

City of Medina

URBAN TREE CANOPY ASSESSMENT

JULY 16, 2025

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Agency Reference: 2406.0332.00

Facet Number: 2406.0332.00

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1. Introduction

Urban forests include the trees and vegetation found in natural areas, formal parks, public spaces, private properties, and transportation corridors. Trees in urbanizing environments help to mitigate the effects of the built environment and provide numerous environmental and public health benefits, including stormwater mitigation, shade and urban cooling, improved air quality, noise abatement, economic advantages, human health and wellness, and traffic calming, fish and wildlife habitat, and carbon sequestration (USDA Forest Service, 2020; Vogel, et al., 2023; Heintz, 2008; Wolf, 2010; Wolf et al., 2014).

Urban tree canopy (UTC) cover is one metric of assessing a community's urban forest resources and is measured at the landscape or city scale using geospatial analysis. This method classifies vegetative land cover, specifically tree canopy, using aerial view imagery and remotely sensed data that depicts leaves and branches covering the ground.

The City of Medina commissioned the following urban tree canopy study to assess the current state of the city's urban forest and determine whether there have been significant gains or losses compared with the baseline tree canopy assessment conducted by Facet (formerly The Watershed Company) in 2014. The purpose of these studies is to inform urban forest management and regulatory approaches to canopy retention and replacement.

As noted in Medina Municipal Code Chapter 16.52 MMC, *Tree Management*, the City seeks “to ensure the protection of urban forestry canopy coverage, and to provide a mechanism to soften the impact of development on the natural environment, while providing mechanisms to ensure responsible development continues” (City of Medina 2022). Balancing the need for urban tree canopy and demand for housing is of particular importance as Medina is actively working to ensure that the MMC Title 16 Unified Development Code aligns with new state law provisions of the Growth Management Act to provide Middle Housing and related issues (Revised Code of Washington [\[RCW\] 36.70A](#)).

This Tree Canopy Assessment provides the City with needed data to support informed urban forest planning and policy decisions.

2. Methods

Tree canopy cover is one of the most encompassing metrics to describe the overall condition of a city's urban forest. It is commonly used to set policy goals and evaluate performance over time. This analysis is provided to determine overall canopy cover in Medina and geographically segmented areas, including zoning districts and census block groups. These groups are selected to be useful for city planning and management and provide increased granularity compared to city-scale metrics. Large privately-owned parcels are also evaluated due to their relative importance in the overall canopy.

In 2014, Facet conducted a tree canopy study using a heads-up digitization method. This process used orthoimagery produced by King County from data gathered in spring of 2012 with 0.25-foot resolution, where 100 percent of the land area was reviewed and analyzed for evergreen and deciduous tree canopy. The City of Medina was divided into a 30-meter square grid, and the percentage of canopies of evergreen and deciduous trees was visually assigned (rounded to the nearest 4). This grid was then used to calculate the total canopy.

For this 2025 study, Facet modernized the tree canopy calculation study by using object-based image classification technology, which was applied to the latest NAIP data (2023) and surface height calculations based on the latest lidar data (2021). Because this method relies on automated digital analysis, it provides a consistent result that eliminates the potential for variability among visual observers.

2.1 Data Sources and Study Area

This tree canopy study focused on the city limits of Medina, Washington. The tables below list the data sources used in the creation of the 2025 tree canopy layer and in subsequent analyses.

Table 1. Source data used to create tree canopy layer

Data Name	Date	Source	Description / Application
City Limits	2025	King County	Delineation of study area (Medina city limits)
NAIP False Color	2023	NAIP Portal	Aerial imagery used as basis for image classification
Lidar (King County West)	2021	WA State Lidar Portal	Remotely-sensed elevation and height information
Building Footprints	2023	City of Medina	Vectorized building footprints to assist in classifying shadowed areas

Table 2. Data layers used in subsequent analysis performed on tree canopy layer

Data Name	Date	Source	Description / Application
SR 520 ROW	2012	Facet 2024	Delineation of ROW matching 2014 analysis metric, allowing canopy change comparison to prior study
Waterbodies	2025	King County	Vectors representing open water areas for land area and percent canopy calculations

Data Name	Date	Source	Description / Application
2012 Tree Canopy Grid	2014	The Watershed Company	Baseline canopy coverage data to visualize canopy change across the city
KC Parcel Layer	2025	King County	Vectors representing parcel boundaries for evaluating tree canopy by ownership
Medina Zoning Layer	2018	City of Medina	Vectors representing zoning for calculating tree canopy by zoning type

2.2 Urban Tree Canopy Classification

To create the tree canopy layer, Facet performed an object-based image classification in tandem with a height model developed from lidar data. For the image classification, the latest available NAIP false-color raster data was used (2023, 0.6-meter resolution). False-color imagery was used because it contains the Near-Infrared (NIR) Band, which is important for picking up vegetation signatures (Figure 1).



