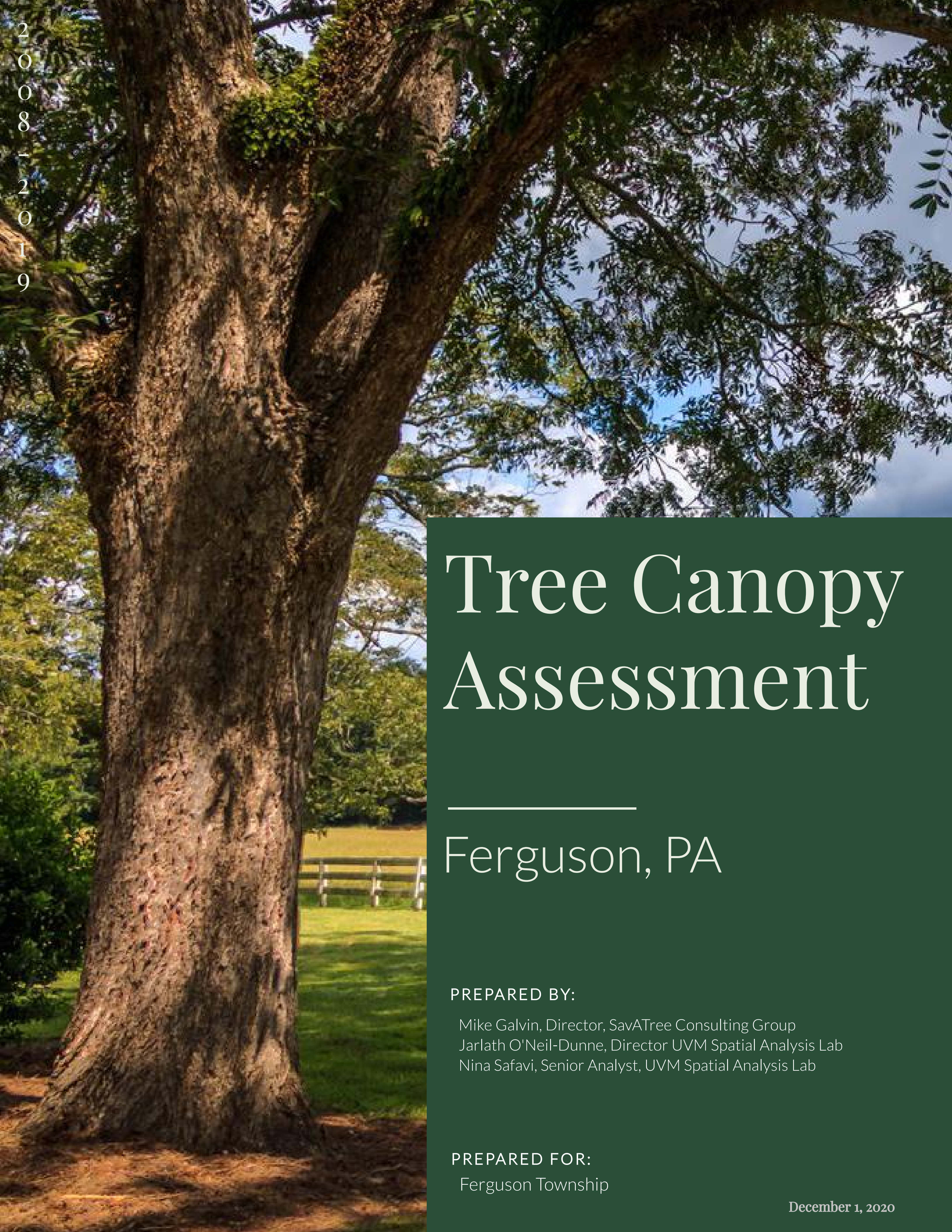


2008-2019

Tree Canopy Assessment

Ferguson, PA

PREPARED BY:

Mike Galvin, Director, SavATree Consulting Group
Jarlath O'Neil-Dunne, Director UVM Spatial Analysis Lab
Nina Safavi, Senior Analyst, UVM Spatial Analysis Lab

PREPARED FOR:

Ferguson Township

December 1, 2020

THE NEED FOR GREEN

Trees provide essential ecosystem services in Ferguson, from reducing stormwater runoff to providing wildlife habitat. Trees are an important part of Ferguson's infrastructure, its green infrastructure. From the street tree cooling the pavement in the summer to the forested stands in the hills, trees are a core part of Ferguson's landscape.

As with any community, Ferguson is facing a host of environmental challenges while seeking to maintain a balance between its rural history and its urban future. A healthy and robust tree canopy is crucial for maintaining this balance, providing Ferguson's residents with a resource that will impact the health and well-being of generations to come.

TREE CANOPY ASSESSMENT

For decades governments have mapped and monitored their infrastructure to support effective management of cities. That mapping has primarily focused on gray infrastructure, features such as roads and buildings. The Tree Canopy Assessment protocols were developed by the USDA Forest Service to help communities develop a better understanding of their green infrastructure through tree canopy mapping and analytics. Tree canopy is defined as the layer of leaves, branches, and stems that provide tree coverage of the ground when viewed from above. When integrated with other data, such as land use or demographic variables, a Tree Canopy Assessment can provide vital information to help governments and residents chart a greener future. Tree Canopy Assessments have been carried out for over 80 communities in North America. This study assessed tree canopy for Ferguson Township over the 2009-2019 time period.

FINDINGS

Ferguson's tree canopy increased from from 2008 to 2019. This increase is the opposite of national trends in which most communities are loosing tree canopy.

Although tree canopy is increasing there are both gains and losses throughout the township stemming from natural and anthropogenic factors.

Agricultural and Forest lands have more tree canopy than any other zoning category. As some agriculture transitions to a natural state, tree canopy will increase. In other cases, urbanization will result in losses.

Urbanization is the driving factor behind the greatest increases, with trees planted in the new developments prior 2008 exhibiting substantial growth.

Street trees provide crucial ecosystems services; the gains of tree canopy within the rights-of-way is encouraging.

Tree canopy will likely increase for decades in urban areas but will eventually decline if new trees are not planted to maintain the age diversity of trees.

Land use history, urban forestry initiatives, natural processes, and landowner decisions, all play a role in influencing the current state of tree canopy in the township.

The gains indicate that tree planting and preservation efforts are effective and paying dividends as trees mature.

RECOMMENDATIONS

Preserving existing tree canopy is the most effective means for securing future tree canopy, as loss is an event but gain is a process.

Planting new trees in areas where tree canopy is low or in locations where there has been tree canopy removed will also help the township grow canopy.

Having trees with a broad age distribution and a variety of species will ensure that a robust and healthy tree canopy is possible over time.

Community education is crucial if tree canopy is to be maintained over time. Residents that are knowledgeable about the value and services trees provide will help the city stay green for years to come.

Integrate the tree canopy change assessment data into planning decisions at all levels of government.

Reassess the tree canopy at 3-5 year intervals to monitor change.

Tree canopy assessments require high-quality, high-resolution data. Continue to invest in LiDAR and imagery to support these assessments and other mapping needs.

Field data collection efforts should be used to compliment this assessment as information on tree species, size, and health can only be obtained through on-the-ground inventories.

THE TREE CANOPY ASSESSMENT PROCESS

This project employed the USDA Forest Service's Urban Tree Canopy assessment protocols and made use of federal, state, and local investments in geospatial data.

Remotely sensed data forms the foundation of the tree canopy assessment. We use high-resolution aerial imagery and LiDAR to map tree canopy and other land cover features.

The land cover data consist of tree canopy, grass/shrub, bare soil, water, buildings, roads/railroads, and other impervious features.

The land cover data are summarized by various geographical units, ranging from the property parcel to the watershed to the municipal boundary.

These summaries, in the form of tree canopy metrics, are an exhaustive geospatial database that enables the Existing and Possible Tree Canopy to be analyzed.

The tree canopy metrics data analytics provide basic summary statistics in addition to inferences on the relationship between tree canopy and other variables.

The report (this document) summarizes the project methods, results, and findings.

The presentation, given to partners and stakeholders in the region, provides the opportunity to ask questions about the assessment.

Existing Tree Canopy

The tree canopy that you currently have, consisting of the leaves, branches, and stems when viewed from above.

Possible New Tree Canopy

Land where it is biophysically feasible to establish new tree canopy (excludes buildings and roads). It is easier to establish tree canopy on vegetated areas as opposed to impervious surfaces.

TREE CANOPY BY THE NUMBERS

11 Year Year Summary from 2008-2019

1.6%

Absolute gain in tree canopy

3.6%

Relative gain in tree canopy

502 acres of net gain of tree canopy coverage from 2008- 2019.

