City of Venice Tree Canopy Analysis

2020


SPEED LIMIT
30

City of Venice Tree Canopy Analysis 2020

Final Report to the City of Venice

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Special Thanks

City Council for the direction and support to accomplish the study

Landowners and residents of the City of Venice

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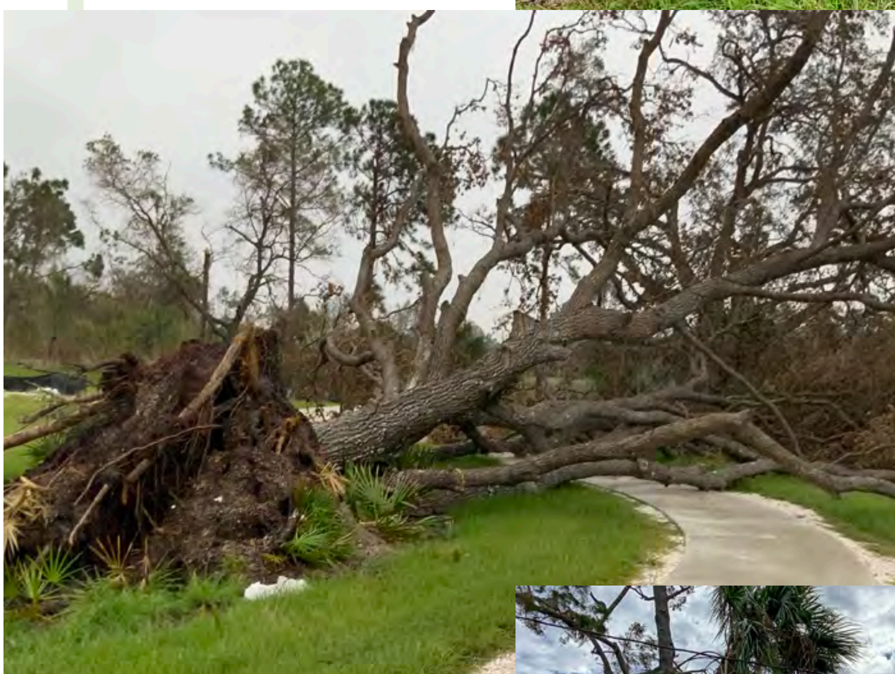


The photographs on these two pages depict storm damage from Hurricane Ian.

Photographs appearing elsewhere in this report were taken prior to the storm.

All photographs were provided by the City of Venice.

Foreword

A tree canopy analysis provides valuable data regarding a city's existing tree canopy. It will reveal changes over a period of time, with ten years being a normal interval. The need for this study was identified as a City Council priority in 2021 and the final draft for staff review was received from the consultant on September 23, 2022.

On September 28, 2022, Hurricane Ian struck southwest Florida, making landfall 30 miles away in Cayo Costa with winds just below Category 5 strength. The City of Venice was immersed in Ian's massive wind field and record setting rainfall for many hours. Structural damage in Venice was minimal overall.

Significant loss of large Heritage and Venetian trees has taken place, however. As a result, the tree canopy has been reduced, though not eliminated. Although this will have some impact, the data in this analysis remains valid and helpful to determine ways to improve the tree canopy.

Contents

Background

This project is part of the City of Venice's Tree Program and its efforts to provide a sustainable future by enacting tangible solutions to protect the City's natural environment for future generations.

This report summarizes the results of two mapping efforts designed to understand the state of urban tree canopy within the City. First, aerial imagery from 2010 and 2020 was used to determine whether tree canopy was lost or gained during the previous decade. Second, an Urban Tree Canopy (UTC) map was created from the 2020 aerial imagery and LiDAR that shows the distribution of tree canopy as well as grass/shrubs and other land cover classes (i.e., roads, other paved areas, buildings, water, and bare soil). The UTC map was used to summarize the amount of canopy within different areas of the City, and to determine where additional tree planting might be possible. Additional analysis was performed to estimate how trees and vegetation might mitigate urban heat, estimate the potential for trees to help reduce stormwater runoff, and identify streets where storm damage to trees might pose a problem.

Key Findings

- Citywide tree canopy changed during the past decade from 24.3% in 2010 to 23.3% in 2020. However, the measurement error of +/-1.5% means that we cannot say with absolute certainly that there was a decrease in tree canopy.
- Detailed landcover mapping of 2020 conditions shows that 59% of the City is covered by tree canopy and other vegetation, 26% impervious surfaces, 11% water, and 4% bare earth (largely from communities under development in 2020).
- Tree canopy cover in Venice neighborhoods ranges from 17% in the Venice Island neighborhood to 32% in the Knights Trail neighborhood.
    - Potential planting sites of 4ft by 4ft or more were mapped, and the percentage of neighborhood land area where trees could be planted ranged from 18% in the Gateway neighborhood to 43% in the Laurel Rd Business Corridor.
- There is 247.6 acres of tree canopy on the 1,244 acres of City owned properties, representing 19.9% tree cover.
    - There is an additional 668 acres, or 54%, of City properties with potential planting sites of 4ft by 4ft or more.
- On the 496 acres of City-maintained right-of-way, there are 98.5 acres of tree canopy
    - There are an additional 109 acres of potential planting site locations within the right-of-way.

- Based on the Future Land Use (FLU) designations of the City of Venice Comprehensive Plan, areas designated as Mixed Use Residential have more than twice as much tree canopy (811 acres) as any other FLU category, and nearly as much grass/shrub cover (1,813 acres) as all other categories combined (2,001 acres).
- According to the City's Zoning Map, the Planned Unit Development zoning category has 898 acres of tree canopy, over five times more than any other category.
- A Heat Map developed to show summertime land surface temperatures indicates that some areas of the City can be 15 degrees Fahrenheit hotter than other areas during the summer.
    - Temperatures in areas with tree canopy and grass/shrub are at least three degrees F cooler than areas with impervious surfaces
    - Neighborhoods with more total vegetation cover (i.e., tree canopy and grass/shrub) are up to six degrees F cooler on average than neighborhoods with less vegetation cover
- Based on data from the US Forest Service and detailed field sampling from the City of Tampa in 2016, one acre of tree canopy cover can help avoid 7,266 gallons of stormwater runoff per year
    - Tree canopy in Venice neighborhoods might be responsible for reducing stormwater runoff by nearly 18 million gallons of water per year that would otherwise have to be treated by more costly stormwater infrastructure
    - Increasing tree canopy on potential planting sites could reduce an additional 29 million gallons of stormwater runoff per year in Venice neighborhoods
    - Tree canopy on City-maintained public right-of-way reduces stormwater runoff by an estimated 715,701 gallons per year, an amount that might be doubled with tree planting on potential planting sites
    - The value of avoided runoff by tree canopy on City properties is estimated at $16,120 per year, an amount that could be increased by another $43,489 per year through tree planting
- In order to prioritize tree maintenance efforts, LiDAR was used to map the location and height of trees in the City and identify where trees might by tall enough to fall on nearby primary and secondary emergency management roads during a storm.
    - Out of the 15 miles of Primary Roadways maintained by the City, there are 2.3 miles of road in the highest risk category.
    - There are only 9.8 miles of Secondary Roadways, but 3.9 miles are in the highest risk category.
    - There were 2,030 trees tall enough to potentially fall on primary emergency management roads, and 2,514 trees tall enough to reach secondary roads.

Methods

Several methods were used in this study to determine the amount and distribution of urban tree canopy within the City of Venice, and how that tree cover had changed during the past decade. In addition, an urban heat map was created to show how summertime land surface temperatures vary throughout the City. The methods followed the latest science from the US Forest Service, urban forest researchers, remote sensing specialists and spatial analysts. The following sections provide a brief description of these methods, including: (1) tree canopy change; (2) Urban Tree Canopy mapping; (3) creation of the urban heat map; and (4) estimation of the location, height and canopy size of individual trees.

Tree canopy change from 2010 to 2020 relied on the dot-based method, a process similar to the US Forest Service i-Tree Canopy method (https://canopy.itreetools.org/), which is a statistically robust method to determine tree canopy change using any aerial imagery. The method used GIS to create randomly distributed points within the City (approximately 3,200 points). At each point location, a skilled technician evaluated whether the aerial imagery showed tree canopy or something other than tree canopy. After evaluation of all points, the data was used to calculate citywide percent tree canopy and confidence intervals. The process is repeated for both recent (i.e., 2020) and historic aerials (i.e., 2010). A second technician evaluated 50 of the same points to determine whether there would be error depending on the person doing the evaluation, and there was >96% agreement. The method allows the determination of whether there was a statistically significant gain or loss in tree canopy.

Figure 1. Illustration of the process to map Urban Tree Canopy.

The Urban Tree Canopy (UTC) map relied on remotely sensed data in the form of 2020 aerial imagery and light detection and ranging (LiDAR) data. These datasets, which have been acquired by various governmental agencies in the region, are the foundational information for tree canopy mapping. Imagery provides information that enables features to be distinguished by their spectral (color) properties. As trees and shrubs can appear spectrally similar, or obscured by shadow, LiDAR, which consists of 3D height information, enhances the accuracy of the mapping. Tree canopy mapping is performed using a scientifically rigorous process that integrates cutting-edge automated feature extraction technologies with detailed manual reviews and editing. This combination of sensor and mapping technologies enabled the city's tree canopy to be mapped in greater detail and with better accuracy than ever before.

Urban heat is becoming an increasingly large problem for many cities. Cities are normally much hotter than surrounding suburban and rural areas, and there are areas within cities that are much hotter than others (e.g., heat islands). This project used well-known and accepted techniques to develop a heat map for the City of Venice. Existing freely available LandSat satellite imagery from July 30, 2021 and August 31, 2021 (daytime imagery) were used to calculate land surface temperature. The land surface temperature or heat map shows where the hotter areas of the city are located.

Mapping the location and characteristics of individual trees is typically accomplished using the very expensive tree inventory method, in which trained arborists visit every tree in the field and record the location, height, canopy size, etc. Unfortunately, field inventories are too expensive for most cities to conduct and maintain. This study used an advanced remote sensing algorithm to map individual tree locations using LiDAR data. LiDAR was collected in Sarasota County in 2018 as part of a large project organized by the Florida Division of Emergency Management. At no cost to the City, we leveraged the available LiDAR and used it for this project. Sophisticated algorithms were able to estimate the location of each tree, along with the tree height and the approximate crown area (i.e., tree canopy).

Finally, spatial analysis was performed to summarize the results of these map products using ArcGIS Pro (a common geographic information systems software). All map layers used for the summaries created for this report (e.g., neighborhood boundaries) were provided by the City of Venice Planning and Zoning Department. Specific spatial analysis is described in the sections of this report.

Tree Canopy Change 2010-2020

Citywide tree canopy was 24.3% in 2010 and 23.3% in 2020 with a confidence interval (e.g., margin of error) of 1.5%. Although these results might appear to be a slight loss in tree canopy, it is important to consider the inherent statistical accuracy of the estimate. In statistical terms, the estimated 24.3% tree canopy in 2010 has a 95% chance of being as low as 22.8% or as high as 25.8%, while the 2020 tree canopy has a 95% chance of being as low as 21.8% or as high as 24.8%. Given the overlap in these estimates, we cannot say with absolute certainty that there was a decrease in tree canopy.

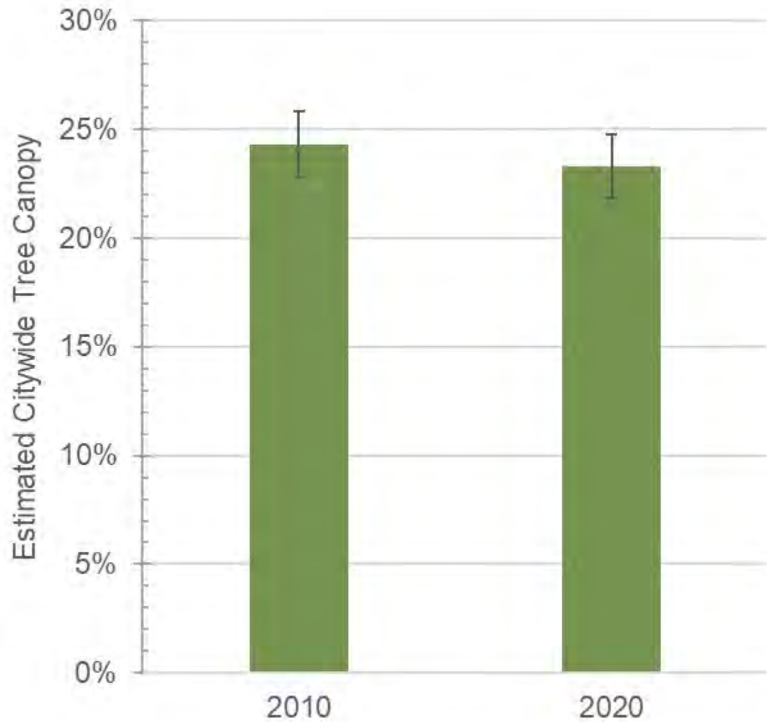


Figure 2. Estimated change in Citywide tree canopy between 2010 and 2020.