Figure 1. Illustrative snapshot of 2023 NAIP false-color image.

The height model was based on the latest publicly available lidar raster data (2021, 1.5-foot resolution). See Figure 2. Because the two datasets were gathered within two years of each other (2021 and 2023), the temporal extent is narrow enough to create an approximate snapshot of tree canopy coverage during this timeframe, which is roughly ten years after the prior canopy cover assessment (c. 2012-2014).



Figure 2. Illustrative snapshot of 2021 lidar data.

In an object-based imagery analysis, the input raster data is first segmented; individual pixels are grouped together based on proximity and similar spectral characteristics to create segments (Figure 3).



Figure 3. Close up of segmented raster. Notice that similar pixels have been lumped together to create 'super pixels.'

After applying raster segmentation to the NAIP data, Facet created a classification schema by which all data segments were sorted. The five overarching categories are: Water, Impervious, Forest, Shrubland, and Planted/Cultivated. Then, a training data set, a shapefile consisting of select areas corresponding to the classification schema, was created and refined. This training data was used to train the Maximum Likelihood Classifier geoprocessing tool and subsequently classify the raster.

A known weakness of automated image classification is detecting the difference between classes with green color signatures (e.g., forest vs. lawn). Hence, a height model based on lidar data collected in a similar timeframe is used to refining preliminary data into a more accurate tree canopy layer. A height model can be created by subtracting the digital terrain/elevation model (DTM or DEM) from the digital surface model (DSM). The height model was used to remove all areas green signatures less than ten feet tall from the canopy model (Figure 4).



Figure 4. Illustrated snapshot showing the lidar height model overlayed on King County aerial. All heights less than 10 feet have been removed.

Another known weakness of automated image classification is the detection of landcover within heavily shadowed areas. Shadows are prevalent in the 2023 NAIP imagery because the flights in Washington state were flown in October, when the low sun angle creates shadows across the landscape. In addition to using the height model to help classify shadowed areas, the 2023 building footprints layer from the City of Medina was to improve classification of shadowed areas. Shadowed areas above ten feet tall and outside of building footprints were reclassified as Shadowed Canopy (Figure 5).



Figure 5. Illustrated snapshot showing tree canopy and canopy elevation overlayed on Medina's building footprints layer. Note the shadows visible on King County's aerial.

After integrating the object-based image classification, lidar data, and building footprint data into a canopy layer, the layer was refined using the Aggregate Polygons tool and the Eliminate Polygon Parts tool. Rogue canopy (pixels less than 5-feet in size) was also removed using a selection query, and additional manual edits were made to clean up the data.

2.3 Assessment Geographies

The tree canopy layer was assessed at two geographies:

- Zoning Type
- Land ownership (Public, Private, and Right-of-Way)

Evaluating urban tree canopy (UTC) by zoning is a widely accepted best practice in urban forest management planning. Zoning classifications regulate permissible land uses, building densities, and development patterns—all of which significantly influence the extent and distribution of vegetation. By analyzing tree canopy coverage within each zoning category, planners and policymakers can identify areas with relatively low canopy cover and prioritize them for urban greening initiatives. These may include targeted tree planting, regulatory adjustments, or incentive programs aimed at enhancing tree coverage in specific zones (Mincey, Schmitt-Harsh, & Thureau, 2013).

In addition to zoning, examining canopy coverage by land ownership—categorized into Public, Private, and Right-of-Way (ROW)—provides essential insights for strategic decision-making. Public lands (such as parks, schools, and other municipal properties) often offer opportunities for large-scale planting projects or preservation efforts. Private lands, where most canopy tends to exist in residential areas, may benefit from outreach programs and incentive-based policies that encourage tree retention or planting by property owners. ROW areas, including streetscapes and transportation corridors, represent a critical yet often underutilized space for expanding the urban forest and delivering ecosystem services citywide. Understanding where canopy exists—and where it could be increased—by ownership type allows for more tailored and effective urban forestry policies.

For the City of Medina, tree canopy was not analyzed at the Census Block Group level. The city encompasses only two block groups—one almost entirely composed of the golf course, and the other encompassing the remainder of the city—making this geographic breakdown ineffective for meaningful analysis. Similarly, the canopy was not evaluated at the neighborhood or drainage basin level due to the unavailability of spatial data for those units. Should such data become available in the future, further analysis at these finer scales could support more localized planning and community engagement efforts.

2.4 Change Analysis

City-wide tree canopy was compared with the city-wide results of the 2014 report. Acknowledging that the 2025 analysis was conducted using updated technology and methodology, in order to facilitate a comparison to the 2014 baseline canopy data (Figure 6), the 2025 results were subdivided into the 30m grid units used in the 2014 study.

