Strategies for Conserving and Enhancing the Green Infrastructure of Woodstock, Virginia

Prepared by Students in the Green Lands Class at the University of Virginia

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This is a report prepared by students in the University of Virginia's School of Architecture.

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Anyone interested in receiving the class college curriculum guide used to create this report, can contact the instructor Karen Firehock. Any comments about this report or other requests may be emailed to the instructor karenfirehock@virginia.edu.

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INTRODUCTION

Green infrastructure is the interconnected network of waterways, wetlands, woodlands, wildlife habitats, and other natural areas that support native species, clean water and contribute to community health and quality of life. Just as localities plan for grey infrastructure, they also must plan for green infrastructure to create healthful places for residents and businesses. Planning for Green Infrastructure helps localities meet their environmental, social, and economic goals. For example, forests filter and absorb rainfall, thereby reducing flooding frequency while protecting streams, facilitating the recharge of groundwater supplies, and enhancing aesthetic beauty. Green infrastructure planning is a framework for assessing and valuing environmental assets.

This report was prepared by students in an applied planning class, titled Green Lands, at the University of Virginia (UVA). This project is a collaborative partnership between the Green Infrastructure Center and UVA. It was funded by the Virginia Department of Forestry. Students proposed strategies for protecting environmental assets and landscape-influenced cultural resources.

Students worked in teams to evaluate and asses tree canopy, impervious surfaces, bike and pedestrian infrastructure, and regional environmental connections. To create this report, student teams conducted research, utilized natural resource models, and the town's spatial data sets (GIS). Students used asset mapping and qualitative evaluation to review the current status of Woodstock's green infrastructure. They met with the town's planners, reviewed the current comprehensive plans for Woodstock, and referenced other important planning documents in order to prioritize the town's goals for creating a green infrastructure plan.

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GOAL SUMMARY:

TREE CANOPY:

GOAL 1: EXPAND AND MAINTAIN THE TOWN'S TREE CANOPY TO CREATE BETTER HABITAT CORRIDORS, MANAGE STORM WATER, AND BEAUTIFY THE TOWN.

Increase Woodstock's overall tree canopy coverage to 30% and manage all town tree plantings.

Enhance the character of downtown historical areas, and improve the urban landscapes in the entrance corridors by planting additional street trees.

Connect areas with significant tree canopy coverage to create intact habitats across town.

BIKE AND PEDESTRIAN PLAN

Create a public trail network, for pedestrians and cyclists, which connects parks, businesses and significant regional sites.

Create a rail trail along the old railroad that goes through the center of the historic downtown in order to provide green infrastructure through downtown, bring tourists into the town center, and connect local assets including historical and cultural sites and local businesses.

Make trail connections to regional assets including the new Seven Bends State park, the Shenandoah River, and trails on Massanutten Mountain, while marketing the town's new bike and pedestrian friendly infrastructure and other cultural assets to encourage tourism.

IMPERVIOUS SURFACES

Reduce excess impervious surfaces by identifying which businesses (buildings between 10,000 and 50,000 square feet and above 50,000 square feet) surpass required off-street parking spaces of the 2013 Parking Ordinance (Sec. 90-387) and add green infrastructure.

Explore appropriate opportunities for low impact development across town focused on areas with high percentages of impervious areas.

Revise the current parking ordinance to include specifications and options for green infrastructure.

RECOMMENDED POLICIES AND STRATEGIES

Written by Ana Derrick, Ethen Strickler, Reid Saunders, Shujing Zhang, and Yu Zhang

> **Goal 1**: Expand and maintain the town's tree canopy to create better habitat corridors, manage storm water, and beautify the town.

Rationale:

Urban tree canopy represents a significant potential green asset for the town of Woodstock. The urban tree canopy must grow and expand to connect natural habitat areas within the town, and add significantly to Woodstock's overall green infrastructure. In 2010, Woodstock's tree canopy totaled 21.7% of all land area. This number was quite low with respect to other Virginia towns (28th out of 29 towns surveyed). Woodstock has 102.15 acres of land for parks and recreation, which represents 4.7% of the town's land area. The town's major green assets include W.O. Riley Park, Fairview Park (Wetzel Farm), Shenandoah County Fairgrounds, Riverview Park, and the Shenandoah River.

Currently Woodstock's green infrastructure network is not adequately connected for pedestrians and bicyclists. It is difficult to travel from one park to another without using a vehicle. Woodstock's green assets are also highly fragmented ecologically. This lack of connectivity between the town's open spaces and green assets hinders their functionality for humans, non-humans, and ecosystem services. Creating ecological and recreational connections between these important existing green assets is a central concern of the Woodstock green infrastructure plan. The tree coverage in Woodstock is distributed unevenly across the town. Therefore, trees should be planted in areas that currently have little to no tree canopy coverage.

In 2011, the Woodstock Tree Board proposed an 8.3% increase in the town's urban tree canopy within ten years, which would result in 30% tree canopy coverage for the town. A 5% increase of tree canopy usually requires thousands of trees to be planted. Today, Woodstock's tree canopy is 25.41%.

The UVA team recommends programs for tree planting in both residential and commercial districts (private properties). Additional street tree plantings are needed in the historic districts, entrance corridors, along the Spring Hollow Run riparian corridor, and in conjunction with the proposed bicycle and pedestrian infrastructure improvements.

There is a lack of connectivity between areas with significant tree canopy. For example, there are many large parking lots with few trees. These parking areas have noticeable impacts on stormwater management and urban heat island effect. The town's newly revised off-street parking ordinance calls for less parking spaces and should be more broadly applied. Other revisions to parking requirements, greening parking lots by planting trees, replacing dead trees, and promoting native landscaping are also key. In sum, UVA proposes a complete plan to both identify the potential locations for additional tree plantings and better connect the landscape between tree plantings.

Initiatives to raise the community's awareness regarding the benefits of tree plantings through tree care guidance and education are also needed.

Woodstock can benefit from a comprehensive and organized plan for promoting connections between significant green assets. While Urban Tree Canopy is a necessary component of this plan, there are opportunities to enhance natural habitat along a proposed rail trail and greenway trail system. Further, connections between ecological integrity and community revitalization can take the form of a community orchard on public land, riparian area restoration, the wetlands park, and private citizen initiatives for planting pollinator habitat.

Image 1: North Main Street in Woodstock, Virginia, looking northeast. Woodstock planted 266 trees across town between 2013 and 2014, including these Honey locust trees along Main St. *Photo taken by the Woodstock Green Infrastructure Team.*

Objective 1A: Increase Woodstock's overall tree canopy coverage to 30% and manage all plantings.

> **Action 1)** Consult and utilize the Fairview Park Master Plan to determine if there are any proposed tree plantings in the park that should be done now.

> **Action 2)** Suggest or facilitate neighborhood tree planting programs.

> **Action 3)** Identify riparian buffers for replanting in order to improve storm water management.

Objective 1B: Enhance the character of downtown historical areas and improve the urban landscapes in the entrance corridors by planting additional street trees.

> **Action 1)** Encourage the maintenance of the trees recently planted in downtown historical areas using the provided tree care and maintenance guide.

> **Action 2)** Mandate low impact development using best management practices for new development in town.

> **Action 3)** Plant street trees in the entrance corridor, to make more human-scale streetscape.

Objective 1C: Connect areas with significant tree canopy coverage to create intact habitats across town. Focus tree plantings and habitat restoration along the Spring Hollow Run habitat corridor.

> **Action 1)** Improve the riparian habitat of Indian Spring Wetland by planting riparian and wetland species in the "wetland plant zone" (as shown in the Indian Springs Wetland Park Trails & Boardwalk Concept Plan).

> **Action 2)** Encourage the build out of the future phases of Indian Springs Wetland Park.

> **Action 3)** Connect town residents to greening efforts through neighborhood workshops.

> - Private property outreach - incentivize homeowners to plant trees (and riparian buffer plants where appropriate) by offering subsidies, grants, etc.
> - Public outreach - facilitate the continued growth of "Tribute Trees" or "Plant a Tree" programs. The town can negotiate with local businesses like Lowes and Fort Valley Nursery to provide discounts for trees being sold to homeowners.

Timeframe: The enhancement of downtown historical areas, green improvements in the entrance corridors, and street tree plantings along the proposed bicycle and pedestrian network should be prioritized first. This will significantly help Woodstock meet its goal of expanding the tree canopy from 25.41% to 30%.

Budget Resources Needed: The Town of Woodstock has $15,000 available next year set aside for tree plantings. They estimate this will cover approximately 90 trees and 230 shrubs. Additional resources are necessary to cover tree planting and maintenance costs in order for Woodstock to meet its canopy goals, which are unlikely to be met over the next five years, given current planting rates. To increase canopy by 5 percent, at least 2,700 large canopy trees would be needed. However, more than 2,700 trees will be needed since some will be smaller spread canopy trees along streets. See Appendix 2 for preliminary tree planting calculations.

Goal 2: Create a bike and pedestrian network to make connections for nature and people between parks, businesses, historic sites and local and regional assets.

Rationale:

There is a significant need for Woodstock to increase bikeability and walkability throughout the town. There are currently no bike lanes and sidewalks are few and mostly disconnected. But, with wide roads and well treed streets, there is a lot of opportunity to create bicycle and pedestrian infrastructure. Pedestrians often use the road and road edges when accessing parts of W.O. Riley Park and Indian Springs Wetlands. Creating a trail network for cyclists and pedestrians will increase the accessibility to Woodstock's many parks and promote a safe and convenient transportation network for visitors and residents alike.

Having bike and trial networks has been known to vastly improve the economic, health, and ecological outlook of small towns like Woodstock. People who live in places where there are safe routes of active transportation tend to have better health outcomes, more economic opportunities, cleaner environments, lower energy bills, and a stronger sense of community (Rails-to-Trails Conservancy, 5). Trail networks and active streets are attractive assets encouraging young adults to visit, move to, and start businesses in small towns (Rails-to-Trails Conservancy, 12). Local and regional trail networks can also have a huge impact on the economy of small towns by bringing people through, and incentivizing visitors to stay and explore all of town's assets. One such small town that has been revitalized due to regional trail networks is New Freedom, Pennsylvania:

> Ed Hughes was unemployed, out of money and lacked any business experience, but he had a big idea: open a bike shop in the empty five-and-dime store on New Freedom's (pop. 4,464) Main Street in south-central Pennsylvania, where the Heritage Rail Trail County Park was slated to run. Bankers politely but quickly showed him the door when he asked for a loan, but Hughes finally secured a Small Business Administration loan and is now the proprietor of a thriving business in a town that grew 12 percent in population during the past decade. (Rails-to-Trails Conservancy, 17)

Other small towns, such as Lanesboro, Minnesota (which is much smaller than Woodstock) have been able to make over $1 million a year just from bike riders and other trail users coming through town (Rails-to-Trails Conservancy, 17). In the same way, a trail network connecting with the rest of the Shenandoah Valley can create opportunities for more businesses and more visitors to Woodstock.

Promoting bicycle and pedestrian travel reduces traffic congestion, contributes to cleaner air, saves energy, creates a more enjoyable atmosphere, and encourages the use and stewardship of the town's parks and natural areas ("Benefits of Trails"). Furthermore, in Woodstock, creating bike and pedestrian trails, specifically a rail trail through the downtown area, will increase habitat connectivity and tree canopy throughout the town. It is important for the trail networks to be shaded, as this is more comfortable and safer for users. The proposed trail goes through highly developed areas of the town bringing much needed green infrastructure with it. The majority of street segments in Woodstock are characterized by very low levels of street tree canopy (map 8). Planting street trees along the proposed trail network (map 9) will accomplish green infrastructure goals while increasing the quality of life within the town. Creating these green connections, and increasing walkability and bikeability, will help Woodstock better utilize its green assets.

Image 2: The intersection of Main Street and Court Street in Downtown Woodstock (looking East). Significant improvements have already been made to enhance the walkability of this street corridor. Further infrastructure improvements to include bicycle access and safety will enliven this street (Phase 1 of Bike-Ped Plan). This street is also the focal point for the proposed *Trails, Tales, and Ales* campaign. *Photo taken by the Woodstock Green Infrastructure Team.*

Objective 2A: Create a public trail network, for pedestrians and cyclists, which connects parks, businesses, and significant regional sites. Incorporate the critical habitat area along Spring Hollow Run to help buffer it. "Re-green" these trails to encourage their use and increase the tree canopy.

> **Action 1)** Following the students' phased bike plan (Map 9), prioritize the creation of bike lanes and trails on the roads that connect the main street, proposed rail trail, Fairview park, and W.O. Riley park.

- Streets were chosen based on road width as viewed through Google Earth and the easiest access to significant sites. In the event of a more limited right of way, the bike lanes and sidewalks can be on one side of the road to allow for two way traffic within them. Other options for bike lanes include painting "sharrows," painting bike lanes, or designing protected bike lanes. Further analysis is needed to determine which style of bike infrastructure would be best for each street, dependent on road widths and traffic patterns.
- When connecting to W.O. Riley Park, Woodstock should consider making an off road trail through the arboretum and public land along Park Avenue.
- These areas are prioritized first because they are significant cultural sites and legitimate green infrastructure assets in close proximity to downtown. Bike lanes through Main Street bring people to local businesses and the town's museums. Having more activity on Main Street helps the local economy and attracts more businesses.
- Connecting the network to Wetzel Farm will encourage the town to reexamine the Fairview Park Master Plan to strategize and prioritize future improvements to this important public space.

Action 2) The second phase (Map 9) is to connect the trail network with Riverview Park, Indian Springs Wetlands, the Shenandoah River, several neighborhoods, and the brewery.

- In attempting to create a more direct path to Riverview Park, Woodstock should consider acquiring an easement to bring the trail through the agricultural land (Image 3) on the east side of Woodstock. Establishing the easement puts in the legal framework to further create an overlay district on these agricultural lands, which have already been subdivided, so that the future development requires green infrastructure that fits into Woodstock's greater GI plan.
- This phase brings the network to Hollingsworth Road which connects Woodstock to the Shenandoah River at the entrance to Seven Bends State Park.
- Connecting the network with Indian Springs Wetlands will encourage the town to complete the Trails and Boardwalk Concept Plan and improve both access and on-site facilities at this iconic green asset.

Image 3: Agricultural Land located with the Town of Woodstock. The farmland is located between Downtown and Riverview Park along the Shenandoah River. *Photo taken by the Woodstock Green Infrastructure Team*

Action 3) The final phase of the trail network plan (Map 9) is to create trail connections with the schools on the southern end of town, additional neighborhoods, and Chapman Landing Road, which provides public access to the Shenandoah River and Muse Winery.

- This final phase helps to increase further regional connections to tourist attractions, while also becoming more useful to the daily lives of residents.
- Ideally, during this phase, the full length of the rail trail will have been completed through the majority of the town.
- By this point, the town should also complete necessary street tree plantings to meet tree canopy goals along the trail network.

Action 4) Create a greenway trail across the town following the course of Spring Hollow Run—an intermittent stream (Map 7).

- Due to Woodstock's unique karst topography, this stream should be buffered and citizens should be educated about its existence and that even intermittent streams need protection (Environmental Science Institute).
- Spring Hollow Run has a history of flooding, and flooded as recently as July 2015 (Beck 2015).
- A greenway following this corridor will meet both environmental and social goals. This environmentally sensitive area connects important neighborhoods in the central area of town with W.O. Riley Park and other significant sites.

Action 5) Prioritize street tree plantings along the proposed bike-ped network (Map 8).

- Street trees provide numerous benefits for residents including shade and calming effects (American Planning Association).

- Integrating street tree plantings with bicycle infrastructure captures storm water, shades impervious surfaces, increases tree canopy coverage, and provides safety for bicyclists (Urban Water).
- 74.1% of Woodstock's total street sections have less than 20% tree canopy, including the majority of streets in the bike-ped plan (Maps 10 and 11).
- Appendix 6 presents an analysis and list of 12 unique street segments where Woodstock should prioritize street tree plantings to meet its tree canopy goals. All of those streets currently have less than 20% tree canopy coverage and are part of the proposed bike-ped plan.
- Map 12 shows the approximate number of large trees needed along each street segment in the network in order to reach 30% tree canopy coverage.
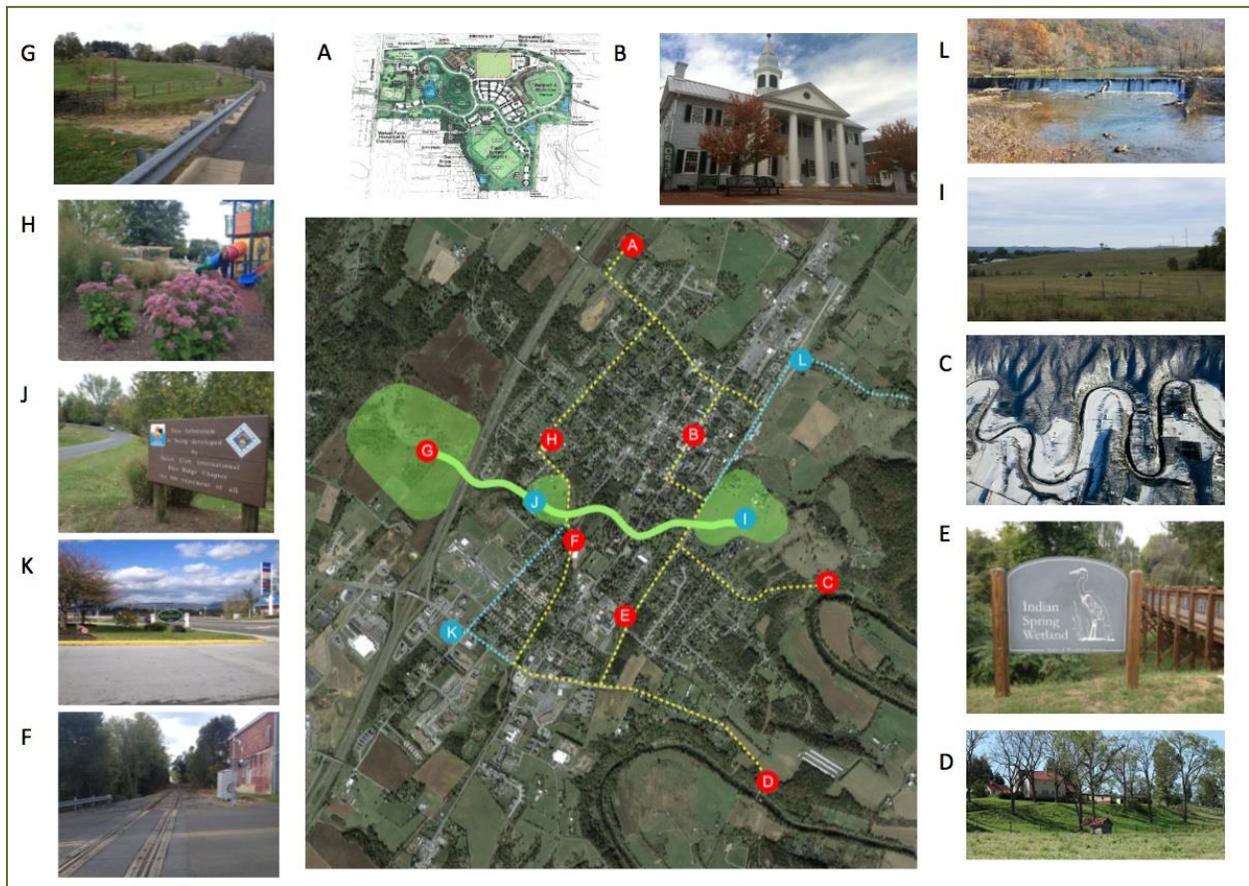
Figure 1: Conceptual diagram of the assessment process and important sites for creating deliberate connections within the bike and pedestrian trail plan. Sites in red represent significant green infrastructure assets in Woodstock, while sites in blue represent potential, site-specific opportunities to improve green infrastructure.

