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May 2, 2019

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434 South Swinton Avenue
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Subject: **Tree Canopy Assessment Report**
Delray Beach, Palm Beach County, Florida
E Sciences Project Number 2-1175-001

Dr. Puszkin-Chevlin:

E Sciences, Incorporated (E Sciences) is pleased to submit the enclosed City of Delray Beach Tree Canopy Assessment Report. This report was prepared in general accordance with E Sciences Proposal Number 2-1175-P02 (revision 2) dated July 18, 2018.

We appreciate the opportunity to provide this service to you. If you have any questions or require additional information, please contact us at (954) 484-8500.

Sincerely,
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Delray Beach Tree Canopy Assessment Report

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Prepared for:

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1.0 Summary of Key Findings

- The City of Delray Beach has an overall tree canopy of 23 percent, or 2,405 acres out of a total of 10,465 acres, which is a moderate density for a city that is largely built out.
- There is significant variation in tree canopy coverage among the City's neighborhoods, with some largely residential areas in the western areas of the city reaching 26 percent to 29 percent and other neighborhoods immediately west and south of the downtown only having a 15 percent to 17 percent canopy.
- The City's tree canopy is storing 82,495 ton of carbon, and each year it sequesters 5,096 tons.
- The City's tree canopy intercepts 2,026,934 cubic meters of rainfall annually, reducing impacts on the city's stormwater system.
- Delray Beach's current tree canopy provides $6,403,962 in ecosystem services, including carbon sequestration, rainfall Interception, and air pollution removal. This is equivalent to $612 per acre.
- It would take approximately 105 acres of new trees to increase the City's tree canopy by one percent. This is approximately equivalent to 2,300 large trees or 230,000 small trees.
- For each one percent of canopy added, ecological benefits will increase. For example, a one percent canopy increase would result in an additional 222 tons of CO^2 sequestration.
- There are 1,653 acres of land covered with ground cover, such as sod, not all of which are suitable for planting as some are golf course or athletic fields. However, if all ground cover areas were forested, the City's tree canopy would increase to 39 percent.
- It is recommended that the City strive for planting 10,000 new shade trees over the next five years. If most of these trees grow to maturity while the City maintains its existing canopy, by 2035 the canopy coverage should increase to 27 to 28 percent. The priority should be to increase the tree canopy in neighborhoods that are currently below the citywide average.
- Strategies for achieving the goal include proactively maintaining the health and density of the current canopy by having more trained arborists in the City's staff, activity enforcing the City's landscape requirements, contracting a detailed tree inventory of city right-of ways and city parks and periodically reviewing the City's tree protection ordinance.
- Strategies for increasing the city's tree canopy include organizing tree give-a-ways to private property owners, organizing community planting events through parks department of local non-profit organizations, reaching out to homeowner associations to plant additional trees in underutilized common areas, reaching out to churches, the Board of Education and other institutional land owners to encourage them to plant trees on their property, and supporting organization that advocate for trees.

2.0 Introduction

The City of Delray Beach (City) has partnered with Community Greening to perform a Tree Canopy Analysis to evaluate the City's current tree canopy and identify prioritization areas to expand the City's canopy. The City contracted E Sciences, Incorporated (E Sciences) to perform this analysis. The goals of this analysis include the following:

- estimating the acreage of tree canopy, impervious surface, pervious areas and non-tree vegetation within the City;
- estimating the environmental benefits (carbon storage and sequestration, air pollution removal, stormwater management and urban heat island reduction) of the current tree canopy;
- developing guidance on how to set and obtain a goal canopy cover, including the number of trees to reach that goal; and
- identifying high prioritization areas to plant trees that will benefit the residents.

A natural forest system is composed of soil, water, vegetation and trees that have not been impacted by development and infrastructure. Forests have evolved over time to be largely self-sufficient. In contrast, the urban tree canopy contains soil, water, vegetation, trees, buildings, roads and utilities, on public and private lands, and require planning, management and maintenance to survive.

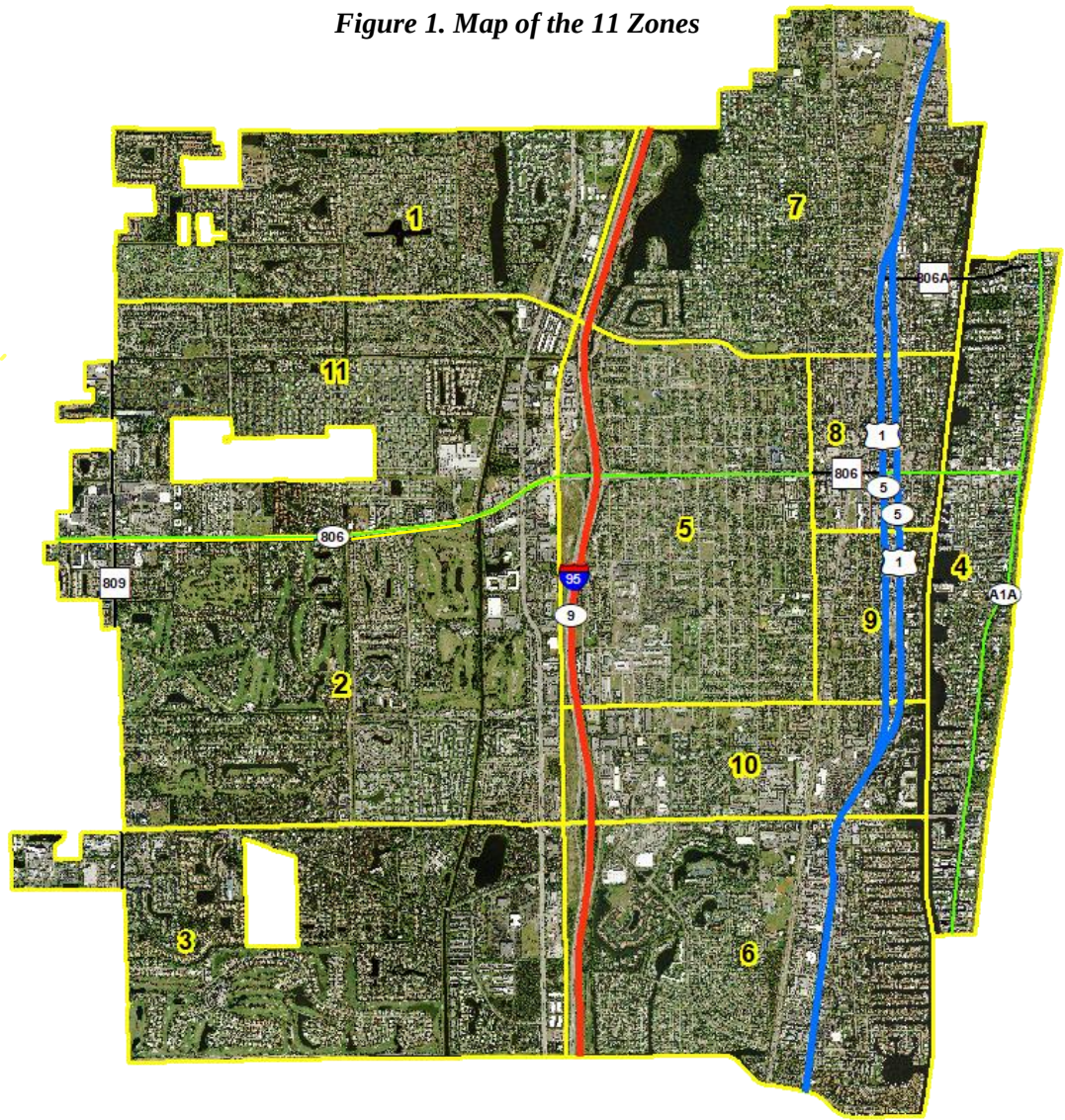
The trees within the urban tree canopy provide a range of ecological, economic and social benefits to the residents of the City, including shade, energy savings, air and water quality improvements, carbon storage and sequestration, reduced crime, improved aesthetics, and increased property values (Escobedo et al., 2009). With increased awareness of the effects of trees on local micro-climates, many local governments and non-profit groups are evaluating their tree canopy with the goal of preserving the existing tree canopy and providing support to programs designed to increase the coverage of trees within the community.

With the results provided within this report, the City can examine planting priority zones to help reach an obtainable goal in canopy cover that provides the most benefits to the residents. The City will be able to use recommendations made within this report to provide evidence of the value of trees to residents, county and municipal staff, and elected officials; and to help justify the costs associated with planting new trees and maintaining existing trees within the City.

3.0 Methodology of Analysis

This analysis was performed on a citywide scale and on 11 different zones within the City that were provided to E Sciences as an ArcGIS shapefile. Each of the 11 zones within the shapefile demarked the study limits for the respective zone, while a merged polygon of the 11 tree zones demarked the study limits on the citywide scale. **Figure 1** depicts the 11 zones provided by the city for use in this analysis.

Figure 1. Map of the 11 Zones



Aerial photographs taken in 2017 (aerials) for the geographic extent of the City were acquired from the Palm Beach County GIS Department. The aerials provided by Palm Beach County were color infrared

images with one-meter resolution and included a near-infrared layer. Near infrared wavelengths are not visible to the human eye but when combined with visible wavelengths, allow scientists to better distinguish between different types of vegetation, and between vegetated and non-vegetated landcover and water.

The aerials were combined using the Mosaic to New Raster tool in ArcMap Version 10.5.1, and an interactive supervised classification was performed on the mosaiced aerial. The classification was run using distinct signatures developed for the aerial mosaic. The signatures were developed by "training" the software to detect different landcover classes based on the value (or color) of individual pixels within the aerial. A range of values were assigned to a landcover class (e.g. tree canopy) by selecting multiple representative areas of the said landcover class throughout the aerial. This range of values would thus "code" for the landcover class that was assigned to it and classify pixels in the aerial based that assignment. The following categories of landcover classes were used:

- Tree canopy – tree cover (including invasive and exotic species)
- Ground cover – vegetated, pervious surface (e.g. grassy fields, lawns, shrubs)
- Bare ground – non-vegetated pervious surface (e.g. sandy beach, sandy lot, land cleared for development)
- Impervious surface – impervious surfaces (e.g. roads, driveways, buildings)
- Water – a body of water (e.g. canal, pond, lake, ocean, river)

Due to the overlap of pixel value of deeper, larger water bodies and some dark impervious surfaces, a water bodies GIS layer from Palm Bach County was used to clip out water bodies (e.g. canals, ponds, lakes and ocean) from the aerial. Water was classified in the absence of these water bodies. After the classification, these water bodies were added to the Water landcover class.

The classified aerial was verified by performing an accuracy assessment of the classification against the aerial. Fifty representative points were selected from the aerial for each landcover classification (250 total). At each point the landcover on the aerial was compared to the landcover assigned by the classification. The accuracy of each landcover classification was calculated by the number of correct classifications divided by 50. The accuracy of each landcover classification was then averaged to obtain an average accuracy for the classified aerial. Modifications to the signatures were made where needed, and the classification process was repeated multiple times. The final accuracy of the tree canopy classification was 94 percent.