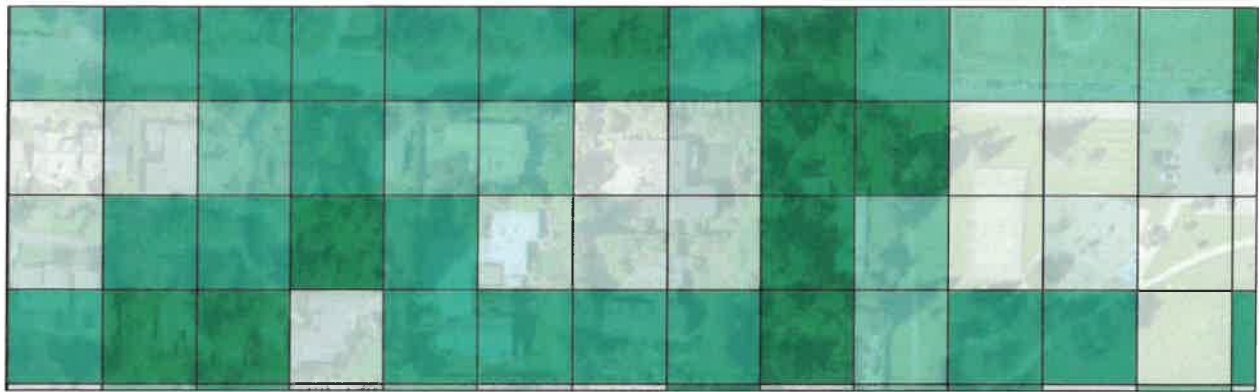


Figure 6. Zoomed-in 30-meter vector grid used in 2014 study, overlaid on 2023 King County aerial. Darker green squares indicate an area with a higher percentage of canopy cover in 2014, and whiter squares indicate an area with a lower percentage of canopy cover in 2014.

By comparing estimated tree canopy cover in each grid cell between the 2014 and 2025 studies, areas of change across the city were visualized geospatially.

Additionally, total canopy change between 2014 and 2025 was analyzed at the grid level by comparing the average percent change in tree canopy per grid cell between the 2014 and 2025 studies. To remove potential outlier percentages, grid polygons along city limits and water edges were removed from the study sample, and only *full-size*, 30-m polygons were used. A two-sided t-test was used to test for significant differences between the 2014 and 2025 tree canopy analyses.

3. Results

The following section presents the key findings of this study, including total tree canopy, tree canopy across various geographies, and canopy change. Waterbodies are excluded from the land area calculations.

3.1 Urban Tree Canopy

Because urban tree canopy (UTC) is expressed as a percentage of the total land area (i.e., total study area less areas of open water), Medina's UTC cover is calculated based on its total land area of 898.2 acres. Facet's urban tree canopy assessment model indicates that the City of Medina has approximately 295.6 acres of tree canopy, representing 32.9% of city land area (Table 3). When SR-520 ROW is removed from the assessment, the percentage slightly increases to 33.1% of the land area or 292.4 acres (Table 4).

Tree canopy was found to have a varying distribution across the landscape, with pockets of high tree canopy and low tree canopy mixed across the city (Figure 7).

Table 3. 2025 tree canopy inside city boundaries, excluding areas of open water.

Summary	Acres	Percent
Tree Canopy	295.6	32.9%
Land Area	898.2	100.0%

Table 4. 2025 tree canopy inside city boundaries, excluding open water and SR 520 right-of-way¹.

Summary	Acres	Percent
Tree Canopy	292.4	33.1%
Land Area	883.7	100.0%

¹ In order to compare with the 2014 tree canopy study, the original SR 520 right-of-way layer was used in this calculation, dated to 2012.

