BARRINGTON
RHODE ISLAND

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Strategic Tree Canopy Plan

Prepared by the Green Infrastructure Center Inc.

MAY 2024

Green Infrastructure Center

This report, tree canopy analysis, goal setting and strategic planning were funded by the U.S. Forest Service and the Rhode Island Department of the Environmental Management's Division of Forest Environment through a grant to the Green Infrastructure Center Inc. The mention of trade names, commercial productions, services or organizations does not imply endorsement by the U.S. Forest Service, Rhode Island Department of Environmental Management, Division of Forest Environment or the Town of Barrington.

Prepared by the Green Infrastructure Center Inc.
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town of

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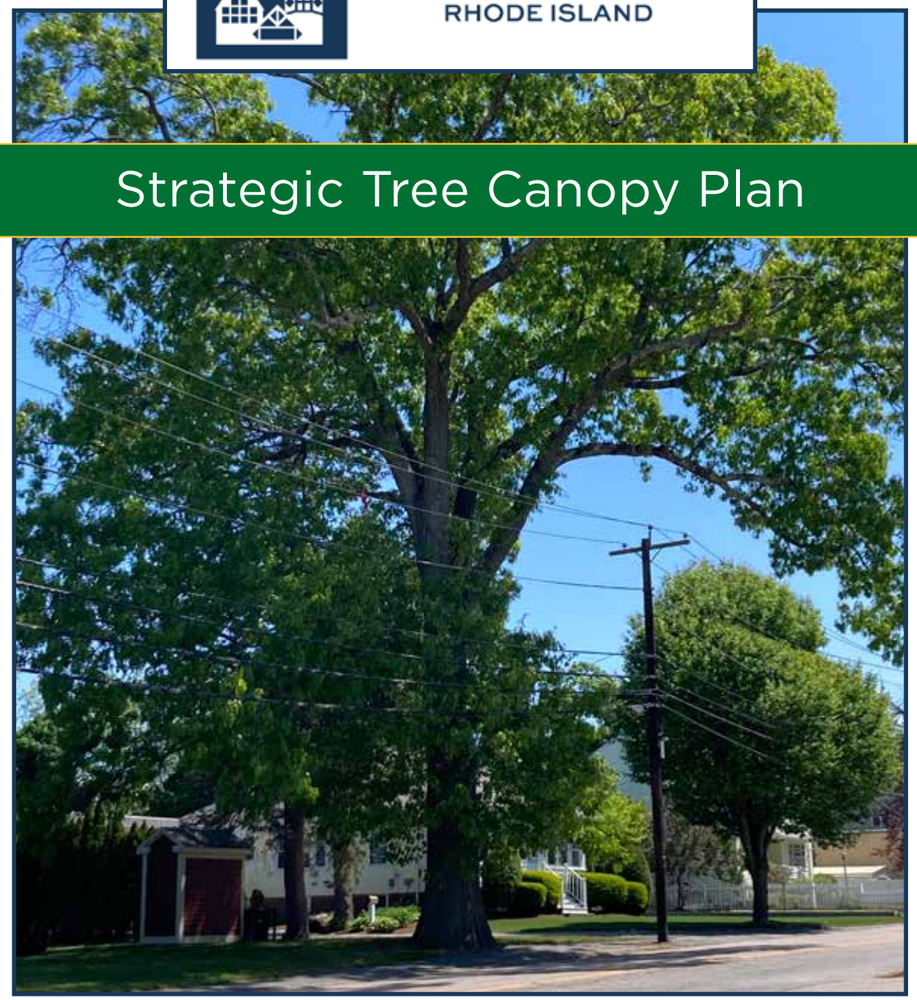

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Executive Summary

This plan and the accompanying assessments were completed by the Green Infrastructure Center Inc. through a grant from the Rhode Island Department of Environmental Management's Division of Forest Environment (DFE). This plan describes the findings of the tree canopy assessment, ecosystem services analysis, and codes and ordinances assessment for Barrington, Rhode Island. Building upon these data the town, DFE, GIC and stakeholders participated in goal setting sessions and developed proposed strategies for meeting the goal to maintain tree canopy at 51% over the next 10 years. Data and strategies were presented to the public at an open house where they were given an opportunity to vote on proposed strategies and add additional comments. Finally, Force of Nature Solutions (FoNS), a consultant company, was brought in to connect trees as green infrastructure and provide guidance on how these data and proposed strategies could be used for disaster planning and hazard mitigation.

Barrington Canopy Goal:
Maintain tree canopy at 51% over the next 10 years.

Top Five Strategies to Achieve This Goal:

- Develop outreach materials to educate the public on the benefits of trees and proper tree care.
- Create a tree species list for the town and share the information with the public.
- Replace invasive tree species with native tree species plantings.
- Factor in annual carbon sequestration by the urban forest in the Town's Resilient Future Resolution objectives.
- Coordinate community tree planting events such as Earth/Arbor Day activities.

(Above) The Rhode Island Division of Forest Environment provided support for Barrington to study its tree canopy, set a goal and identify strategies for managing its community forest.

(Left) Some of the best areas for planting trees are on residential private property.

Barrington, RI
Fast Facts

County: Bristol County
Population: 17,113 people*
Total Town Area: 15.4 sq. miles
Land Area: 8.2 sq. miles
Lakes/ponds: 194 acres
Swamp & Marsh: 727 acres
Tidal shoreline: 11.5 miles
Streams: 15 miles
Tree canopy: 2,456 acres
Impervious surfaces: 994 acres

(U.S. Census 2022 estimate)

In summary, Barrington Can Use the Results of This Report to:

- Support the town's upcoming comprehensive plan update by including tree canopy data, goals and strategies into the natural resources and resiliency elements.
- Use the tree canopy data, potential planting areas and ecosystem services calculations to inform the Barrington Climate Action Plan.
- Mitigate stormwater runoff in neighborhoods through tree planting and other green infrastructure.
- Document the many environmental and social benefits provided by town trees.
- Support greater resiliency of the urban forest in the face of storms, pests and other natural disasters.
- Determine the strategic locations for retaining or planting trees to realize environmental and social equity benefits.
- Inform management of the town's urban forest and support investments in tree care and planting.
- Prioritize policy and code updates to support more tree plantings and tree preservation.

Trees play an important role in mitigating stormwater runoff and preventing nonpoint source pollution from entering into bays and rivers.

Summary Outcomes

Canopy

Barrington has a tree canopy of 51% and this tree canopy provides benefits to the town such as stormwater capture, cleaner air, urban cooling, wildlife habitat and natural beauty.

These benefits provided by trees are called ecosystem services. Barrington has room to add more tree cover and could achieve a maximum tree canopy of 59%. Any increase in tree canopy Barrington achieves expands the benefits provided.

Air quality

Trees play a critical role in not only providing oxygen, but also cleaning the air of particulate matter and ground level ozone (O3), which can harm human health. Trees also sequester greenhouse gases such as sulfur dioxide and carbon dioxide, and as these gasses are trapped by trees, the severity of climate change is reduced. Trees also store carbon and prevent its release, also mitigating climate change impacts. Each year, the tree canopy of Barrington removes 9,677 metric tons of carbon, 46,740 lbs. of ground-level ozone (O3) and 8,699 lbs. of airborne particulate matter that can cause respiratory distress.

Heat Island

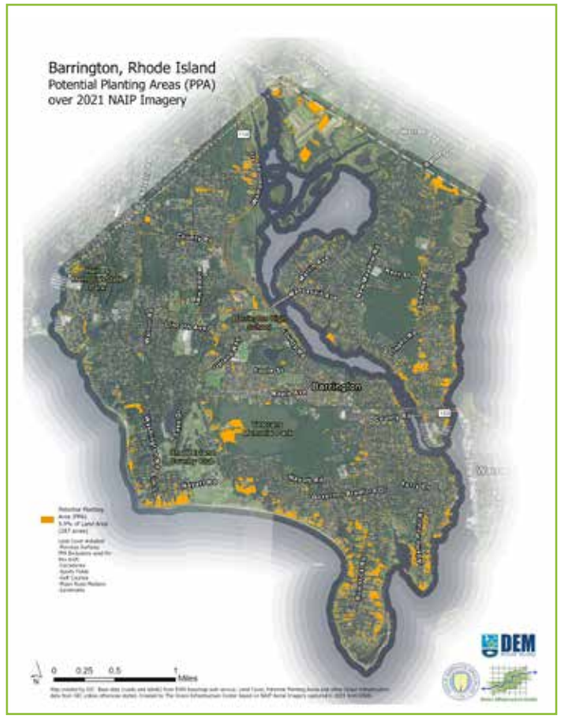
Barrington, like many developed areas, suffers from urban heating and stormwater runoff impacts resulting from high and localized concentrations of impervious surfaces coupled with a lack of vegetative cover. Excessive pavement and lack of shade lead to increased temperatures known as urban heat islands. Barrington's existing tree canopy provides urban cooling. The higher the tree canopy cover, the lower the surface temperatures and the cooler the town.

Stormwater Uptake

The town's trees also help mitigate stormwater as they capture rainfall in their canopy, trunk and roots and surrounding soils and then release some of that water back to the atmosphere through evapotranspiration. One mature large tree can absorb thousands of gallons of water per year. During a one-year/24-hour rainfall event (2.83 inches), the town's trees soak up 6.5 million gallons of water! This means less flooding of streets. During that same rainfall, the town's trees reduce runoff pollution loads for nitrogen by 28%, phosphorus by 36%, and sediment by 27%, thereby reducing water pollution into local waterways and the Narragansett Bay.

Canopy Trends and Goals

Barrington's trees are continually lost as older trees age and die, storms destroy trees, pests kill trees, or trees are cleared for development. As the town recovers from past storms and continues to grow and develop, it will be important to maintain existing coverage and to plant replacement trees to overcome losses. To achieve its proposed goal, the community needs to increase the rate of planting on both public and private property. Barrington has proposed a townwide goal of maintaining at least 51% canopy over the next ten years. This requires planting more than 3,674 trees in total or 245 trees annually across the town to achieve a no net loss goal, assuming the town loses on average 150 trees per year due to storms, pests, old age or new development. The town can reassess progress and adapt its canopy goal over time based on changing conditions and environmental pressures.



The Town of Barrington now has baseline data on its tree canopy and potential planting areas to identify opportunities to plant new trees. More trees equate to better air quality, shade and energy savings, more stormwater uptake and improved water quality too!

Introduction

Barrington, Rhode Island is a charming historic coastal community east of Providence RI and 2 hours south of Boston. The town is an 8.2 square-mile community in Bristol County in Eastern Rhode Island and is the twenty-first largest municipality in Rhode Island, with an estimated 2022 population of 17,113 persons. The town was established as an independent Rhode Island town in 1770 on land once cared for by the Pauquunaukit people, (anglicized to Pokanoket which means "land at the clearing") who lived and stewarded most of the East Bay. The town is 87.8% non-Hispanic Whites, 0.3% Black/African Americans, 4.3% Asian, and 4.5% Hispanic or Latino residents.[1]

The Narragansett Bay (Algonquian: Naiaganset) is a brackish water body covering 120.5 square miles of Rhode Island and it is an important ecological, economic and cultural resource for Rhode Islanders. The bay's border adjoins 11.5 miles of Barrington's shoreline along with the Barrington River and Warren River. These waters hold important marine ecosystems such as S. Providence/Seekonk Rivers Shellfish Management Area, the B. Conimicut Point Shellfish Management Area and the T. Warren River Shellfish Management Area. According to the 2015 Comp Plan, the town is rich in natural amenities that contribute to its high-quality lifestyle such as 1200 acres of municipal parks, beach and conservation lands (both private and public).

Why Map the Urban Canopy?

Trees are declining throughout the United States. The causes of this decline include land conversion for development, storm damage, pests and disease, and lack of tree replacement as older trees die. Many communities in Rhode Island are looking for ways to protect or expand their tree canopy and community forests. Data describing Barrington's trees will allow the town to track trends, assess losses or set goals to retain or restore canopy. Through this planning process the town now has baseline data to set canopy goals, monitor canopy protection progress, measure environmental benefits of town trees and prioritize strategic tree planting locations.

Trees are an important part of the town's 'green infrastructure.' Just as we manage our grey infrastructure (roads, sidewalks, bridges and pipes), we also need to manage our 'green infrastructure' (trees and other vegetation). Barrington's green infrastructure provides many values that support a vibrant, safe and healthful community. Trees add to the town's historic coastal character, and they enhance its livability by filtering

[1] https://www.census.gov/quickfacts/fact/table/barringtontownbristolcountyrhodeisland

Gray vs Green. Image at left shows an example town's gray infrastructure including buildings and roads. Classified high-resolution satellite imagery (at right) adds town green infrastructure data layer (trees and other vegetation). The green infrastructure provides cleaner air, water, energy savings and natural beauty.

storm water and reducing runoff, cleaning the air, providing oxygen, shading, and natural beauty and enhanced property values. As the town continues to grow and adapt to climate change and more frequent and severe storm events, it should also manage and sustain the urban forest. This will help the town meet its many goals set forth in other community plans.

One of the town's beautiful trees

The Canopy Assessment

This plan describes the state of the town's urban forest based on current canopy coverage, an analysis of the canopy's environmental benefits and a review of the relevant codes and ordinances. With these data the town and community devised strategies to sustain and expand the urban forest. Products created include:

- Analysis of the current extent of the community forest through high resolution tree canopy mapping.
- Possible Planting Area analysis to determine where additional trees could be planted.
- Calculation of the environmental benefits and pollution removal by town trees.
- Analysis of town's codes, ordinances and practices for their ability to conserve or protect the community forest.
- A public open house concerning where the town should prioritize tree planting efforts and the top strategies for increasing tree canopy.
- Tree canopy community outreach and educational materials.

The town can utilize the tree canopy to maximize environmental and social benefits including:

- Community health and vibrancy,
- Aesthetic values and natural beauty,
- Decreased heat island impacts and reduced heating and cooling costs,
- Abundant bird and wildlife habitat,
- Expanded walkability and multimodal transit support; and,
- Revenue from tourism and retail sales.

New tree plantings and new canopy can reduce nonpoint source pollution from entering into the local waterways such as the Barrington or Palmer Rivers.