Once the classified aerial was verified, it was analyzed for tree canopy benefits: carbon storage and sequestration, air pollutant removal and stormwater management using i-Tree Landscape, a web-based application that calculates tree canopy benefits from classified aerial images. Instead of using the i-Tree Landscape web-application, E Sciences requested the aid of i-Tree staff to run a custom analysis using the classified aerial. This custom analysis was run with the same models used in the i-Tree

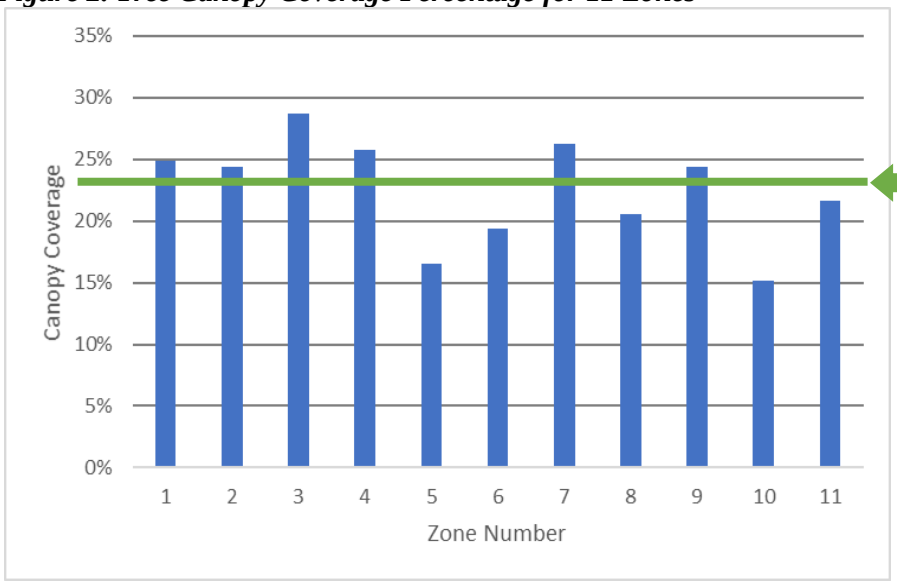
Landscape web-application and was run for the entire city as well as the individual zones. A description of each model used in i-Tree Landscape is provided in **Appendix A**.

Note: This land cover classification only provided the acreages of tree canopy within the City. The results did not include a field inventory of the trees within the City, so the number and type of trees is not provided within this report. This information could be obtained through a detailed tree inventory and could be performed as a separate follow-up project for the whole City or specific areas of interest. Tree inventories are generally conducted for city-owned trees only. Based upon the miles of roadway and the number of trees per mile (sampled using Google Earth), an inventory of trees within city right of way would require an estimated 1,000 hours of field data collection.

4.0 Tree Canopy Analysis

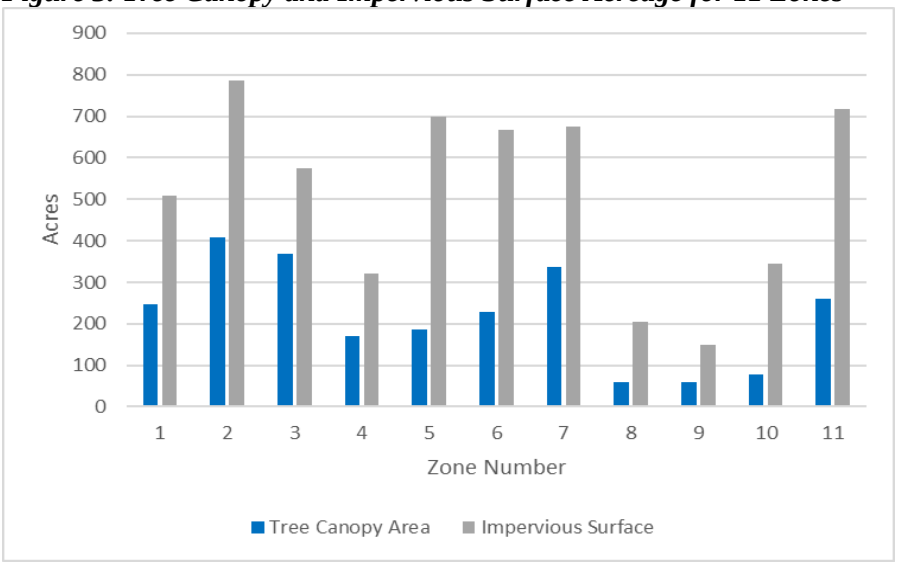
The estimated tree canopy of the City is 2,405 acres, or 23 percent of the total land cover of the City. (Note the total land area of the City used for this analysis is 10,465 acres, which is the area provided in the GIS Shapefile of the City, provided by the City). The City does not currently have a canopy coverage goal. Figure 2 below displays the percent of tree canopy coverage for the 11 different zones. Figure 3 depicts the acreage of tree canopy and the acreage of impervious surface in each zone.

Figure 2. Tree Canopy Coverage Percentage for 11 Zones



Tree Zone #	Tree Canopy %
1	24.88%
2	24.35%
3	28.68%
4	25.79%
5	16.54%
6	19.38%
7	26.21%
8	20.59%
9	24.38%
10	15.12%
11	21.60%

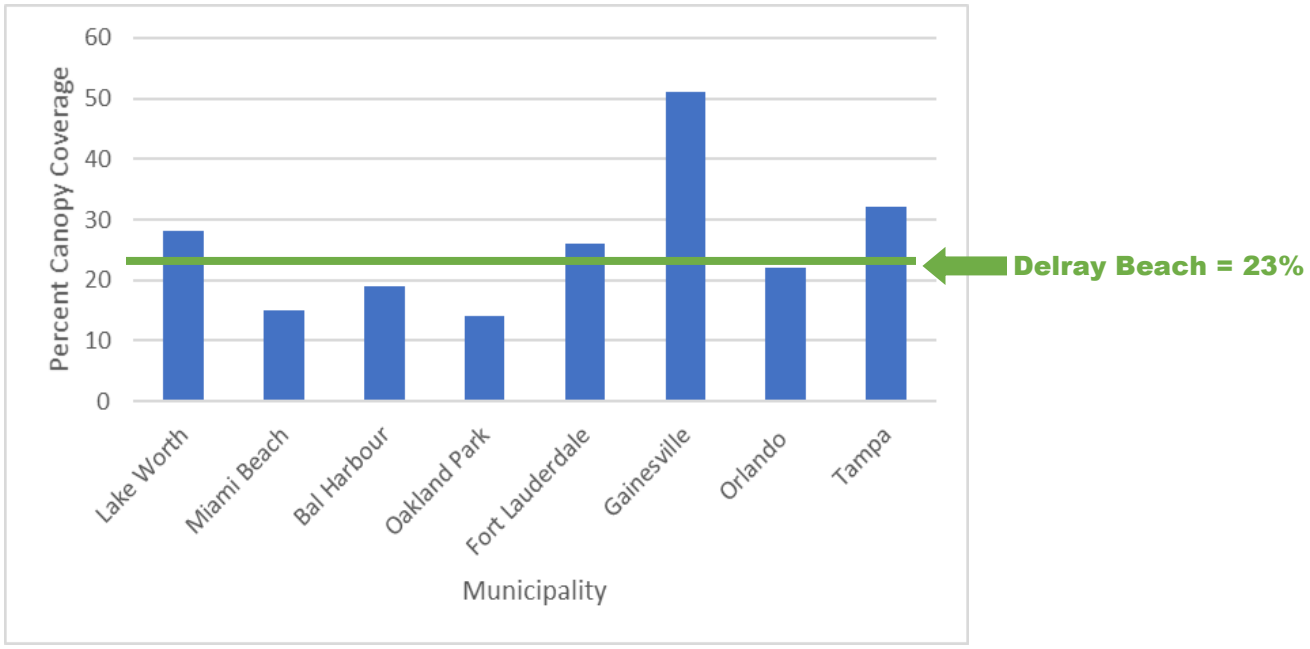
Figure 3. Tree Canopy and Impervious Surface Acreage for 11 Zones



Tree Zone #	TCA	IS
1	246	508
2	409	786
3	369	575
4	170	321
5	186	700
6	228	667
7	337	676
8	61	205
9	60	149
10	78	345
11	260	717

Figure 4 below shows the 2017 percent tree canopy for the City in comparison with the tree canopy for Tampa (2016, University of Florida [UF] i-Tree Eco Study), Orlando (2012, UF Urban Forest Effects Model [UFORE] Study), Gainesville (2006, UF UFORE Study), Fort Lauderdale (2018, City of Fort Lauderdale i-Tree Canopy Study), Bal Harbour (2017, E Sciences i-Tree Canopy Study), Lake Worth (2014, E Sciences i-Tree Canopy Study), Oakland Park (2014, E Sciences i-Tree Canopy Study) and Miami Beach (2013, E Sciences i-Tree Canopy Study).

Figure 4. Municipality Tree Canopy Comparison



4.1 Environmental Function Analysis

The classified images were run through i-Tree Landscape by the U.S. Forest Service as described above in Section 2.0. Using the i-Tree Landscape application, scientists evaluated the City's tree canopy for the environmental benefits of carbon storage (i.e. the amount of carbon assimilated by trees) and annual sequestration (i.e. the amount of CO_2 removed from the atmosphere), air pollutant removal, and stormwater management.

Table 1 below provides the i-Tree results for carbon sequestration and storage. The City's tree canopy is sequestering 5,096 tons of carbon from the atmosphere per year and storing 82,495 tons of carbon. Sequestration rates vary locally based on tree size, health and growth rates associated with the species and location. The rates will increase as forests grow and diminish as the forest matures and will become negative during times of forest decline or loss (Nowak et al., 2013). Carbon storage estimates have evolved over time. Based on a 2013 study, the standard estimated rate of carbon storage per square meter of tree cover has decreased since 2010 due to increased availability of data, and better

tree cover estimates from photo-interpretation (Nowak et al., 2013). As trees die and decay, the carbon is released back into the system. This occurs quickly when wood is burned or slowly if the trees decay as they would in a natural system or if disposed of in a landfill or similar situation. The re-use of trees in wood products allows the carbon to remain stored. The amount of carbon stored in existing trees supports the preservation of mature, existing trees critical to the continued removal of carbon dioxide from the atmosphere. Carbon sequestration and storage is valued at $139.33 per metric ton of carbon in the i-Tree model based on work by the Interagency Working Group on Social Cost of Carbon, United States Government (2013). Thus, the value of the City's tree canopy in terms of carbon sequestration is $709,989.

Table 1. 2017 Carbon Sequestration and Storage Benefits for the City of Delray Beach

Tree Zone	Total Acres	Carbon Sequestration (tons/year)	Carbon Storage (tons)
Zone 1	990	522	8,449
Zone 2	1679	866	14,024
Zone 3	1285	781	12,642
Zone 4	660	361	5,838
Zone 5	1126	395	6,389
Zone 6	1179	484	7,838
Zone 7	1287	715	11,570
Zone 8	294	128	2,077
Zone 9	243	127	2,057
Zone 10	517	166	2,681
Zone 11	1205	552	8,930
City Total	**10,465**	**5,096**	**82,495**

The greater the City's tree canopy, the more pollutants such as nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone (O_3), carbon monoxide (CO) and particulate matter less than 2.5 microns (PM2.5) are being removed from the atmosphere. It is especially important that these five pollutants are removed in the urban areas, where people, cars and industry are concentrated. The total amount of these pollutants being removed annually by the City's tree canopy is 152,298 pounds. **Table 2** below shows the amount of pollutants removed in each tree zone and in the City as a whole based on the 2017 tree canopy. The i-Tree analysis for air pollution removal and value estimates are based on procedures detailed in Nowak et al. (2014). The 2014 Nowak study used information from the U.S. EPA Environmental Benefits Mapping and Analysis Program (BenMAP) model (US EPA, 2012a). For the City of Delray Beach, the value of the total air pollutant removal (NO_2, SO_2, O_3, CO and PM2.5) was calculated at $5.97 per pound.

Table 2. 2017 Air Pollutant Removal Benefits for the City of Delray Beach (pounds per year)

Tree Zone	NO_2	SO_2	O_3	CO	PM2.5	Total
Zone 1	1,082	543	12,563	632	778	15,598
Zone 2	1,795	901	20,853	1,049	1,292	25,890
Zone 3	1,618	812	18,798	946	1,164	23,338
Zone 4	747	375	8,681	437	538	10,778
Zone 5	818	410	9,499	478	588	11,793
Zone 6	1,003	503	11,655	587	722	14,470
Zone 7	1,481	743	17,204	866	1,066	21,360
Zone 8	266	133	3,088	155	191	3,833
Zone 9	263	132	3,059	154	190	3,798
Zone 10	343	172	3,987	201	247	4,950
Zone 11	1,143	574	13,279	668	823	16,487
City Total	**10,559**	**5,298**	**122,666**	**6,173**	**7,599**	**152,295**

Table 3 below indicates the amount of rainfall that is intercepted by the current tree canopy. The i-Tree analysis uses local leaf area indices as well as weather data for this calculation. When rainfall is intercepted by the tree canopy, less treatment and storage is needed for stormwater runoff from impervious surfaces. By incorporating trees into construction projects, municipalities and private developers can save money on stormwater management. The i-Tree analysis for rainfall interception value estimates are based on procedures detailed in McPherson et al. (2004). For the City of Delray Beach, the value of the total rainfall interception was calculated as $2.36 per m^3.