Objective 2B: Create a rail trail along the old railroad that goes through the center of the historic downtown in order to provide green infrastructure through the most dense part of Woodstock, bring tourists into the town center, and connect local assets including historical and cultural sites and local businesses.

Action 1) Create a rails to trails plan, based upon local and regional precedents, that connects the trail to local businesses and historic features.

- The nearby towns of Warrenton and Front Royal have created rail trails through their town centers. Both of these are wheelchair and stroller accessible and are used to create easy access to the towns' historic sites (National Recreation Trails, Community Design Assistance Center).
- The Virginia Creeper trail and Cumberland Valley Rail Trail are larger regional trails that show precedents for how small towns can fit into larger regional trail networks (Virginia Creeper Trail, Cumberland Valley Rail Trail).
- A rail trail on the abandoned rail line in Woodstock will make the town a county and regional leader in green infrastructure planning and the implementation of green infrastructure in the Shenandoah Valley.

Action 2) Create trail signage to explain the historic significance of both the railroad and the town.

- The Manassas Gap Railroad passes through Woodstock. Historically, it ran from Mount Jackson, Virginia to what is now Manassas, Virginia (Johnson 2014, 2).
- In 1862, the Manassas Gap Railroad became the first railroad in history to bring Confederate troops to battle during the Civil War (Johnson 2014, 3).
- It was also used in the Great Train Raid of 1861, where "Stonewall" Jackson raided the Baltimore and Ohio Railroad, capturing 67 locomotives and 386 railway cars (Johnson 2014, 3).
- Woodstock is the fourth oldest town in Virginia, claims to be home to the oldest courthouse still in use in the state and has two historical museums on Court Street in Downtown.

Image 4: Abandoned railroad to be used for the rail trail which runs through the heart of of Woodstock. *Photo by the Woodstock Green Infrastructure team.*

Objective 2C: Make trail connections to local and regional assets such as Seven Bends State park, the Shenandoah River, and trails on Massanutten Mountain. Utilize these regional connections in an effort to brand the town as a hub for outdoor enthusiasts, tourism, and river recreation.

Action 1) Develop a branding and outreach campaign for Court Street called "Trails, Tales, and Ales" (Map 13).

- Court Street, located in the historic downtown, has proposed rail trail access, two museums, the courthouse, and a brewery; all within three blocks.
- A branding campaign focusing on Court Street represents an opportunity for economic growth and holds significant potential to become a regional attraction.
- Hiking, biking, cultural tourism, and brewery tourism will draw visitors to the town center.

Action 2) Explore greater connectivity between the town and the Shenandoah River.

- There are four public river accesses in close proximity to Woodstock (Map 14). Two river accesses, Chapman Landing Road and Hollingsworth Road have been incorporated into the town's long term bicycle network.
- There are four major river impediments on the Shenandoah in close proximity to Woodstock. These impediments include three dams and one low water bridge (Map 16).
- Since the river does not fall within Woodstock's jurisdictional boundaries at any point, coordination with Shenandoah County is necessary to determine the best locations for new public river access, recreational opportunities, festivals and events, and further collaboration with the local river outfitter.

Action 3) Inventory regional assets to facilitate the development of Woodstock as a regional outdoor recreation hub.

- The abandoned rail line extends into other communities in the Shenandoah Valley, including Strasburg and Mount Jackson. These communities represent potential partners for our regional rail trail network, similar to the Virginia Creeper Trail and the Cumberland Valley Rail Trail.
- Work with Shenandoah County to improve access along Woodstock Tower Road to create greater connectivity and access for residents to the Woodstock Tower Hike, the Massanutten Mountain Trail network and the National Forest.

Timeframe:

The first priority for this goal is to creating trails between the historic downtown, W.O. Riley Park, and Fairview Park. This is to ensure that the downtown's major parks and cultural assets are connected by alternative transportation routes for residents and visitors. This can be achieved through simply restriping roads to include bike lanes, sharrows, or creating alternative paths. It will be important to concurrently increase the tree canopy by planting street trees along these roadways to make them more comfortable for users. The second priority is the main street marketing campaign "Trails, Tales and Ales." Branding Woodstock as a small town with outdoor recreation opportunities, historic significance, and modern amenities will attract tourists from both the Washington D.C. metropolitan area the greater Shenandoah Valley. The final tasks for this goal are the final two phases of the bike and pedestrian plan and fostering better connections between Woodstock and the region's numerous assets.

Budget Resources Needed:

There are grant and funding resources available for creating bike and pedestrian infrastructure as well as for rail trails. See funding list at the end of the report.

Image 5: The entrance corridor between Interstate 81 and South Main Street in Woodstock is characterized by strip development and high concentrations of impervious surfaces. *Photo by the Woodstock Green Infrastructure Team.*

Goal 3: Reduce impervious surfaces to improve the town's storm water management, mitigate the urban heat island effect, and create a more aesthetically beautiful environment.

Rationale:

In July 2015, the town of Woodstock experienced extreme flooding, causing Shenandoah County officials to declare a state of emergency (Beck 2015). After hours of torrential morning rain, Spring Hollow Run overflowed its banks in the downtown area and nearby streets (Beck 2015). The town received four inches of rain—about as much as they would normally get in a month—in about two hours (U.S. Climate Data 2015). As illustrated by Image 6, Main Street was completely flooded and various businesses including Spring House Tavern (the red building) were forced to close.

Image 6: Flooding on Main Street, Woodstock in July 2015. (Photo: http://www.whsv.com/news/headlines/Flooding-Forces-Evacuations-Closes-Roads-in-Shenandoah-County-314567211.html)

After this event, the town became more aware of ways to use green infrastructure to improve storm water management. Woodstock can save millions of dollars in the long-run. As shown in Appendix 7, many cities across the United States have saved thousands to millions of dollars every year by using trees to mitigate stormwater.

In addition to storm water management needs, research funded by the National Science Foundation and the Department of Energy shows that Woodstock has experienced record high temperatures twice as often as record lows over the last decade (Homewood 2014). This phenomenon is correlated with the urban heat island effect, which can be mitigated by reducing and re-greening impervious surface areas in town.

Woodstock can be innovative in the way it manages its natural resources on a limited budget. By using its green infrastructure to manage storm water, the town can accomplish several goals. The town is also interested in educating the public about its water resources and how water naturally flows through their town in places like the wetlands and dry streams. 21.593% of the town is characterized by impervious surfaces with .036% characterized by water (Appendix 15). Clearly, there is a lot of possibility for runoff with few points of infiltration.

Objective 2A: Reduce excess impervious surfaces by identifying which businesses (buildings between 10,000 and 50,000 square feet and above 50,000 square feet) surpass required off-street parking spaces of the 2013 Parking Ordinance (Sec. 90-387) and add green infrastructure.

Image 7: Lowe's pakring. (Photo Credit: Google Earth)

> **Action 1)** Woodstock should apply the required number of parking spaces for buildings between 10,000 and 50,000 square feet (view Appendix 8: Woodstock Town Building Footprints 10k-50k) and over 50,000 square feet (view Appendix 9: Woodstock Town Building Footprints +50k). Many buildings exceed requirements (see Image 7: Lowe's google earth pic).

- A visual representation of the building locations and their required parking spaces is found in Map 17 (Woodstock Town Building Footprints 10k-50k (Part 1) and Woodstock Town Building Footprints 10k-50k (Part 2) and Map 18 (Woodstock Town Building Footprints +50k).
- A GIS analysis for the required parking spaces can be found in Appendix 11.

Action 2) Approach businesses that have surpassed the required parking minimum and use the grant options to encourage them to re-green parts of their parking lots.

- Grant funding opportunities include the "Virginia Clean Water Revolving Loans Fund," "Storm water Local Assistance Fund," "Virginia Water Quality Improvement Fund," and "Virginia Conservation Assistance Program." (See Funding Section)

Action 3) Provide businesses with a guide for planting trees in parking lots. (Appendix 10)

Action 4) Apply to grant programs or begin an off-set cost program to fund impervious surface removal, to help incentivize businesses to replace areas of impervious surfaces with green infrastructure, such as bioswales. Bioswales can reduce surface runoff up to 89 percent (Arbor Day Foundation 2010).

Action 5) Implement green storm water management systems that mimic the natural water cycle, and manage storm water through effective rainfall retention, water infiltration, and pollutant removal in designated areas of parking lots. Implementing green infrastructure such as swales, vegetated filter strips, rain gardens, dry detention basins, wet retention basins, infiltration systems can mitigate stormwater runoff.

Action 6) Use the case study of "Bloedel Donovan Park in Bellingham, Washington" as precedent for stormwater best management practices applied to parking lots (view Appendix 12). The case study provides excellent guidelines for designing raingardens.

Action 7) Transform large parking lots by dividing lots into smaller parking fields with large landscaped islands (Image 8). Refer to "Parking Lot Landscaping Ordinance and Design Guidelines" (view Appendix 16) as a guide for how to accomplish this.

Image 8: Large landscaped islands in large parking lot. (Photo: http://glenview.il.us/government/Documents/Parkin

Objective 3B) Explore appropriate opportunities for low impact development across town, especially in areas with high percentages of imperviousness.

    Action 1) Analyze the percentage of impervious surface by parcel (Map 19) and identify the parcels with highest percentages. This includes areas in the entrance corridor (coming from the highway to the intersection of Reservoir Road and South Main Street), industrial area on North Main Street, and Downtown.

    Action 2) Prioritize tree planting in these areas in order to mitigate storm water and prevent future flooding in these parts of town.

    Action 3) Create signage alongside low impact development practices to teach residents and visitors about the importance of trees and greenery in helping to handle storm water. Examples include signs for bioretention gardens (view Appendix 13) and raingardens (view Appendix 14).

Objective 3C: Revise general parking ordinance (Sec. 90-387) to include more specifications and options for green infrastructure.

    Action 1) Reduce or eliminate unnecessary parking requirements. A useful precedent for lifting downtown parking requirements is Nashville, Tennessee (view Appendix 17). The cities of Staunton and Charlottesville, Virginia have also modified parking standards for businesses in their downtown areas.

    Action 2) Consider making a Parking Lot Shade Ordinance to require businesses to green their parking lots. The before and after photos (Images 9 and 10) of Main Street in Woodstock show how planting trees can provide shade in parking spaces. A useful precedent for making a Parking Lot Shade Ordinance is Sacramento, California.

Images 9 and 10: Main Street, Woodstock, before and after tree plantings, provide shade and storm water management.

Action 3) Suggest permeable surface options for parking spaces and access driveways in Section A of the general off-street parking ordinance (Sec 90-387) such as porous concrete and asphalt or grass planting brick. Another useful option to include in the parking ordinance is grasscrete, which is mixed concrete that has a defined pattern of voids achieved through the use of disposable form that once removed and replaced with stone or grass and soil allows water to pass through the concrete.

Action 4) Revise "Landscaping" section of parking ordinance to make it more specific using Glenview, Illinois as precedent (view Appendix 16): utilize trees, a dense hedge, berming, landscaped islands or decorative metal fencing. Landscaped islands are encouraged to contain a variety of planting materials (which can include shade trees, evergreen trees, plants with seasonal interest, low shrubs, and salt-tolerant groundcover).

Timeframe: The Woodstock Planning Commission should prioritize approaching businesses that have surpassed their required parking minimum. After this is accomplished, identify and prioritize areas where the impacts of impervious surface need to be mitigated. Lastly, revise Woodstock's current parking ordinance.

Budget Resources Needed: There are many resources for funding reduction of impervious surfaces from both public/private partnerships and state funds (view Resources section). Costs for the objectives mentioned above are project dependent. A useful guide for calculating these costs is the U.S. Environmental Protection Agency's Green Parking Lot Resource Guide.

RESOURCES

1. **Tree Care Tips**: Tree Care Tips was created and maintained by the Tree Care Industry Association (TCIA), seeks to provide homeowners with information on caring for trees and protecting landscapes. Covering everything from planting to pests, from soil to storm damage, Tips is a one-stop resource to learn more about enhancing your tree canopy and improving your green space.

Tree Care Tips Website: http://www.treecaretips.org/

2. **The Arbor Day Foundation** is a non-profit conservation and education organization founded in Nebraska in 1972. It is the largest membership organization dedicated to tree planting. The Foundation's stated corporate mission is "to inspire people to plant, nurture, and celebrate trees. The website provides information on tree identification and tree care.

Arbor Day Foundation Website: https://www.arborday.org/trees/

3. **Fairfax County Public Facilities Manual, Chapter 12: Tree Conservation**: The Public Facilities Manual (PFM) sets forth the guidelines which govern the design of all public facilities which must be constructed to serve new development. The purpose and intent of Tree Conservation Chapter is to provide plan submission requirements, technical specifications and on-site practices that support the administration, implementation and enforcement of the tree conservation requirements of the Code including.

Fairfax County Tree Conservation ordinance: http://www.fairfaxcounty.gov/dpwes/publications/pfm/chapter12.pdf

4**. NYC Parks Street Tree Planting Guidelines:** The diagram of street tree planting guidelines illustrates useful rules for planting trees on streets.
Retrieved from Collab of Green Land Class.

7. **Growing Native Field Guide to Desired Native Species Virginia**: This is a Virginia field guide for native tree species, made by Virginia Tech Forestry Department.

Retrieved from: http://growingnative.org/pdfs/VirginiaSpeciesIDGuide.pdf

5. **Virginia Urban Street Tree Selector**: The street tree selector is designed to serve as a resource and forum for street trees, providing information on how to select urban tree species. Trees in downtown areas are under intense pressures from pavement, buildings, and people. Finding a variety of trees that will perform well in these situations can be difficult. The site is designed for Virginia communities, but will also be useful to the Mid-Atlantic region and beyond.

 Virginia Urban Street Tree Selector: http://dendro.cnre.vt.edu/treeselector/

6. **Jersey City Tree Canopy Assessment**: Green Infrastructure Center Inc. mapped and analyzed Jersey City's tree canopy in order to protect and expand the city's investment in its trees. The tools and methods in this assessment provide important methods for assessing tree canopy potential in Woodstock.

Recourse: http://www.gicinc.org/jersey_city.htm

7. **Rails to Trails Conservancy:** The Rails-to-Trails conservancy is a "nonprofit organization dedicated to creating a nationwide network of trails from former rail lines and connecting corridors to build healthier places for healthier people." The conservancy was founded in 1986 and helps to support the creation, advertisement, and maintenance of rail trails across the country. This group offers funding and other assistance for communities who what to create trails of their own. The second link below is for a document outlining how much public trail networks can do for small towns.

Rails-to-Trails Conservancy: http://www.railstotrails.org/

Active Transportation Beyond Urban Centers: https://www.railstotrails.org/resourcehandler.ashx?id=4141

8. **The Virginia Native Plant Society** is a nonprofit organization dedicated to the appreciation and conservation of Virginia's Native plants and habitats. VNPS is organize in state and local chapters, and works with government agencies, developers, horticulturalists, and conservation groups across the state.

Virginia Native Plant Society website: http://vnps.org/

9. **Sacramento's Parking Lot Ordinance**: Environmental and Economic Costs of Compliance: This document includes strategies for revising parking ordinances to enhance their effectiveness.

Elsevier: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.155.5211&rep=rep1&type=pdf

10. **Green Parking Lot Resource Guide**: This document is expected to be particularly useful for local government officials involved in planning and development activities, as well as construction industry professionals (developers, project managers, facility managers and other decision makers) interested in green parking lot technologies.

United States Environmental Protection Agency:
http://www.streamteamok.net/Doc_link/Green%20Parking%20Lot%20Guide%20(final).PDF

ADDITIONAL RESOURCES FROM THE GREEN INFRASTRUCTURE CENTER

1. **Virginia Statewide Assessment of Forest Resources, 2010:** The Statewide Assessment of Forest Resources was published in May of 2010. It is a comprehensive, statewide assessment of the forest resource and any potential threats to that resource. The report includes information on forest benefits, Green Infrastructure planning and an action plan. The data on current trends and conditions are useful for local comparisons.

Virginia Department of Forestry: http://www.dof.virginia.gov/info/index-forms-docs.htm

2. **Virginia Conservation Lands Needs Assessment (VCLNA):** The VCLNA is a comprehensive green infrastructure planning tool developed by the Department of Conservation & Recreation. There are a total of six GIS (Geographic Information System) models, including the Virginia Natural Landscape Assessment and the Forest Economics Model.

Virginia Department of Conservation & Recreation:
http://www.dcr.virginia.gov/natural_heritage/vclna.shtml

3. **Using Land Use Planning Tools to Support Strategic Conservation:** The fact sheet developed by the Green Infrastructure Center gives an overview of planning tools in Virginia that can be used to support strategic conservation, including comprehensive planning, zoning, subdivision regulations, and overlay districts. The section on subdivision regulations shows how clustering can be used to help protect forest cores and corridors.

Green Infrastructure Center: http://www.gicinc.org/resourcesonlinelit.htm

4. **Nature-Friendly Communities: Habitat Protection and Land Use Planning:** Covers both green infrastructure planning tools and has 20 case studies from cities and counties, both rural and urban, across the United States.

Duerksen, Christopher and Snyder, Cara. *Nature Friendly Communities, Habitat Protection, and Land Use Planning*. Washington, D.C., Island Press. 2005.

5. **Green Infrastructure: Linking Landscapes and Communities**

Benedict, Mark A. and McMahon, Edward T. *Green Infrastructure: Linking Landscapes and Communities*. Washington, D.C., Island Press. 2006.

6. **Economic and Forest Industry Data**

Virginia Department of Forestry: http://www.dof.virginia.gov/econ/data.shtml

FUNDING OPPORTUNITIES FOR TARGET AREA REPLANTING AREAS

Environmental Quality Incentives Program (EQIP): EQIP is a USDA program administered by the Natural Resource Conservation Service (NRCS). The program provides funding for the implementation of conservation systems such as grazing land improvement systems, waste management, and wildlife management reforestation and management of timberland projects. Eligible farmers may apply at any time.

http://www.va.nrcs.usda.gov/programs/eqippage.html

Conservation Reserve Enhancement Program (CREP): The CREP program is administered through the Thomas Jefferson Soil and Water Conservation District (TJSWCD). The program provides incentives for farmers to take land out of production and install riparian forest buffers and riparian herbaceous buffers, including a reimbursement up to 25 percent from the state and a state income tax credit, and a Federal reimbursement up to 50 percent. This program funds riparian buffers of 100-foot wide on each side. CREP applications will be accepted at Farm Service Centers within CREP eligible areas until Dec. 31, 2011.

http://www.dcr.virginia.gov/soil_and_water/crep.shtml

VOLUNTEER ORGANIZATIONS

Friends of the North Fork of the Shenandoah River: founded in 1988, this group's mission is to keep the North Fork of the Shenandoah clean, healthy and beautiful. The group uses advocacy, community action, and education.

