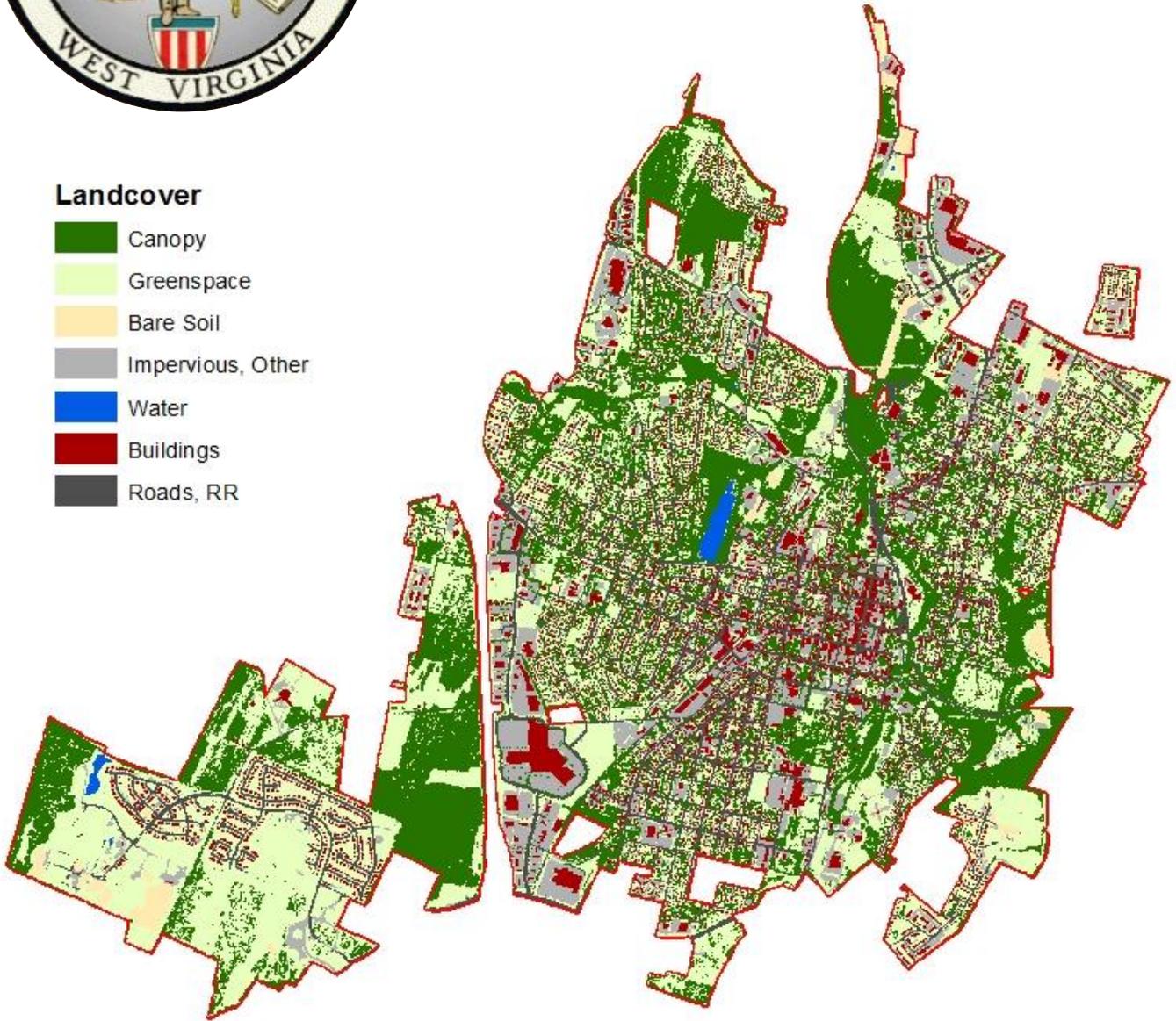




The City of Martinsburg Urban Tree Canopy Analysis

Landcover

-  Canopy
-  Greenspace
-  Bare Soil
-  Impervious, Other
-  Water
-  Buildings
-  Roads, RR



Report
Prepared
By:



Funding
Provided
By:



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Downtown Martinsburg circa 1913 and today (2013).

Introduction

Cacapon Institute, in partnership with the USDA Forest Service, WV Division of Forestry, and The City of Martinsburg has completed an Urban Tree Canopy (UTC) analysis for Martinsburg to model four Hypothetical Tree Canopy scenarios by property parcels. In addition to the property parcel analysis, landcover was analyzed in terms of forest patches (clusters of trees) and a 200' stream corridor. The Existing Tree Canopy was determined by the University of Vermont based on 2011 information. The four Tree Canopy models are hypothetical and more investigation is needed in order to develop actionable intelligence on the potential for Tree Canopy expansion.

This report is a snapshot in time and change has occurred since the original landcover assessment was completed. The analysis should be used as a guideline for understanding UTC and setting UTC goals. It is not intended as a definitive conclusion or as a discussion of the current condition of UTC or landcover because changes in the landscape including construction, development, tree growth and plantings have altered the landcover since 2011.

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CI's mission, from the Cacapon River to the Potomac to the Chesapeake Bay, is to protect rivers and watersheds using science and education. Founded in 1985, Cacapon Institute has grown from a local watershed research and protection group to an organization reaching a broad audience across the Mid-Atlantic. Our online Potomac Highlands Watershed School is used by tens of thousands of students. We facilitate community and school based hands-on watershed conservation across the Potomac Highlands, Shenandoah Valley, and downstream to the Bay. Cacapon Institute is an active participant in the WV Chesapeake Bay Tributary Team and Chesapeake Bay Program.

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Background

UTC (Urban Tree Canopy)

UTC is a measure of the trees we live with, the trees that grace our neighborhoods, towns, parks, schools, and roadsides. Cacapon Institute, in partnership with the USDA Forest Service and West Virginia Division of Forestry, is assisting government agencies and volunteers to improve UTC in the Potomac Basin of WV. Assistance includes analyzing UTC to determine high priority planting sites, setting UTC goals, fostering tree planting initiatives, and developing long-term plans to expand UTC. Our goal is to increase the public benefits of UTC including clean air, shade, and reduced stormwater runoff pollution. Investigating and defining UTC are first steps for city officials, decision makers, managers and the public in efforts to enhance Tree Canopy. Trees' benefits can be measured and quantified. The "2012 Martinsburg WV i-Tree Street Survey," for example, found the street tree population's benefit is estimated to provide a 9:1 return on investment.¹ For every \$1.00 Martinsburg spends on tree maintenance i-Tree estimates \$9.00 in benefits is returned by the street tree population.



UTC Landcover Assessment

In 2011, with financial support from the USDA Forest Service and WV Division of Forestry, Cacapon Institute engaged the Spatial Analysis Laboratory at the University of Vermont's Rubenstein School of Environmental and Natural Resources to produce a landcover assessment for Berkeley County, WV.² UVM applied high-resolution National Agriculture Inventory Program³ color infrared and U.S. Geological Survey Light Detection and Ranging data to complete a landcover assessment of Berkeley County, including Martinsburg. The color infrared indicates the composition of the land surface so asphalt, concrete, bare soil, water, plants and other surfaces can be identified. Light Detection and Ranging (LiDAR) data indicates the height of objects on the ground. By combining the two UVM can differentiate Tree Canopy from plants under 8' in height. UVM also uses the LiDAR height information to define building footprints to distinguish building from other impervious surfaces. This unique and complex process, developed by UVM and the Forest Service, produces a 97% accurate landcover assessment. UVM distinguishes seven landcover types: Tree Canopy, Greenspace (fields, grass, and vegetation <8 feet), Bare Soil, Water, Building, Road-Railroad (asphalt, concrete, dirt-gravel roads and other surfaces connected to transportation arteries), and Impervious (parking lots, sidewalks, driveways, etc.).

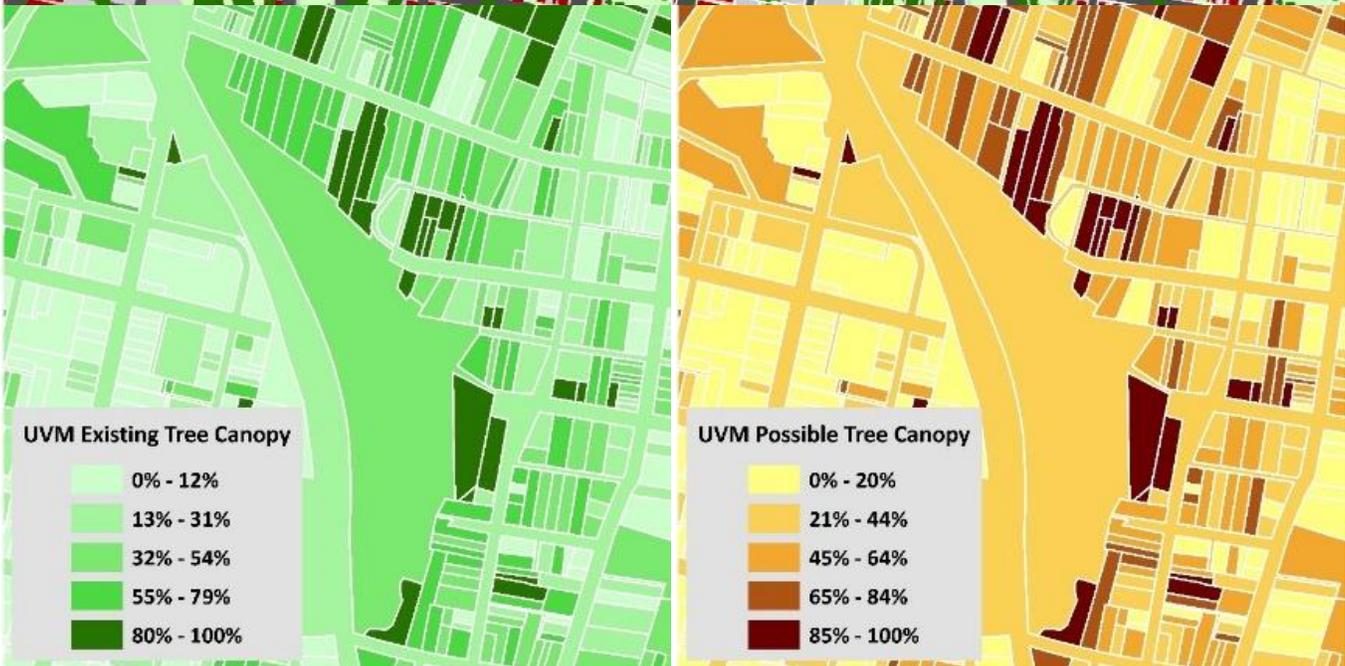
¹ The full "[Martinsburg iTree Streets Inventory Report](#)" (2.8MB PDF) is available at the Forestry Tab at "Reports" at www.cacaponinstitute.org.

² "[A Report on Berkeley County's Existing and Possible Tree Canopy](#)" (5.3 MB PDF) is available at the "Publication Tab" at www.cacaponinstitute.org.

³ "High-resolution" in this case is <1 meter accuracy National Agriculture Inventory Program (NAIP) data. An example of natural color imagery at <1 meter is on this page - the B&O Roundhouse is a Martinsburg landmark and used for reference in many images.

After determining landcover, UVM used the Berkeley County Assessor’s property parcel boundaries to determine landcover by individual property parcels. Using Forest Service methodology UVM reported how the landcover, by parcel, might change if the Greenspace, Bare Soil, and Impervious landcover types were converted to Tree Canopy; i.e., how might the landcover present if Tree Canopy replaced the Greenspace, Bare Soil, and

■ Canopy ■ Green ■ Soil ■ Impervious ■ Water ■ Buildings ■ Roads&RR

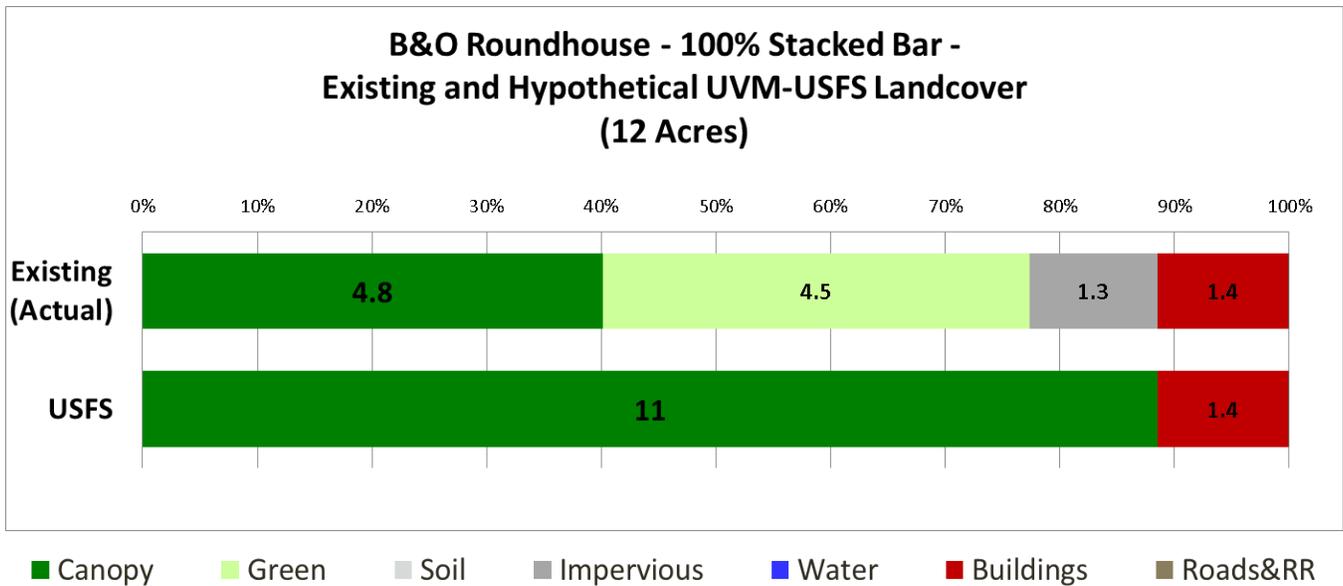
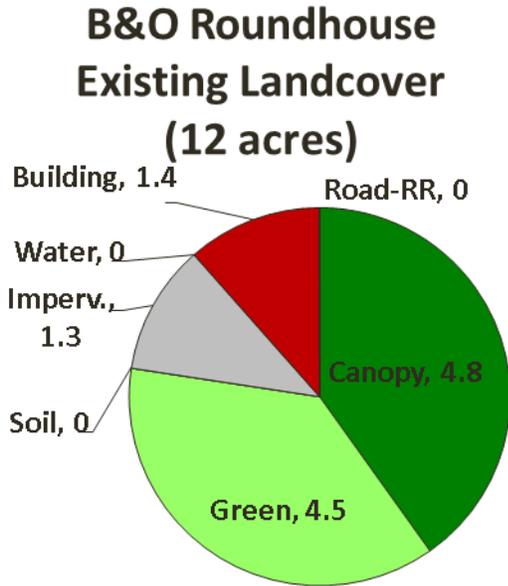


Impervious landcovers. UVM defines this expansion as “Possible Tree Canopy.” Possible Tree Canopy is central to Cacapon Institute’s further analyzes and is accepted as the maximum area of Tree Canopy in all of our Hypothetical Tree Canopy scenarios.

Once the landcover types were “parcelized” by dividing landcover by the seven types into individual property

parcel groups. UVM determined the percentage of Tree Canopy per property parcel and the Possible Tree Canopy per property parcel.

