STAFF REPORT

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To: Tree Board

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2025 Tree Canopy Cover Assessment

Contents

1. Introduction

The Tumwater City Council adopted the Urban Forestry Management Plan (UFMP) on March 2, 2021, by Ordinance No. 2020-004. As part of the development of the UFMP, City GIS[1] staff completed a baseline tree canopy assessment in 2020 which is included as Appendix A of the UFMP. The evaluation of "canopy cover" in the UFMP is intended to allow the City to use change in canopy cover over time as a way to measure the performance of City policies and regulations on the City's urban forest over the 20-year scope of the plan. The term "canopy cover"

Table 1. 2040 Tree Canopy Cover Goals per Land Use Type.

Land Use Type	2040 Tree Canopy Cover Goal in UFMP
Industrial	25%
City Core Mixed Use	25%
Other Mixed Use	25%
General Commercial	30%
Single-Family Residential	50%
Multifamily Residential	40%
Open Space & Green Belt	55%
Port of Olympia – Olympia Regional Airport	3%
Port of Olympia- Industry	25%
Tumwater + Urban Growth Area	39%

[1] Geographic Information Systems.

means the area in the City and its urban growth area currently covered by a tree and vegetation canopy made up of street trees, areas of native forest, and trees in parks, green space, and landscaping on private property. Canopy cover usually is expressed as a percentage of the total area of the City and its urban growth area covered by tree and vegetation canopy or as a percentage of the area of
individual zone districts grouped into larger general land use categories covered by tree and vegetation canopy.

Because each zone district has different policies and regulations governing the type and intensity of development, the UFMP identified different canopy cover targets for its larger general land use categories (Table 1). These tree canopy targets by land use type is intended to allow the City to meet a range of legislative and strategic policies, by establishing different canopy cover goals for the different zone districts in the City. The canopy cover targets by zone district are intended to be used as a measure of the progress of the UFMP. In addition, the canopy cover targets will be used to provide policy guidance for Tumwater Municipal Code amendments address street trees, the protection of trees and vegetation, and landscaping. In turn, these regulations will establish the minimum requirements and standards for development and redevelopment of individual properties in the City as they relate to the urban and community forest.

Objective 1.1, Action A of the City Council Adopted UFMP includes a monitoring action to measure tree canopy cover every five years.

Goal 1. Restore and enhance the community and urban forest.

Objective 1.1. Increase canopy cover in the City to expand the community and urban forest.

Action A. Establish tree-canopy cover targets for the City and its neighborhoods to increase canopy cover in appropriate areas, taking into account land uses established by the *Comprehensive Plan*, community desires, tree functions, climate, and ecosystems.

Priority	Leads [Primary (P) & Secondary (S)]	Timing	Monitoring Action
#1 ✓	Community Development (P) Public Works (P) Tree Board (S)	Review every five years based on City cycle for acquiring updated LiDAR or equivalent	Measure Tree canopy cover (Percentage of total City land covered by tree canopy and percentage of land use designation and/or neighborhoods covered by tree canopy every five years) Plan includes targets in Chapter 2, Table 5 *Canopy Cover Targets by Land Use Designation* based on 2018 Plan development work

The intent of this agenda item is to review the updated tree canopy cover assessment and assess changes against both the baseline year data and the tree canopy cover goals established in the UFMP.

2. Methodology

The City of Tumwater's GIS Team has determined that the Support Vector Machines (SVM) classification method is best suited to classify tree canopy cover within the City. SVM classification is a supervised, high-level machine learning classification method that uses kernel functions and hyperplanes to classify data. Please click here to learn more about SVM.

This analysis is completed using ArcGIS Pro with the following tools: The Image Classification Wizard, Segment an Image, and Create Accuracy Assessment Points.

There are several steps to a Tree Canopy Cover analysis:

1. Create a segmented image.
2. Create training samples
3. Train the classifier
4. Add additional training samples and retrain the classifier (repeat as much as necessary)
5. Create final classification
6. Create accuracy assessment points
7. Compute confusion matrix
8. Determine accuracy
9. Export raster to polygons
10. Compute tree canopy cover by zoning

To complete this analysis, the GIS Team used 19-inch 3-band Maxar imagery that was captured on April 14, 2025.