Trees Virginia, Virginia's Urban Forest Council: Trees Virginia, registered with the state as Virginia Urban Forest Council is a private, non-profit organization whose mission is to enhance the quality of life through the Stewardship of our Commonwealth's urban and community trees. Volunteers could involve by attending workshops and roundtables, or becoming a tree steward.

http://www.treesvirginia.org/

Stream and Shoreline Restoration, Chesapeake Bay Foundation: Planting native trees and shrubs along the banks of waterways in one of the most effective ways to keep polluted runoff out of streams. Creating living shorelines with native wetland plants and grasses helps restore habitat for wildlife, prevent erosion, capture sediment, and filter pollution.

http://www.cbf.org/about-cbf/offices-operations/richmond-virginia/volunteer

FOREST CURRICULA

The Virginia Department of Forestry invites all educators to make use of this unique and valuable resource. Teachers and group leaders are welcome to schedule educational trips to the New Kent Forestry Center. Trips can be "on your own" with the teacher conducting his own class using our 850-acre outdoor classroom or, specific, SOL-correlated lessons can be taught by DOF staff. Topics can be adapted to suit any age group and can be taught in an outdoor setting where students can learn by doing, feeling, seeing, hearing, and smelling. Many of these can be taught through engaging Project Learning Tree.

http://dof.virginia.gov/edu/index.htm

Virginia Naturally: Virginia Naturally was designated the official environmental education program of the Commonwealth in 2000. Educator workshops and materials are free or offered at a nominal charge. See

Project Learning Tree, Exploring Environmental Issues: Biodiversity, Resource Education Guide Chapter 4 (Forests) & 11 (Wildlife)

http://www.cnr.vt.edu/plt/

Virginia Envirothon: A natural resources competition for high school students. Students work in teams of five students throughout the school year and compete. Forestry Envirothon questions are specific to Virginia.

http://www.vaswcd.org/envirothon.htm

If Trees Could Talk: A Curriculum in Environmental History: 11-module middle-school curriculum that can be downloaded online. Module 10, *The Significance of Private Forests in the U.S.,* is particularly relevant to Nelson County.

http://www.foresthistory.org/Education/

PARTNER ORGANIZATIONS FOR LAND CONSERVATION & MANAGEMENT

DCR- Virginia Natural Heritage Program: Through this program the Department of Conservation & Recreation will manage lands that are donated to be a State Natural Area Preserve

http://www.dcr.virginia.gov/natural_heritage/

Virginia Outdoors Foundation: The Virginia Outdoors Foundation is established to promote the preservation of open-space lands and to encourage private gifts of money, securities, land or other property to preserve the natural, scenic, historic, scientific, open-space and recreational areas of the Commonwealth. This organization currently holds the majority of conservation easements in Nelson County (8,500 of approximately 10,000).

http://www.virginiaoutdoorsfoundation.org/

The Forest Legacy Program (FLP): A federal program designed to encourage the protection of privately-owned forestlands. The Virginia program requires a minimum of 20 acres; 80 percent under forest cover.

http://www.dof.virginia.gov/mgt/index-flp.htm

Tree City USA (Arbor Day Foundation): is greening communities across the country. This program is a great opportunity to celebrate the importance of an urban tree canopy and improve care of these vital city trees.

http://www.arborday.org/programs/TreeCityUSA/index.cfm

MAC-ISA: The MAC-ISA is a non-profit professional organization of arborists, urban foresters, and others involved in the caring of trees. Our membership is made up of people from commercial, utility municipal sectors, educational institutions and other green industry related fields. Our mission is to promote a culture of safety while fostering education and research that supports the care and benefits of trees. Our chapter area includes District of Columbia, Maryland, Virginia and West Virginia.
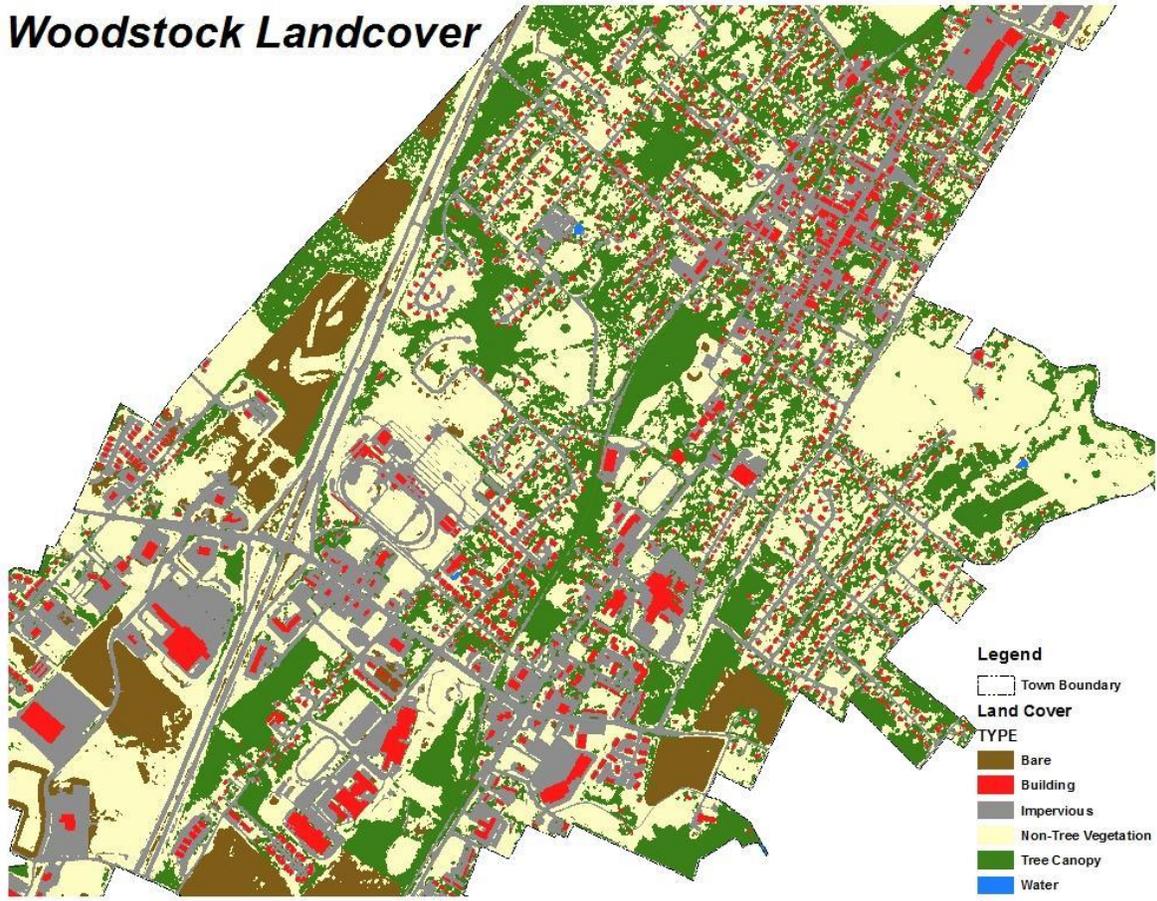
http://www.mac-isa.org/

American Grove: An online community for sharing tree-planting experiences, and knowledge that will encourage others to create thriving community forests.
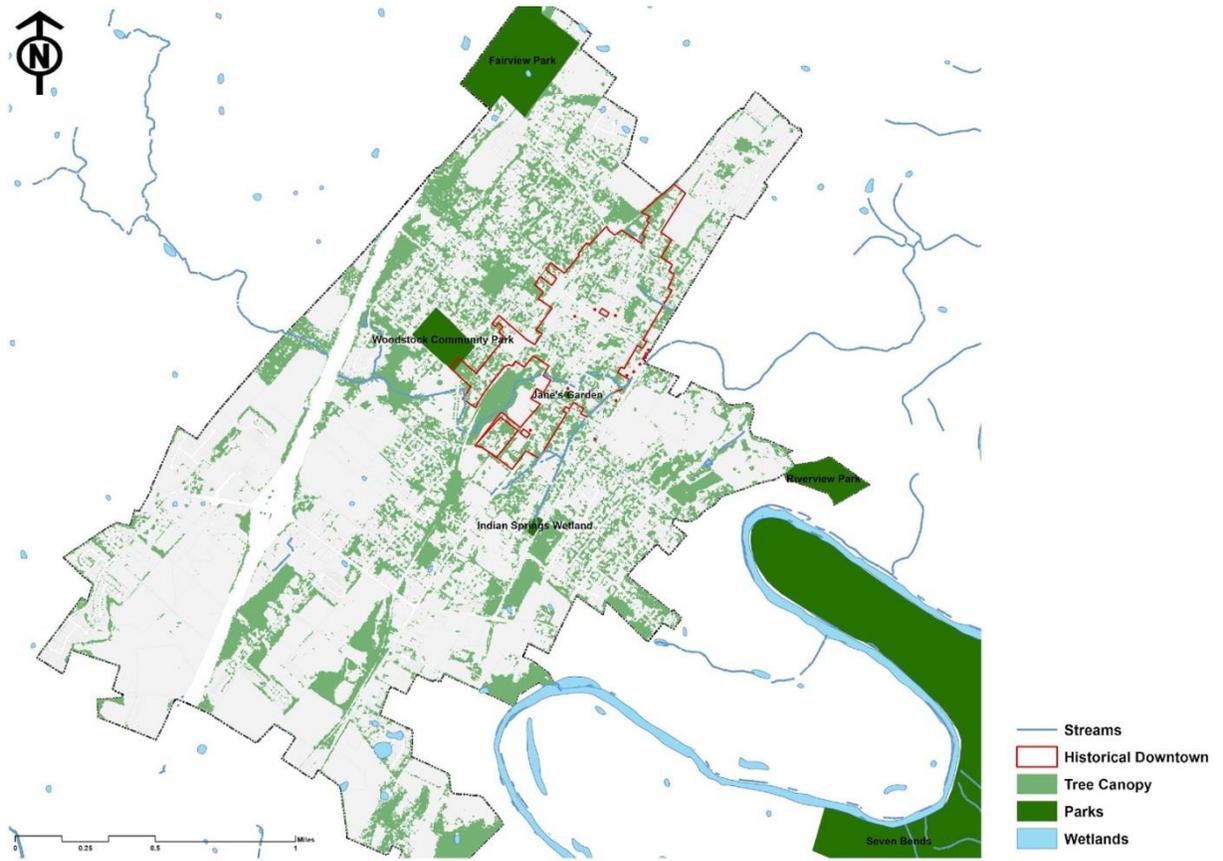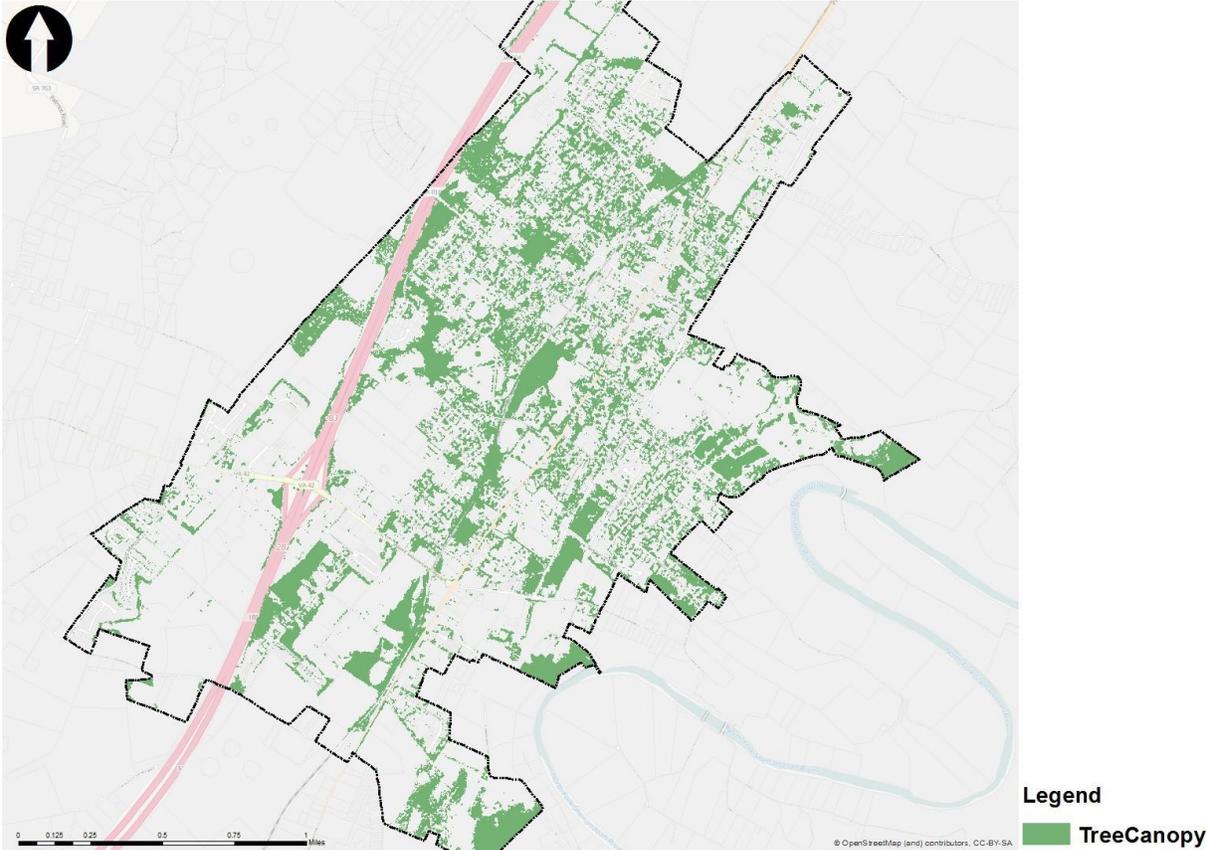
http://thegrove.americangrove.org/

Woodstock Landcover

Legend

Town Boundary

Land Cover
TYPE

- Bare
- Building
- Impervious
- Non-Tree Vegetation
- Tree Canopy
- Water

Legend:
- Streams
- Historical Downtown
- Tree Canopy
- Parks
- Wetlands

Map labels: Fairview Park, Woodstock Community Park, Jane's Garden, Riverview Park, Indian Springs Wetland, Seven Bends