The pie chart below represents UTC for one parcel, the B&O Roundhouse. The image displays the Roundhouse⁴ property as an example of the parcelization of UTC. The 100% stacked bar graphs below shows Existing Tree Canopy and Possible Tree Canopy. PTC, or USFS, model converts all the “suitable lancover” to Tree Canopy. In this case everything was converted except Building lancover.⁵

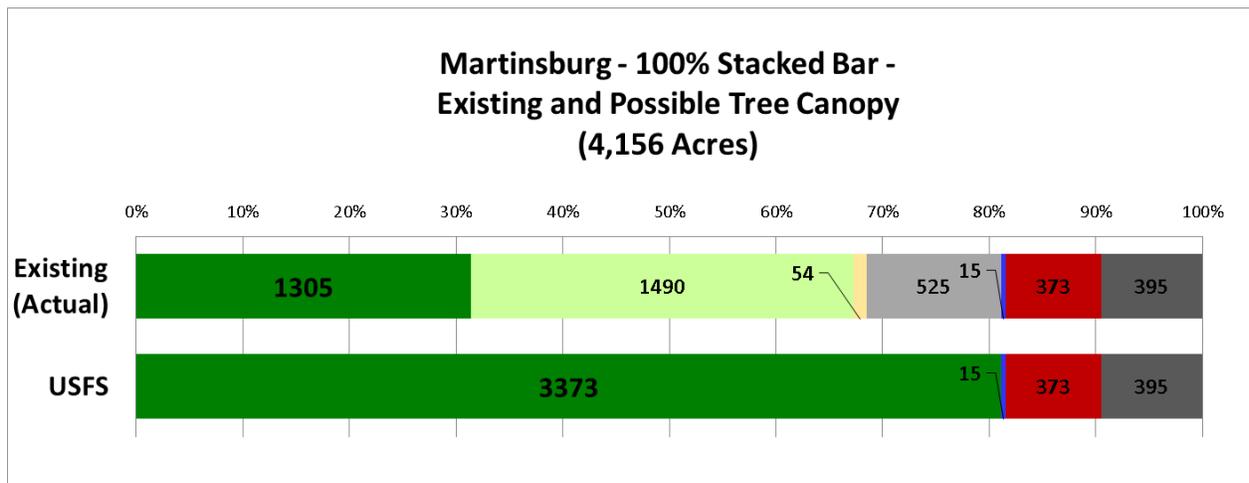
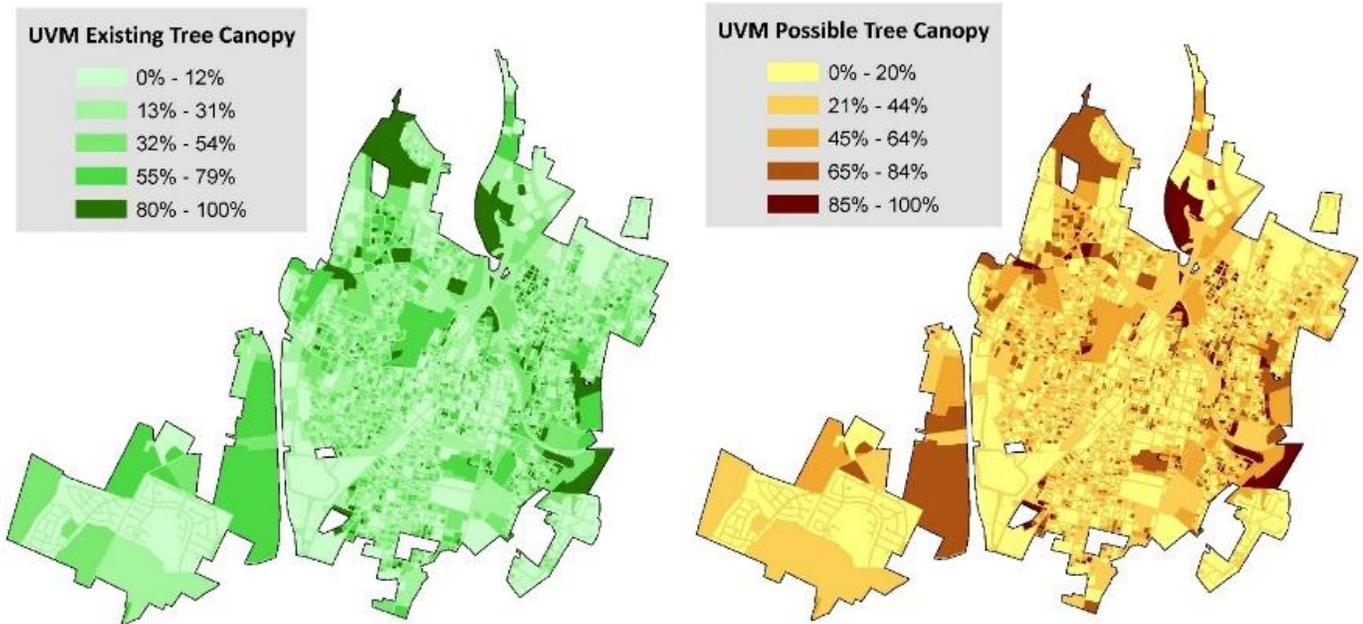


⁴ The B&O Roundhouse is a historic railroad property. The UVM landcover assessment found 0.00425 acres (17 square feet) of Road-Railroad landcover on the property. It is not connected in a significant way to operating freight or commuter rail road lines.

⁵ The B&O Roundhouse parcel does not include any significant areas of bare Soil, Water, or Road-Railroad. This is typical of most property parcels in the city with the exception of right-of-way and the parcel with the city’s water reservoir.

The stacked bar graph shows how UVM-USFS PTC model converts all the “suitable landcover” of Greenspace, Soil, and Impervious to Tree Canopy.

The UVM-USFS Existing and Possible Tree Canopy by parcel for Martinsburg.⁶



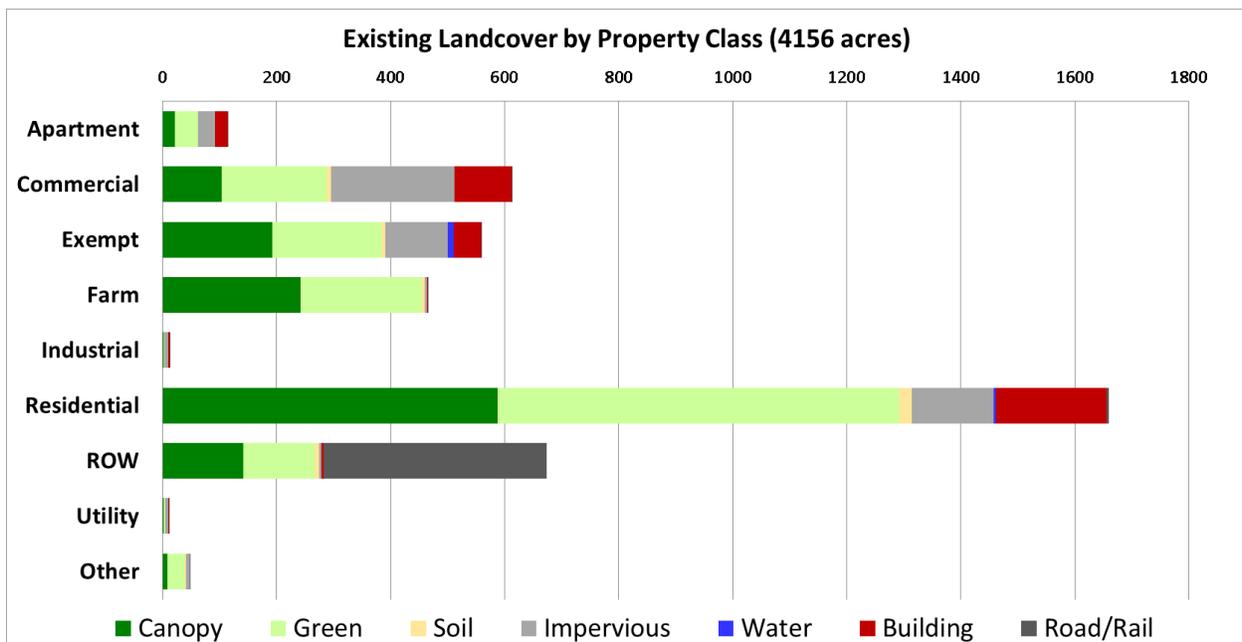
■ Canopy ■ Green ■ Soil ■ Impervious ■ Water ■ Buildings ■ Roads&RR

⁶ [“A Report on Berkeley County’s Existing and Possible Tree Canopy”](#) (5.3 MB PDF) is available at the “Publication Tab” at www.cacaponinstitute.org.

Cacapon Institute UTC Analysis

Parsing the landcover by the property parcel boundary isolates the landcover within each property parcel. Cacapon Institute built on UVM’s landcover assessment by incorporating an additional layer of identification to the property parcels. By adding “landuse” it is possible to subdivide the property parcels by “property class.” Landuse, in this report, is based on the tax status of parcels of land as defined by the Berkeley County Assessor’s Office. The assessor defines seven property classes that were used to differentiate the likely use of a parcel of land. “Use” does not represent a specific application, or activity, on a parcel but is a generalization based on the seven property tax designations: Apartment, Commercial, Farm, Industrial, Residential, Utility, and Exempt (tax exempt). To these property class definitions Cacapon Institutes added two property classes: “other” is parcels without a property class indicated; and Right Of Way. ROW is all the land within the city boundary that is outside of the parcel property boundaries.

Cacapon Institute analyzed landcover by these nine property classes. The majority of land is in the Residential class. Acreage of Residential Tree Canopy and Greenspace is more than twice the acreage in any other property class. ROW is the second largest land area and the majority of Road-Railroad landcover is within the Right Of Way, more than all other classes combined. Each property class landcover is discussed individually later.



■ Apartment ■ Commercial ■ Farm ■ Industrial ■ Residential ■ Right of Way ■ Utility ■ Exempt ■ Other

Building on UVM-USFS PTC Cacapon Institute presents three additional Hypothetical Tree Canopy scenarios with less than 100% Possible Tree Canopy. Hypothetical Tree Canopy (HTC) conversion of 60%, 40%, and Average of the land area to Tree Canopy is presented. The HTC uses the landcover by parcel data and caps landcover conversion at PTC.⁷ The HTC model never reduces Tree Canopy but will expand canopy to HTC if possible. If a property has more Existing Tree Canopy than the 60%, 40%, or Average then the Existing Tree Canopy is maintained in the model. If the PTC is greater than the HTC the model increases canopy to the 60%, 40%, or Average. If PTC is less than the HTC then the model caps canopy at PTC. Put another way; if Existing Tree Canopy is greater than the 60%, 40%, or Average it stays the same but if HTC is less than PTC the model increases canopy to the 60%, 40% or Average.

⁷ See appendix for the complete flow chart.

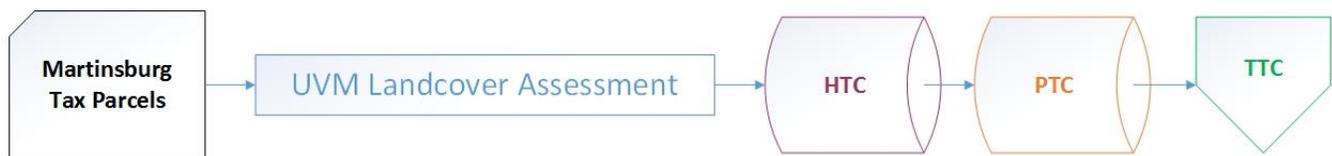
HTC – Hypothetical Tree Canopy Defined

	Description
PTC	Possible Tree Canopy. 100% of Greenspace, Soil, and Impervious is converted to Tree Canopy
HTC60	60% of the property is converted to Tree Canopy <i>if</i> there is sufficient Greenspace, Soil, and Impervious landcover area. Existing Tree Canopy increases or stays the same.
HTC40	40% of the property is converted to Tree Canopy <i>if</i> there is sufficient Greenspace, Soil, and Impervious landcover area. Existing Tree Canopy increases or stays the same.
HTCA	Average amount of Existing Tree Canopy by property class. Average Tree Canopy is converted to Tree Canopy <i>if</i> there is sufficient Greenspace, Soil, and Impervious landcover area. Existing Tree Canopy increases or stays the same.

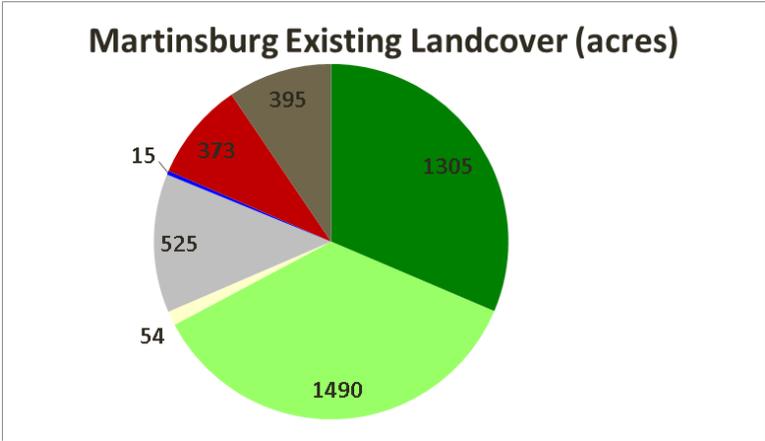
Where the model finds conversion is possible then the suitable landcover were converted proportional to their existing percentage of landcover.

If, for example, a parcel has equal parts of Greenspace, Soil, and Impervious then they are converted in equal amounts into canopy by the model. If, on the other hand, 50% of the suitable landcover is Greenspace, 25% is in Bare Soil, and 25% is in Impervious landcover then 50% of the Greenspace is converted and 25% of the other suitable landcover areas are converted in the models as Tree Canopy.

For readers interested in the ArcGIS process the specific steps of the model are detailed in the appendix pages E-G. In brief; the tax parcel data is imposed on the UVM landcover data to determine if the HTC 60%, 40% or Average was above or below PTC. If the HTC is below PTC then other landcovers were converted to canopy to “make room” for expanded Tree Canopy in the model.⁸

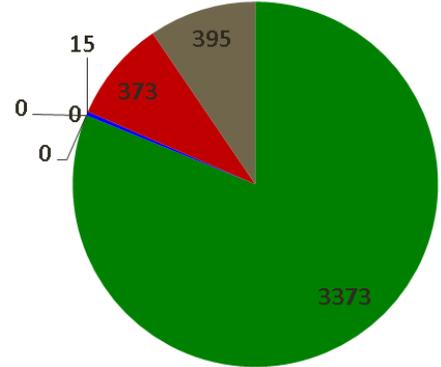


⁸ TTC (Total Tree Canopy) is referenced only in the ArcGIS information. In the text below, for simplicity of narrative, HTC is used in place of TTC.