The net amount of tree canopy area gained is the equivalent of 380 football fields.

Key Terms

Existing Tree Canopy: The amount of urban **tree canopy** present when viewed from above using **aerial** or satellite imagery.

Possible Tree Canopy - Vegetated: Grass or shrub area that is theoretically available for **the** establishment of tree canopy.

Possible Tree Canopy - Impervious: Asphalt **or concrete** surfaces, excluding roads and buildings, that are theoretically available for the establishment of tree canopy

Not Suitable: Areas where it is highly unlikely that new tree canopy could be established (primarily buildings and roads).

There are three ways of tree canopy change

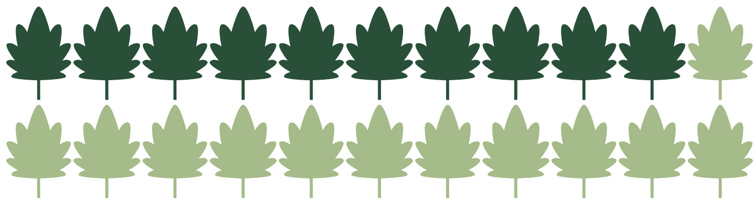
Area Change - the change in the area of tree canopy between the two time periods.

Relative % Change - a calculation used in economics, is the relative gain or loss of tree canopy using 2014 as the base year.

Absolute % Change - the percentage point change between the two time periods.

TREE CANOPY METRICS

47% *of Ferguson's land is covered by tree canopy*



Using Geographic Information Sytems (GIS) tree canopy was summarized at various geographical units of analysis, ranging from land use and property parcel to neighborhood boundaries. These tree canopy metrics provide information on the area of Existing and Possible Tree Canopy for each geographical unit.

Existing Tree Canopy

Ferguson Township, like most cities, has an uneven distribution of tree canopy. There are some 50-acre hexagons with less than 14% tree canopy and others with nearly 100% tree canopy (Figure 1). This unequal distribution can be traced back decades and reflects everything from land use history to the placement of parks. Those residents living and working in more treed areas benefit disproportionately from the ecosystem services that trees provide. Conversely, the more urbanized and rural regions, particularly the large span from the south-west to north-east, and the stretch in the north-western part of the township, have strikingly low amounts of tree canopy and therefore receive fewer ecosystem services from trees.

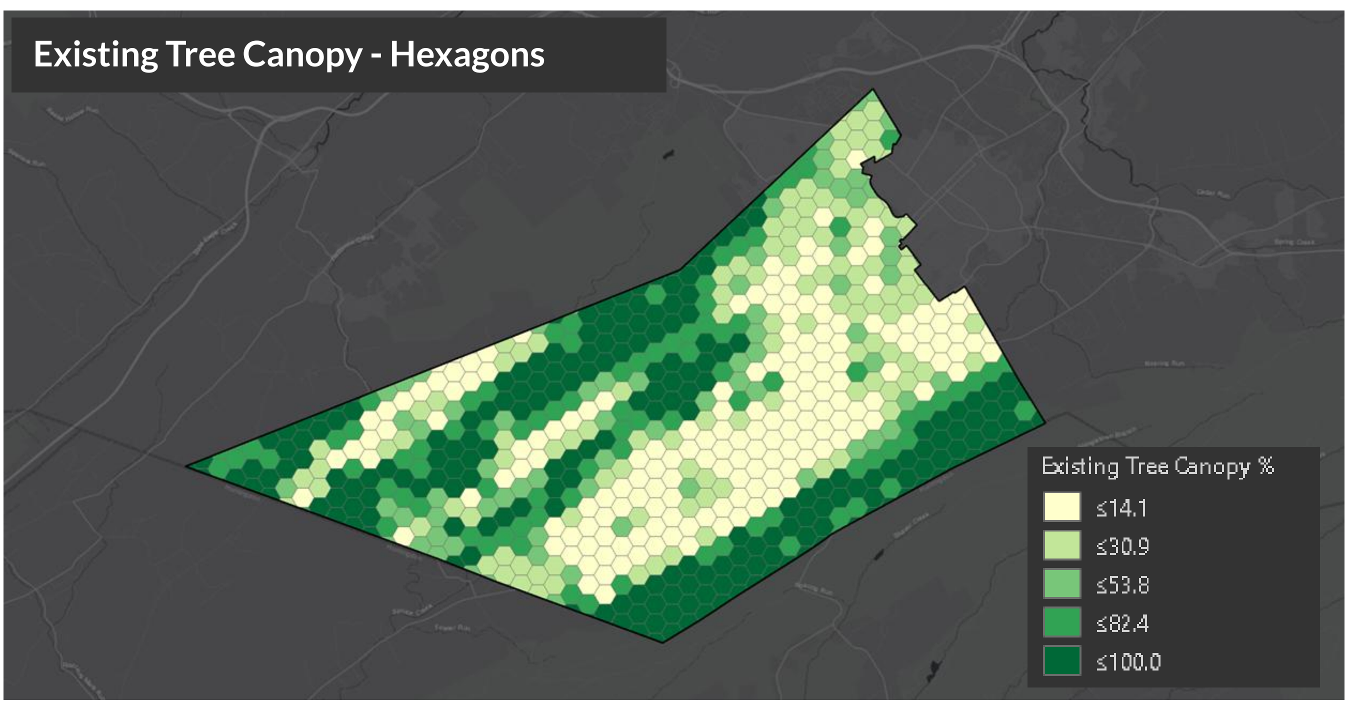


Figure 1. Existing tree canopy percentage for 2019 conditions summarized using 50-acre hexagons. For each of the hexagons, the percent tree canopy was calculated by dividing the amount of tree canopy by the land area, which excludes water. Using hexagons as the unit of analysis provides a standard mechanism for visualizing the distribution of tree canopy without the constraints of other geographies that have unequal area (e.g., zip codes).

Possible New Tree Canopy

Ferguson has room to plant more trees. In this assessment, any areas with no trees, buildings, roads, or bodies of water are considered Possible-Vegetation and represent locations in which trees could theoretically be established without having to remove paved surfaces. It should be noted that many other factors go into deciding where a tree can be planted and flourish, including land use, social, and financial considerations. Examples include golf courses and recreational fields. Thus, the Possible-Vegetation category should serve as a guide for further analysis, not a prescription of where to plant trees. With just under 14,600 acres of land (comprising 48% of the city's land base) falling into the Possible-Vegetation category, there remain significant opportunities for planting trees and preserving canopy that will improve the city's total tree canopy in the long term.

In the most densely urbanized areas of Ferguson' such as in the commercial district, significantly increasing the tree canopy will be difficult; nevertheless, it remains vitally important to promote the health and number of street trees even in these areas. In the township's residential neighborhoods, attention must be paid to ensure healthy natural regeneration of the existing tree canopy and planting new trees. Young trees that were planted in newly developed areas will likely contribute more canopy for decades but will eventually decline if new trees are not planted to achieve a healthy age distribution.