How the Community Forest Benefits Barrington, RI

Reducing Stormwater Runoff and Filtering Pollutants

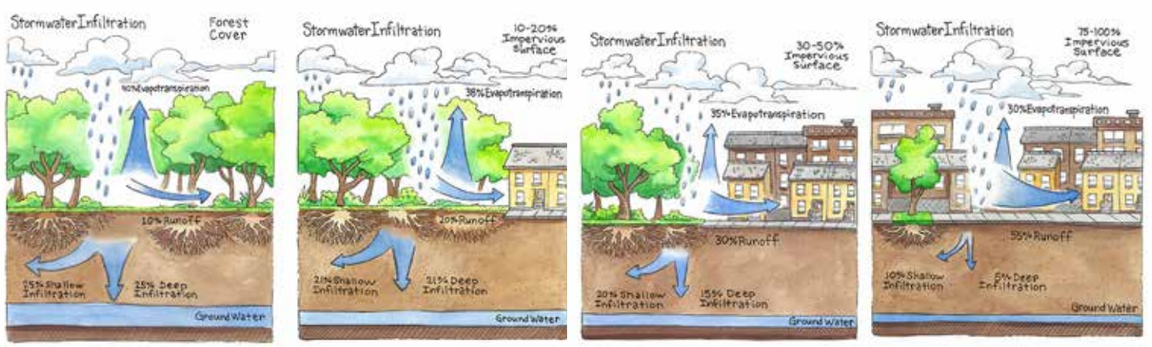
Trees provide natural flood protection and stormwater filtration at a fraction of the cost of engineered systems. As forested land is converted to impervious surfaces, runoff increases. Excess stormwater runoff can cause temperature spikes in receiving waters, increased pollution of surface and ground waters, and greater potential for flooding.

Trees also reduce nitrogen, phosphorus, and sediment runoff by cleaning rainfall and stormwater of these pollutants. Increased loads of nutrients can reduce oxygen in surface water causing harm to fish and other aquatic life. The presence of trees means less pollutants reach drainage ditches, the river, and the bay.

The average annual precipitation in Barrington is 44 inches (112 cm), some of which runs off carrying surface pollutants. Large, paved areas contribute significant volumes of this runoff. During a one-inch rainfall event, a one-acre paved area such as a mall parking lot, will release 27,000 gallons of runoff compared to an acre of forest, where only 750 gallons of water runoff. While stormwater ponds and other best management practices are designed to mimic rainfall release by detaining and filtering runoff, they do not fully replicate pre-development hydrology. In addition, older parts of the town may lack stormwater management practices that are required for new developments, so not all runoff is captured or treated before it flows to open waterways.

Excess impervious areas cause hot temperatures and runoff. This parking lot can be retrofitted to add more trees.

Water Infiltration Rates with Development



Stormwater runoff increases as land is developed. Data Source: U.S. EPA

Since trees filter stormwater and reduce overall flows, planting or conserving trees is a natural way to mitigate stormwater. Each tree plays an important role in stormwater management. Based on the GIC's review of multiple studies of canopy rainfall interception, a typical street tree's crown can intercept between 760 gallons to 4000 gallons of water per tree per year, depending on the species and age. During a 1-year/24-hour rainfall event (2.83 inches) in Barrington, the trees take up 6.5 million gallons of runoff, or about 13 Olympic swimming pools of water. In a larger rainfall event similar to the Rhode Island floods in 2010 (up to 5 inches of rain in 24 hours) the trees take up 21.7 million gallons.

As tree cover is lost and impervious areas expand, excessive stormwater runoff results in pollutants such as oil, metals, lawn chemicals (e.g., fertilizer and herbicides), pet waste, trash, and other contaminants flowing into surface waters. Trees help capture and filter that urban runoff. According to GIC's stormwater model, during a 1-year/24hour rainfall event (2.83 inches) in Barrington the trees capture:

- 19,146 lbs. nitrogen,
- 1,557 lbs. of phosphorus and
- 1,057 tons of sediment.

Nitrogen and phosphorus are plant nutrients that can cause harmful algal blooms while sediment can clog fish gills, smother aquatic life, and necessitate additional dredging of canals and waterways. Algal blooms can reduce oxygen levels further harming fish and other aquatic life.

Tree islands and planting strips in developments should be pervious and adequately sized for healthy tree growth. The town can establish soil surface and soil volume standards based on the proposed size of the tree for the tree well.

Trees help mitigate stormwater runoff from residential properties too.

Buffering Storms and Flooding

Another benefit of conserving trees and forests is buffering against storms and losses from flooding. According to the U.S. Environmental Protection Agency (EPA), excessive stormwater runoff accounts for more than half of the pollution in the nation's surface waters and causes increased flooding and property damages, as well as public safety hazards. The EPA recommends a number of ways to use trees to manage stormwater in the book *Stormwater to Street Trees*.

Retaining trees and forests along coasts also provides a wind break and helps to evaporate and reduce standing water. In addition, utilizing trees as 'green infrastructure' can provide a basis for reimbursement from FEMA if trees are damaged during storms. To qualify, trees must be inventoried and specifically utilized for stormwater management, erosion and sediment control, buffers or other green infrastructure functions.

Barrington is moving towards participation in the National Flood Insurance Program's Community Rating System (CRS). The CRS is a voluntary incentive system that allows local governments to earn flood insurance premium discounts for policyholders in the community. Local governments receive points for actions or policies that reduce flooding and flood damage; these points earn premium discounts as high as 45%.

Additionally, communities can earn credit for adopted management plans that protect the critical natural functions of floodplains and native species, while implementing habitat restoration projects. CRS requirements include an inventory all species in the plan's geographic purview, action items for protecting one or more of the identified species of interest, restoring natural floodplain functions, and the review and update of the plan every 10 years. If a green infrastructure plan is created using the canopy data, this can earn additional points in the CRS to further reduce flood insurance premiums. Multiple objectives can be achieved by combining canopy data with the planning efforts to identify green infrastructure networks.

Air Quality and Surface Temperature

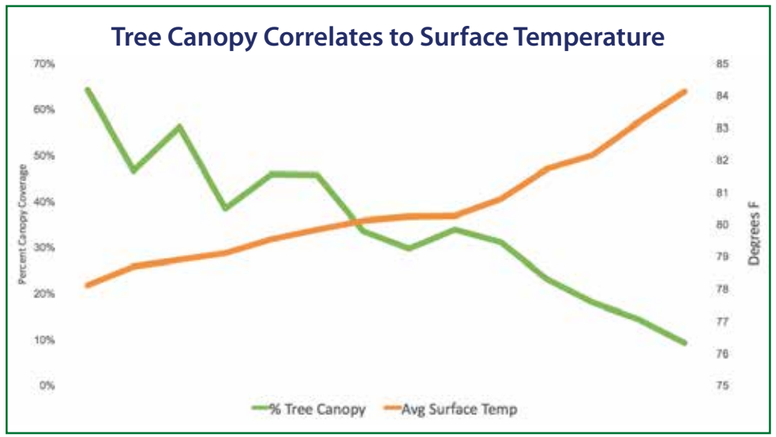
Trees Cool the Town

As summer temperatures in Rhode Island climb, the importance of shade cast by trees increases. Excessive heat can lead to heat stress which especially affects infants and children up to four years of age, those 65+ years of age and older, those with underlying medical issues, and those on some medications (Centers for Disease Control 2020).

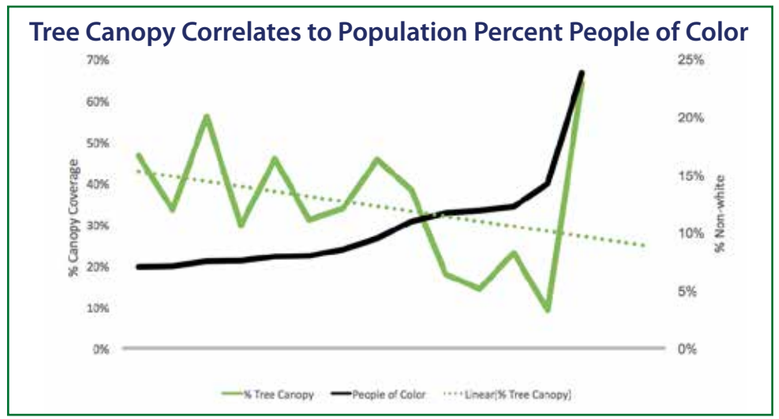
Tree cover shades streets, sidewalks, parking lots, and homes, making urban locations cooler, and more pleasant for walking or biking. Multiple studies have found significant cooling (2-7 degrees Fahrenheit) and energy savings from having shade trees in cities (McPherson et al 1997, Hashed et al 2001). Shaded pavement also has a longer lifespan, so maintenance costs associated with roadways and sidewalks are less (McPherson and Muchnick, 2005).

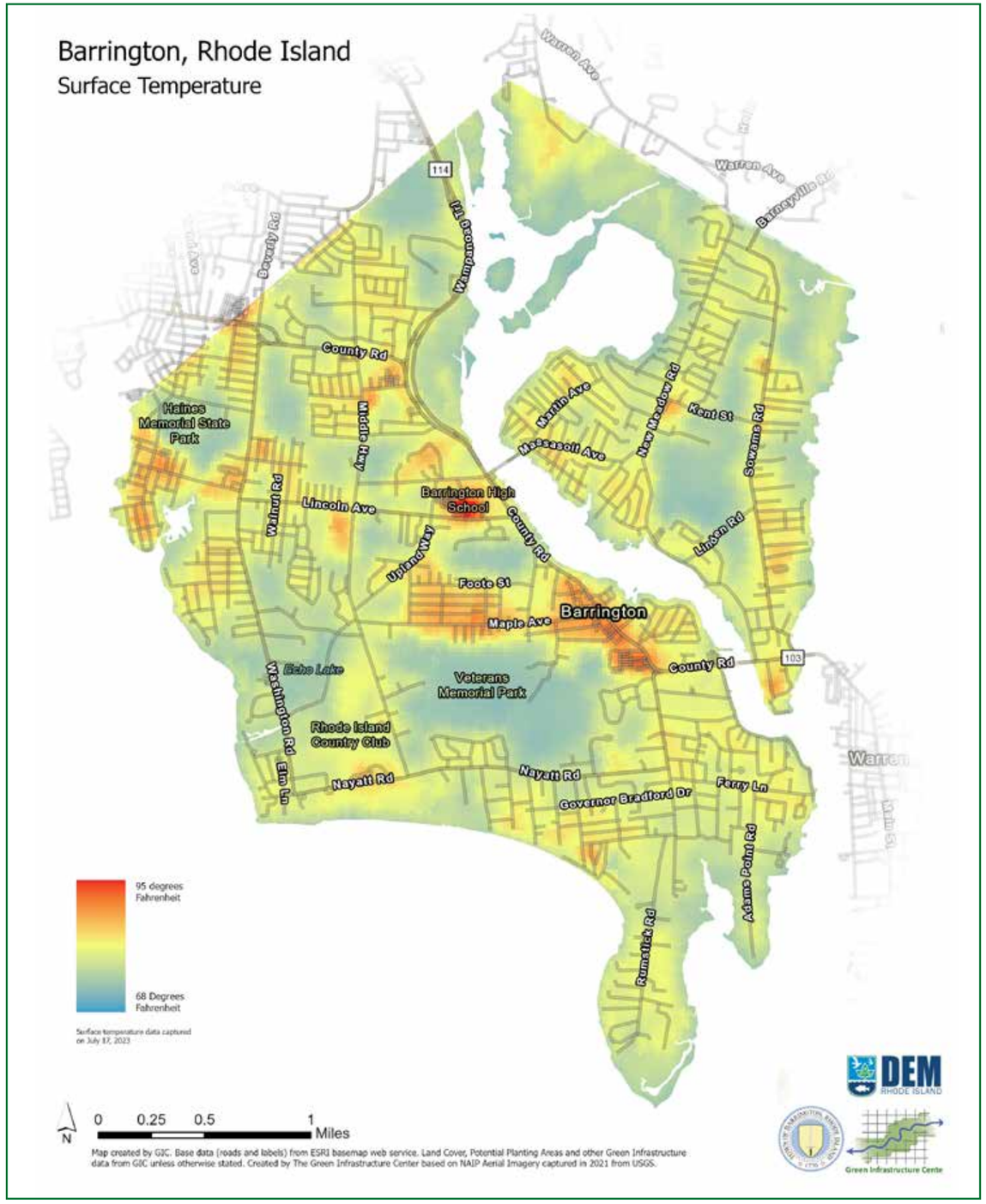
Using the tree canopy data, surface temperature data and U.S. Census data at the Block Group level, analyses can be done to identify inequities in the distribution of tree canopy and discover opportunities to correct those inequities through strategic tree planting efforts. The following map illustrates one way to prioritize tree planting efforts in the town through an urban heat island and tree equity lens. Using the Potential Planting Areas (PPA) data, surface temperature and the U.S. Census's Median Household Incomes (MHHI) data at the Block Group level, GIC was able to prioritize areas of the town for tree planting that lack canopy, are the hottest and have low-income populations that are vulnerable to heat (see map page 15). The town can use this data to do further analysis and inform how they implement tree planting efforts in the town that are equitable and help to restore canopy in neighborhoods where trees are lacking.

Higher surface temperatures are positively correlated with reductions in tree canopy coverage.

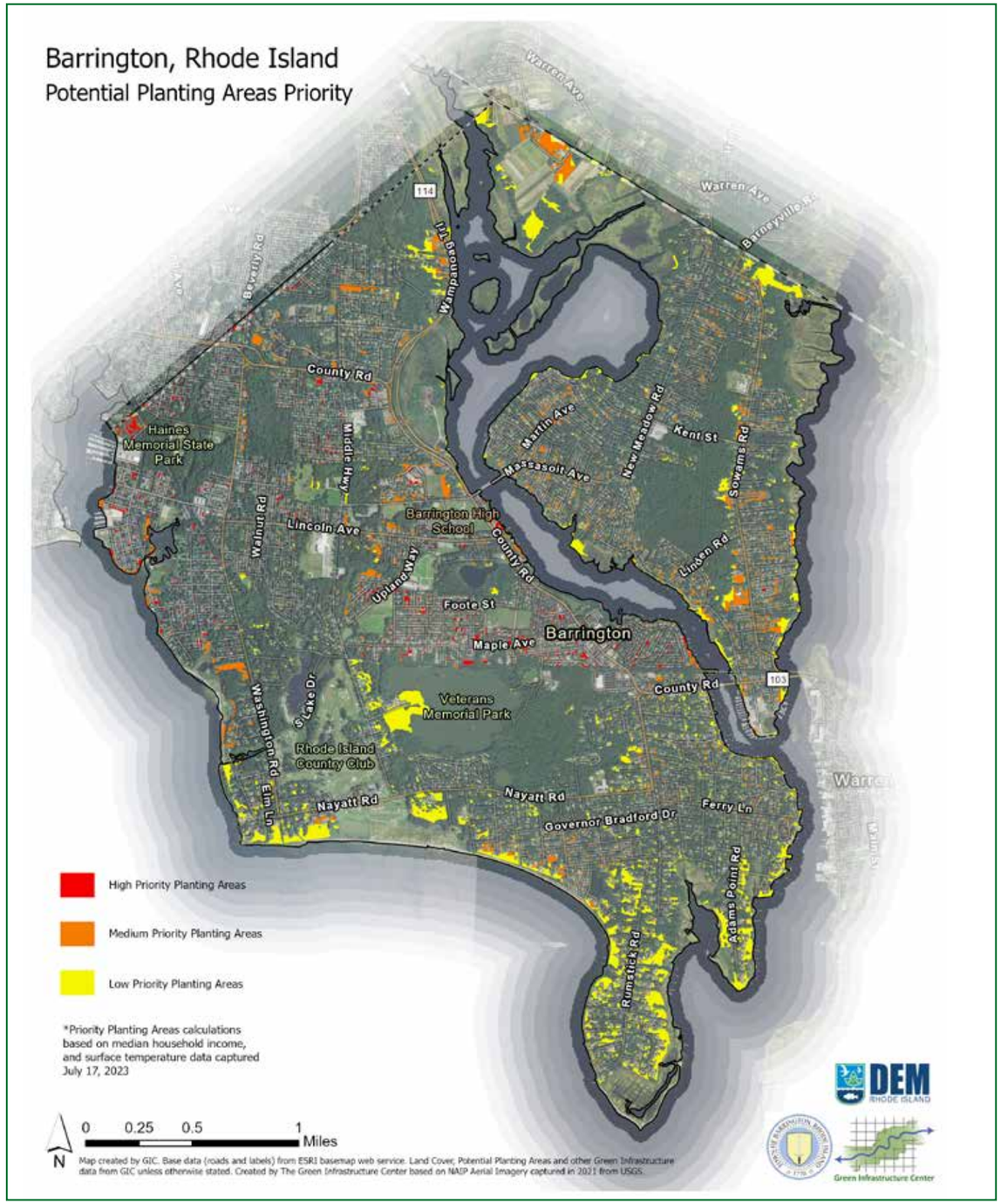


Combining U.S. Census data with tree canopy coverage we can see that Census Block Groups with higher percentages of People of Color (POC) tend to have lower canopy cover.