Existing Tree Canopy

The Urban Tree Canopy (UTC) map shows where existing tree canopy is located within the City of Venice. In combination with other map layers, the existing tree canopy can be summarized by neighborhood, within public right-of-way, on public lands or other geographic locations. The City can also use the Urban Tree Canopy (UTC) GIS map to conduct future analysis.

Maps on the following pages show the locations of tree canopy and other land cover within the City of Venice. The City is divided into three maps in order to show as much detail as possible within the format of this report: Venice Island; Central Venice; and Northeast Venice.

TREE CANOPY IN OTHER U.S. CITIES

Tree canopy cover results for other US cities were assembled to provide a comparison with the City of Venice.

Sources: [1]Georgia Tech. (2014). Assessing Urban Tree Canopy in the City of Atlanta; A Baseline Canopy Study (geospatial.gatech.edu/Greenspace). [2]Various sources, from the article Nine Cities That Love Their Trees (www.nationalgeographic.com/news-features/urban-tree-canopy). [3]UVM Spatial Analysis Lab. Urban Tree Canopy Assessments (gis.w3.uvm.edu/utc/). [4]Andreu, M. G., Fox, D., Landry, S., Northrop, R., and Hament, C. (2017). Urban Forest Ecological Analysis. City of Gainesville, March 2017; Appendix C. City of Gainesville, FL. [5]Nowak, D. J., & Greenfield, E. J. (2012). Tree and impervious cover change in U.S. cities. Urban Forestry & Urban Greening, 11(1), 21-30. [6]Plan-it Geo. (2015). An Assessment of Urban Tree Canopy in the City of Jacksonville, Florida (www.planitgeo.com). [7]Plan-It Geo. (2015). An Assessment of Urban Tree Canopy in Chatham County, Georgia (www.planitgeo.com). [8]Landry, S., et al. (2018). City of Tampa Tree Canopy and Urban Forest Analysis 2016. Tampa, FL: City of Tampa, Florida.

City	Year	Tree Canopy
Atlanta, GA[1]	2008	48%
Austin, TX[2]	2010	37%
Baltimore, MD[2]	2007	27%
Charlotte, NC[3]	2012	37%
Detroit, MI[2]	2010	23%
Gainesville, FL[4]	2015	54%
Houston, TX[5]	2009	27%
Jacksonville, FL[6]	2015	41%
Miami, FL[4]	2009	22%
New York City, NY[2]	2010	21%
Philadelphia, PA[2]	2008	20%
Pittsburgh, PA[2]	2010	42%
Portland, OR[2]	2007	30%
Savannah, GA[7]	2013	44%
Tampa, FL[8]	2016	32%
Venice, FL	2020	23%
Virginia Beach, VA[3]	2008	38%
Washington, DC[2]	2011	36%

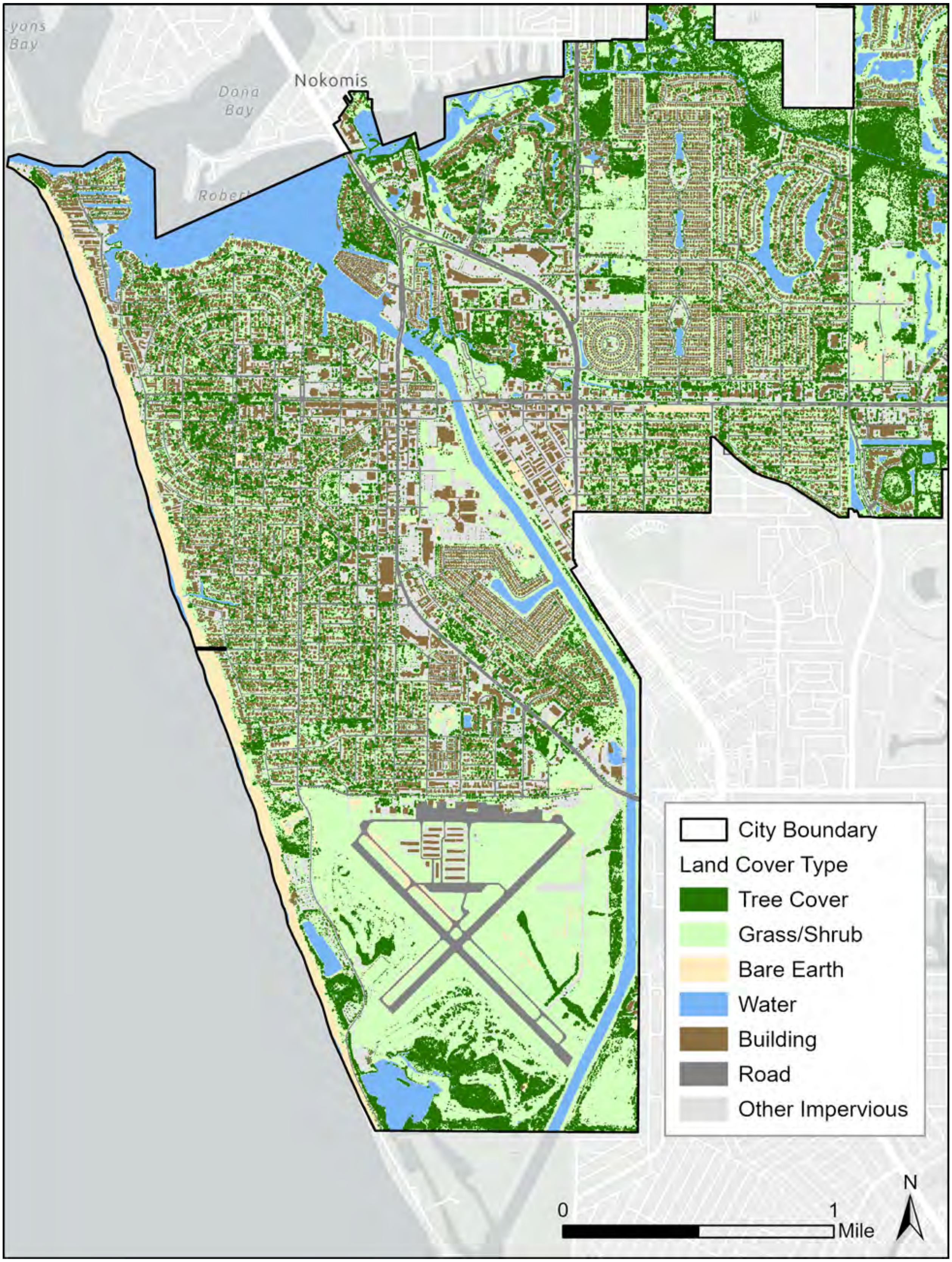


Figure 3. Map of tree canopy and other land cover in the Venice Island area.

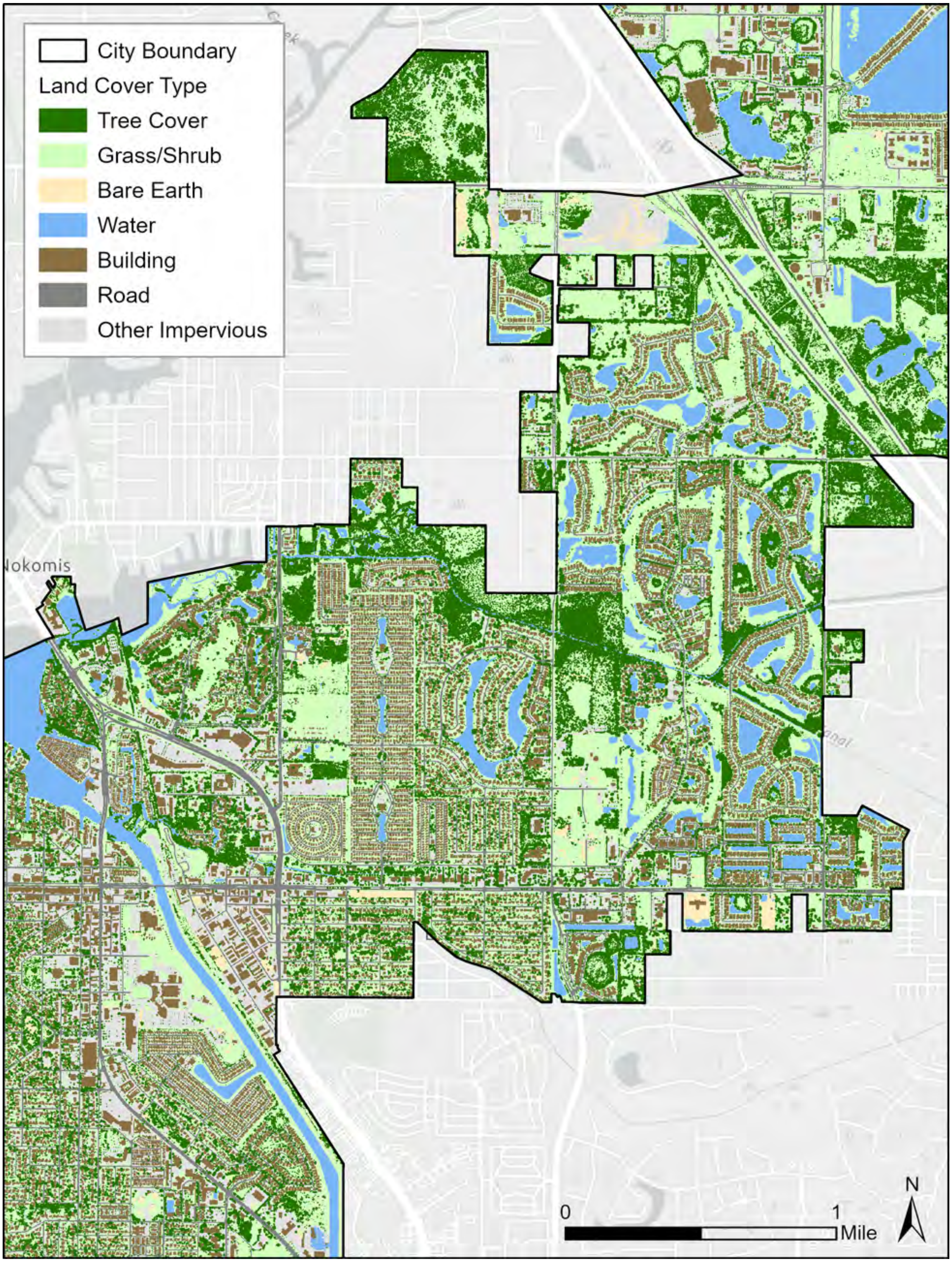


Figure 4. Map of tree canopy and other land cover in the Central Venice area.

