planning, Design, and Construction, and other departmental services can promote better management decisions that will improve the overall health and safety of urban trees. By promoting better management decision, stakeholders can share with the public the knowledge that trees are a capital asset to the community. With sound planning and good decision making, newly planted and existing trees will continue to grow, thrive and lessen the probability of causing future problems or conflicts. Moving away from a reaction based management program to a pro-active approach will ensure a healthier and safer campus and, over time, will reduce management and maintenance costs.

Key Findings

- Number of trees: 2,236*
- 25% Canopy Cover
- Most common species: live oak, crape myrtle, Shumard Red oak
- Over 50% of the tree's are between 4-12 inches in DBH (Diameter Breast Height)
- Of the 2,236 trees, 2,075 are in fair to good condition
- Carbon Sequestration: 793,251 pounds per year (value: $6,283/year)
- Carbon Storage: 12,278,716 total pounds stored (value: $92,000)
- Energy Savings: $24,417 each year
- Annual Rainfall Interception: 8.1 million cubic feet per year (value: $80,472/year)
- Structural value: $10.2 million

Ecosystem service benefits were analyzed using the i-Tree Streets model (formerly known as STRATUM) developed by the USDA. Forest Service, Northern Research Station.

For more information about i-Tree methodology, see Appendix A..

**At the time of this report, due to construction around Moody Coliseum, approximately 20 trees remain to be inventoried. These trees will be inventoried upon completion of the construction project in the Spring 2014*

Introduction

Southern Methodist University (SMU) is a beautifully maintained, tree-lined campus which has an abundance of shade and ornamental trees which are primarily planted throughout the oldest portions of campus. Located near downtown Dallas, Texas, SMU is a private university with nearly 11,000 students. Founded in 1911 and opened in 1915, this educational institution is celebrating its centennial anniversary and looking forward to its next 100 years of being a state of the art, 'green' campus.

Texas Trees Foundation began the inventory and assessment of the SMU campus in May, 2013. The following tree characteristics were assessed in the field or obtained through the ArborPro software:

- Latitude
- Longitude
- Species
- Diameter Breast Height (inches)
- Height (feet)
- Canopy Width (feet)
- Planting Location
- Defects Present
- Condition Rating
- Recommended Maintenance
- Location on Campus
- Notes associated with tree

Over the past decade, there has been an increase in both the knowledge of ecosystem services and social benefits of urban forests as well as the availability of quantitative tools, such as i-Tree, for the measurement and dispersal of reputable information regarding the importance of trees in the urban forest (Dwyer et. al 1992). Since the introduction of these new quantitative tools for measuring tree benefits, nearly 827 international and 773 national assessments have been produced (as of January, 2012). SMU's recognition of the multitude of benefits urban forests provide prompted the development of this campus tree inventory. Commissioned in part to quantify the monetary value and quality of life values associated with urban trees, this study highlights the importance SMU leaders have placed on their campus tree population. The results will enable campus leaders to continue enhancing the University's urban forestry program.

Dwyer, J., G. McPherson, H. Shroeder, and R. Rowntree. "Assessing the Benfits and Costs of the Urban Forest." *Journal of Arboriculture*. 18(5). pp. 227-234. 1992.

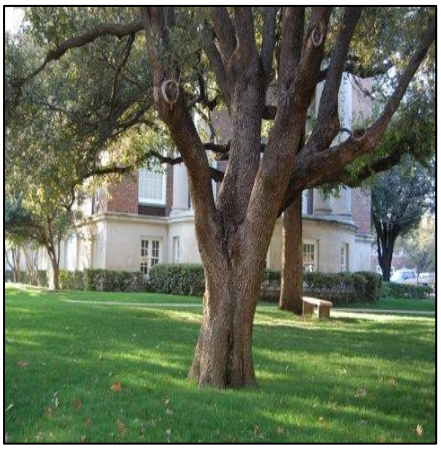
Methodology

Data were collected on the SMU campus from June to August, 2013, using a Motion CL900 tablet (Intel Atom Z670 processor, 62 GB hard drive, Windows 7 Professional) and ArborPro USA, Inc software (California, USA; www.arborpro-usa.com). ArborPro USA, Inc software (ArborPro) is a state of the art, robust tree inventory and data storage system which has the ability to facilitate maintenance cost scheduling and tree maintenance records management for the inventoried trees. It has the capability to integrate aerial imagery and other GIS based software (ArcMap, etc.) to accurately identify where trees are located in the landscape through the use of Latitude and Longitude coordinates.

Once a tree is placed in the approximate location on the aerial imagery, Latitude and Longitude coordinates were recorded so crews can be dispatched for geo-referencing or maintenance to be performed. Each tree on the SMU campus was assessed for the current health of the tree, size of the trunk (DBH) and canopy, location of tree (near buildings, athletic areas, residences, etc.) as well as any defects which were present at that time of the survey.

All shade trees and most ornamental tree species were included in the inventory. Holly species (*Ilex* spp.) were not included in the survey. All trees were also evaluated to determine what maintenance, if any, needed to be scheduled. Below is a list of attributes and maintenance recommendations collected for each tree:

- Species
- Height (feet)
- Canopy Width/Spread (feet)
- Diameter at breast height (DBH) (inches)
- Maintenance concerns
- Overall heath
- Defects
- Latitude and Longitude
- Location on Campus
- Pruning needs
- Root collar maintenance
- Fertilization
- Removal



Campus Tree Inventory Results

Tree Species

At SMU, Southern live oak (*Quercus virginiana)* accounts for 33% of the entire campus tree population (Figure 1). The next two most common species are crape myrtles *(Lagerstroemia* spp.*)* and Shumard red oak *(Quercus shumardii)* In all, over 45% of SMU's tree population is in the *Quercus* genera (oak family). This could *potentially* be a serious issue, especially with oak wilt (see page 12) currently confirmed and actively being treated on campus.

*Santamor (1990) describes the ideal proportion of family, genera and species which should reside in a given area. Santamor recommends that no more than 30% of the entire population should be comprised of the same family of trees (e.g. *Fagacea* oak and beech family); no more than 20% should be comprised of the same genera (e.g. oak trees); and no more than 10% should be comprised of the same species (e.g. Shumard red oak).

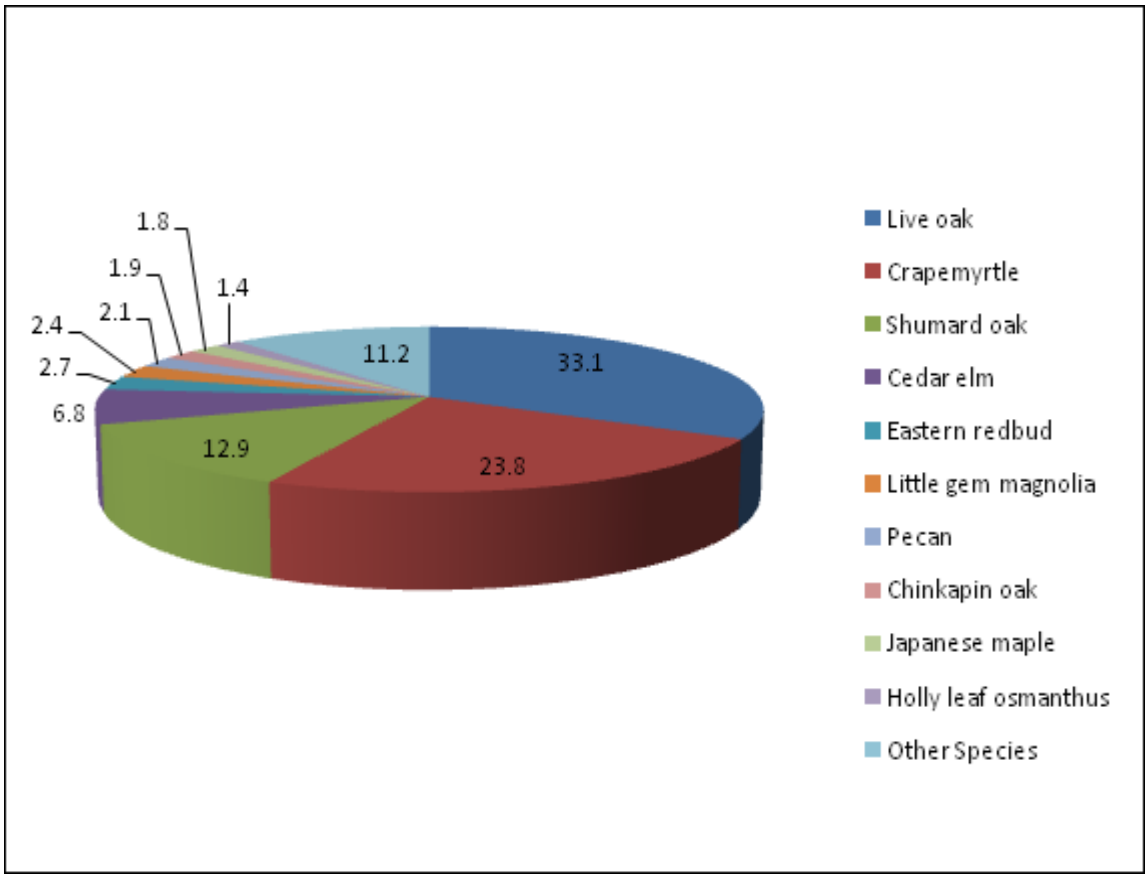


Figure 1: Species distribution of Top 10 tree species as represented by parts of the entire campus tree population at SMU.

*Santamour, Frank S. Jr.1990. Trees for Urban Planting: Diversity, Uniformity, and Common Sense. Proc. 7th Conference Metropolitan Tree Improvement Alliance (METRIA) 7:5765

Diameter Distribution

Tree diameter can often be used to determine the age distribution of a stand of trees. Healthy urban forests are typically characterized by a mix of tree ages throughout the stand, with a large number of smaller trees and a smaller population of large mature trees. This ensures that as trees age and perish there is not a gap in the canopy.

SMU's tree canopy is comprised of two age classes (Figure 2); one consisting of large mature trees, mostly live oaks, and the other class of younger newly planted trees. This is consistent with the amount of new landscape that has been installed. Over 20% of the trees are in the 6-12" diameter class which would normally indicate a fairly good age distribution, but in this instance it is misleading with over 50% of these trees having been recently planted. This can create management challenges. Without an established succession pattern, there may not be an adequate number of well established younger trees ready to assume the place of the older trees as they die. This can lead to a revolving door of having to plant larger trees to try and fill the canopy gaps. Larger trees cost more and require more time and effort to maintain.