This map shows the hottest surface temperature areas (in degrees Fahrenheit) of Barrington on July 17, 2023



This map shows one way to prioritize tree planting efforts in the town through a tree equity lens by focusing tree planting in the hottest and lowest income neighborhoods of the town.

Trees Clean the Air

In addition to cooling surfaces, trees absorb volatile organic compounds and particulate matter from the air, improving air quality, and thereby reducing asthma rates. Trees play a critical role in not only providing oxygen but also cleaning the air of particulate matter and ground level ozone (O3), which can harm human health. Trees also sequester greenhouse gases such as sulfur dioxide and carbon dioxide. As these gasses are trapped by trees, the severity of climate change is reduced. Trees also store carbon and prevent its release, further helping to alleviate climate change impacts. Even at the neighborhood level, trees reduce pollutants. Trees clean the air and well treed neighborhoods suffer less respiratory illnesses, such as asthma. (Rao et al, 2014),

Social Values

Trees Improve Cognitive Function

Children who suffer from Attention Deficit Hyperactivity Disorder (ADHD) benefit from living near forests and other natural areas. One study showed that children who moved closer to green areas have the highest level of improved cognitive function after the move, regardless of level of affluence (Wells 2000). Thus, communities with greener landscapes benefit children and reduce ADHD symptoms. Exposure to green spaces for 20 minutes a day can also improve cognitive function. Providing more natural areas on or near school grounds as well as greening routes to school can better prepare children to learn.

The trees provide cooling shade during hot summer months.

Exposure to green spaces for 20 minutes a day can improve cognitive function.

Well treed areas encourage people to walk and bike.

Trees Improve Walkability

The presence of trees encourages people to walk more and walk farther. According to research, when trees are not present, distances are perceived to be longer and destinations farther away, making people less inclined to walk than if streets are well treed (Tilt, Unfried and Roca 2007).

Home buyers are willing to pay more for homes located near a park or other natural area.

Trees Increase Property Values and Sales

Developments that include green space or natural areas in their plans sell homes faster and for higher profits than those that take the more traditional approach of building over an entire area without providing for community green space (Benedict and McMahon 2006).

A study by the National Association of Realtors found that 57% of voters surveyed were more likely to purchase a home near green space and 50% were more willing to pay 10% more for a home located near a park or other protected area.

Urban Tree Loss – Reversing the Trend

Barrington now has baseline data to monitor canopy increases from plantings, measure the stormwater and water quality benefits of its community forest, and can prioritize restoration of canopy where it is most needed. Currently the town's canopy coverage is 51%, and the data identifies areas to plant to help maintain its existing canopy into the future.

To maintain the canopy, the town needs to actively plant trees to replace those lost to natural mortality (old age), storms, development, pests, and neglect or poor care. As older trees die (or before they die), younger trees need to be planted to restore the older canopy. While the town has been planting trees, more trees need to be planted by both the public and private sectors at greater numbers to achieve the goal of a sustaining canopy at 51%. The data from this report can inform the town's tree canopy planting plan and can be shared with the public to encourage them to plant trees. This goal and data can also be used to secure grants and donations to help fund the effort.

Newly Planted Tree

Why Are Urban Trees Declining?

Tree loss is not a problem that is unique to Barrington. Trees are declining throughout the United States. Cities are also losing older, established trees from the cumulative impacts of land development, storms, diseases, old age and other factors (Nowak and Greenfield 2012).

It is not just development and storms that contribute to tree loss. Millions of trees are also lost as they reach the end of their life cycle through natural causes. Choosing the wrong tree for a site or climate, planting it incorrectly, or caring for it poorly can all lead to tree canopy loss. For every 100 street trees planted, only 50 will survive 13-20 years largely due to poor planting conditions and care (Roman et al 2014). Even in older developed areas with a well-established tree canopy, redevelopment projects may remove trees. It is important to realize that an older, well-treed neighborhood of today may not have good coverage in the future unless young trees – the next generation – are planted.

Current and Potential Canopy

In order to determine the current tree canopy, model scenarios for future tree coverage, and quantify their ecosystem services, a highly detailed land cover analysis and an estimation of potential future planting areas were developed (see Appendix A for details). In addition to community forest planning, the new land cover data can be used for other purposes such as analyzing urban cooling, walkability, street tree plantings, inform area plans, or the town's comprehensive plan.

Method

Satellite imagery from the National Agricultural Imagery Program (NAIP) distributed by the USDA Farm Service Agency was classified based on 4 infrared bands to determine the types and extent of different land covers in Barrington. Canopy maps were created using NAIP imagery data from 2021. Additional data from the Town of Barrington, the National Wetlands Inventory, and National Hydrography Dataset were also used to determine:

1) Tree canopy (including trees and wooded wetlands).
2) Wetlands not distinguishable using spectral/feature-based image classification tools.
3) Forested open space (compact, continuous tree canopy greater than one acre) not intersected by buildings or paved surfaces.

The final classification for land cover consists of eight classes (types of land cover).

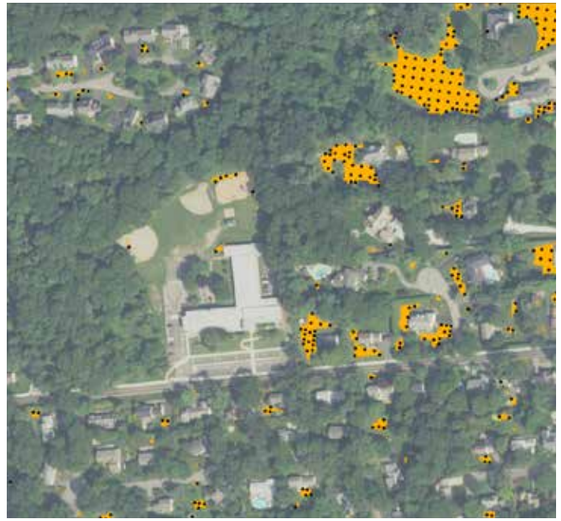
NAIP Image 2021

Potential Planting Area (PPA) with exclusions in red hatching

Potential Planting Areas (PPA)

In urban areas, realistic goals for expanding tree canopy depend on an accurate assessment of plantable open acreage. A Potential Planting Area (PPA) map estimates areas that may be feasible to plant trees. The PPA is created by selecting the land cover features that have space available for planting trees and accounts for the overlap of canopy (e.g., canopy that is intermingled or a large canopy tree that partially covers an understory tree). Of the eight land cover classes, only pervious/turf were considered for PPA. However, some paved areas could be removed or reduced, soils conditioned, and then used to plant new canopy.

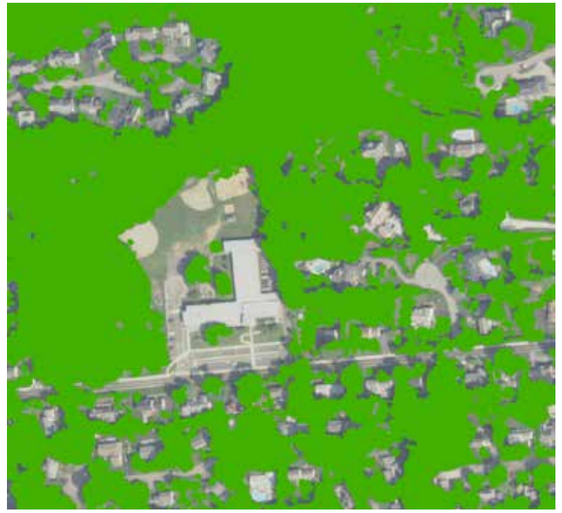
Eligible planting areas are limited based on their proximity to features that might either interfere with a tree's natural growth (such as buildings) or places a tree might affect the feature itself, such as power lines, sidewalks or roads. Playing fields, cemeteries and other known land uses that would not be appropriate for tree cover, such as golf courses and airports were also avoided in calculating plantable areas. The resulting PPA represent the maximum potential places trees can be planted and grow to full size. The GIC recommends no more than half the available PPA is realistic to plant, since many uses such as tomato gardens or sunbathing by the pool require full sun.



Potential Planting Spots (PPS)

Potential Planting Spots (PPS)

Potential Planting Spots (PPS) are created from the PPA. A GIS modeling process is applied to select spots where a tree can be planted depending on the desired size. For this analysis, expected sizes of 20 ft. and 40 ft. diameter for individual mature tree canopy were used with priority given to 40 ft. diameter trees (larger trees have more benefits).



Potential Canopy Area (PCA)

Potential Canopy Area (PCA)

The Potential Canopy Area (PCA) is created from the PPS. Once possible planting spots are selected, a buffer around each point that represents a tree's mature canopy is created. For this analysis, that buffer radius is either 10 ft. or 20 ft., which represents a 20 ft. or 40 ft. diameter canopy. These individual tree canopies are then dissolved together to form the potential overall canopy area. For Barrington 8% more canopy could be added to the town.

Maps and Findings

The tree canopy map should be used to plan for tree conservation and as a benchmark to gauge future progress in tree preservation and planting. An ArcGIS geodatabase with all GIS shape files produced during the study was provided to the town.

Tree Canopy Goal for the Town of Barrington

Using tree canopy and land cover data, this plan's consultants mapped the maximum potential tree canopy for planting 100% of the available planting areas which equates to a potential canopy cover of 59%. However, planting 100% of the PPA is not a realistic goal because property owners have other uses for their land such as vegetable and ornamental gardens, or lawns. A more realistic goal for the maximum potential tree canopy is to plant only 50% of the PPA, resulting in a maximum desired goal of 55% tree canopy.

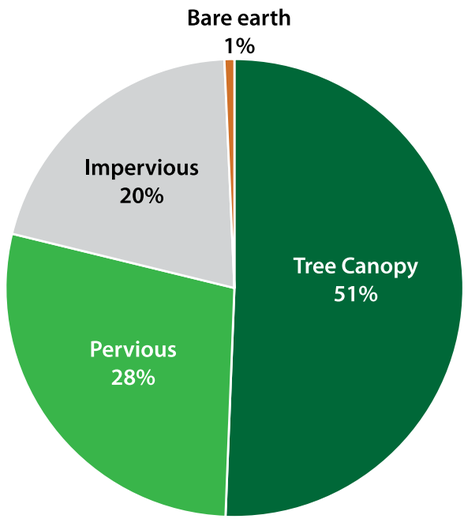
Using this information and other tools, such as GIC's Canopy Budget Calculator Tool which estimates the financial cost of increasing canopy to a certain percentage, the town decided to set a goal of at least maintaining its current canopy at 51% over the next 10 years. If the Barrington community wants to maintain the canopy at its current 51% over the next 10 years assuming around 150 trees are lost per year, it will require planting an additional 3,674 trees; approximately 1,958 large shade trees and 1,716 small trees at a rate of 245 trees planted annually.

The town also requested statistics for canopy by the following geographies:

- Streets
- Flood zones
- Watersheds
- Parcels

The canopy data and the possible planting area map can inform tree planting decisions to meet many goals such as walkability, stormwater mitigation, energy savings or economic revitalization. Knowing the distribution of canopy for different types of properties allows the town to craft more specific strategies for achieving their canopy goal of "no net loss" and ensuring that canopy is distributed equitably across the landscape. The following maps can be used to prioritize where to start planting and for public awareness of such planting needs.

Barrington Percent Tree Canopy



Townwide forest cover is 51%.

One mature tree can absorb thousands of gallons of water per year.