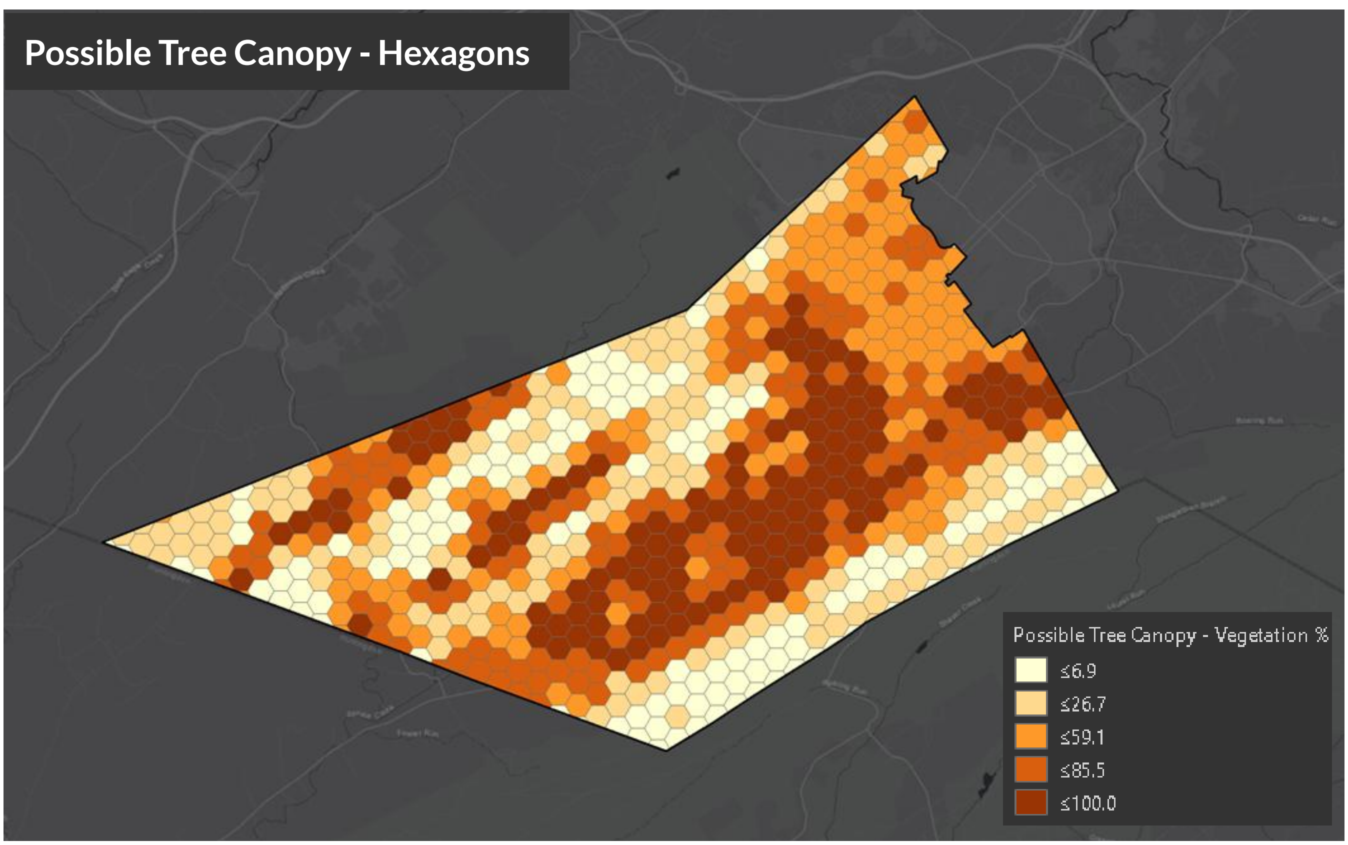


Figure 2. Possible Tree Canopy consisting of non-treed vegetated surfaces summarized by 50-acre hexagons. These vegetated surfaces that are not currently covered by tree canopy represent areas where it is biophysically feasible to establish new tree canopy. It may be financially challenging or socially undesirable to establish new tree canopy on much of this land. Examples include golf courses, recreational and agricultural fields. Maps of the Possible Tree Canopy can assist in strategic planning, but decisions on where to plant trees should be made based on field verification. Surface, underground, and above surface factors ranging from sidewalks to utilities can affect the suitability of a site for tree canopy planting.

City Change Distribution

The relative tree canopy change percentage shows the magnitude of change throughout the city over the 2008-2019 time period. The relative change is calculated by taking the tree canopy area in 2008, subtracting the tree canopy area in 2019, then dividing this number by the area of tree canopy in 2008. Areas with the greatest change indicate that the canopy is markedly different in 2019 as compared to 2008. In some of the commercial and urbanized areas with little tree canopy in 2008, the growth of street trees resulted in a sizeable relative gain. Conversely, removals of trees as a result of construction in sparsely treed areas resulted in substantial relative reductions in tree canopy.

Over time tree canopy will likely increase for Ferguson Township, but the expansion will be greatest in newly developed areas with younger trees. There are both environmental and anthropogenic risks facing canopy cover. Invasive species could pose a serious threat if not identified and controlled early. Natural events such as storms can have a mixed impact on the canopy. In woodland areas, trees will return, but in urbanized areas, trees lost to storms will need to be replaced. Climate change may cause trees to grow more quickly but could also result in inhospitable conditions for native species. Anthropogenic factors include preservation and conservation efforts, the strength of tree ordinances, and the conversion of agricultural land use to urbanized land use. Managing these risks will be key to achieving canopy growth.

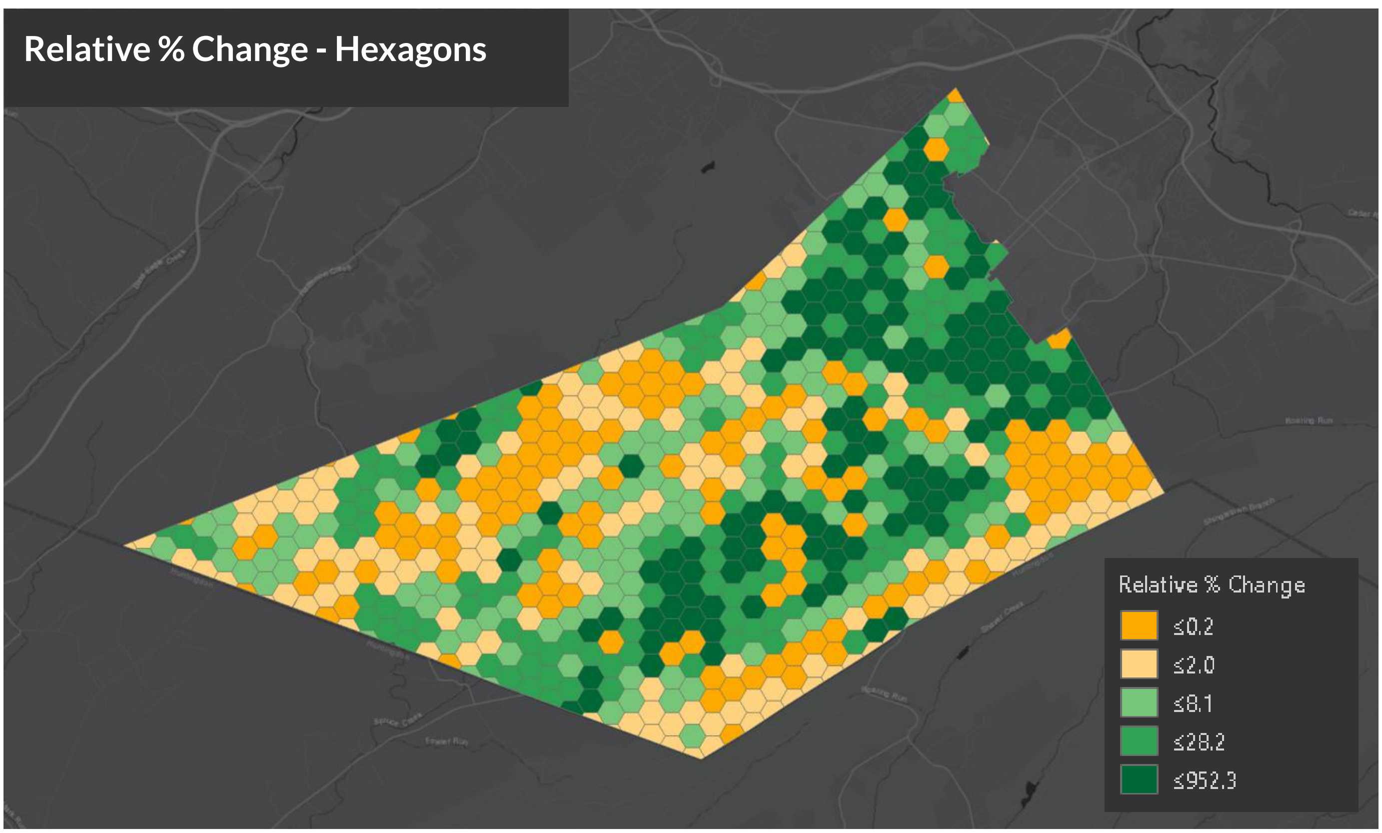


Figure 3: Tree canopy change metrics summarized by 50-acre hexagons. Relative tree canopy is calculated by using the formula (2008-2019)/2019. Colors are categorized by data quantiles. Darker greens indicate greater relative gain, while darker orange reflects minimal relative change or loss.