Large trees are generally transplanted from one location and planted in another; by doing this they lose upwards of 95% of their roots (Donald 1998). This leads to transplant shock and the need for a robust maintenance plan. On average, it takes a transplanted tree the same number of year as its caliper to re-grow its lost root system, e.g. a 6" caliper tree can take up to 6 years before it is fully established to its new location.

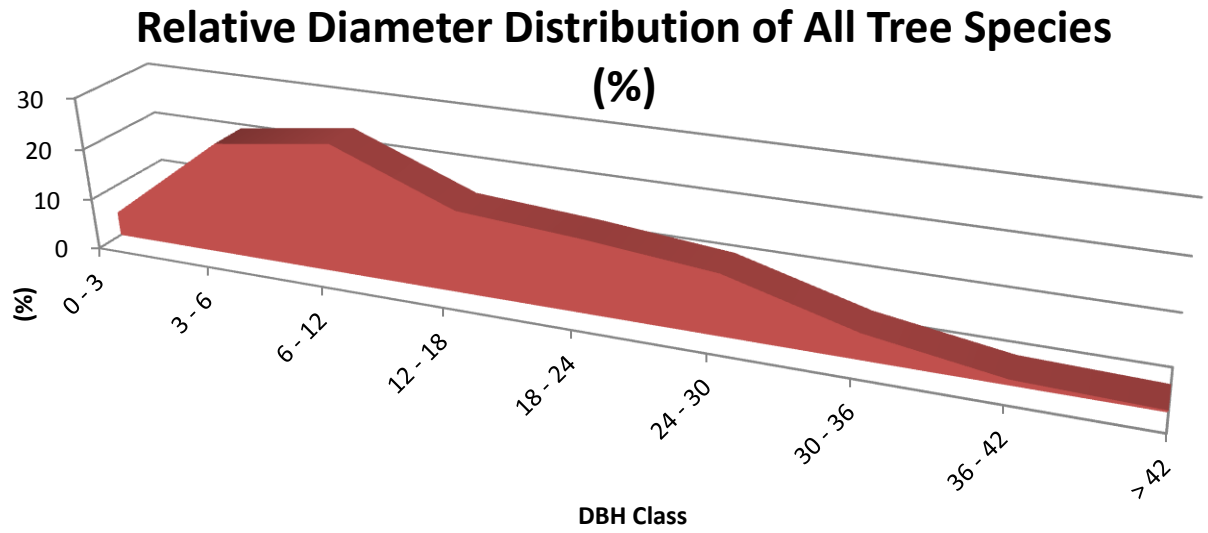


Figure 2: Relative diameter distribution of all trees represented by diameter classes by diameter breast height (inches)

Donald L. Ham, Larry R. Nelson. "Newly Planted Trees: Strategies for Survival." *Clemson University Extension*. 1998

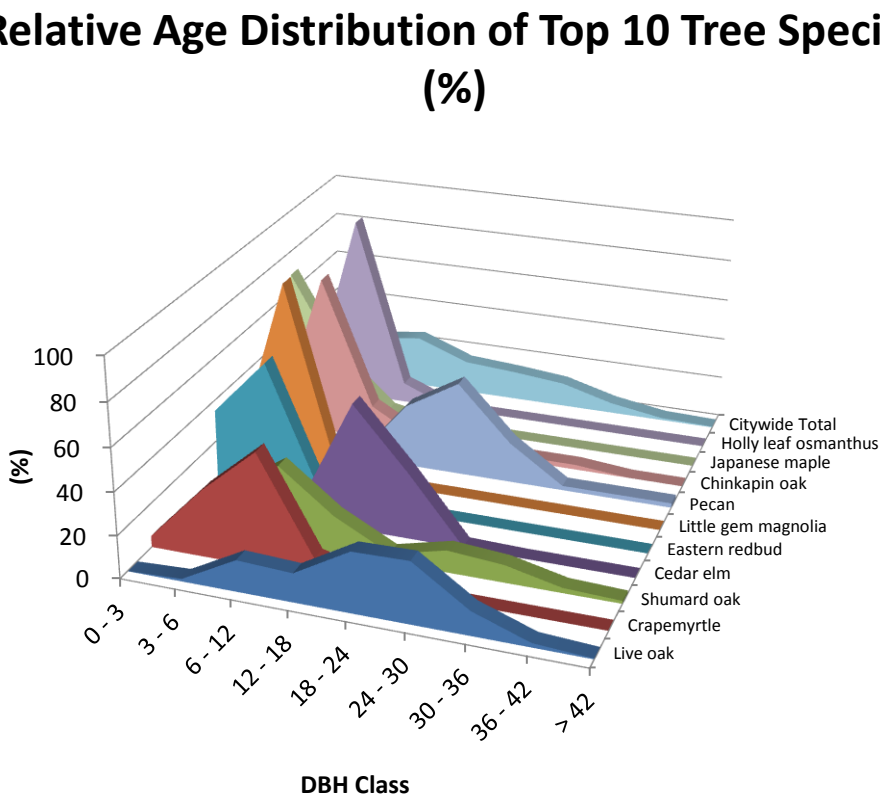


Figure 3: Relative diameter distribution of top 10 species based on overall percentage

Condition

The condition of an individual tree can vary greatly over time. This inventory should be considered as a "snapshot" of each tree on the particular day that the tree was assessed. Information regarding the condition of the trees is pertinent, but it is highly recommend that a system be established to ensure the periodic assessment of the condition of all the trees on campus.

The rating system used for assessing tree health at SMU was reported as follows:

- **Good** – No apparent problems or issues; no dead limbs or leaves and the tree is growing extremely well with a well excised root flare in a good location with little to no scars, wounds or decay.

- **Fair** – Few apparent problems or issues; few dead limbs or twigs were present and leaves may have been slightly chlorotic or scorched/wilted. Root collar may be buried but few scars, wounds or decay present.

- **Poor** – Many problems and issues were present, including but not limited to wounds and decay; many scars, buried root collars and death or decline of large tree parts.

- **Critical** – In serious need of maintenance or tree death is imminent; risk to personal safety and property is greater than any other condition above.

- **Dead** – Life processes have ceased and the tree is now in a state of high risk if not removed.

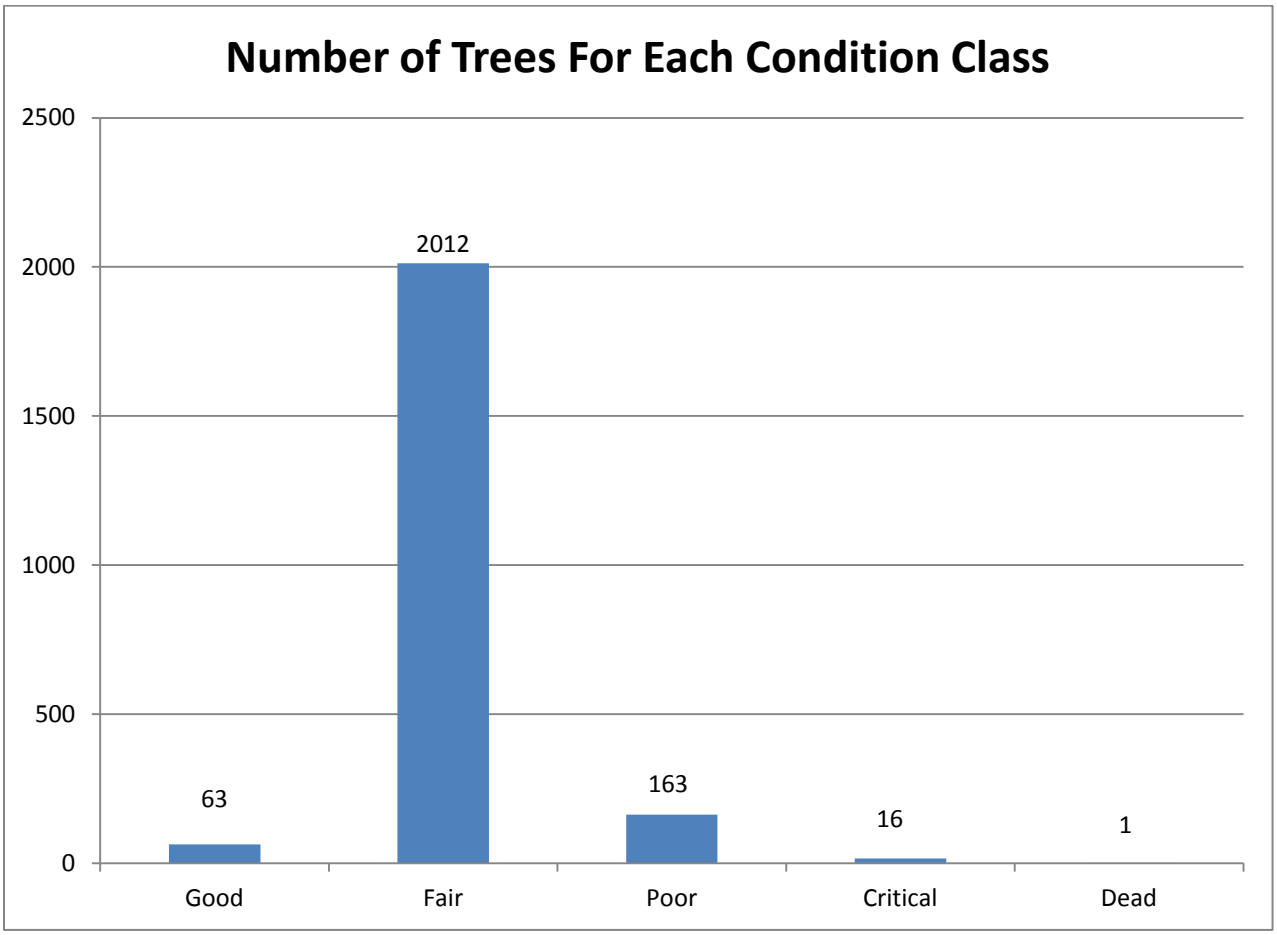


Figure 4: Number of trees for each condition rating at the time of the inventory
Note: dead tree has been removed at the time of this report

Maintenance Recommendations

A very positive finding from the SMU inventory is that over 2,000 trees (out of the 2,236 surveyed) are in the "fair" or "good" categories. While no individual tree is completely healthy and free of all defects, ratings at this level are encouraging and a positive reflection on the grounds facility staff.

Some of the major maintenance requirements are listed here and a complete breakdown with definitions can be found in Appendix C.

Root Collar Excavation

The root collar is an important area of the tree; it is the interface between trunk and roots. In this area, the tissue grows about 1.5 times faster than the trunk. This is where the flare is created. It helps retain support and structure for the tree during wind events and aids in gas exchange for respiration. If buried, the tree could suffocate from gas interruptions or latent buds could be activated and circling, potentially girdling roots could be formed at the base; weakening the entire structure of the tree. To ensure long term survival measures should be taken to keep the root collar clear of excess soil, grass, or other obstacles. If the root collar is already buried an air spade can be used to remove the excess material without causing damage to the existing root system.