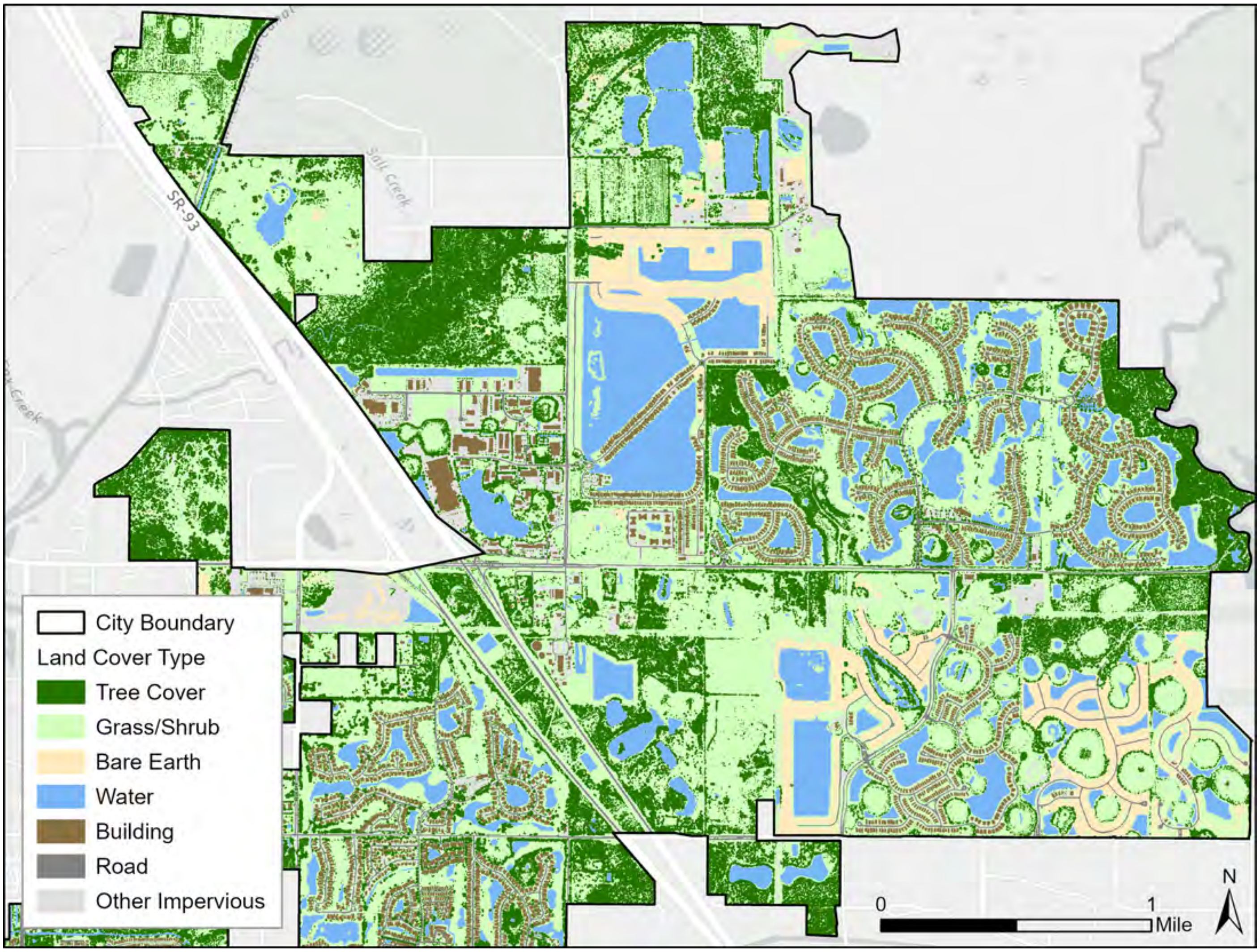


Figure 5. Map of tree canopy and other land cover in the Northeast Venice area.

Landcover in the City of Venice

The Urban Tree Canopy (UTC) map classified every ½ foot of the City in land cover classes. The 22.2% tree canopy from the mapping effort is within the margin of error of the dot-based result of 23.3%. The chart below shows that 59% of the City of Venice is covered by tree canopy and other vegetation. The relatively large amount of bare earth (4%) is a result of the large areas in the Northeast Venice area that were actively being developed during the time represented by the UTC map (i.e., 2020). Once developed, those areas will be comprised of a combination of vegetation, buildings, roads and other impervious surfaces.

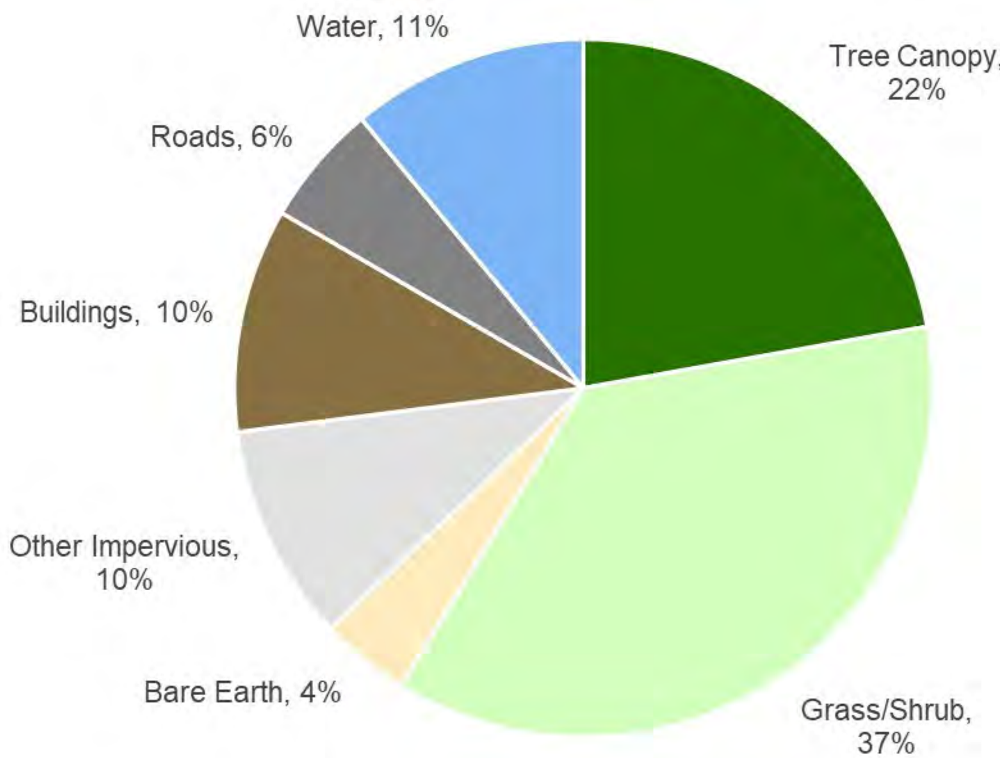


Figure 6. Summary of Citywide land cover within the City of Venice.

Existing Tree Canopy by Neighborhood

The amount of tree canopy within City of Venice neighborhoods is shown in the map and summarized in the chart below. While the map only shows the locations of tree canopy within each neighborhood, the chart also shows the total acreage of tree canopy within the neighborhood. The percentage of the neighborhood covered by tree canopy ranges from 17% in the Venice Island neighborhood to 32% in the Knights Trail neighborhood. In terms of total acreage of tree canopy, the largest amount (603 acres) is in the Pinebrook neighborhood, followed by Northeast Venice and Venice Island. The section of the report about Potential Tree Canopy will show that there are opportunities to plant trees and increase canopy in most neighborhoods of the City.

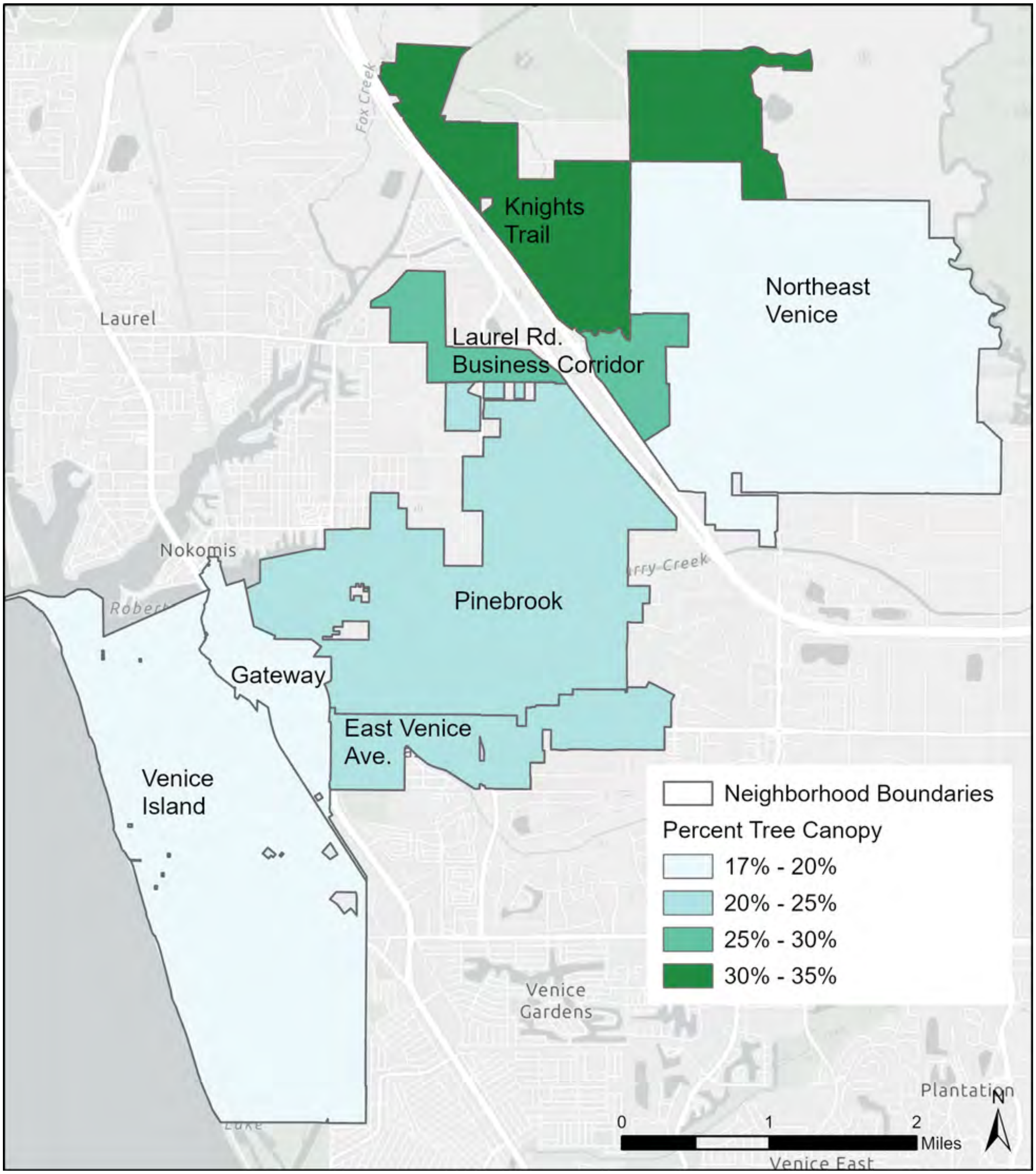


Figure 7. Percentage of tree canopy within City of Venice neighborhoods.

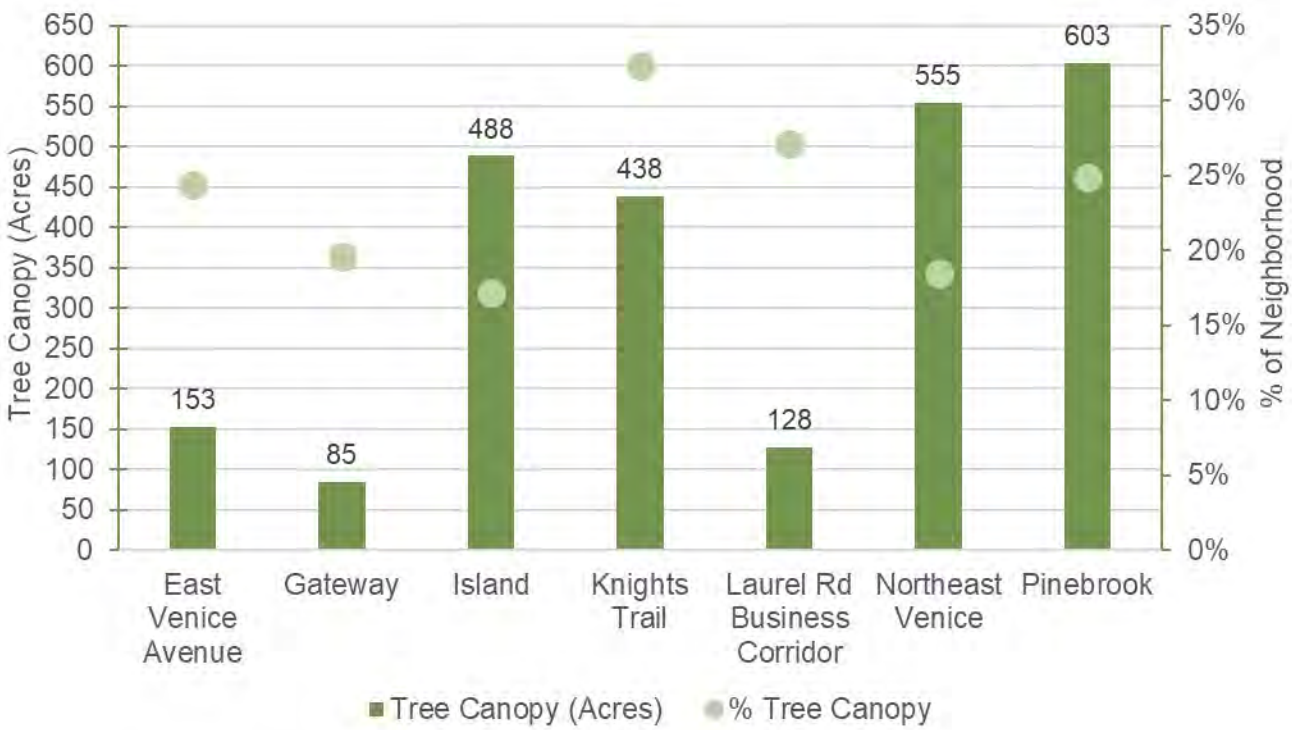


Figure 8. Total acreage and percent tree canopy within City of Venice neighborhoods.