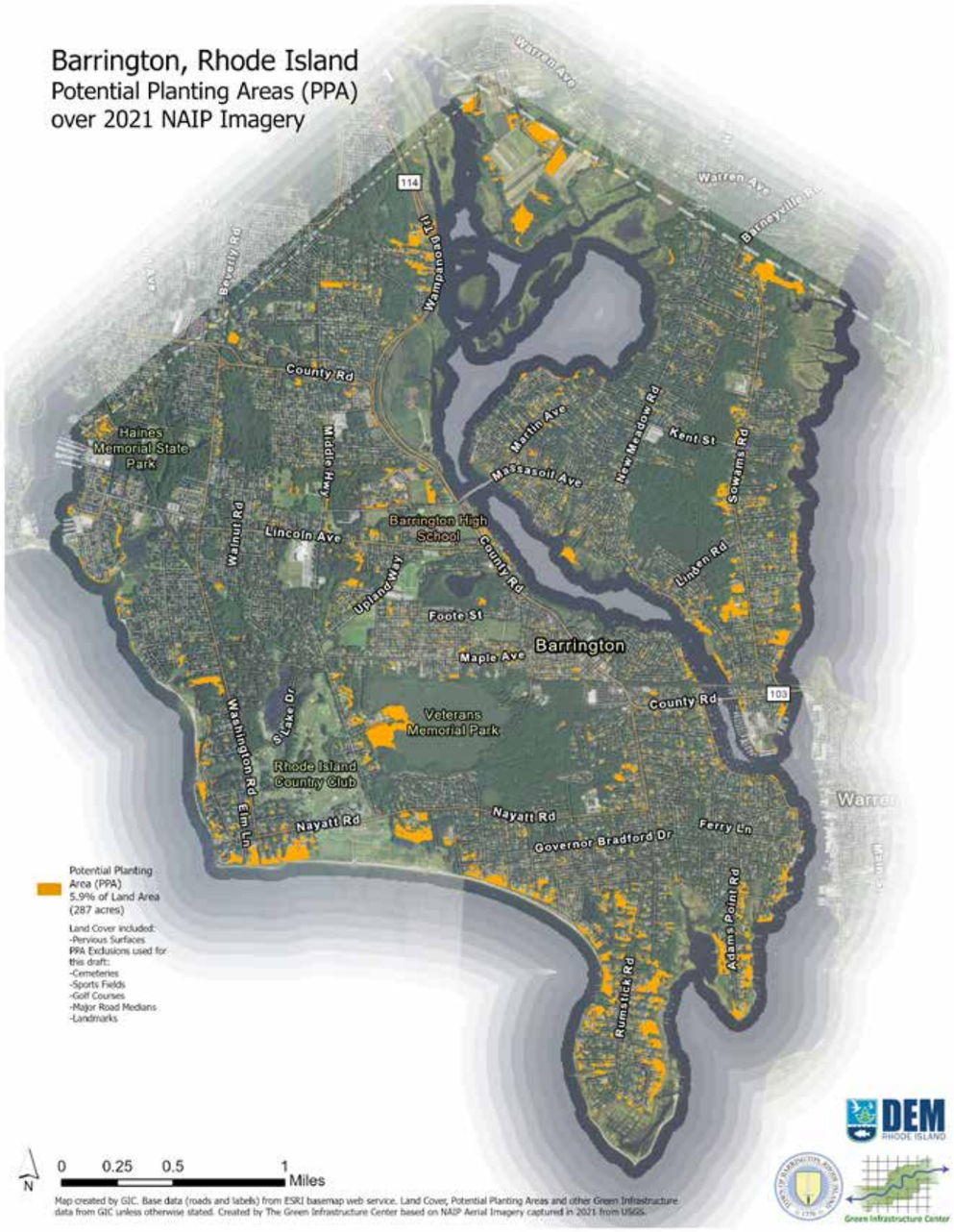
Map of Town Land Cover and Tree Canopy

This map shows the tree canopy of the town which covers 51% of the area.

Map created by GIC. Base data (roads and labels) from ESRI basemap web service. Land Cover, Potential Planting Areas and other Green Infrastructure data from GIC unless otherwise stated. Created by The Green Infrastructure Center based on NAIP Aerial Imagery captured in 2021 from USGS.

Map of Possible Planting Areas

Potential Planting Areas (PPA) shown in orange depicts areas where it may be possible to plant trees.
All sites need to be confirmed in the field and may be on private or public lands.



Map of Street Tree Coverage

Percent Street Trees is calculated using the Land Cover Tree Canopy and road centerlines, which are buffered to 50 ft. outward from each road segment's centerline. The percent value represented is the percentage of tree cover within that 50 ft. buffer.

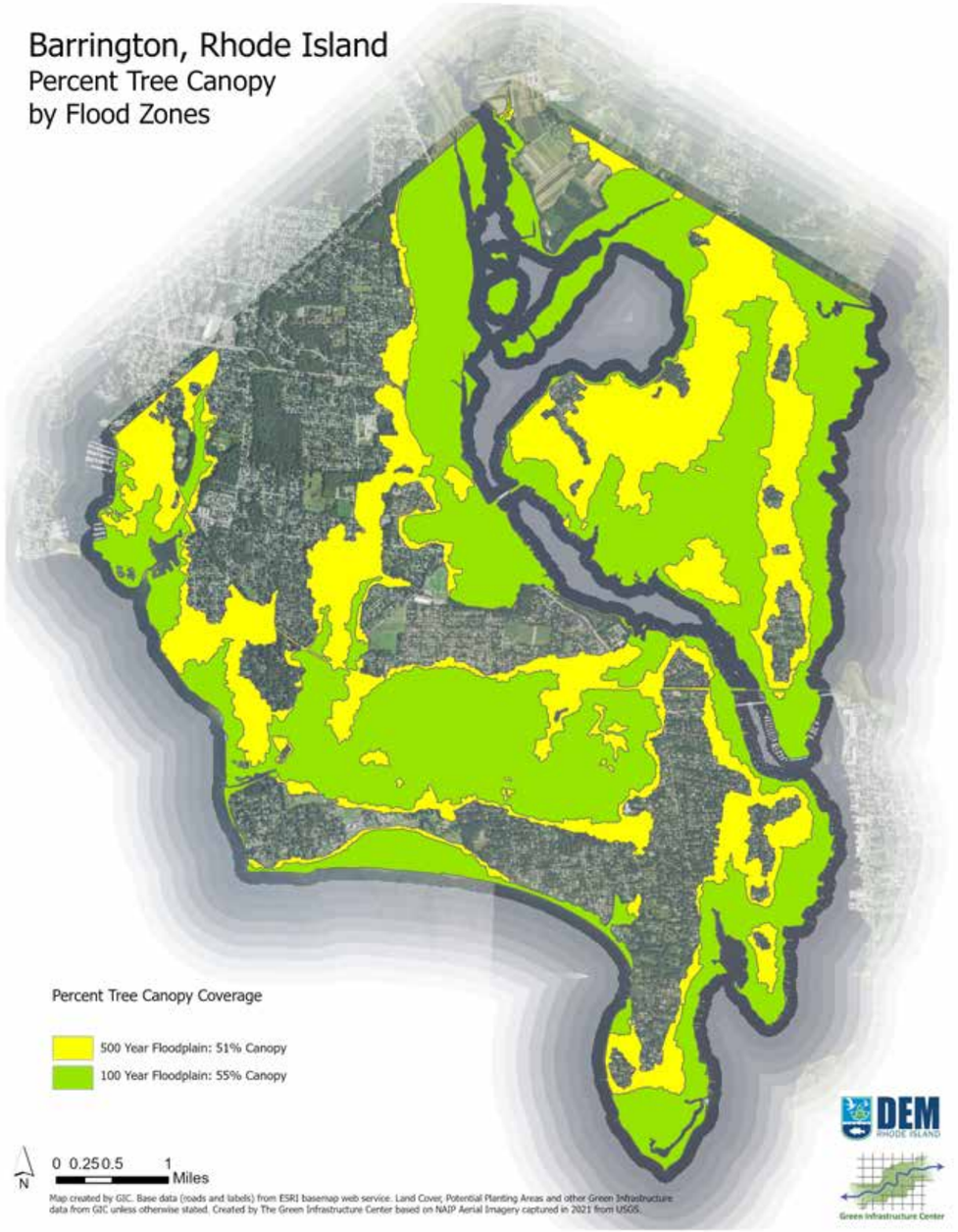
This map shows which streets have the most canopy (dark green) and which have the least (red). Streets lacking good coverage can be prioritized for tree plantings to facilitate uses, such as Safe Routes to School or beautifying a shopping district.

Map of Potential Street Trees

The potential street trees map shows which streets could support additional tree canopy if planted with more trees. Greater canopy coverage along streets and sidewalks can keep neighborhoods cooler and more walkable.

Map of Flood Zones

Barrington's 100-year floodplain is composed of 55% tree canopy and 15% impervious surfaces. The 500-year floodplain is composed of 51% tree canopy and 23% impervious surfaces.

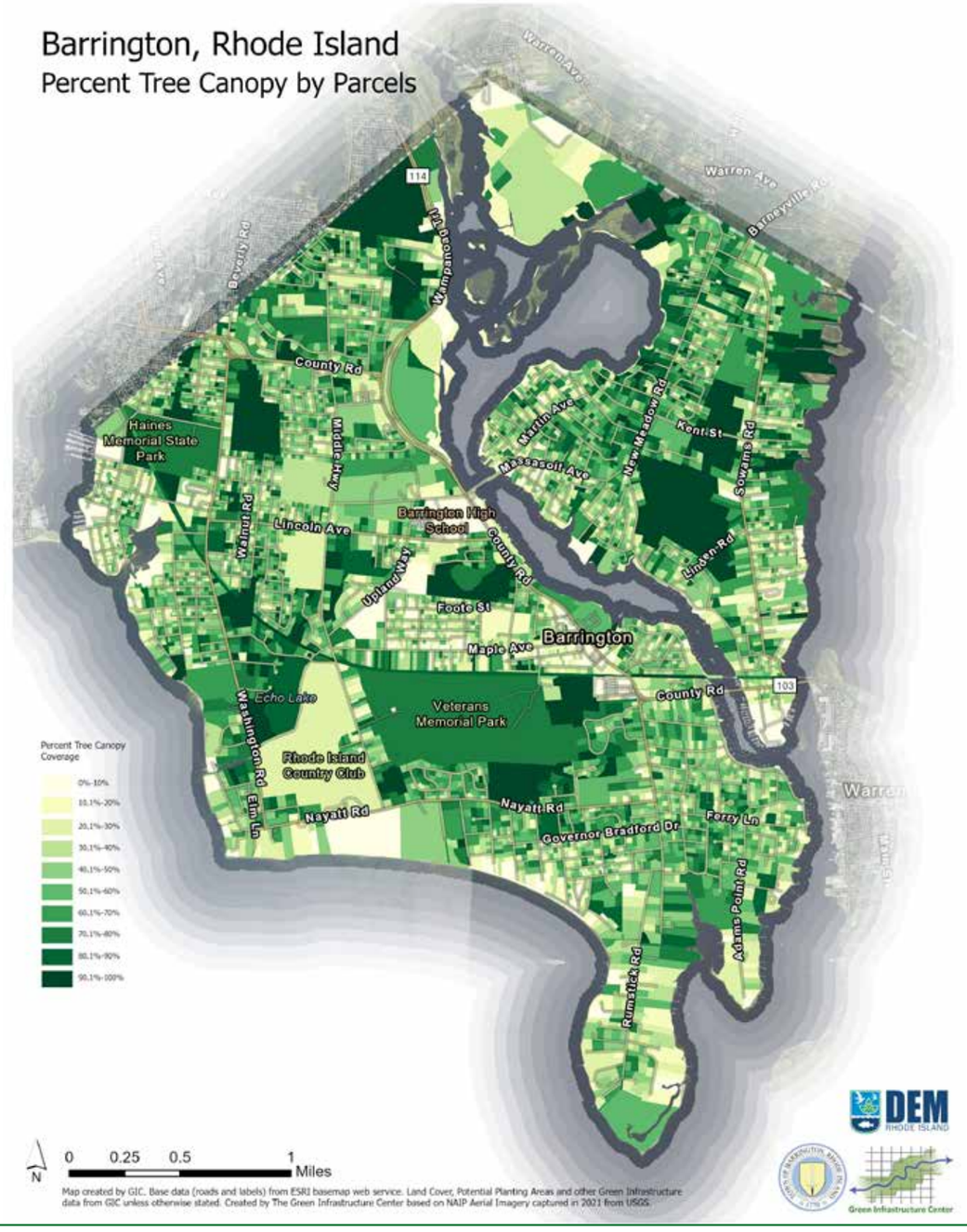


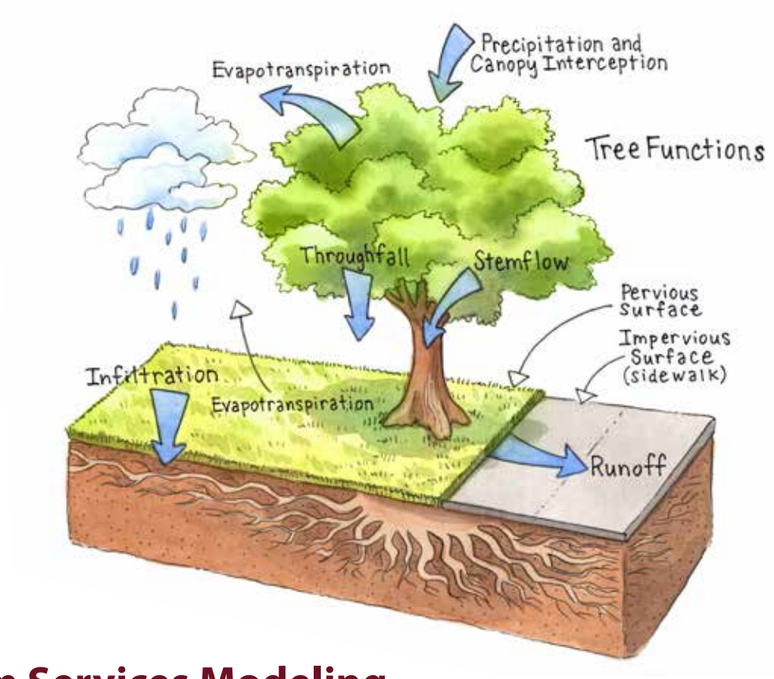
Map of Watershed Coverage

This map shows tree canopy by watersheds using the Hydrological Unit Code 12 (HUC12). Trees help manage stormwater runoff and reduce harmful pollution from entering into the bay.

Map of Parcel Coverage

Every town parcel was analyzed for tree canopy cover. The data show that some residential properties lack sufficient canopy and have potential for more trees.





Ecosystem Services Modeling

Methods to Calculate Tree Benefits

Stormwater Uptake Modeling

The best land cover for taking up stormwater is the urban forest. The GIC evaluated stormwater runoff and uptake by the town's tree canopy using the GIC's Trees Stormwater Calculator (TSW) Tool. The TSW tool estimates the capture of precipitation by tree canopies and the resulting reductions in runoff yield. It considers the interaction of land cover and soil hydrologic conditions. It can also be used to run 'what-if' scenarios, specifically losses of tree canopy from development or storms and increases in tree canopy from tree planting programs.

Trees intercept, take up and slow the rate of stormwater runoff. Canopy interception varies from 100 percent at the beginning of a rainfall event to about three percent at maximum rain intensity. Trees take up more water early on during storm events and less water as storm events proceed and the ground becomes saturated (Xiao et al., 2000). Many forestry scientists, as well as civil engineers recognize that trees have important stormwater benefits (Kuehler 2017, 2016).

See diagram of tree water flow above.