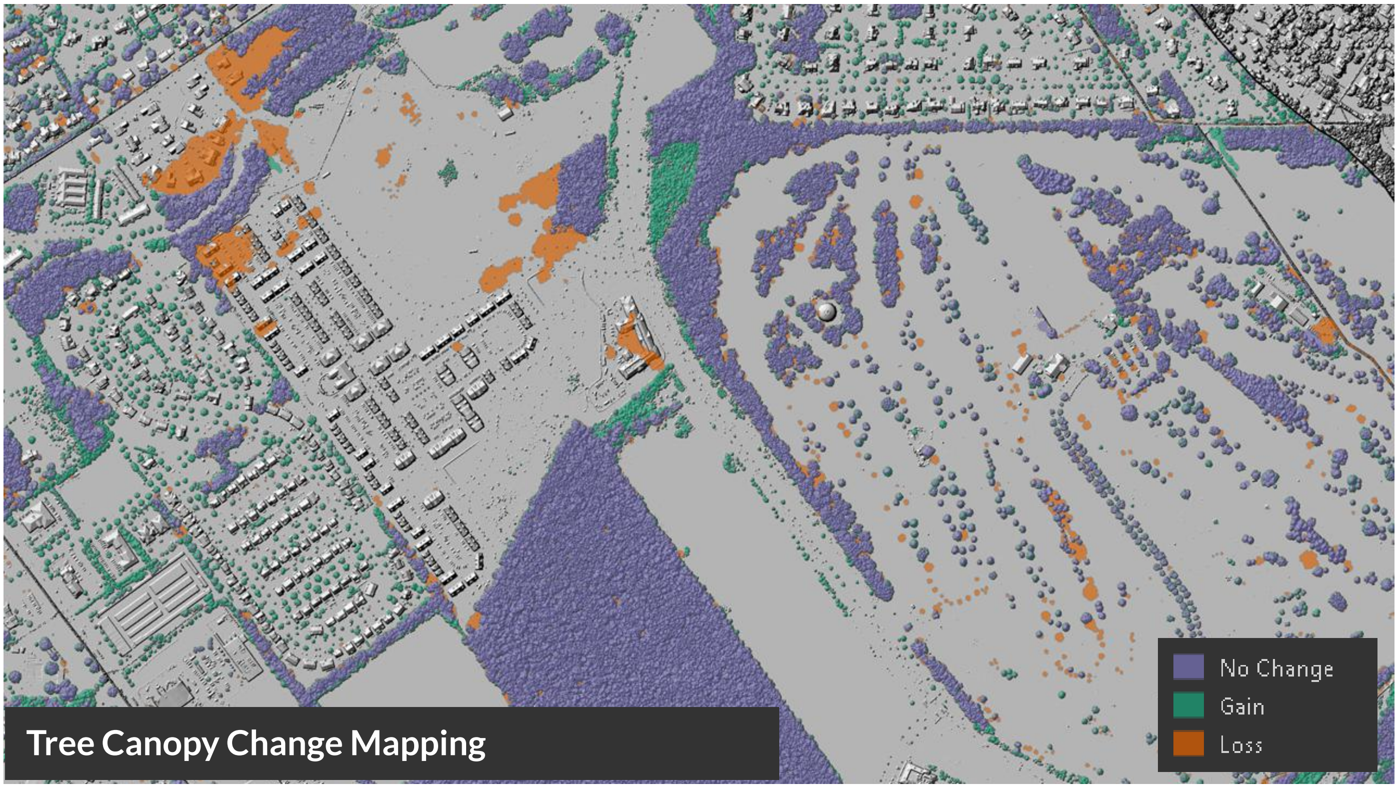


Figure 4: Tree canopy change mapping for the area in the vicinity of Greenleaf Manor. This area experienced a high amount of canopy loss due to removals (orange) as well as gains due to new plantings and natural regeneration. Tree canopy change was mapped for the 2008-2019 time period and is overlaid on the 2019 LiDAR hillshade map.

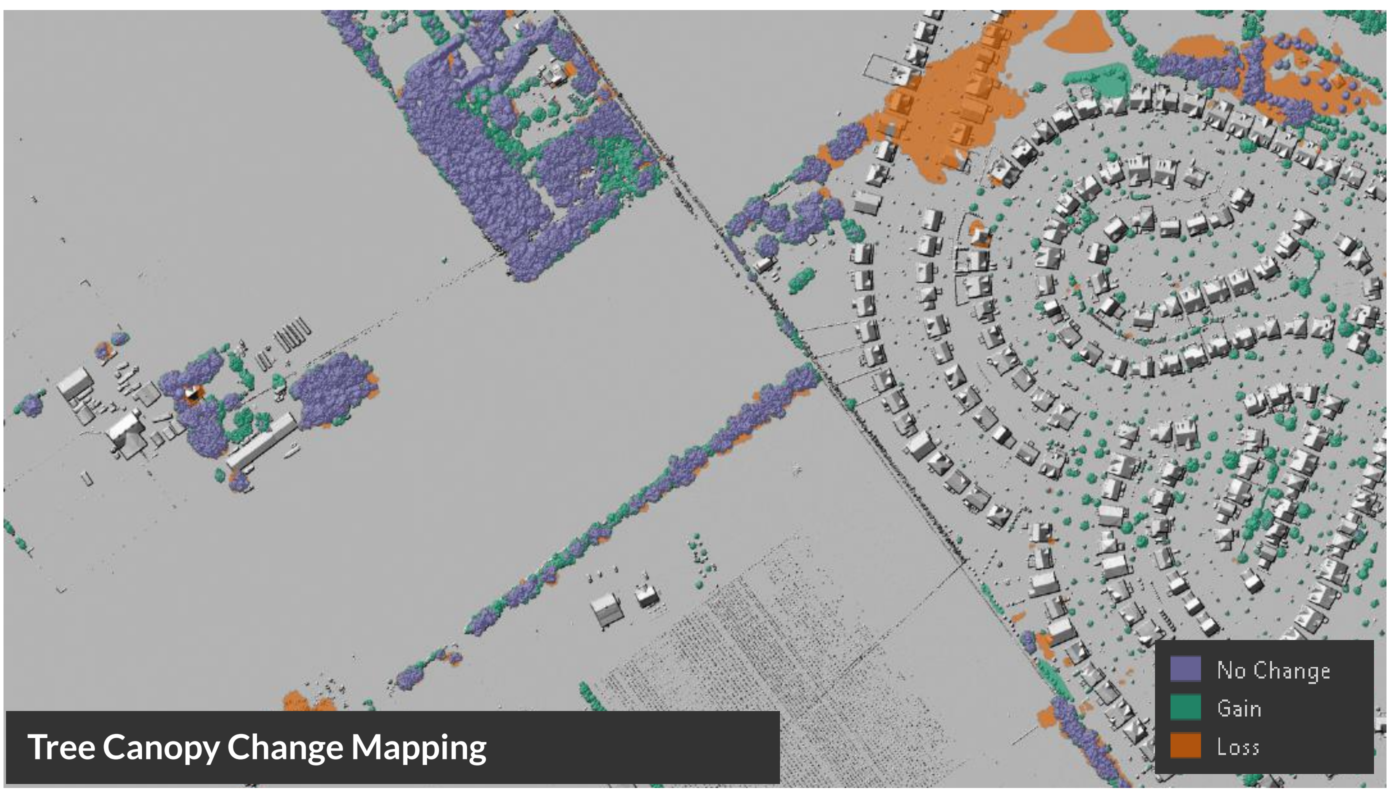


Figure 5: Tree canopy change mapping for an area near Hunter's Chase Development. This area experienced a mix of gain and loss on rural and suburban land. Tree canopy change was mapped for the 2008-2019 time period and is overlaid on the 2019 LiDAR hillshade map.

Land Use

Land use is how we, as humans, make use of the land. Land use is different from land cover. Land cover refers to the features, such as the trees, buildings, and other classes mapped as part of this study. For example, residential land use can contain tree, building, impervious, grass, and other land cover features. Land use can significantly influence the amount of tree canopy and the room available to establish new tree canopy.

Residential lands experienced the most tree canopy gain (398 acres) and loss (280) acres of any other land use. Trees planted in new developments have grown, adding to canopy cover, while new construction has removed trees from the landscape. There was no agriculture category in Ferguson's land use map, which was often combined in the Residential category. Vacant lands also revealed significant gain (240 acres), and included some of Ferguson's woodlands along with other tracts of land, not allowing for conclusive analysis based on this category.

It is an encouraging sign that there were gains in both the rights-of-way (ROW) (56 acres) and Commercial (155 acres) land uses. Trees in the ROW and urbanized areas face inhospitable conditions associated with their close proximity to roads. Regular salting, compaction, limited space, clearance pruning, and plow collisions are some of the challenges that limit canopy establishment and growth in these limiting environments. The gain in the ROW is a sign of the township's effective maintenance and planting efforts between 2008 and 2019. While the ROW experienced a net gain, there was a loss of 15 acres. Street trees not only make roads more aesthetically pleasing, but they also play an important role in reducing stormwater runoff and decreasing the urban heat island effect.