Table 3. Rainfall Interception Benefits for the City of Delray Beach 2017 (m^3 per year)

Tree Zone	Rainfall Interception
Zone 1	207,592
Zone 2	344,566
Zone 3	310,608
Zone 4	143,466
Zone 5	156,968
Zone 6	192,591
Zone 7	284,283
Zone 8	51,031
Zone 9	50,551
Zone 10	65,873
Zone 11	219,425
City Total	**2,026,954**

m^3 = meters cubed

Economic values can be applied to the carbon sequestration, air pollutant removals and rainfall interception from the tables above. **Table 4** below shows the dollar values of the environmental benefits provided by the City's tree canopy.

Table 4. Annual Value of Benefits Based on 2017 Tree Canopy ($ per year)

Tree Zone	Tree Canopy (% Coverage)	Carbon Sequestration	Rainfall Interception	Air Pollution Removal	Total Benefits
1	25%	$72,730	$490,051	$93,108	$655,889
2	24%	$120,691	$813,398	$154,543	$1,088,632
3	29%	$108,796	$733,234	$139,312	$981,342
4	26%	$50,245	$338,625	$64,338	$453,208
5	17%	$54,981	$370,544	$70,402	$495,927
6	19%	$67,459	$454,638	$86,380	$608,477
7	26%	$99,575	$671,089	$127,505	$898,169
8	21%	$17,875	$120,467	$22,888	$161,230
9	24%	$17,706	$119,332	$22,673	$159,711
10	15%	$23,073	$155,502	$29,545	$208,120
11	22%	$76,858	$517,984	$98,415	$693,257
City Total	**23%**	**$709,989**	**$4,784,864**	**$909,109**	**$6,403,962**

The purpose of calculating and providing these figures is to demonstrate the market value of the functional services that trees provide. It should be noted that the cost to provide carbon sequestration by a CO_2 removal system (e.g. by using a carbon scrubbing technology) is not a cost that is paid for by the general public, and therefore saved by planting trees. However, it is a cost paid for by increased health costs and mitigation efforts.

4.2 Urban Heat Island Reduction

The Urban Heat Island (UHI) effect describes how urban areas are typically hotter than surrounding rural areas. Trees and other vegetation help lower surface temperatures by providing shade and through evapotranspiration, a process of releasing water to the surrounding atmosphere. In contrast, urban areas contain more dry and impervious surfaces that result in less moisture available for evapotranspiration. Urban development tends to reduce the tree and vegetation cover in the city, and results in less shade and moisture available to cool the surrounding environment (EPA, 2008).

The current models used in i-Tree Landscape do not include a model for the reduction in the UHI effect that tree canopy can provide. Additionally, the four-band aerial photographs were not suitable to

create a thermal infrared map of the City to evaluate the areas most affected by UHI. However, the UHI reduction benefit of the City's tree canopy can be conceptualized based on results of similar studies. A 2014 study by Özer et al. at the 1100 block of Lincoln Road Mall in Miami Beach, Florida showed that tree canopy on the 1100 block reduced summer air temperatures by an average of 1.4° F more than the less "forested" 1200 block. This data provides some evidence for the reduction of UHI in a South Florida streetscape. The reduction in UHI likely would increase with better selection of and increased density of shade providing trees. It is clear that tree canopy and vegetation aids in reducing the UHI effect; however, data collected from a variety of trees in a variety of densities would be needed to better quantify this benefit.

5.0 Discussion

The purpose of this study was to estimate the City's current urban forest canopy coverage, to calculate the environmental services provided by the City's trees, to provide guidance on how to develop an achievable canopy coverage goal and to prioritize locations in which to focus tree plantings to meet that goal.

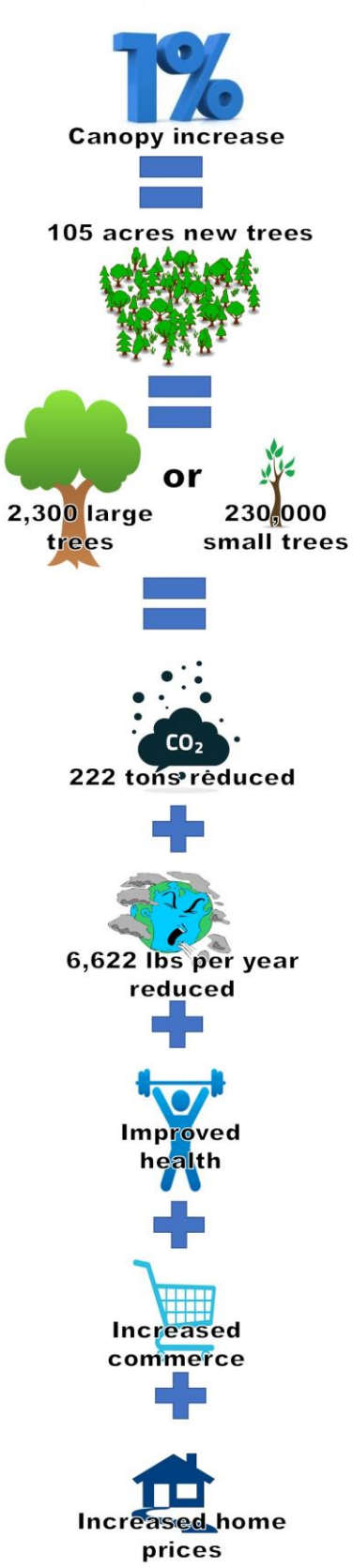
This study has shown that the City currently has a 23 percent (2405 acres) tree canopy cover. The current tree canopy provides the City with an estimated yearly environmental services value of $5,748,071. These services include carbon sequestration, rainfall interception and air pollution removal.

In 1997, American Forests published an article citing a universal canopy coverage goal of 40 percent, which became a benchmark in the industry and spurred municipalities across the country to strive to meet this goal. While the intent was noble and lead many cities to develop robust tree protection and planting programs, this number is not achievable by most cities, particularly the generally built-out cities that comprise our larger metropolitan areas. American Forests now recognizes the role constraints such as development densities, land use patterns, ordinances and climate play in dictating potential tree canopy coverage. Accordingly, it is now clear that cities should focus on maximizing their urban forest and its environmental services by developing a well-staffed urban forestry program that works to maintain a healthy and structurally sound urban forest through proper urban forest management strategies, a protective tree ordinance and outreach and cooperation with tree advocacy groups.

The City is comprised of 10,465 acres. To increase the canopy by one percent the City would need to establish an additional 105 acres of forest in addition to maintaining existing trees. The canopy area for a mature shade tree (e.g. oak, strangler fig, black olive) with a 50-foot spread is just under 2,000 square feet. Achieving one percent growth using established shade trees would require approximately 2,300 trees, assuming the trees are at full growth and maturity. In reality it will require planting many more young trees to eventually get the growth needed. New trees purchased from nurseries to be planted along roadways, in parks or to be given to residents are much smaller. With an average spread of five feet, a new tree might only represent approximately 20 square feet of canopy. Thus, it would require planting 230,000 new trees (in addition to those required to replace the trees that die every year) to increase the canopy by one percent. For each percent canopy increase there would be a corresponding improvement to the environmental services provided, including an additional annual sequestration of 222 tons of $C0^2$ and an additional removal of 6,622 pounds of airborne pollutants.

Though the City is generally fully developed, there are areas of opportunity for the City to expand its tree canopy. There are 1,653 acres of the City that were identified as ground cover within the City. This includes sodded areas and other areas of low-growing vegetation that represent approximately 16 percent of the City. If all areas of ground cover were transformed into tree canopy, the City's tree canopy would increase to approximately 39 percent. However, not all the areas of ground cover are suitable for tree plantings, such as canal right-of-way, golf courses, athletic fields and other recreation areas. Much of the remaining ground cover areas can be found in passive parks, individual residential lots, churches, schools and community association common areas. It should be noted that impervious surfaces can be retrofitted to provide ecological benefits. Some examples include green roofs and solar panels. The City should review their landscape code to make sure sufficient landscaping is being provided in vehicular areas (e.g. parking lots) and evaluate the possibility of expanding canopy into these areas.

Setting a reasonable goal canopy for the City is a task that requires thorough evaluation and planning, and which would benefit from input from a variety of stakeholders. There several factors to consider when evaluating the capacity for canopy expansion, including, but not limited to: available space; tree planting budget; availability of suitable trees; time for trees to reach maturity and installation and maintenance costs. The paragraphs above outlined the number of trees required to increase the canopy by one percent and gave general examples of the types of spaces that might be suitable for canopy expansion. The Recommendations section below includes a more detailed Tree Planting Plan that identifies a tree planting goal and prioritizes areas for the City to expand the tree canopy.



6.0 Recommendations

As previously noted, the City's urban forest canopy provides estimated yearly environmental services valued at $5,748,071. This figure does not include the benefits to real estate value, commerce, health and safety that trees provide. If the City wishes to maintain and increase the ecosystem services provided by the City's trees, the following are recommended.

6.1 Maintain Existing Trees

The City should focus on maintaining and preserving the health, structure and function of the existing tree canopy. This requires allocating adequate resources to an urban forestry program whose mission is to "manage" the resource. Successful urban forestry programs share the following characteristics: they are properly staffed, they have a tree protection ordinance to preserve existing trees, they have a management plan and they support tree advocates in the community through outreach and coordination. We provide the following recommendations:

- Ensure there are staff within the appropriate departments (e.g. Planning, Parks and Recreation, Public Works) that are International Society of Arboriculture Certified Arborists
- Review and update the City's tree protection ordinance periodically
- Train appropriate staff on implementing and enforcing the City's tree protection ordinance
- Conduct a street and right of way tree inventory and develop an urban forestry management plan that utilizes the results of that inventory and this study
- Continue to engage the public through outreach and coordination with groups such as Community Greening and the Arbor Day Foundation's Tree City program

6.2 Tree Planting Plan

E Sciences recommends that the City plant 10,000 new (i.e. above and beyond replacement for lost trees) shade trees over the next five years. These trees should be native or known to thrive in south Florida conditions and should come from reputable nurseries. They should be inspected at planting for proper health and structure and planted in appropriate locations. If most of these trees grow to maturity while the City maintains its existing tree canopy, by 2035 the canopy coverage should increase by four to five percent to reach 28 percent.