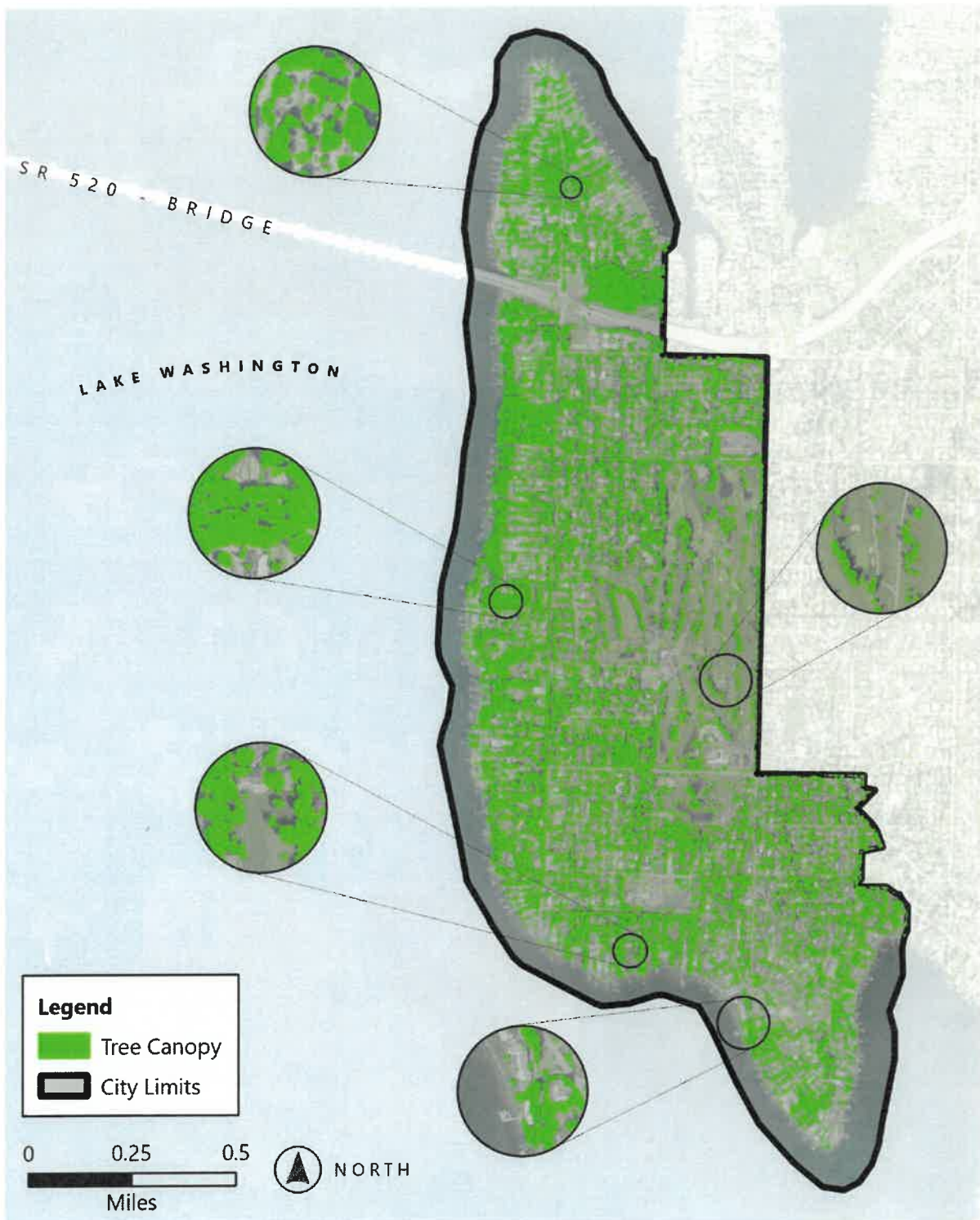


Figure 7. Modeled tree canopy in the City of Medina.

Canopy by Zoning

Facet also examined tree canopy by zoning (Table 5). Of the primary zoning types (excluding the lone parcel zoned as NA - Neighborhood Auto Servicing), the highest tree canopy percentage was found in R-30 (Single Family Residence) zone, while the lowest occurred in the R-20 (Single Family Residence) zone. However, the R-20 (Single Family Residence) zoning type includes a golf and country club, which drastically lowers the percentage of tree canopy. When divided into two zoning subtypes, the R-20 non-Golf subtype has the second-highest tree canopy percentage (31.4%), and the R-20 Golf subtype has the lowest tree canopy percentage (15.5%). See Figure 8 for the modeled tree canopy overlaid on zoning type.

Table 5. Tree canopy by City of Medina Zoning

Zoning Class	Land Area (Ac)	Tree Canopy Area (Ac)	% Tree Canopy
NA (Neighborhood Auto Servicing)	118.3	30.6	25.9%
Public (Parks and Public Spaces)	53.8	17.0	31.6%
R-16 (Single Family Residence)	254.1	87.9	34.6%
R-20 (Single Family Residence) – Overall	346.2	108.6	31.4%
<i>R-20 (Single Family Residence) – Non-Golf</i>	<i>224.9</i>	<i>89.9</i>	<i>40.0%</i>
<i>R-20 (Single Family Residence) – Golf & Country Club</i>	<i>121.2</i>	<i>18.8</i>	<i>15.5%</i>
R-30 (Single Family Residence)	99.9	44.4	44.4%
SR-30 (Suburban Gardening Residential)	17.6	5.6	31.8%