Scale: 0, 0.25, 0.5, 1 Miles

MAP 3: TREE CANOPY

Legend

TreeCanopy

Legend

Parcels

PERCENTAGE

- 0 - 15
- 15 - 32
- 32 - 50
- 50 - 70
- 70 - 100
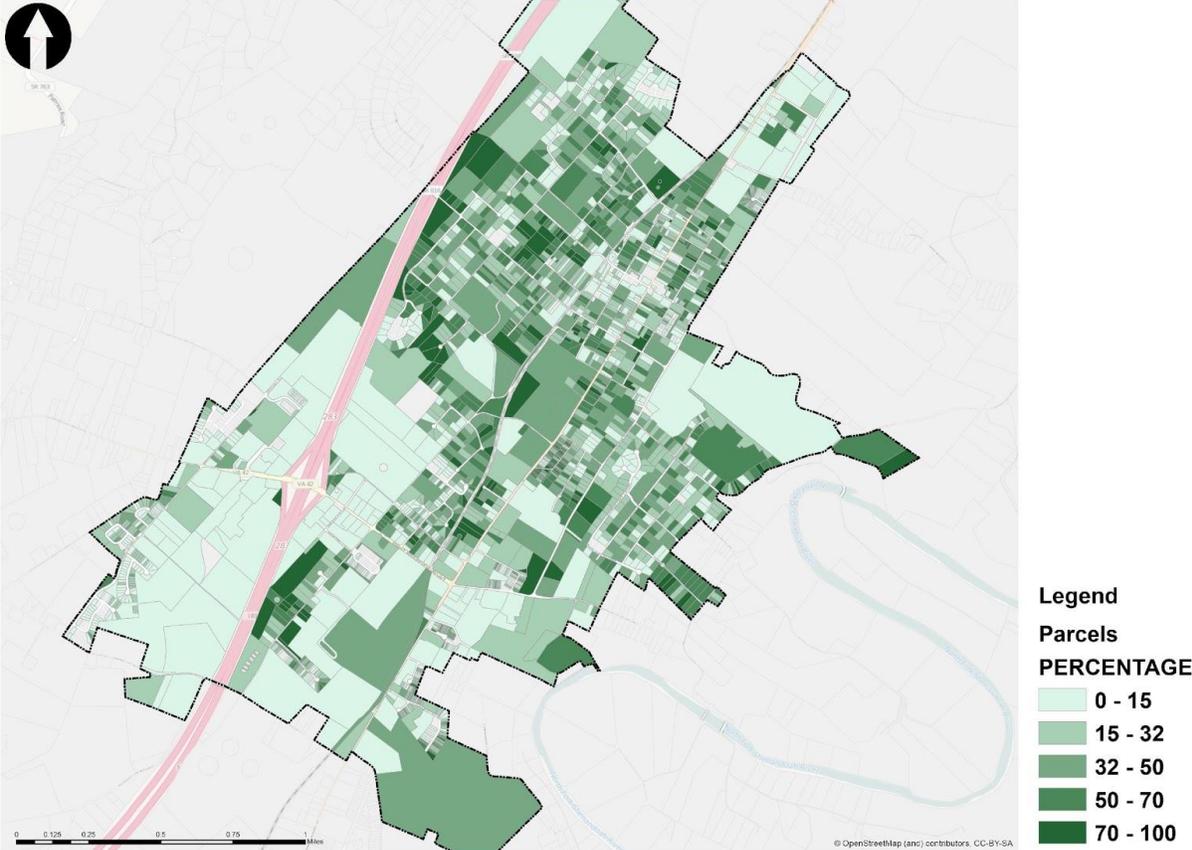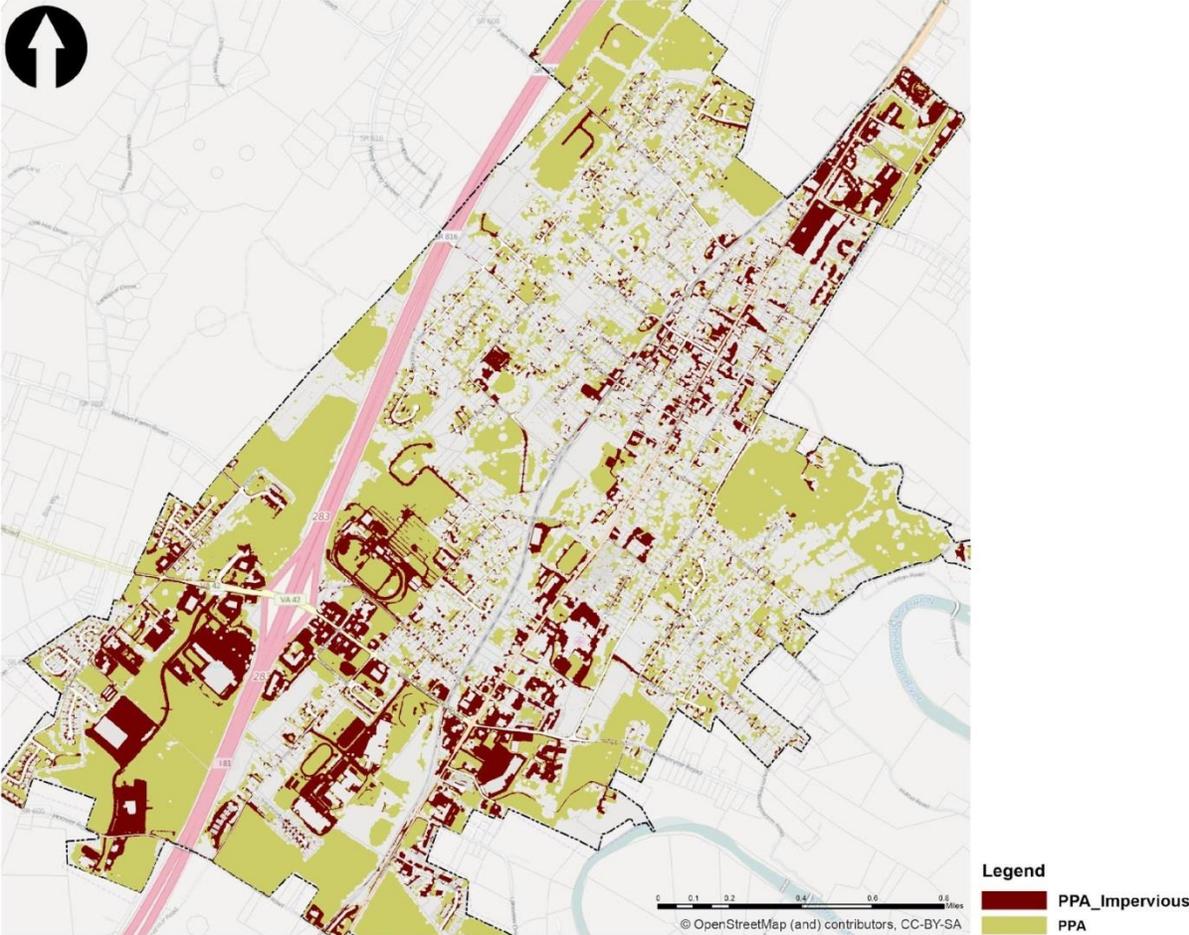
Priority Protection Areas
Green Corridors
Woodstock Town Bound:
Building Footprint
Railroad_clip
Town Streets
Tree Canopy
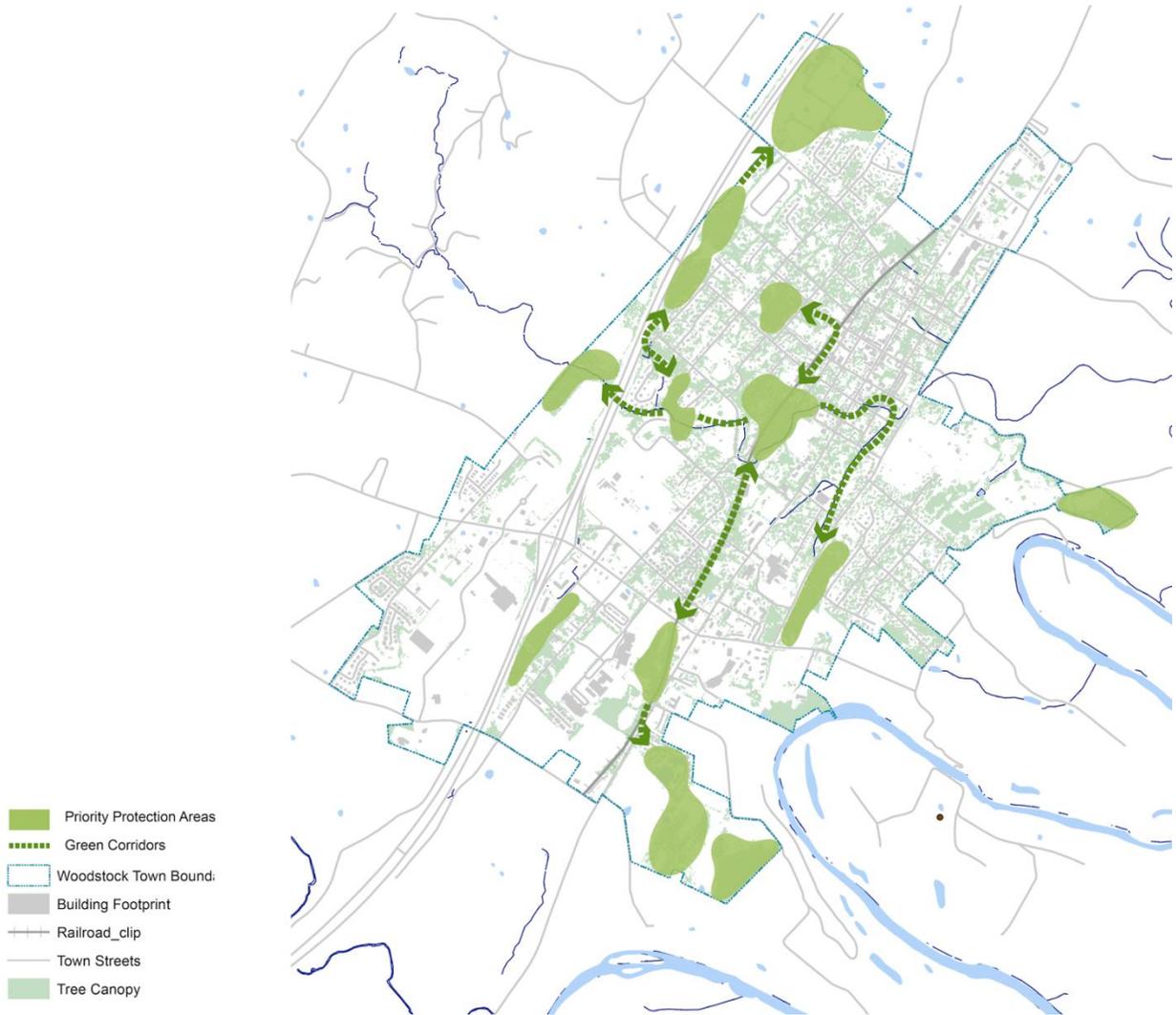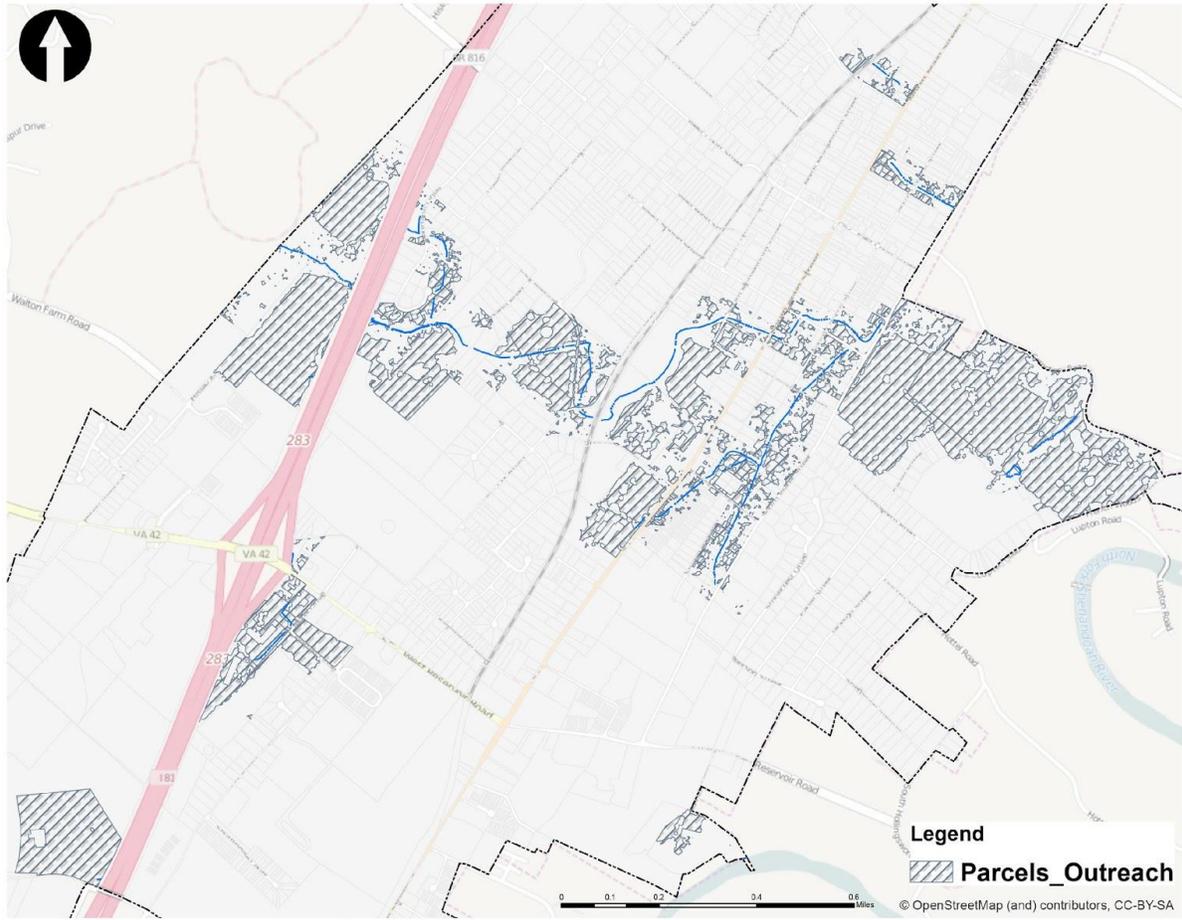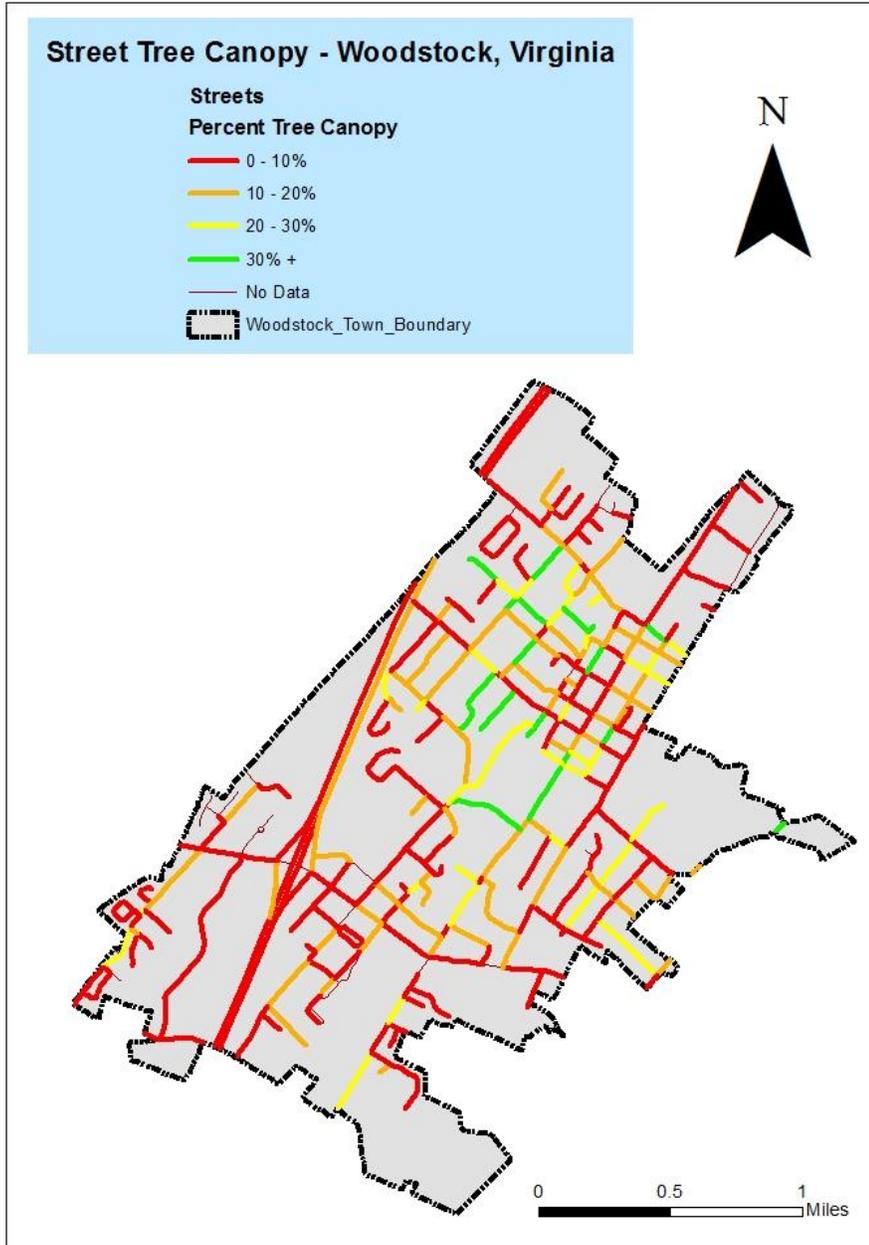
Map 9: Bike Trail Plan
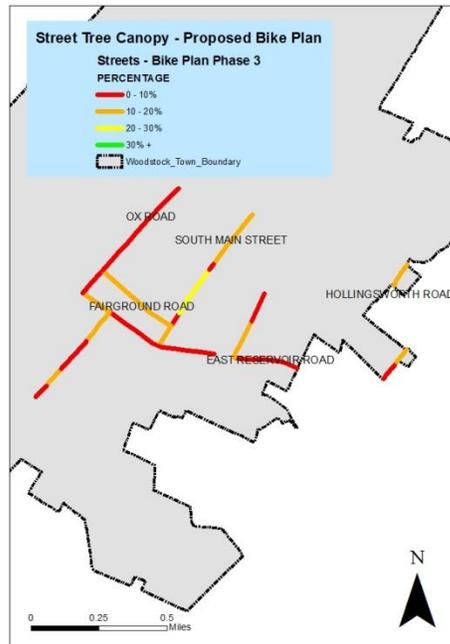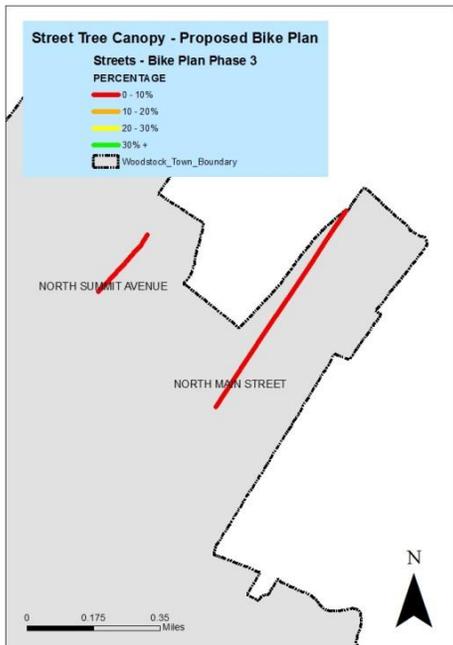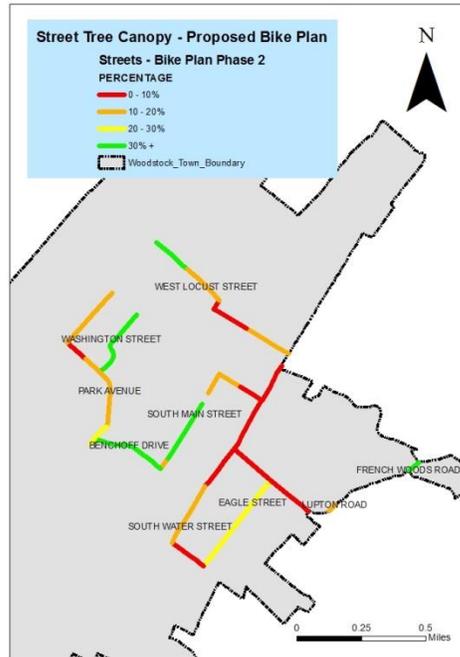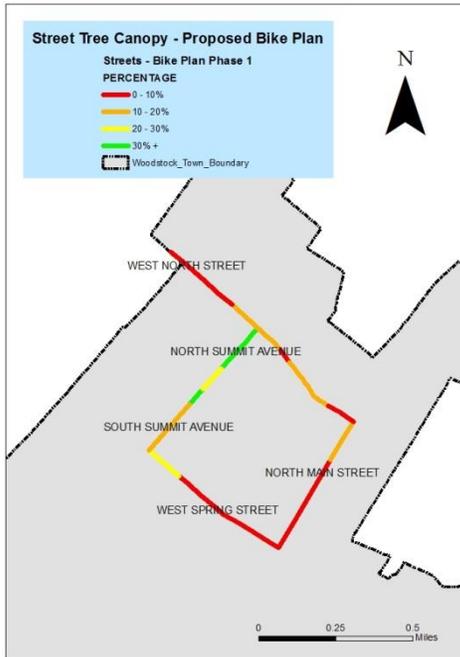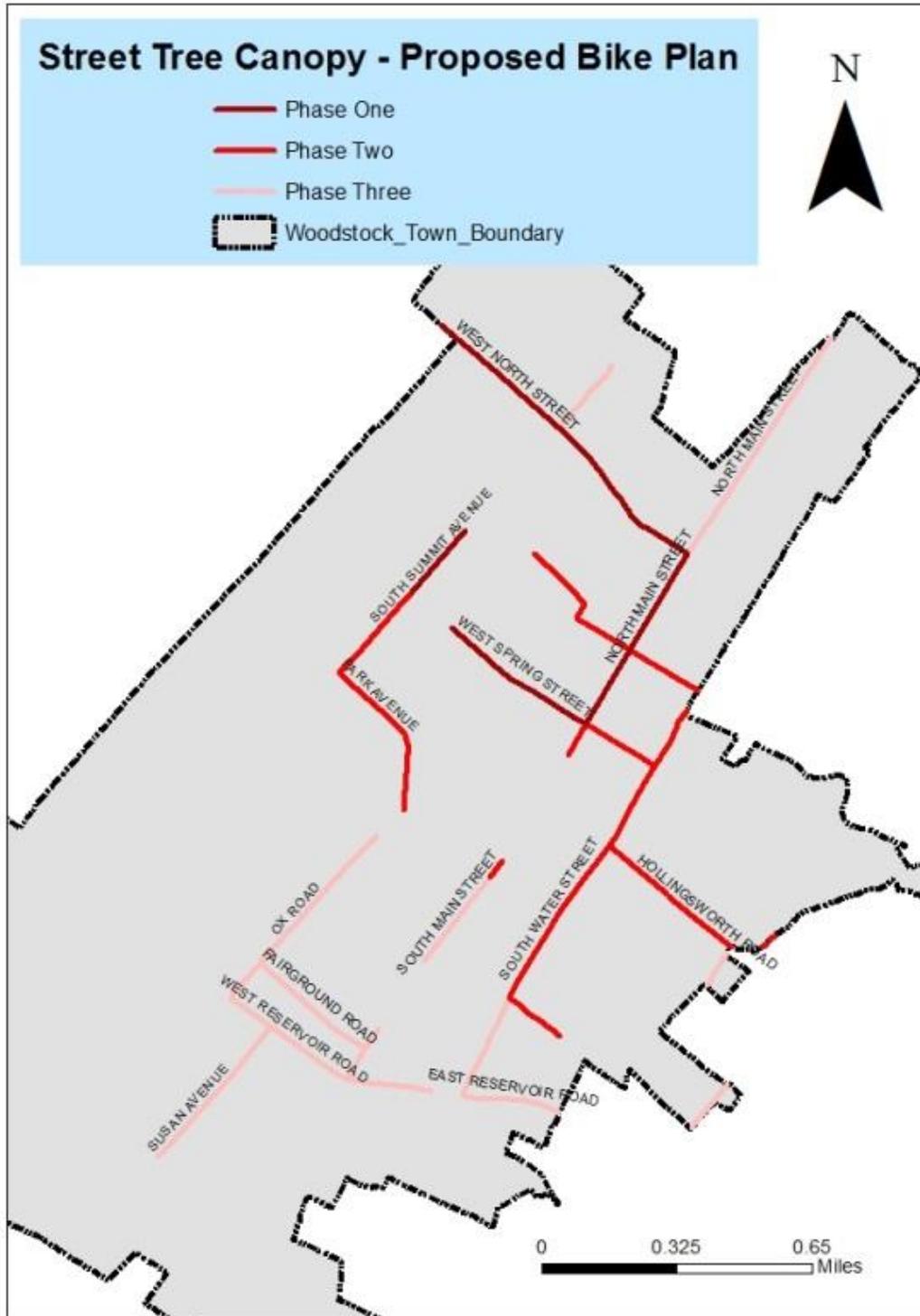
Legend:
- ▬ Bike Trail Phase 1
- ▬ Bike Trail Phase 2
- ▬ Bike Trail Phase 3
- ⬚ Woodstock Town Boundary
- ▨ Building Footprint
- ┼┼┼ Railroad_clip
- — Town Streets
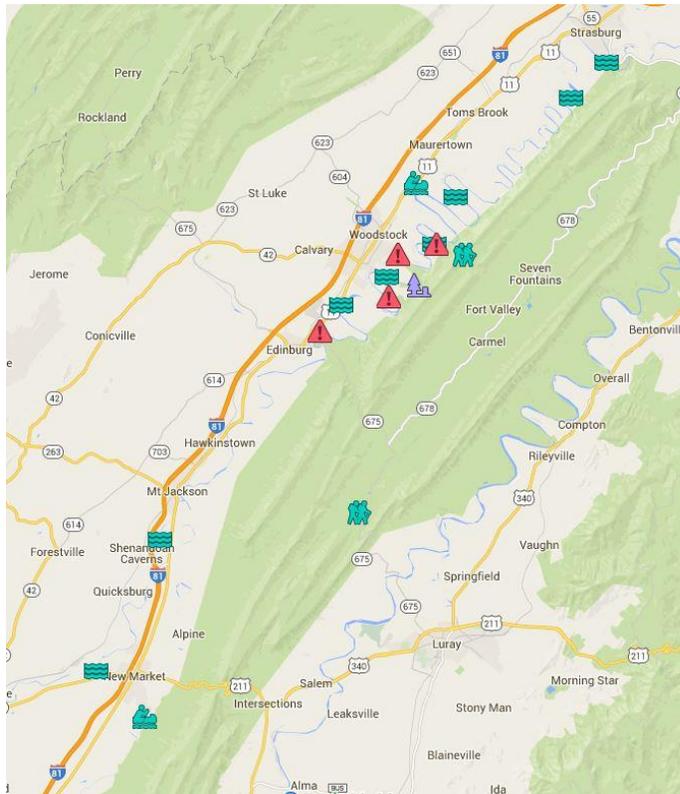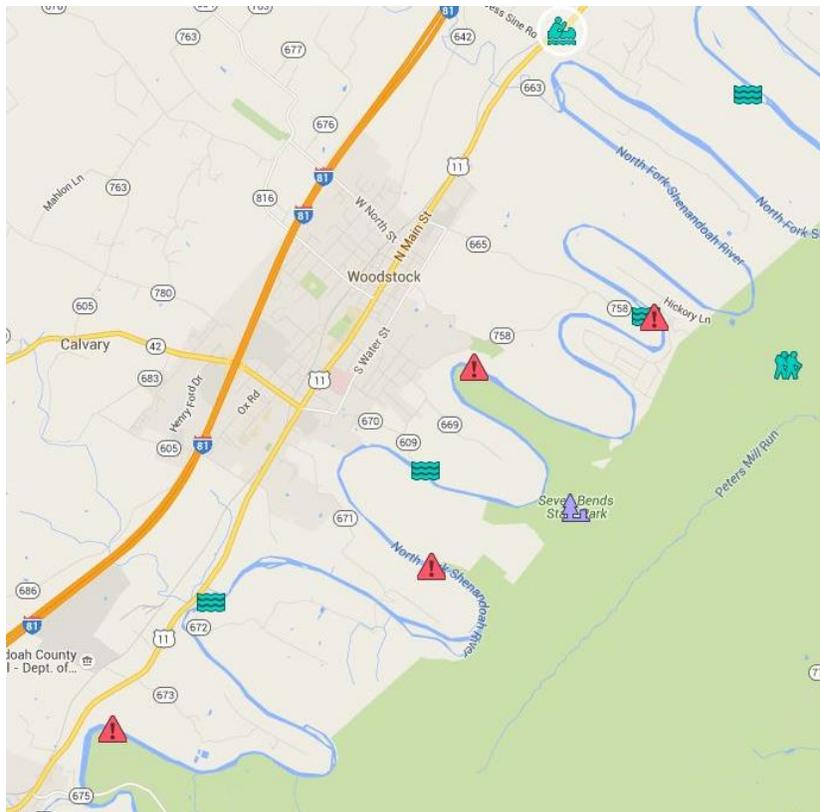- ▨ Tree Canopy
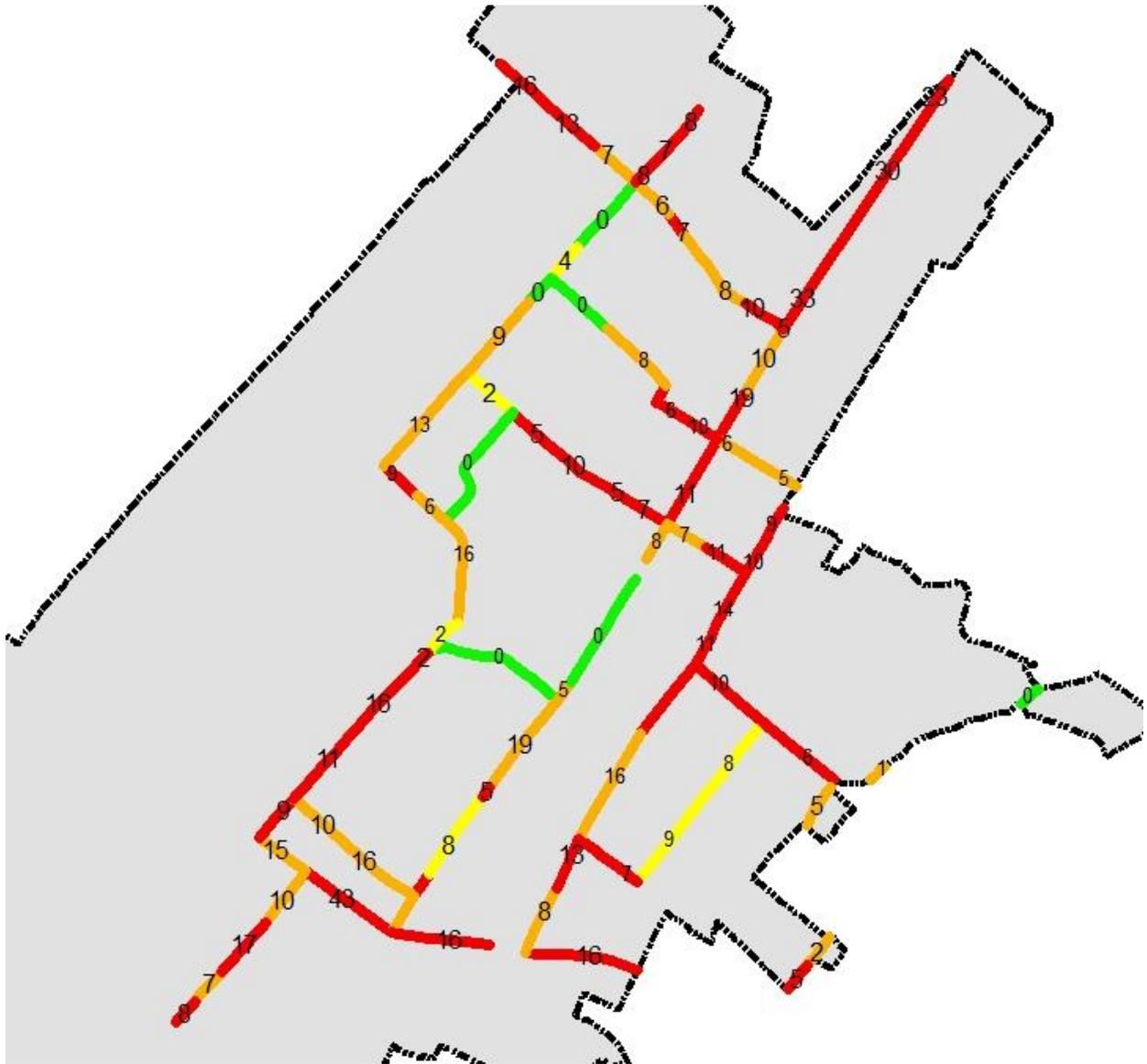
MAP 13: TRAILS, TALES, AND ALES
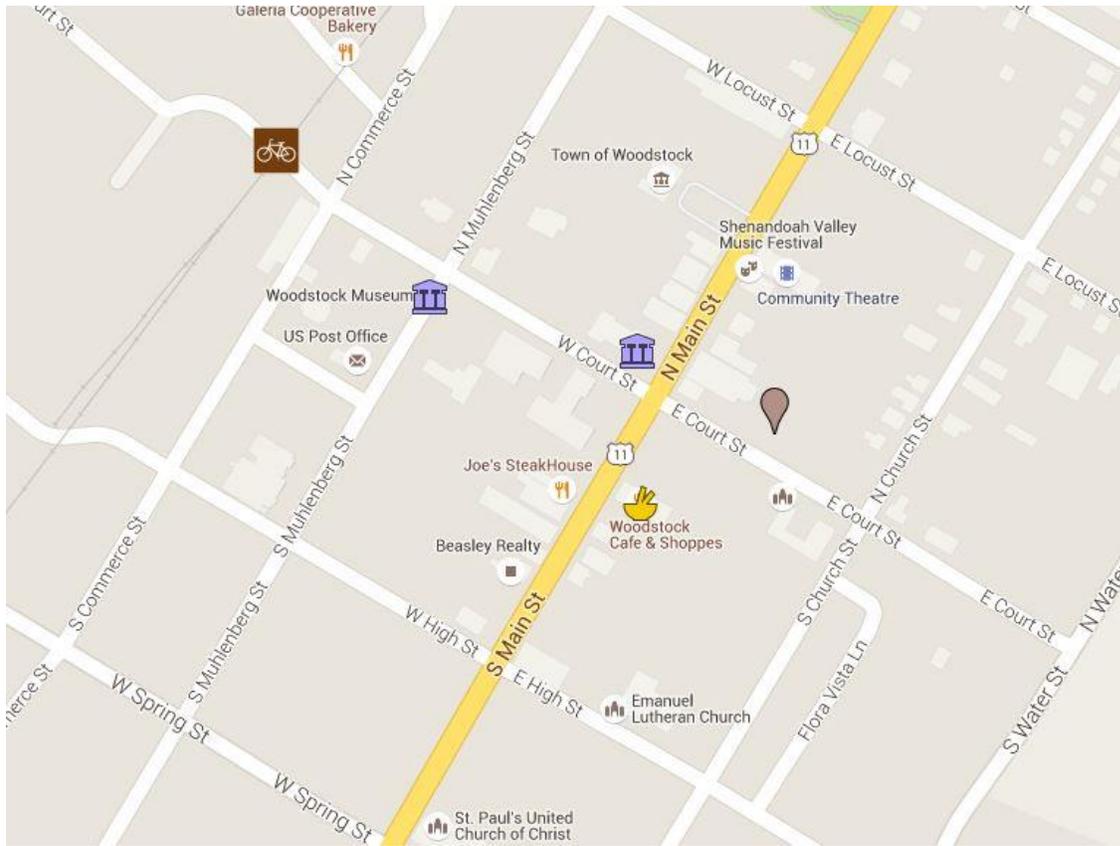
MAP 14: PUBLIC RIVER ACCESS
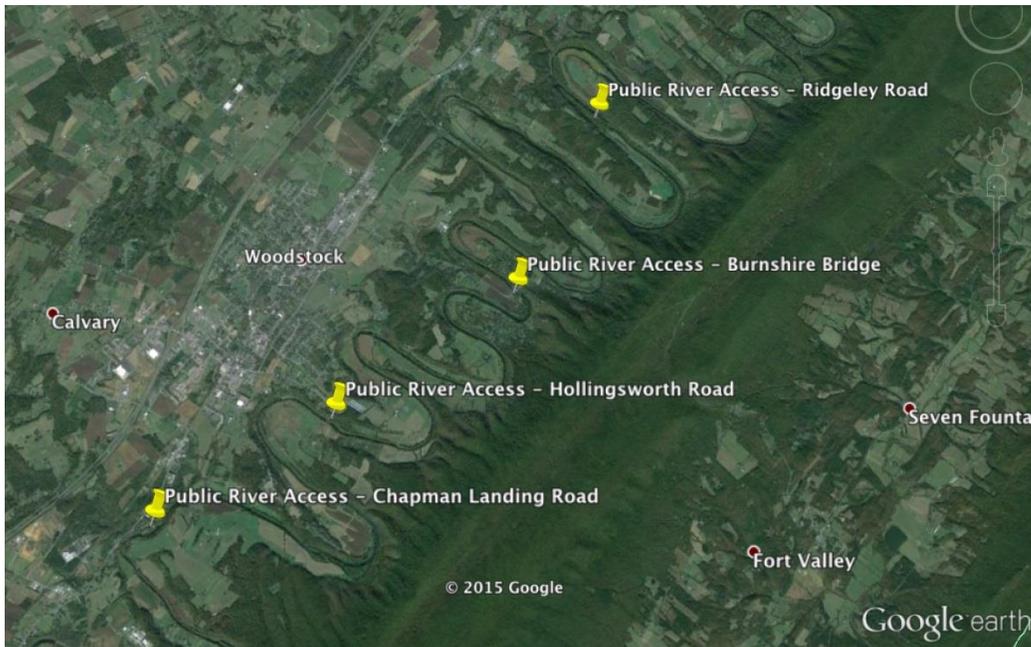
MAP 15: REGIONAL ASSETS