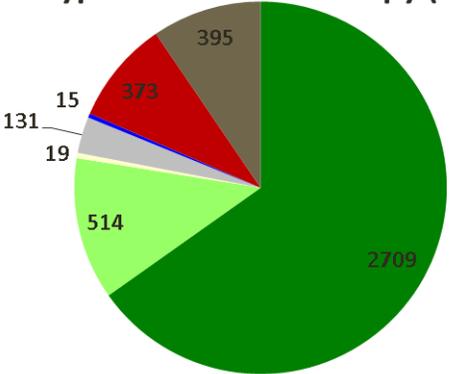


■ Canopy
 ■ Green
 ■ Soil
 ■ Impervious
 ■ Water
 ■ Buildings
 ■ Roads&RR

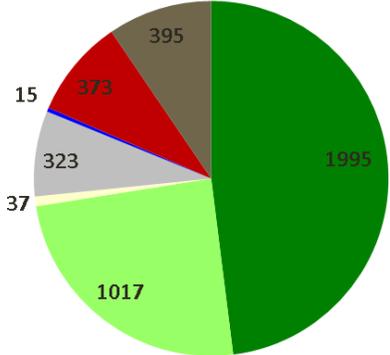
UVM-USFS Possible Tree Canopy



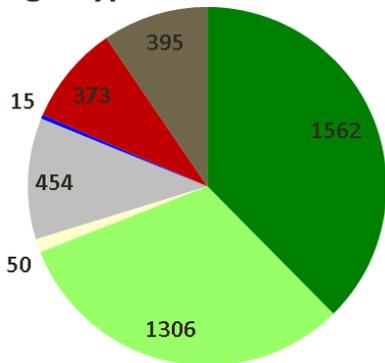
60% Hypothetical Tree Canopy (acres)



40% Hypothetical Tree Canopy (acres)

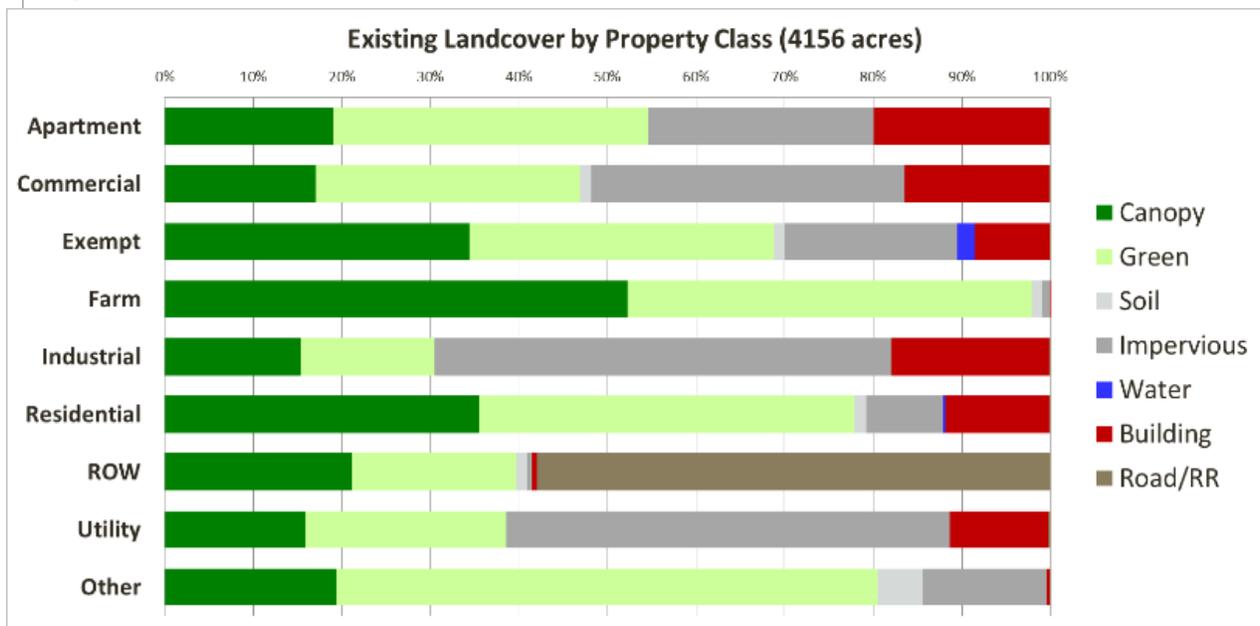
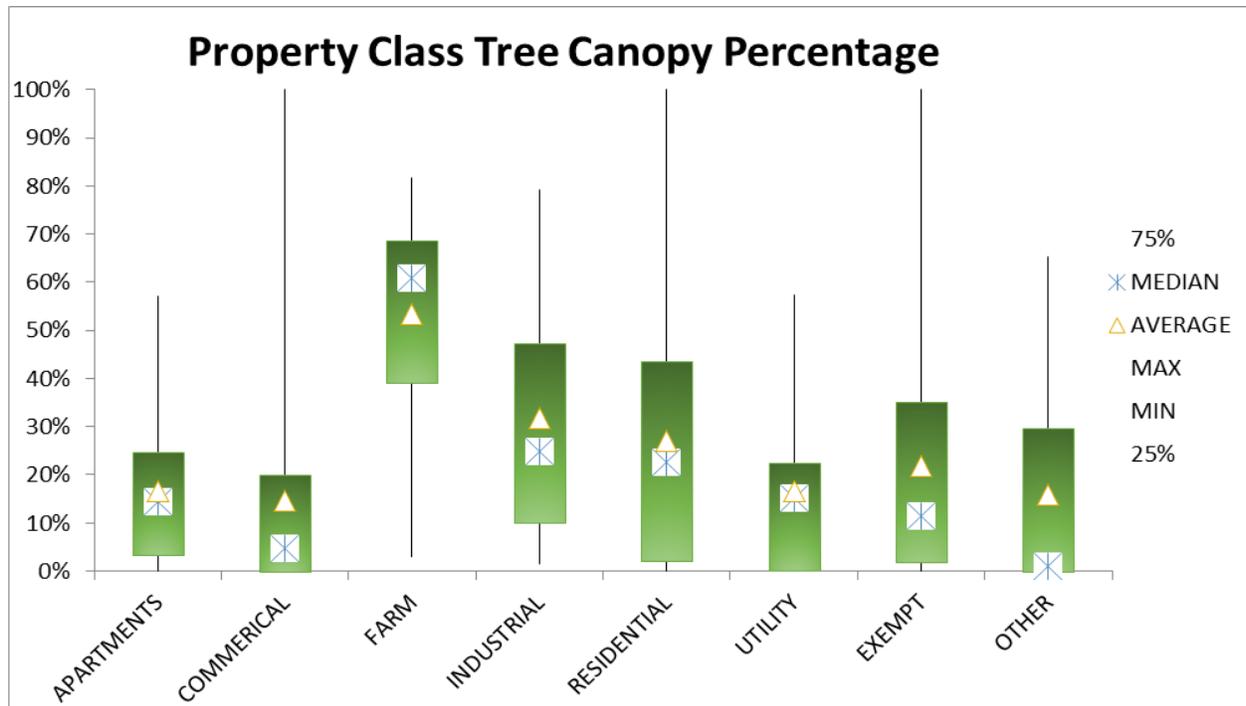


Average Hypothetical Tree Canopy (acres)



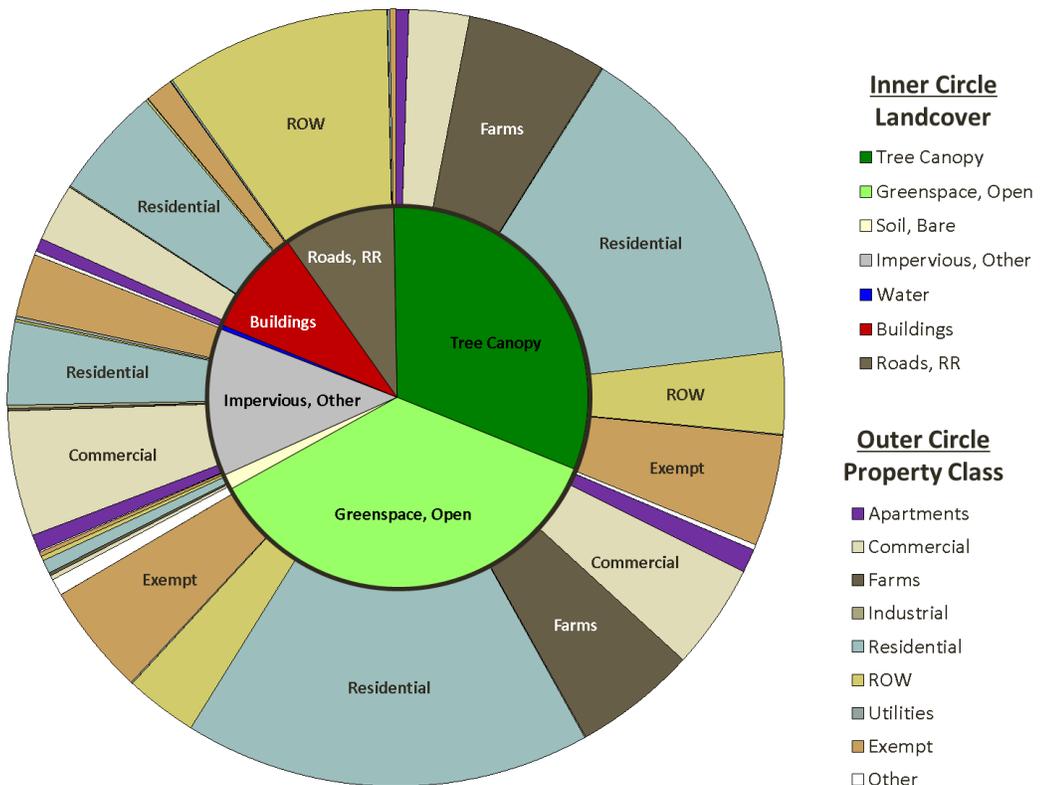
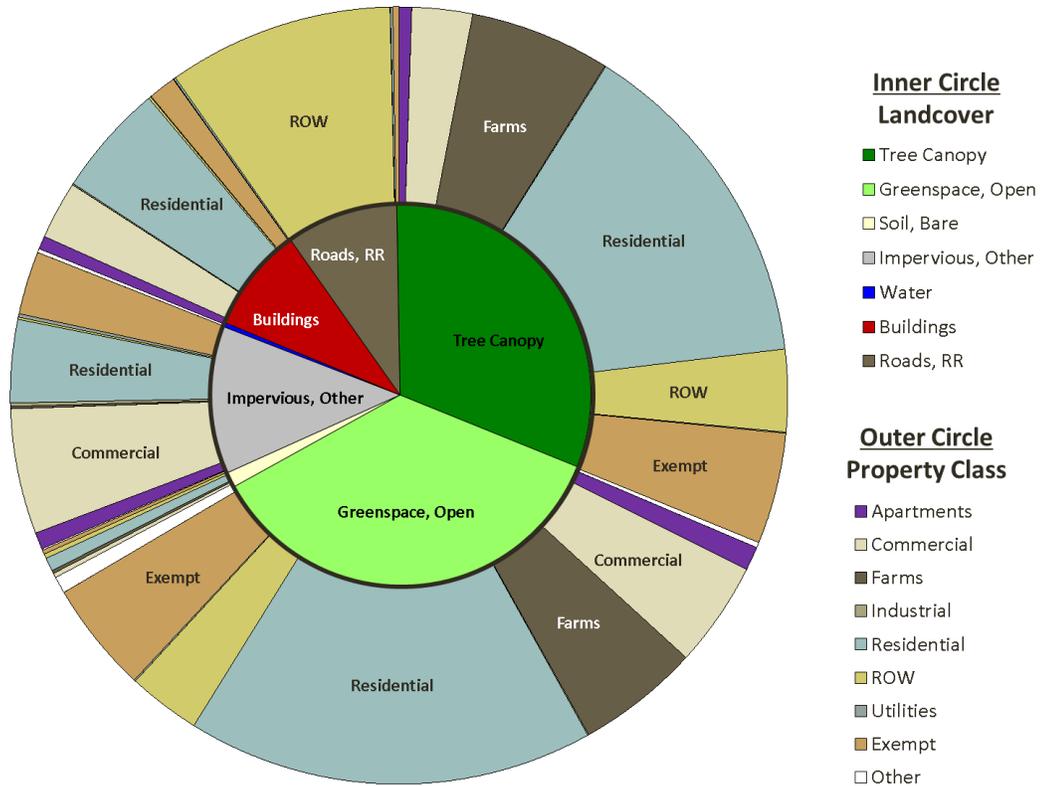
Landuse and Landcover

There are 7,568 property parcels in Martinsburg in nine property classes. The landuse segmented by landcover is displayed in relative acres in a 100% stacked bar graph for each property class. The minimum, maximum, 75th percentile, 25th percentile, and average Tree Canopy for each property class, by parcel, was identified. The Property Class Analysis section discusses in more detail the



landcover by each property class and discusses Tree Canopy on parcels in each property class based of the PTC, and HTC 60%, 40% and Average. The majority of PTC and HTC is in the Residential and Farm property classes. The largest property class is Residential, by acre and by number of parcels.

Landcover and Property Class Analyses



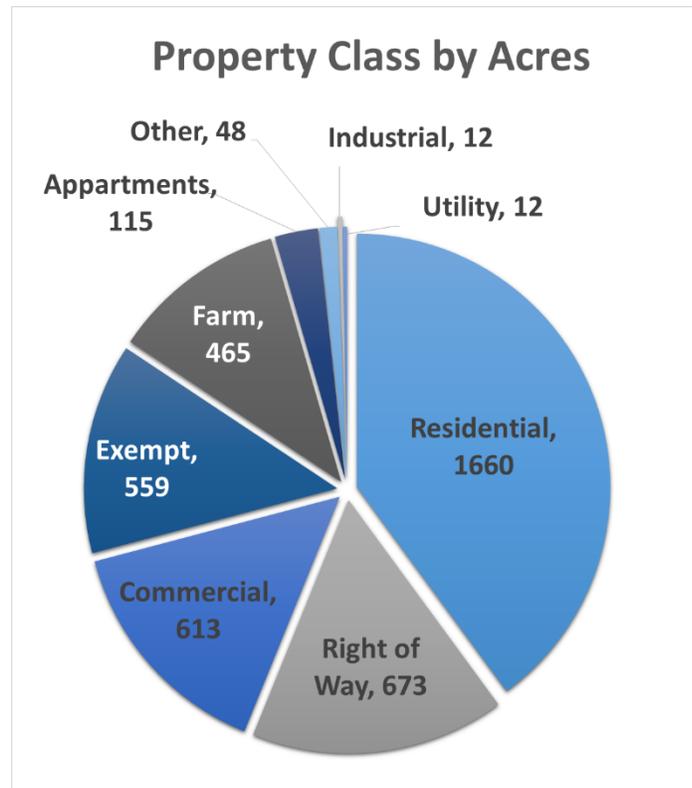
Tree Canopy by Property Class

Following is the analysis and discussion of Existing and Hypothetical Tree Canopy by property class. They are in order of total acres city-wide.

Summary of Conclusions

Residential is the largest and most heterogeneous parcel class. Parcel size and percent Tree Canopy vary greatly. This class presents the greatest potential for expanding Tree Canopy city-wide. To investigate further the property class should be subdivided and classified using additional information such as parcel size, canopy percentage, or location in the city.

Right Of Way is a single “parcel” consisting of all the land not inside a property parcel. It is a homogenous unit and, since it is a single unit, has no average. ROW holds 99% of the Road-Railroad landcover and offers, at most, 137 acres of conversion under the PTC model. ROW should be subdivided to identify subsets by indicators such as ROW width, location in the city, or use in order to better understand the Tree Canopy.



Commercial property class, like Residential, is dispersed across the city. It represents 15% of the landuse. The average parcel size is less than one acre but eight (8) large parcels hold 31% of the Commercial property. After Residential it offers the largest potential for conversion to Tree Canopy. More information such as type of “commercial” use is needed for further analysis and understand property in this class.

Exempt property class is the second most heterogeneous property class after Residential with a 32 point range between the 25% and 75% percentile of Tree Canopy. If one assumes a civic value for the parcels based on their tax exempt status then the parcels should be prioritized to maximize tree benefit to the population served (children, seniors, veterans, etc.). The property class could be subdivided for further analysis based on use (church, school, hospital, etc.) or ownership (state, city, religious institution, non-profit, etc.).

Farm property class is the fewest number of parcels at 13 but represents 11% of the city. Based on the 2011 UVM assessment Farm has the highest average Existing Tree Canopy (35%) and offers an additional 211 acres of PTC. However, most Farm landuse is planned for development as Residential, Commercial, or Exempt properties so Tree Canopy in this property class may decline as it is developed. Development plans, such as the West Side Development plans, should be reviewed to maximize preservation of Existing Tree Canopy.

Apartment property class represents just 3% of the city landuse and offers 70 acres PTC. If one assumes apartments have more occupants than an equal area of Residential land, the population in Apartment parcels is greater than the 3% of landuse suggests. The population benefiting from Tree Canopy in apartments could be higher per capita by land area than Residential. Apartment parcels should be analyzed to maximize benefit to the population served.

Other property class is parcels without a tax designation. The 39 Other parcels cover 48 acres (1.1% of the city).

While the UVM-USFS PTC models 38 acres for canopy conversion, the HTC Average model converts only 1.3 acres. More investigation is needed to understand the disparity between PTC and HTC Average.

Industrial property class is just nine parcels and covers 12 only acres (0.3% of the city). This property class offers only a small portion for conversion city-wide. However, within the property class there is great potential for conversion in the HTC model. As a property class the HTC Average would increase canopy by 126% (2.4 acre up from 1.9 acres Existing Tree Canopy). Tree Canopy on Industrial properties could offer benefits as visual screens, noise reduction, and pollution abatement.