Pruning

Several different types of tree pruning need to occur on campus. The majority of pruning needed is for clearance of the roadways and sidewalks on campus. Due to the large number of live oaks on campus and their natural growth habit, clearance pruning needs to be an ongoing practice. The other major pruning that is needed is young tree pruning. Many defects, such as double leaders or co-dominant stems, can be corrected at an early age and should be done after the first growing season following the planting of the new tree.

Oak Wilt Treatment

Oak wilt is a devastating disease pathogen that affects oak trees in the red oak family (Shumard red oak and live oak). Oak wilt is extremely difficult to manage and eradicate. Thus, management options are limited. Pruning of live oaks and red oaks SHOULD NOT be performed from February to June. Pruning tools should be sterilized in between trees when pruning in an area where oak wilt is known to occur. Pruning cuts and other wounds should be painted on Live oaks and Red oaks only to help limit the spread of the pathogen.

For more information about Oak Wilt please visit texasoakwilt.org.

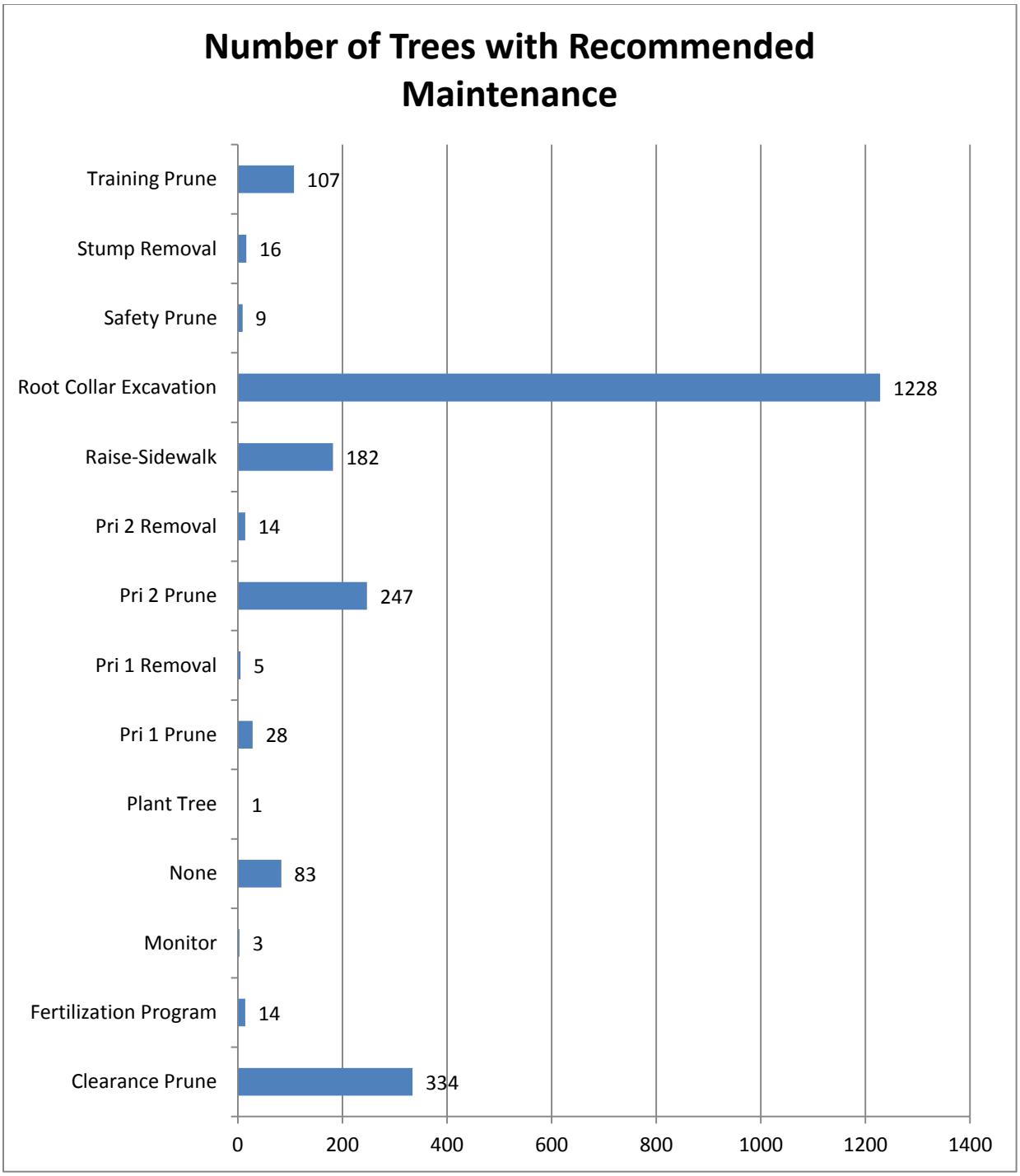
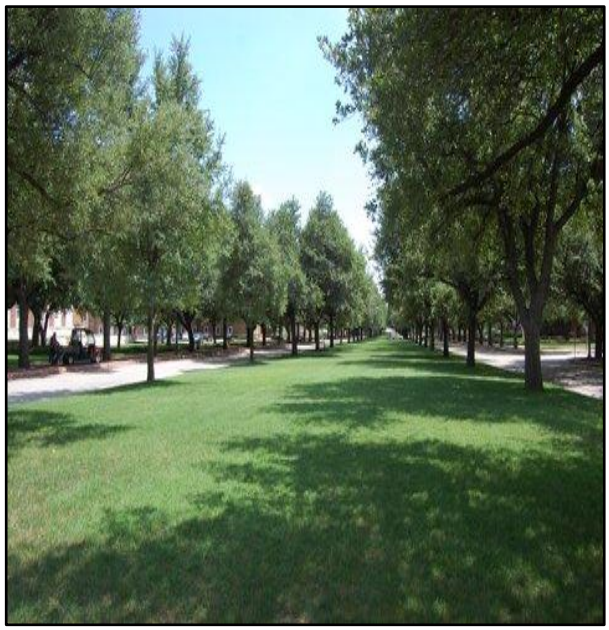


Figure 5: Number of trees by maintenance need. Note there can be multiple recommendations for one tree and are not represented on this figure.

Ecosystem Service Benefits



Carbon Sequestration and Storage

Trees reduce the amount of carbon in the atmosphere by sequestering carbon in new growth every year. The amount of carbon annually sequestered is increased with the size and health of the trees (Brack 2002). The gross sequestration of trees on the SMU campus is 793,251 pounds of carbon per year.

As trees grow they store carbon as wood fibers. Carbon storage is a one-time value which represents how much carbon is being stored collectively at the time of the inventory. Trees on the SMU campus are currently storing approximately 12,278,716 pounds (6,139 tons) of carbon.

Energy Savings

Trees lower energy consumption by shading buildings, providing evaporative cooling and blocking winter winds. Deciduous trees that are planted on the east and west facing sides of buildings tend to reduce building energy consumption in the summer months.

Based on 2013 energy costs, trees on the SMU campus reduce energy-related costs by an estimated $24,417, annually.

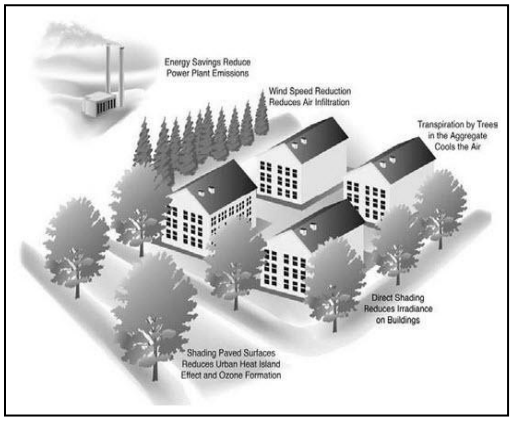


Figure 6: Secondary benefits from energy conservation are reduced water consumption and reduced pollutant emissions by power plants (drawing by Mike Thomas).

C.L. Brack, "Pollution mitigation and carbon sequestration by an urban forest," *Environmental Pollution*, 116(1),2002, pp.195-200

Annual Rainfall Interception

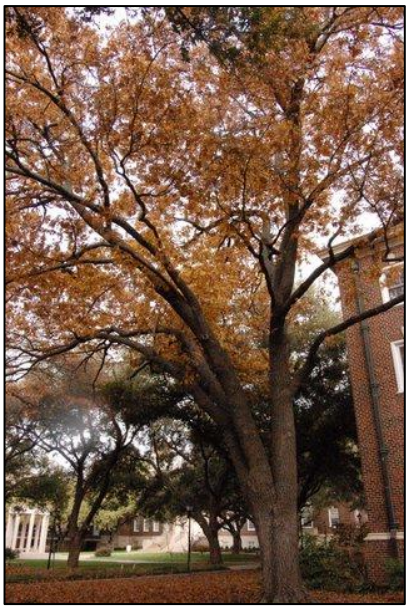
Trees can aide in reducing storm water runoff during rain events by intercepting and storing rainfall on leaves and branches and allowing water to infiltrate more slowly into the surrounding soil. Reducing runoff volume during a rain event helps to minimize soil erosion. More specifically, healthy urban trees play an important role in storm water management in three ways:

1. Reducing the overall volume of water entering the storm system by leaf and branch interception.
2. Increasing soil health and structure, thus aiding water infiltration into the soil and further reducing peak flow levels.
3. Reducing rainfall velocity and soil impact helps reduce soil erosion, soil compaction, and surface transport rates of water (stormwater runoff).

It is estimated that SMU campus trees mitigate 8,128,537 gallons of storm water each year, resulting in an annual savings of $80,472. That is, on average, nearly $35 for each tree. This value is based on monthly storm water management fees that are assessed for moving, storing, and cleaning storm water.

Aesthetics

Trees provide a host of aesthetic, social, economic, and health benefits. When asked, one of the most common reasons people plant trees is for aesthetics. Trees add color, texture, and a dimension to the landscape that help soften the hardness of a man-made environment. Research on the aesthetics quality of trees has shown that trees are the single strongest positive influence on scenic quality (Schroeder and Cannon 1983).



Structural and Functional Value

Urban trees have a structural/replacement value in addition to their functional/environmental value. The structural value is based on the cost of replacing a tree with one of a similar size and species, or the equivalent in the number of inches mitigated for tree loss.

*The value of a tree, whether structural or functional, is not static. Typically, the value of the benefits increases over time as trees mature in size and remain healthy.