MAP 16: BARRIERS TO RIVER NAVIGATION
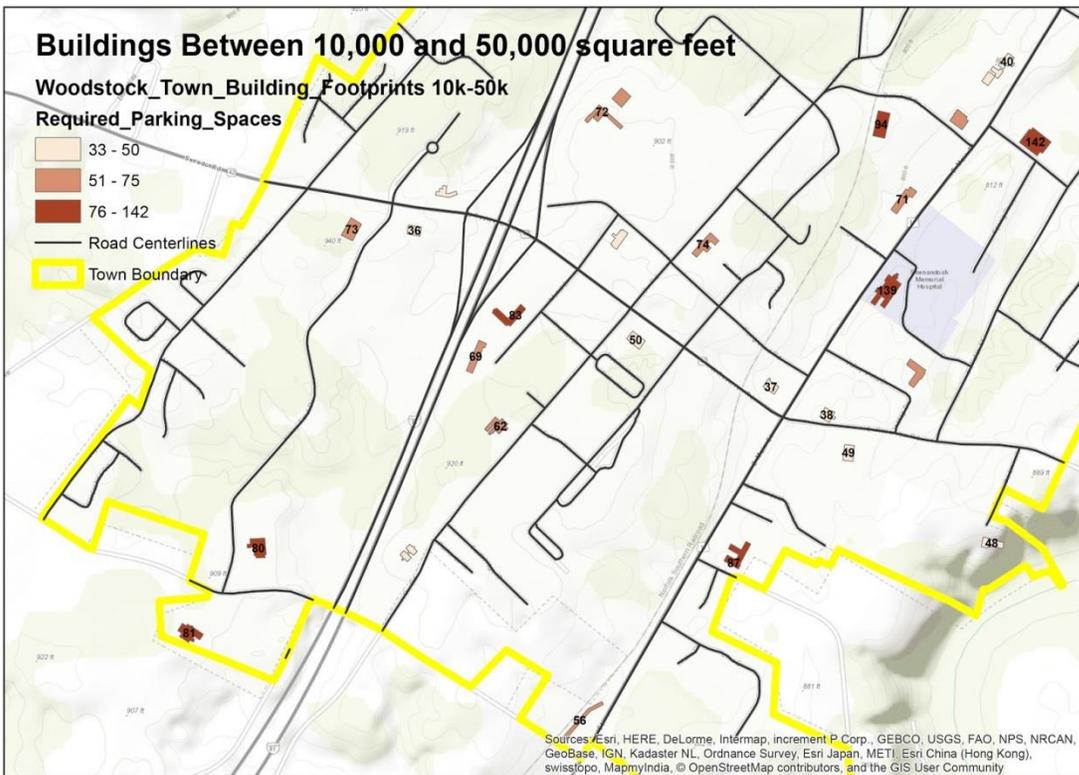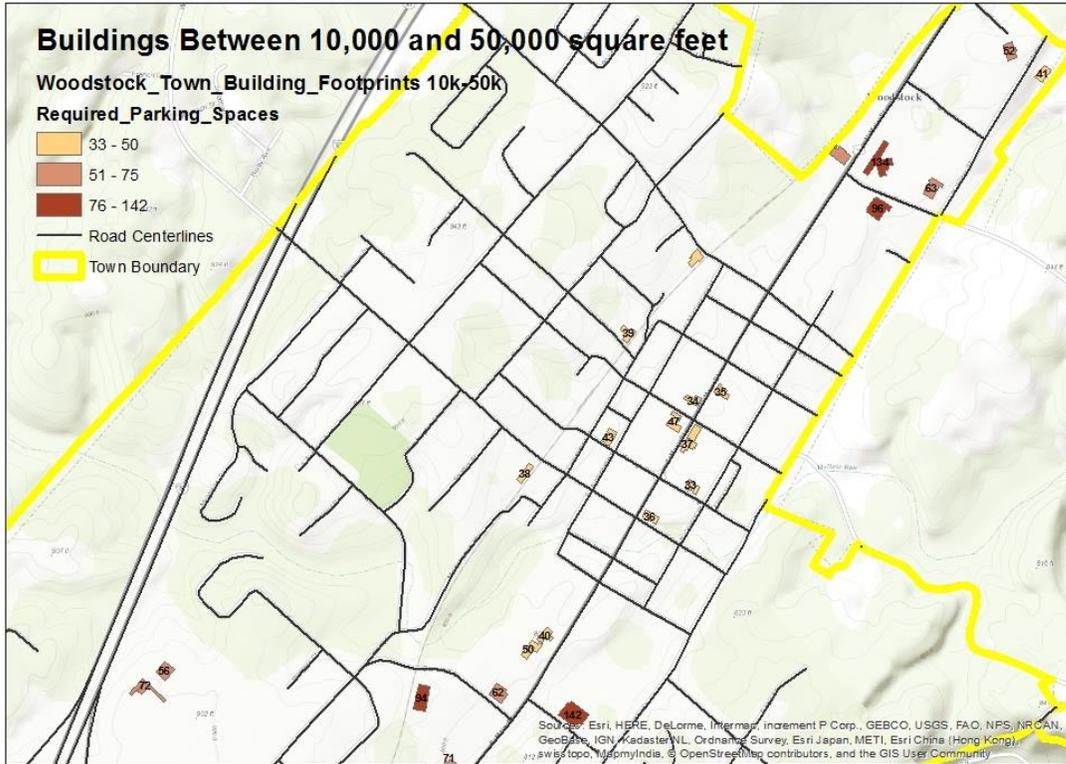
Buildings Between 10,000 and 50,000 square feet

Buildings Between 10,000 and 50,000 square feet

Building Footprints Greater than 50,000 square feet

Woodstock Town Building Footprints +50k

Required_Parking_Spaces
- 243 - 300
- 301 - 400
- 401 - 504
- Road Centerlines
- Town Boundary

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Map 19: Impervious Surface by Parcel