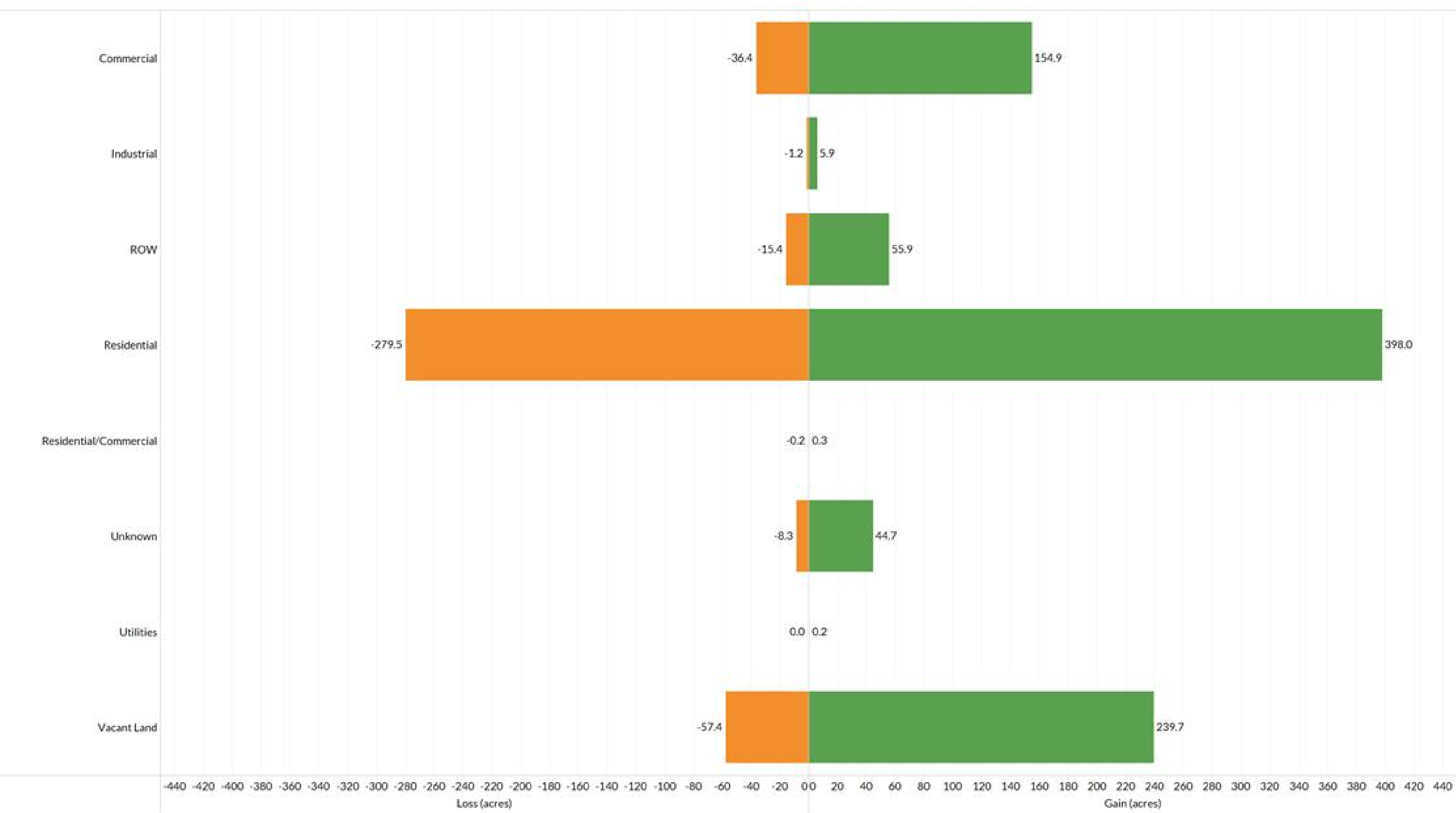


Figure 6: The area, in acres, of tree canopy change in each of Ferguson's Land Use categories.

Land Use (continued)

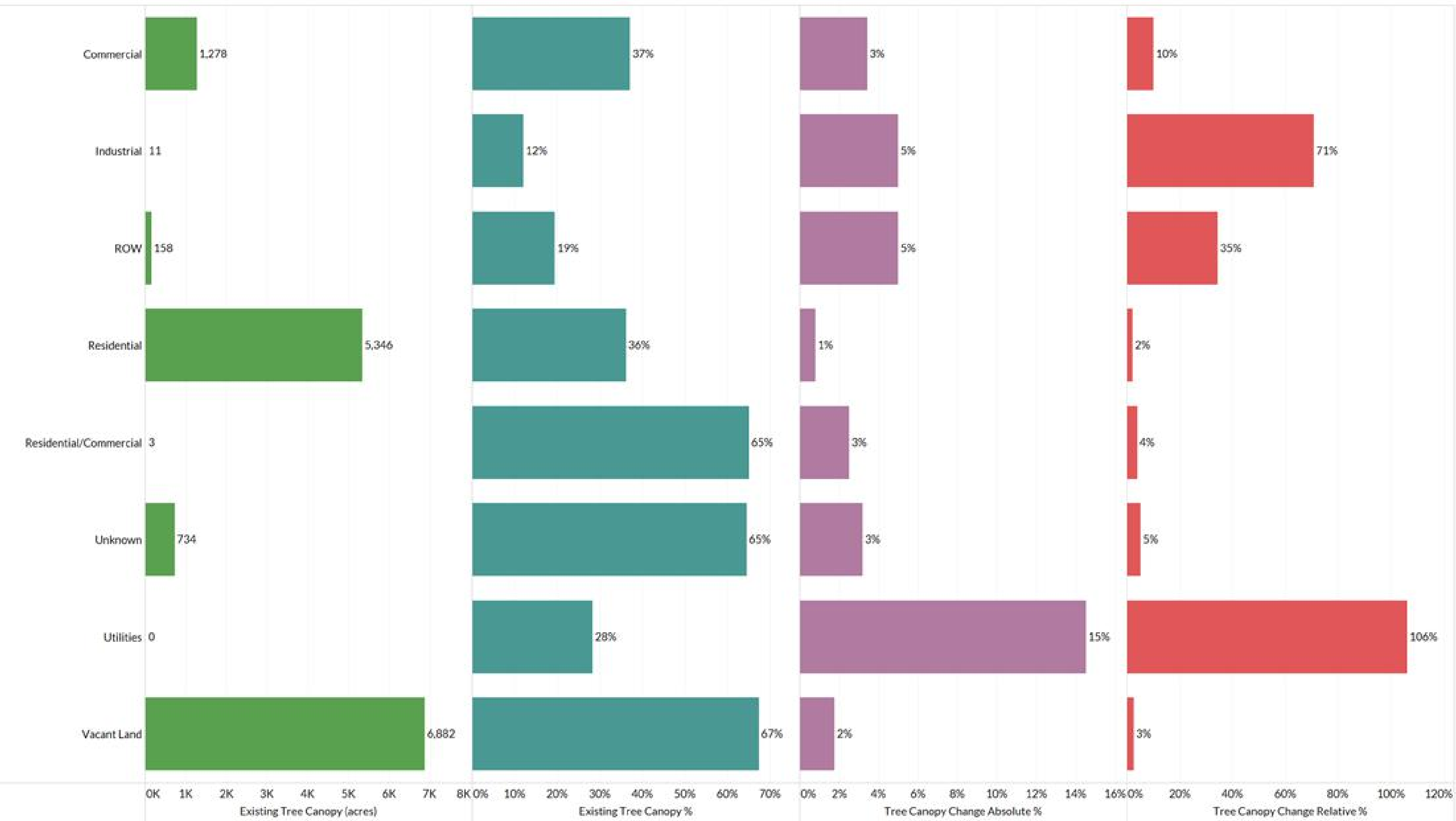
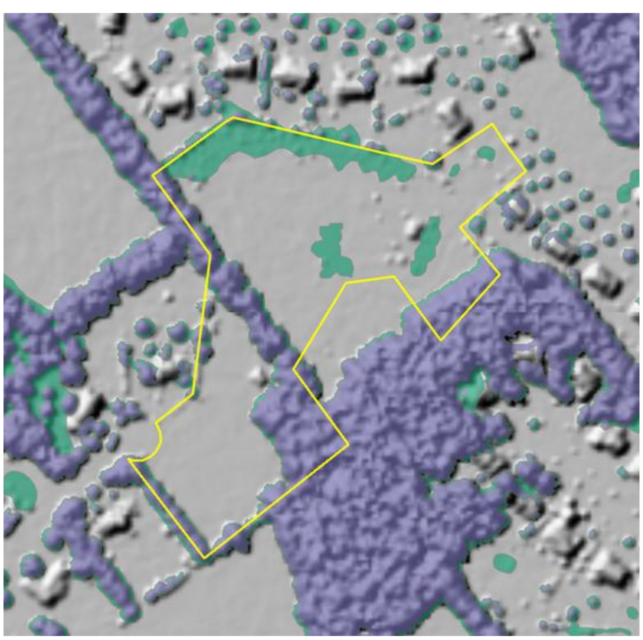


Figure 7: Existing tree canopy and canopy change by Land Use.