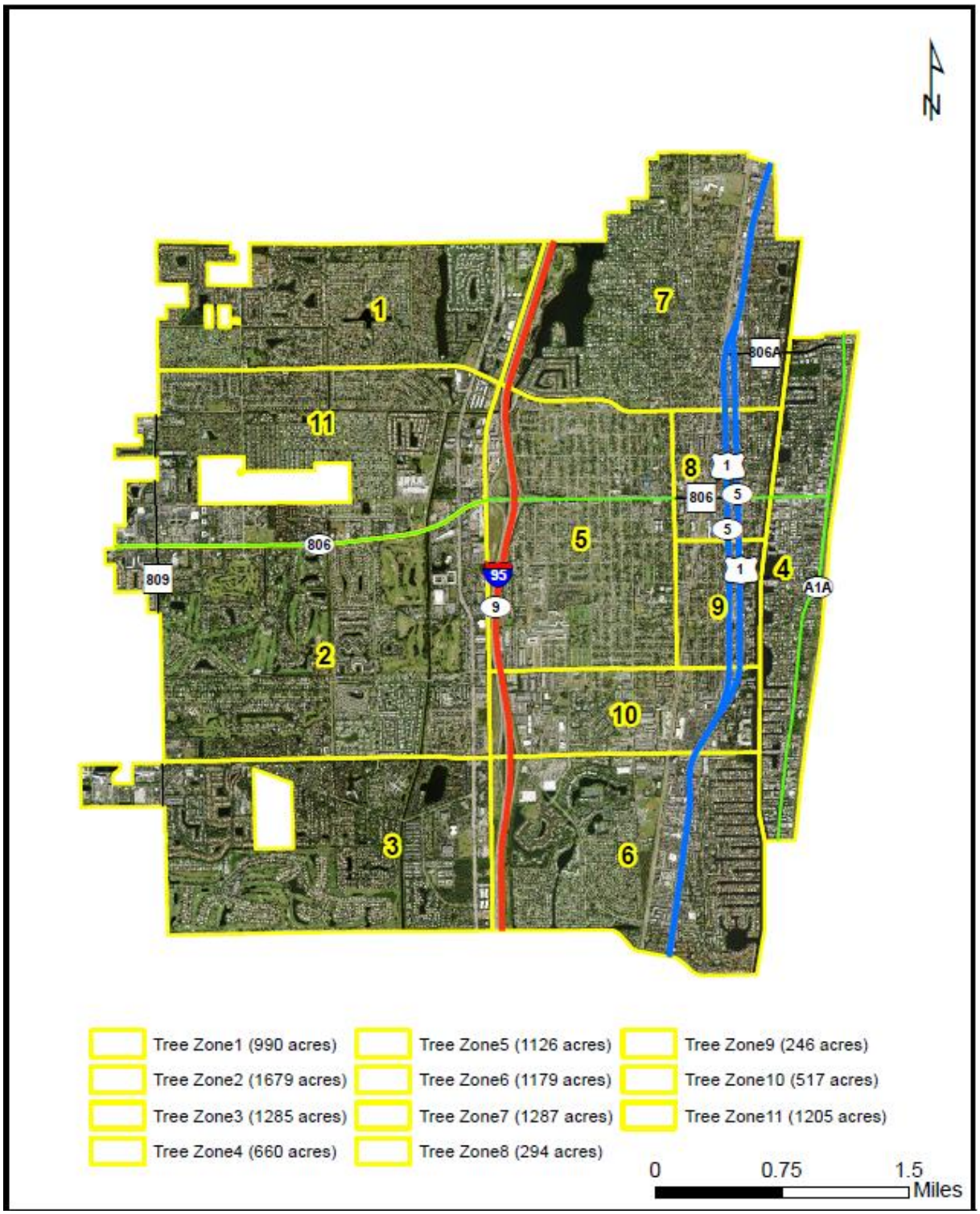
This recommendation includes planting trees on city-owned lands. There are 616 acres of city-owned parcels and 257 miles of road in the City. Assuming an average of five feet of right of way on each side of the street this adds an additional 311 acres of land. However, adding trees at suitable intervals along roadways could add five acres of new canopy (assuming 10 trees per mile). It should be noted that there are trees on much of this right of way green space, as well as constraints such as driveways, drainage swales and utilities that need to be addressed when planting trees along roadways. Street tree plantings should follow FDOT, County and City guidelines. If there are utilities, "right tree right

place" principles should be followed. Conducting a tree inventory as described above would allow the City to identify gaps along streets and planting opportunities. This is recommended as a priority for all the zones.

The recommendation also includes additional tree plantings on private lands. For residential areas, targeted tree give-aways and other programs will encourage tree planting. The City should also work with community associations to identify and encourage opportunities for tree plantings. The City's landscape and tree protection ordinances should be utilized to ensure that commercial and industrial properties have sufficient tree canopy. Institutional sites (i.e. schools, churches) should be included in outreach and tree give-away programs as well.

The following pages include recommendations for each of the 11 zones, prioritized based on need, land use and demographic data. Individual pages highlight environmental and land use statistics for each zone. A map of the zones is provided on the following page for reference.

Figure 5. Map of the 11 Zones with Acreage



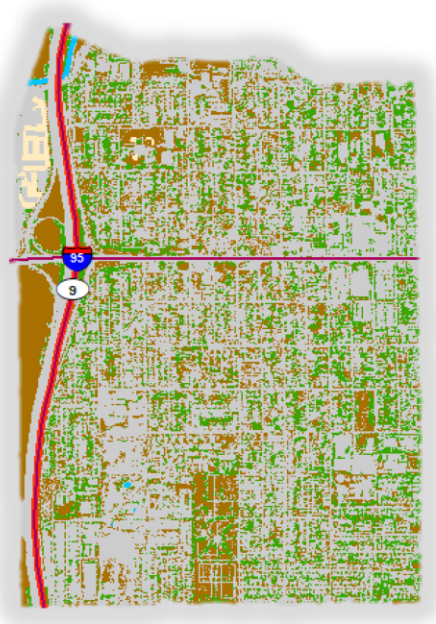
Priority 1: Zones 5 and 10

Zones 5 and 10 have the lowest canopy coverage (186 and 78 acres, respectively) in the City and therefore provide the best opportunities for increased canopy coverage through tree planting. Statistics about zones 5 and 10 are included on the following pages. To increase the canopy coverage in these zones by 1 percent, 1.86 acres of canopy (approximately 40 large trees and 4,051 small trees) and 0.78 acres of canopy (approximately 17 large trees or 1,700 small trees) would need to be planted in Zones 5 and 10, respectively. Zone 10 is generally industrial and commercial and has fewer opportunities for significant canopy increases. Zone 5 features more residential land use and includes some of the lowest income neighborhoods in the City (based on median income data). There is significant coverage of grass and other groundcover in parks, vacant lots and in private yards. Our recommendations for increasing canopy coverage in Zones 5 and 10 are as follows:

- Some city-owned parcels have capacity for additional trees. The City should consider planting trees in these locations. This includes Parcel 12434620560020000 (across from the Village at Delray), parcels between SW 7 and 8 Avenue north of SW 3 Avenue, Parcel 12434620180000141 at 1026 SW 9 Avenue and Parcel 12434616010480010 (corner of SW 4 Street and SW 3 Avenue).
- Delray Beach Memorial Gardens Municipal Cemetery has capacity for additional trees, as does Pompey Park in areas where they will not interfere with athletics.
- The Delray Water Treatment Plant property has capacity for trees, primarily to the east, away from the tanks and operations.
- Work with Palm Beach County School Board to plant trees at schools (e.g. Pine Grove Elementary School, Village Academy School of the Arts, and SD Spady Elementary School) outside of areas designated for sports or other activities.
- Incentivize owners of undeveloped and underdeveloped lots to plant trees that might eventually fit into a site plan.
- Hold tree giveaways to increase the canopy coverage in residential yards.
- Encourage tree planting at the church-owned parcels such as the Cavalry Bible Baptist Church and land owned by the Ebenezer Wesleyan Methodist Church.

City of Delray Beach
Tree Canopy Assessment
Zone 5

- Tree Canopy
- Impervious
- Ground Cover
- Bare Ground
- Water



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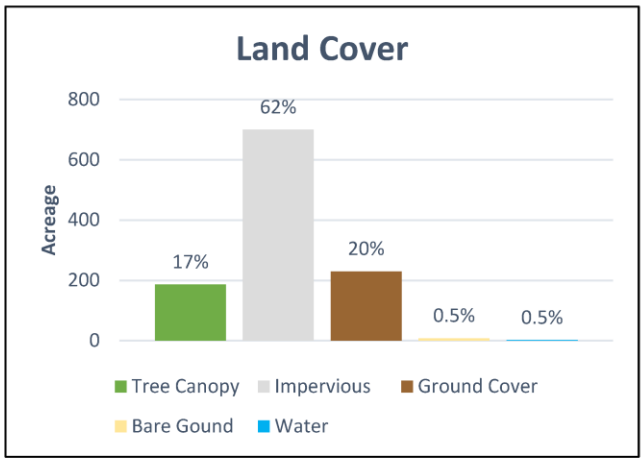


Land Use Statistics		
Land Cover	**Acres**	**Percentage**
Residential	498	62%
Commercial	21	3%
Public/Semi-Public	178	22%
Industrial	20	3%
Other	79	10%
Total Acreage**	796	

**Water and transportation ROW are excluded from the land use total.

Environmental Benefits Statiistics	
Carbon Sequestration (tons/year)	395
Total Carbon Stored (tons)	6389
Annual Value of Carbon Removal	$54,981
Total Air Pollution Removed	11794
Annual Value of Air Pollutant Removal	$70,402
Stormwater Storage (m^3/year)	156968
Annual Value of Stormwater Storage	$370,544

City of Delray Beach
Tree Canopy Assessment
Zone 10

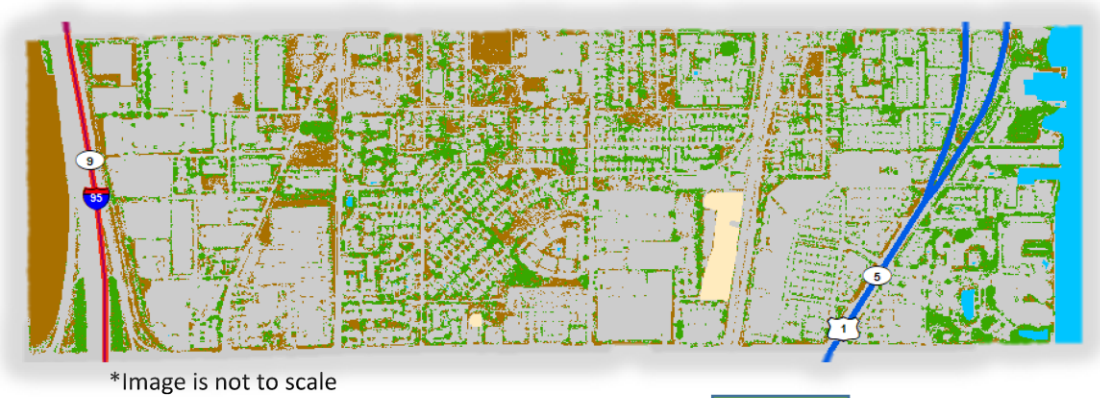
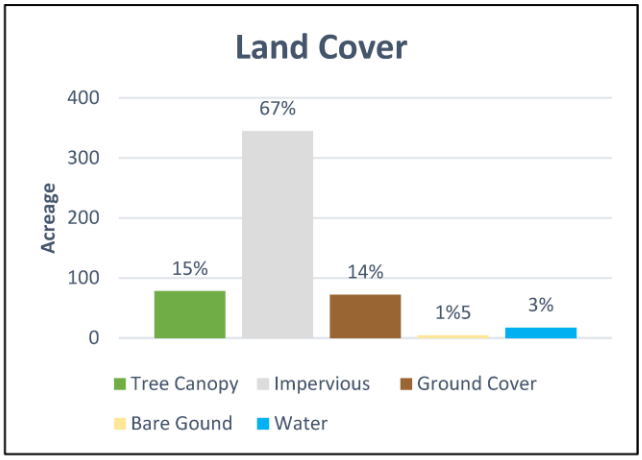


*Image is not to scale

Tree Canopy
Impervious
Ground Cover
Bare Ground
Water



Land Use Statistics		
Land Cover	**Acres**	**Percentage**
Residential	165	43%
Commercial	99	26%
Public/Semi-Public	30	8%
Industrial	67	17%
Other	24	6%
Total Acreage**	385	

**Water and transportation ROW are excluded from the land use total.

Environmental Benefits Statistics	
Carbon Sequestration (tons/year)	166
Total Carbon Stored (tons)	2681
Annual Value of Carbon Removal	$23,073
Total Air Pollution Removed	4950
Annual Value of Air Pollutant Removal	$29,545
Stormwater Storage (m^3/year)	65873
Annual Value of Stormwater Storage	$155,502