Existing Tree Canopy on Public Lands

There are 1,244 acres of land owned by the City of Venice. The map on the next page shows the location of these properties and the percentage of each property covered by tree canopy. There is a total of 247.6 acres of tree canopy on City-owned property, representing 19.9% of the total land area.

247.6	19.9%
Acres of Tree Canopy on City-owned Property	Percentage of Public Land that is tree canopy

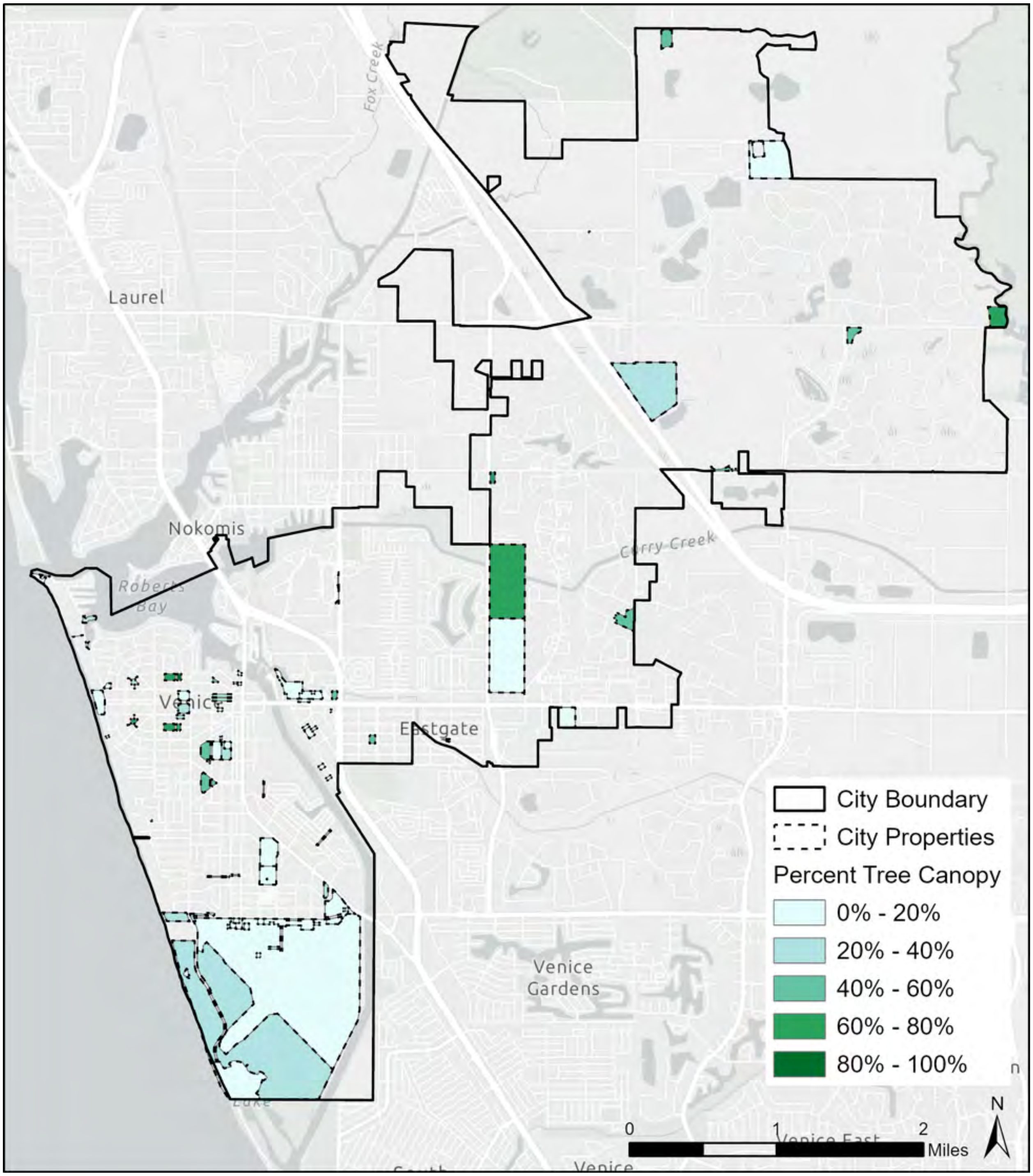


Figure 9. Location of City properties and percentage of the land covered by tree canopy.

Existing Tree Canopy on Public Right-of-way

The term right-of-way (ROW) generally refers to the land on which streets are located, including a portion of land bordering the street where sidewalks, utilities and street trees are often located. Streets and ROW within the City of Venice are maintained by several different government agencies, including the State of Florida, Sarasota County, the City of Venice, and sometimes the local neighborhoods (especially in large planned communities). The City of Venice maintains approximately 496 acres of public ROW. A total of 98.5 acres of ROW land area are covered by tree canopy, representing 19.8% of all City-maintained right-of-way.

98.5	19.8%
Acres of Tree Canopy on City-maintained ROW	Percentage of ROW that is tree covered

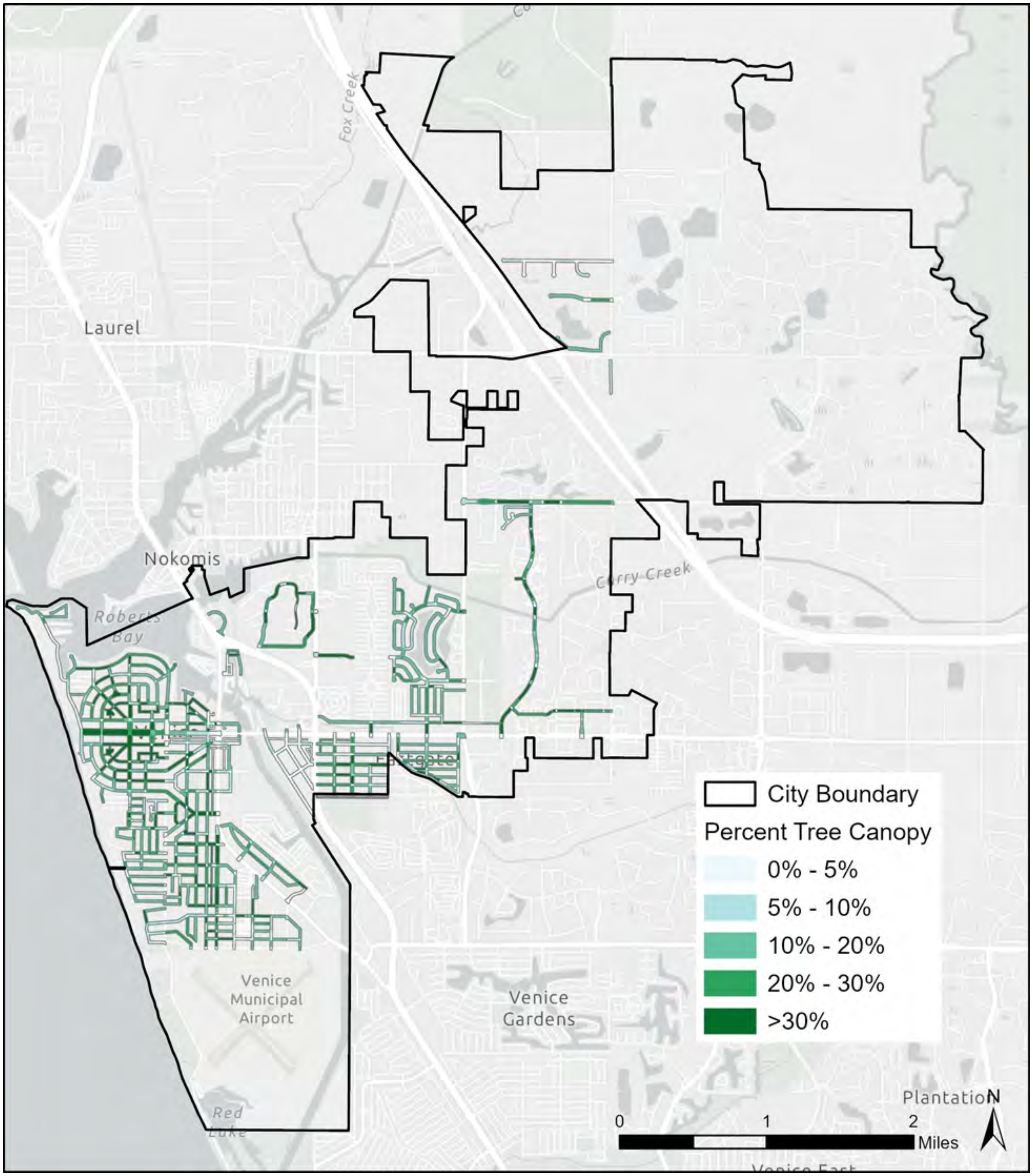


Figure 10. Location of City-maintained public right-of-way (ROW).

Existing Land Cover by Future Land Use

The City of Venice Comprehensive Plan is the City's blueprint for the future. The Comprehensive Plan is an umbrella document that guides other City plans, capital projects, and programs which affect the community. The most recent plan covers the timeframe from 2017-2027 and was adopted January 12, 2018. One of the important elements of any Comprehensive Plan is a plan for the Future Land Use (i.e., FLU), reflecting what type of land use will be permitted in different areas of the City in the future. Using the UTC map, the existing land cover was determined for each of the City's Future Land Use (FLU) categories. The table below show the percentage of the land designated by each FLU category that is currently covered by the mapped land cover classes. The chart shows the total acres of both tree canopy and grass/shrub (i.e., other vegetation) within each FLU category. The chart shows that the acres of tree canopy located in areas designated as Mixed Use Residential (811 acres) represent more than twice as much as any other FLU category, and the amount of grass/shrub (1,813 acres) is nearly equal to all other FLU categories combined (2,001 acres). Many Mixed Use Residential areas are undeveloped lands located in Northeast Venice. As these lands are developed, the development plans for new neighborhoods and the regulations of the City will determine how much of the tree canopy will be retained and how much new canopy might be gained as a result of neighborhood tree planting and landscaping. In many areas of Florida, where the undeveloped land was historically open canopy pine flatwoods habitat, the amount of tree canopy often increases after residential development.

Land use and land cover are easily confused, but the key difference is that land cover represents what is on the land surface when viewed from above (e.g., Google Maps), while land use is simply how we (i.e., humans) utilize the land. In Florida, the Water Management Districts also map Land Use Land Cover (LULC), which shows both how the land is used (land use) as well as the type of habitats on less developed land areas (land cover).

Table 1. Percentage of each FLU category covered by tree canopy and other land cover.