Barrington — Urban Tree Canopy Stormwater Model — version May 4, 2022

The Green Infrastructure Urban Tree Canopy Stormwater Model estimates stormwater runoff yields for current and potential land cover. The methodology is based upon the NRCS TR-55 method for small urban watersheds. It is used to provide better estimates using GIC's high-resolution land cover and modeling of potential canopy area.

					million gallons												
	TOTALS	50.5%	18.0%	6.5	-	-	50.5%										
	Statistics by Drainage Basin (current settings)							Variable									Variable
	Area	Current Tree Cover	Current Impervious Cover	Tree H20 Capture	Increased H20 w/xx% tree loss	Added H20 Capture w/xx% PCA	Adjusted Tree Cover from loss and gain scenarios	Pick an Event	Pick a loss scenario		Converted Land			Canopy Added	Enter % canopy to add
		%		million gallons			%	Event	% UTC loss	% FOS Loss	% Imperv	Max TC Possible	Maximum Potential Added Canopy Area	% Canopy Added	% of PCA achieved
1	Barrington River-Warren River	51.2%	20.2%	2.6	-	-	51%	1 yr / 24 hour	0%	0%	0%	59.5%	8.3%	0.0%	0%
2	Old Mill Creek-Narragansett Bay	41.6%	18.4%	0.1	-	-	41%	1 yr / 24 hour	0%	0%	0%	59.1%	18.1%	0.0%	0%
3	Palmer River	53.3%	20.4%	0.1	-	-	53%	1 yr / 24 hour	0%	0%	0%	82.8%	11.5%	0.0%	0%
4	Seekonk River-Providence River	52.6%	21.0%	3.8	-	-	53%	1 yr / 24 hour	0%	0%	0%	58.1%	5.5%	0.0%	0%
5								1 yr / 24 hour	0%	0%	0%				0%
6								1 yr / 24 hour	0%	0%	0%				0%

The Trees to Offset Stormwater Tool (TSW) allows the town to see the water uptake by existing canopy and model impacts from changes, whether positive (adding trees) or negative (removing trees and adding impervious surfaces).

The amount and type of open space under and around the tree and the condition of surface soils affect the infiltration of water. The TSW tool developed for Barrington has a data field to hypothetically add trees to determine stormwater uptake from new tree planting. The TSW tool applies the PPA data to determine how many more trees could be planted. The tool also calculates the amount of nitrogen, phosphorus and sediment the trees and their surrounding soils take up. For more about the stormwater calculator tool, see Appendix B.

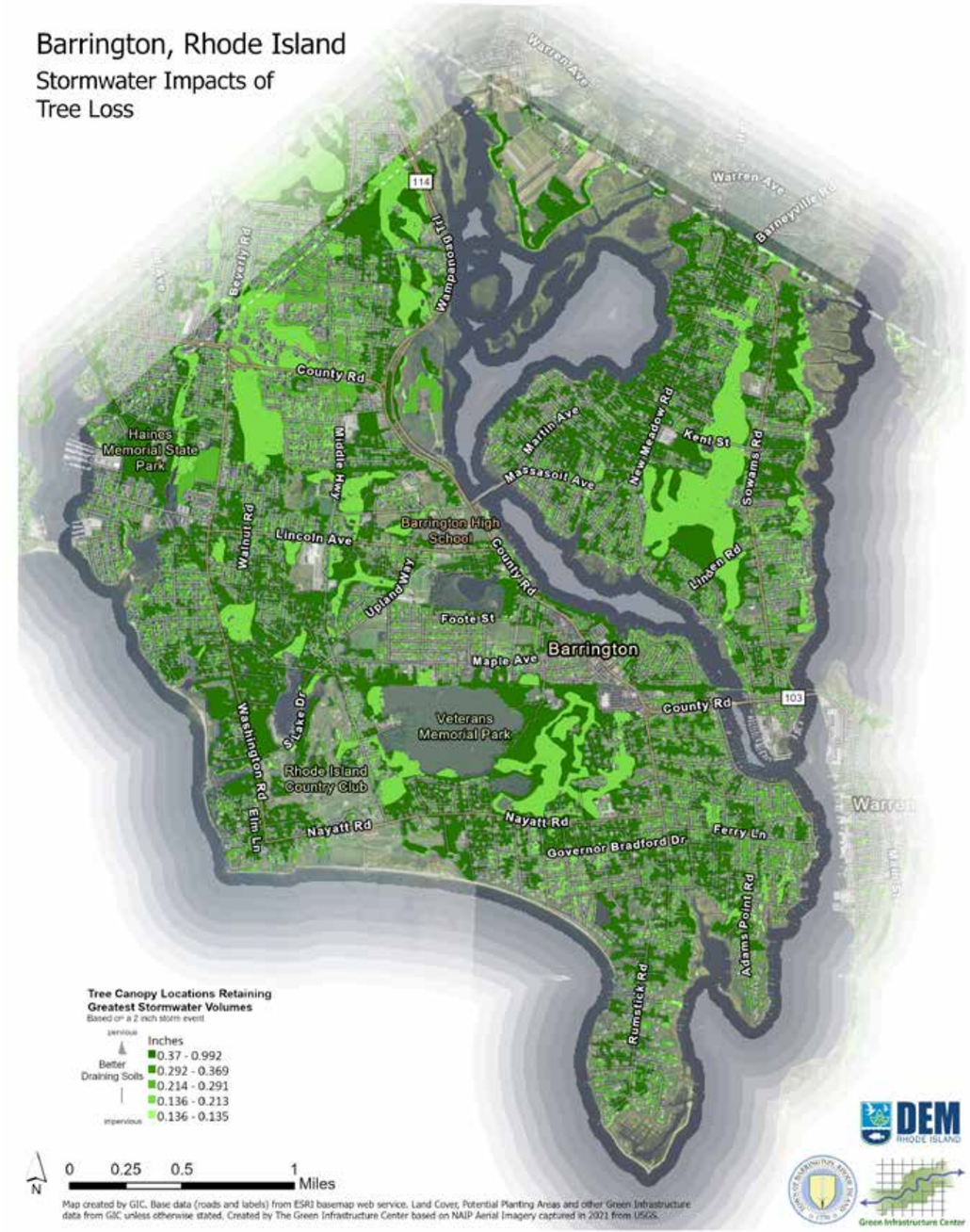
The TSW model is a tool for seeing the stormwater impacts of adding or losing tree canopy and the resulting pollution increases or decreases.

The TSW model is a tool for seeing the results of adding or losing tree canopy and the resulting pollution increases or decreases (nitrogen, phosphorus, sediment). For example, the model shows that for a hypothetical 5% loss of tree canopy for the town, during a 1-year storm event, an additional 600,000 gallons of rainfall runoff would occur: that's more than 1.2 Olympic swimming pool's water volume. Conversely, if half of each plantable area were covered with new trees – increasing tree canopy – the TSW model shows that trees could capture an additional 100,000 gallons of water during the same storm.

Removal of mature trees and existing forests generates the greatest impacts for increasing stormwater runoff. As more land is developed, the town should seek to maximize tree conservation for maintenance of surface water quality and groundwater recharge. The following maps show areas that are the most important to retain trees for stormwater uptake and those areas where tree planting will have the most benefits for stormwater uptake. This is based on the types of soils present.

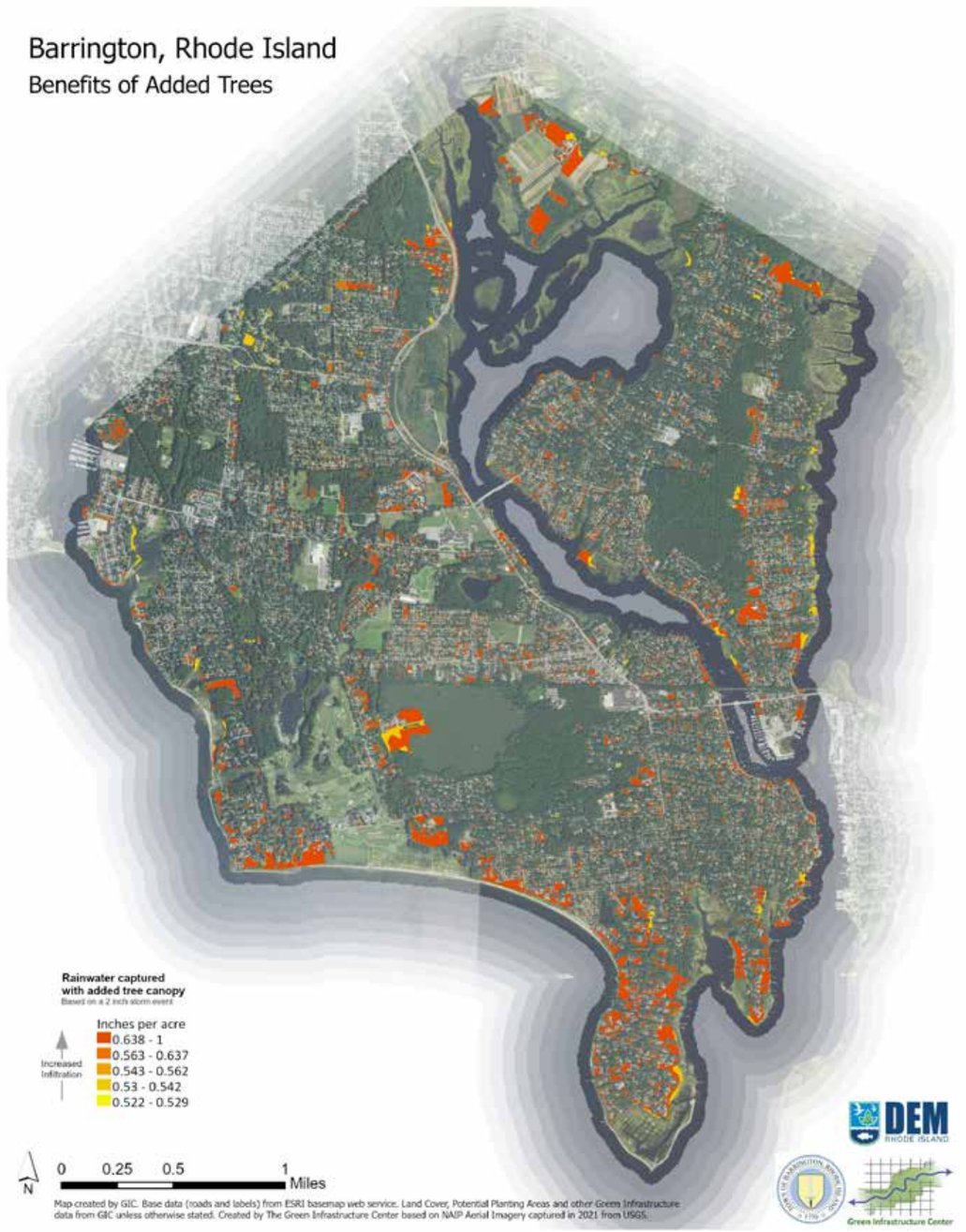
Map of Stormwater Impacts of Tree Loss

This map identifies existing mature tree canopy that is in the best location (in dark green) for retaining stormwater on site.



Map of Stormwater Benefits of Planting Trees

This map identifies the best planting areas to plant trees to infiltrate stormwater into the soil.



Investments in canopy at the neighborhood level can improve the respiratory health of residents.

Air Quality Pollution Removal Values

Air quality pollution removal values were calculated by applying the multipliers used by the i-Tree models. I-Tree is a peer-reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefit assessment tools. It provides standard pollution removal values per acre for various air pollutants. The following i-Tree model values for urban areas were used to derive the pollution removal values per acre of tree canopy.

Carbon monoxide (CO) affects how quickly greenhouse gases such as methane breakdown, which are linked to climate change and global warming. Carbon is another element that contributes to climate change mainly in the form of carbon dioxide. Trees sequester carbon from carbon dioxide in their leaves, trunk, and roots, and prevent it from being released into the atmosphere where it can contribute to climate change.

Ground level ozone O_3 can cause the muscles in people's airways to constrict, trapping air in the alveoli, leading to wheezing and shortness of breath, which is particularly harmful to those with respiratory diseases or chronic conditions, such as asthma. Nitrogen dioxide (NO_2) and Sulphur dioxide (SO_2) also irritate airways in the respiratory system and aggravate respiratory conditions such as asthma.

PM10 is particulate matter measuring 10 micrometers or less in diameter and PM2.5 is particulate matter 2.5 micrometers or less in diameter (a human hair is about 100 micrometers = about 40 fine particles). PM2.5 is generally described as fine particles. Finer particles have the potential for greater harm since they may lodge deeper in the lungs. Trees are able to filter and clean particles from the air.

Well-treed neighborhoods suffer less respiratory illnesses, such as asthma (Rao et al, 2014). This means that investments in canopy at the neighborhood scale can increase the health of residents.

Pounds of air pollution and greenhouse gases removed annually by all trees in Barrington

CO (carbon monoxide)	NO_2 (nitrogen dioxide)	O_3 (ozone)	PM_{10}* (particulate matter 10 microns)	$PM_{2.5}$ (particulate matter 2.5 microns)	SO_2 (sulphur dioxide)	CO_2seq (carbon dioxide sequestered) in lbs	CO_2stored ** (carbon dioxide stored in lbs)
560	2,800	46,740	6,933	1,766	5,217	21,334,133	301,482,144

*PM = Particulate matter
**CO_2 stored is not an annual rate but a total amount of carbon stored.

Codes, Ordinances and Practice Review

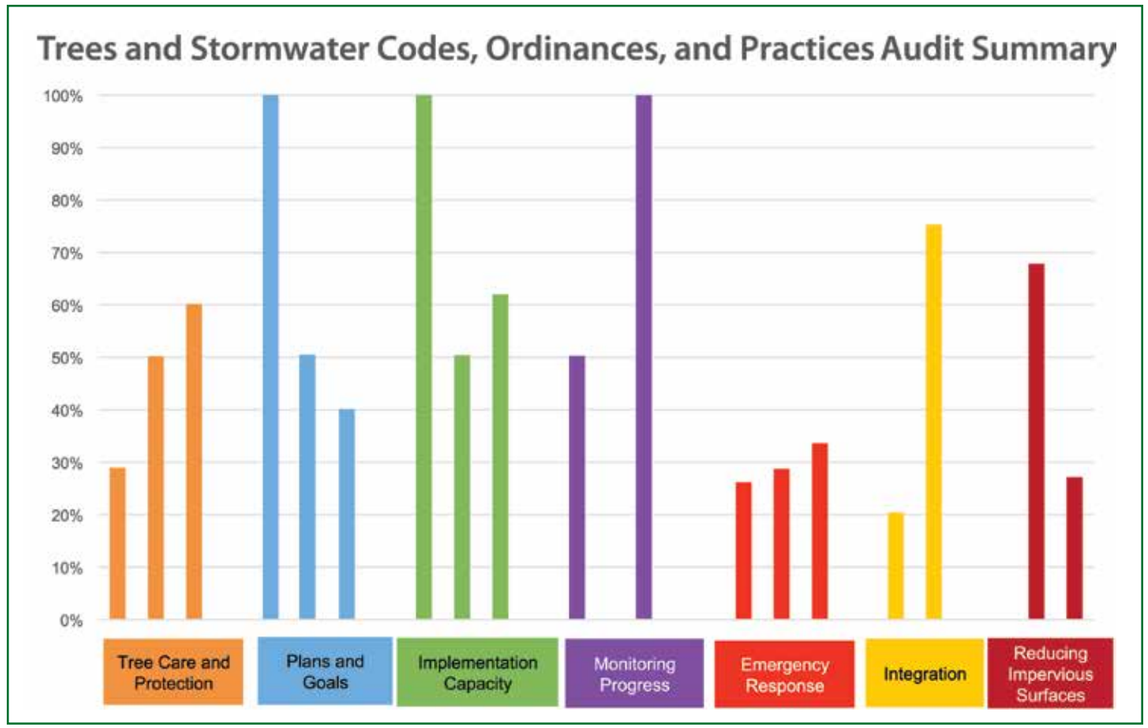
This review determined which practices create more impervious surfaces (e.g., too much parking required), protect or restore pervious surfaces (e.g., conserving trees or requiring open spaces), and create a healthy urban forest (e.g., tree planting and care standards). Documents reviewed during the codes, ordinances and practices analysis for the project include relevant sections of the town's current code that influence urban forest practices, runoff or infiltration. Data were gathered through analysis of town codes and policies, as well as interviews with town staff, whose input was incorporated directly on the spreadsheet summary prepared by the GIC. The spreadsheet provided to the town lists all the codes reviewed, interviews held and relevant findings.