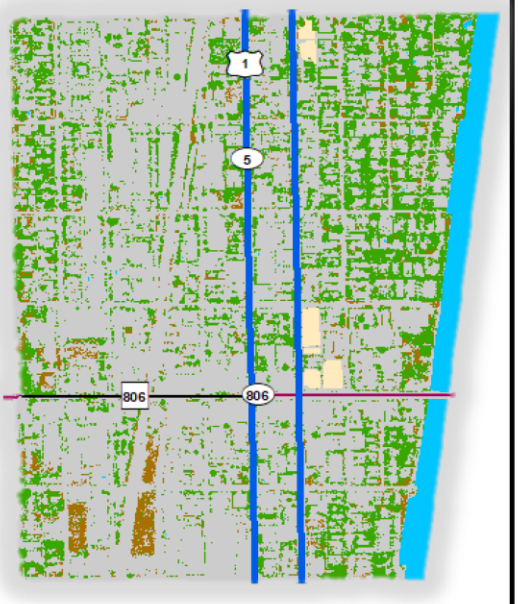
Priority 2: Zones 8 and 9

These two zones include some affluent single-family residential neighborhoods adjacent to the Intracoastal Waterway that already have significant tree canopy coverage. The central business district is located in this area and includes retail, restaurants, offices and multi-family residential units. Zone 8, at 20 percent canopy coverage, has a lower canopy coverage than the City average. There are less affluent communities towards the southern portion of Zone 9. There are fewer opportunities in these zones due to the density of development. The current canopy cover in Zones 8 and 9 are 61 and 60 acres, respectively. To increase the canopy coverage in these zones by 1 percent, 0.61 acres of canopy (approximately 13 large trees and 1,329 small trees) and 0.60 acres of canopy (approximately 13 large trees and 1,307 small trees) would need to be planted in Zones 8 and 9, respectively.

- Some city-owned parcels have capacity for additional trees. The City should consider planting trees in these locations, such as Parcel 12434621010080360 (east of railroad tracks in Zone 9).
- Incentivize owners of undeveloped and underdeveloped lots to plant trees that might eventually fit into a site plan.
- Portions of Veterans Park not being used for athletics or other active uses can be used to plant more trees.

City of Delray Beach
Tree Canopy Assessment
Zone 8

Tree Canopy
Impervious
Ground Cover
Bare Ground
Water



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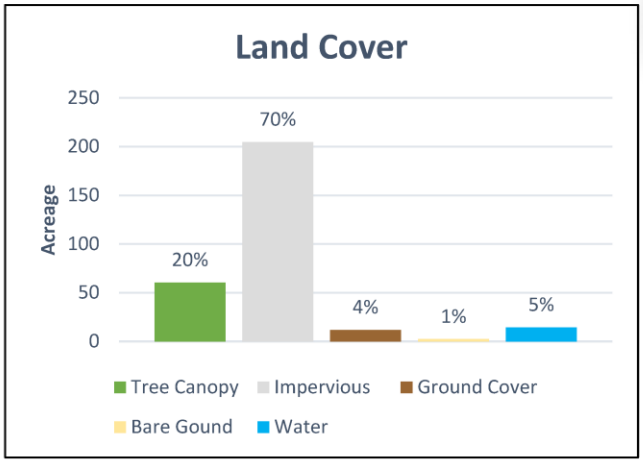


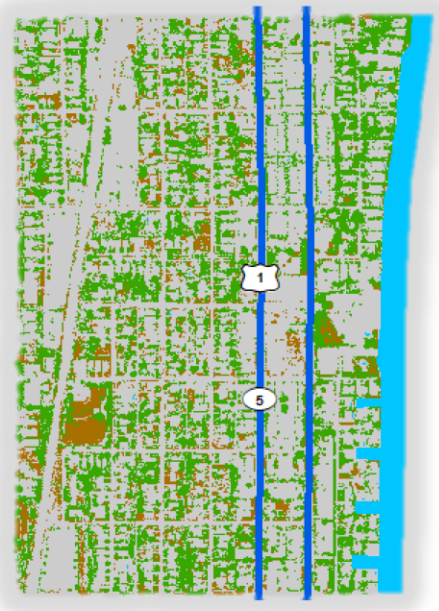
Land Use Statistics		
Land Cover	**Acres**	**Percentage**
Residential	92	42%
Commercial	72	33%
Public/Semi-Public	20	10%
Industrial	5	2%
Other	27	13%
Total Acreage**	216	

**Water and transportation ROW are excluded from the land use total.

Environmental Benefits Statistics	
Carbon Sequestration (tons/year)	128
Total Carbon Stored (tons)	2077
Annual Value of Carbon Removal	$17,875
Total Air Pollution Removed	3834
Annual Value of Air Pollutant Removal	$22,888
Stormwater Storage (/year)	51031
Annual Value of Stormwater Storage	$120,467

City of Delray Beach
Tree Canopy Assessment
Zone 9

Tree Canopy
Impervious
Ground Cover
Water



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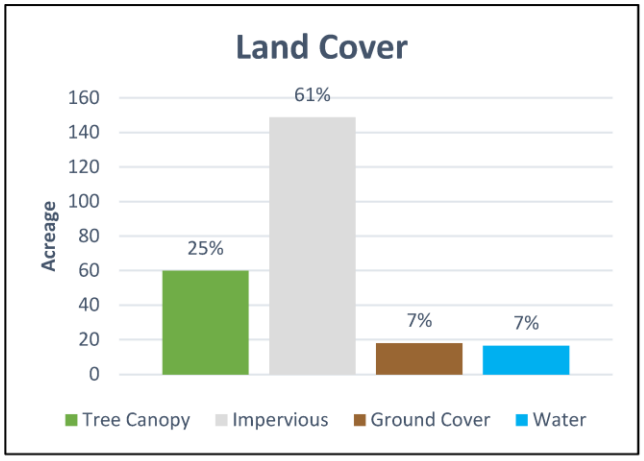


Land Use Statistics		
Land Cover	**Acres**	**Percentage**
Residential	109	63%
Commercial	28	16%
Public/Semi-Public	7	4%
Industrial	10	6%
Other	19	11%
Total Acreage**	173	

**Water and transportation ROW are excluded from the land use total.

Environmental Benefits Statistics	
Carbon Sequestration (tons/year)	127
Total Carbon Stored (tons)	2057
Annual Value of Carbon Removal	$17,706
Total Air Pollution Removed	3798
Annual Value of Air Pollutant Removal	$22,673
Stormwater Storage (m^3/year)	50551
Annual Value of Stormwater Storage	$119,332

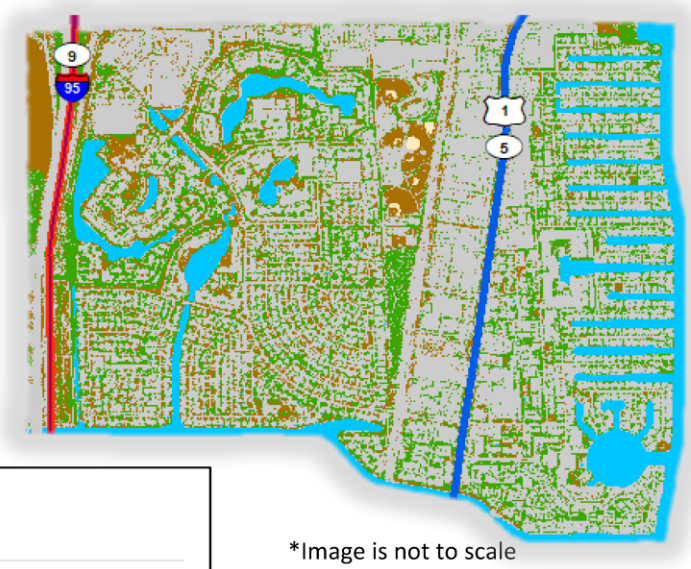
Priority 3: Zone 6

Zone 6, located in the southeast corner of the City, has a relatively low canopy coverage of 19 percent. It features numerous community associations and apartment complexes. While this area is generally fully developed, there are a few opportunities to increase canopy coverage. According to flooding event data provided by the City for June 3 – 7, 2017, flooding has occurred in the eastern portion of Zone 6 along the Intracoastal Waterway. Trees vulnerable to flooding and wind should be avoided.

- Encourage tree plantings in the single-family homes adjacent to Lindell Boulevard through targeted tree giveaways.
- The City can plant trees at the city-owned parcel at 2350 Jaeger Drive in areas not being utilized for athletics.
- Discuss opportunities with community associations to plant trees in green open spaces, including common areas and around lakes.
- Investigate the possibility of planting trees in parking lot green spaces.

City of Delray Beach
Tree Canopy Assessment
Zone 6

- Tree Canopy
- Impervious
- Ground Cover
- Bare Ground
- Water



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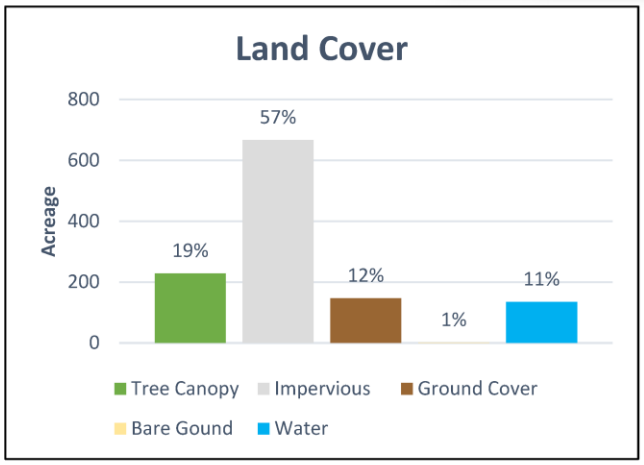

Land Use Statistics		
Land Cover	**Acres**	**Percentage**
Residential	479	56%
Commercial	179	21%
Public/Semi-Public	96	11%
Industrial	8	1%
Other	95	11%
Total Acreage**	857	

**Water and transportation ROW are excluded from the land use total.

Environmental Benefits Statistics	
Carbon Sequestration (tons/year)	484
Total Carbon Stored (tons)	7838
Annual Value of Carbon Removal	$67,459
Total Air Pollution Removed	14471
Annual Value of Air Pollutant Removal	$86,380
Stormwater Storage (m3/year)	192591
Annual Value of Stormwater Storage	$454,638

Priority 4: Zones 1, 2, 3 and 11

These four zones in the western portion of the City feature a variety of land uses and canopy coverage varies. Zone 3 has the highest coverage in the City at 29 percent, with Delray Oaks Preserve contributing to the canopy cover. Zone 11 has coverage less than the City average at 21 percent. The western portion of the City is generally more affluent, with fewer residents living below the poverty line than some of the eastern
neighborhoods. Some of the commercial and industrial areas between Congress Avenue and the I-95 right-of-way have little to no canopy coverage, as do some of the retail areas to the west, such as the "Four Corners" area at the intersection of Military Trail and Atlantic Avenue. There are also community associations in these areas with plantable space. According to 2017 flooding event data provided by the City, flooding events were reported in parts of Zones 1 and 11. Tree species that are vulnerable to flooding should be avoided in these areas. Our recommendations for increasing canopy coverage in these zones are as follows:

- Shopping centers around the corner of West Atlantic Avenue and Military Trail have little tree cover within their vehicular use and other areas, as do commercial and industrial areas between Congress Avenue and the I-95 right of way. Ensure that they are meeting code requirements for landscaping and encourage additional tree planting.
- Carver Middle School, the School Board property at 101 Barwick Road has capacity for additional trees. Work with the Palm Beach County School Board to plant trees where they will not interfere with other activities.
- Discuss opportunities with community associations to plant trees in green open spaces, including common areas and around lakes.