Utilities property class is just twenty-one (21) parcels and covers 12 acres (0.3% of the city). Similar to Industrial property class the Utility parcels are not significant city-wide but they present potential for incorporating Tree Canopy to mitigate noise pollution and visually screen utilities from the surrounding neighborhoods.

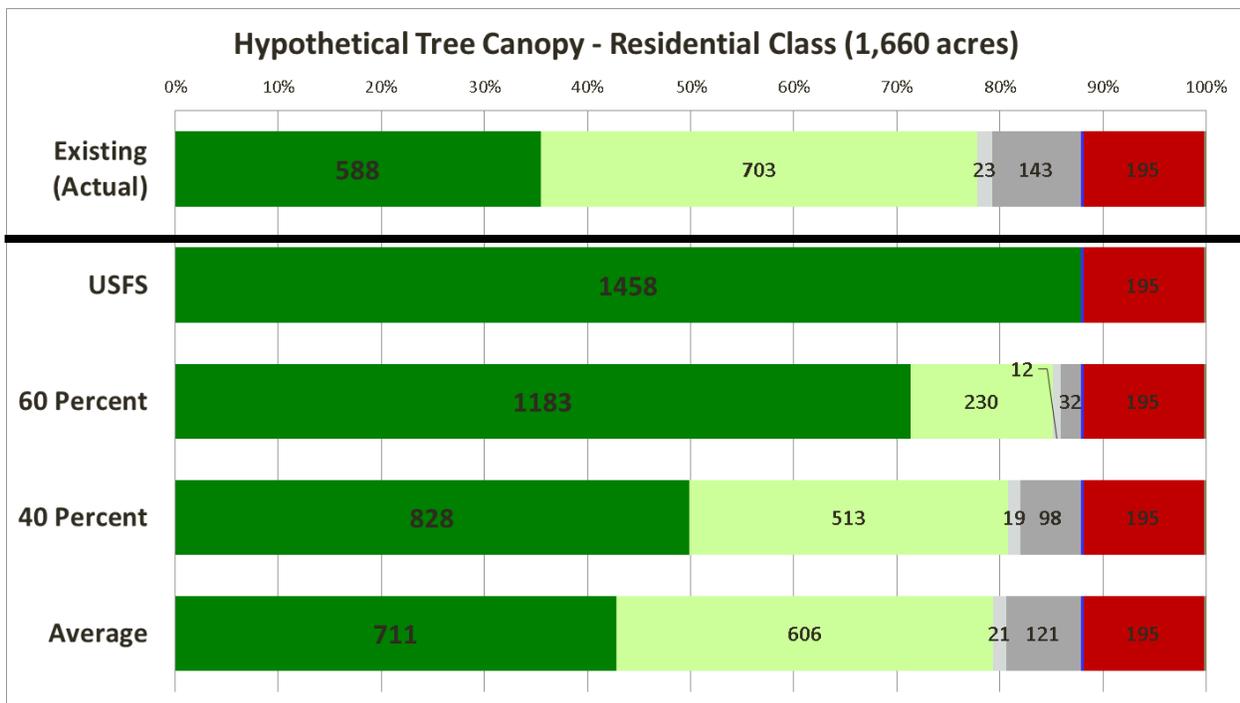
Residential Class Parcels

Analysis

Six thousand three hundred and ninety-eight (6,398) property parcels are classified as Residential. This represents 85% of all property parcels in Martinsburg (6398/7568 parcels). The class covers 40% of the city (1,660/4,156 acres). Statistics show:

Residential	Size (Acres)	Canopy Acres	Canopy Percent
MAX	119.66	56.14	100%
75%	0.24	0.08	44%
25%	0.10	0.00	2%
MEDIAN	0.16	0.03	23%
AVERAGE	0.26	0.09	27%
MIN	0.01	0.00	0%

Possible Tree Canopy with full conversion of suitable landcover would add 870 acres of canopy; HTC60 would add 595 acres; HTC40 would add 240 acres; and, if all Residential class properties with the potential to reach HTCA reached 23% it would add 123 acres of Tree Canopy (9.4% city-wide). The HTCA would increase Residential property class Existing Tree Canopy by 21% (123/588 acres).



Conclusion

The Residential Class is largest number of parcels and the greatest landuse by acres. It is the most heterogeneous property class with the greatest variation in size and greatest variation in Tree Canopy cover. It is the dominate landuse in the city and offers the largest potential increase in Tree Canopy cover.



A cursory review of property parcel ownership in this class suggests many adjacent parcels are owned by the same person and, in effect, are a single larger property unit (not several disjointed property parcels). In this example the number of “parcels” drops by one-quarter when consolidated by owner (i.e., neighboring parcels owned by the same person are consolidated into one “parcel”).

The “Parcel Ungrouped” property lines (red) would dissolve and the adjacent two or three parcels would consolidated by ownership.

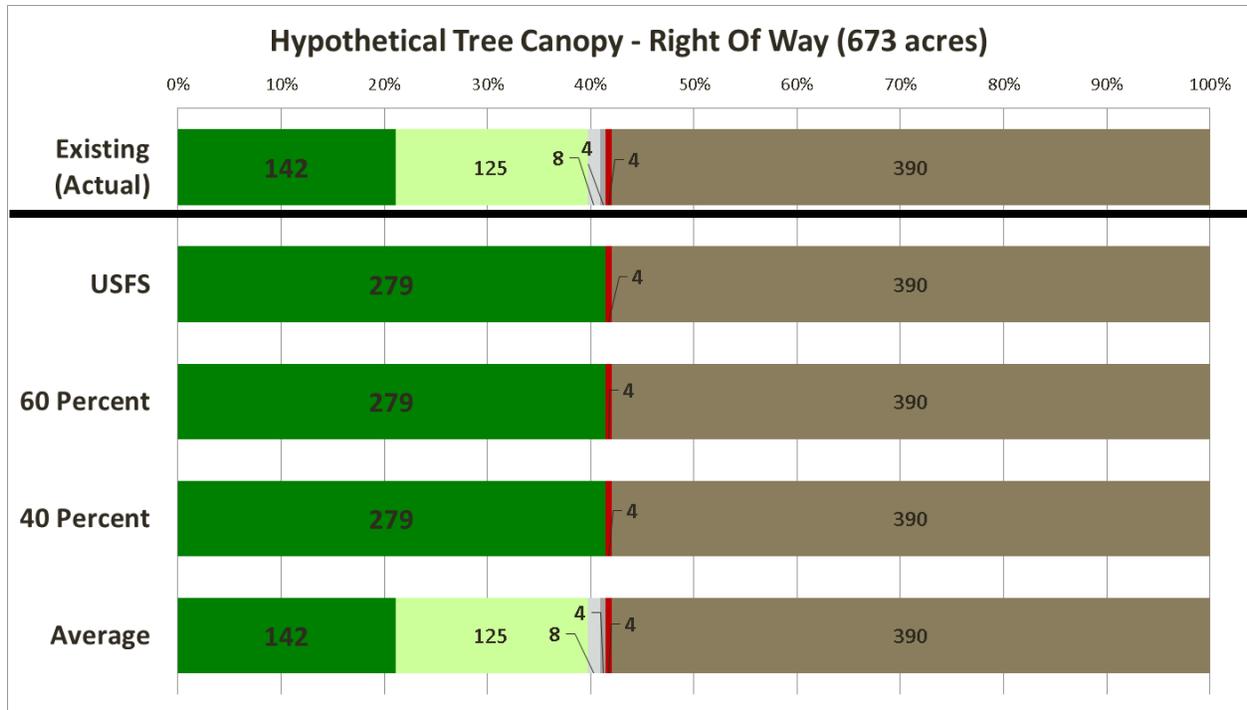
Property parcel size varies widely and it may be useful to further classify and subdivide this property class based on indicators such as property size, landcover disbursement, and location in the city. More investigation is needed into the “actual size” of properties when ownership is factored in and

adjacent parcels are consolidated. Location of the parcels should also be considered if one assumes potential for increased Tree Canopy is different based on neighborhood structure. Row homes downtown, for example, may offer less yard potential than more suburban-like neighborhoods in town.

Right Of Way (ROW) Class Parcels

Analysis

Only one property parcels is classified as Right Of Way because it is the *consolidation* of all land in Martinsburg that is not within a property parcel. The class covers 16% of the city (673/4,156 acres). Since there is only one parcel the Average is the same as the Existing Tree Canopy and there is no minimum, maximum, 75th or 25th percentile.



Conclusion:

The Right-Of-Way landcover “property class” is unique. The shape was derived by Cacapon Institute⁹. The ROW is the area within Martinsburg boundary that is not in any property parcel. It is all area that remains when parcels have been “removed.” The shape offers no differentiation since it is a homogeneous single. It holds 99% of the Road-Railroad landcover classification. The PTC limit does not allow the model to reach 60% HTC. It may be possible to subdivide segments of the entire ROW to parse out unique subsets. Subdividing the ROW based on indicators such as road width (e.g., alley, street, thoroughfare), location in the city (e.g., downtown, residential, Westside), and/or use (e.g., neighborhood street, city street, state route) may bring a better understanding of Tree Canopy. More investigation into the location and use of the ROW is required in order to make meaningful subsets with actionable intelligence.



⁹ Cacapon Institute created a boundary for Martinsburg by combining U.S. Census Tracts lines for the city with information provided by the Berkeley County Assessor’s Office.

Commercial Class Parcels

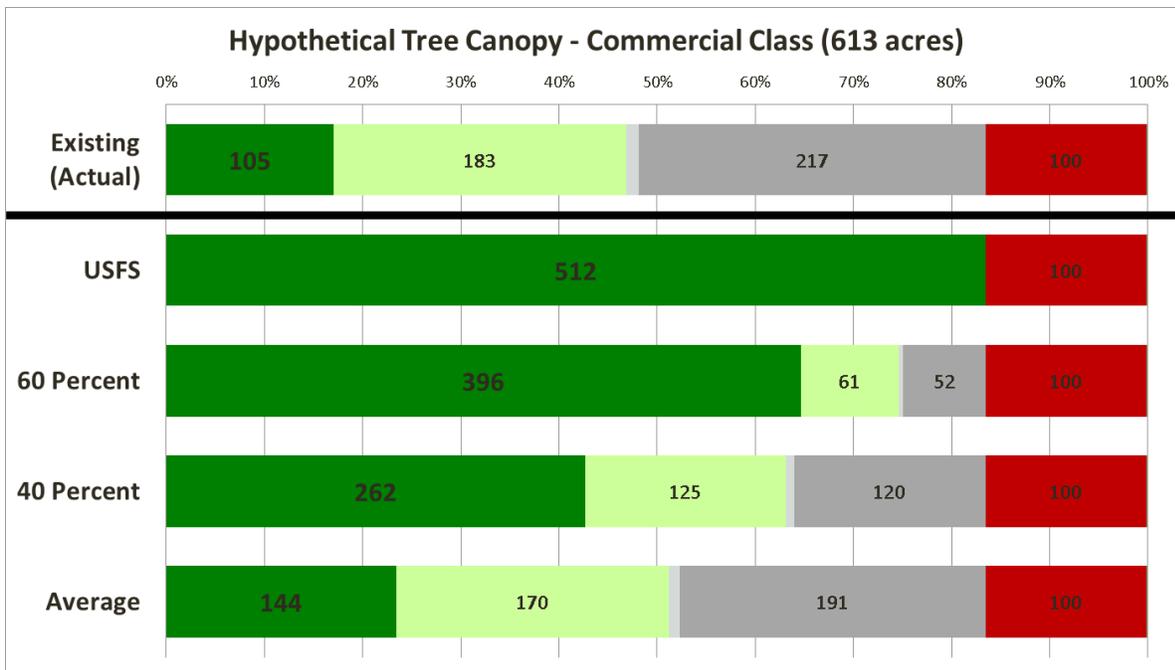
Analysis

Six hundred and eighty-one (681) property parcels are classified as Commercial. This represents 9% of all property parcels in Martinsburg (681/7568 parcels). The class covers 15% of the city (681/4,156 acres). Statistics show:

Commercial	Size (Acres)	Canopy Acres	Canopy Percent
MAX	63.96	11.63	100%
75%	0.64	0.06	20%
25%	0.10	0.00	0%
MEDIAN	0.22	0.01	5%
AVERAGE	0.90	0.15	15%
MIN	0.01	0.00	0%



Possible Tree Canopy with full conversion of suitable landcover would add 407 acres of canopy; HTC60 would add 291 acres; HTC40 would add 157 acres; and, if all Commercial class properties with the potential to reach the HTCA reached 5% it would add 39 acres of Tree Canopy (2.9% city-wide). The HTCA would increase Commercial property class Existing Tree Canopy by 47% (39/105 acres).



Conclusion

Commercial property is dispersed across the city and is significant (15% of land). The average size for the 681 parcels is just under one acres (0.9) but 31% of the land (192/613 acres) is in just eight (8) parcels. The ten (10) largest parcels are 64; 26; 20; 20; 20; 18; 12; 12 acres. After Residential, it offers the largest opportunity for landcover conversion to Tree Canopy. It is also the second largest number of parcels by class. More information, such as use or ownership information could be applied to subdivide the parcel class into smaller groups in order to differentiate the 813 Commercial parcels. More understanding of property use and specific management practices is needed to prioritize parcels for canopy expansion.

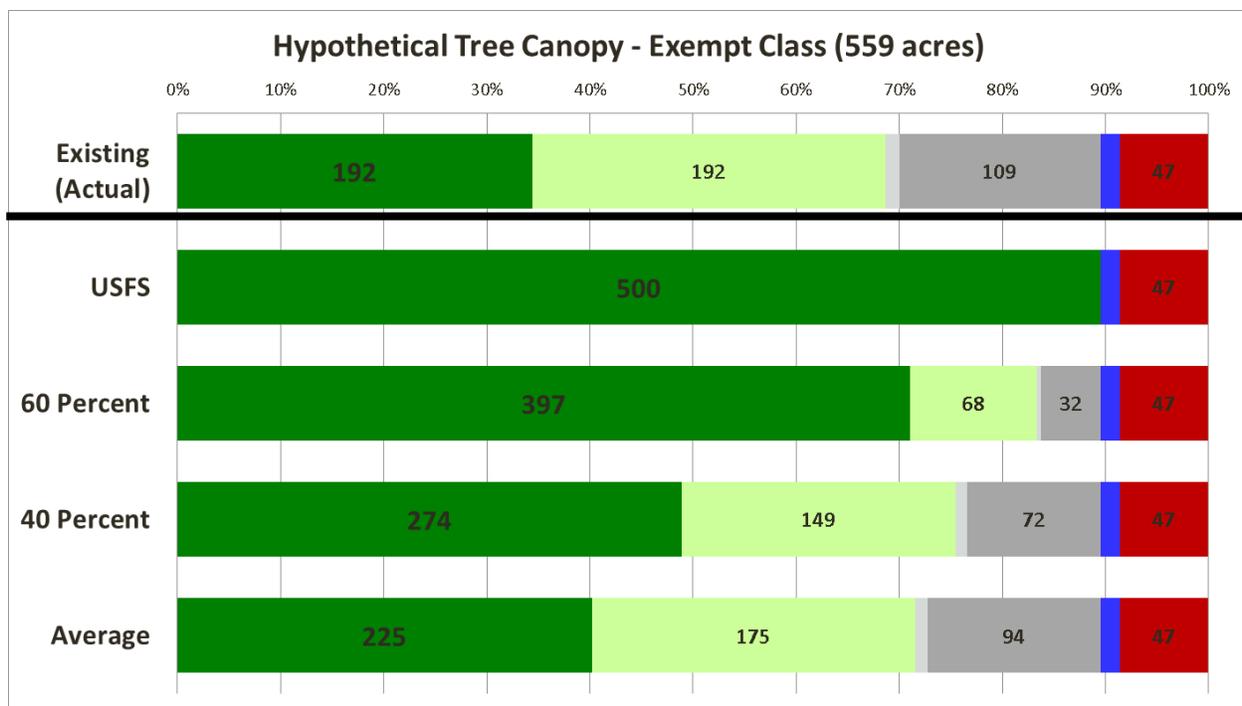
Exempt Class Parcels

Analysis

Three hundred and twenty-two (322) property parcels are classified as Exempt. This represents 4.3% of all property parcels in Martinsburg (322/7568 parcels) and the class covers 13.5% of the city (559/4,156 acres). Statistics show:

Exempt	Size (Acres)	Canopy Acres	Canopy Percent
MAX	42.84	26.32	100%
75%	0.94	0.16	35%
25%	0.10	0.00	2%
MEDIAN	0.23	0.04	11%
AVERAGE	1.74	0.60	22%
MIN	0.01	0.00	0%

Possible Tree Canopy with full conversion of suitable landcover would add 308 acres of canopy; HTC60 would add 205 acres; HTC40 would add 82 acres; and, if all Exempt class properties with the potential to reach HTCA reached 11% it would add 33 acres of Tree Canopy (2.5% city-wide). HTCA would increase Exempt class Existing Tree Canopy by 17% (33/192 acres).