Points were assigned to indicate what percentage of urban forestry and planning best practices have been adopted to date by the town. The spreadsheet tool created for town codes can also serve as a tracking tool and for determining other practices or policies the town may want to adopt in the future to strengthen the urban forestry program or to reduce impervious land cover. The less town land that is paved, the more room there is to add trees.

Categories the town scored best in were "Plans and Goals", "Implementation Capacity," "Monitoring Progress," and "Reducing Impervious Surfaces" while "Tree Care and Protection", "Emergency Response", and "Integration" all had room for improvement. Best practices the town follows under "Implementation Capacity" include having a certified arborist on staff who supports the day-to-day operations of the urban forest and specific municipal forest line item for tree planting, removal, and staff salaries who manage public trees. The urban forestry line of the budget has been consistently increased over the last few years providing more funds for tree planting, hazardous tree removal and maintenance. This investment in the urban forest allows for more proactive management of this community asset. The town also has a Tree Commission (under the Conservation Commission's authority) that is actively engaged in the urban forest program. The town is in a phase 1 of collecting tree inventory data with the support of volunteers ("Monitoring Progress") for all public trees to inform strategic decision-making. The tree inventory data will also allow the town to better manage the health and condition of trees and be more proactive in mitigating hazards and risk before storms and other natural disasters.

		Present?	Municipality Comments	Reviewer Comments	Source	What to Look For	Score	Potential Score
Tree Protection								
	Are tree inventories required when greater than 10,000 square feet of land is being disturbed? What DBH trees must be inventoried?	Yes		Trees over 12" DBH must be flagged and species identified on preliminary site plans for minor and major subdivisions and master plans. For other development projects trees over 6" DBH must be flagged on site plans that are going to be retained or removed.	LAND DEVELOPMENT AND SUBDIVISION REGULATIONS Checklist for Development Plan Review Applications Submitted under § 185-151C or D of the Barrington Zoning Ordinance	Include hardwoods 18" and over, softwoods 24" and over, and understory species 8" and over in tree inventories of proposed development properties. Require inventories of the entire property including 100' offsite from all property boundaries. Require correct species identification, DBH size, and, general condition description. Also require that the person completing the inventory is a ISA Certified Arborists or Registered Consulting Arborists through the American Society of Consulting Arborists. Score three points if all of the requirements above are present and enforced in the municipality.	3	3
	Are tree protection fencing (TPF) or other tree protection mechanisms (e.g. root protection, aeration, vertical mulching) required on public property during construction? Are TPF or other tree protection mechanisms required on private property during construction? Is this enforced?	Sort of		Some protections exist for proper gas exchange and solid fencing, but the CRZ is insufficient and other protection measures such as mulching, irrigation and signage are lacking. The protections that do exist only apply to public trees and not private trees.	§ 149-14. Protection of trees within public rights-of-way.	Require tree protection fencing on public and private property. Inspect the site for adequate tree protection mechanism installation before any further work is permitted on-site. Score three points if all of the requirements above are present and enforced in the municipality.	0	3
	Are standard details available for TPF and other kinds of tree protection mechanisms? Are these details required on development plans?	Not really		The code mentioned the use of 4 ft high and sturdy fencing to protect trees in the ROWs from nearby impacts, but more measures could be required to ensure greater protection and survival of trees in construction zones.	§ 149-14. Protection of trees within public rights-of-way.	Create root pruning, mulch matting, and aeration matting details. Require the inclusion of these details on development plans. Score two points if the tree protection details are present and inclusion on development plans is enforced in a municipality.	0	2
	Are minimum canopy coverage requirements set by zoning area or land use? Is there a fee or planting requirement when canopy coverage is lowered beyond set levels? Is this	No		No canopy coverage requirements in the zoning ordinance.	Chapter 185 ZONING	Set minimum canopy levels by zoning area. Incute a fine or planting requirement when tree removals exceed set levels. Score two points if minimum canopy levels are set by zoning areas and fees/tree plantings are required canopy levels fall below required levels.	0	2

A snapshot of the types of questions or sections of code evaluated.



Summary scores for town codes and policies within each category.
The town scored best in 'Plans and Goals', 'Implementation', 'Monitoring Progress' and 'Reducing Impervious Surfaces' but had room for improvement in 'Tree Care and Protection', 'Emergency Response', and 'Integration'.

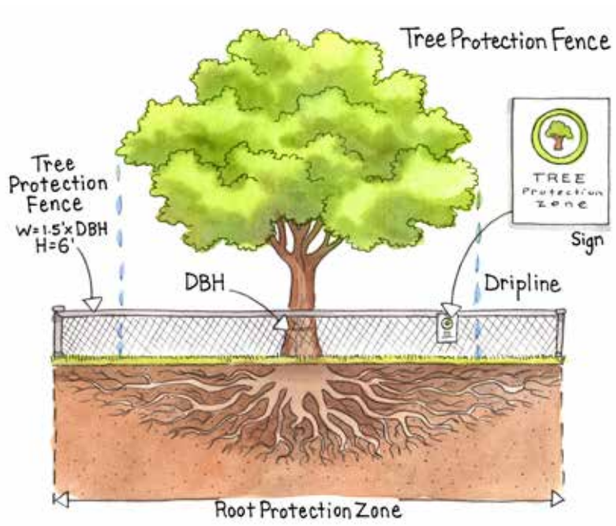
Recommendations

Tree Care and Protection

The town tree canopy would benefit from strengthened tree protection requirements. Currently tree protection only applies to public trees. The town should expand tree protections to include trees on private property and not just public trees. The urban forest is part of the greater community fabric and as such the impacts of tree loss on private property impact the entire town. The town could limit tree protection on private property to only include significant trees (16 inches DBH or greater) or another standard for tree size found on site. By updating the tree ordinance to include private trees, this can minimize the loss of trees during the development process. In situations where trees must be removed to accommodate the development, require the replacement of those trees elsewhere on site or require the developer pay a fee into a tree mitigation fund in-lieu of planting. Establishing a tree mitigation fund that allows funds to be used to plant trees on public and private property will give greater flexibility to plant trees where they are most needed. The tree replacement fee should be strong enough to discourage the wholesale tree removal on a site.

Requiring tree protection on private property for trees of a certain size during new or redevelopment can help reduce canopy loss in the community.

The town should create a more flexible tree protection zone. The current standard is to protect 30 feet from the base of the tree which in practice gives much greater protection to smaller trees while giving less protection to the largest trees in the community. The tree protection zone only applies to public trees. The Critical Root Zone (CRZ) is the zone where small roots at the radial extents of the tree root area uptake water and absorb nutrients. Protection of these roots is critical for the optimal health of a tree. Many municipalities require that tree protection fences be placed at the dripline. While protection at the dripline is an accepted practice, it does not adequately protect the roots. Instead, the town should require placement of tree protection fencing at a distance 1.5' times the tree's diameter at breast height (DBH) from the tree. For example, a 20-inch DBH tree would need its CRZ protected out to a distance of 30-feet while a 10-inch DBH tree would need its CRZ protected out to a distance of 15-feet. This formula adequately sizes tree protection of the CRZ based on the size of the tree and not a standard distance.



Tree Protection Fence and Signage

The ordinance should also include detailed standards for what constitutes tree protection mechanisms. The most common form of tree protection is tree fencing. It is a physical barrier that keeps people and machines out of a tree's critical root zone during construction. However, some municipalities only require plastic orange fencing and wooden stakes. This type of fencing can be removed or trampled easily and reduces protection effectiveness. Without effective barriers, even trees designated to be saved may suffer development impacts such as root compaction and trunk damage. The town should require sturdy metal chain link fencing in high-risk areas (e.g., near heavy construction equipment and active site grading) and use orange plastic fencing in lower risk areas (e.g. along the tree line at the edge of a development property).

The town currently does not require tree protection signage. Tree protection signage communicates how work crews should follow tree protection requirements. It also informs construction crews and citizens about the consequences of violating town code. Construction crew members may not understand that building materials may not be placed in tree protection zones and that moving the protective fencing around the tree is never permitted. The town should design a standard tree protection sign which summarizes the dos and don'ts of working near and around tree protection zones.

Soil volume and soil surface area standards for various sizes of trees.

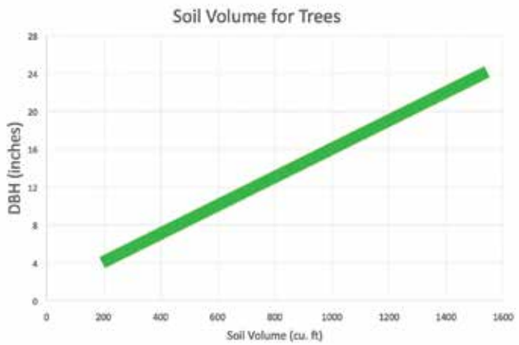


Table 1. Soil requirements for trees based on their size at maturity.

Tree Size at Maturity	Total Soil Area*	Distance From Paved Surface
SMALL Height: less than 30 ft	10 ft x 10 ft	2 ft
MEDIUM Height or less than 50 ft	20 ft x 20 ft	6 ft
LARGE Height or spread greater than 50 ft	30 ft x 30 ft	10 ft

*Measurements for when rootable soil depth is 3 feet or greater. For soil less than 3 feet deep, smaller maturing trees are recommended

Additional training may be helpful to ensure that developers comply with the town's tree ordinances and understand how to protect trees during construction. If the work crews are of different nationalities, consider signage that has multi-lingual instructions.

Other examples of best management practices for tree protection include require the severing of roots of nearby trees prior to being removed, require thick mulching (no more than 4-5") if heavy equipment is to be driven in the critical root zone, encourage (or require) boring versus trenching for utilities and irrigate protected trees during construction during periods of drought.

In urban environments, many trees do not survive to their full possible life span. Factors such as lack of watering or insufficient soil volume and limited planting space put stresses on trees, stunt their growth and reduce their lifespans. For every 100 street trees planted, only 50 will survive 13-20 years (Roman et al 2014). This means that adequate tree well sizing standards are a critical factor in realizing the advantages of a healthy urban forest allowed to reach its full potential.

To encourage proper planning, planting and design for trees on sites, the town should designate root soil volume and soil surface area standards. Tree roots need adequate soil volume and surface area to absorb water and promote gas exchange for healthy root growth. At a minimum, large canopy trees require 1000 cubic feet of soil volume to thrive. Additionally, the most critical factor for a tree to withstand hurricane force winds without falling over is adequate soil volumes to allow for proper tree anchorage into the ground. (Duryea 2007). The table on page 37 provides recommended soil volume and soil surface area standards for healthy tree growth and resistance to wind. In areas where space is tight or where heavy uses occur at the surface, underground tree support cells can be used to stabilize and direct tree roots towards areas with less conflicts (e.g., away from pipes).

In addition, large trees should not be planted where they may interfere with overhead lines. The town can promote better tree planting by specifying non-interference with utilities in the tree ordinance and on intake forms for street tree and tree setback plantings on private property. These and other practices, implemented to provide long term care, protection and best planting practices for the urban forest, will ensure that investments in town trees will pay dividends for reducing stormwater runoff, as well as cleaner air and water, lower energy bills, higher property values and natural beauty long into the future.

Emergency Response

The town is proactive when it comes to planning for the management of the community forest ahead of natural disasters. The town's Hazard Mitigation Plan clearly identifies the role and value trees play at mitigating environmental impacts such as stormwater and flooding. The plan also highlights several strategies using trees and other green infrastructure practices, such as planting trees, educating the public on tree health and maintenance and assessing the risk of public trees. Trees are a low cost, low impact solution to managing stormwater runoff. Specifically calling out green infrastructure practices and trees in the plan opens opportunities for federal funding through FEMA's grant programs. Identifying trees as green infrastructure and documenting the role they play at managing stormwater on public property and in rights-of-way makes them eligible for funding assistance through FEMA's Public Assistance grant program if the town experienced a federally declared disaster.

Planting trees in the right place can avoid harmful over pruning.

The town has a designated site for staging woody debris, but further analysis can be done to estimate how much debris could be generated from various categories of storms. The Army Corp of Engineers has a formula to estimate storm debris and the approximate sized debris management site. More information on estimating debris management sites can be found at GIC's storm planning website: https://gicinc.org/projects/resiliency/storm-mitigation-planning/

Another area of improvement is establishing an annual program to assess tree risk for public trees. The town could apply for funding from the Division of the Forest Environment to contract a tree risk assessment on its tree inventory data once it is complete. An annual Level-1 tree risk assessment of public trees, also known as a windshield survey, is a simple and relatively quick way to assess trees in the town for potential risk. This type of survey can help the town track trees with potential hazards and follow-up for a more detailed assessment and mitigation. Using the tree inventory the town can develop a risk management program for public trees and mitigate potential impacts from natural disasters such as winter storms.

Integration

Recommendations under "Integration" include incorporating urban forestry data (canopy data, tree inventory) throughout town departments and systems. Integrating this data also allows for various town staff to use and incorporate the data into their work such as planning staff who can use the data in daily and long-range planning. For example, staff can use this data to more strategically target plantings in neighborhoods with the greatest need or mitigate environmental harms such as stormwater runoff or extreme heat. In addition, by making the canopy data available online, the town can provide information to the public about this important natural asset. Integrating this data also allows for staff to understand the resources on site during the development review process and potentially limit tree loss from new development or infill.