City of Delray Beach
Tree Canopy Assessment
Zone 1

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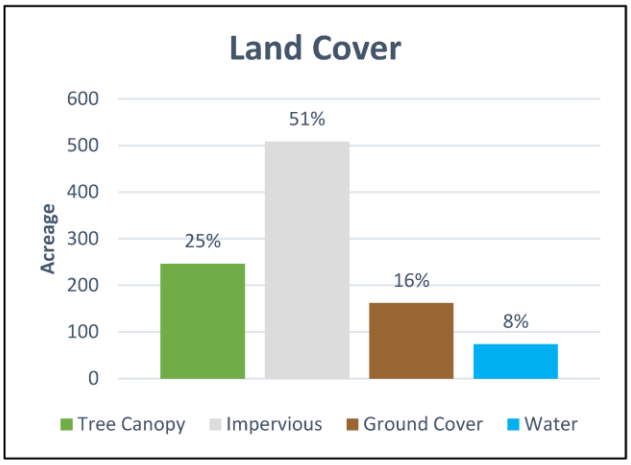
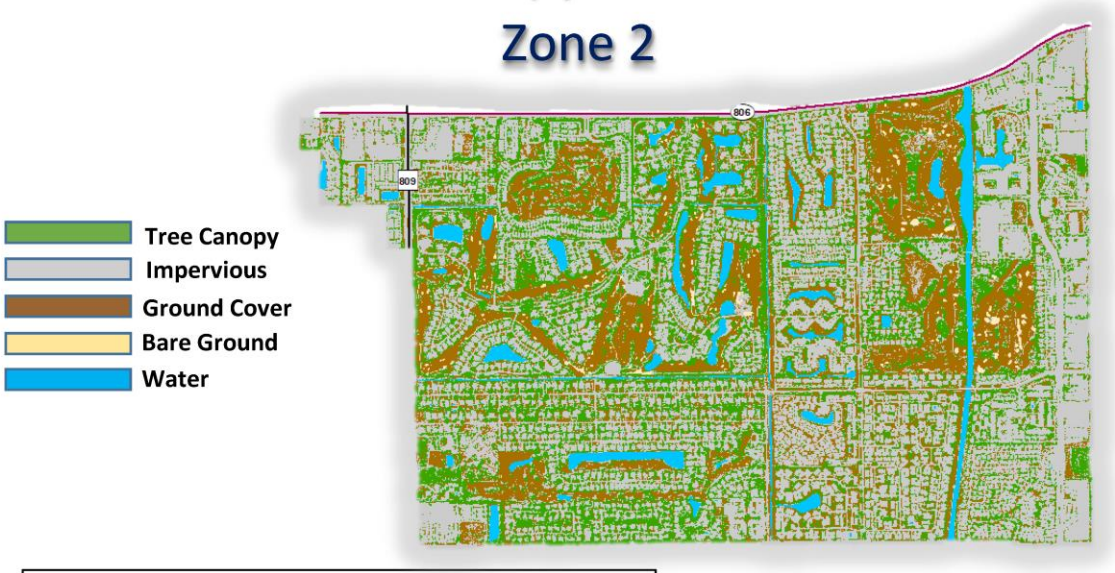


Land Use Statistics		
Class	**Acres**	**Percentage**
Residential	730	73%
Commercial	19	2%
Public/Semi-Public	123	13%
Industrial	25	3%
Other	30	3%
Total Acreage**	927	

**Water and transportation ROW are excluded from the land use total.

Environmental Benefits Statistics	
Carbon Sequestration (tons/year)	522
Total Carbon Stored (tons)	8449
Annual Value of Carbon Removal	$72,730
Total Air Pollution Removed (lbs/yr)	15598
Annual Value of Air Pollutant Removal	$93,108
Stormwater Storage (m^3/year)	207592
Annual Value of Stormwater Storage	$490,051

City of Delray Beach
Tree Canopy Assessment
Zone 2



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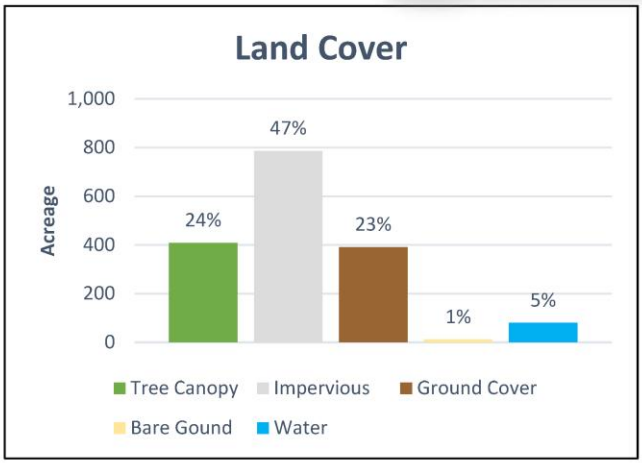
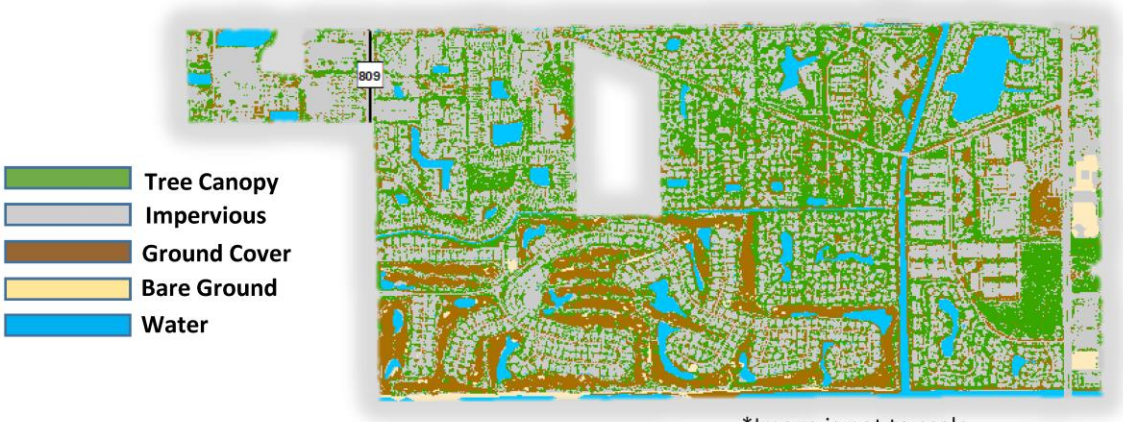


Land Use Statistics		
Class	**Acres**	**Percentage**
Residential	796	54%
Commercial	92	6%
Public/Semi-Public	453	31%
Industrial	64	4%
Other	65	5%
Total Acreage**	1470	

**Water and transportation ROW are excluded from the land use total.

Environmental Benefits Statistics	
Carbon Sequestration (tons/year)	866
Total Carbon Stored (tons)	14024
Annual Value of Carbon Removal	$120,691
Total Air Pollution Removed (lbs/yr)	25890
Annual Value of Air Pollutant Removal	$154,543
Stormwater Storage (m^3/year)	344566
Annual Value of Stormwater Storage	$813,398

City of Delray Beach
Tree Canopy Assessment
Zone 3



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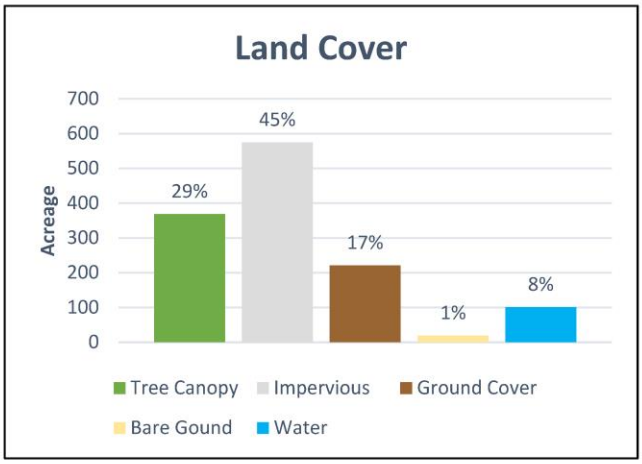


Land Use Statistics		
Land Cover	**Acres**	**Percentage**
Residential	633	53%
Commercial	108	9%
Public/Semi-Public	369	31%
Industrial	22	2%
Other	68	5%
Total Acreage**	1200	

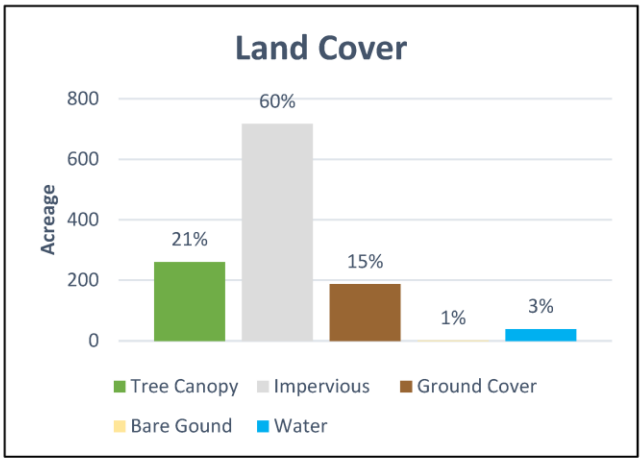
**Water and transportation ROW are excluded from the land use total.

Environmental Benefits Statistics	
Carbon Sequestration (tons/year)	781
Total Carbon Stored (tons)	12642
Annual Value of Carbon Removal	$108,796
Total Air Pollution Removed	23338
Annual Value of Air Pollutant Removal	$139,312
Stormwater Storage (/year)	310608
Annual Value of Stormwater Storage	$733,234

City of Delray Beach
Tree Canopy Assessment
Zone 11

*Image is not to scale

Tree Canopy
Impervious
Ground Cover
Bare Ground
Water



Land Use Statistics		
Land Cover	**Acres**	**Percentage**
Residential	679	63%
Commercial	145	13%
Public/Semi-Public	128	12%
Industrial	66	6%
Other	63	6%
Total Acreage**	1081	

**Water and transportation ROW are excluded from the land use total.

Environmental Benefits Statistics	
Carbon Sequestration (tons/year)	552
Total Carbon Stored (tons)	8930
Annual Value of Carbon Removal	76858
Total Air Pollution Removed	16,487
Annual Value of Air Pollutant Removal	$98,415
Stormwater Storage (m^3/year)	219425
Annual Value of Stormwater Storage	$517,984

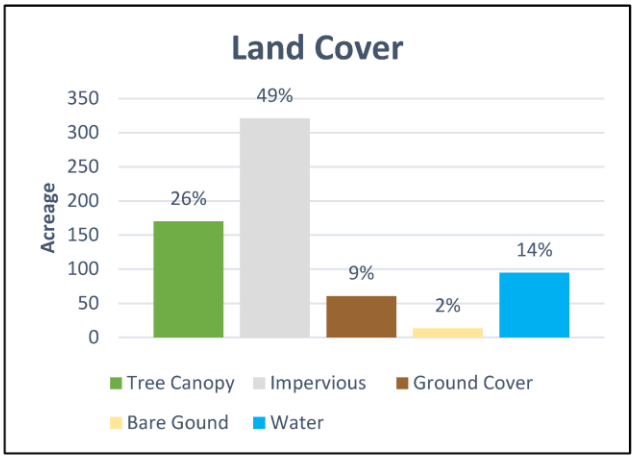
Priority 5: Zones 4 and 7

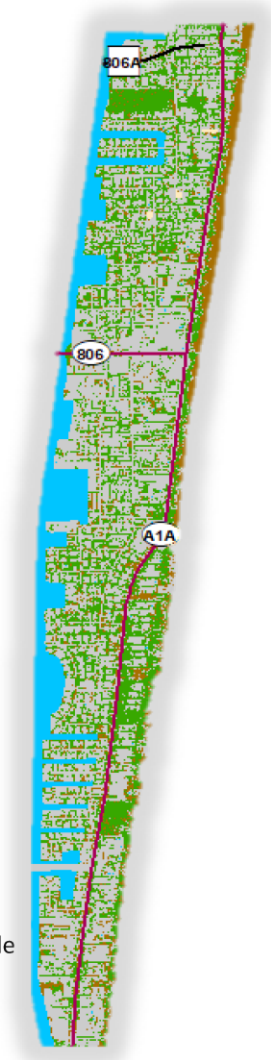
Zone 4 consists of the barrier island and contains the beach, hotels and affluent single-family homes. The canopy coverage on the barrier island is 26 percent. Zone 7 is primarily comprised of affluent single-family homes with commercial land uses to the east. Zone 7 also has a canopy coverage of 26 percent, which is equal to the second highest canopy coverage. There are also properties owned by churches and the school board, including Pulmosa Elementary School. While these areas are generally fully developed, there are a few opportunities to increase canopy coverage. Trees that are vulnerable to flooding and salt water should be avoided as data from the City show that flooding has been reported in Zone 4.