Conclusion

The Exempt property class is a significant landuse covering 13% of the city. It is the second most heterogeneous property class after Residential with 33 points between the 25th and 75th percentile of Existing Tree Canopy. The Exempt property class indicates the owner is not required to pay property tax because of a charitable purpose. Exempt parcels include schools, churches, parks, food banks, senior centers and other charitable or civic institutions. One could assume these property parcels, because of their recognized public benefit, have more impact on the community than their size suggests. Like Residential, some of these property uses suggest citizens spend time around the clock. Also, like Residential, adjacent individual parcels are owned by the same

institutions so, in practice, they are being managed not as small individual parcels but as a single larger parcel. Some of these properties serve vulnerable and/or disadvantaged populations (e.g., children, seniors, homeless, and ill). While an increase in Tree Canopy to the HTCA will only increase the city's overall Tree Canopy by 2.5%, within the property class it will add 17% to the Existing Tree Canopy. Given the civic mission of the property owners, and that some of the land is publicly owned, one can hope the owners will be open to increasing Tree Canopy to benefit their constituents and the broader public. More investigation into ownership is required to determine where adjacent properties are being managed as a single larger property. The property class should be further subdivided to differentiate subsets by indicators such as use (church, school, etc.) or property owner (state, city, religious institutions, etc.).

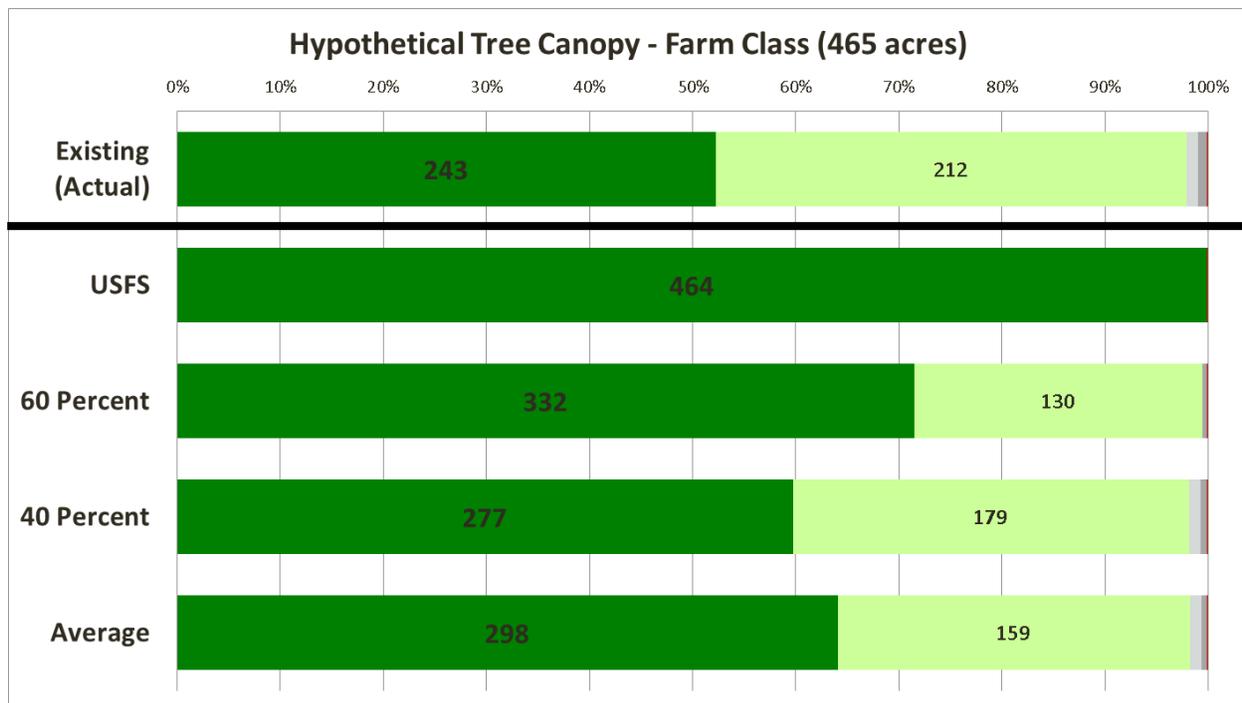
Farms Class Parcels

Analysis

Thirteen (13) property parcels are classified as “Farm.” This represents 0.2% of all property parcels in Martinsburg (13/7568 parcels) and the class covers 11% of the city (465/4,156 acres). Statistics show:

Farm	Size (Acres)	Canopy Acres	Canopy Percent
MAX	83.13	65.06	82%
75%	54.73	19.87	69%
25%	13.15	5.15	39%
MEDIAN	22.35	10.75	61%
AVERAGE	35.75	18.67	53%
MIN	4.85	1.54	3%

Possible Tree Canopy with full conversion of suitable landcover would add 211 acres of canopy; HTC60 would add 89 acres; HTC40 would add 34 acres; and, if all Farm class properties with the potential to reach the HTCA reached 61% it would add 55 acres of Tree Canopy (4.2% city-wide). The HTCA would increase Farm class Existing Tree Canopy by 23% (55/243 acres).



Conclusion

“Farm Class” is a property class, like all the other class designations, from the Berkeley County Assessor’s Office. It is a reflection of property registration as it is now, not as it might become. Most of the Farm parcels are slated for development as Residential, Commercial, or Exempt properties in the near future or are already under development. The landcover reflects conditions in 2011 and the parcel class is 2012 information. These parcels are in transition. Updated information is required and future outlooks, such as incorporation of the West Side Development Plan, are recommended.

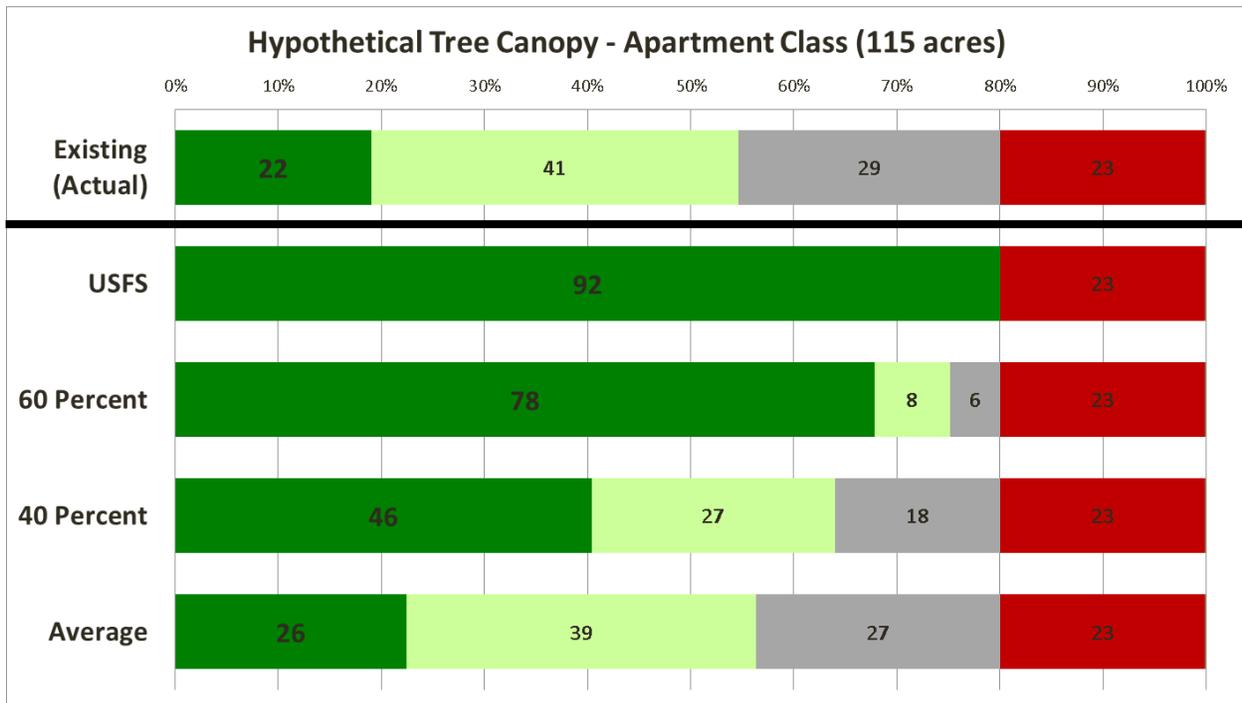
Apartment Class Parcels

Analysis

Eighty-four (84) property parcels are classified as Apartment. This represents 1% of all property parcels in Martinsburg (84/7568 parcels) and the class covers 3% of the city (115/4,156 acres). Statistics show:

Apartments	Size (Acres)	Canopy Acres	Canopy Percent
MAX	17.28	4.38	57%
75%	0.72	0.16	25%
25%	0.21	0.01	3%
MEDIAN	0.35	0.05	14%
AVERAGE	1.36	0.26	17%
MIN	0.04	0.00	0%

Possible Tree Canopy with full conversion of suitable landcover would add 70 acres of canopy; HTC60 would add 56 acres; HTC40 would add 24 acres; and, if all Apartment class properties with the potential to reach HTCA reached 14% it would add 4 acres of Tree Canopy (0.3% city-wide). The HTCA would increase Apartment class Existing Tree Canopy by 18% (4/22 acres).



Conclusion

Changes in landcover on Apartment properties, as a class, will not have a significant influence on Martinsburg's overall landcover. However, if one assumes the population density in apartments is relatively higher than that of most other property parcels, an increase (or decrease) in Tree Canopy may have a relatively greater impact per capita. The population enjoying trees' benefits on Apartment parcels may be greater than the landcover data suggests. More research into the value of Tree Canopy vis-à-vis the population of apartment tenets is recommended in order to prioritize parcels for Tree Canopy expansion to provide the maximum human health and economic benefits.

Other Class Parcels

Analysis

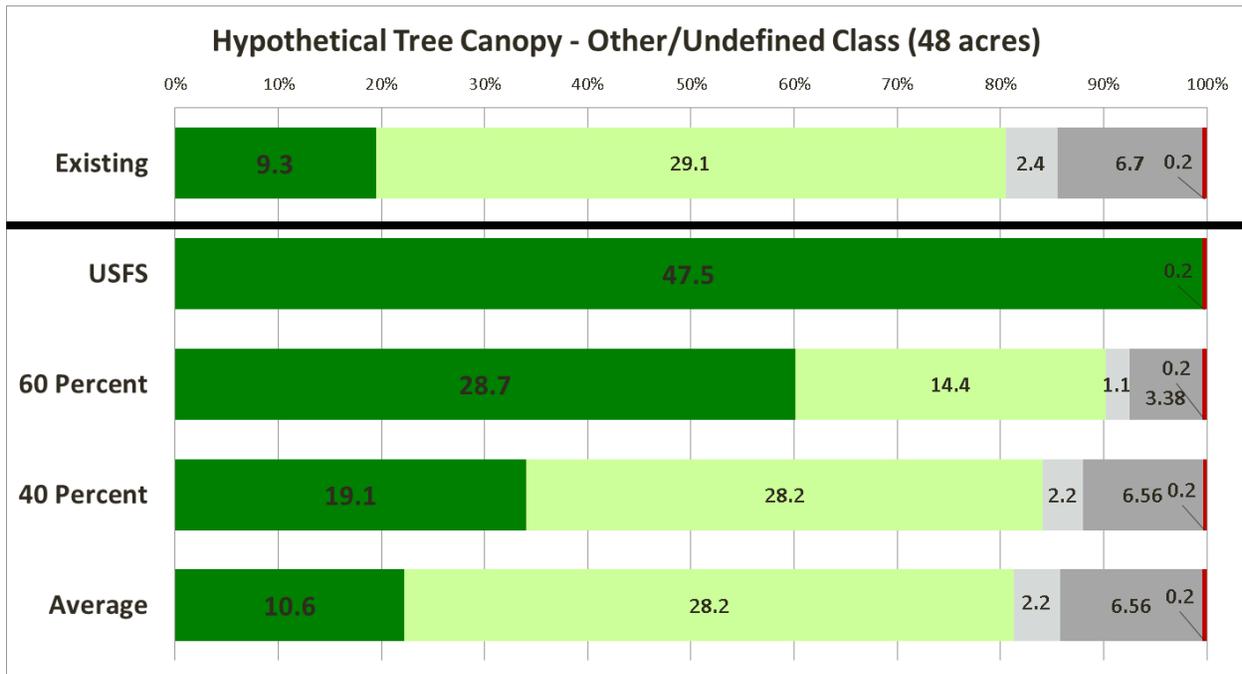
Thirty-nine (39) property parcels are classified as “Other”. This represents 0.5% of all property parcels in Martinsburg (39/7568 parcels) and the class covers 1.1% of the city (39/4,156 acres). Statistics show:

Other	Size (Acres)	Canopy Acres	Canopy Percent
MAX	34.76	8.17	65%
75%	0.12	0.04	30%
25%	0.11	0.00	0%
MEDIAN	0.12	0.00	1%
AVERAGE	1.22	0.24	16%
MIN	0.01	0.00	0%

Possible Tree Canopy would add 38 acres of canopy; HTC60 would add 19.4 acres; HTC40 would add 9.8 acres; and, if all properties with the potential to reach HTCA reached 16% it would add 1.3 acres of Tree Canopy (0.1% city-wide). The HTCA would increase the “other” parcel class Existing Tree Canopy by 13% (1.3/9.3 acres).

Conclusion

The “Other” property parcel class indicates properties that did not have a designated parcel classification. City-wide the class is only 1.1% of the landuse. The USDA Forest Service Possible Tree Canopy full conversion of suitable land suggests a 500% increase in Tree Canopy within the property class. As a class it has 5% Soil



landcover, five times higher than any other class. The presence of Bare Soil suggests erosion and potential for sediment stormwater runoff pollution. Given the relatively small number of parcels and the relatively small land area they occupy a quick evaluation, conclusion, and action plan to increase Tree Canopy may be feasible. The high potential for increased Tree Canopy and, conversely, the negative impact of existing Bare Soil and erosion, suggest attention to these properties could produce positive results greater than their relative size suggests. More investigation is required to determine the nature of these 39 Other properties.