Legend
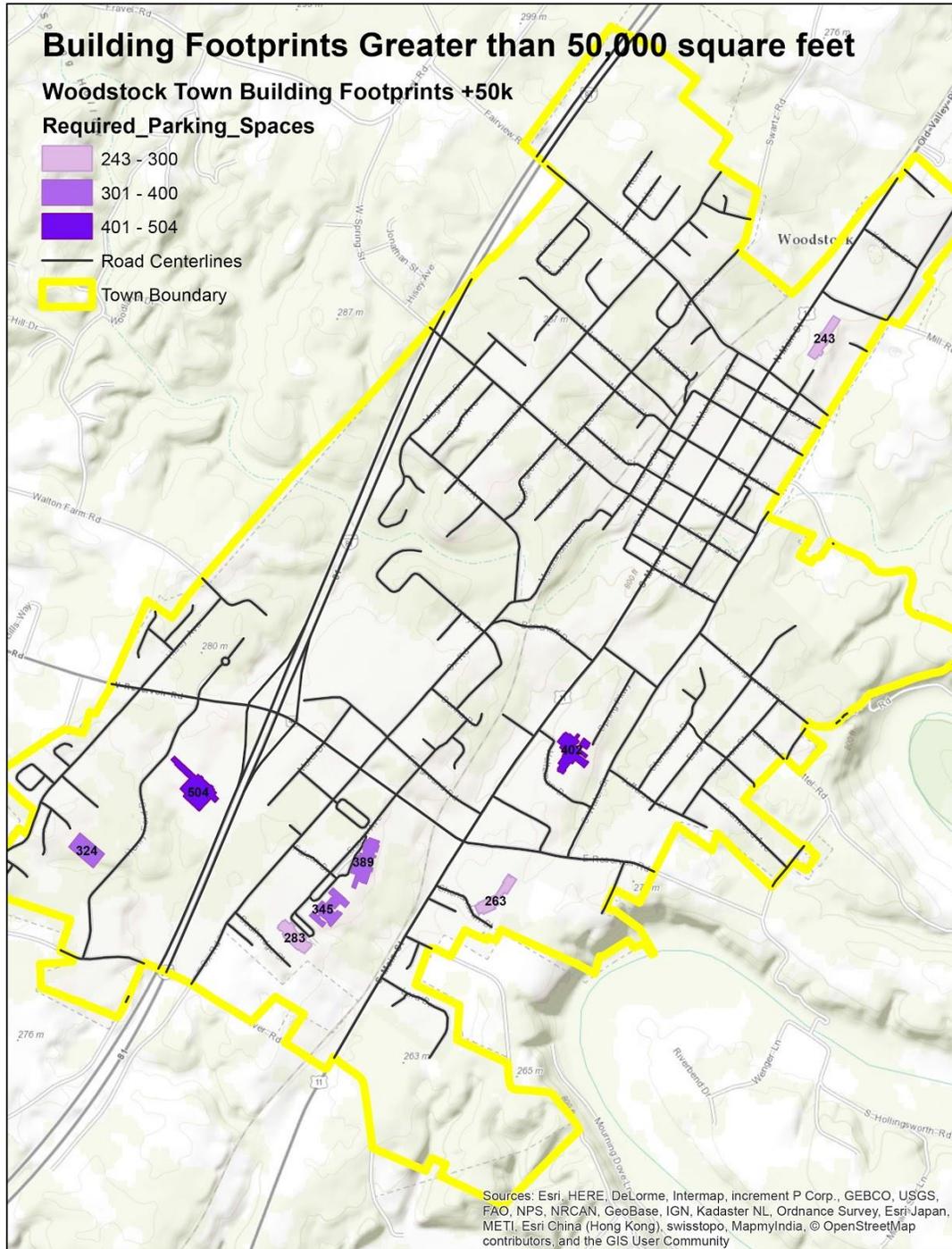
Parcels
PERCENTAGE
- 0 - 10
- 10 - 20
- 20 - 40
- 40 - 60
- 60 - 100
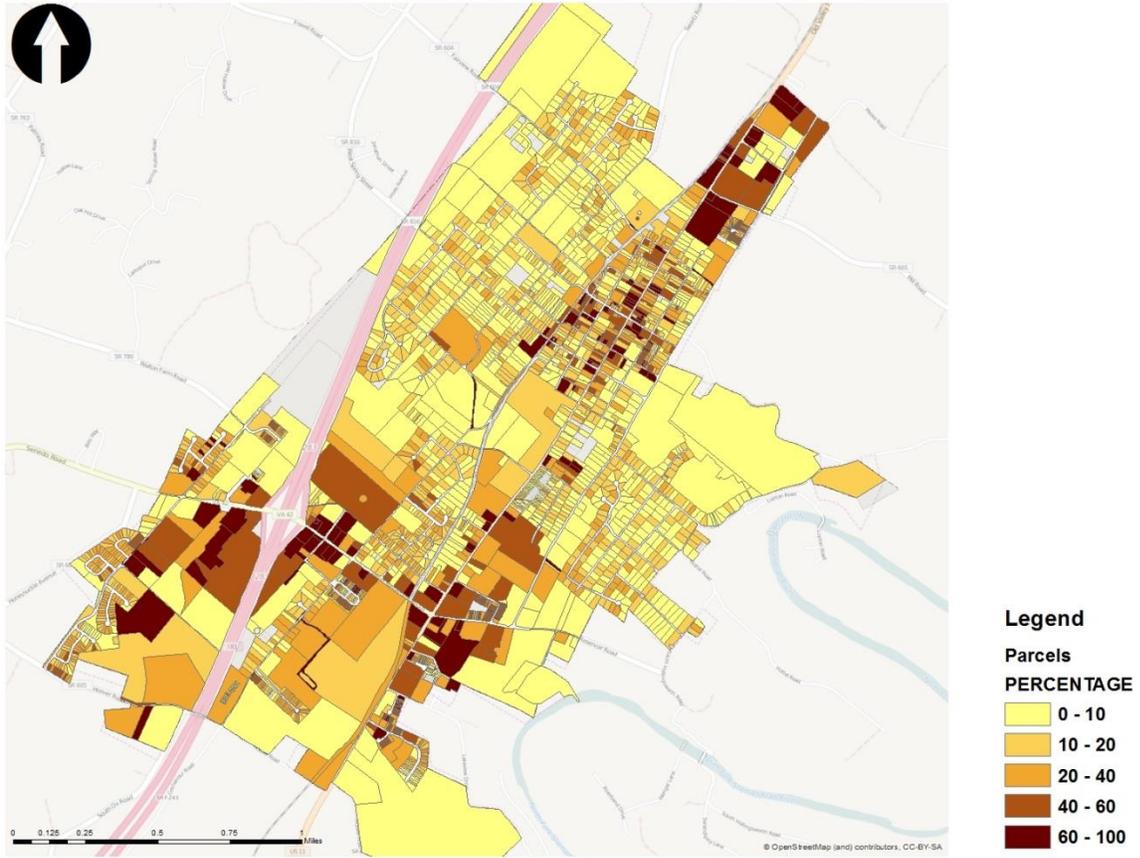
FUNDING

1. *Recreational Trails Program* - The Recreational Trails Program of the DOT's Federal Highway Administration provides funding for states to develop recreational trails and facilities. Funds can be used for the maintenance of existing trails, the development of trail linkages, the construction of new trails, or the acquisition of easements or property for trails. This program should be considered as a funding mechanism for trails in the Spring Hollow Run Corridor. http://www.fhwa.dot.gov/environment/recreational_trails/

2. *Federal Lands Transportation Program* - The Federal Lands Transportation Program provides funding for projects that improve access within Federal Lands for transportation facilities owned by the Federal government. $30 million dollars are allocated competitively every year to Federal land owning agencies like the U.S. Forest Service. This program could provide funding for improving road access to the Woodstock Tower hiking trail and the Massanutten Mountain hiking trails. https://www.fhwa.dot.gov/map21/factsheets/fltp.cfm

3. *US DOT Federal Highway Administration*.-These grants are administered through a number of different programs. The following links provides a helpful place to start when trying to visualize the wide range of funding opportunities available. http://www.fhwa.dot.gov/environment/bicycle_pedestrian/funding/funding_opportunities.cfm

4. *The Rivers, Trails, and Conservation Assistance Program* (RTCA) - Supports community-led natural resource conservation and outdoor recreation projects across the nation.

http://www.nps.gov/orgs/rtca/index.htm

5. VDOT (*Virginia Department of Transportation*) - provides grants for biking and walking infrastructure in close proximity to schools through its Safe Routes to School Program. Their assistance ranges anywhere from QuickStart $1000 mini-grants to full on funding for infrastructure projects.

http://www.virginiadot.org/programs/srsm_school_travel_plans_and_grants.asp

6. *The Virginia Department of Conservation* and recreation has approximately $1 million to award in trails grants through the Recreational Trails Program. The program requires a 20 percent match from applicants. The Virginia Recreational Trails Program is a matching reimbursement grant program for building and rehabilitation of trails. More information can be found at http://www.dcr.virginia.gov/recreational-planning/trailfnd

7. *Congestion Mitigation and Air Quality Improvement Program* - Non-motorized projects are eligible for grant funding. http://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/cmaqfunds.cf

8. *Virginia Clean Water Revolving Loans Fund*- This fund provides low interest loans for water quality improvement projects throughout the Commonwealth. Loans can be made from the Fund to a local government for the purpose of constructing facilities or structures or implementing other best management practices that reduce or prevent pollution of state waters caused by stormwater runoff from impervious surfaces. http://www.deq.state.va.us/Programs/Water/CleanWaterFinancingAssistance/StormwaterFundingPrograms/StormwaterLoans.aspx

9. *Stormwater Local Assistance Fund (Grant)*- Funded by the Virginia Department of Environmental Quality, applications for this fund are being solicited for stormwater projects including new stormwater best management practices, low impact development projects, and wetland restorations.

http://www.deq.state.va.us/Programs/Water/CleanWaterFinancingAssistance/StormwaterFundingPrograms.aspx

10. *Virginia Water Quality Improvement Fund*- Eligible applicants for this grant include regional and local governments. Grant funding is available for projects that and local programs that will result in nonpoint source (NPS) pollution reductions. This includes projects involving green infrastructure and retrofitting existing impervious surfaces to reduce the impact of stormwater runoff. http://www.deq.state.va.us/Portals/0/DEQ/Water/NonpointSource/DEQ_2015NPS-WQIF_RFA.pdf

11. *Virginia Conservation Assistance Program (VCAP)-* Funding is available for a wide variety of projects District-wide involving best management practices. This includes impervious surface removal. http://tjswcd.org/vcap.php

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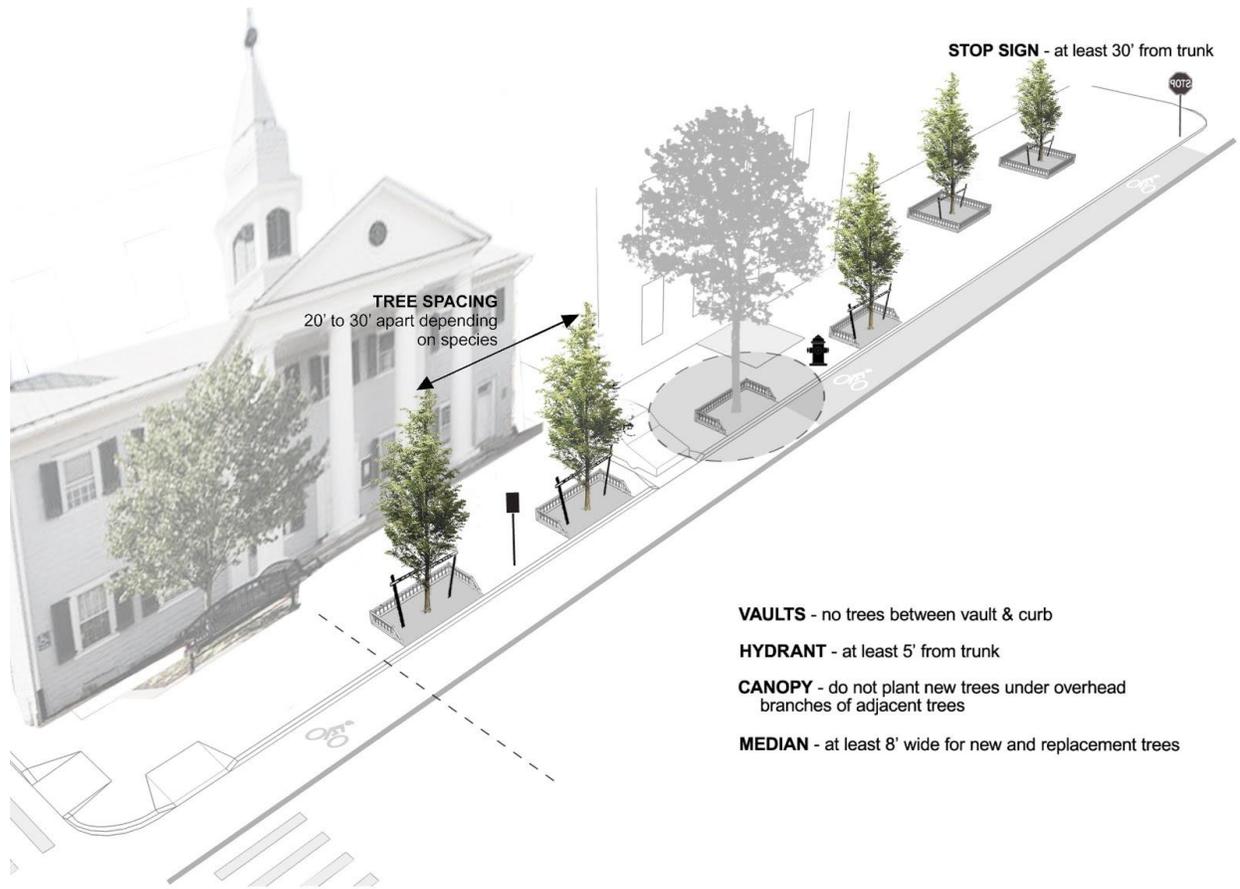U.S. Environmental Protection Agency. "Stormwater to Street Trees." *EPA*. September 2013. http://www.davey.com/media/183712/Stormwater_to_Street_Trees.pdf

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APPENDIX 1: WOODSTOCK STREET TREE PLANTING GUIDE

STOP SIGN - at least 30' from trunk

TREE SPACING
20' to 30' apart depending on species

VAULTS - no trees between vault & curb

HYDRANT - at least 5' from trunk

CANOPY - do not plant new trees under overhead branches of adjacent trees

MEDIAN - at least 8' wide for new and replacement trees

To increase its overall tree canopy to 30 percent, Town of Woodstock will require a net increase of about 4,875,000 square feet of tree canopy.
• 4,875,000 square feet of tree canopy roughly equates to 4800 mature trees.
- This number is based on a ratio of 27.5/54.31/18.28 percent for small/medium/large trees.
- Small/medium/large trees were defined as trees having canopy spread of 25ft/35ft/50ft respectively.
- The canopy spreads are averages of trees found Town of Woodstock Recommended Trees and Shrubs for Urban Planning, Woodstock Tree Board (2012)
- The planting ratio (27.5/54.31/18.28) was estimated using GIS by looking at the Possible Planting Area. From that total area, it was estimated whether a large, medium, or small tree could be planted there. Thus, the PPA was divided into three classes, based on the size of tree that could be planted. Thus the ratio of 27.5/54.31/18.28 percent was arrived at for these three classes.

Table 1 Woodstock Tree canopy summary   Unit: Square ft

Name	Total Area	Existing Tree Canopy	30% Tree Canopy	Tree Canopy Needed
Town of Woodstock	106163886.2	26974542.23	31849165.85	4874623.619

Table 2 Town of Woodstock new tree summary

Category	Spread/ ft	Surface area /square ft	Cells Required (3 ft *3ft/cell)	Percentage	# of Trees	Cost/ per tree/ per year	Total Cost	Sum
Small	25	490	54	27.41%	1461	15	21914.3	104,167
Medium	35	962	107	54%	2895	20	57894.5	
Large	50	1962	197	18.28%	974	25	24358	

• It can be assumed that there is a 3.5-5% tree mortality rate per year (Lara, 2014).
• Suppose the town of Woodstock will plant the same amount of trees per year.
To estimate the number of trees that need to be planted by 2020, in order to increase the city's canopy to 30 percent (when the trees mature):
$Tb + Tb*(1-5\%)+Tb*(1-5\%)2+Tb*(1-5\%)3+Tb*(1-5\%)4=4800$
Tb => The base amount of trees per year that need to be planted to reach 20 percent canopy.
Thus, 1066 new trees are needed per year to reach a 30 percent tree canopy and 5330 trees in total. The rough total cost would be $104167 for the entire 5 years and $20,833.4 per year.

This brochure shows some basic and important aspects of tree maintenance for Woodstock. This guide is made for residents and the employees of the town to pay attention on the tree maintenance. The information of the brochure mainly derives from Tree Care Tips website and The Arbor Day Foundation website.

Watering

Trees grow best when soils are moist to a depth of six inches.

- Young trees require sufficient water until their roots are able to tap available groundwater.
- Make every effort to water existing trees during periods of drought.
- Water deeply and slowly.
- A gator bag will help trees to receive water. The town should be responsible to full it with water at the time of planting and then once again if the landscape is restored.

Backfill

Normally, natural loam topsoil and the addition of humus consist the backfill material. Topsoil must be free from subsoil, obtained from an area which has never been stripped. No topsoil shall be delivered in a frozen or muddy condition. The topsoil shall be organic matter. The organic content shall not exceed fourteen percent. pH range should be 6.0 - 7.0.

Tree Maintenance

Prepared by Heather and Shujing in the Green Lands Class at UVa working in partnership with the Green Infrastructure Center Inc.

Woodstock Tree Maintenance Guide

Woodstock Green Infrastructure Assessment

Pruning

Pruning is normally not required the first two years after planting. Pruning can even be harmful to balled and burlapped trees because food-producing leaves are removed. Dead or broken branches should be removed immediately. Plan for removal of low forks or V-shaped crotches in the trunk to avoid future splitting. Generally, lower side branches can be removed from the trunk as the tree grows to promote a "shade tree" form. Always leave the branch collar intact when removing a branch from the trunk.
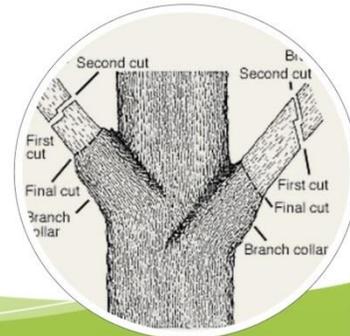

Mulching Is Vital for Newly Planted Tree.

- Mulch insulates the soil helping to provide a buffer from heat and cold temperatures
- Mulch can retain water to keep the roots moist
- Mulch can prevent weeds competition with tree roots
- Mulch prevents soil compaction, and reduces lawn mower damage
-

Add mulching:

Add mulch to the base of your tree by removing any grass within a 3 to 10 foot area depending on the size of your tree; then pour natural mulch such as wood chips or bark pieces 2 to 4 inches deep within the circle; finally keep the mulch from touching the trunk of the tree.


CORRECT — Mulch with 2-3" of mulch.
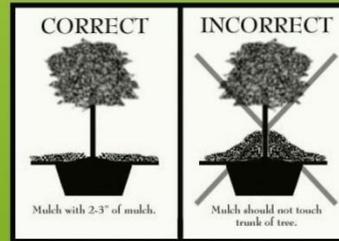
INCORRECT — Mulch should not touch trunk of tree.

A tree canopy is defined as "the layer of tree leaves, branches, and stems that cover the ground when viewed from above". When tree canopy is present, especially in the urban environment, benefits that essentially outweigh costs can be identified including saving energy, reducing in atmospheric carbon dioxide, improving air quality, better managing storm water, increasing property values and providing aesthetic benefits.

Based on the field data of 10 US cities and a national urban tree cover data, it is estimated that urban tree canopy in the contiguous USA currently stores 708 million tons of carbon (tC) ($14,300 million value) with a gross carbon sequestration rate of 22.8million tC/year ($460/million per year) which reduces a lot in atmospheric carbon dioxide. (Nowak et al. ,2002).

Another study shows that tree canopy can remove fine particulate pollution from the air annually from 5.2 tons in Syracuse to 71 tons in Atlanta, with values from$1.1 million in Syracuse to $60.1 million in New York City (Nowak, et.al., 2013) which can improve human health.
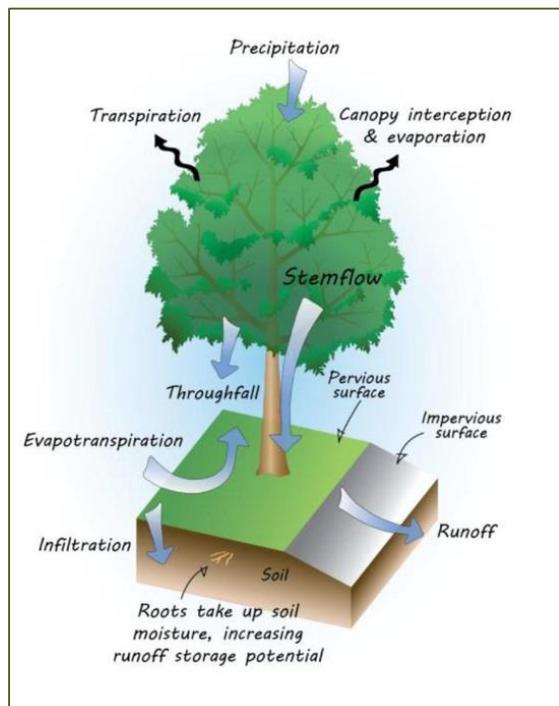
A study on the value of street and park trees in five U.S. cities found that for every dollar invested in urban tree management resulted in benefits valued between $1.37 to $3.09 annually (McPherson, et al.,2005). In Washington D.C., the region boasts a tree canopy of 46 percent that reduces storm water retention needs by 949 million cubic feet, saving an estimated $4.7 billion in construction every 20 years (Schwab, 2009) which is a good case of better storm water management using urban canopy. Furthermore, the city of Minneapolis calculated that not only had they saved approximately $6.8 million in energy expenditure by planting trees, but they had also increased property values by $7.1 million (City Of Minneapolis, Minnesota Municipal Tree Resource Analysis). The aesthetic benefits of trees extend beyond residential planting. McPherson, et al, note that "in contrast to areas without trees, shoppers shop more often and longer in well-landscaped business districts…they are willing to pay more for parking and [are] willing to pay more for goods and services" (McPherson, et al.,2005).