- The City can plant trees along three city-owned parcels along Lake Ida Road and at 301 NW 9 Street.
- Hold tree giveaways to increase the canopy coverage in residential yards.
- Encourage tree planting at the church-owned parcels.
- Tree planting opportunities exist along the edges of Lake Ida; however, these areas are County owned. The City should discuss opportunities with Palm Beach County.
- School Board owned properties along Lake Ida Road, at 2501 Seacrest Boulevard and 1712 NE 2 Avenue have capacity for additional tree plantings. Work with the Palm Beach County School Board to plant trees in locations where they will not interfere with other activities.

To achieve maximum canopy growth, large native shade trees are generally recommended, as long as they are appropriate for the planting location. **Appendix B** includes a list of trees suitable for planting in Delray Beach that was provided by Senior Landscape Planner William Wilsher.

City of Delray Beach
Tree Canopy Assessment
Zone 4





Tree Canopy
Impervious
Ground Cover
Bare Ground
Water

*Image is not to scale

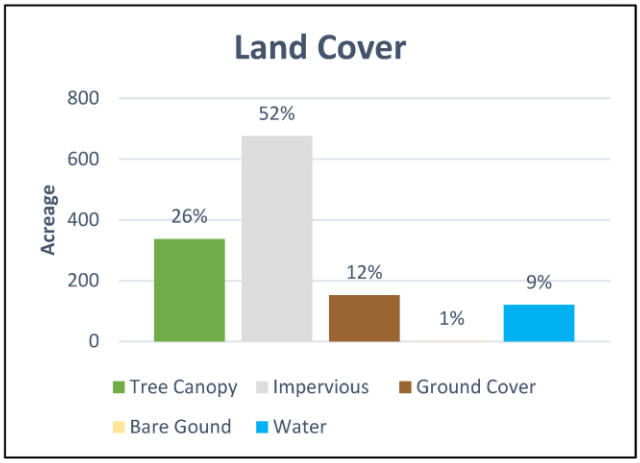
Land Use Statistics		
Land Cover	**Acres**	**Percentage**
Residential	361	79%
Commercial	28	6%
Public/Semi-Public	59	13%
Other	10	2%
Total Acreage**	459	

**Water and transportation ROW are excluded from the land use total.

Environmental Benefits Statiistics	
Carbon Sequestration (tons/year)	361
Total Carbon Stored (tons)	5838
Annual Value of Carbon Removal	$50,245
Total Air Pollution Removed	10778
Annual Value of Air Pollutant Removal	$64,338
Stormwater Storage (m^3/year)	143446
Annual Value of Stormwater Storage	$338,625

City of Delray Beach
Tree Canopy Assessment
Zone 7

*Image is not to scale



Land Use Statistics		
Land Cover	**Acres**	**Percentage**
Residential	639	62%
Commercial	82	8%
Public/Semi-Public	212	21%
Industrial	4	0%
Other	91	9%
Total Acreage**	1028	

**Water and transportation ROW are excluded from the land use total.

Environmental Benefits Statistics	
Carbon Sequestration (tons/year)	715
Total Carbon Stored (tons)	11570
Annual Value of Carbon Removal	$99,575
Total Air Pollution Removed	21360
Annual Value of Air Pollutant Removal	$127,505
Stormwater Storage (m^3/year)	284283
Annual Value of Stormwater Storage	$671,089

7.0 References

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APPENDICES

APPENDIX A

Appendix A – Description of iTree Landscape Models

The below description of the iTree models are from the iTree Landscape References webpage. Additional information on the data used to create the models and other functions of iTree Landscape can be found at https://landscape.itreetools.org/references/.

Carbon

Carbon storage and annual sequestration values are calculated from two separate sources depending upon location in non-forest or forest land cover. Land cover classification was determined using the National Land Cover Database (NLCD).

- Non-forest carbon: For non-forest NLCD classes, total carbon storage and net annual sequestration were estimated using values from urban forests (Nowak et al., 2013). Net annual sequestration is estimates of carbon accumulation from tree growth minus estimated carbon lost through decomposition due to tree mortality. Carbon storage was estimated based on the national average storage value of 7.69 kgC/m2 tree cover (standard error (SE) = 1.36 kgC/m2). Net sequestration was based on state estimates that varied based on length of growing season and averaged 0.226 kgC m2 tree cover/yr (SE = 0.045 kgC m2 tree cover/yr). State values varied from 0.430 kgC m2 tree cover/yr (Hawaii) to 0.135 kgC m2 tree cover/yr (Wyoming) (Nowak and Greenfield 2010). These estimates per unit of tree cover are essential as these values were applied to the tree cover estimates (m2) from the tree cover map to estimate total carbon (kg).
- Forest carbon: For forested regions, total carbon storage and net annual sequestration were derived from U.S. Forest Service Forest Inventory and Analysis (FIA) data for each county (Special thanks to Jim Smith for extracting these county FIA data). Net annual sequestration was carbon accumulated annually between FIA re-measurements based on accumulation from tree growth and new trees minus carbon lost through tree mortality.

Note: sequestration in forests is based on field measurements of change including the influx of new trees and loss of existing trees; in non-forest areas, net sequestration is modeled based on tree growth of existing trees and estimated mortality based on tree condition over a one-year period; this estimate does not include new tree influx and only includes a partial loss of carbon from mortality due to decomposition (entire carbon from trees is not removed, only part of carbon lost to decomposition is removed).

Total carbon storage and net sequestration per hectare of land was converted to total carbon storage and net sequestration per hectare of tree cover by dividing the carbon per hectare by percent tree cover in the forest land in the county. As tree cover on FIA land was not known, tree cover estimates from NLCD forest classes were used. In counties where tree cover in forest land was less than 10 percent (19 counties), tree cover was set to 10 percent to avoid inflating

carbon density values per unit of cover due to low tree cover estimates. If a county had no FIA carbon storage data, but had tree cover estimates, storage density values (kgC/m2 tree cover) from the closest county were used. FIA carbon storage densities per m2 of land area averaged 6.3 kgC/m2; carbon storage density adjusted for tree cover equaled 9.8 kgC/m2 tree cover.

Net sequestration per m2 of tree cover was calculated in the same manner as for carbon storage. For net carbon sequestration, values for some counties are missing. If a county had a missing value, sequestration density values (kgC/m2 tree cover/yr) from nearby counties in the same state were used. If the entire state had missing values, the county sequestration value was estimated based on converting the national FIA sequestration density value from all known counties to state values based on the ratio of state sequestration densities to national sequestration density for non-forest areas:

Forest sequestration density for state = national average forest density x (state non-forest sequestration density / national average non-forest density).

This procedure was used for net forest sequestration in many western states (AZ, CA, ID, MT, NM, NV, OR, UT, WA, WY). The average net sequestration value for forests was 0.14 kgC/m2 tree cover/yr (average SE = 0.10 kgC/m2 tree cover/yr)(see "i-Tree Landscape Carbon Storage and Sequestration for U.S. Counties"). This value is about 60 percent of the non-forest sequestration value. This difference is likely due to increased growth rates in urban areas (due to more open-grown nature of trees) and differences in means of calculating net sequestration (forest estimates remove all carbon from trees that die, but in urban estimates only a small portion are removed).

Value of carbon storage and sequestration is estimated at $139.33 / metric ton of carbon (Interagency Working Group, 2013).

Air Pollution

Air pollution removal and value estimates are based on procedures detailed in Nowak et al. (2014). This process used local tree cover, leaf area index, percent evergreen, weather, pollution, and population data to estimate pollution removal (g/m2 tree cover) and values ($/m2 tree cover) in urban and rural areas for each county. These values are applied to the m2 of tree cover to determine total removal and values related to carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3), particulate matter less than 2.5 microns (PM2.5), particulate matter between 2.5 and 10 microns (PM10*), and sulfur dioxide (SO2). Value estimates are based on local health impacts estimated using the U.S. EPA BenMAP model for each county (based on local population data) for all pollutants except for CO and PM10*, which use externality values ($/t) to estimate pollutant removal value.

Estimates of pollution removal varied by county. Average county removal rates are used, but have a potential maximum and minimum value (see i-Tree Landscape Pollutant Ranges) that illustrates a potential range. The minimum and maximum values on average are about 57 percent of the mean value. Average differences from the mean varied from a low of 30 percent for NO2 to a high of 106 percent for PM2.5. The maximum and minimum values are likely unreasonable values as they assume a maximum or minimum removal rate for every hour of the year. No maximum or minimum values are estimated for CO.

Hydrology

Estimates of transpiration, precipitation interception, and avoided runoff for each county in the conterminous United States in 2010 were developed using the i-Tree Eco model and local leaf area indices and weather data. Methods are detailed in Hirabayashi (2015), Hirabayashi and Endreny (2015) and Hirabayashi and Nowak (2015). The margin of error on these estimates is unknown.

APPENDIX B

RECOMMENDED SINGLE FAMILY PLANT LIST

Common Name	Botanical Name

SHADE TREES: Minimum 12' o.a, 4' straight trunk, 6' c.t., 6'spr.
One (1) tree/2,500 sq. ft. of property (To meet LDR 4.6.16)

LAUREL OAK	*Quercus laurifolia**
LIVE OAK	*Quercus virginiana**
MAHOGANY	*Swietenia mahagoni**
PIGEON PLUM	*Coccoloba diversifolia**
GREEN BUTTONWOOD	*Conocarpus erectus**
SILVER BUTTONWOOD	*Conocarpus erectus 'Sericeus'**
GUMBO LIMBO	*Bursera simaruba**
BRAZILIAN BEAUTYLEAF	*Callophyllum brasilience*
EAST PALATKA HOLLY	*Ilex attenuata 'East Palatka'**
DAHOON HOLLY	*Ilex cassine**
MAGNOLIA	*Magnolia grandiflora 'Little Gem' or 'DD Blanchard'**
BLACK OLIVE	*Bucida buceras*
BLACK IRONWOOD	*Krugiodendron ferreum**
WAX MYRTLE	*Myrica cerifera**
RED MAPLE	*Acer rubrum**
STOPPERS	*Eugenia spp.**
PARADISE TREE	*Simarouba glauca**

*Native tree species

FLOWERING & SMALL TREES: No minimum size, if not to meet LDR required trees

HONG KONG ORCHID	*Bauhinia blakeana*
VERAWOOD	*Bulnesia arborea*
BOTTLEBRUSH	*Callistemon spp.*
SATIN LEAF	*Chrysophyllum oliviforme**
ORANGE GEIGER	*Cordia sebestina**

FLOWERING & SMALL TREES:

PITCH APPLE	*Clusia rosea**
JAPANESE BLUEBERRY	*Elaeocarpus decipiens*
JAPANESE FERN	*Filicium decipiens*
SOUTHERN RED CEDAR	*Juniperus virginiana 'Silicicola'**
CRAPE MYRTLE	*Lagerstroemia indica*
QUEEN CRAPE MYRTLE	*Lagerstroemia speciosa*
JAPANESE PRIVET	*Ligustrum japonicum*
MADAGASCAR OLIVE	*Noronhia emarginata*
LANCEWOOD	*Ocotea coriacea**
FRANJIPANI	*Plumeria*
CASSIA	*Senna spp.*
TRUMPET	*Tabebuia spp.*

*Native tree species

PALMS: Minimum 12' o.a., 6' c.t.