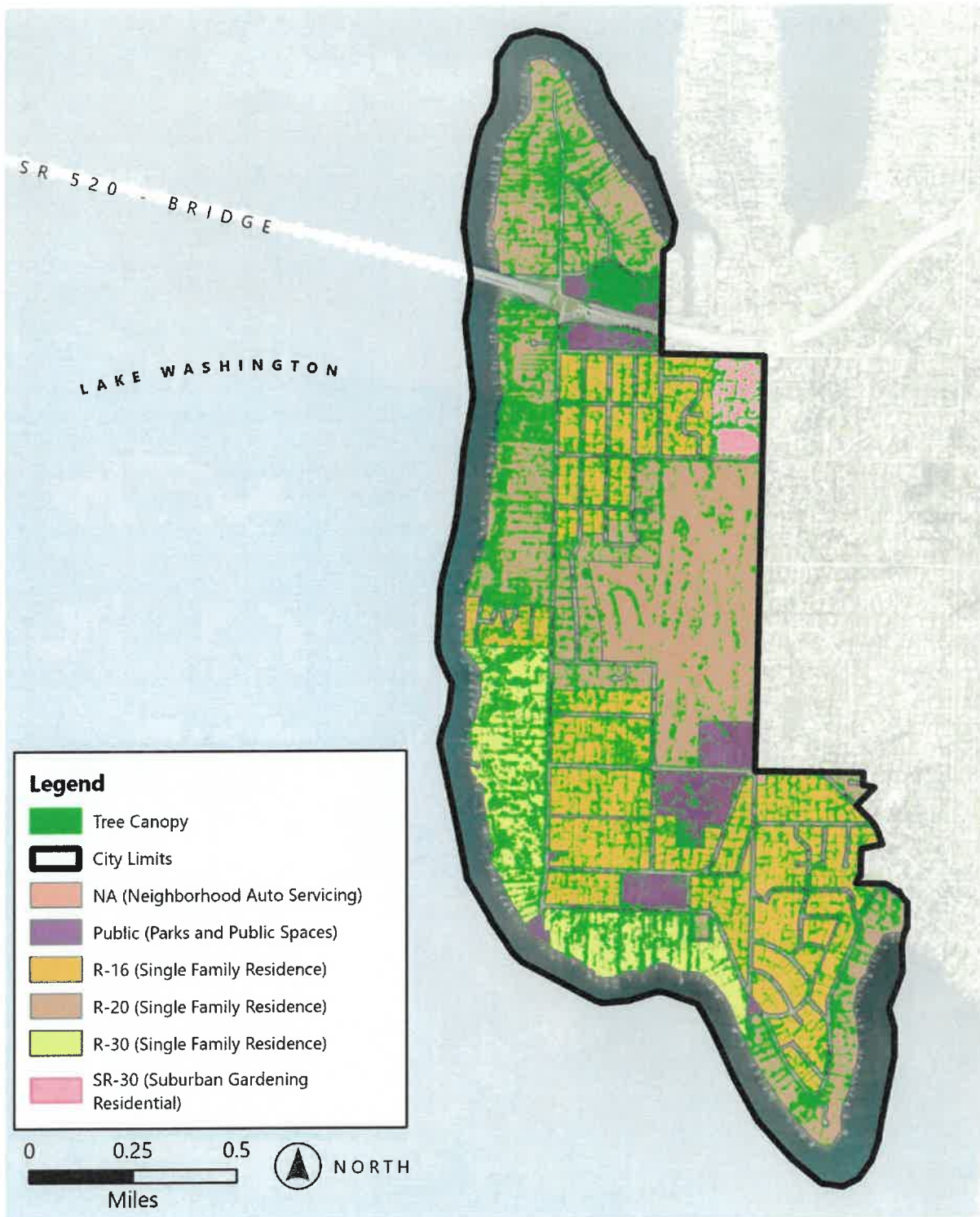


Figure 8. Modeled tree canopy overlaid on Medina's zoning layer

Canopy by Land Ownership

Facet also analyzed tree canopy by land ownership (Table 6). Notably, private parcels have a higher percentage of tree canopy compared to public parcels—even when accounting for the golf course included in the private category. The lower canopy coverage on public land is partly due to the significant portion contained within Medina Elementary School, which has a relative lack of trees. Figure 9 illustrates the modeled tree canopy in relation to land ownership.

Table 6. Tree canopy by City of Medina land ownership

Land Ownership	Land Area (Ac)	Tree Canopy Area (Ac)	% Tree Canopy
Private	718.1	246.6	34.3%
Public	53.8	17.0	31.6%
Row (All)	118.3	30.6	25.9%
ROW (SR-520 approx.)	12.9	0.7	5.8%
ROW (Not SR-520)	105.4	29.9	28.3%