Schroeder, H.W.; Cannon, W.N. 1983. The esthetic contribution of trees to residential streets in Ohio towns. J. Arboric. 9:237–243.

However, the value of the tree population can decrease over time, especially if there is decline in tree health. Ensuring proper tree management is essential to maximizing the value of trees and the urban forest.

The following values represent the one-time structural values of the SMU campus tree population and the annual functional benefits which are provided while the tree is actively growing:

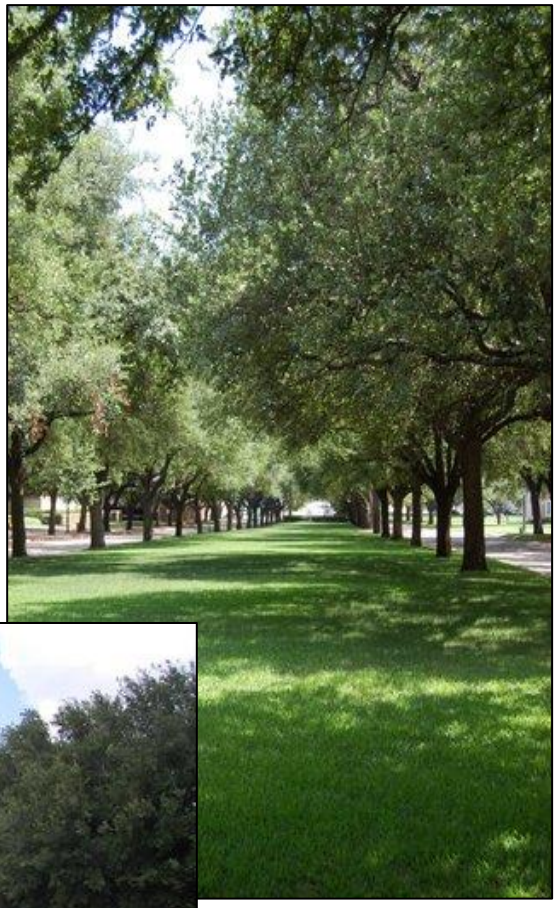
Structural values

- Replacement value: $10.2 million
- Carbon Storage: $92,000

Annual functional values

- Carbon Sequestration: $6,238
- Energy Savings: $24,417
- Stormwater Mitigation: $80,472
- Aesthetic Value: $109,291

*D. Nowak, R. Rowntree, E.G. McPherson, S. Sisinni, E. Kerkmann, J. Stevens, "Measuring and analyzing urban tree cover", *Landscape and Urban Planning*, 36(1), 1996, pp. 49-57



*Nowak, D., M. Noble, S. Sisinni, J. Dwyer. "People and Trees: Assessing the US Urban Forest Resource." *Journal of Forestry*. 99(1). 2001. pp. 37-

Summary Observations

Southern Methodist University's urban forest provides many benefits to students and faculty and creates a sense of community while fostering an environment of learning. An increase in the understanding of these benefits and their associated economic values can facilitate more precise and better planning and management of the landscape services.

With a canopy cover of 25% SMU's urban forest is in fair condition*, and since a majority of the trees are in the six to eight inch diameter range, canopy cover should grow significantly, as long as proper urban tree management practices are in place. As trees are planted, SMU leaders must be cautious of which trees they choose to plant. With over 50% of the canopy comprised of three species; and with two of them in the same family, diversifying species selection in future planting initiatives is highly recommended in order to enhance the quality and resiliency of the campus tree population. .

The following are observations and recommendations observed during the inventory process:

- Construction on campus will continue to lead to conflicts between existing trees and new development. All precautions should be taken to ensure proper tree protection is established and maintained during the construction process.

- Careful monitoring of newly planted trees and trees impacted by construction is highly recommended. Fertilization and other arboriculture practice may be required to treat stressed trees. Also, careful inspection and, where appropriate, rejection of poor quality nursery stock upon delivery is essential.

- Turf management practices around trees will continue to cause issues with tree health. Reducing turf within the drip line of trees and maintaining a rigorous mulching program will help in reducing these conflicts.

- Lightning protection is recommended for high priority trees.

- Exposed root flares often get buried in high maintenance landscapes and care should be taken to ensure root flares remain exposed (and that trees stay at a proper depth.) I don't understand.

- Tree species diversity is low; more tree plantings with a variety of species need to occur.

- Plant more trees on the Northern part of campus where the trees are older and there are few younger trees to take the place of those trees as they die.

- Green Infrastructure Best Management Practices need to be put in place for storm water management when planning for all future construction on campus!

Appendices

Appendix A: i-Tree and Appraised Value

i-Tree is a state of the art, peer reviewed tree evaluation tool which was created through the U.S. Forest Service and Davey Resource Group. i-Tree Streets was used to determine the value of the trees ecosystem service benefits it provides on both an annual basis and the overall economic value for the one-time replacement cost. This software program does has its limitations and, for SMU's purposes, will underestimate the total value (this is due to the fact street trees grow in a different orientation than open grown trees; which is more the situation for SMU).

Peer reviewed, journal manuscripts were the foundation for this software program. It has been an industry wide known to be true program with merits from both the private and public institutions and professional organizations. Stormwater data was collected using local stormwater infrastructure from 20 municipalities to determine peak flow rates during rain events with communities with and without a significant tree canopy cover. Energy abatement values are from utility providers in the 20 main reference cities and were determined from power usage between treed and non-treed neighborhoods.

Other such non-tangible evidence of tree benefits were given from anecdotal studies of tree lined areas (hospitals, streets for crime prevention, schools, etc.) versus non-tree lined areas. Carbon storage and sequestration are approximate values determined by studies involving the amount of carbon which is interned within the cell walls of the plant material (mainly xylem).

Appendix B: Glossary of Key Terms

Arbor Pro USA: A software based tree inventory solution to creating tree records and associated maintenance and cost with each tree inventoried. Information was captured using a tablet PC with aerial imagery overlaid onto ArcMap. Arbor Pro software has the ability to record, search and create maintenance scheduling/reporting and cost reporting for maintenance. It is a robust system which has flexibility to be used for campus tree inventories, street tree inventories and rural forest stand inventories.

Diameter at Breast Height (DBH): a standard method of expressing the diameter of the trunk or bole of a standing tree.

Ecosystem Services: benefits people obtain from ecosystems. Healthy forest ecosystems are ecological life-support systems. Forests provide a full suite of goods and services that are vital to human health and livelihood.

Geo-Referencing: to define its existence in physical space. That is, establishing its location in terms of map projections or coordinate systems.

Girdling Roots: when a tree is planted incorrectly, or when rooting space is limited, there is the potential for some of the roots to start growing around the trunk of the tree instead of fanning outward. As the tree grows, the roots gradually get tighter and tighter around the trunk of the tree, preventing the flow of water and nutrients absorbed by the roots to move up into the woody and leafy parts of the tree. This girdles (chokes) the tree, causing it to die.

Green Infrastructure: an approach that communities can choose to maintain healthy waters, provide multiple environmental benefits and support sustainable communities. Unlike single-purpose gray storm water infrastructure, which uses pipes to dispose of rainwater, green infrastructure uses vegetation and soil to manage rainwater where it falls. By weaving natural processes into the built environment, green infrastructure provides not only storm water management, but also flood mitigation, air quality management, and much more.

iTree: i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. The i-Tree Tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of community trees and the environmental services that trees provide.

Root Collar: A tree's root collar is the area where the roots join the main stem or trunk. This area is typified by a flare leading to the major roots. The root collar is part of the tree's trunk. Unlike roots, the trunk is not specialized to resist constant soil moisture.

Transplant Shock: a term that refers to a number of stresses occurring in recently transplanted trees and shrubs. It involves failure of the plant to root well; consequently the plant becomes poorly established in the landscape. New transplants do not have extensive root systems, and they are frequently stressed by lack of sufficient water. Plants suffering from water stress may be more susceptible to injury from other causes such as the weather, insects, or disease. When several stresses are being experienced, the plant may no longer be able to function properly.

Tree: a perennial plant with an elongated stem, or trunk, supporting leaves or branches.

Urban Forest: a forest or a collection of trees that grow within a city, town or a suburb.

Appendix C: Data Collection Designation and Specifications for Tree Attributes

The following terms are defined as they are used in this report, as each term can be misinterpreted by different professionals.

Wound, Scar and Decay

A wound is an active situation where an object, person or pest has damaged the cambium layer of the tree part. However, the wound has not properly sealed completely and thus still active.

A scar is when a wound has occurred on the tree part and the tree has completely sealed the wound with callous wood.

Decay is where a wound has happened and the phloem, cambium and xylem are in state of being broken down where wood strength is compromised and the tree could prove to be at a higher risk than a tree without strength compromise.

Root Collar Excavation

Root Collar Excavations (RCX) is a technique where the root collar is buried to some extent. The varying degrees of how much the root collar is buried is not pertinent. If a RCX has been recommended, the root collar of the tree has been buried, at the time of inspection, or decay or some other defect may be present and examining the root plate, the transition are between roots and trunk at the soil line, may be necessary to determine the risk the tree poses to life and property.

Training Prune

By training a young tree to grow with a central main lead stem, the long term after care of the tree can be greatly reduced and cause less defects to become obvious as the tree matures. In this recommendation, trees which has co-dominant stems, both in size and/or height, should be pruned to allow for central dominance. This should be repeated every 3 to 5 years until the tree has been pruned at least 5 cycles.

Priority Pruning/Removal

Priority 1 and Priority 2 Pruning and Removal detail when the tree should be pruned or removed. Priority 1 means the maintenance should be performed within the next 12 months. Priority 2 means the maintenance should be carried out within the 18 to 24 months.

Raise/Clearance

Raise and Clearance can be used interchangeably to describe the maintenance needed for trees which are over sidewalks and roadways. For SMU, we decided to create two separate nomenclatures so that clear communication could commence. Raise will mean to raise the tree limb which is over a sidewalk. Clearance will refer to clear the tree limbs which are over a roadway.