Three (3) palm trees equal one (1) tree (To meet LDR 4.6.16)

ADONIDIA PALM	*Adonidia merrilli*
ALEXANDER PALM	*Ptychosperma elegans*
ARECA PALM	*Dypsis lutescens*
BOTTLE PALM	*Hyophorbe lagenicaulis*
CAT PALM	*Chamaedorea cataractarum*
COCONUT PALM	*Cocos nucifera 'Malayan'* or *'Maypan'*
FISHTAIL PALM	*Caryota mitis*
FLORIDA SILVER PALM	*Coccothrinax argentata**
FLORIDA THATCH PALM	*Thrinax radiata**
FOXTAIL PALM	*Wodeytia bifurcata*
MONTGOMERY PALM	*Veitchia montgomeryana*
PIGMY DATE PALM	*Phoenix roebeleni*
SABAL PALM	*Sabal palmetto**
SPINDLE PALM	*Hyophorbe verschaffeitii*
WILD DATE PALM	*Phoenix sylvestris*

*Native palm species

SHRUBS/ACCENT PLANTS: 3+ Gallon can, to meet screening and foundation plant requirements (To meet LDR 4.6.16)

SMALL-LEAF CLUSIA	*Clusia flava*
JAMAICA CAPER	*Capparis cynophallaphora**
SILVER BUTTONWOOD	*Conocarpus erectus 'Sericeus'**
COCOPLUM	*Chrysobalanus icaco**
SIMPSON STOPPER	*Myricanthes fragrans**
MYRSINE	*Myrsine guianensis**
FIREBUSH	*Hamelia patens**
FAKAHATCHEE GRASS	*Tripsacum dactyloides**
DWARF SCHEFFLERA	*Schefflera arboricola* or *'Trinette'* or *'Gold Capella'*
CHENILLE PLANT	*Acalypha hispida*
COPPER LEAF	*Acalypha wilkesiana*
SOFT-TIP AGAVE	*Agave attenuata*
VARIEGATED SHELLGINGER	*Alpinia zerembet 'Variegata'*
YESTERDAY/TODAY/TOMORROW	*Brunsfelsia grandiflora*
CROTON	*Codiaeum spp.*
TI PLANT	*Cordyline fruticosa*
CRINUM LILY	*Crinum spp.*
BLUEBERRY FLAX LILY	*Dianella tasmanica*
DRACEANA	*Draceana spp.*
GOLDMOUND	*Duranta erecta 'Goldmound'*
SPANISH STOPPER	*Eugenia foetida**
GREEN ISLAND FICUS	*Ficus microcarpa*
GIANT FALSE AGAVE	*Furcraea foetida*
THRYALLIS	*Galphimia gracilis*
DWARF YAUPON	*Ilex vomitoria 'Nana'*
IXORA	*Ixora 'Maui'*, *'Nora Grant'* or *'Red Taiwan Dwarf'*
JASMINE	*Jasmine multiflorum*, *nitidum* or *volubile*

SHRUBS/ACCENT PLANTS:

JATROPHA	*Jatropha integerrima*
PLUMBAGO	*Plumbago auriculata*
BRIDAL BOUQUET	*Plumeria pudica*
PODOCARPUS	*Podocarpus macrophyllus*
DWARF PODOCARPUS	*Podocarpus macrophyllus 'Pringles'*
RHAPHIOLEPSIS	*Rhaphiolepsis indica*
GROUND ORCHID	*Spathoglottis spp.*
WHITE BIRD OF PARADISE	*Strelitzia nicolai*
ORANGE BIRD OF PARADISE	*Strelitzia reginae*
PINWHEEL JASMINE	*Tabernaemontana spp.*
VIBURNUM	*Viburnum odoratissimum 'Awabuki'* or *suspensum*

*Native plant species

GROUNDCOVERS/LOWSHRUBS: 1 & 3 Gallon can, to meet the foundation plant requirements (To meet LDR 4.6.16)

SPIDER LILY	*Hymenocallis latifolia**
BOSTON FERN	*Nephrolepsis exaltata**
MACHO FERN	*Nephrolepsis falcata*
DWARF FAKAHATCHEE GRASS	*Tripsacum floridanum**
COONTIE	*Zamia pumila**
DWARF CHENILLE PLANT	*Acalypha pendula*
BROMELIADS	*Aechmeas, Neoregelia 'Fireball', Alcantarea 'Imperialis'* (sun) *Guzmania*, *Vriesia* (shade)
JUNIPERS	*Juniperus conferta* or *parsonii*
LANTANA	*Lantana camara* or *montevidensis*
LIRIOPE	*Liriope muscari*
WART FERN	*Microsorum scolopendrium*
DWARF OYSTER PLANT	*Tradescantia spathacea 'Dwarf'*

*Native plant species

RIGHT TREE RIGHT PLACE PLANT LIST

Common Name	Botanical Name
Small trees, under 20’ o.a., for under power poles and within 10’ of mast arms	
BOTTLEBRUSH	*Callistemon spp.*
ORANGE GEIGER	*Cordia sebestina**
WHITE GEIGER	*Cordia boissieri*
PITCH APPLE	*Clusia rosea**
JAPANESE BLUEBERRY	*Elaeocarpus decipiens*
STOPPERS	*Eugenia spp.**
JAPANESE FERN	*Filicium decipiens*
DAHOON HOLLY	*Ilex cassine**
CRAPE MYRTLE	*Lagerstroemia indica*
JAPANESE PRIVET	*Ligustrum japonicum*
SIMPSON’S STOPPER	*Myricanthes fragrans**
WAX MYRTLE	*Myrica cerifera**
MADAGASCAR OLIVE	*Noronhia emarginata*
FRANJIPANI	*Plumeria spp.*
CASSIA	*Senna spp.*
TRUMPET	*Tabebuia spp.*
YELLOW ELDER	*Tecoma stans**
Small palms, under 20’ o.a., for under power poles and within 10’ of mast arms	
PAUROTIS PALM	*Acoelorrhaphe wrightii**
ADONIDIA PALM	*Adonidia merrilli*
CAT PALM	*Chamaedorea cataractarum*
MEDITERRANEAN FAN PALM	*Chamaerops humilis*
FLORIDA SILVER PALM	*Cocothrinax argentata**
BOTTLE PALM	*Hyophorbe lagenicaulis*
SPINDLE PALM	*Hyophorbe verschaffeitii*
PIGMY DATE PALM	*Phoenix roebeleni*
LADY PALM	*Rhaphis excelsa*
NEEDLE PALM	*Rhapidophyllum hystrix**
DWARF PALMETTO	*Sabal minor**
SAW PALMETTO	*Serenoa repens**
ARIKURY PALM	*Syagrus schizophylla*
FLORIDA THATCH PALM	*Thrinax radiata**

Native plant species*

Common Name	Botanical Name

Medium trees, under 40’ o.a., for beside power poles and within 20’ of mast arms

HONG KONG ORCHID	*Bauhinia blakeana*
VERAWOOD	*Bulnesia arborea*
GUMBO LIMBO	*Bursera simaruba**
SATINLEAF	*Chrysophyllum oliviforme**
PIGEON PLUM	*Coccoloba diversifolia**
GREEN BUTTONWOOD	*Conocarpus erectus**
SILVER BUTTONWOOD	*Conocarpus erectus ‘Sericieus’**
EAST PALATKA HOLLY	*Ilex attenuata ‘East Palatka’**
BLACK IRONWOOD	*Krugiodendron ferreum**
LANCEWOOD	*Ocotea coriacea**

Medium palms, under 40’ o.a., for beside power poles and within 20’ of mast arms

CARNAUBA PALM	*Copernicia spp.*
ARECA PALM	*Dypsis lutescens*
FISHTAIL PALM	*Caryota mitis*
ALEXANDER PALM	*Ptychosperma elegans*
SABAL PALM	*Sabal palmetto**
MONTGOMERY PALM	*Veitchia montgomeryana*
FOXTAIL PALM	*Wodeytia bifurcata*

Native plant species*

PERIMETER/SITE TREES

*Acer rubrum**	Red Maple
Bauhinia blakeana	Hong Kong Orchid
Bulnesia arborea	Verawood
Callistemon spp.	Bottlebrush
*Chrysophyllum oliviforme**	Satinleaf
*Coccoloba uvifera**	Seagrape
*Coccoloba diversifolia **	Pigeon Plum
Cocos nucifera	Coconut Palm
*Cordia sebestina**	Orange Geiger
Delonix regia	Royal Poinciana
Elaeocarpus decipiens	Japanese Blueberry
*Eugenia foetida**	Spanish Stopper
Filicium decipiens	Japanese Fern
Jacaranda mimosifolia	Jacaranda
*Juniperus virginiana 'Silicicola'**	Southern Red Cedar
*Krugiodendron ferreum**	Black Ironwood
Koelreuteria elegans	Golden Rain
Lagerstroemia indica	Crape Myrtle
Lagerstroemia speciosa	Queen Crape Myrtle
Ligustrum japonicum	Japanese Privet
*Myrcianthes fragrans**	Simpson's Stopper
*Myrica cerifera**	Wax Myrtle
Noronhia emarginata	Madagascar Olive

*Ocotea coriacea**	Lancewood
Peltophorum spp.	Yellow Poinciana
Phoenix spp.	Date Palm
*Pinus elliotti**	Slash Pine
Plumeria	Franjipani
Senna spp.	Cassia
*Simarouba glauca**	Paradise Tree
Tabebuia spp.	Trumpet
Taxodium spp. *	Cypress
Tacoma stands	Yellow Elder

*Native tree species

These are the species of trees that may be readily available in the nursery industry but may not quite meet the current City of Delray's standard for Trees, under LDR 4.6.16(H)(2)(d) Landscape Design Standards-Trees: "Shall be a species having an average mature spread of crown greater than twenty (20) feet and having trunks which can be maintained in a clean condition with over six (6) feet of clear mature wood. Tree species shall be a minimum of sixteen (16) feet in overall height at the time of planting, with minimum six (6) feet of single straight trunk with eight (8) feet of clear trunk and a seven (7) foot spread of canopy." Also they may require additional maintenance: for pruning to meet the clear mature wood requirement (interfering with CPTED standards or tree clearance for vehicles); for cleanup due to excessive leaf loss or due to flower, pod, fruit or seed loss. For that reason these tree species may be better utilized in larger turf area and or in perimeter areas, that are away from parking areas.

STREET/PARKING ISLAND TREES

Bucida buceras	Black Olive
*Bursera simaruba**	Gumbo Limbo
Calophyllum brasilience	Brazilian Beautyleaf
*Conocarpus erectus**	Green Buttonwood
*Conocarpus erectus 'Sericeus'**	Silver Buttonwood
*Ilex cassine**	Dahoon Holly
*Ilex attenuata 'East Palatka'**	East Palatka Holly
*Magnolia grandiflora 'DD Blanchard'**	Magnolia
*Magnolia grandiflora 'Little Gem'**	Magnolia
*Quercus laurifolia**	Laurel Oak
*Quercus virginiana** (In particular *'Highrise'* & *'Cathedral'*)	Live Oak
*Roystonea regia**	Royal Palm
*Swietenia mahagoni**	Mahogany

*Native tree species

These are the species of trees that are readily available in the nursery industry and can meet the current City of Delray Beach's standard for Trees, under LDR 4.6.16(H)(2)(d) Landscape Design Standards-Trees: "Shall be a species having an average mature spread of crown greater than twenty (20) feet and having trunks which can be maintained in a clean condition with over six (6) feet of clear mature wood. Trees species shall be a minimum of sixteen (16) feet in overall height at the time of planting, with a minimum of six (6) feet of single straight trunk with eight (8) feet of clear trunk and a seven (7) foot spread of canopy."