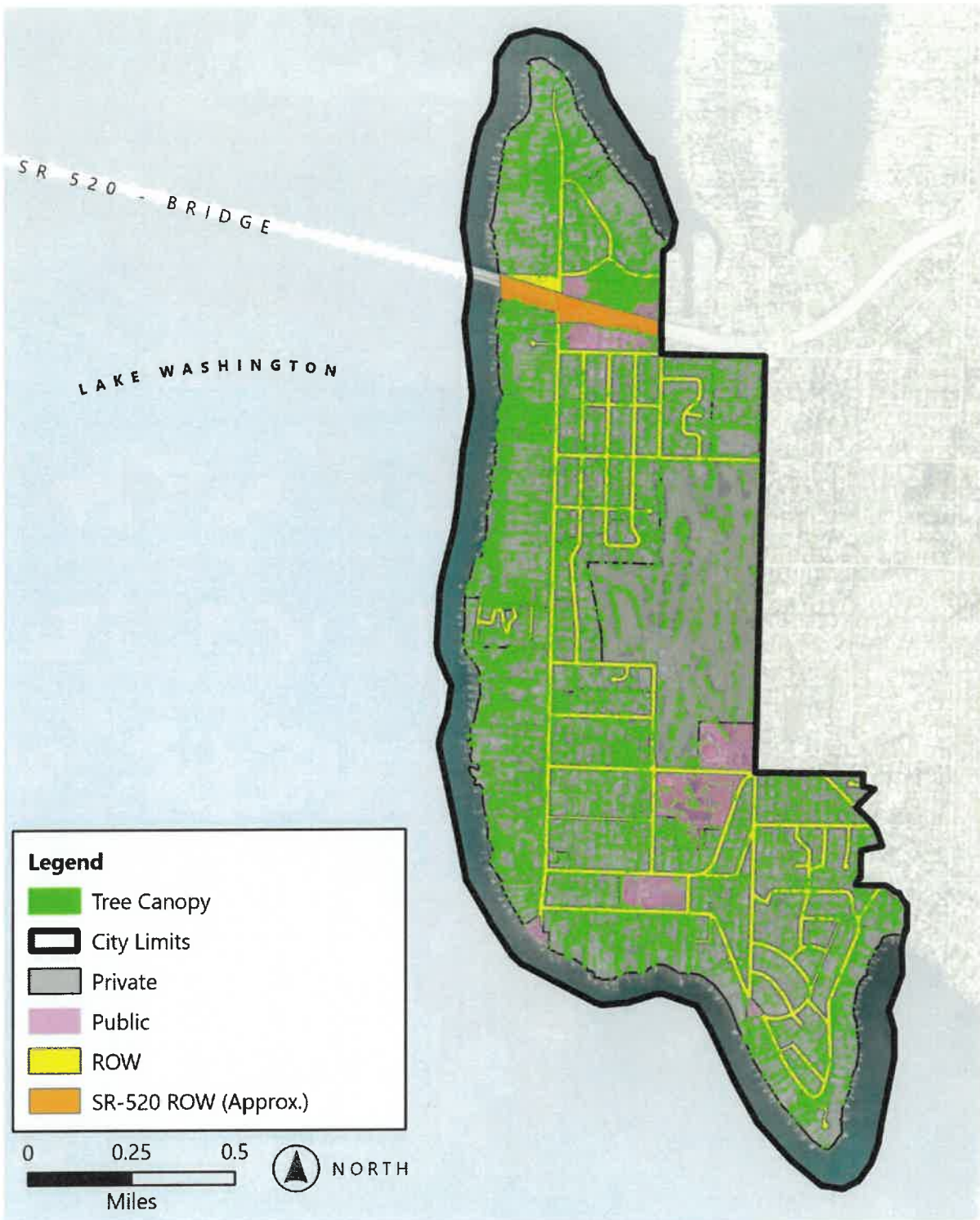


Figure 9. Modeled tree canopy overlaid on land ownership.

3.2 Change Analysis

Facet compared the city-wide results of this tree canopy analysis with the city-wide results of the 2014 tree canopy study. Facet found approximately 9 acres of additional canopy, equivalent to about 0.3% increase in city-wide tree canopy (Table 7).

Table 7. Comparison between 2014 and 2025 tree canopy studies.

Summary	City-wide %	% without SR-520 ¹
Tree Canopy 2014	31.9% (287.7 acres)	32.2% (286.0 acres)
Tree Canopy 2025	32.9% (295.6 acres)	33.1% (292.4 acres)

¹ The same SR-520 shapefile was used in 2025

Facet calculated tree canopy percentages per polygon of the 30-m grid used in the 2014 tree canopy study in order to examine statistical trends (Figure 10) and visualize change across the landscape (Figure 11). However, both studies are intended to be used overall at larger geographies than the 30-m grid as the intent of the studies are city-wide canopy calculations. Using the tree canopy percentages per *full-size* polygon (removing partial polygons along city limits and water edges) of the 30-m grid to test for significant differences between the 2014 and 2025 tree canopy analyses, Facet found an average grid percent canopy cover of 31.9% in 2014 and 32.8% in 2025, reflecting the city-wide canopy percentages. Facet then ran a two-tailed t-test (sample size of 3,830). This resulted in a p-value less than 0.05 (0.0000612), indicating that, despite the seemingly minor difference in canopy between 2014 and 2025, there is a significant difference in canopy between the two study years.