First, the GIS Team created a segmented raster from the original aerial photo. Segmenting smooths and groups like-pixels together to create an almost "animated" looking raster. They used the following values to create our segmented raster:

Spectral Detail	Spatial Detail	Minimum Segment Size (Pixels)
18.5	19	20

Spectral Detail: Spectral detail is used to distinguish between features that have similar spectral characteristics. For our analysis, we needed to distinguish between grass and deciduous trees and between shadows and fir trees.

Spatial Detail: Spatial detail determines the importance of space between features. A higher value is used when features are small and close together. In this analysis, trees were clustered around pockets of development or next to roads.

Minimum Segment Size: Segments smaller than the designated segment size are grouped with the best fitting neighboring segment.

Next, they then created 30+ training samples for each of the following classes:

Class Name	Class Value
Tree Canopy Cover	1
Non-canopy Vegetation	2
Soil and Dry Vegetation	3
Buildings	4
Other Impervious	5
Water	6

More training samples create a higher statistical significance when classifying, thus, they ensured that the Tree Canopy Cover class had the highest percentage of samples (70-80% of samples). Creating training samples can take several hours to several days, depending on how many times the model needs to be trained.

The GIS Team trained the SVM classifier using supervised, object-based classification. They generated the classification schema from their training samples and used the segmented image as an additional input to the tool. The segmented image helps the classifier recognize like-groups of pixels more easily. This process takes varying amounts of time depending on the resolution of the image. For this process, training took 10 minutes on average. Training the classifier is an iterative process that involves adding additional training samples and re-running the trainer. For this aerial imagery, the classifier was trained approximately 12 times. Each "retraining", which involved adding additional training samples and, for several classified images, completing an accuracy assessment, of the classifier took three to six hours in total.

Then, they ran the SVM classifier using the default sample size per class but adding on four segment attributes: active chromaticity color, mean digital number, standard deviation, and count of pixels. These attributes provide additional information about each class (tree canopy cover, water, buildings, etc.). Classification took about 10-15 minutes on average but can take much longer.

When classification was complete, they created 250 equalized stratified random Accuracy Assessment Points using the 'Classified' value from the classified raster. Then they determined the 'ground truth' value for each point. With this information, they were able to populate a Confusion Matrix to compute various statistics (precision, commission, error of omission, Kappa, etc.) and the accuracy of the classifier.

For 2025, the classifier was 97% accurate at identifying tree canopy cover.

Next, they exported the rasters to polygons. The export process takes about 10 to 30 minutes on average but can take much longer depending on the size of the raster. When the export was complete, they exported Tree Canopy Cover to its own feature class. Using the 'Union' tool, they combined Tree Canopy Cover, and Zoning categories. This enabled us to compute the amount of tree canopy cover by zoning type and land status.

3. Results

Land Use Type	2020 Total Acres	2025 Total Acres	2020 Canopy Acres	2025 Canopy Acres	2020 Percent Canopy	2025 Percent Canopy	2040 Tree Canopy Cover Goal in UFMP
Industrial	2,445.73	2,529.02	771.29	778.66	32%	31%	25%
City Core Mixed Use	525.78	527.28	143.22	119.15	27%	23%	25%
Other Mixed Use	138.40	141.69	41.46	44.29	30%	31%	25%
General Commercial	733.64	642.60	301.96	214.25	41%	33%	30%
Single-Family Residential	6,306.41	6,320.08	3,253.21	2,876.53	52%	46%	50%
Multifamily Residential	813.61	816.13	328.02	312.55	40%	38%	40%
Open Space & Green Belt	1,472.12	1,487.45	714.10	647.75	49%	44%	55%
Port of Olympia – Olympia Regional Airport	807.59	805.85	24	27.30	3%	3%	3%
Port of Olympia-Industry	688.41	688.93	282.02	278.45	41%	40%	25%
Tumwater + Urban Growth Area	13,931.69	13,959.03	5,859.28	5,298.92	49%	38%	39%

	Acres	Canopy Acres	Percent Canopy Cover	2040 Tree Canopy Goal in UFMP
City Limits	1,1377.692	3,935.558	34.59%	-
Urban Growth Area	2,729.25	1,477.716	54.14%	-
City Limits and Urban Growth Area	14,317.677	5,413.318	37.81%	39%

4. Discussion

The Tree Board is encouraged to discuss these results.

Please note that in the next cycle of tree canopy assessment (2030), some City Land Use designations and their acreage may change with the adoption of the 2025 Comprehensive Plan. Visit the City 2025 Comprehensive Plan Periodic Update to learn more about changes proposed: 2025 Comprehensive Plan Update | City of Tumwater, WA.