Appendix D: Population Summary of All Trees Inventoried on SMU Campus

	DBH Class (in)										
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total	SE
Broadleaf Deciduous Large (BDL)											
Shumard oak	0	57	106	50	12	30	24	7	4	290	(±0)
Cedar elm	0	0	13	91	48	1	0	0	0	153	(±0)
Pecan	0	0	0	14	21	9	1	1	1	47	(±0)
Baldcypress	0	1	3	22	0	0	0	0	0	26	(±0)
Hackberry	0	0	0	6	3	0	1	0	0	10	(±0)
Bur oak	0	0	5	2	1	0	0	0	0	8	(±0)
Sweetgum	0	0	3	5	0	0	0	0	0	8	(±0)
Red mulberry	0	1	0	0	4	1	0	0	0	6	(±0)
Texas red oak	0	0	1	1	0	1	0	1	0	4	(±0)
Southern sugar maple	0	0	2	0	0	0	0	0	0	2	(±0)
Mexican white oak	0	2	0	0	0	0	0	0	0	2	(±0)
Texas ash	0	0	2	0	0	0	0	0	0	2	(±0)
Tree of heaven	0	0	0	1	0	0	0	0	0	1	(±0)
American elm	0	0	0	0	0	1	0	0	0	1	(±0)
Green ash	0	0	0	0	1	0	0	0	0	1	(±0)
Total	**0**	**61**	**135**	**192**	**90**	**43**	**26**	**9**	**5**	**561**	**(±0)**
Broadleaf Deciduous Medium (BDM)											
Chinkapin oak	0	33	7	1	0	1	1	0	0	43	(±0)
Chinese elm	0	27	1	0	0	0	0	0	0	28	(±0)
Chinese pistache	0	9	6	3	4	1	0	0	0	23	(±0)
Osage orange	0	0	0	0	0	3	0	0	0	3	(±0)
Japanese Privet	0	0	2	1	0	0	0	0	0	3	(±0)
Lacey oak	0	0	2	0	0	0	0	0	0	2	(±0)
October Glory Red Maple	0	0	1	0	0	0	0	0	0	1	(±0)
Total	**0**	**69**	**19**	**5**	**4**	**5**	**1**	**0**	**0**	**103**	**(±0)**
Broadleaf Deciduous Small (BDS)											
Crapemyrtle	28	169	285	47	7	0	0	0	0	536	(±0)
Eastern redbud	21	37	2	0	0	0	0	0	0	60	(±0)
Japanese maple	28	11	2	0	0	0	0	0	0	41	(±0)
Holly leaf osmanthus	0	28	3	0	0	0	0	0	0	31	(±0)
Saucer magnolia	4	19	3	0	0	0	0	0	0	26	(±0)
Rose-of-sharon	1	23	0	0	0	0	0	0	0	24	(±0)
Chaste tree	7	8	2	0	0	0	0	0	0	17	(±0)
Bradford pear	0	0	1	10	3	0	0	0	0	14	(±0)

Flowering dogwood	6	3	0	0	0	0	0	0	0	9	(±0)
Rough-leaf dogwood	6	2	0	0	0	0	0	0	0	8	(±0)
Desert willow	0	5	2	0	0	0	0	0	0	7	(±0)
Purple blow maple	0	0	1	0	0	0	0	0	0	1	(±0)
Total	**101**	**305**	**301**	**57**	**10**	**0**	**0**	**0**	**0**	**774**	**(±0)**
Broadleaf Evergreen Large (BEL)											
Live oak	0	9	110	101	210	214	84	15	3	746	(±0)
Total	**0**	**9**	**110**	**101**	**210**	**214**	**84**	**15**	**3**	**746**	**(±0)**
Broadleaf Evergreen Medium (BEM)											
Little gem magnolia	4	50	1	0	0	0	0	0	0	55	(±0)
Southern magnolia	1	2	1	2	5	3	1	0	0	15	(±0)
Total	**5**	**52**	**2**	**2**	**5**	**3**	**1**	**0**	**0**	**70**	**(±0)**
Conifer Evergreen Medium (CEM)											
Eastern red cedar	0	0	0	1	0	0	0	0	0	1	(±0)
Total	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**(±0)**
Grand Total	**106**	**496**	**567**	**358**	**319**	**265**	**112**	**24**	**8**	**2255**	**(±0)**

Species distribution of all trees tallied during the inventory process based on the percentage represented throughout the campus.

Southern Methodist University
Species Distribution of All Trees

Species	Percent
Quercus virginiana	33.08
Lagerstroemia sp	23.77
Quercus shumardii	12.86
Ulmus crassifolia	6.78
Cercis canadensis	2.66
Magnolia grandiflora 'Little Gem'	2.44
Carya illinoiensis	2.08
Quercus muehlenbergii	1.91
Acer palmatum	1.82
Osmanthus heterophyla	1.37
Other Species	11.22

Appendix E: Relative Age Distribution for Top 10 Species on SMU Campus

	DBH class (in)								
Species	0 - 3	3 - 6	6 - 12	12 - 18	18 - 24	24 - 30	30 - 36	36 - 42	> 42
Live oak	0.00	1.21	14.75	13.54	28.15	28.69	11.26	2.01	0.40
Crapemyrtle	5.22	31.53	53.17	8.77	1.31	0.00	0.00	0.00	0.00
Shumard oak	0.00	19.66	36.55	17.24	4.14	10.34	8.28	2.41	1.38
Cedar elm	0.00	0.00	8.50	59.48	31.37	0.65	0.00	0.00	0.00
Eastern redbud	35.00	61.67	3.33	0.00	0.00	0.00	0.00	0.00	0.00
Little gem magnolia	7.27	90.91	1.82	0.00	0.00	0.00	0.00	0.00	0.00
Pecan	0.00	0.00	0.00	29.79	44.68	19.15	2.13	2.13	2.13
Chinkapin oak	0.00	76.74	16.28	2.33	0.00	2.33	2.33	0.00	0.00
Japanese maple	68.29	26.83	4.88	0.00	0.00	0.00	0.00	0.00	0.00
Holly leaf osmanthus	0.00	90.32	9.68	0.00	0.00	0.00	0.00	0.00	0.00
Citywide Total	4.70	22.00	25.14	15.88	14.15	11.75	4.97	1.06	0.35

Appendix F: Average Annual Benefits of All Trees on SMU Campus by Species

Average Annual Benefits of All Tree by Species ($/tree)

Species	Energy	CO2	Air Quality	Stormwater	Aesthetic/Other	Total	Standard Error
Live oak	19.08	4.93	- 9.85	71.00	88.54	173.70	(N/A)
Crapemyrtle	3.50	0.40	1.29	4.38	7.35	16.92	(N/A)
Shumard oak	11.19	2.73	- 7.62	39.37	54.57	100.24	(N/A)
Cedar elm	12.63	3.34	- 5.37	36.28	67.98	114.86	(N/A)
Eastern redbud	1.74	0.30	0.68	2.11	4.01	8.83	(N/A)
Little gem magnolia	1.74	0.11	0.93	2.43	7.18	12.38	(N/A)
Pecan	17.83	4.41	- 11.97	62.52	81.89	154.68	(N/A)
Chinkapin oak	5.12	1.21	1.93	9.70	23.16	41.11	(N/A)
Japanese maple	1.44	0.19	0.56	1.67	3.39	7.25	(N/A)
Holly leaf osmanthus	2.24	0.46	0.89	2.83	4.90	11.32	(N/A)
Chinese elm	3.56	0.65	1.30	4.93	17.26	27.71	(N/A)
Saucer magnolia	2.13	0.42	0.84	2.67	4.65	10.71	(N/A)
Baldcypress	10.18	2.73	- 3.10	25.80	59.00	94.61	(N/A)
Rose-of-sharon	1.97	0.38	0.78	2.44	4.51	10.09	(N/A)
Chinese pistache	8.83	3.56	3.42	20.48	37.37	73.66	(N/A)
Chaste tree	1.87	0.33	0.73	2.30	4.15	9.38	(N/A)
Southern magnolia	12.93	1.65	3.27	42.79	24.30	84.95	(N/A)
Bradford pear	11.35	2.50	5.07	22.38	31.34	72.63	(N/A)
Hackberry	14.86	3.80	- 8.15	47.42	74.05	131.97	(N/A)
Flowering dogwood	1.34	0.16	0.52	1.53	3.28	6.82	(N/A)
Rough-leaf dogwood	1.25	0.13	0.48	1.41	3.11	6.39	(N/A)
Sweetgum	7.66	1.34	- 4.18	18.24	48.69	71.75	(N/A)
Bur oak	8.05	2.22	- 2.48	20.70	50.33	78.82	(N/A)
Desert willow	2.68	0.59	1.06	3.48	5.48	13.29	(N/A)
Red mulberry	15.60	4.00	- 9.53	52.86	74.61	137.54	(N/A)
Texas red oak	19.14	4.31	- 17.10	77.30	77.46	161.11	(N/A)
Osage orange	20.52	13.45	8.29	71.89	89.44	203.58	(N/A)
Japanese Privet	9.43	3.03	3.62	18.26	37.41	71.75	(N/A)
Lacey oak	7.68	1.95	2.91	13.14	30.23	55.92	(N/A)
Texas ash	4.96	1.47	- 0.57	10.33	38.35	54.53	(N/A)
Mexican white oak	1.72	0.42	0.30	2.39	15.08	19.92	(N/A)
Southern sugar maple	8.08	1.68	2.43	12.60	44.50	69.29	(N/A)
Tree of heaven	11.28	3.01	- 3.60	28.98	63.82	103.48	(N/A)
Purple blow maple	4.34	1.06	1.73	5.91	7.70	20.74	(N/A)
American elm	23.74	5.84	- 18.53	90.74	99.59	201.38	(N/A)

October Glory Red Maple	5.90	1.15	1.78	11.69	39.54	60.06	(N/A)
Green ash	17.03	4.43	- 9.74	56.01	83.25	150.98	(N/A)
Eastern red cedar	6.95	1.29	4.06	14.18	9.03	35.52	(N/A)
Citywide Total	10.83	2.64	- 4.45	35.69	48.47	93.17	(N/A)

Appendix G: Net Annual Benefits of All Inventoried Trees on SMU Campus

Southern Methodist University
Total Annual Benefits and Gross Benefits For All Trees

Benefits	Total ($)	Total SE	$/tree	Tree SE
Energy	24,418	(N/A)	10.83	(N/A)
CO2	5,949	(N/A)	2.64	(N/A)
Air Quality	- 10,040	(N/A)	- 4.45	(N/A)
Stormwater	80,473	(N/A)	35.69	(N/A)
Aesthetic/Other	109,291	(N/A)	48.47	(N/A)
Total Benefits	210,092	(N/A)	93.17	(N/A)

Appendix H: Replacement Value/Structural Value of All Inventoried Trees on SMU Campus