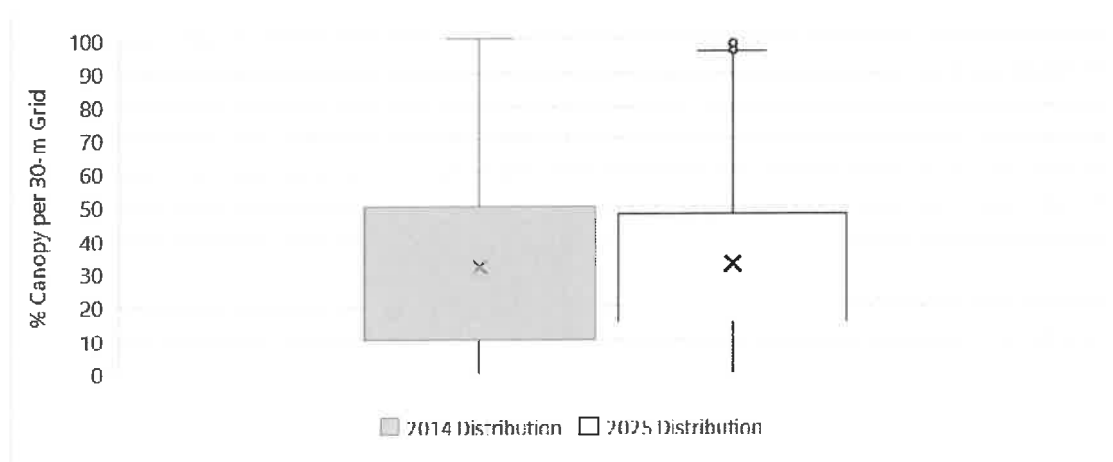


Figure 10. Box and whisker plot showing distribution (maximum, minimum, first quartile, third quartile, and median) of tree canopy percentage per 30-m grid polygon in 2014 (mean 31.9%) and 2015 (mean 32.8%). X indicates average percent canopy per square, and O indicates outliers as determined by Excel.