Parks



All Parks in Ferguson Township gained canopy from 2008 to 2019. Tudek Harden and Whitehall Road Regional Park had just short of 1% absolute gain, while Tudek Butterfly Garden and Greenbriar Saybrook Park had the most absolute gain of 22.5% and14.1%, respectively. Natural growth of trees planted before 2008 contributed to Greenbriar Saybrook's canopy gain. Parks canopy change should be dependent on park objectives and use for active versus passive recreation.

Figure 8: Tree canopy change mapping for Greenbriar Saybrook Park. This park experienced gain. Tree canopy change was mapped for the 2008-2019 time period and is overlaid on the 2008 LiDAR hillshade map.

Zoning

Further insights into canopy change on Residential and Agricultural/Forest lands can be obtained by honing in on Ferguson's Zoning data in Figure 9. Agriculture and Forest Lands also experienced growth of 465 acres and loss of 244 acres. While the gain has outpaced the loss, Agriculture & Forest Land are a significant contributor to tree canopy by total land area. There can be a direct conflict between agricultural operations and planting trees. Tree planting and preservation activities that focus on the conservation benefits, such as riparian buffers, may help integrate trees into these landscapes and even supporting agricultural practices by serving as windbreaks.

The Residential zoning class gained 365 acres of tree canopy and lost 124 acres. With the exception of Town Development, all Zoning categories experienced gain. Town Development experienced a net loss of 2 acres. Given that Residential land use contributes a large total area of tree canopy, losses on residential land, if continued, will have a substantial effect on Ferguson's overall tree canopy.

It is customary to set canopy cover goals based on zoning or land use. Figure 10 shows existing canopy cover by acreage for each of Ferguson Township's zoning categories. Setting a target acreage canopy cover based on existing canopy can be an effective data-driven approach to canopy planning and future evaluation.

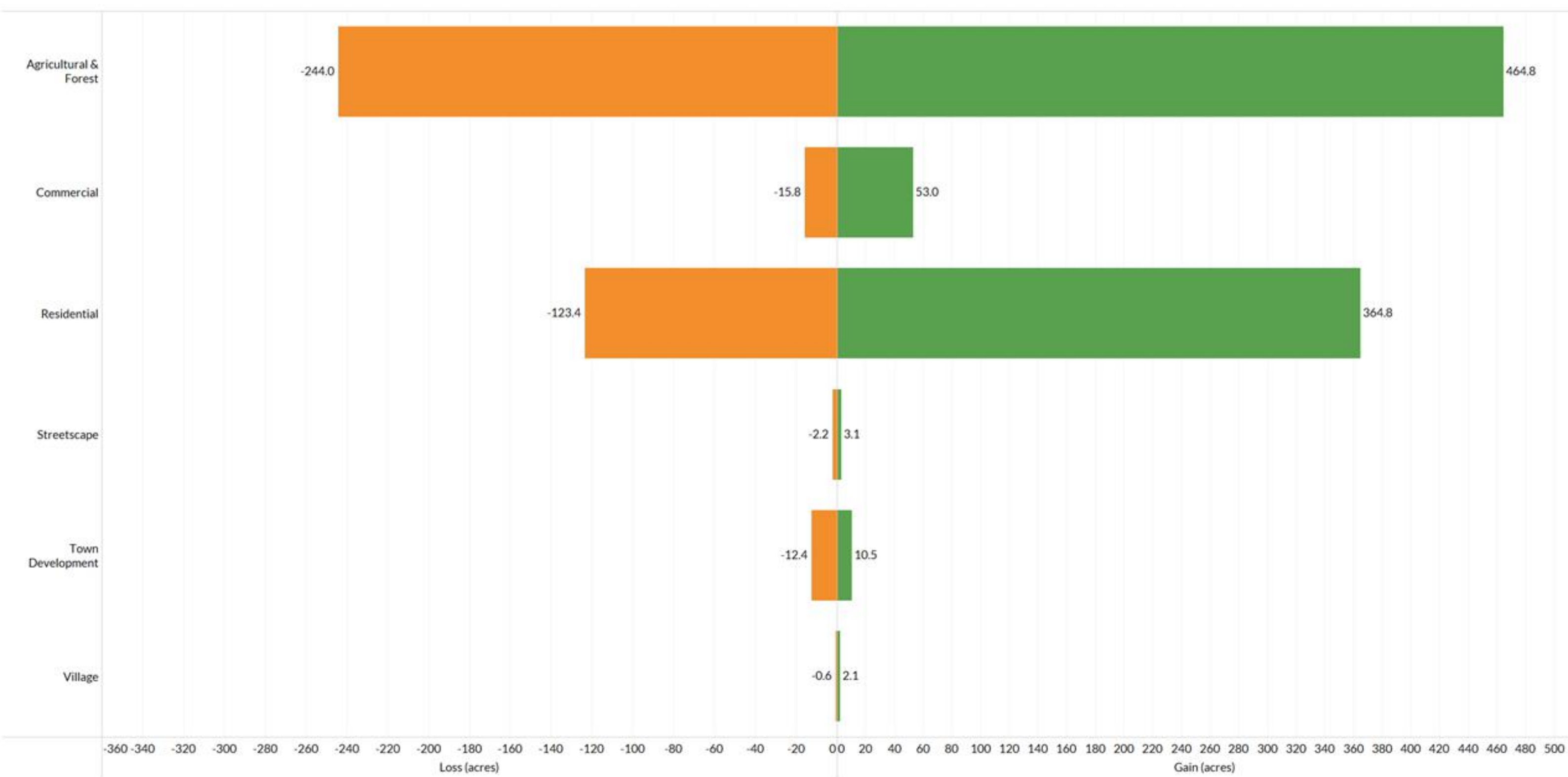


Figure 9: The area, in acres, of tree canopy change in each of Ferguson's Zoning categories.

Zoning (continued)

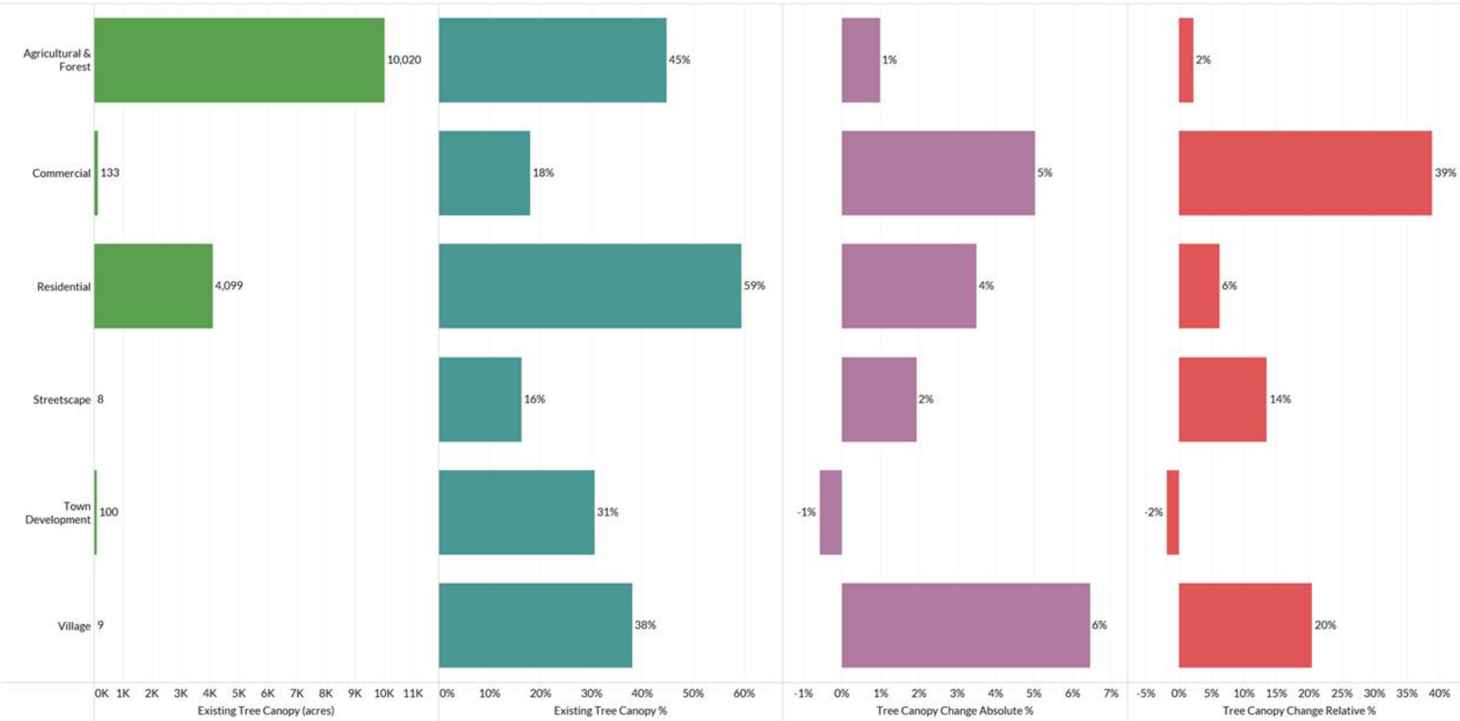


Figure 10: Existing tree canopy and canopy change by Zoning.