The Town of Woodstock has done a lot to improve their tree canopy. It has earned and maintained its "Tree City USA" status from the Arbor Day Foundation for nine consecutive years. Also, in 2015 Woodstock won the Tree City USA "Growth Award" for the 2nd year in a row, which reflects their excellent performance in executing the tree program. For the past two years, the Town of Woodstock planted 266 trees and will continue to plant at least 91 trees and 230 shrubs in 2016.

Woodstock's "Recommended Tree and Shrub Species for Urban Plantings" document, prepared by the Woodstock Tree Board in 2012, provides a comprehensive list of trees and shrubs appropriate for urban plantings intended to inform town officials and town residents when selecting species. The document offers recommendations for Low Height Zone Plants (for planting under utility lines), Medium Height Zone Plants (for planting near utility lines), and Tall Height Zones (for planting in open yards away from utility lines). While the document is useful, it is rather limited in terms of choice and lacks native species diversity with respect to similar recommendations drafted by other communities in northern Virginia. The document only offers 9 "tall" species (only 5 of which are native), with 27 "medium" species representing the greatest diversity of recommendations. Only 40% (22 out of 55) of the species in Woodstock's "Recommended Tree and Shrub Species" document are native, with "low" and "medium" height zone plants recommendations particularly dominated by non-native and exotic species.

Species diversity in urban tree species selection safeguards against pest and disease problems (Santamour Jr. 2002), adds significantly to the value of urban trees as habitat, and brings an element of aesthetic diversity to the urban landscape. Additionally, native species are an important consideration in landscaping and habitat restoration for the following reasons. First, native plants are evolved to handle local climactic conditions, soils, and pest and disease pressure, and therefore, once established, thrive with minimal management or costly inputs (James River Association). Second, native plants provide food and shelter for native animal species, including native birds, butterflies, bees, other pollinators, and additional charismatic species (Plant NoVA Natives). Local wildlife species use native plant communities for habitat because they evolved with these species (JRA). Lastly, towns and urban areas can promote a deeper understanding of the local landscape, and a greater appreciation for a sense of place, through planting initiatives that encourage the use of natives (VNPS).

Numerous resources exist that allow localities to make more informed decisions regarding the use of native plants (grasses, wildflowers, shrubs, and trees) for green infrastructure purposes. Albemarle County has a native plants database on the county's website that allows everyone from the local government to the development community to the local resident search for native plant species they can plant on the public and private lands of Albemarle. The database allows the user to search for native plants by category, recommended uses, plant needs, and plant characteristics. This tool is an easy and useful resource for promoting the use of native plants in the Charlottesville's Piedmont region, as well as the entire State of Virginia. In terms of green infrastructure, the database allows the user to find specific plants for specific stormwater management strategies, including bioretention basins, rain gardens, stream buffers, wetlands, and green roofs. The link to the database is http://www.albemarle.org/nativeplants/. The Virginia Native Plant Society also has an interactive native plant database, titled the "Virginia Native Plant Finder," that divides the state into three general physiogeographic regions; the western mountains, the piedmont, and the coastal plain. The link for their database is http://vnps.org/interactive-plant-finders/. Their website also includes links to regional native plant nurseries that carry, or specialize in, Virginia native plants: http://vnps.org/conservation/plant-nurseries/. Locally, the Shenandoah chapter plant sale of VNPS has native plant sales in Waynesboro and Staunton every spring.

Fairfax County's provided a basis for recommendations regarding expanding the selection of native species in Woodstock's list. The list of "Additional Native Species Recommendations" are sourced primarily from Fairfax County's "Public Facilities Manuel" Chapter 12 (Tree Conservation), the Virginia Department of Forestry's "Common Native Shrubs and Woody Vines of Virginia", and Virginia Cooperative Extension's "Problem-

Solving Shrubs for Virginia Landscapes." Additional resources consulted in making the recommendations, and recommended as helpful resources, include Fairfax County's "Recommended Tree and Shrub Species for Reforestation of Resource Protection Areas", Green Spring Gardens "Recommended Evergreen Trees and Large Evergreen Shrubs or the Washington D.C. Area", the Virginia Native Plant Society, Plant NoVA Native's "Native Plants for Northern Virginia", and the James River Association's "How to Landscape with Native Plants at Home."

Additional Native Species Recommendations for Woodstock's "Tree and Shrub Species for Urban Plantings" - Species already in Woodstock's list are in *Italics.* Urban Trees Observed by the Authors within central Virginia are in **Bold.**

Tree Species for Parking Lots:

Gleditsia triacanthos inermis - thornless honeylocust (cultivars - Imperial, Skyline, Shademaster)
Acer Rubrum - Red Maple
Quercus palustris - Pin Oak
Nyssa sylvatica - Black Gum
Quercus phellos - Willow Oak
Quercus prinus - Chestnut Oak
Tilia americana - American Linden (Basswood)

Native Shrub Species to Consider:

Aronia arbutiflora - Red Chokeberry
Callicarpa americana - Beautyberry
Ceanothus americanus - New Jersey Tea
Cephalanthus occidentalis - Buttonbush
Clethra alnifolia - Sweet Pepperbush
Corylus americana - American Hazelnut
Hydrangea arborescens - Smooth Hydrangea
Ilex verticillata - Winterberry
Lindera benzoin - Spicebush
Myrica pensylvanica - Northern Bayberry
Physocarpus opulifolius - Ninebark
Prunus angustifolia - Chickasaw Plum
Prunus virginiana - Choke Cherry
Sambucus canadensis - Elderberry
Viburnum dentatum - Arrowwood Viburnum
Viburnum nudum - Possumhaw Viburnum
Viburnum prunifolium - Blackhaw Viburnum

Native Tree Species to Consider

Aesculus flava - Yellow Buckeye - large
Asimina Triloba - Pawpaw - small
Castenea pumila - Allegheny chinkapin - small

Cercis canadensis - Eastern Redbud - small
Cornus florida - Flowering Dogwood - small
Carya cordiformis - Bitternut Hickory - Large
Carya glabra - Pignut Hickory - Large
Carya illinoensis - Pecan - Large
Carya ovata - Shagbark Hickory
Carya tomentosa - Mockernut Hickory
Celtis occidentalis - Hackberry - large
Diospyros virginiana - American Persimmon - large
Fagus americana - American Beech – Large
Gymnocladus dioicus - Kentucky Coffeetree – large
Hamamelis virginiana - Witch-Hazel - medium
Ilex opaca - American Holly – Medium
Juglans Nigra - Black Walnut - large
Juniperus virginiana - Eastern Red Cedar - Medium
Liriodendron tulipifera - Tulip Poplar – Large
Maclura pomifera - Osage Orange (male) – large
Magnolia acuminata - Cucumber Magnolia - large
Magnolia virginiana - Sweetbay Magnolia – small
Oxydendrum arboreum - Sourwood - small
Platanus occidentalis - Sycamore - Large
Quercus alba - White Oak - Large
Quercus falcata - Southern Red Oak- Large
Quercus imbricaria - Shingle Oak - Large
Quercus rubra - Northern Red Oak - Large
Quercus stellata - Post Oak - Large
Quercus velutina - Black Oak - Large
Pinus strobus - White Pine - Large
Pinus virginiana - Virginia Pine - Large
Sassafras albidum - Sassafras – small
Taxodium distichum - Bald Cypress – large (for wet areas)

When implementing bicycle and pedestrian infrastructure improvements, planners, urban designers, town officials, and individual residents can achieve multiple quality of life goals simultaneously by prioritizing street tree plantings in accordance with current and future bike-ped infrastructure. Nationwide surveys in the United States reveal that the top two benefits that street trees provide for people are 1) shade and cooling and 2) a calming effect. Street trees represent a simple solution in the GI planners toolbox that meet ecological, social, and (with their value to stormwater management) economic goals. Urban designers can even combine street tree plantings with bike lanes by planting trees in the median space between on-road bicycle lanes and traffic lanes to capture stormwater, shade impervious surfaces, increase tree canopy coverage, and provide safety for bicyclists. Protected bike lines such as this also calm traffic and provide shade and safety to pedestrians. Whatever the final design, incorporating street trees can only enhance bike and pedestrian infrastructure,.

As a part of our bike-ped infrastructure analysis, we analyzed the current tree canopy in Woodstock by street, and specifically examined the streets we prioritized as important for current and future bike-ped improvements. The street tree canopy was calculated by using the street's classification, an assigned average street width for each street classification, and a buffer from the street centerline based upon that street's assigned width. A lack of road width attribute data table required approximations to be made. It is recommended that Woodstock gather this data for more accurate analyses in the future. Streets were characterized for those with less than 10% canopy coverage as "very low", 10 - 20% as "low", 20 – 30% as "moderate", and above 30% as "adequate" (based on the town's goal of 30% canopy coverage). 77.75% of Woodstock's street length exhibits less than 20% tree canopy coverage. 74.1% of Woodstock's total streets sections have less than 20% tree canopy, including the majority of streets in our proposed bike-ped network (Map 8). Maps exist for the street tree canopy of all three phases of the proposed bike-ped infrastructure network (Map 10).

The maps allow for the prioritization of street segments that need additional street trees to increase their overall tree canopy to approach or surpass Woodstock's overall goal of 30% coverage. The list includes twelve unique street segments, and is located in Appendix 6 of this report. Woodstock should prioritize these streets when deciding on where to plant street trees, and should plant enough street trees along these road corridors to ensure they exhibit 30% canopy coverage in the future. Planting should be prioritized according to the phases of implementation for the bike-ped plan (Map 11), beginning with priority streets in Phase 1, and finishing with priority streets in Phase 3. This will ensure that, as bicycle and pedestrian infrastructure is improved throughout this network, it will be accompanied by newly planted trees and shrubs.

Additionally, using the following approximations for small, medium, and large tree size -- Small – 17ft diameter, 227 square feet, Medium – 24ft, 452, Large – 32ft, 804 -- we calculated the approximate number of street trees (by size) per street that it would take to plant in order to achieve (at a minimum) 30% tree canopy coverage along all of the streets in the bike-ped network. These approximations were the average square footage used for small, medium, and large trees in the GIC's Jersey City Report. The number of large trees needed to be planted along each street segment of the proposed bike-ped network is mapped in Map 12. Street segments in red and orange (between 0 and 20% canopy coverage) require many more large trees to achieve 30% canopy than streets in yellow and green. Streets in orange and red on this map represent the street segments listed in Appendix 6. Using these numbers, Woodstock can approximate how many street trees they will need to plant to achieve their goals, set an annual tree planting target, and budget appropriately. Appendix 18 represents GIS reports run for Phases 1, 2, and 3 of the bike-ped plan

respectively. These reports reveal the approximate number of small, medium, and large trees needed to achieve 30% tree canopy coverage per street segment. For example, Appendix 18 reveals that, in Phase 1 of the plan, South Summit Avenue will need 32 small trees, 16 medium trees, or 9 large trees to reach the target tree canopy coverage. Woodstock can use these appendices as a reference in future public plantings, private landowner outreach, or its tribute trees program.

RECOMMENDED – ADDITIONAL STREET TREES – PRIORITY STREETS

1) West North Street – between I-81 and N Main Street

2) North Main Street – between North Street and Moose Rd

3) Spring Street – between Summit Ave and Water Street

4) Hollingsworth Rd

5) South Water Street – between Holtzman Dr and Cemetery Rd

6) Court Street – between Commerce Street and Water Street

7) Ox Road – between W Reservoir Rd and Henry Dr

8) West Reservoir Rd – between Ox Rd (on W Reservoir) and the Town Boundary (on E Reservoir)

9) Susan Ave

10) Fairground Rd – between Ox Rd and Main Street

11) Summit Avenue – between Park Ave and W Court St

12) South Main Street – between Indian Springs Rd and Reservoir Rd

APPENDIX 7: FINANCIAL BENEFITS OF STORMWATER MANAGEMENT FROM TREES

Year Completed	i-Tree Reference City	Number of Trees Studied	Annual Stormwater Benefits (dollars)	Rainfall Intercepted Annually by Trees (million gallons)
2006	Albuquerque, N.M.	4,586	$55,833	11.1
2005	Berkeley, Calif.	36,485	$215,645	53.9
2004	Bismarck, N.D.	17,821	$496,227	7.1
2007	Boise, Idaho	23,262	$96,238	19.2
2005	Boulder, Colo.	25,281	$357,255	44.9
2006	Charleston, S.C.	15,244	$171,406	28.3
2005	Charlotte, N.C.	85,146	$2,077,393	209.5
2004	Cheyenne, Wyo.	17,010	$55,301	5.7
2003	Fort Collins, Colo.	31,000	$403,597	37.4
2005	Glendale, Ariz.	21,480	$18,198	1.0
2007	Honolulu, Hawaii	235,800	$350,104	35.0
2008	Indianapolis, Ind.	117,525	$1,977,467	318.9
2005	Minneapolis, Minn.	198,633	$9,071,809	334.8
2007	New York City, N.Y.	592,130	$35,628,220	890.6
2009	Orlando, Fla.	68,211	$539,151	283.7
2003	San Francisco, Calif.	2,625	$466,554	99.2
2001	Santa Monica, Calif.	29,229	$110,784	3.2

Street trees in cities throughout America make a difference in the amount of runoff entering combined sewer systems and stormwater drains. The mere presence of street trees reduces runoff by millions of gallons and saves cities tens of thousands to millions of dollars annually in stormwater management facility costs. Data from the United States Forest Service i-Tree Streets Reference Cities Guides are available at: http://www.fs.fed.us/psw/programs/uesd/uep/tree_guides.php.

http://www.davey.com/media/183712/Stormwater_to_Street_Trees.pdf

Woodstock_Town_Building_Footprints 10k-50k

FULL_ADDRESS	USE_	SPECIFIC	Shape_Area	Required Parking Space
113 INDIAN SPRING ROAD	Commercial		42560.50011	142
803 SOUTH MAIN STREET	Commercial	Nursing home	41825.509398	139
600 NORTH MAIN STREET	Tax exempt		40284.761266	134
494 NORTH MAIN STREET	Tax exempt		28685.047772	96
131 BENCHOFF DRIVE	Commercial		28256.989191	94
123 LAKEVIEW DRIVE	Commercial	Nursing home	26249.893759	87
1065 SOUTH MAIN STREET	Commercial	<null>	26249.893759	87
1130 MOTEL DRIVE	Commercial		24969.627761	83
451 HOOVER ROAD	Tax exempt		24303.341822	81
430 HOOVER ROAD	Commercial		23956.62023	80
935 OX ROAD	Residential	Assisted living	22081.324991	74
541 WEST RESERVOIR ROAD	Residential	House	21842.802175	73
			21560.172543	72
149 VALLEY VISTA DRIVE	Residential	Apartments	21460.010487	72
752 SOUTH MAIN STREET	Commercial		21233.445952	71
1150 MOTEL DRIVE	Commercial	Motel	20605.812405	69
601 NORTH MAIN STREET	Commercial		18905.606786	63
617 NORTH MAIN STREET	Commercial		18905.606786	63
621 NORTH MAIN STREET	Commercial		18905.606786	63
215 MILL ROAD	Tax exempt	Courthouse	18912.939654	63
1222 OX ROAD	Commercial		18637.023522	62
1226 OX ROAD	Commercial		18637.023522	62
650 SOUTH MAIN STREET	Tax exempt		18497.576643	62
1290 SOUTH MAIN STREET	Commercial		16820.207647	56

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53

FULL_ADDRESS	USE_	SPECIFIC	Shape_Area	Required Parking Space
<null>	<null>	<null>	16771.402971	56
152 MOOSE ROAD	Tax exempt		15728.176763	52
221 WEST RESERVOIR ROAD	Commercial	CVS	15076.097519	50
			14859.524966	50
1011 MOTEL DRIVE	Commercial		15005.949443	50
150 EAST RESERVOIR ROAD	Commercial		14612.061698	49
145 BROADVIEW LANE	Tax exempt		14384.325917	48
102 SOUTH MAIN STREET	Tax exempt	Courthouse	13970.49669	47
112 SOUTH MAIN STREET	Tax exempt		13970.49669	47
115 WEST COURT STREET	Tax exempt		13970.49669	47
113 WEST COURT STREET	Tax exempt		13970.49669	47
109 WEST COURT STREET	Tax exempt	Sheriffs department	13970.49669	47
215 WEST NORTH STREET	Commercial		12773.848541	43
154 SOUTH MUHLENBERG STREET	Tax exempt	Church	13015.92043	43
200 MOOSE ROAD	Tax exempt		12193.663491	41
614 SOUTH MAIN STREET	Tax exempt/Res	School	12129.004957	40
402 WEST LOCUST STREET	Commercial		11610.331514	39
1282 OX ROAD	Residential	Condo	11316.800555	38
1284 OX ROAD	Residential	Condo	11316.800555	38
335 WEST SPRING STREET	Commercial		11389.125104	38
925 SOUTH MAIN STREET	Commercial		11416.887704	38
120 WEST RESERVOIR ROAD	Commercial		11015.055575	37
117 SOUTH MAIN STREET	Commercial		11090.035562	37
121 SOUTH MAIN STREET	Comm/Res	Apartment	11090.035562	37
123 SOUTH MAIN STREET	Commercial		11090.035562	37

FULL_ADDRESS	USE_	SPECIFIC	Shape_Area	Required Parking Space
125 SOUTH MAIN STREET	Commercial		11090.035562	37
127 SOUTH MAIN STREET	Commercial		11090.035562	37
129 SOUTH MAIN STREET	Commercial		11090.035562	37
101 SOUTH MAIN STREET	Commercial		10966.482555	37
103 SOUTH MAIN STREET	Commercial		10966.482555	37
107 SOUTH MAIN STREET	Commercial		10966.482555	37
109 SOUTH MAIN STREET	Commercial		10966.482555	37
111 SOUTH MAIN STREET	Commercial		10966.482555	37
235 SOUTH MAIN STREET	Tax exempt	Church	10803.499982	36
446 WEST RESERVOIR ROAD	Commercial		10665.125249	36
451 WEST RESERVOIR ROAD	Commercial	Cracker Barrel	10763.70806	36
144 NORTH MAIN STREET	Commercial		10554.142259	35
138 NORTH MAIN STREET	Commercial		10554.142259	35
136 NORTH MAIN STREET	Commercial	<null>	10554.142259	35
119 NORTH MAIN STREET	Commercial		10059.8552	34
117 NORTH MAIN STREET	Commercial		10059.8552	34
109 NORTH MAIN STREET	Commercial		10059.8552	34
127 EAST HIGH STREET	Tax exempt	Daycare	10047.220786	33

Woodstock Town Building Footprints +50k

FULL_ADDRESS	USE_	SPECIFIC	Shape_Area	Required_Parking_Space
461 WEST RESERVOIR ROAD	Commercial		176337.460312	504
495 WEST RESERVOIR ROAD	Commercial		176337.460312	504
493 WEST RESERVOIR ROAD	Commercial		176337.460312	504
491 WEST RESERVOIR ROAD	Commercial		176337.460312	504
489 WEST RESERVOIR ROAD	Commercial		176337.460312	504
481 WEST RESERVOIR ROAD	Commercial		176337.460312	504
473 WEST RESERVOIR ROAD	Commercial		176337.460312	504
471 WEST RESERVOIR ROAD	Commercial		176337.460312	504
469 WEST RESERVOIR ROAD	Commercial		176337.460312	504
465 WEST RESERVOIR ROAD	Commercial		176337.460312	504
475 WEST RESERVOIR ROAD	Commercial		176337.460312	504
479 WEST RESERVOIR ROAD	Commercial		176337.460312	504
483 WEST RESERVOIR ROAD	Commercial		176337.460312	504
463 WEST RESERVOIR ROAD	Commercial		176337.460312	504
485 WEST RESERVOIR ROAD	Commercial		176337.460312	504
487 WEST RESERVOIR ROAD	Commercial		176337.460312	504
755 SOUTH MAIN STREET	Tax exempt		140638.649566	402
1147 SUSAN AVENUE	Tax exempt	Central High School	136138.835527	389
1231 SUSAN AVENUE	Tax exempt	W.W. Robinson Elementary	120790.893486	345
1220 HENRY FORD DRIVE	Commercial	Lowes	113261.431984	324
1251 SUSAN AVENUE	Tax exempt	Peter Muhlenburg Middle	98882.550686	283
1019 SOUTH MAIN STREET	Commercial		91968.747364	263
1000 SOUTH MAIN STREET	Commercial		91968.747364	263

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| FULL_ADDRESS	USE_	SPECIFIC	Shape_Area	Required_Parking_Space
1011 SOUTH MAIN STREET	Commercial		91968.747364	263
1013 SOUTH MAIN STREET	Commercial		91968.747364	263
1015 SOUTH MAIN STREET	Commercial		91968.747364	263
1023 SOUTH MAIN STREET	Commercial		91968.747364	263
1021 SOUTH MAIN STREET	Commercial		91968.747364	263
1025 SOUTH MAIN STREET	Commercial		91968.747364	263
1029 SOUTH MAIN STREET	Commercial		91968.747364	263
1037 SOUTH MAIN STREET	Commercial		91968.747364	263
1011 SOUTH MAIN STREET	Commercial		91968.747364	263
496 NORTH MAIN STREET	Commercial		84923.049137	243
468 NORTH MAIN STREET	Commercial		84923.049137	243

Planting Trees in Parking Lots

Description

Parking lots have two distinct areas where trees can be planted—the interior and the perimeter—each of which has unique planting requirements and considerations (Figure 43). The parking lot interior can be a very harsh planting environment for trees, due to higher temperatures of the pavement, little water, exposure to wind, air pollution, and potential damage from automobiles. Landscaped islands are typically used within parking lots to provide a separation between parking bays and to meet landscaping requirements. These islands may be planted with grass, trees, or other vegetation and can be designed to accept storm water. Typically, most traditional parking lot islands do not provide adequate soil volumes for trees.