Future Land Use Category	Total Acres	Tree Canopy	Grass/ Shrub	Impervious	Bare Earth	Water
Commercial	183	22%	15%	60%	0%	3%
Conservation	685	33%	22%	2%	1%	42%
Government	634	9%	59%	24%	4%	4%
High Density Residential	134	24%	16%	51%	1%	1%
Industrial	523	22%	28%	30%	3%	17%
Institutional Professional	144	32%	36%	55%	2%	2%
Low Density Residential	992	29%	30%	37%	1%	8%
Medium Density Residential	266	23%	28%	36%	5%	8%
Mixed Use Airport	125	10%	63%	26%	2%	0%
Mixed Use Corridor	684	24%	38%	31%	3%	3%
Mixed Use Downtown	84	12%	11%	76%	0%	2%
Mixed Use Residential	4,304	19%	42%	16%	6%	16%
Mixed Use Seaboard	67	4%	6%	86%	4%	0%
Mixed Use Transitional	214	50%	25%	30%	0%	0%
Moderate Density Residential	535	50%	31%	46%	1%	2%
Open Space Functional	568	28%	49%	29%	7%	7%

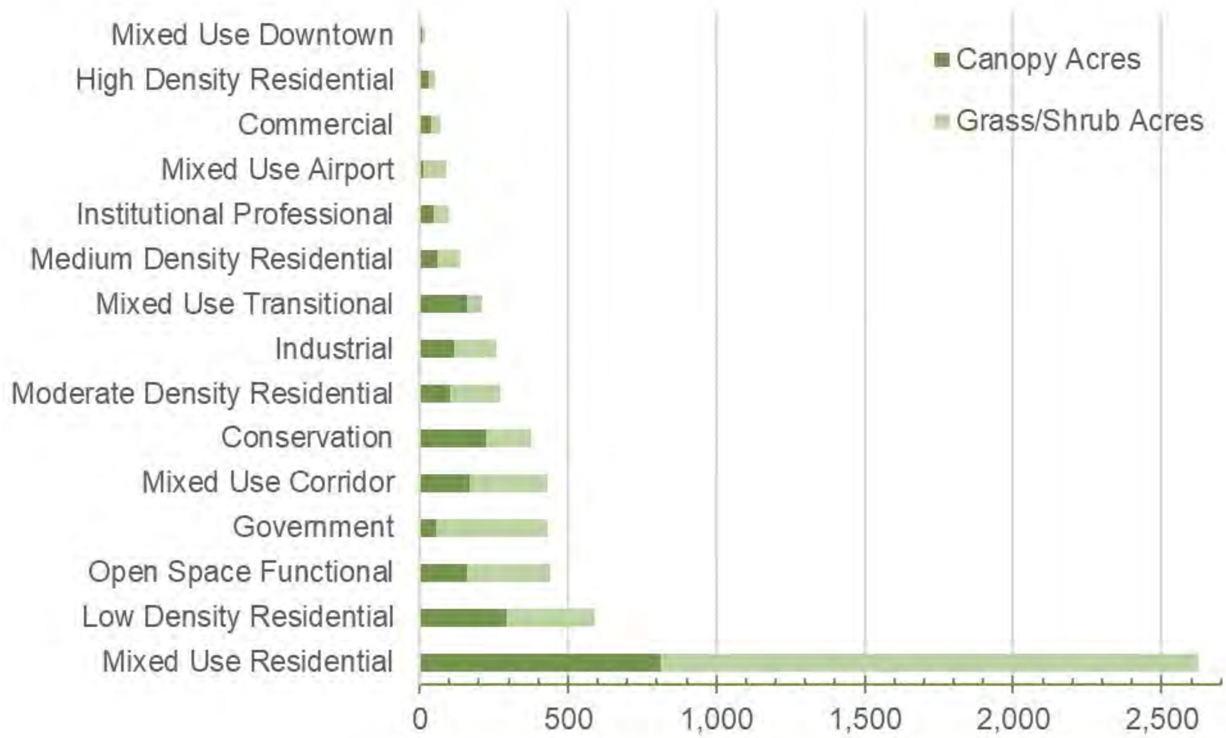


Figure 11. Total acreage of tree canopy and grass/shrub within each FLU category.

Existing Land Cover by Zoning Category

The City of Venice Land Development Code, Chapter 87, City of Venice Code of Ordinances, outlines development review procedures, use regulations and development standards within specific zoning districts. The City's Zoning Map outlines the zoning designations within the City's boundaries. Using the UTC map, the existing land cover was determined for each of the City's Zoning categories. The table below shows the percentage of the land designated by each Zoning category that is covered by the mapped land cover classes. The chart shows the total acres of both tree canopy and grass/shrub (i.e., other vegetation) within only the Zoning categories that have more than 80 acres of total vegetation land cover (tree canopy plus grass/shrub). The chart shows that the acres of tree canopy located in areas designated as Planned Unit Development (898 acres) represent over five times more than any other zoning category (e.g., recreation has 166 acres of tree canopy). The amount of grass/shrub (1,852 acres) is nearly equal to all other zoning categories combined (2,119 acres).

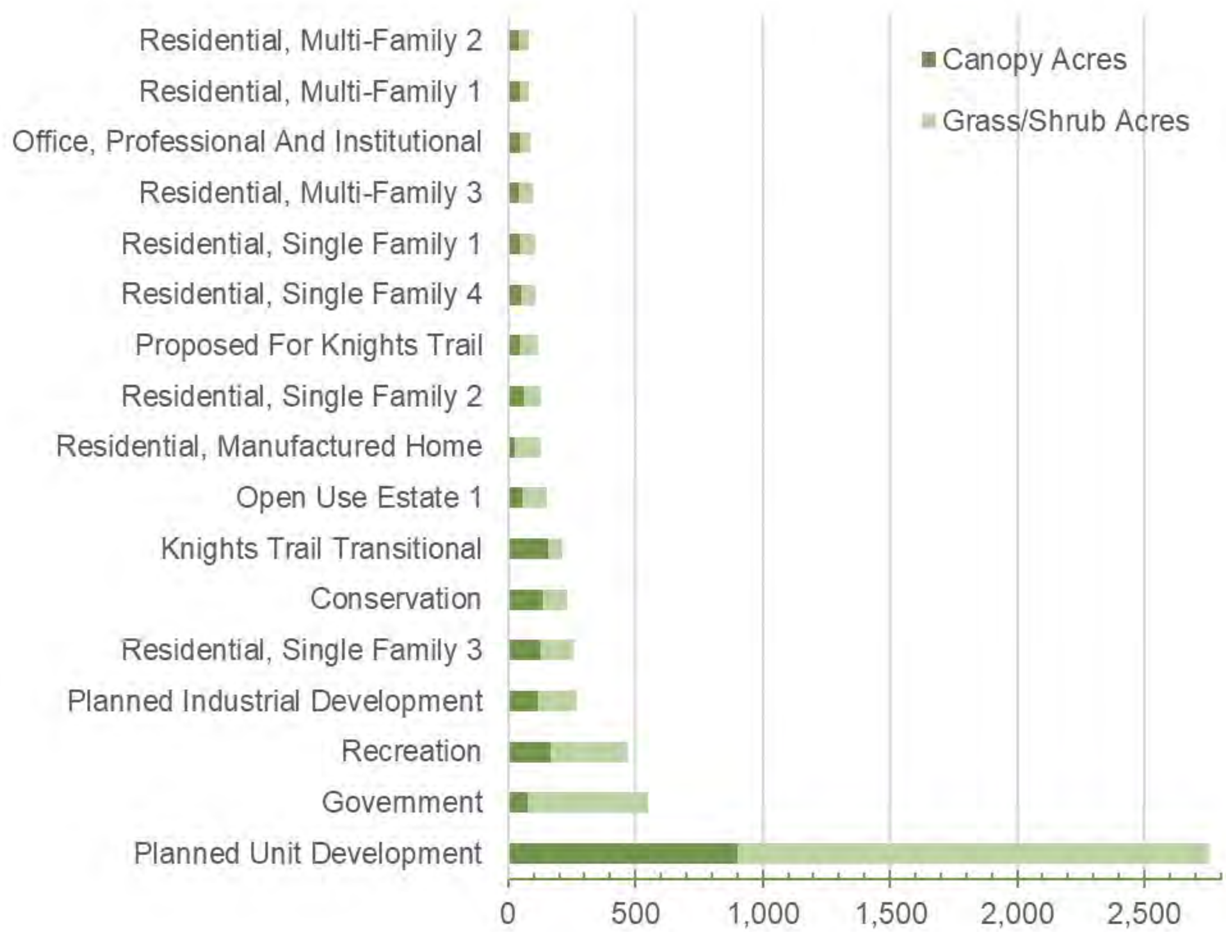


Figure 12 . Total acreage of tree canopy and grass/shrub within each Zoning category. Only zoning categories with more than 80 acres of total vegetation are shown.

Table 2. Percentage of each Zoning category covered by tree canopy and other land cover.

Zoning Category	Total Acres	Tree Canopy	Grass/ Shrub	Impervious	Bare Earth	Water
Airport Avenue	27	14%	20%	66%	0%	0%
Commercial	155	25%	17%	53%	1%	5%
Commercial, General	60	56%	42%	1%	0%	0%
Commercial, Intensive	1	0%	1%	99%	0%	0%
Commercial, Shopping Center	36	13%	8%	80%	0%	0%
Conservation	531	26%	18%	1%	1%	54%
Downtown Edge	34	16%	19%	61%	0%	4%
Enclave	55	27%	65%	5%	1%	2%
Government	811	10%	58%	23%	4%	6%
Industrial	14	29%	22%	47%	0%	3%
Industrial, Light & Warehousing	9	3%	4%	88%	5%	0%
Knights Trail Transitional	214	74%	25%	0%	0%	0%
Laurel East	102	15%	56%	27%	1%	1%
Laurel West	122	13%	32%	38%	12%	5%
North Trail Gateway	13	6%	6%	63%	0%	25%
Office, Professional And Institutional	134	34%	31%	31%	3%	2%
Open Use Estate	40	74%	25%	0%	0%	1%
Open Use Estate 1	167	35%	56%	4%	2%	3%
Open Use Estate 2	19	22%	62%	15%	1%	1%
Open Use Rural	11	80%	17%	1%	0%	3%
Planned Industrial Development	529	22%	29%	29%	3%	17%
Planned Unit Development	4,549	20%	41%	18%	6%	16%
Proposed For Knights Trail	131	35%	55%	4%	3%	4%
Proposed For Laurel East	25	29%	65%	6%	0%	0%
Recreation	583	29%	52%	11%	6%	2%
Residential, Manufactured Home	338	8%	29%	61%	0%	2%
Residential, Multi-Family 1	115	38%	32%	25%	0%	4%
Residential, Multi-Family 2	161	25%	26%	36%	5%	8%
Residential, Multi-Family 3	172.2	25%	32%	34%	5%	4%
Residential, Multi-Family 4	127	23%	21%	46%	8%	1%
Residential, Single Family 1	152	30%	39%	25%	4%	2%
Residential, Single Family 2	213	28%	31%	41%	0%	0%
Residential, Single Family 3	459	27%	28%	44%	1%	0%
Residential, Single Family 4	154	35%	36%	24%	0%	5%
Residential, Tourist Resort	2	16%	31%	52%	0%	0%
Seaboard Improvement	48	4%	7%	84%	5%	0%
South Trail: Subarea 1	14	9%	3%	88%	0%	0%
South Trail: Subarea 2	114	14%	19%	64%	2%	2%
South Trail: Subarea 2 (Auc)	34	13%	12%	74%	0%	1%
Venice Avenue	43	8%	6%	86%	0%	0%

Potential planting sites

In this assessment, any areas with no trees, buildings, roads, or bodies of water are considered potential planting sites, and represent locations in which trees could theoretically be established without having to remove paved surfaces. The UTC map shows potential planting sites as grass/shrub. Only locations four feet by four feet (i.e., 4ft x 4ft) or larger were considered viable for a tree planting site. Bare earth was not included as a possible planting site because there were very large developments that were characterized as bare earth from the 2020 imagery because the areas were under construction. Those same developments would not be bare earth once full development has taken place.

Potential planting sites indicate the locations where additional trees could be planted. However, other factors go into deciding where a tree can be planted and flourish, including land use, social, and financial considerations. Thus, the potential planting sites should serve as a guide for further analysis, not a prescription of where to plant trees. For example, the map shows potential planting sites on the airport property, but obviously trees should not be planted near the runway.