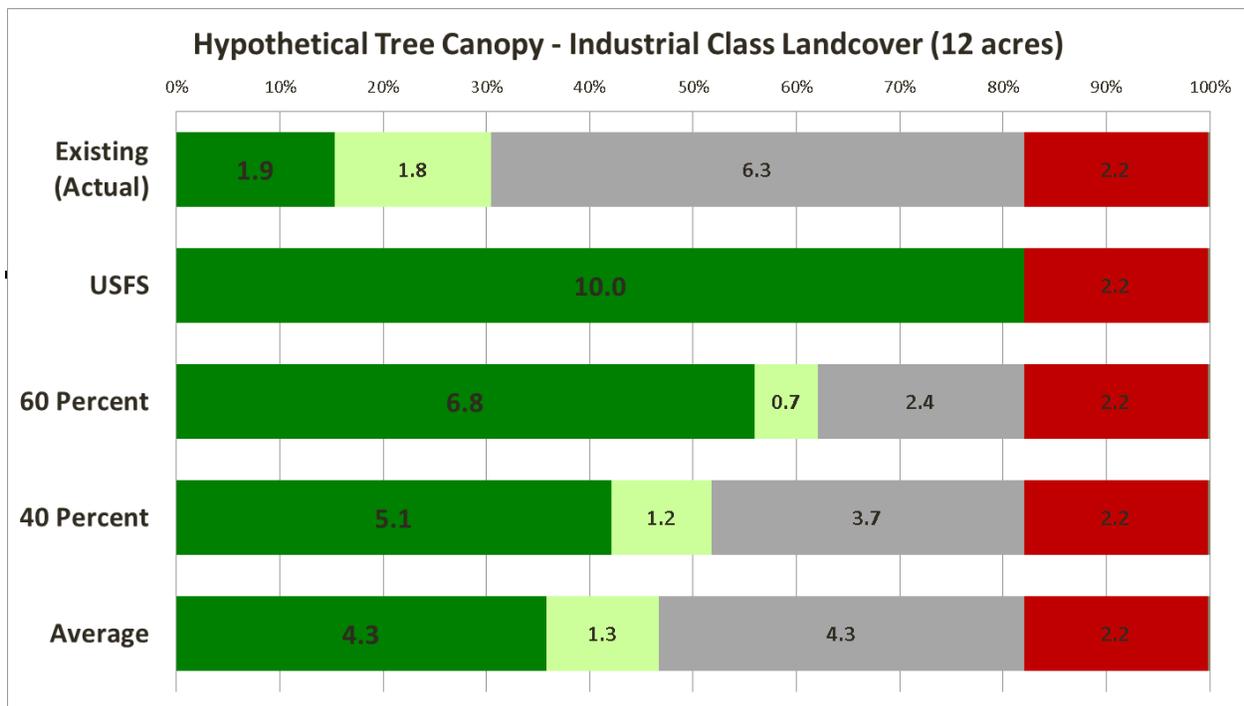
Industrial Class Parcels

Analysis

Nine (9) property parcels are classified as Industrial. This represents 0.1% of all property parcels in Martinsburg (9/7568 parcels). The class covers 0.3% of the city (12/4,156 acres). Statistics show:

Industrial	Size (Acres)	Canopy Acres	Canopy Percent
MAX	7.78	0.78	79%
75%	1.18	0.23	47%
25%	0.12	0.02	10%
MEDIAN	0.24	0.06	25%
AVERAGE	1.35	0.21	32%
MIN	0.07	0.00	2%

Possible Tree Canopy would add 8.1 acres of canopy; HTC60 would add 4.9 acres; HTC40 would add 3.2 acres; and, if all Industrial class properties with the potential to reached HTCA reached 25% it would add 2.4 acres of Tree Canopy (0.18% city-wide). The HTCA would increase Industrial class Existing Tree Canopy by 126% (2.4/1.9 acres).



Conclusion

As a property class Industrial has an insignificant impact on Tree Canopy city-wide. As a class Industrial has the highest potential rate of canopy increase. PTC is a 226% increase (4.3 Possible / 1.9 Existing). Even an increase to HTC Average more than doubles the Existing Tree Canopy. Given the importance trees can play in improving landscapes, both as visual screens and for noise reduction, trees might be incorporated into Industrial parcels to benefit the surrounding neighborhoods. Given the small overall landuse in acres, and the small number of parcels, additional detailed investigation could lead to quick benefits.

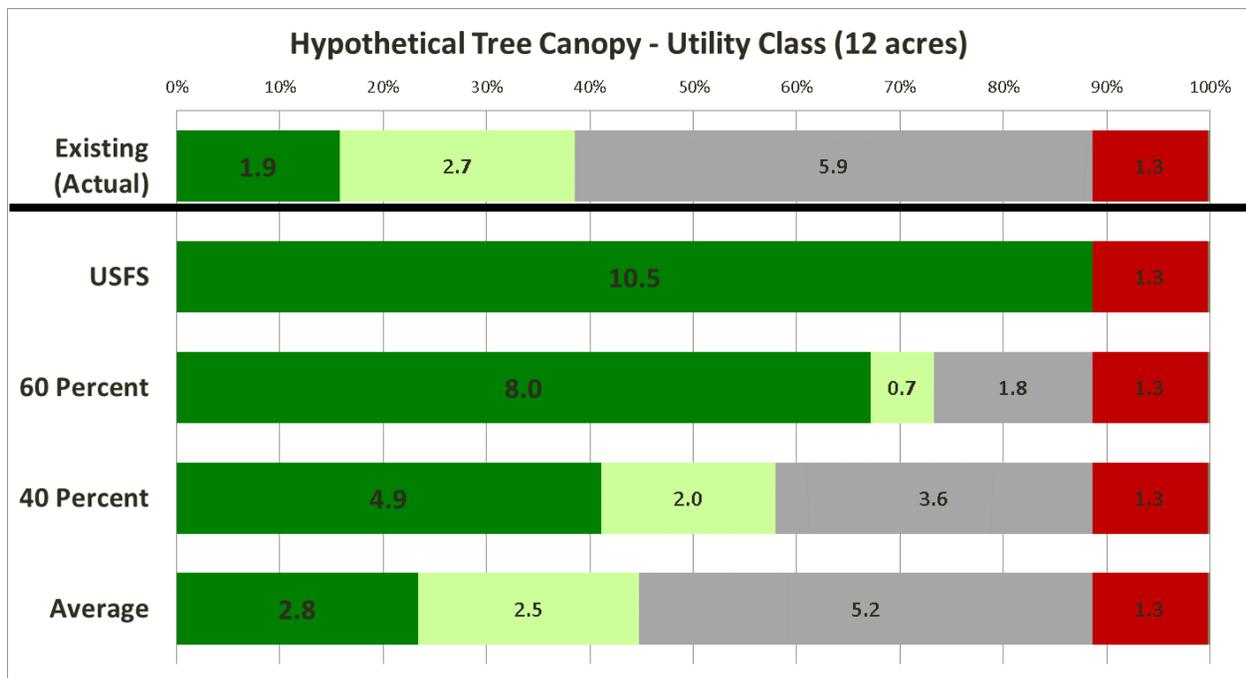
Utilities Class Parcels

Analysis

Twenty-one (21) property parcels are classified as Utility. This represents 0.3% of all property parcels in Martinsburg (21/7568 parcels) and the class covers 0.5% of the city (21/4,156 acres). Statistics show:

Utility	Size (Acres)	Canopy Acres	Canopy Percent
MAX	3.42	0.59	57%
75%	0.70	0.09	23%
25%	0.19	0.00	0%
MEDIAN	0.41	0.04	15%
AVERAGE	0.56	0.09	17%
MIN	0.00	0.00	0%

Possible Tree Canopy with full conversion of suitable landcover would add 8.6 acres of canopy; HTC60 would add 6.1 acres; HTC40 would add 3 acres; and, if all Utility class properties with the potential to reach the HTCA reached 15% it would add 0.9 acres of Tree Canopy (0.07% city-wide). The HTCA would increase Utility parcel class Existing Tree Canopy by 47% (0.9/1.9 acres).



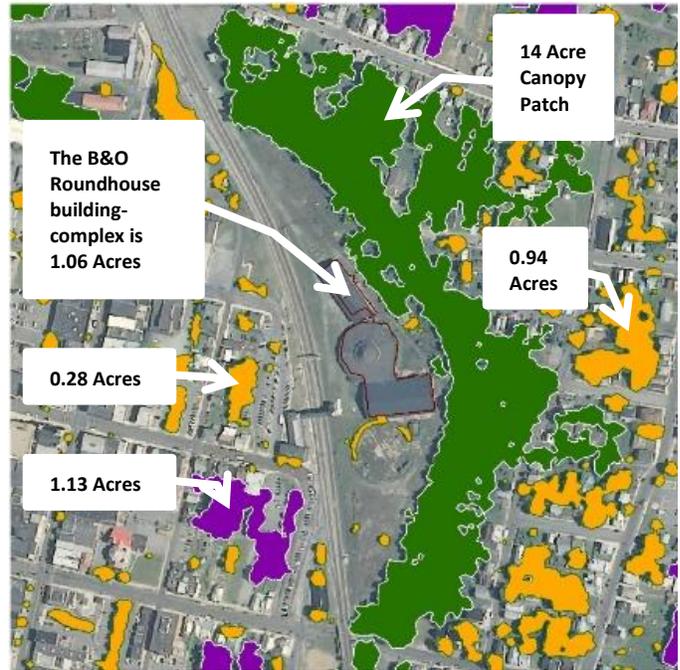
Conclusion

As a property class Utility is not a significant landuse and is just 0.2% of the area city-wide (12/4156 acres). Within its own property class however it has high potential for Tree Canopy increase. The HTC Average would increase Existing Tree Canopy by 147% (2.8 HTCA / 1.9 Existing). As with Industrial parcels, trees might be incorporated to benefit the broader neighborhoods and additional detailed investigation could lead to quick conclusions.

Tree Canopy Patch-Size

Tree Canopy “patch size” was reported in the UVM landcover assessment. Patch size is the total area of a contiguous group of trees or the acreage of area covered by canopy where the canopy is unbroken between individual trees. This is important because the relative benefits of trees increases as the patch size increases. Larger groves of trees with interconnected canopy offer greater benefit. Large-patch Tree Canopy is better at mitigating water and air pollution. The larger the patch size the greater the benefit to habitat for wildlife in the networks of interconnecting leaves and branches. Large-patch Tree Canopy provides greater unbroken areas of shade to reducing ambient temperature. The larger the patch size, the more efficient the trees are as wind block and, depending on relative position of the trees to buildings, can reduce heating costs in winter. Tree Canopy patches were defined in three categories:

- Small-patches; <1 acre (orange),
- Medium-patches; 1-5 acres (purple); and,
- Large-patch; >5 acres (green).

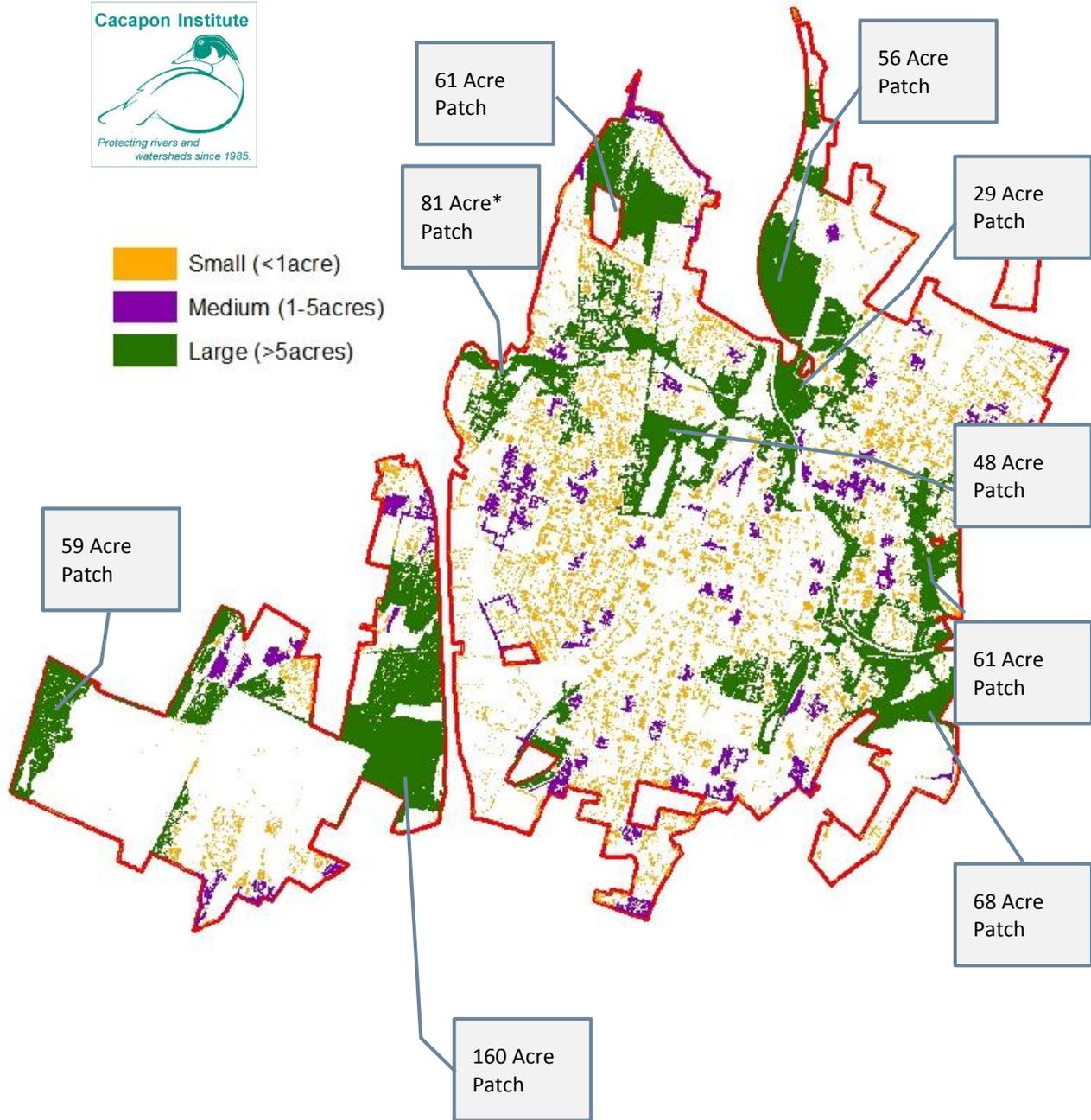


There are 6,990 Tree Canopy patches in Martinsburg;¹⁰ 98% of the patches are small-patch (<1 acre) and account for 28% of the overall Tree Canopy (357 acres); 1% of the patches are medium-patch (1-5 acre) and account for 12% of the overall Tree Canopy (86 acres); 2% of the patches are large-patch (>5 acre) and account for 60% of city-wide Tree Canopy (785 acres). Only nine patches exceed 20 acres (next page).

¹⁰ There are 33,646 landcover patches within Martinsburg’s boundary: 10,564 Impervious, 8,706 Greenspace; 6,990 Tree Canopy; 6,618 Building, 418 Road-Railroad; 44 Soil; and 6 Water patches.



Tree Canopy Patch Size



* The 81 acre patch is the second largest but it is not a dense patch. Unlike the larger 160 acre patch or smaller patches that are more cohesive, in the 81 acre patch the canopy ranges widely but is narrow.

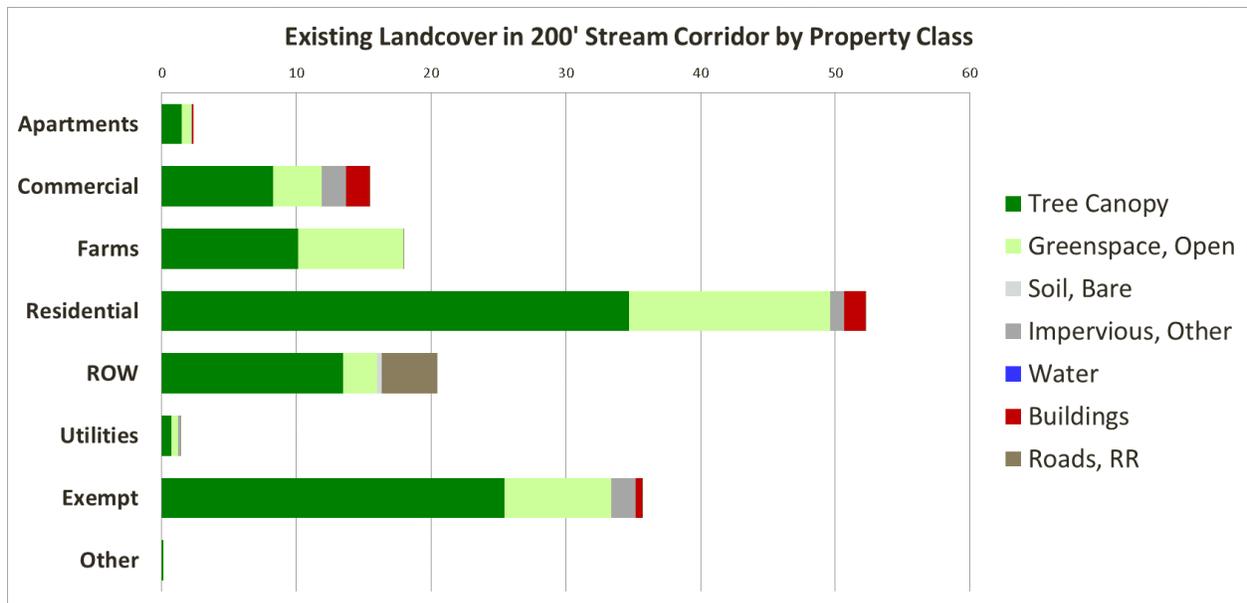
200' Stream Corridor

Tree Canopy in stream corridor reduces soil erosion, provides shade and critical wildlife habitat and helps prevent nutrient, sediment, and other non-point source pollution from entering the streams.