Planning Process and Community Engagement

Steering Committee

The first step in the process was develop a steering committee of town staff and conservation and resiliency commission members to provide their knowledge and expertise when reviewing data, maps and tools. The steering committee participated in a series of six workshops each focused on a different area of analysis presented in this report. Using final land cover, Potential Planting Areas (PPA) data and each of the analyses, the steering committee created a list of proposed strategies and a proposed canopy goal. The proposed goal and strategies along with a summary of the results from the canopy study and codes audit were presented to the general public at an open house in October of 2023. The open house was an opportunity for the public to learn the results of the study and vote on the proposed goal and strategies developed by the steering committee. The voting results were reported to the steering committee which influenced the final strategies chosen. This process is only a first step in thinking strategically and engaging the public on a broader scale around the tree canopy. This information and community feedback will support future tree canopy planning for the Town of Barrington.

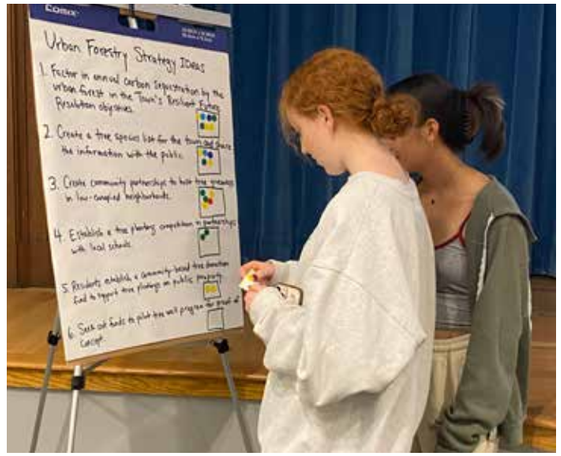


Photo credit: Town of Barrington

The Barrington community attended an open house in the fall of 2023 to review maps and learn more about the town's tree canopy.

Public Open House and Input

The Green Infrastructure Center held an open house on October 5, 2023 in the Salem Family Auditorium at the Barrington Public Library to share maps and findings from the canopy study with the public. GIC also presented the town's proposed canopy and strategies for increasing canopy or reducing its loss. Twenty-three members of the community showed up to learn more about the tree canopy and vote on the town's proposed strategies.

The Top Five Strategies

Voted Highest by the Public

- Develop outreach materials to educate the public on the benefits of trees and proper tree care. (17 votes)
- Create a tree species list for the town and share the information with the public. (14 votes)
- Replace invasive tree species with native tree species plantings. (14 votes)
- Factor in annual carbon sequestration by the urban forest in the Town's Resilient Future Resolution objectives. (12 votes)
- Coordinate community tree planting events such as Earth/Arbor Day activities. (9 votes)

Informing Other Existing Planning Efforts With Barrington

Community forest planning has roots in other existing planning efforts in the town. The following plans highlight previous community input for managing the community forest resource or are policies, programs or goals that align with many of the strategies and recommendations found within this document. The data from this study and many of the strategy ideas developed during the course of this project can inform other planning efforts in the town and identify ways to accomplish many of these stated goals. The integration of canopy data and planning of the town's green infrastructure will make other types of planning more successful by achieving many different goals. For example, this year the town is beginning its comprehensive plan update, which much of these data and subsequent strategies can help inform. Furthermore, the town is developing a climate action plan which the tree canopy data is already being used by the town's contractor in analyses. Both of these planning efforts illustrate the usefulness tree canopy data serves in the long-range planning of the town.

Barrington's Comprehensive Plan, 2015

Chapter 5: Natural and Cultural Resources

Goal NCR-1: Protect important natural areas, including wetlands, wildlife habitats, groundwater aquifers, and tl1e salt marshes especially around Hundred Acre Cove and the Barrington and Palmer Rivers.

Policy NCR-1.1.1: Evaluate potential open space protections based on the following criteria:

- Community benefit: promotes benefits for tl1e town at large- such providing land for recreational areas, expanding an existing open space network, or enhancing buffers.
- Connectivity: adds to die existing or planned open space system and enhances ecological, hydrological, and recreational vitality.
- Ecologically significant habitat (rare or endangered flora or fauna).
- Property provides storm water storage, flood protection, or groundwater recharge.

Actions:

A. Evaluate proposed protections of open space parcels, through acquisition, easements or other techniques, and identify priority areas based on Policy NCR-1.1.1

Goal NCR-1.2: By 2017, amend local regulations and procedures to improve protections of natural resources.

Policy NCR-1.2.1: Effectively regulate and enforce regulations protecting critical conse1vation lands from development impacts.

Actions:

D. Amend Zoning Ordinance and Land Development & Subdivision Regulations to establish review procedures to ensure development/ subdivision proposals provide dedicated open space consistent with tl1e Town's open space acquisition criteria.

E. Amend drainage and site plan design standards in tl1e Land Development & Subdivision Regulations to encourage low-impact development techniques.

Goal NCR-2: Effectively manage open space properties to maintain and protect conservation values of the Town's critical cultural and natural resources.

Policy NCR-2.1.1: Manage town owned property to ensure protection of important natural and cultural features, and develop regulations and/ or techniques for the protection of such land tl1at is privately owned, including scenic, historical and cultural sites.

Policy NCR-2.1.2: Encourage cooperation with private owners of open space parcels to establish public access, enhance trail connectivity, expand wildlife corridors and coordinate management responsibilities.

Actions:

A. Implement management plans developed for priority sites. Review and revise as necessary.

Goal NCR-3: Work to protect and restore water quality, including in Hundred Acre Cove, Brickyard Pond, Prince's Pond, and Annawamscutt Creek.

Policy NCR-3.1.1: Pursue cost-effective water quality measures and include projects in capital budget planning.

Actions:

A. Complete a watershed study within priority areas, including Town Beach and Brickyard Pond, to identify and prioritize future stormwater / water quality improvement projects, with an emphasis on "green infrastructure" such as rain gardens, where feasible. Prepare detailed plans as necessa1y to determine estimated costs and capitalize on funding opportunities available through the State or other sources.

B. Prioritize and phase in implementation of watershed study recommendations, emphasizing the most cost-effective measures.

C. Formalize a partnership (or consortium) with neighboring communities to adopt measures to improve water quality in Hundred Acre Cove.

D. Develop an education/ public outreach program on everyday uses and activities that contribute to the degradation of the water quality of local ponds and streams.

Chapter 6 Outdoor Recreation

Goal OR-1: Meet die community's evolving recreational needs, both passive and active, by providing high quality multiple-use outdoor recreation facilities benefiting people of all ages.

Policy OR-1.1.1: Emphasize improving existing facilities over acquisition of new properties in order to fully realize the potential of die Town's assets and limit conversion of natural areas into active recreational facilities.

Actions:

A. Develop park master plans in order to establish capital improvement priorities.

B. Include park improvements in long-term capital budget planning based on master plan priorities. Budgeting for die park improvements will put the Town in die position of leveraging local funding with grants that require a match.

Goal OR-2: Create an "emerald chain" of parks by establishing and improving linkages between and within recreational areas throughout town, including facilities at schools, to provide passive recreation opportunities and alternative routes to parks and other areas throughout town.

Policy OR-2.1.1: Support creation of a cohesive system of open space prope11ies and trails.

Actions:

F. Establish South Lake Drive between Washington Road and North Lake Drive as a multimodal facility providing a safe walking/biking area within the right of way while also maintaining vehicular traffic.

Chapter 8 – Natural Hazards

Goal NH-1: Reduce current and future risk of natural hazards and sea level rise to the built environment.

Objective NH-1.1: By 2018 complete a townwide assessment of the potential impacts to structures and infrastructure resulting from projected sea-level rise.

Policy NH-1.1.1: Plan for effects of projected sea level rise and flooding in die site selection and planning of parks, buildings and other public projects.

Policy NH-1.1.2: Reduce impact of development within the floodplain and other vulnerable areas.

Actions:

A. Complete an assessment of potential impacts, including physical and financial, of projected sea-level rise on publicly and privately owned buildings and sites, roads, storm-water systems, sewer systems and other utilities.

B. Include in the six-year capital improvement program critical projects required to mitigate threats to infrastructure and properties.

C. Consider requiring smaller lot sizes, such as through a cluster subdivision design, to ensure development is outside die existing or projected floodplain, reducing potential impacts of rising sea levels.

F. Adopt low-impact development standards to reduce the amount of impervious coverage, such as reduced street widths and a maximum impervious lot coverage percentage.

G. Provide measures to improve stormwater retention in the planning and design of park improvements and construction of schools and other new public buildings.

I. Improve Geographic Information Systems (GIS) capabilities to support assessment and planning activities.

Goal NH-2: Preserve and enhance the capacity of the natural environment to improve Barrington's resilience against impacts of natural hazards.

Policy NH-2.1.1: Identify and protect critical open space areas that are vulnerable to natural hazards and sea level rise.

Policy NH-2.1.2: Plan for and implement projects that allow natural systems to adapt over time to cl1anges in sea level rise and die climate.

Actions:

B. Implement a tree management program to reduce risk to property due to winds, heavy snow/ice or other natural hazard impacts, to include:

- Identification of tree species that will be most resilient to climate change and use these species in public projects.
- Requiring resilient tree species in new subdivisions and land development projects.

D. Develop plan to allow restoration of natural areas at Walker Farm.

Goal NH-3: Reduce flood risk and the cost of flood insurance within Barrington.

Objective NH-3.2: Achieve a Community Rating System score of "7" or better by 2020 (with "1" being the top score).

Policy NH-3.2.1: Participate in die Community Rating System and provide resources necessary to run an effective program that reduces future risk and results in a CRS score of 7 or better.

Policy NH-3.2.2: Maintain a FEMA-approved Hazard Mitigation Plan that is based on die latest data and proposes strategies on natural hazards and climate change.

Actions:

C. Complete die required Hazard Mitigation Plan7 five-year update that addresses effects of climate change and includes activities that would achieve a CRS goal of "7" by 2020. Update die plan as necessary to address impacts of new significant natural hazard events such as severe flooding, wind damage and storm surge.

Goal NH-4: Improve die community's awareness of threats to minimize risk to die public due to natural hazards.

Policy NH-4.1.1: Inform die public on die concept of community resilience and die risk of impacts from natural hazards.

Actions:

B. Conduct community outreach, including public forums and publication/ posting of information at Town facilities and die website, on natural hazard mitigation initiatives, preparedness and response. Program should include:

- Opportunities property owners can take to mitigate future impacts; include "how-to" sessions on mitigation activities including house elevation projects.

Town of Barrington Rhode Island, Hazard Mitigation and Flood Management Plan 2022

Goal 1: Reduce impacts from current and future natural hazards to the built environment.

Action 2022-1.1: Assess Hurricane Evacuation Routes Vulnerabilities.

Perform a risk assessment of trees located along these routes for defects or failures.

Action 2022-1.3: Increase DPW (Department of Public Works) capacity to allow for more aggressive stormwater management for public facilities and roadways.

Identify best management practices for stormwater management with emphasis on green infrastructure, which includes the planting and maintenance of trees.

Provide measures to improve stormwater retention in the planning and design of park improvements and construction of schools and other new public buildings. Increase the amount of tree canopy on these sites through required tree plantings.

Continue and strengthen Town management of public trees to mitigate hazards such as stormwater, flooding, erosion and extreme heat.

Action 2022-1.5: Continue to improve GIS capabilities.

Create a GIS layer identifying all public trees along road ROWs; and shoreline access points.

Hire a consultant to conduct a GIS based tree canopy assessment to identify areas for greater stormwater, mititgation of urban heat island effects, and reducing inequities in canopy distribution.

Action 2022-1.8: Review and adopt Barrington appropriate LID standards to reduce impervious surfaces within new subdivisions and other private development projects.

Adopt tree planting standards for increased stormwater absorption and water quality treatment (trees as BMPs).

Goal 2: Preserve and enhance the capacity of the natural environment to improve Barrington's resilience against impacts of natural hazards.

Policy 2.3: Preserve existing tree canopy and maintain public trees for their value as green infrastructure and their ability to mitigate natural hazards such as stormwater, flooding, erosion, and extreme heat.

Action 2022-2.1: Increase DPW capacity to allow for more aggressive tree maintenance and management program.

Improve program to further reduce risk to people or property due to winds, heavy snow/ice, extreme heat, or other natural hazard impacts.

Identify native tree species that will be more resilient to climate change and have higher carbon sequestration rates, for use in public projects and new subdivisions and land develpoment projects.

Elevate the importance of forests and trees; increase community based planting opporuntities, including partnering with BLCT to implement tree planting projects on their properties.

Complete a town-wide tree inventory, planting plan using native tree species, and updated debris management plan.

Create a list of undesired species which are prone to breakage or failure and identify these on the tree inventory for potential replacement.

Develop a long-term urban forest recovery plan post-disaster which includes potential planintg spots and identifies community partners to support the urban forest's recovery.

Investigate incentives for developers to save mature trees or plant more on development sites.

Residential properties play a key role in the stewardship of the urban forest.

Goal 4: Through communication and educational outreach, improve the community's awareness and capacity to reduce or adapt to impacts from natural hazards.

Policy 4.2: Educate the public on the value of trees to mitigate hazards such as stormwater, flooding, erosion, and extreme heat; and encourage tree protection and planting in the community.

Action 2022-4.1: Conduct community outreach to increase awareness and improve preparedness for impacts of natural hazards.

Increase awareness amongst residents about the benefits of green infrastructure such as trees, parks, and wetlands that can absorb and store stormwater and floodwaters and is a part of the Town's stormwater system.

Educate the public on tree species appropriate for property protection and proper upkeep (right tree/right place) and the benefits trees with respect to flooding and heat index; discuss how to deal with invasive species.

Trees can be placed to compliment and not interfere with other facilities in parks and open spaces, while providing needed shade and stormwater management.

Barrington, Municipal Resilience Program, Community Resilience Building Workshop Summary of Findings, October 2019

Environmental Challenges and Concerns:

Trees and Forests:

- Increasing impacts to tree health from pests and pathogens resulting in a large population of dead and damaged trees posing risks to power lines and blocking of roads during emergencies.

Higher Priority Projects:

- Explore and prioritize additional shoreline adaptation projects for low-lying, dead- end roads at the shore across municipality which may include pavement removal and green infrastructure to manage runoff and erosion.
- Identify best management practices for stormwater management at Town Beach and install proper green stormwater infrastructure projects to minimize localized flooding and erosion.
- Continue to conduct tree maintenance operations in partnership with municipality and RIDOT on high priority power corridors.

Moderate Priority Projects:

- Elevate the importance of forests and trees across municipality via local municipal nursery establishment to supply native trees and shrubs that are more resilient to changes in climate and increased community-based planting opportunities.
- Seek to reduce stormwater runoff into wetlands and waterways via the use of green stormwater infrastructure (i.e. rain gardens, bioswales) across municipality.