Growth Boundary

Ferguson Township has a designated growth boundary as illustrated in Figure 11. Within the more densely urbanized growth boundary promoting the health and number of street trees will be important.

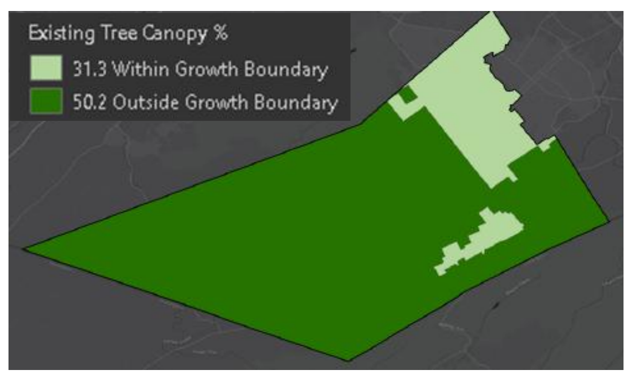


Figure 11: Existing tree canopy within and outside the growth boundary of Ferguson Township.

There is more tree canopy outside of the growth boundary (50.2%) as a result of less urbanization, with residential and agricultural lands largely contributing to canopy cover. However, large areas of state land within the boundary of Ferguson Township's also impacted canopy cover outside of the growth boundary illustrated in Figure 12. 92.5% of state lands are covered by existing tree canopy. Existing Tree Canopy across Ferguson Township, when excluding state lands, is 39.9%. Collaboration between the township and the state will be necessary to manage the tree canopy as a unit across boundaries.

Figure 12: Map of state and township jurisdiction boundaries.

Growth Boundary (continued)

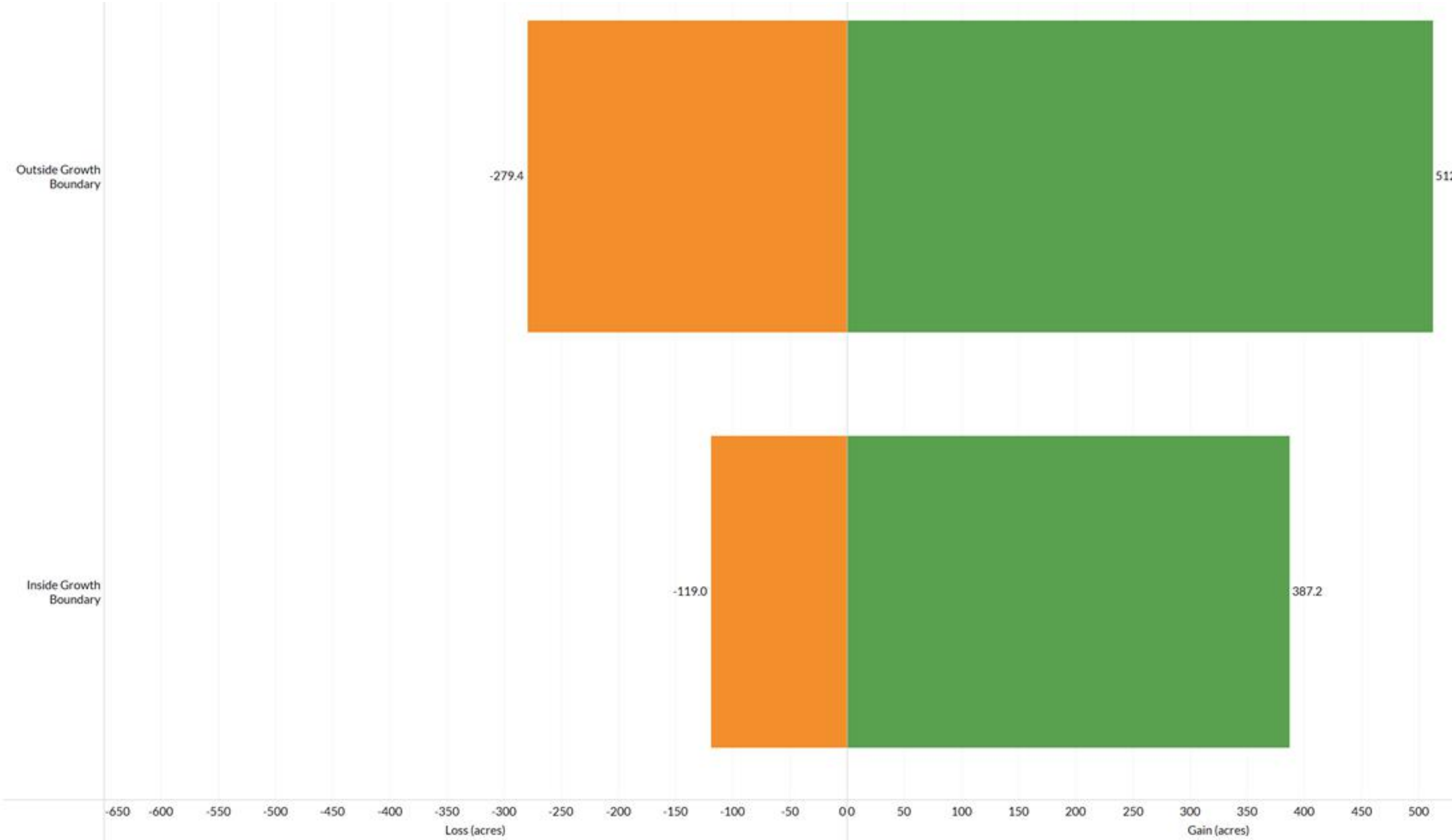


Figure 13: The area, in acres, of tree canopy change within and outside of Ferguson's growth boundary.