Replacement Value of All Trees by Species

	DBH Class (in)										
Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total	% of Total
Live oak	0.00	2,069.43	145,743.36	356,426.91	1,389,617.87	2,381,815.61	1,395,467.17	314,264.07	72,251.54	6,057,655.97	59.67
Shumard oak	0.00	20,115.28	147,056.79	182,793.73	75,191.07	339,409.04	382,163.89	142,282.82	60,172.52	1,349,185.13	13.29
Cedar elm	0.00	0.00	19,873.83	394,269.08	395,274.26	14,330.45	0.00	0.00	0.00	823,747.63	8.11
Crapemyrtle	2,532.02	74,333.91	458,731.58	209,385.84	60,811.42	0.00	0.00	0.00	0.00	805,794.77	7.94
Pecan	0.00	0.00	0.00	59,107.11	152,999.68	114,866.21	18,584.77	24,596.24	27,492.60	397,646.61	3.92
Southern magnolia	90.43	886.25	1,633.47	7,053.78	39,817.00	42,991.35	20,880.04	0.00	0.00	113,352.32	1.12
Baldcypress	0.00	443.12	3,539.18	88,729.11	0.00	0.00	0.00	0.00	0.00	92,711.40	0.91
Chinese pistache	0.00	3,418.73	8,244.92	11,954.25	30,987.28	12,762.91	0.00	0.00	0.00	67,368.09	0.66
Hackberry	0.00	0.00	0.00	15,576.89	19,008.08	0.00	15,141.86	0.00	0.00	49,726.84	0.49
Texas red oak	0.00	0.00	1,633.47	4,455.02	0.00	14,330.45	0.00	27,642.95	0.00	48,061.88	0.47
Bradford pear	0.00	0.00	1,241.56	30,060.67	16,368.07	0.00	0.00	0.00	0.00	47,670.30	0.47
Chinkapin oak	0.00	11,427.28	8,626.90	3,044.21	0.00	9,627.83	13,994.23	0.00	0.00	46,720.45	0.46
Red mulberry	0.00	443.12	0.00	0.00	31,129.66	8,359.43	0.00	0.00	0.00	39,932.21	0.39
Bur oak	0.00	0.00	8,614.10	7,969.50	7,746.82	0.00	0.00	0.00	0.00	24,330.42	0.24
Little gem magnolia	361.72	21,786.89	1,633.47	0.00	0.00	0.00	0.00	0.00	0.00	23,782.07	0.23
Eastern redbud	2,403.27	14,098.66	2,702.58	0.00	0.00	0.00	0.00	0.00	0.00	19,204.51	0.19
Sweetgum	0.00	0.00	3,348.44	14,515.66	0.00	0.00	0.00	0.00	0.00	17,864.10	0.18
Holly leaf osmanthus	0.00	11,853.54	2,858.56	0.00	0.00	0.00	0.00	0.00	0.00	14,712.11	0.14
Chinese elm	0.00	11,584.28	1,586.44	0.00	0.00	0.00	0.00	0.00	0.00	13,170.72	0.13
Osage orange	0.00	0.00	0.00	0.00	0.00	12,369.47	0.00	0.00	0.00	12,369.47	0.12
Rose-of-sharon	90.43	11,853.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11,943.97	0.12
Saucer magnolia	479.20	7,488.24	3,959.82	0.00	0.00	0.00	0.00	0.00	0.00	11,927.26	0.12
Japanese maple	2,458.73	4,689.72	2,586.32	0.00	0.00	0.00	0.00	0.00	0.00	9,734.77	0.10
Chaste tree	633.00	3,544.99	3,266.93	0.00	0.00	0.00	0.00	0.00	0.00	7,444.92	0.07

Green ash	0.00	0.00	0.00	0.00	6,806.29	0.00	0.00	0.00	0.00	6,806.29	0.07
Japanese Privet	0.00	0.00	2,796.64	3,749.61	0.00	0.00	0.00	0.00	0.00	6,546.26	0.06
American elm	0.00	0.00	0.00	0.00	0.00	5,708.99	0.00	0.00	0.00	5,708.99	0.06
Desert willow	0.00	1,661.71	3,266.93	0.00	0.00	0.00	0.00	0.00	0.00	4,928.64	0.05
Southern sugar maple	0.00	0.00	3,517.75	0.00	0.00	0.00	0.00	0.00	0.00	3,517.75	0.03
Eastern red cedar	0.00	0.00	0.00	3,514.48	0.00	0.00	0.00	0.00	0.00	3,514.48	0.03
Texas ash	0.00	0.00	3,266.93	0.00	0.00	0.00	0.00	0.00	0.00	3,266.93	0.03
Lacey oak	0.00	0.00	2,796.64	0.00	0.00	0.00	0.00	0.00	0.00	2,796.64	0.03
October Glory Red Maple	0.00	0.00	2,247.45	0.00	0.00	0.00	0.00	0.00	0.00	2,247.45	0.02
Flowering dogwood	493.72	1,329.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,823.09	0.02
Purple blow maple	0.00	0.00	1,633.47	0.00	0.00	0.00	0.00	0.00	0.00	1,633.47	0.02
Rough-leaf dogwood	493.72	886.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,379.96	0.01
Tree of heaven	0.00	0.00	0.00	952.82	0.00	0.00	0.00	0.00	0.00	952.82	0.01
Mexican white oak	0.00	886.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	886.25	0.01
Citywide Total	10,036.22	204,800.57	846,407.53	1,393,558.67	2,225,757.51	2,956,571.75	1,846,231.97	508,786.08	159,916.66	10,152,066.96	100.00

Appendix I: Carbon Dioxide Net Annual Sequestration and Storage Benefits for All Inventoried Trees on SMU Campus

Annual CO2 Benefits of All Trees by Species

Species	Sequestered (lb)	Sequestered ($)	Decomposition Release(lb)	Maintenance Release (lb)	Total Release ($)	Net Total (lb)	Total ($)	% of Total $	Avg. $/tree
Live oak	519,861.54	3,898.96	- 28,413.31	- 1,199.08	- 8.99	490,249.15	3,676.87	61.80	4.93
Crapemyrtle	29,814.57	223.61	- 588.07	- 311.82	- 2.34	28,914.68	216.86	3.65	0.40
Shumard oak	112,445.17	843.34	- 6,619.89	- 315.37	- 2.37	105,509.91	791.32	13.30	2.73
Cedar elm	70,896.03	531.72	- 2,572.00	- 186.01	- 1.40	68,138.02	511.04	8.59	3.34
Eastern redbud	2,416.71	18.13	- 37.41	- 15.96	- 0.12	2,363.33	17.72	0.30	0.30
Little gem magnolia	857.83	6.43	- 14.34	- 17.74	- 0.13	825.76	6.19	0.10	0.11
Pecan	29,345.52	220.09	- 1,632.32	- 74.71	- 0.56	27,638.49	207.29	3.48	4.41
Chinkapin oak	7,135.04	53.51	- 194.44	- 20.73	- 0.16	6,919.88	51.90	0.87	1.21
Japanese maple	1,058.86	7.94	- 19.44	- 8.09	- 0.06	1,031.33	7.73	0.13	0.19
Holly leaf osmanthus	1,950.05	14.63	- 33.63	- 11.31	- 0.08	1,905.11	14.29	0.24	0.46
Chinese elm	2,500.38	18.75	- 50.96	- 9.64	- 0.07	2,439.77	18.30	0.31	0.65
Saucer magnolia	1,489.70	11.17	- 27.55	- 8.76	- 0.07	1,453.40	10.90	0.18	0.42
Baldcypress	9,772.54	73.29	- 282.34	- 26.72	- 0.20	9,463.48	70.98	1.19	2.73
Rose-of-sharon	1,245.32	9.34	- 16.54	- 7.76	- 0.06	1,221.02	9.16	0.15	0.38
Chinese pistache	11,183.14	83.87	- 233.57	- 18.51	- 0.14	10,931.06	81.98	1.38	3.56
Chaste tree	768.31	5.76	- 15.41	- 4.77	- 0.04	748.13	5.61	0.09	0.33
Southern magnolia	3,537.17	26.53	- 223.16	- 19.84	- 0.15	3,294.16	24.71	0.42	1.65
Bradford pear	4,850.51	36.38	- 176.60	- 16.41	- 0.12	4,657.51	34.93	0.59	2.50
Hackberry	5,325.72	39.94	- 244.03	- 13.75	- 0.10	5,067.95	38.01	0.64	3.80
Flowering dogwood	198.47	1.49	- 2.68	- 1.66	- 0.01	194.12	1.46	0.02	0.16
Rough-leaf dogwood	144.59	1.08	- 1.97	- 1.33	- 0.01	141.29	1.06	0.02	0.13
Sweetgum	1,473.22	11.05	- 36.25	- 7.54	- 0.06	1,429.44	10.72	0.18	1.34

Bur oak	2,446.44	18.35	- 70.39	- 7.09	- 0.05	2,368.95	17.77	0.30	2.22
Desert willow	563.70	4.23	- 12.64	- 2.99	- 0.02	548.07	4.11	0.07	0.59
Red mulberry	3,370.88	25.28	- 165.59	- 8.54	- 0.06	3,196.75	23.98	0.40	4.00
Texas red oak	2,502.56	18.77	- 197.06	- 6.65	- 0.05	2,298.85	17.24	0.29	4.31
Osage orange	5,531.39	41.49	- 146.88	- 5.99	- 0.04	5,378.52	40.34	0.68	13.45
Japanese Privet	1,235.60	9.27	- 19.97	- 2.44	- 0.02	1,213.19	9.10	0.15	3.03
Lacey oak	529.22	3.97	- 7.55	- 1.33	- 0.01	520.34	3.90	0.07	1.95
Texas ash	399.07	2.99	- 7.03	- 1.33	- 0.01	390.71	2.93	0.05	1.47
Mexican white oak	115.23	0.86	- 1.28	- 0.67	0.00	113.28	0.85	0.01	0.42
Southern sugar maple	456.31	3.42	- 7.55	- 1.33	- 0.01	447.43	3.36	0.06	1.68
Tree of heaven	414.38	3.11	- 12.33	- 1.11	- 0.01	400.94	3.01	0.05	3.01
Purple blow maple	147.16	1.10	- 4.53	- 0.67	0.00	141.96	1.06	0.02	1.06
American elm	833.23	6.25	- 52.25	- 2.00	- 0.01	778.98	5.84	0.10	5.84
October Glory Red Maple	157.73	1.18	- 3.77	- 0.67	0.00	153.29	1.15	0.02	1.15
Green ash	620.01	4.65	- 28.18	- 1.55	- 0.01	590.28	4.43	0.07	4.43
Eastern red cedar	180.00	1.35	- 6.39	- 1.11	- 0.01	172.50	1.29	0.02	1.29
Citywide Total	837,773.29	6,283.30	- 42,179.30	- 2,342.95	- 17.57	793,251.05	5,949.38	100.00	2.64