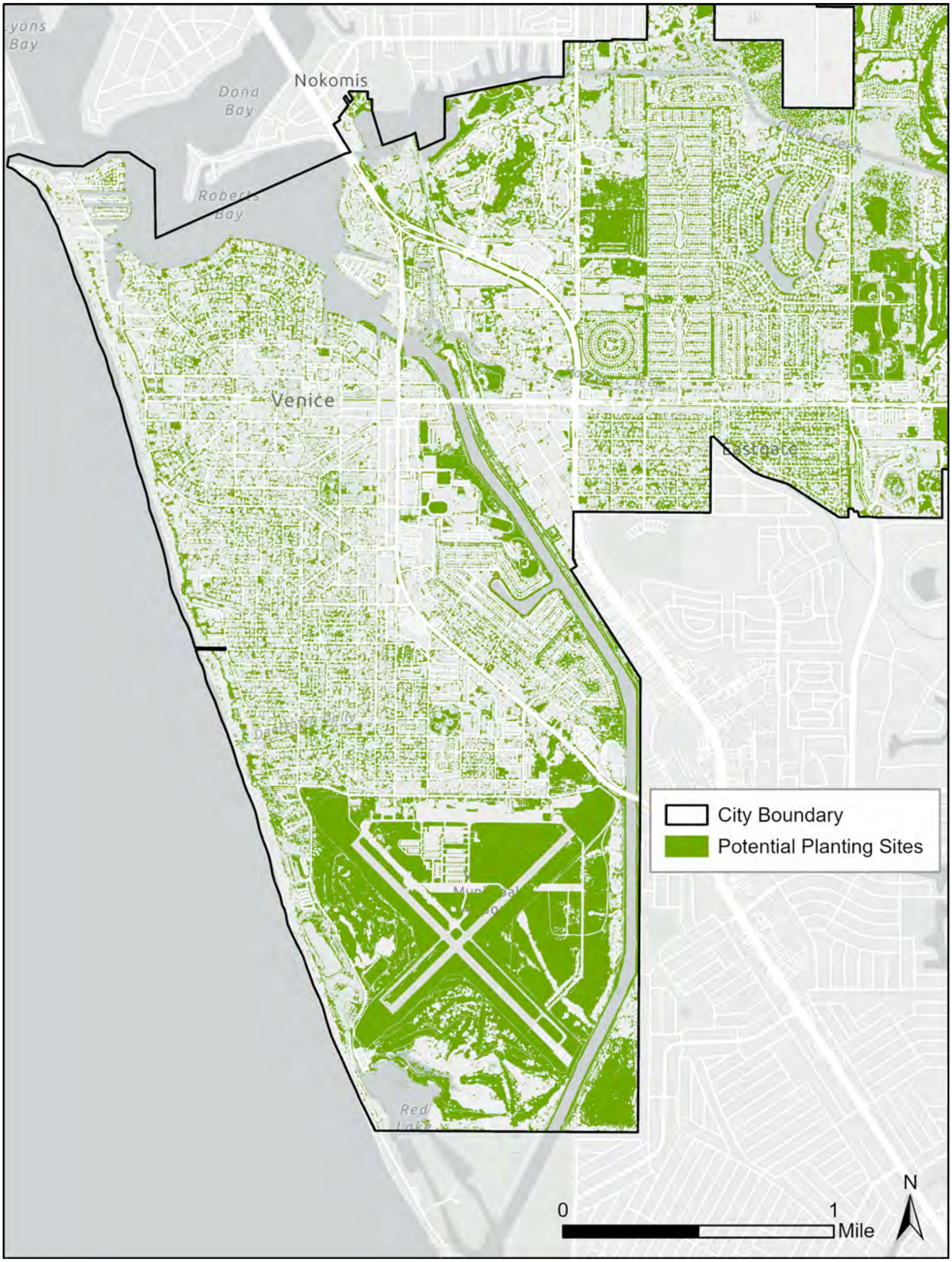


Figure 13. Potential Planting Sites in the Venice Island area.

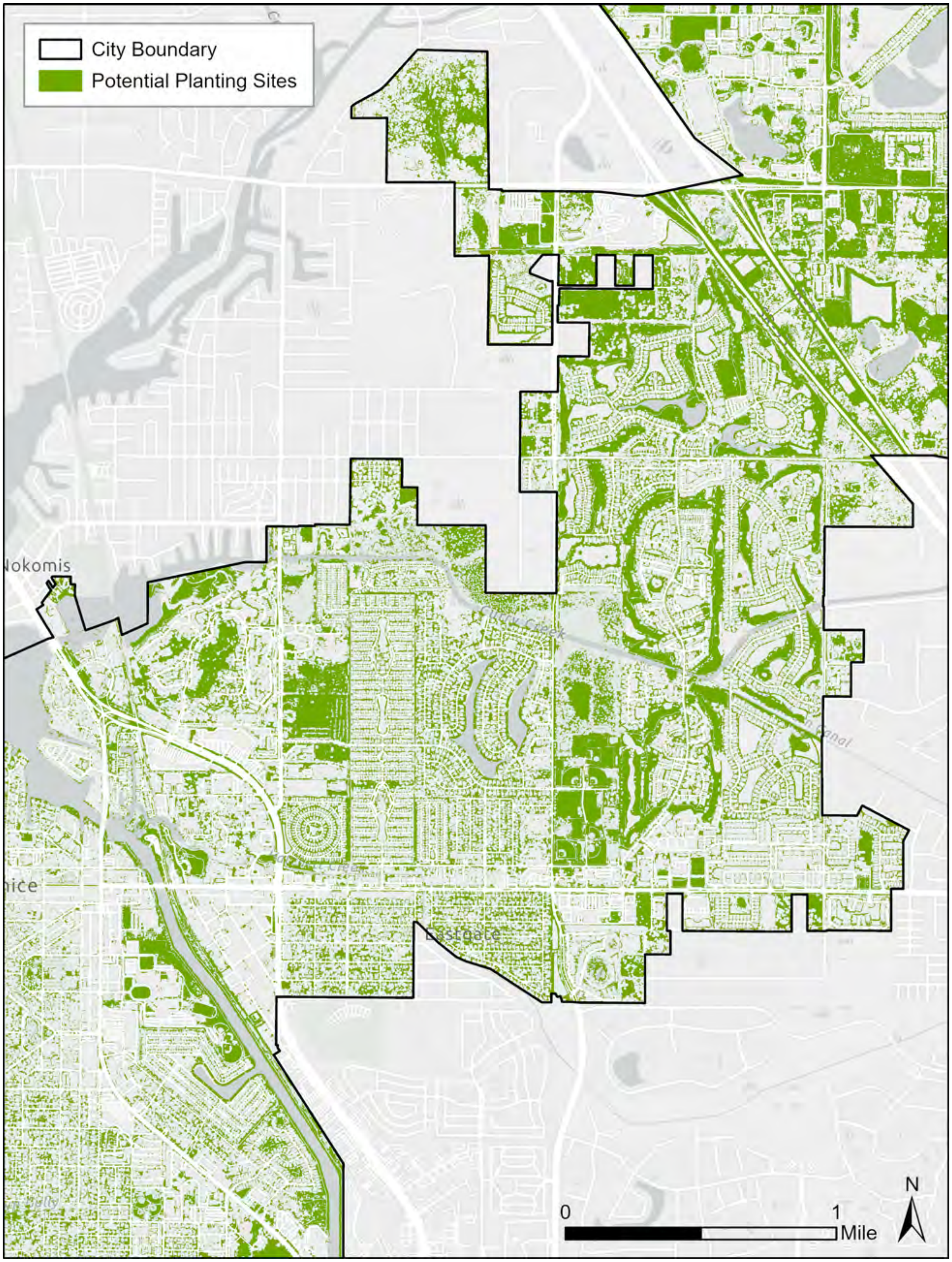


Figure 14. Potential Planting Sites in the Central Venice area.

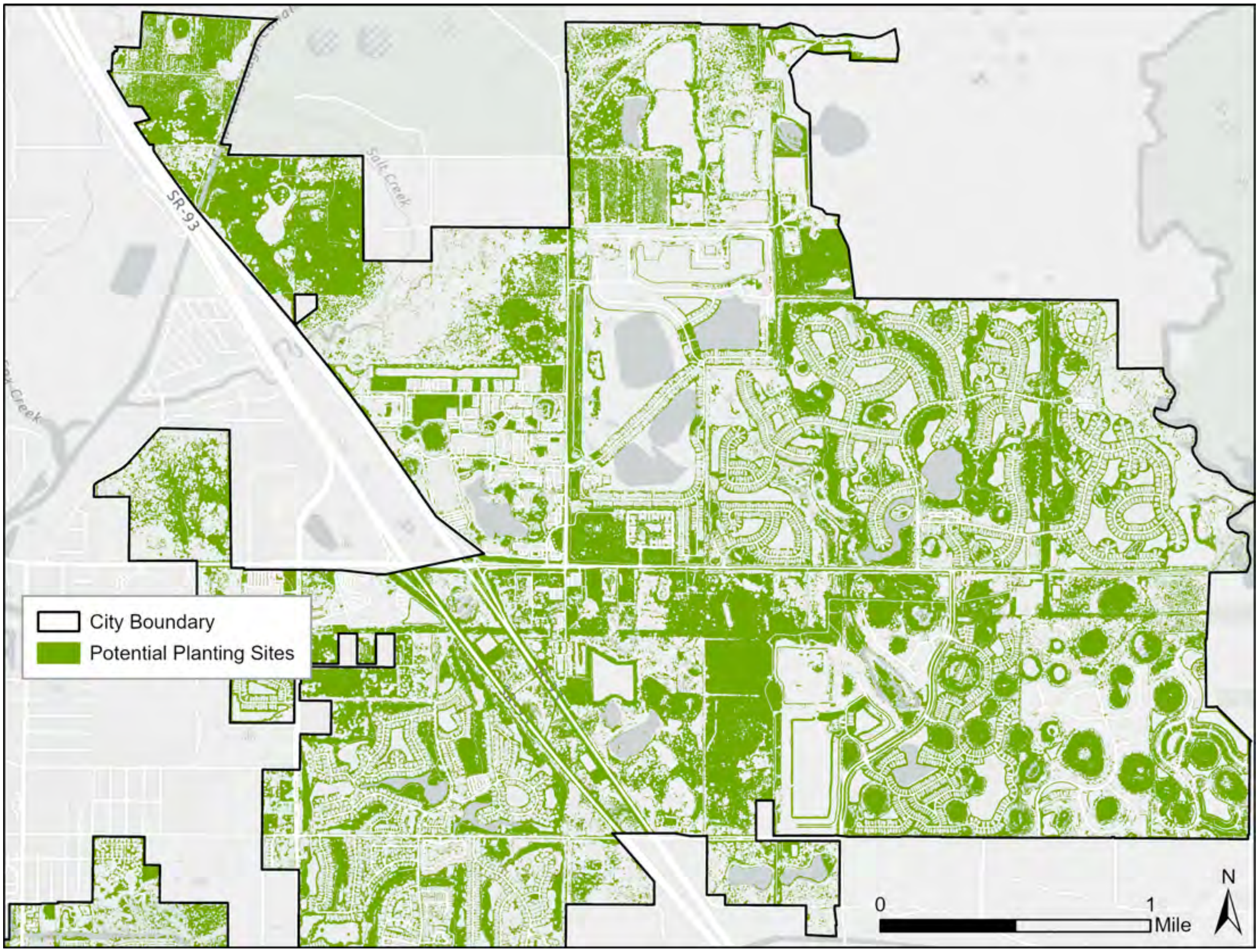


Figure 15. Potential Planting Sites in the Northeast Venice area.

Potential Planting Sites on City Properties

On the 1,244 acres of land owned by the City of Venice, there are 668 acres that are classified as potential planting sites. This area represents 54% of the acreage of all city properties and contains approximately 1.8 million potential planting sites.

1,244	668	1,819,586	54%
Total Acreage of City Properties	Potential Planting Site Acreage	Number of Potential Planting Sites	Percent of City Property Acreage with Potential Planting Sites

Potential Planting Sites in Venice Neighborhoods

Most neighborhoods in the City of Venice have sufficient potential planting site locations to more than double their tree canopy. For example, from Figure 7, the Venice Island neighborhood has only 17% tree canopy. An additional 34% of the land area in the Island neighborhood could become tree canopy if trees were planted in all potential planting sites. Although planting trees in all potential planting sites is clearly not feasible or desirable, the area of potential sites shows that there is plenty of room to grow the tree canopy in all neighborhoods.

Table 3. Summary of potential planting sites within Venice neighborhoods.