Trees planted along the perimeter of a parking lot provide a screen or buffer between the lot and an adjacent land use or road. Perimeter planting areas often provide a better planting environment for trees and good opportunities for conserving existing trees during parking lot construction.

The many benefits of incorporating trees in parking lots include shade for people and cars, reduction of the urban heat island effect, interception of storm water, improved esthetics, improved air quality and an increase in or creation of habitat for birds.

Tree pits are connected to lawn area and share rooting space
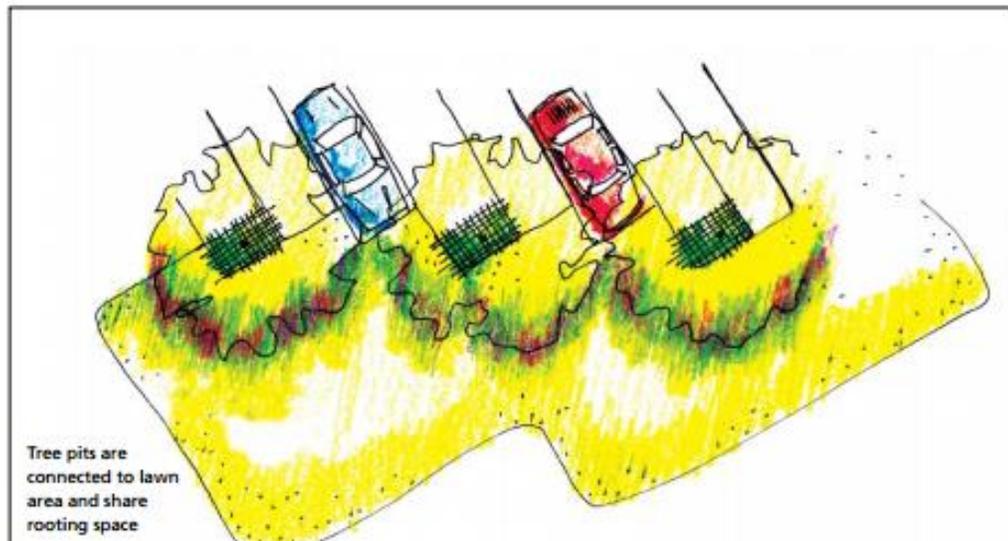
Pre-Planting Considerations

Before planting trees in parking lots, designers need to address some important considerations:

- ☐ How to provide clear lines of sight, safe travel surfaces, and overhead clearance for movement of pedestrians and vehicles within the lot
- ☐ How to prevent compaction of planting area soils by construction and foot traffic
- ☐ How to resolve potential conflicts between trees and surrounding utilities, pavement, and lighting
- ☐ How to maximize canopy coverage and shading in the lot and make it more attractive with plantings
- ☐ How to reduce exposure of trees to auto emissions, polluted runoff, wind and drought
- ☐ How to provide adequate soil volume for trees in the confined space of a parking lot
- ☐ How to prevent damage to trees from cars
- ☐ How to address concerns about safety, increased maintenance due to tree litter, damage to cars from trees (e.g., sap, branches), and snow removal and storage
- ☐ How to maximize plantings for visual screening and buffers, at the same time offering view corridors to merchants

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Species Selection

Species selection is important in urban parking lots because it is such a stressful environment. Tree species that comprise a diverse mix of hardy, native species that are adapted to soils and site conditions are needed.

The following characteristics should be sought when selecting a parking lot tree:
- ☐ Tolerant of salt
- ☐ Tolerant of drought and extreme temperatures
- ☐ Tolerant of poor, highly compacted soils
- ☐ Tolerant of urban pollutants
- ☐ Tolerant of inundation, if used for storm water treatment
- ☐ Does not produce abundant fruits, nuts, or leaf litter
- ☐ Wide-spreading canopy

Site Preparation	☐	Improve soil drainage by tilling soils and adding compost.

General Planting Guidance	☐	Use structural soils below pavement to allow for root growth where possible.
	☐	A few great trees are better than a lot of smaller ones.
	☐	Design concave planting areas to discourage pedestrian traffic.
	☐	Provide adequate setbacks from utilities, signs, lighting, and pavement.
	☐	Plant only species that are appropriate for parking lots.
	☐	Maintain appropriate setbacks from edge of planting strip or island to allow clear sight lines and reduce heat impact on trees (generally 4 feet).
	☐	Maintain an adequate setback between parking stalls and trees to prevent damage from cars.
	☐	Plant large balled and burlapped stock.
	☐	Have a landscape architect design the parking lot planting plan.

Specific Planting Guidance	*Interior*	Use alternative planting clusters in parking lot islands that allow shared rooting space and provide additional soil volume for trees.
		Employ "better site design" techniques, which include reducing the size of parking stalls to make the parking lot more efficient and to provide more room for trees (CWP, 1998)
	Perimeter	Use trees to provide shade over pedestrian walkways.
		Maintain a 6- to 8-foot overhead clearance for pedestrian walkways.
		When planting on steep slopes, use tree clusters and create small earthen berms around the group to retain moisture.
		When planting along a flatter slope, use linear spacing for safety and functionality

Maintenance	☐	Use mulch to retain moisture.
	☐	Plan for minimal maintenance (watering may not be feasible).
	☐	Have trees pruned by a qualified arborist to maintain sight lines and overhead clearance.
	☐	Monitor and control invasive species.

APPENDIX 11: IMPERVIOUS SURFACE ANALYSIS- GIS ANALYSIS FOR REQUIRED PARKING SPACES

Woodstock recently amended its parking ordinance, Chapter 90 of their town code, to change the amount of required parking spaces for Retail Stores (90-387. n.), Restaurants (90-387. p.), and Offices (90-387. r.). For Retail Stores, the ordinance requires a different ratio of parking spaces per square foot depending on the overall square footage of the building. Several large retail spaces around the town of Woodstock have large parking lots that represent enormous areas of impervious surfaces with noticeable impacts on stormwater management and eventually water quality. In order to mitigate the impacts of large areas of impervious surfaces, identifying where large retail stores far exceed the minimum parking requirements is critical. Once specific businesses, entities, or property owners are identified, the town can approach them with proposals or incentives to integrate green infrastructure into their parking lots and reduce impervious surfaces.

Using GIS, building footprints with greater than 50,000 square feet and building footprints between 10,000 and 50,000 square feet were analyzed because the newly amended parking ordinance requires (retail operations) a minimum of one parking space per 350 square feet and a minimum of one parking space per 300 square feet respectively. We chose to only do the analysis using the using Retail Store requirements above 10,000 square feet due to the straightforward nature of the Retail Store parking requirements, the GIS data we had available, and the number of buildings in the analysis. The GIS attribute table for the buildings layer was very incomplete with respect to building use and business name. This made it nearly impossible to identify whether individual buildings were retail locations, restaurants, or offices. In addition, the parking requirements for restaurants required knowing the square footage of seating area versus the square footage of non-seating area in the building, and required different numbers of spaces per square foot for each. Because we used the ordinance parking requirements of retail for all buildings, further GIS data and analysis will be required to determine the required offstreet parking spaces for everything other than Retail Stores in Woodstock's offstreet parking ordinance.

The analysis revealed that eight buildings in Woodstock exceed 50,000 square feet, with minimum offstreet parking requirements ranging from 243 to 504 spaces (Appendix 9). Specific examples of retail store businesses in this category include Wal-Mart (504 required spaces) and Lowes (324 required spaces). Our GIS data did not contain attribute data indicating the current number of parking spaces associated with individual buildings and businesses. Therefore, to see if businesses far exceed their minimum parking requirements necessitates on the ground counting and data gathering. For this project, Lowes was used as a case study, and Google Earth was overlaid to approximate how many current parking spaces they have. Lowes currently has 550 parking spaces, which is 226 parking spaces greater than its required number of 324. Lowes represents a perfect example of a business that Woodstock must approach with potential partnerships or solutions regarding their large area of impervious surface.

For buildings between 10,000 and 50,000 square feet, we made two maps, one each for Woodstock South and Woodstock North (Map 17), which display the required number of parking spaces based on the Retail Store parking requirements. There are approximately forty-five buildings in this size category in Woodstock, with required parking spaces ranging from 33 to 142 spaces (Appendix 8). Further analysis and research is required to determine which of these forty-five buildings are retail operations before Woodstock can approach the landowners and businesses that own these parcels about reducing parking.

http://www.streamteamok.net/Doc_link/Green%20Parking%20Lot%20Guide%20(final).PDF

CASE STUDY 1: STORMWATER BEST MANAGEMENT PRACTICES (BMP) BLOEDEL DONOVAN PARK, BELLINGHAM, WASHINGTON[54]

Stormwater runoff in Bellingham, Washington, like much of the U.S., is a foremost water quality issue. The Washington Department of Ecology estimates that roughly one-third of the state water bodies with pollution related problems are impaired because of stormwater runoff impacts. In an effort to protect the receiving waters of nearby Lake Whitcom from such impacts, City of Bellingham officials chose to retrofit stormwater management at the heavily used Bloedel Donovan Park parking lot. Rather than choosing a conventional technique, they elected to build an innovative rain garden to manage stormwater on-site.

The raingarden in Bloedel Donovan Park helps protect the water quality in nearby Lake Whatcom, and recharge groundwater supplies.

DESIGN AND CONSTRUCTION

Designed on a 550 square-foot section of the parking lot near the catch basin, the park's rain garden supports runoff from 80 parking spaces and two parking lanes. To meet water quality guidelines, the rain garden was also designed to treat 91 percent of the runoff from a 50-year storm event. Aspects of its construction included:

- **Site excavation**—From site topography and soils logs, the city determined the maximum allowable depth for water to pond in the rain garden. Under a 50-year storm event, the depth should be no more than six-feet. Thus, the site was excavated three to four feet.

- **Layering of materials**—The rain garden is composed of three layers of non-woven geotextile fabric alternated with six inches of drain rock, and topped with a layer of fabric to constrain the sand and restrict any plants from growing through. An 18- to 24-inch layer of sand composed of twenty percent organic materials is the top layer.

- **Landscaping**—For landscaping, the city chose native plants that could survive the year-round climatic conditions of the site. This included plants that prefer wet soil, but could also tolerate drought.

EXHIBIT 2: CASE STUDY INITIAL COST COMPARISON

Conventional stormwater technique (4,400 ft³ wet vault)	$52,800
Rain Garden	$12,820
Cost Savings	$39,980

Cost and Pollutants Removal Effectiveness

The benefits from incorporating this rain garden are numerous. It adds aesthetic value to the site, increases wildlife habitat, and is a highly effective BMP for treating stormwater runoff. According to officials at the Bellingham Public Works Department's, monitoring shows that approximately 80 percent of total runoff is captured by the rain garden, with overflows running through media filtration and then another infiltration bed. Furthermore, Bellingham saved 70 percent in initial costs compared to installing a conventional in-ground storage and treatment stormwater system (see Exhibits 2 and 3). This was achieved through reduced construction and equipment costs, as well as reduced labor costs from the relative ease of installation, some of which was accomplished by volunteer landscaping help. These costs savings do not include future regular maintenance costs.

A more detailed case study of the city of Bellingham's rain garden can be found on the Puget Sound Action Team's Web site at www.psat.wa.gov/Publications/Rain_Garden_book.pdf.

Exhibit 3: Cost for Bloedel Donovan Park Raingarden

Labor	$3,600
Vehicle use	1,900
Amended soil	1,650
Concrete	1,200
Asphalt	1,200
PVC/grates/catch basins/fabric/other misc.	1,000
Washed rock	805
Excavator rental (1.5 days)	500
Plants	400
Debris Removal	300
WCC crew planting time	265
Total Cost	$12,820

APPENDIX 13: BIORETENTION GARDENS SIGN

http://www.montgomerycountymd.gov/DEP/Resources/Images/water/stormwater-facilities/signs/Bioretention-sign.jpg

APPENDIX 14: RAINGARDEN SIGN

http://www.pulsedesign.com/urban-habitat-environmental-signs/

Town of Woodstock Land Cover

0.036%

7.328%

5.938%

25.408%

21.593%

39.696%

- Bare
- Building
- Impervious
- Non-Tree Vegetation
- Tree Canopy
- Water

APPENDIX 16: PARKING LOT LANDSCAPING ORDINANCE AND DESIGN GUIDELINES (GREENVIEW, ILLINOIS)

https://las.depaul.edu/centers-and-institutes/chaddick-institute-for-metropolitan-development/programs/mdrn/Documents/Glenview_Design_Guidelines--Parking_Lots.pdf

APPENDIX 17: NASHVILLE, TENNESSEE

The city of Nashville, Tennessee eliminated minimum parking requirements within the 600-acre downtown core in 2010. Since then, the city has seen the development of 9 new projects and 10 rehabilitations of existing buildings. http://bettercities.net/article/nashville-axes-parking-minimums-17539

Streets - Bike Plan Phase 1

ROADNAME	Shape_Length	width	SmallTree	MediumTree	LargeTree
NORTH MAIN STREET	649.542725	40	66	33	19
NORTH MAIN STREET	444.855749	40	36	18	10
NORTH MAIN STREET	328.282906	40	19	9	5
NORTH SUMMIT AVENUE	948.673115	30	0	0	0
NORTH SUMMIT AVENUE	356.263233	30	0	0	0
NORTH SUMMIT AVENUE	462.061975	30	13	7	4
SOUTH MAIN STREET	647.936919	40	67	33	19
SOUTH MAIN STREET	446.015964	40	39	20	11
SOUTH SUMMIT AVENUE	1038.349102	30	32	16	9
WEST NORTH STREET	759.708829	30	57	28	16
WEST NORTH STREET	309.271487	30	24	12	7
WEST NORTH STREET	487.16149	30	22	11	6
WEST NORTH STREET	601.11033	30	26	13	7
WEST NORTH STREET	542.286131	30	27	14	8
WEST NORTH STREET	473.739874	30	23	12	7
WEST NORTH STREET	508.430929	30	36	18	10
WEST NORTH STREET	624.293831	30	47	24	13
WEST SPRING STREET	776.692241	20	37	19	10
WEST SPRING	367.627116	20	16	8	5

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Streets - Bike Plan Phase 2

ROADNAME	SHAPE_Leng	width	SmallTree	MediumTree	LargeTree
BENCHOFF DRIVE	1624.432856	30	0	0	0
EAGLE STREET	1116.683484	30	30	15	9
EAGLE STREET	1120.114709	30	29	14	8
EAST COURT STREET	514.862329	30	17	9	5
EAST COURT STREET	505.431231	30	21	11	6
EAST SPRING STREET	497.750215	30	24	12	7
EAST SPRING STREET	528.261547	30	38	19	11
FRENCH WOODS ROAD	1986.562579	20	0	0	0
HOLLINGSWORTH ROAD	540.570584	20	20	10	6
HOLLINGSWORTH ROAD	489.582032	20	27	14	8
HOLLINGSWORTH ROAD	942.422928	20	37	19	10
JEFFERSON STREET	507.307335	30	38	19	11
JEFFERSON STREET	299.709913	30	24	12	7
LUPTON ROAD	1032.896379	20	4	2	1
NORTH COMMERCE STREET	211.776772	30	20	10	6
OX ROAD	481.277583	20	8	4	2
PARK AVENUE	494.424573	30	32	16	9
PARK AVENUE	1223.431406	30	57	29	16
PARK AVENUE	392.5063	30	20	10	6
SOUTH MAIN STREET	446.310416	40	29	15	8
SOUTH MAIN STREET	252.716277	40	16	8	5
SOUTH MAIN STREET	1322.29806	40	0	0	0

Streets - Bike Plan Phase 3

ROADNAME	SHAPE_Leng	width	SmallTree	MediumTree	LargeTree
EAST RESERVOIR ROAD	1089.849941	20	58	29	16
EAST RESERVOIR ROAD	1251.269348	20	56	28	16
FAIRGROUND ROAD	1090.280448	30	58	29	16
FAIRGROUND ROAD	628.844767	30	34	17	10
HOLLINGSWORTH ROAD	607.624683	20	18	9	5
NORTH MAIN STREET	1367.264115	40	117	59	33
NORTH MAIN STREET	1062.722279	40	108	54	30
NORTH MAIN STREET	1016.013245	40	80	40	23
NORTH SUMMIT AVENUE	351.885196	30	26	13	7
NORTH SUMMIT AVENUE	323.26449	30	27	14	8
NORTH SUMMIT AVENUE	374.521916	30	29	15	8
OX ROAD	584.468107	20	30	15	9
OX ROAD	1092.797925	20	56	28	16
OX ROAD	136.97589	20	8	4	2
OX ROAD	939.456006	20	40	20	11
SOUTH HOLLINGSWORTH ROAD	990.35932	20	8	4	2
SOUTH HOLLINGSWORTH ROAD	809.13739	20	16	8	5
SOUTH MAIN STREET	303.547115	40	29	15	8
SOUTH MAIN STREET	1030.375289	40	28	14	8
SOUTH MAIN STREET	457.865904	40	27	14	8