Stored CO2 Benefits of All Trees by Species

Species	Total stored CO2 (lbs)	Total ($)	Standard Error	% of Total Tree Numbers	% of Total $	Avg. $/tree
Live oak	8,284,977.11	62,137.33	(N/A)	33.08	67.47	83.29
Crapemyrtle	171,389.12	1,285.42	(N/A)	23.77	1.40	2.40
Shumard oak	1,930,800.30	14,481.00	(N/A)	12.86	15.72	49.93
Cedar elm	750,167.64	5,626.26	(N/A)	6.78	6.11	36.77
Eastern redbud	10,598.83	79.49	(N/A)	2.66	0.09	1.32
Little gem magnolia	4,166.82	31.25	(N/A)	2.44	0.03	0.57
Pecan	476,092.25	3,570.69	(N/A)	2.08	3.88	75.97
Chinkapin oak	47,098.51	353.24	(N/A)	1.91	0.38	8.21
Japanese maple	5,252.13	39.39	(N/A)	1.82	0.04	0.96

Holly leaf osmanthus	9,807.92	73.56	(N/A)	1.37	0.08	2.37
Chinese elm	6,999.25	52.49	(N/A)	1.24	0.06	1.87
Saucer magnolia	7,974.78	59.81	(N/A)	1.15	0.06	2.30
Baldcypress	82,350.59	617.63	(N/A)	1.15	0.67	23.75
Rose-of-sharon	4,810.22	36.08	(N/A)	1.06	0.04	1.50
Chinese pistache	65,503.98	491.28	(N/A)	1.02	0.53	21.36
Chaste tree	4,391.27	32.93	(N/A)	0.75	0.04	1.94
Southern magnolia	65,085.46	488.14	(N/A)	0.67	0.53	32.54
Bradford pear	51,507.62	386.31	(N/A)	0.62	0.42	27.59
Hackberry	71,175.67	533.82	(N/A)	0.44	0.58	53.38
Flowering dogwood	693.07	5.20	(N/A)	0.40	0.01	0.58
Rough-leaf dogwood	484.42	3.63	(N/A)	0.35	0.00	0.45
Sweetgum	10,571.83	79.29	(N/A)	0.35	0.09	9.91
Bur oak	20,531.20	153.98	(N/A)	0.35	0.17	19.25
Desert willow	3,687.01	27.65	(N/A)	0.31	0.03	3.95
Red mulberry	48,297.45	362.23	(N/A)	0.27	0.39	60.37
Texas red oak	57,474.52	431.06	(N/A)	0.18	0.47	107.76
Osage orange	42,840.44	321.30	(N/A)	0.13	0.35	107.10
Japanese Privet	5,825.50	43.69	(N/A)	0.13	0.05	14.56
Lacey oak	2,201.34	16.51	(N/A)	0.09	0.02	8.26
Texas ash	2,049.29	15.37	(N/A)	0.09	0.02	7.68
Mexican white oak	373.17	2.80	(N/A)	0.09	0.00	1.40
Southern sugar maple	2,201.34	16.51	(N/A)	0.09	0.02	8.26
Tree of heaven	3,595.00	26.96	(N/A)	0.04	0.03	26.96
Purple blow maple	1,321.87	9.91	(N/A)	0.04	0.01	9.91
American elm	15,238.94	114.29	(N/A)	0.04	0.12	114.29
October Glory Red Maple	1,100.67	8.26	(N/A)	0.04	0.01	8.26
Green ash	8,217.98	61.63	(N/A)	0.04	0.07	61.63
Eastern red cedar	1,862.44	13.97	(N/A)	0.04	0.02	13.97
Citywide total	12,278,716.94	92,090.38	(N/A)	100.00	100.00	40.84

Appendix J: Net Annual Energy Savings for All Inventoried Trees on SMU Campus

Annual Energy Benefits of All Trees by Species

Species	Total Electricity (MWh)	Electricity ($)	Total Natural Gas (Therms)	Natural Gas ($)	Total ($)	% of Total Tree Numbers	% of Total $	Avg. $/tree
Live oak	129.44	9,824.43	4,215.58	4,409.50	14,233.93	33.08	58.29	19.08
Crapemyrtle	14.57	1,105.51	738.21	772.17	1,877.68	23.77	7.69	3.50
Shumard oak	29.00	2,201.15	997.15	1,043.02	3,244.17	12.86	13.29	11.19
Cedar elm	16.71	1,268.55	634.39	663.58	1,932.12	6.78	7.91	12.63
Eastern redbud	0.74	56.54	45.59	47.69	104.23	2.66	0.43	1.74
Little gem magnolia	0.71	53.90	39.77	41.60	95.50	2.44	0.39	1.74
Pecan	7.47	567.31	258.65	270.55	837.86	2.08	3.43	17.83
Chinkapin oak	1.81	137.10	79.35	83.00	220.11	1.91	0.90	5.12
Japanese maple	0.41	31.28	26.39	27.60	58.88	1.82	0.24	1.44
Holly leaf osmanthus	0.51	38.54	29.52	30.87	69.42	1.37	0.28	2.24
Chinese elm	0.78	59.22	38.77	40.56	99.77	1.24	0.41	3.56
Saucer magnolia	0.40	30.59	23.62	24.71	55.30	1.15	0.23	2.13
Baldcypress	2.28	172.91	87.76	91.80	264.71	1.15	1.08	10.18
Rose-of-sharon	0.34	25.97	20.42	21.36	47.32	1.06	0.19	1.97
Chinese pistache	1.75	132.63	67.29	70.39	203.02	1.02	0.83	8.83
Chaste tree	0.23	17.40	13.77	14.40	31.81	0.75	0.13	1.87
Southern magnolia	1.92	145.88	45.99	48.10	193.98	0.67	0.79	12.93
Bradford pear	1.39	105.27	51.21	53.56	158.84	0.62	0.65	11.35
Hackberry	1.31	99.22	47.18	49.35	148.57	0.44	0.61	14.86
Flowering dogwood	0.08	6.34	5.46	5.71	12.05	0.40	0.05	1.34
Rough-leaf dogwood	0.07	5.23	4.60	4.81	10.04	0.35	0.04	1.25
Sweetgum	0.53	40.50	19.88	20.80	61.30	0.35	0.25	7.66
Bur oak	0.54	41.19	22.17	23.18	64.38	0.35	0.26	8.05

Desert willow	0.14	10.57	7.83	8.19	18.75	0.31	0.08	2.68
Red mulberry	0.82	62.35	29.87	31.25	93.60	0.27	0.38	15.60
Texas red oak	0.71	53.92	21.62	22.62	76.54	0.18	0.31	19.14
Osage orange	0.56	42.88	17.85	18.67	61.55	0.13	0.25	20.52
Japanese Privet	0.24	18.27	9.57	10.01	28.28	0.13	0.12	9.43
Lacey oak	0.13	9.66	5.46	5.71	15.36	0.09	0.06	7.68
Texas ash	0.08	6.06	3.68	3.85	9.92	0.09	0.04	4.96
Mexican white oak	0.03	2.06	1.32	1.38	3.44	0.09	0.01	1.72
Southern sugar maple	0.13	9.90	5.98	6.25	16.16	0.09	0.07	8.08
Tree of heaven	0.10	7.40	3.71	3.88	11.28	0.04	0.05	11.28
Purple blow maple	0.03	2.51	1.75	1.83	4.34	0.04	0.02	4.34
American elm	0.22	16.37	7.05	7.38	23.74	0.04	0.10	23.74
October Glory Red Maple	0.05	3.59	2.21	2.32	5.90	0.04	0.02	5.90
Green ash	0.15	11.24	5.54	5.80	17.03	0.04	0.07	17.03
Eastern red cedar	0.07	5.29	1.58	1.65	6.95	0.04	0.03	6.95
Total	216.45	16,428.76	7,637.75	7,989.09	24,417.85	100.00	100.00	10.83

Appendix K: Net Annual Stormwater Mitigation Benefits for All Inventoried Trees on SMU Campus

Annual Stormwater Benefits of All Trees by Species

Species	Total Rainfall Interception (Gal)	Total ($)	Standard Error	% of Total Tree Numbers	% of Total $	Avg. $/tree
Live oak	5,349,811.55	52,963.13	(N/A)	33.08	65.82	71.00
Crapemyrtle	237,358.42	2,349.85	(N/A)	23.77	2.92	4.38
Shumard oak	1,153,408.77	11,418.75	(N/A)	12.86	14.19	39.37
Cedar elm	560,641.02	5,550.35	(N/A)	6.78	6.90	36.28
Eastern redbud	12,758.07	126.30	(N/A)	2.66	0.16	2.11
Little gem magnolia	13,477.87	133.43	(N/A)	2.44	0.17	2.43
Pecan	296,831.37	2,938.63	(N/A)	2.08	3.65	62.52
Chinkapin oak	42,122.98	417.02	(N/A)	1.91	0.52	9.70
Japanese maple	6,920.80	68.52	(N/A)	1.82	0.09	1.67
Holly leaf osmanthus	8,869.62	87.81	(N/A)	1.37	0.11	2.83
Chinese elm	13,951.70	138.12	(N/A)	1.24	0.17	4.93
Saucer magnolia	7,014.95	69.45	(N/A)	1.15	0.09	2.67
Baldcypress	67,765.62	670.88	(N/A)	1.15	0.83	25.80
Rose-of-sharon	5,920.51	58.61	(N/A)	1.06	0.07	2.44
Chinese pistache	47,571.55	470.96	(N/A)	1.02	0.59	20.48
Chaste tree	3,952.67	39.13	(N/A)	0.75	0.05	2.30
Southern magnolia	64,840.18	641.92	(N/A)	0.67	0.80	42.79
Bradford pear	31,650.87	313.34	(N/A)	0.62	0.39	22.38
Hackberry	47,896.55	474.18	(N/A)	0.44	0.59	47.42
Flowering dogwood	1,389.83	13.76	(N/A)	0.40	0.02	1.53
Rough-leaf dogwood	1,137.00	11.26	(N/A)	0.35	0.01	1.41

Sweetgum	14,741.30	145.94	(N/A)	0.35	0.18	18.24
Bur oak	16,730.75	165.63	(N/A)	0.35	0.21	20.70
Desert willow	2,457.62	24.33	(N/A)	0.31	0.03	3.48
Red mulberry	32,036.56	317.16	(N/A)	0.27	0.39	52.86
Texas red oak	31,230.90	309.19	(N/A)	0.18	0.38	77.30
Osage orange	21,783.98	215.66	(N/A)	0.13	0.27	71.89
Japanese Privet	5,532.79	54.77	(N/A)	0.13	0.07	18.26
Lacey oak	2,655.25	26.29	(N/A)	0.09	0.03	13.14
Texas ash	2,087.81	20.67	(N/A)	0.09	0.03	10.33
Mexican white oak	483.33	4.78	(N/A)	0.09	0.01	2.39
Southern sugar maple	2,545.09	25.20	(N/A)	0.09	0.03	12.60
Tree of heaven	2,926.92	28.98	(N/A)	0.04	0.04	28.98
Purple blow maple	596.71	5.91	(N/A)	0.04	0.01	5.91
American elm	9,165.29	90.74	(N/A)	0.04	0.11	90.74
October Glory Red Maple	1,180.69	11.69	(N/A)	0.04	0.01	11.69
Green ash	5,657.40	56.01	(N/A)	0.04	0.07	56.01
Eastern red cedar	1,432.82	14.18	(N/A)	0.04	0.02	14.18
Citywide total	8,128,537.12	80,472.52	(N/A)	100.00	100.00	35.69