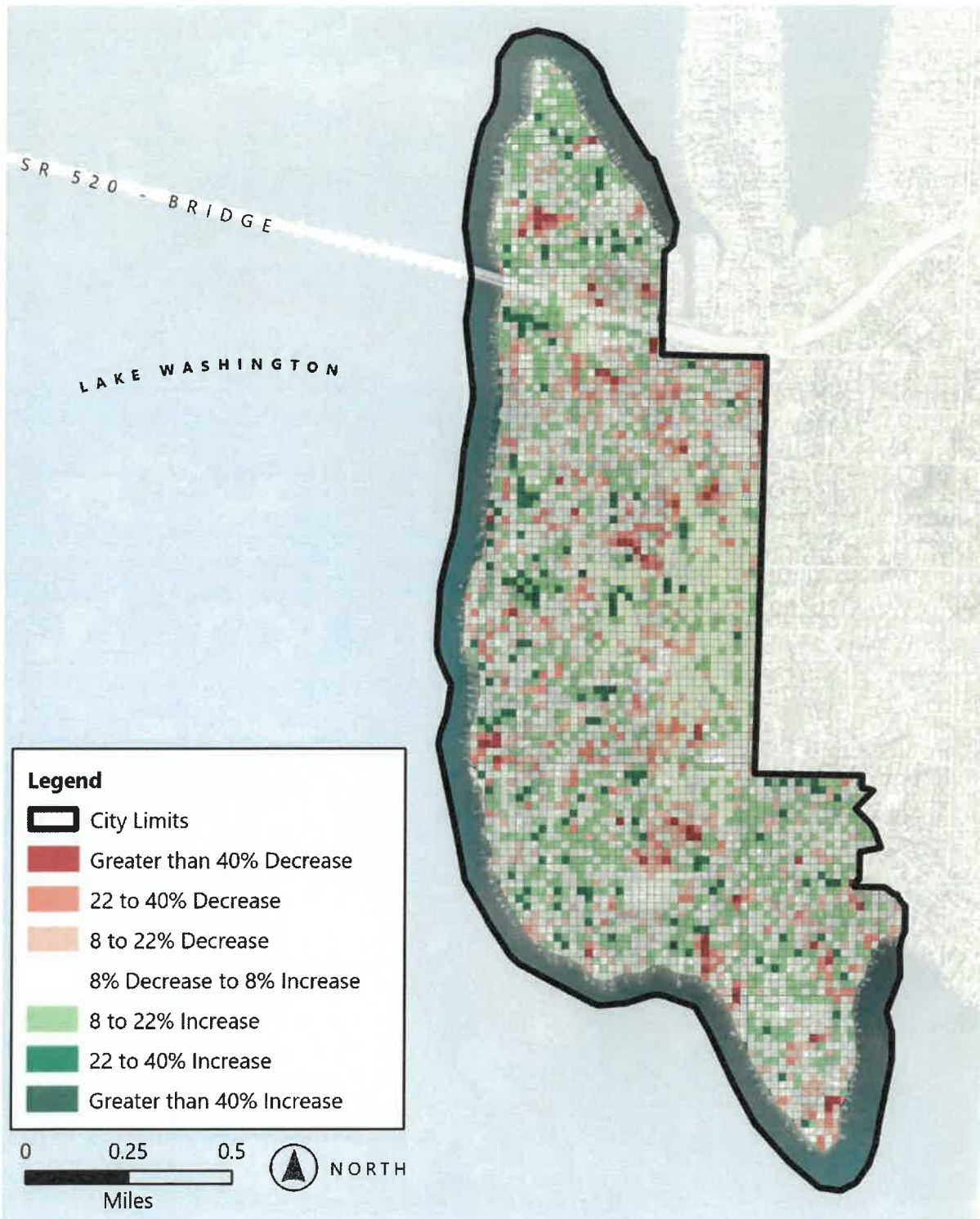


Figure 11. A visualization of canopy change from 2014 to 2025 per 30m analysis unit.

4. Discussion

4.1 Change Analysis

Overall, tree canopy within the City of Medina is relatively similar between the 2014 and 2025 tree canopy studies. A notable takeaway from the statistically significant, but relatively small, amount of canopy increase is that the policies guiding development over the ten-year comparison period are consistent with canopy growth, rather than driving canopy decline.

While the two tree studies used different methods, both are effective for calculating tree canopy. One benefit of the 2014 heads-up digitization method is that it can be used to differentiate between evergreen and deciduous canopy; however, this relies on arborist skill in identifying evergreen and deciduous tree tops from remote imagery. Additionally, the 2014 heads-up digitization method relies on human judgement in multiple areas that can make it susceptible to error across large scales. These areas of judgement include:

- identification of evergreen versus deciduous canopy
- visual estimation of percent area per grid, and
- successfully determining vegetation height (greater than 10 feet) from a two-dimensional surface.

The 2025 object-based image classification modernizes this approach by removing potential the subjectivity of visual observance and relying on replicable spatial geoprocessing. Integration of lidar further improves results by using a data-informed approach to determining whether vegetation heights meet the 10-foot threshold; and, the near-infrared band of NAIP data allows for high-quality automated detection of living vegetation from aerial imagery. Two potential flaws of object-based image classification are:

- classification within heavily shadowed areas on aerial imagery, and
- temporal difference between critical source data (e.g., lidar and imagery).

Fortunately, Facet was able to use building footprints to reduce shadow error in the classification analysis, and lidar and NAIP data were available for the jurisdiction in a relatively close intervals (2021 and 2023, respectively).

4.2 Recommendations/Next Steps

The following recommendations outline potential next steps for further enhancing Medina's UTC that are supported by the canopy change analysis and geospatial analysis of current canopy conditions. Based on the study findings, a potential way to increase Medina's urban tree canopy is to prioritize planting on public lands. Medina Elementary School and Medina Park both offer big parcels that could increase urban tree canopy with strategic tree plantings.

Another potential way to increase Medina’s urban tree canopy is to prioritize planning on city ROW. Planting on city ROW, while potentially coming into conflict with utility infrastructure, has the added benefit of shading city streets, which contribute large areas of impervious surfaces.

A significant proportion of Medina’s tree canopy is located on private property, making the preservation and management of these trees essential to meeting urban forestry goals. The city’s tree code (MMC Chapter 16.52) regulates tree removal, protection, and replacement and is designed to protect existing trees while allowing for development. They include restrictions on removing significant, legacy, and landmark trees, as well as requirements for replacement when trees are removed due to development. As the city implements new Growth Management Act housing legislation ([RCW] 36.70A), it may consider conducting additional analyses to assess the potential impacts on tree canopy within private properties subject to increased density requirements. By aligning tree codes with urban forestry and development objectives, municipalities can help ensure that private land contributes to long-term canopy sustainability while balancing development and property rights.

Further analysis of Medina’s current UTC based on additional analytic units could yield information that could guide strategic tree planting and canopy growth. Specifically, it may be beneficial to examine urban tree canopy based on:

- Watersheds/Basins – This analysis may assist in analyzing localized flooding issues and stormwater benefits from strategic tree planting
- Neighborhoods – This analysis may assist in determining equity benefits and general tree distribution trends across the city
- Urban Heat Islands – This analysis may provide recommendations for reducing or mitigating urban heat concentration

The analysis may be further enhanced as new data sources become available for classifying urban tree canopy. For example, the City of Medina may be able to request to use King County’s Ecopia landcover dataset, which was preliminarily available in June 2025 through limited distribution. Based on Facet’s communication with county staff, jurisdictions should contact the King County GIS Center for more information on use and availability. This landcover dataset, with its additional landcover classifications such as impervious surfaces and low vegetation, could be used to inform a plantable area analysis that could provide a framework for infill tree planting opportunities and priorities.

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