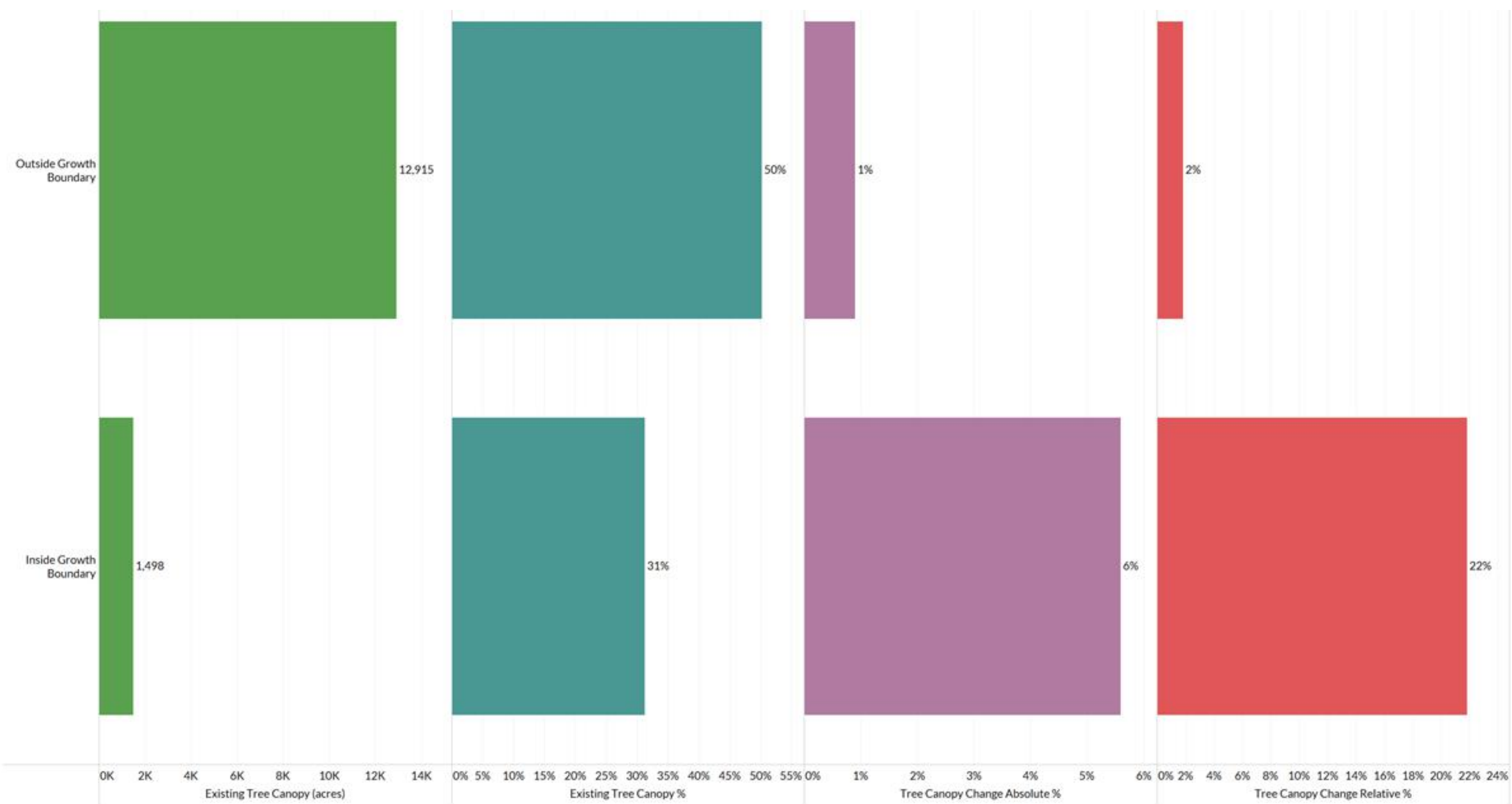


Figure 14: Existing tree canopy and tree canopy change within and outside Ferguson's growth boundary.

MAPPING THE TREE CANOPY FROM ABOVE

Tree canopy assessments rely on remotely sensed data in the form of 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 township's tree canopy to be mapped in greater detail and with better accuracy than ever before. From a canopy tree in Pine Hall cemeteray to a patch of trees in Songbird Sanctuary Park, every tree in the township was accounted for.

Tree Canopy Mapping

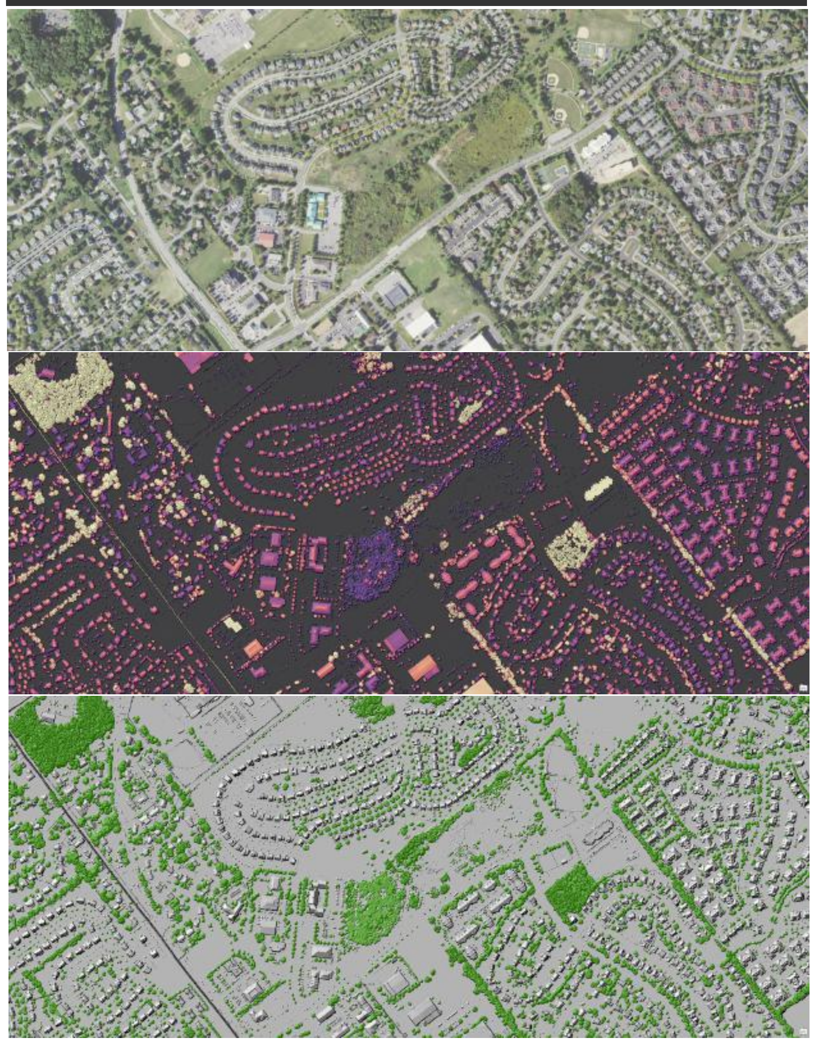


Figure 15: Imagery (top), LiDAR surface model (middle), and high-resolution tree canopy (bottom). By combining these datasets the land cover mapping process capitalizes on their strengths and minimizes their weaknesses. The land cover dataset is the most detailed, accurate, and current for Ferguson.

The high-resolution land cover that forms the foundation of this project was generated from the most recent LiDAR, which was acquired in 2019. Compared to national tree canopy datasets, which map at a resolution of 30-meters, this project generated maps that were over 1000 times more detailed and better account for all of the city's tree canopy.

Land Cover Mapping

Figure 16: High-resolution land cover developed for this project.

MAPPING TREE CANOPY CHANGE

This study made use of aerial imagery and LiDAR data acquired in 2008 and 2019. LiDAR is positionally more accurate and thus served as the primary data source for determining change. The imagery was used to confirm the change detected using the LiDAR. Both LiDAR datasets were acquired under leaf-off conditions and thus tend to underestimate tree canopy slightly. The two LiDAR and imagery datasets are not directly comparable due to differences in the sensor, time of acquisition, and processing techniques employed. This study went to great efforts to reduce the errors associated with differences in the datasets to come up with the most accurate estimate of tree canopy change possible. Losses are generally easier to detect than gains as losses tend to be due to a large event, such as tree removal, whereas gains are incremental growth or new tree plantings, both of which are smaller in size.

Tree Canopy Change

Figure 17: Tree canopy change mapping in the vicinity of the Haymarket Park. Tree canopy change was mapped for the 2008-2019 time period and is overlaid on the 2019 LiDAR hillshade map.

Comparisons to Past Studies

A vital component of the Tree Canopy Assessment Protocols is ensuring that changes in tree canopy are attributed to actual gains and losses in tree canopy as opposed to differences in the source data. The 2008 and 2019 datasets were acquired with different specifications. Great care was put into resolving the differences in the data to ensure that tree canopy change between 2008 and 2019 reflected an actual change in the canopy as opposed to differences in the source data.

This assessment was carried out by SavATree and the University of Vermont Spatial Analysis Lab in collaboration with Ferguson Township. The methods and tools used for this assessment were developed in partnership with the USDA Forest Service. The source data used for the mapping came from Ferguson Township and the USDA. The project was funded by Ferguson Township. Additional support for data analytics came from a Catalyst Award from the Gund Institute for Environment at the University of Vermont and NASA . Computations were performed on the Vermont Advanced Computing Core supported in part by NSF award No. OAC-1827314. and from the Vermont Advanced Computing Core.

Report Authors
Mike Galvin, Director, SavATree
Jarlath, O'Neil Dunne, Director, UVM Spatial Analysis Lab
Nina Safavi, Senior Analyst, UVM Spatial Analysis Lab

Tree Canopy Assessment Team
Ernie Buford
Anna Royar
Kelly Schulz
Vivian Karins
Jackson Schilling
Vivian Karins
Katie Kobylaski
Travis Miller
Emily Downs
Austen Thum
Emma Hoyt

City Point of Contact:
Lance A King, Township Arborist
Ferguson Township
lking@twp.ferguson.pa.us

SAVATREE® Consulting Group

University of Vermont Spatial Analysis Lab

Gund Institute for Environment