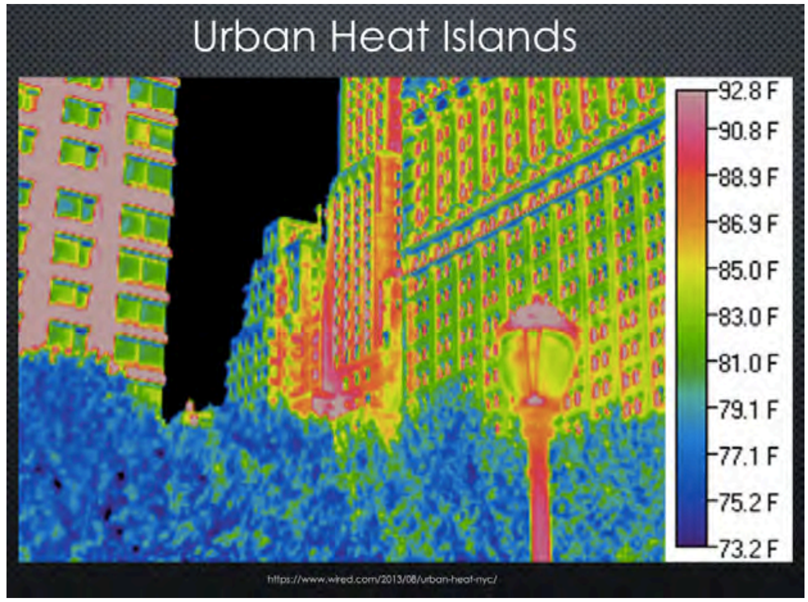
Neighborhood Name	Acres of Potential Planting Sites	Number of Potential Planting Sites	Potential Planting Sites as a percent of Neighborhood Area
East Venice Avenue	162	442,297	26%
Gateway	80	217,411	18%
Island	956	2,603,186	34%
Knights Trail	570	1,551,976	42%
Laurel Rd Business Corridc	203	552,952	43%
Northeast Venice	1,192	3,245,212	40%
Pinebrook	890	2,422,876	37%

Potential Planting Sites in Public Right-of-Way

The City of Venice maintains approximately 496 acres of public ROW, inclusive of the roadway and bordering property where sidewalks, street trees and utilities are located. There are 109 acres of potential planting sites within the City-maintained right-of-way, which represents 22% of the total ROW area. However, with 18,506 potential planting site locations, there is still land available where trees could be planted.

496	109	18,506	22%
ROW Acreage	Potential Planting Site Acreage	Number of Potential Planting Sites	Percent of ROW Acreage with Potential Planting Sites

Heat island mitigation



Heat islands are generally considered to be locations within the city where the surface temperature is higher than other areas, usually due to the presence of higher amounts of impervious surfaces (e.g., roads, parking lots). Existing freely-available LandSat satellite imagery from July 30, 2021 and August 31, 2021 (daytime imagery) were used to calculate land surface temperature. The land surface temperature map shows where the hotter areas of the city are location. As seen in the map, some areas of the City can be 15 degrees Fahrenheit hotter than other areas.

A visual comparison of the land surface temperature map to the map of vegetation cover (i.e., tree canopy and grass/shrub combined), shows that areas of the City with more vegetation are much cooler than areas with less vegetation. There is a lot of scientific research that has documented that trees and other vegetation can dramatically reduce urban heat.

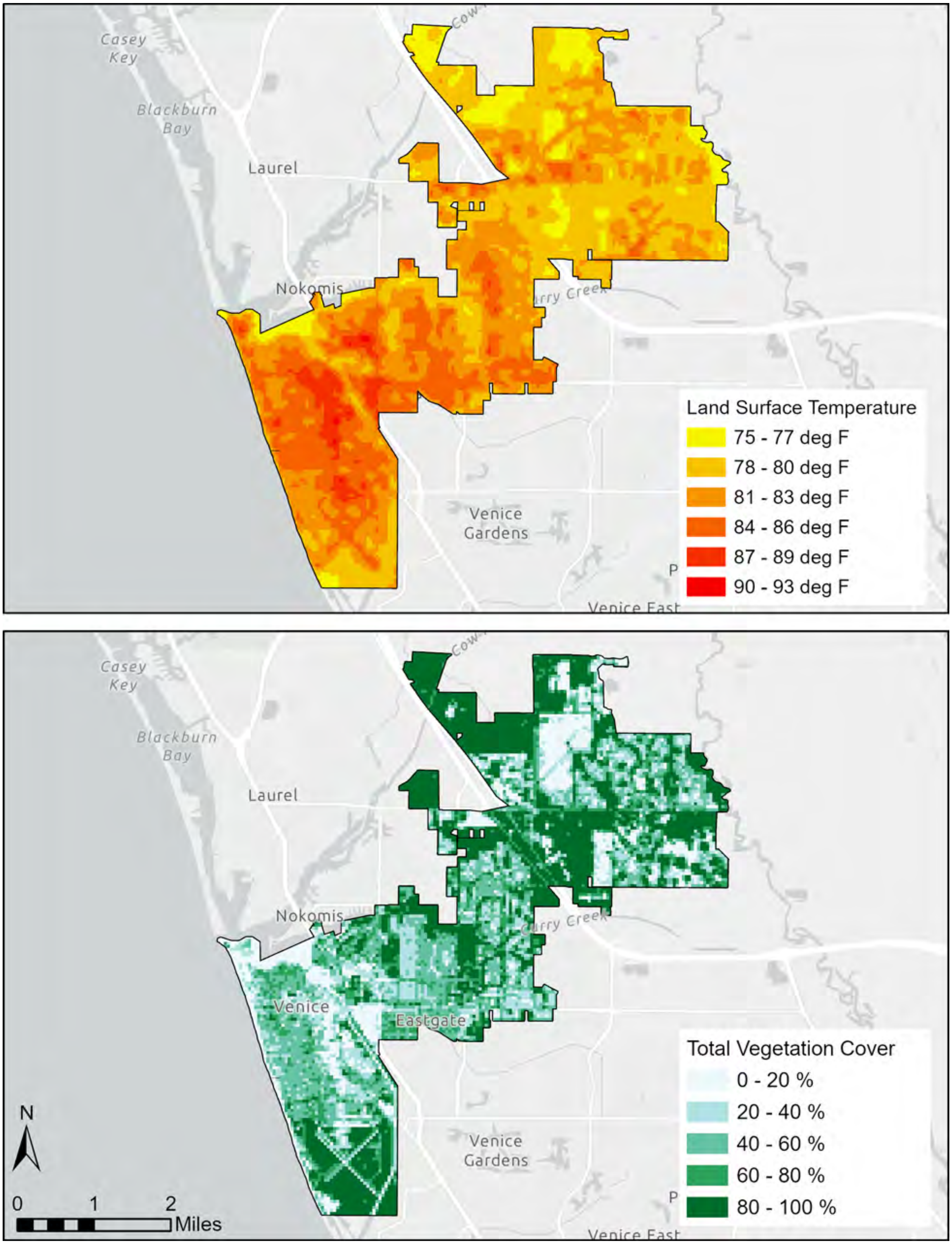


Figure 16. Summertime land surface temperature (top) and total vegetation cover (bottom).

A summary of the median land surface temperature in all areas of the City shows that areas with tree cover are at least three degrees F. cooler than areas covered by impervious surfaces (i.e., buildings, roads and other impervious surfaces).

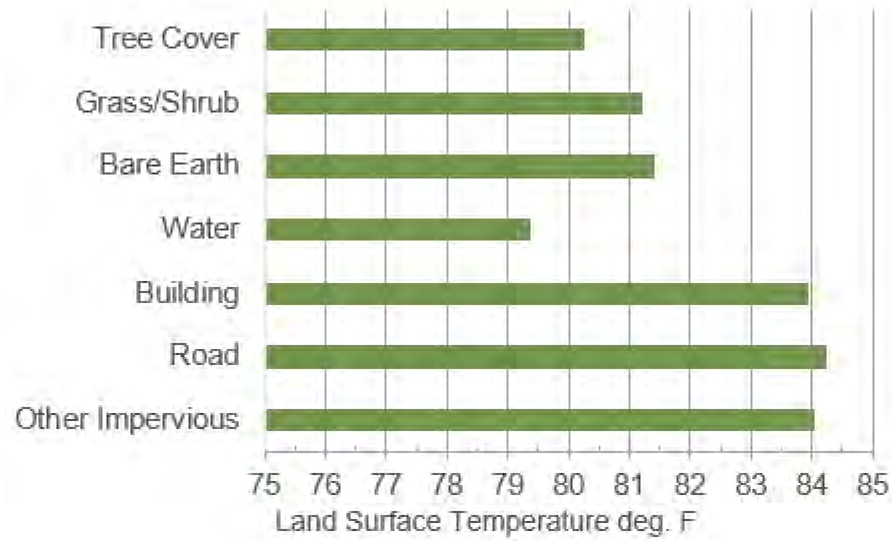


Figure 17. Median land surface temperature in areas with different land cover.

Neighborhoods with a larger percentage of land covered by vegetation (i.e., tree canopy and grass/shrub) are generally cooler than other neighborhoods. Knights Trail, a less developed area with 75% total vegetation cover, has a median land surface temperature of only 78.8 degrees F. The Gateway neighborhood, with only 38% vegetation cover, has a land surface temperature of nearly 84 degrees F. There is a six degree difference in temperature between these two neighborhoods that could be mitigated by additional tree planting.

Figure 18. Median land surface temperature in Venice neighborhoods.

Stormwater management

Tree canopy can intercept rainfall and reduce the amount of stormwater runoff that needs to be managed using ponds and other infrastructure. Cities around the United States are beginning to implement policies that can allow housing developers to use trees for stormwater credits, and thereby reduce the need for costly stormwater infrastructure. The stormwater interception and avoided runoff estimates were based on scientific models developed by the US Forest Service and incorporated into the i-Tree ECO software program (itreetools.org). Although these stormwater benefits are based on the best available scientific models, it is important to understand that these are only estimates. The numbers presented below show the potential for trees to contribute to stormwater management, but may differ from the actual amount of avoided runoff realized in different areas of the City.

Estimates for the City of Venice used the US Forest Service models in conjunction with data from the City of Tampa Tree Canopy and Urban Forest Analysis study[1]. The study collected field data in 2016 at over 200 patches of trees in Tampa which were then used to estimate benefits provided by trees. The stormwater interception benefits were based on models that consider tree species, tree size and canopy dimensions. Results from 3,113 trees in the City of Tampa were used to calculate an average stormwater interception and average avoided runoff per acre of tree canopy. Avoided runoff takes into account the amount of impervious surface underneath the trees included in the model. Using these results for the City of Venice makes the following assumptions: 1) that Venice has a similar tree species composition as Tampa; 2) Venice has approximately the same annual rainfall as Tampa (i.e., 55.8 inches/year was used for the model); and 3) Venice has roughly the same proportion of impervious surfaces underneath its' tree canopy.

Based on results from City of Tampa, the following stormwater benefit estimates were used:

- Rainfall Interception: 36,365 gallons of water per acre of tree canopy, per year
- Avoided runoff: 7,266 gallons of water per acre of tree canopy, per year
- Avoided runoff value is estimated at $8.96 per 1,000 gallons, based on the estimates provided by the US Forest Service

Landry, S., Koeser, A., Northrop, R. J., McLean, D., Donovan, G. H., Andreu, M., & Hilbert, D. (2018). City of Tampa Tree Canopy and Urban Forest Analysis 2016. https://waterinstitute.usf.edu/upload/documents/TampaUEA2016_FinalReport-lowres.pdf.

Estimated Neighborhood Stormwater Benefits

The estimates shown below suggest that the existing tree canopy might be responsible for intercepting over 89 million gallons of rainfall per year in Venice neighborhoods. The total avoided stormwater runoff might be nearly 18 million gallons per year, with an approximate value of $159,513 per year. In other words, the existing tree canopy within Venice neighborhoods is potentially saving taxpayers from having to invest in additional stormwater ponds, pipes or other infrastructure.

Table 4. Estimated annual stormwater benefits due to existing trees in Venice neighborhoods.