Appendix L: Net Annual Aesthetics Values for All Inventoried Trees on SMU Campus

Annual Aesthetic/Other Benefit of All Trees by Species

Species	Total ($)	Standard Error	% of Total Tree Numbers	% of Total $	Avg. $/tree
Live oak	66,053.60	(N/A)	33.08	60.44	88.54
Crapemyrtle	3,937.75	(N/A)	23.77	3.60	7.35
Shumard oak	15,825.19	(N/A)	12.86	14.48	54.57
Cedar elm	10,401.59	(N/A)	6.78	9.52	67.98
Eastern redbud	240.38	(N/A)	2.66	0.22	4.01
Little gem magnolia	394.74	(N/A)	2.44	0.36	7.18
Pecan	3,848.68	(N/A)	2.08	3.52	81.89
Chinkapin oak	995.91	(N/A)	1.91	0.91	23.16
Japanese maple	139.18	(N/A)	1.82	0.13	3.39
Holly leaf osmanthus	151.78	(N/A)	1.37	0.14	4.90
Chinese elm	483.20	(N/A)	1.24	0.44	17.26
Saucer magnolia	120.88	(N/A)	1.15	0.11	4.65
Baldcypress	1,534.12	(N/A)	1.15	1.40	59.00
Rose-of-sharon	108.33	(N/A)	1.06	0.10	4.51
Chinese pistache	859.54	(N/A)	1.02	0.79	37.37
Chaste tree	70.47	(N/A)	0.75	0.06	4.15
Southern magnolia	364.52	(N/A)	0.67	0.33	24.30
Bradford pear	438.78	(N/A)	0.62	0.40	31.34
Hackberry	740.47	(N/A)	0.44	0.68	74.05
Flowering dogwood	29.48	(N/A)	0.40	0.03	3.28
Rough-leaf dogwood	24.88	(N/A)	0.35	0.02	3.11
Sweetgum	389.50	(N/A)	0.35	0.36	48.69

Bur oak	402.62	(N/A)	0.35	0.37	50.33
Desert willow	38.37	(N/A)	0.31	0.04	5.48
Red mulberry	447.68	(N/A)	0.27	0.41	74.61
Texas red oak	309.85	(N/A)	0.18	0.28	77.46
Osage orange	268.33	(N/A)	0.13	0.25	89.44
Japanese Privet	112.23	(N/A)	0.13	0.10	37.41
Lacey oak	60.47	(N/A)	0.09	0.06	30.23
Texas ash	76.69	(N/A)	0.09	0.07	38.35
Mexican white oak	30.17	(N/A)	0.09	0.03	15.08
Southern sugar maple	89.01	(N/A)	0.09	0.08	44.50
Tree of heaven	63.82	(N/A)	0.04	0.06	63.82
Purple blow maple	7.70	(N/A)	0.04	0.01	7.70
American elm	99.59	(N/A)	0.04	0.09	99.59
October Glory Red Maple	39.54	(N/A)	0.04	0.04	39.54
Green ash	83.25	(N/A)	0.04	0.08	83.25
Eastern red cedar	9.03	(N/A)	0.04	0.01	9.03
Citywide Total	109,291.34	(N/A)	100.00	100.00	48.47

About Texas Trees Foundation

The Texas Trees Foundation, formerly the Dallas Parks Foundation, was established as a 501 (c) (3) organization in 1982 as a resource to support the Dallas parks system. In 1998, the Foundation merged with Treescape Dallas, Inc., a project that had been funded by the Dallas Junior League and the Central Dallas Association. The Texas Trees Foundation was then known as the Dallas Trees and Parks Foundation. In 2003, the Foundation was renamed the Texas Trees Foundation to expand the area of focus from Dallas to the North Texas region to better reflect its mission. The Texas Trees Foundation has a rich history and is positioned to build on the traditions established by its founders and nurtured by the generous support of individuals, foundations, corporations and, agencies throughout Texas.

MISSION

The Mission of the Texas Trees Foundation is (i) to preserve, beautify and expand parks and other public natural green spaces, and (ii) to beautify our public streets, boulevards and rights-of-way by planting trees and encouraging others to do the same through educational programs that focus on the importance of building and protecting the "urban forest" today as a legacy for generations to come. The Foundation will share its vision on a national level, but will focus its efforts and develop loyalties among communities in the North Central Texas area.

VISION

The Texas Trees Foundation has a vision for our community. It is a community comprised of beautiful, well maintained parks, shady tree-lined streets and boulevards, hiking, biking and nature trails, and other outdoor amenities which combine to form a living and working environment that enhances the economic value of its commercial areas and its neighborhoods, and nurtures the health, safety and quality of life of all its citizens; a community in which its citizens actively participate in building and sustaining its "urban forest." The Foundation will serve as a catalyst in creating such a community.

Texas Trees Foundation
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Janette Monear, President/CEO

Janette K. Monear is the President/CEO of Texas Trees Foundatio in Dallas, Texas. The Texas Trees Foundation is a private non-profit dedicated to "Greening North Central Texas." Under Monear's leadership, the Foundation maintains the TXU Energy Urban Tree Farm and Education Center and supports tree-planting projects and education outreach for municipalities, schools, utilities, and builders/developers. With the national agenda for environmental action catalyzing around global climate change, air and water quality, and energy conservation, Texas Trees Foundation has created a national model, *The Roadmap to Tree Planting in the Dallas*, by identifying and prioritizing planting sites through the use of geographical information systems (GIS). The emphasis for urban forestry through community development provides a platform for Ms. Monear to create partnerships that support programs and projects that improves the quality of life in communities.

Prior to her work with the Texas Trees Foundation, Ms. Monear was the Director of Urban & Community Forestry for the Tree Trust in Minnesota, where she developed the *Time for Trees* outdoor learning program, the *Trade-a-Tree* program with utilities, and a grant program that helps communities replace hazardous trees under power lines with small-stature trees. She worked closely with the MN Department of Natural Resources, local government planners, foresters, and soil and water conservation district professionals to develop comprehensive programs for protecting and managing community forest resources for maximum benefit for the environment -- especially in rapidly growing communities. She also developed TreeOrd, an interactive CD-ROM for local governments to write tree ordinances, a Community Tree Planting Manual, Environmental Service Learning Manual, and the new Open Spaces-Clean Water guidebook. Her recent award winning guidebook, City Trees Sustainability Guidelines and Best Practices, has positioned trees as a capital asset and part of a community's infrastructure. Ms. Monear also co-produced the international award winning Public Television documentary, *Spirit of the Trees*.

Ms. Monear began work in community forestry for the University of Minnesota as an Anoka County Extension Specialist for Oak Wilt where she coordinated a statewide effort for Oak Wilt suppression to preserve trees and promote research. She served on the Board of Trustees for TreeLink, an international website for urban forestry, is active with the National Alliance for Community Trees, Regional Tech Transfer Committee of the USDA Forest Service, Dallas Urban Forestry Advisory Committee, and served on the Arboretum Advisory Council for Saint John's University, Collegeville, Minnesota. Monear is a frequent speaker and panelist at regional and national environmental and land-development conferences. She is recognized nationally for her more than 30 years of experience in urban forestry, program development and project

implementation. She has received numerous awards which include the President's Award for the Minnesota Shade Tree Advisory Council (MNSTAC), Chevrolet Geo Award of Excellence, Minnesota Shade Tree Advisory Committee Innovation Award for the City Trees Sustainability Guidelines & Best Practices Guidebook, and the Distinguished Service Award from the Minnesota Society of Arboriculture.

Matt Grubisich, Operations Director/Urban Forester

Matt Grubisich received his Bachelor of Science in Urban Forestry and Forest Management from Iowa State University and has been working in the Urban Forestry field for over 13 years in the DFW area. Matt joined the Texas Trees Foundation staff as the Operations Director/Urban Forester in September 2010 after working 2 years as a private consulting arborist/urban forester specializing in assisting communities, developers, landscaping companies and others with Urban Forestry related issues. Prior to consulting, he served eight years with the Texas Forest Service as the Regional Urban Forester serving the Dallas and surrounding areas.

Matt is a Certified Arborist with the International Society of Arboriculture (ISA) and specializes in GIS mapping, technology transfer, and eco-system analysis.

His recent work in Arlington, McKinney, Mesquite, and in Dallas has produced several tools advancing Urban Forestry in those communities. Matt has hands-on experience with GIS based eco-system studies and urban forestry development with federal, state, and local government agencies, utilities, private firms, non-profits and universities.

Matt has served in a leadership position on several boards and commissions including President of the Trinity Blacklands Urban Forestry Council, Chair of the Dallas Chapter of the Society of American Foresters, founding member of the Dallas Urban Forestry Advisory Committee and two terms on the Rowlett Parks and Recreation Board. He is a frequent speaker at national & state conferences and workshops related to urban forestry and green infrastructure management.

Gordon Tyler Wright, M.S., Urban & Community Forester

G. Tyler Wright, a native of Lyndhurst, Virginia, earned his Bachelor of Science in Forestry degree while attending West Virginia University (Morgantown, WV) and has a Master of Science in Forestry from Virginia Polytechnic Institute and State University, (Blacksburg, VA). Tyler's five successful internships with the F. A. Bartlett Tree Expert Company Research Laboratory and Arboretum, earned him a position as a Plant Health Care Technician. Tyler also worked for Davey Resource Group as a Municipal Inventory Arborist, capturing street tree data in Spokane and Seattle, WA. In 2013, Tyler was hired by the Texas Trees Foundation as an Urban and Community Forester. His duties include research/technology, education outreach,

nursery management/volunteer and internship coordination, urban forest project management and he provides technical assistance for urban forestry consulting to municipalities, universities, corporations and homeowners. Tyler is a Certified Arborist and has earned several awards from Gamma Sigma Delta, WVU Division of Forestry and Natural Resources, VPI& SU Forestry Student Graduate Association, and VPI&SU Forestry Graduate Symposium. He is a member of the Dallas Urban Forestry Advisory Committee, Trinity Blacklands Urban Forestry Council and the International Society of Arboriculture. Tyler is an articulate speaker and has shown merit in working with different organizations and industry professionals.