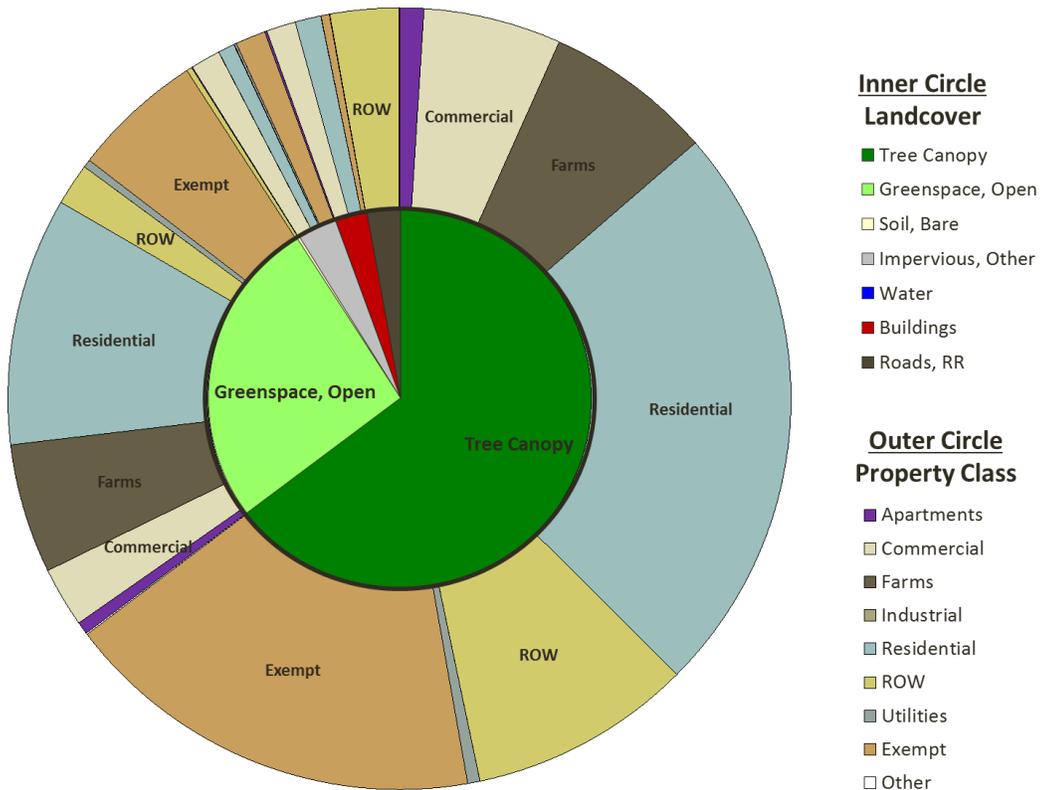
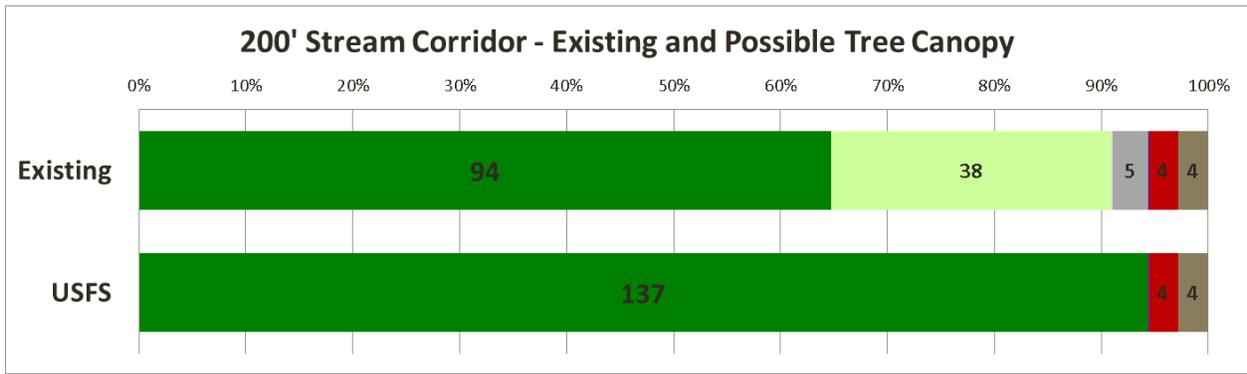
Two major streams run through Martinsburg, Dry Run and Tuscarora Creek. They are tributaries to Opequon Creek that drains to the Potomac River and eventually to the Chesapeake Bay. Opequon Creek is a priority watershed for the WV DEP Chesapeake Bay Program and faces many challenges stemming from urban development. Developed lands have associated pollutant loads that are detrimental to water quality, specifically nutrients and sediment. In streams, nutrients (nitrogen and phosphorous) cause algal blooms which lead to eutrophication and fish death, unpleasant odors, un-swimmable waters, and overall degraded waterways. Sediment degrades aquatic habitat and increases the cost of purifying drinking water.



The 200' stream corridor along Martinsburg's streams contains 65% Existing Tree Canopy (94/147 acres). The majority of the riparian zone, similar to all land area in the City, is in the Residential property class. Significant portions of the riparian buffer are in the ROW, Exempt, Farm and Commercial property classes.



Setting aside the Road-Railroad and Building as unsuitable for expanding Tree Canopy, the PTC model adds 26% canopy (38 acres) to model canopy at 91%. The Green-open, Bare soil, and Impervious-other landcover areas could be targeted for increasing Tree Canopy.



Conclusion

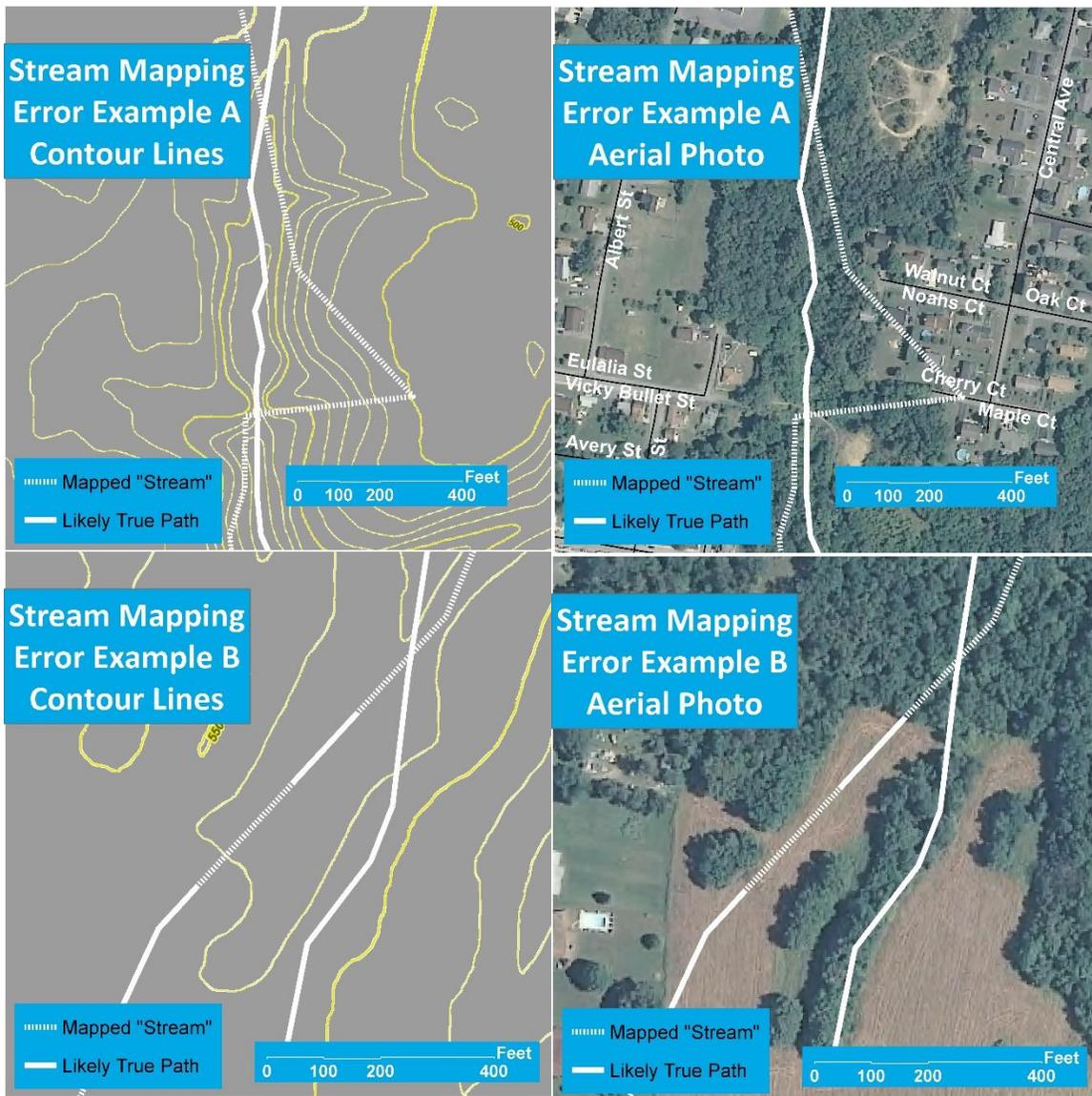
The 200’ stream corridor is environmentally significant because no less than a 100’ riparian buffer on both sides of a stream is recommended by the Chesapeake Bay Program and USDA Forest Service. The Existing Tree Canopy of 60% is nearly twice the city-wide 31%. A Possible Tree Canopy expansion of 38 acres is significant and more investigation is needed into the specifics of the areas in Greenspace and Impervious landcover.

NOTE: Obvious and potential errors were discovered in the location of streams that will need to be corrected before a more accurate analysis of the stream corridor’s canopy, and potential canopy can be completed. See appendix for examples of errors.

Stream Corridor Real and Possible Errors

“Stream corridor” is used in place of “riparian buffer” because real and probable errors were found in the geographic information systems shapefile for stream location. Given there is limited confidence in the projection of stream location there is even less confidence in the “left” or “right” side of the stream. Therefore the preferred investigation of the 100’ riparian buffer on the left and right was not analyzed. Further investigation is needed to correct the GIS shapefile for the Tuscarora and Dry Run. After the streams are better located more accurate canopy cover can be determined. Examples of errors are below.

The 200’ stream corridor was found to have 65% Existing Tree Canopy and a Possible Tree Canopy of 91%. Preliminary investigations into the errors of the GIS shapefile for the stream suggests the Existing Tree Canopy maybe even higher. The true stream corridor, after corrections, appears to run through more canopy. Riparian areas are less suitable for development because of flooding and steep banks so it is not unreasonable to assume the Existing Tree Canopy in 2011 was greater than 65%. See in the examples below how the more likely stream corridor runs through more canopy than the “existing” stream as mapped.