Neighborhood Name	Acres Existing Tree Canopy	Estimated Rainfall Interception by Existing Tree Canopy (gallons/year)	Estimated Avoided Runoff by Existing Tree Canopy (gallons/year)	Estimated value of Avoided Runoff ($/year)
East Venice Avenue	153	5,567,164	1,112,435	$ 9,964
Gateway	85	3,092,451	617,936	$ 5,535
Island	488	17,761,439	3,549,105	$ 31,788
Knights Trail	438	15,941,401	3,185,423	$ 28,531
Laurel Rd Business Corric	128	4,650,218	929,210	$ 8,323
Northeast Venice	555	20,175,726	4,031,529	$ 36,109
Pinebrook	603	21,938,985	4,383,865	$ 39,265

Potential planting sites were identified as locations at least 4 feet by 4 feet in area that were currently covered by grass/shrub. Although trees will never be planted at all of these potential sites, it is possible to estimate the stormwater benefits that might be provided if all areas identified as potential planting sites were covered by tree canopy. If trees were planted in such a way that the future tree canopy covered these areas, it is estimated that an additional 29 million gallons of avoided stormwater runoff per year might be realized, at a value of nearly $256,000 per year.

Table 5. Estimated annual stormwater benefits in Venice neighborhoods if all potential sites were covered by tree canopy.

Neighborhood Name	Acres of Potential Planting Sites	Estimated Avoided Runoff if tree canopy covered potential planting sites (gallons/year)	Estimated value of Avoided Runoff ($/year)
East Venice Avenue	162	1,177,171	$ 10,230
Gateway	80	581,319	$ 5,052
Island	956	6,946,761	$ 60,367
Knights Trail	570	4,141,897	$ 35,993
Laurel Rd Business Corric	203	1,475,097	$ 12,819
Northeast Venice	1192	8,661,652	$ 75,270
Pinebrook	890	6,467,173	$ 56,200

Estimated Stormwater Benefits in the Public Right-of-way

The public right-of-way is one of the primary areas where stormwater management is needed, in order to prevent street flooding and to mitigate the negative effects of runoff. There are currently 98.5 acres of existing tree canopy within the public right-of-way managed by the City of Venice. As previously mentioned, this does not include right-of-way managed by other entities such as Sarasota County. The existing tree canopy is estimated to result in a reduction of 715,701 gallon of runoff per year, at an estimated value of $6,413 per year. If additional trees were planted and the future tree canopy covered the areas classified as potential planting sites, it might be possible to reduce another 217,980 gallons of runoff per year, valued at $1,953 per year. Although these stormwater benefit amounts are relatively small, the trees located within the public right-of-way also provide other benefits, such as shade and cooling effects for pedestrians.

	Acres in ROW	Avoided Runoff, Estimated, gal./yr.	Estimated Value of Avoided Runoff, $/yr.
Existing	98.5	715,701	$6,413
Potential	30	217,980	$1,953

Estimated Stormwater Benefits on City Properties

The City of Venice is also responsible for stormwater management on City properties. The properties currently have 247.6 acres of existing tree canopy that is estimated to reduce stormwater runoff by approximately 1.79 million gallons per year. The value of this estimated avoided runoff is $16,120 per year. There are 668 acres of potential planting sites on City properties. If trees were planted in these areas such that they were covered by tree canopy in the future, an additional 4.8 million gallons of avoided runoff might be realized, with a value of approximately $43,000.

	Acres in City Property	Avoided Runoff, Estimated, gal./yr.	Estimated Value of Avoided Runoff, $/yr.
Existing	247.6	1,799,062	$16,120
Potential	668	4,853,688	$43,489

Debris planning

Estimating the potential tree debris that might be generated along roadways during storms can be invaluable tool to proactively manage the trees to avoid emergency management delays. This project used an advanced remote sensing algorithm to map individual tree locations using LiDAR data. Each tree on the map was labelled with the tree height from the LiDAR and the approximate crown area (i.e., tree canopy). The tree crowns were represented as circles, rather than the uneven dimensions of many trees.

Utilizing the tree height and crown area of individual trees, spatial analysis was used to determine which trees were tall enough to fall into the roadway designed by the City of Venice as primary and secondary roads for the purpose of emergency management. Primary and then secondary roads would be the first to be cleared after a storm by emergency crews, since these roadways are critical for travel for evacuation, or to/from hospitals and other emergency facilities, or other reasons. The resulting analysis provides an estimate of the total number of trees that could potentially fall into a roadway. In addition, it was possible to estimate the canopy area of the trees that were tall enough to potentially fall on the roadways. Unfortunately, the volume (cubic yards) of the potential debris cannot be known from data available about the two-dimensional area of the canopy (square yards). However, the area of the canopy provides a good indication of the amount of debris that could block the roadway.

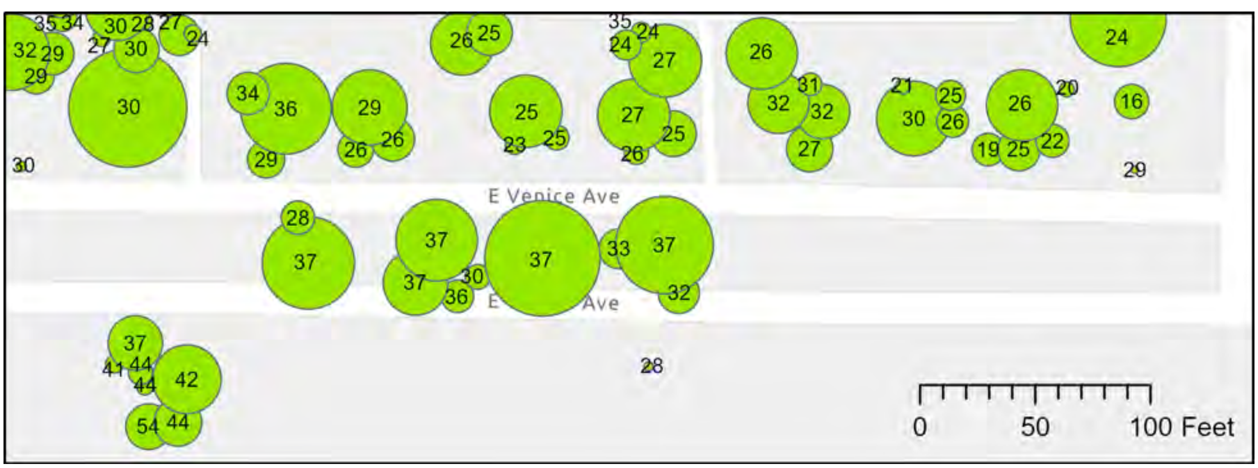


Figure 19. Tree locations identified from LiDAR. The size of the circle is the canopy area of the tree, and the number is the height of the tree in feet.

The map below shows the number of trees per 100 linear feet of roadway that are tall enough to possibly fall on the road during a storm (i.e., possible debris trees). Individual road segments are classified from least to most trees per 100 linear feet. Very few road segments have zero (0) possible debris trees, while numerous road segments are in the highest risk category with more than five possible debris trees per 100 linear feet of road. Out of the 15 miles of Primary Roadways maintained by the City, there are 2.3 miles of road in the highest risk category. There are only 9.8 miles of Secondary Roadways, but 3.9 miles are in the highest risk category.

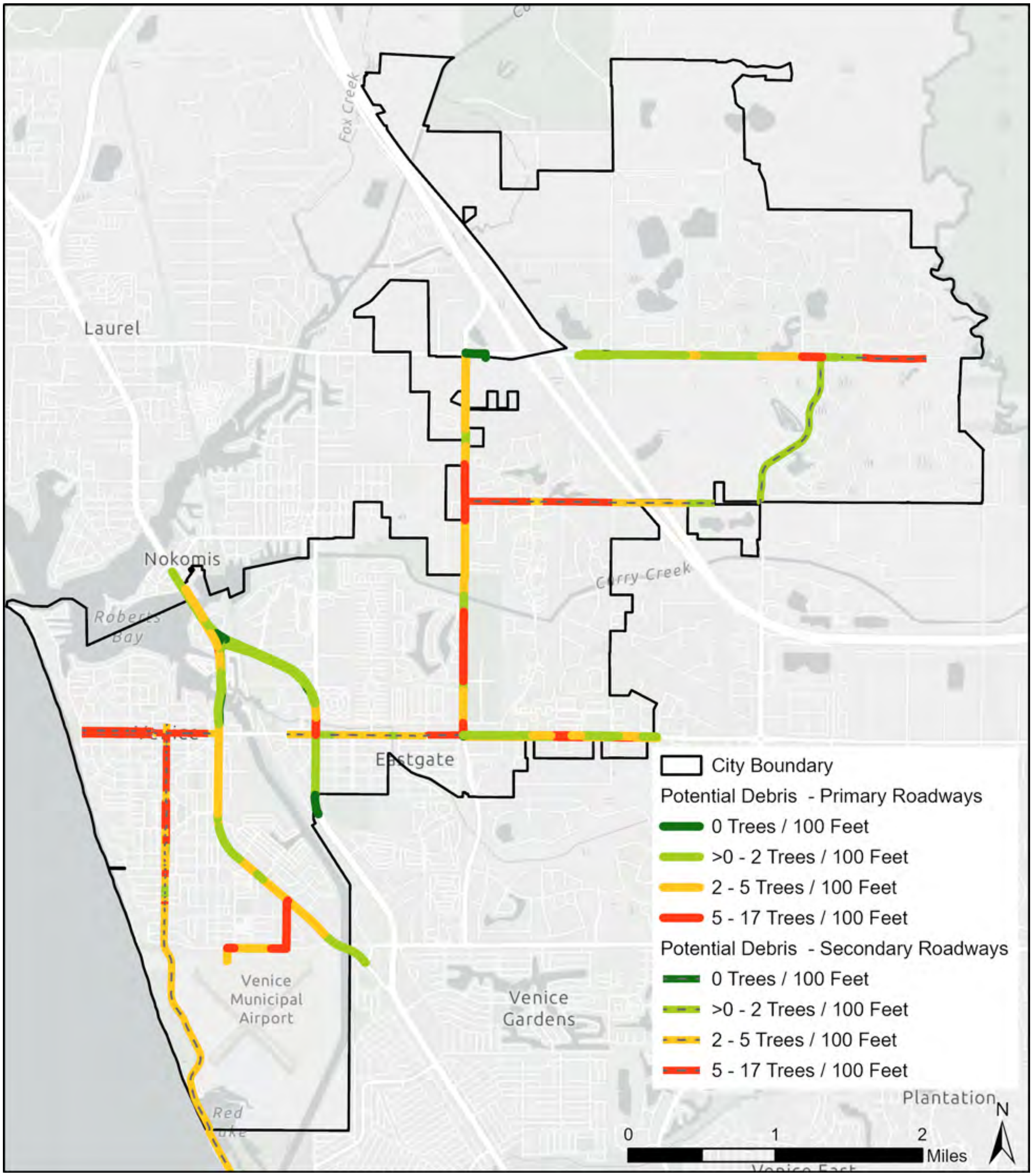


Figure 20. Estimated number of trees per 100 linear feet that could possibly fall on primary and secondary roadways during a storm.

Based on the analysis of possible debris trees, there are a total of 2,030 trees tall enough to fall on Primary Roadways and 2,514 trees tall enough to fall on Secondary Roadways. Secondary Roadways also seem to have the largest amount of possible debris as estimated by the square yards of canopy area on the trees that could fall on the roads. There are 88,115 square yards of possible canopy debris on Primary Roads, and 118,835 square yards of possible canopy debris on Secondary Roads.

Table 6. Estimated number of trees tall enough to fall on Primary and Secondary Roadways and associated canopy debris.

	Primary Roads	Secondary Roads
Total number of trees tall enough to fall on a roadway:	2,030	2,514
Average number of possible debris trees per 100 linear feet of roadway:	2.6	4.9
Total Canopy area of possible debris trees (square yards):	88,115	118,835

The estimates produced for this debris planning analysis do not consider the species or health of the trees that are tall enough to fall on roadways. Trees such as Live Oak may be tall enough to reach a road if fallen, but this species of tree is adapted to the Florida environment and very resistant to wind damage. Therefore, these estimates should be considered a worst-case scenario of storm damage. Using the results of this analysis, including the map, the City can prioritize the roadways where trees should be inspected to determine whether there is actual risk of storm damage.

Conclusion

This study provides a baseline analysis of the City's Urban Tree Canopy and associated benefits of trees. Future studies can be conducted to evaluate the progress and effectiveness of the City's tree preservation and planting programs. Policy makers, agency managers, businesses, neighborhood associations and City residents will all play a critical role in the success of the City's tree program. This report is intended to be a first step in providing information about where the trees are in the City and where efforts to maintain and improve the City's tree canopy should be focused. This report should be followed up on every ten to twenty years to determine what changes in practice are needed to continue protecting the trees that do so much for us and for the generations to come.

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