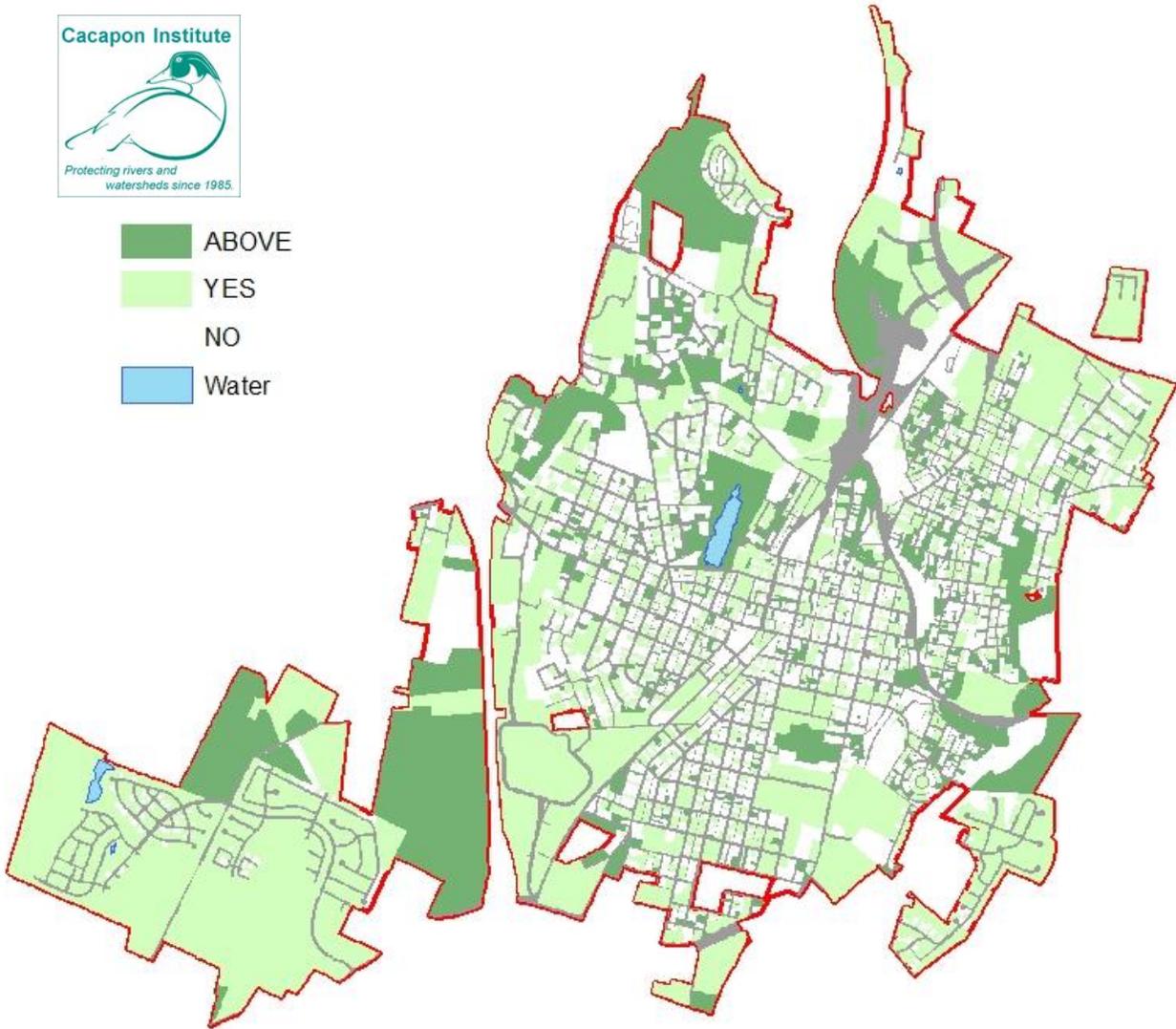
Hypothetical Tree Canopy – 60 Percent



60% Tree Canopy Conversion



-  ABOVE
-  YES
-  NO
-  Water



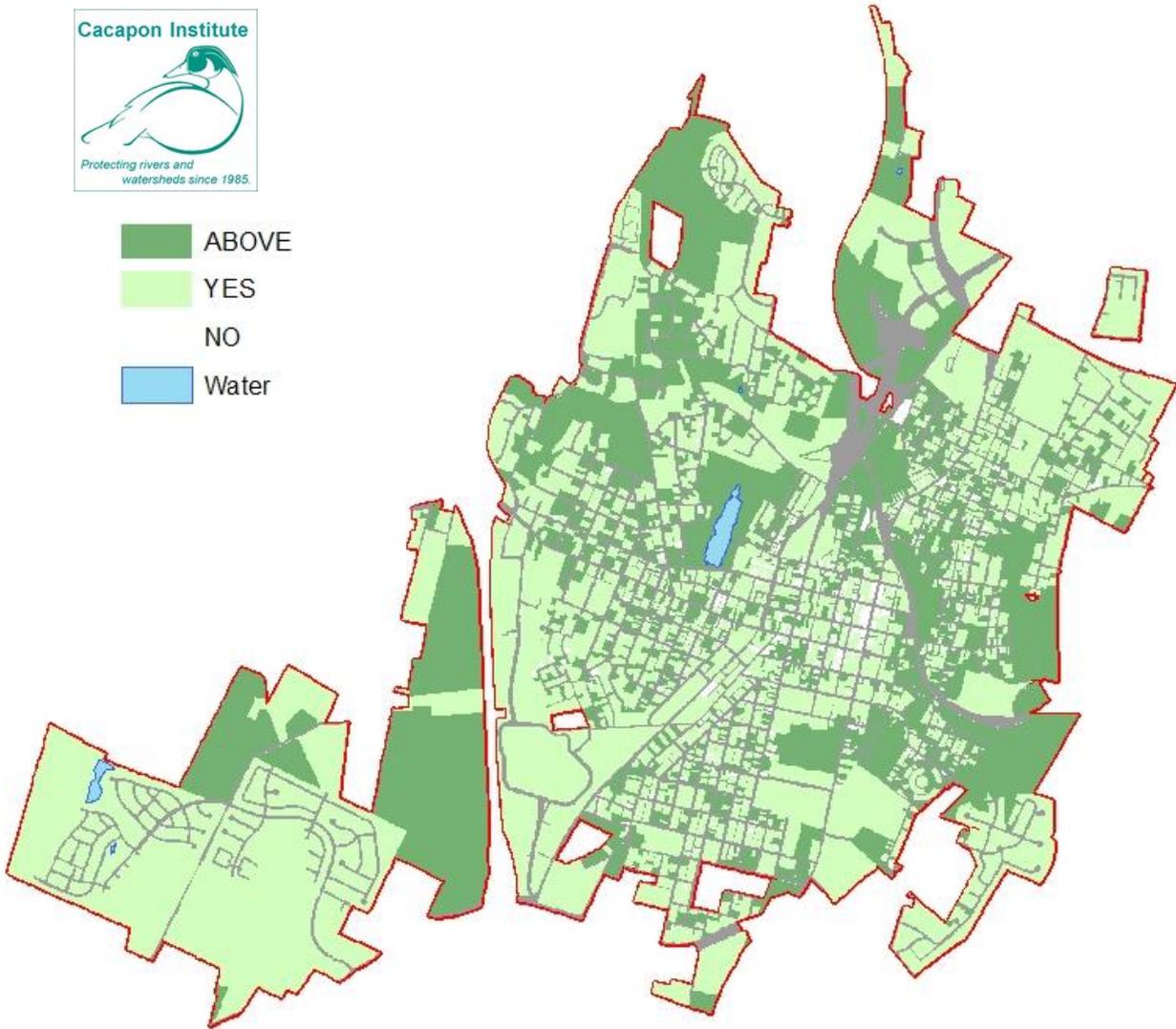
Hypothetical Tree Canopy – 40 Percent



40% Tree Canopy Conversion



-  ABOVE
-  YES
-  NO
-  Water

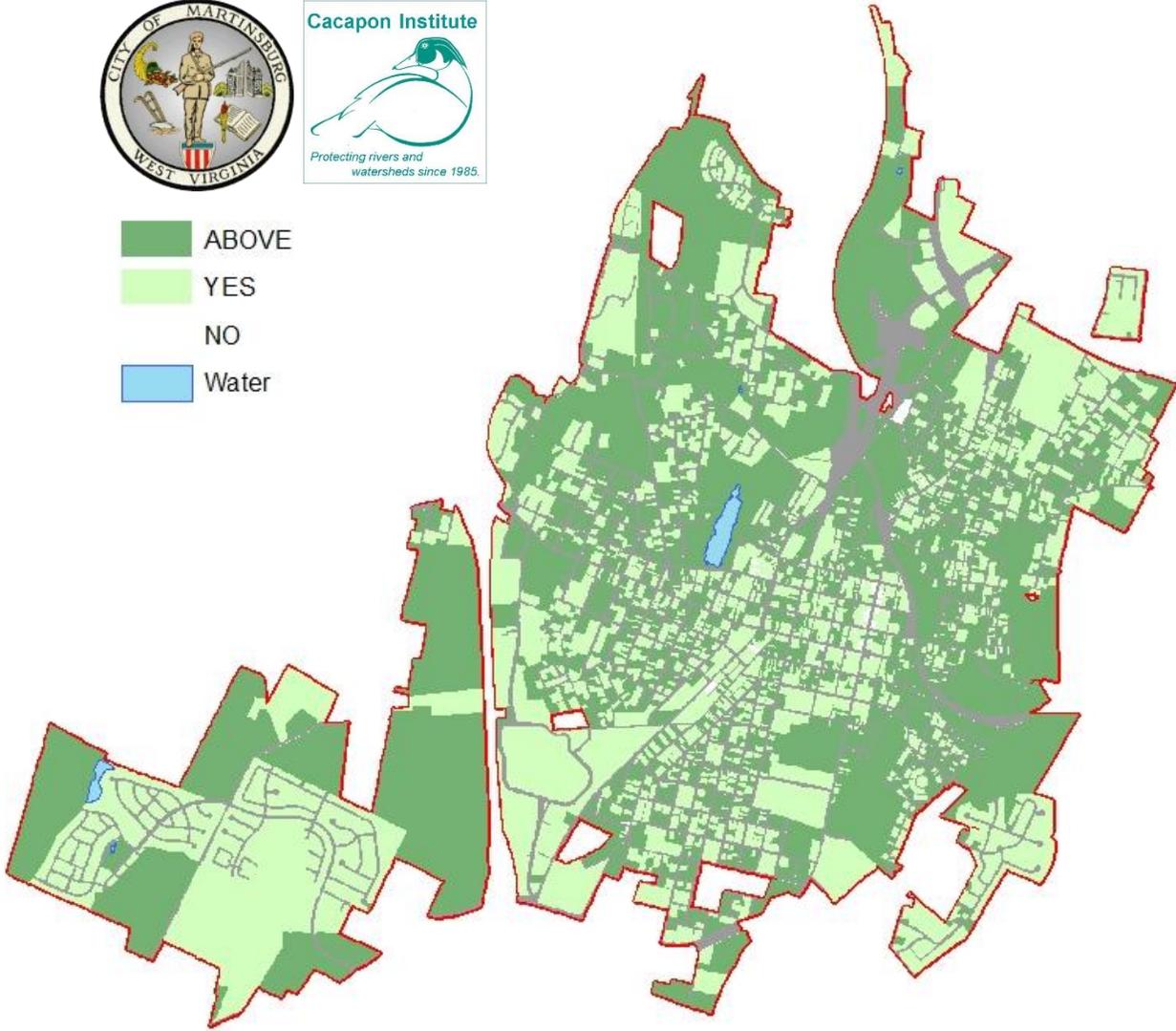


Hypothetical Tree Canopy - Average

Average (by Property Class) Tree Canopy Conversion

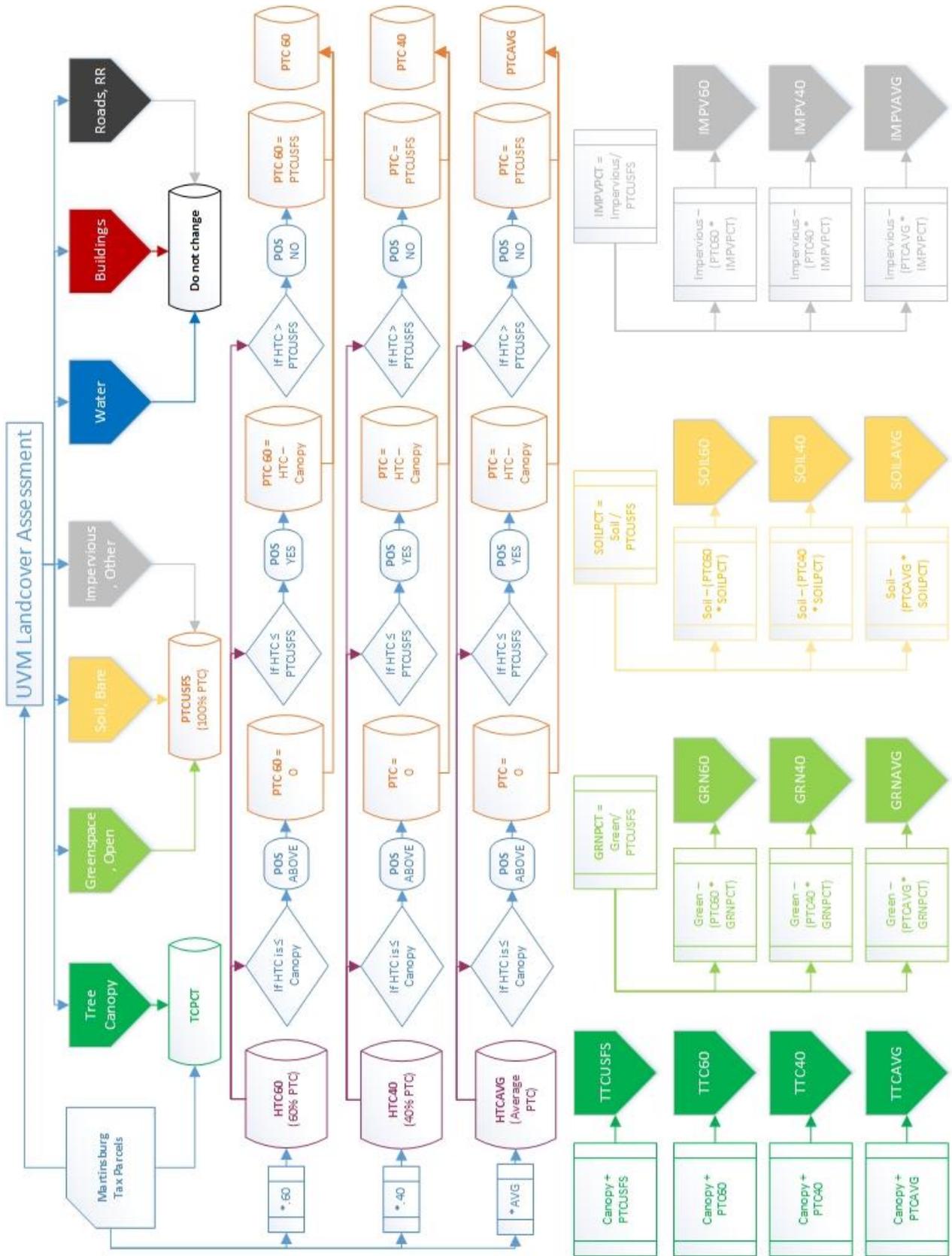


- ABOVE
- YES
- NO
- Water



Hypothetical Tree Canopy Conversion Flow Chart (ArcGIS)

Hypothetical Tree Canopy Conversion Calculation Flow Chart



Hypothetical Tree Canopy Conversion Calculation Rules (ArcGIS)

Required information:

UVM/USFS Landcover Assessment

Property parcel information with "class" (information to differentiate landuse)

Dissolve UTC Landcover by landcover-type (Canopy, Greenspace, Bare Soil, etc.) for target area

Create a new "PAR_ACRE" field in the parcel shapefile and use calculate geometry tool to determine the acres for each property parcel in the parcel file

Union property parcel with new dissolved landcover

Create 7 new DOUBLE fields in the union shapefile

TCACRE – Tree Canopy Acres

GRNACRE – Green, open space Acres

SOILACRE – bare soil Acres

H2OACRE – Water Acres

BLDACRE – Building Acres

RDRRACRE – Road & Railroad Acres

IMPVACRE – Transportation, other impervious Acres (not road)

Use calculate geometry to determine the area for each (using acres) by

Selecting each landcover-type row one by one and use Calculate Geometry to populate the column with acre values

Dissolve the rows by parcel identification retaining as may field as possible (fields can also be bought back later through Join tool from an external data base).

The PAR_ACRE must be retained a "First Value"

The seven landcovers can be retained as "Sum Value"

New fields (all DOUBLE).

TCPCT – Tree Canopy Percent: TCACRE/PARACRE

PTCUSFS – Potential Tree Canopy USFS method: GRNACRE + SOILACRE + IMPVACRE

HTC60 – Hypothetical TC at 60%: PARACRE * 0.60

HTC40 – Hypothetical TC at 40%: PARACRE * 0.40

HTCAVG – Hypothetical TC at the Average TC for Parcel Class/Code:

PARACRE * Average TC for each Parcel. Use Average TC from Excel file, select by Property Class and multiply.

(TEXT Field) POS60 – Possibility for 60% TC: Use SELECT TOOL to assign text.

If PTCUSFS >= HTC60 Then "YES"

If PTCUSFS < HTC60 Then "NO"

If TCACRE >= HTC60 Then "ABOVE"

(TEXT Field) POS40 – Possibility for 40% TC: Repeat with HTC40

(TEXT Field) POSAVE – Possibility for Average % TC: Repeat with HTCAVG

PTC60 – Potential Tree Canopy at 60% (i.e.; the additional new tree canopy added by converting green, soil, and impervious to TC): Use SELECT TOOL to assign field value.

If POS60 "YES" Then: HTC60 – TCACRE (i.e., if there is a possibility to convert enough suitable land to TC then enough land is converted to reach 60%)

If POS60 "NO" Then: PTCUSFS (i.e., if there is not a possibility to convert enough suitable land to reach 60% TC then conversion is all the suitable land)

If POS60 "ABOVE" Then: 0 (i.e., no conversion if the existing TC is greater than 60%)

PTC40 – Potential Tree Canopy to Reach 40%: (Repeat using POS40)

PTCAVE – Potential TC to Reach Average TC: (Repeat using POSAVG)

GRNPCT – Green Percentage: $\text{GRNACRE} / \text{PTCUSFS}$ (i.e., of the suitable land for conversion what percentage is green)

SOILPCT – Soil Percentage: $\text{SOILACRE} / \text{PTCUSFS}$

IMPVPCT – Impervious Percentage: $\text{IMPVACRE} / \text{PTCUSFS}$

TTCUSFS – Total TC with USFS method: $\text{TC} + \text{PTCUSFS}$

(Note: there is no remaining GRNACRE, SOILACRE or IMPVACRE since 100% is converted)

TTC60 – Total Tree Canopy with 60% Hypothetical Method: $\text{TC} + \text{PTC60}$

GRN60 – Green at 60%: $\text{GRNACRE} - (\text{PTC60} * \text{GRNPCT})$ (i.e., green remaining after conversion to TC is equal to the original green acres minus the acres converted (PTC60) as a percentage of the amount of green for each parcel)

SOIL60 – Soil at 60%: $\text{SOIL} - (\text{PTC60} * \text{SOILPCT})$

IMPV60 – Impervious at 60%: $\text{IMPVACRE} - (\text{PTC60} * \text{IMPVPCT})$

TTC40 – Total Tree Canopy with 40% Hypothetical Method: $\text{TC} + \text{PTC40}$

GRN40 – (Repeat Above with PTC40)

SOIL40 – ibid

IMPV60 – ibid

TTCAVG – Total Tree Canopy with Averaged Hypothetical Method: $\text{TC} + \text{PTCAVG}$

GRNAVG – (Repeat above with PTCAVG)

SOILAVG – ibid

IMPVAVG – ibid