Lower Priority Projects:

- Install flood resilience projects including nature-based solutions and green infrastructure at Barrington High School as well as relocate facility utilities in second floor or on roof.

Strategies and Recommendations

The strategies in this report were developed in workshops with the technical advisory committee and voted on by community members. GIC made additional recommendations. All strategies and recommendations are based on the land cover and ecosystem service modeling, analysis of the tree canopy and potential planting areas and the codes, or ordinances and policy review.

The top strategies and recommendations to improve tree canopy cover in Barrington listed in priority order include:

1 Develop outreach materials to educate the public on the benefits of trees and proper tree care.

Trees provide many functional benefits to our communities, from managing stormwater and extreme heat to improving public health and increasing quality of life for residents. It is important that the general public be aware of these values and that the urban forest resource needs to be managed on both public and private properties. By giving residents more information on proper tree care and maintenance, the community can become better stewards and contribute to sustaining this resource in the town.

Additional GIC Recommendations

- **Create a webpage on the town's website with resources and links on trees and the community forest.**
  A dedicated centralized webpage about the Town's tree canopy can host important education material and links for the public to access information and resources on tree care, placement and municipal tree programs. The town could eventually create a story map of its tree canopy data to allow residents access to see where canopy is robust and lacking in the community.

2 Create a tree species list for the town and share the information with the public.

An approved tree species list for the town will guide developers and residents to choose trees that are suited for Barrington's climate, the site location, are not invasive and limit potential conflicts with other nearby infrastructure such as utilities. The town can regularly update this list to ensure tree species diversity is maintained as new data is collected through the public tree inventory or as the local climate changes due to global warming. Tree species diversity is also important to increase the resiliency of the urban forest to pests and diseases that exist or may be introduced to the region.

Additional GIC Recommendations

- **Create a prohibited tree species list.**
  A prohibited list will compliment a preferred tree species list by clearly designating undesirable tree species from being planted by developers or the general public. A town tree species list can limit the species that are prone to pests, for example Emerald Ash Borer, which is an insect pest that is decimating the ash tree, a once commonly planted tree along the streets of cities across America. Other undesirable species include invasive tree species (for example Norway maple) or species with poor structural traits such as weak branch connections (Bradford pear) or prone to decay (Eastern cottonwood) which create a greater risk of tree parts failing during storms or high wind events. Keeping these species from being planted in the community in the first place will create a more resilient urban forest.

3 Replace invasive tree species with native tree species plantings.

The town's tree inventory will allow it to identify public trees that are known to be invasive to be removed and replaced by native species or nonnative, non-invasive cultivars. The town can analyze the tree inventory data and develop a replacement plan that can be phased in over time. This type of plan can be integrated into other municipal planning efforts such as capital improvements or the maintenance of the rights-of-way. When the town or other public agencies are upgrading or maintaining grey infrastructure, new trees can be replaced or better tree wells installed that give more soil surface area and volume to support healthier native tree growth. This plan can also help build greater collaboration with Rhode Island Department of Transportation and the local electrical utility to better manage the tree canopy in ROWs.

4 Factor in annual carbon sequestration by the urban forest in the Town's Resilient Future Resolution objectives.

The town is currently in process of developing a climate action plan for the community. Elements of this climate action plan will include accounting for and tracking greenhouse gas emissions. The urban forest is a critical piece to account for and is one of the few areas of town infrastructure and management that can offset the balance of emissions. The carbon sequestration and storage data along with the air pollution calculations can play an important role as the town tracks and monitors its emissions. The town can also seek out funding opportunities through state and regional funding sources to plant more trees to offset carbon dioxide and other emissions. Another option the town can consider is getting credits from planting urban trees and then selling them through the voluntary carbon market. The nonprofit organization City Forest Credits (website: https://www.cityforestcredits.org/) works with communities to develop projects to receive carbon credits for urban tree plantings. These carbon credits can be sold to generate funds for the maintenance of a community's urban forest program. All tree plantings must be located on publicly-owned properties and voluntary, meaning they cannot be tree plantings that are required through local code enforcement or mitigation. There are long-term monitoring and reporting requirements for tracking the survivorship of trees over the course of the agreement, but this can be an opportunity for communities with limited funding for the urban forest to access funds for public tree management and care.

Trees and forests are natural carbon sinks and a low-cost solution to offsetting carbon emissions through their protection and planting.

5 Coordinate community planting events such as Earth/Arbor Day activities.

The town works with local community groups such as Master Gardeners and the Rhode Island Tree Council to plant trees in the community. More opportunities to engage with residents and volunteers will build local capacity for urban forest management. Besides community tree planting events, the town should consider expanding into giving away trees during local celebrations such as Arbor Day or Earth Day. Since the local government only manages approximately 20% of the land and ROW in the town's boundary, it is important to encourage voluntary tree plantings on private property.

Photo credit: Town of Barrington

Tree planting events like this one at Police Cove Park and Woods Pond, in partnership with community groups, can help get more trees planted in Barrington.

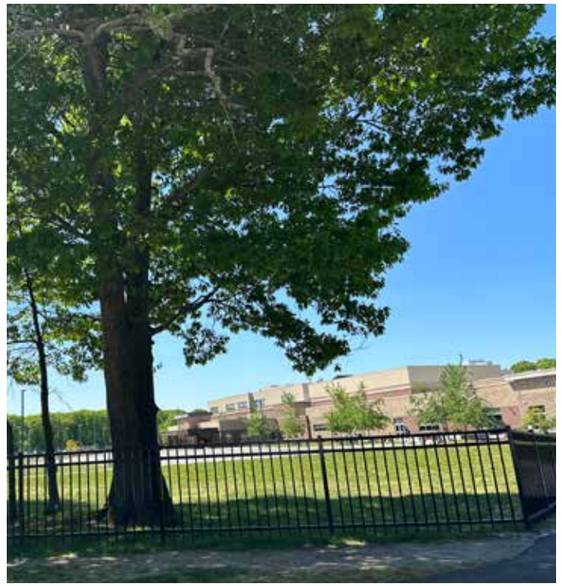
> **Tree giveaways are one of the most popular and cost-effective ways to get trees planted on private property.**

6 Create community partnerships to host tree giveaways in low-canopied neighborhoods.

Prioritizing low-canopied neighborhoods for tree giveaways will jumpstart the replacement of canopy in areas that need it most. Tree giveaways are one of the most popular and cost-effective ways to get trees planted on private property and provide an opportunity to educate the public on proper tree planting, care and maintenance. The town can start off by giving away a small number of trees, and then build from there as the community gains interest in this type of programming. The town should pull in community partners such as the Conservation Commission, Master Gardeners or other groups to support the planning of the event and day of logistics. Tree giveaways are also a way for the town to prioritize specific species or native trees in the giveaway, influencing over time the composition of the urban forest, even on private property.

7 Develop an urban forest management plan to support priority tree maintenance.

An urban forest management plan (UFMP) details the process for managing the town's community forest. It is used to achieve local government and community goals to proactively manage the town's canopy and achieve long term benefits. A UFMP also informs budgeting for urban forest maintenance or tree planting. An urban forest management plan requires data to inform it including canopy and tree inventory data. An urban forest management plan is different from this plan, in that it prioritizes maintenance needs for all public trees and estimates the resource needed. Then it develops a timeline for implementing the necessary maintenance. UFMP are typically on a 5-year cycle and need updating as the work is completed or new challenges arise such as damage from storms. Once the town has finished its tree inventory it can develop an urban forest management plan for its public trees and make sure that it is adequately funded to meet maintenance needs. Replacing invasive tree species with native tree plantings is a task that could be planned for and incorporated into an urban forest management plan.



Many potential tree planting opportunities exist at local area schools. The town can explore how to engage with students to create the next generation of stewards in the community.

8 Establish a tree planting competition in partnership with local schools.

Establishing the next generation of tree stewards in the community is key for the long-term sustainability and management of Barrington's urban forest. A friendly and competitive tree planting competition between schools or among homerooms in a single school can generate enthusiasm and interest by youth in the town's community forest. Many high schools require community service hours as a part of graduation requirements and tree planting and stewardship can be an excellent way for students to give back to their community and create a legacy at their school.

9 Coordinate a speaker series on community forestry and the town's trees.

Educational programming on tree planting and care, stormwater green infrastructure or other tree-related topics is a great opportunity to routinely engage with residents in the community. Many organizations provide this type of educational programming as part of their mission. Some examples include the Rhode Island Tree Council, Groundworks RI, Garden Time and the Eastern Rhode Island Conservation District. Partnering with existing organizations that specialize in education and outreach can expand the reach of the town's community engagement.

10 Establish a community-based tree donation fund to support tree plantings on public property.

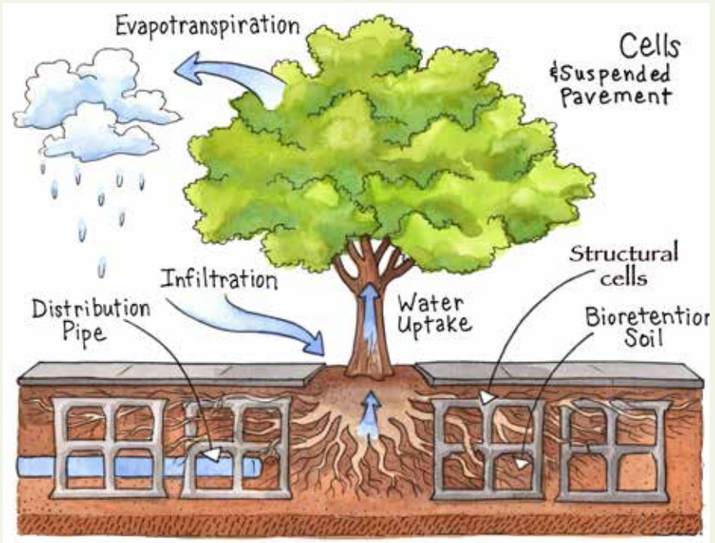
Many communities establish a tree donation fund that residents can voluntarily contribute money for new tree plantings. These types of funds are often structured as memorial funds or honorariums that connect a gift to the memory of a loved one. This type of fund can provide additional resources for new tree plantings in the community and a great way to connect the past to the present and future as the legacy of these memorials live on in the community.

Many communities establish a memorial tree fund that residents can donate to honor the memory of a loved one through tree plantings. Often these trees are planted in cemeteries or other public properties or in rights-of-ways.

Additional GIC Recommendations

- **Require and enforce 600, 1,000, and 1,500 cubic feet soil volume planting requirements for small, medium, and large trees respectively.**

  At a minimum, canopy trees require 1,000 cubic feet of soil volume to thrive, as recommended by the Environmental Protection Agency (Stormwater to Street Trees, 2013). Soil volume allows for adequate room for root growth which will help keep the tree healthier for longer, further extending the investment of green infrastructure. Greater soil volume and soil areas will also decrease a tree's risk of failure during a storm by providing adequate area for root anchoring. When planting sites are narrow or surrounded by impervious surfaces then municipalities can consider structural cells which provide the support and hard surface needs for high trafficked areas, but also provide the adequate soil volume needed for healthy tree growth. These structural cells can also function, depending on the design, as a way to capture stormwater runoff and irrigate the tree.



Structural Cells and Suspended Pavement are techniques to integrate trees in highly impervious areas.

- **Update the tree protection ordinance to include protecting trees on private property and require tree mitigation when significant trees must be removed to accommodate development.**

  Trees are part of the town's infrastructure and impact both public and private properties alike. By increasing the protection of trees on private property, the town can conserve and minimize tree canopy loss over time. Tree mitigation fees or penalties should be strong enough to limit the wholesale clearing of trees on a site, but not so punitive to limit necessary development. A tree mitigation fund should also be flexible to allow for tree plantings on both public and private property.

- **Incentivize developers to incorporate and retain mature trees on sites and protect those trees during construction.**

  Large mature trees provide greater and more immediate ecosystem service benefits than newly planted trees used for mitigation. The town's code can be amended to incentivize retention of mature trees for meeting stormwater requirements. Other types of incentives include faster permitting for preserved trees or patches of forest. The tree preservation code should also provide specific protections for mature trees during the construction process such as require fencing a distance of 1.5' times the tree's diameter at breast height (DBH) from the tree, exclude storage and staging of materials near the tree, place clearly visible signage and avoid trenching utilities that would impact tree roots. Existing large trees should be indicated on site plans along with tree protection measures.

Additional GIC Recommendations

(Continued)

- **Continue the integration of planning for trees in all planning and pre-development activities.**

  Holding pre-development conferences before sites are designed allows for creative solutions for tree retention to be considered as well as to calculate potential stormwater impacts from tree removal or planting. Sketching these site design ideas to protect trees early on allows for exploration of ideas for tree conservation before extensive funds are spent on site planning.

- **Integrate public tree inventory data into asset management systems.**

  Once the town finishes collecting a tree inventory for all public trees the data should be integrated into the town's asset management tracking systems where other types of public infrastructure are tracked and managed. This will allow the town to track and monitor its assets for tree locations, condition and maintenance needs as further work is conducted over time. These records are critical for securing future FEMA reimbursement to replace trees under its Public Assistance grants available after federally-declared disasters.

The town can do rapid tree risk assessments to flag trees for further evaluation that are within the public rights-of-way. Then follow-up to mitigate risk before the next storm.

- **Proactively conduct annual tree risk assessments on public trees in highly trafficked areas of the town.**

  Tree risk assessments can be used to determine and develop plans to mitigate tree risks, such as diseased limbs that may fall. This information is a great baseline dataset the town can use to develop a risk management program for town trees. In highly trafficked areas, a Level-1 assessment, also known as a windshield survey, should be done annually for all public trees. Implementing proactive tree risk assessments will reduce overall risks and potential losses. The town should develop a formalized tree risk assessment program to ensure this work is being done consistently every year.

- **Conduct a land cover assessment every four to six years to compare tree canopy coverage changes over time.**

  Tree canopy coverage should be expanded and maintained to promote public health, walkability, water quality and groundwater recharge. Regular updates to land cover maps also track trends (losses or gains) in the canopy over time. It allows for monitoring and supports adaptive management for prioritizing planting strategies. This will also be a useful measure to help the town track its progress.

Conclusion

The community of Barrington has started to collect data for the management of its urban forest. These data (canopy data, codes audit) provide a variety of assessments that can inform actions and strategies moving forward. Other new types of data in process of collection (tree inventory) can support further decision-making around its green infrastructure assets. Implementing these strategies and recommendations will significantly reduce the impact of stormwater sources (impervious cover) and benefit the local ecology by using native species (trees and other vegetation) to uptake and clean stormwater along with other ecosystem service benefits (air quality, urban heat island, etc.). It will also lower costs of tree cleanup after storms since proper pruning or removal of trees deemed to be at risk can be done before storms occur.

Barrington should use the canopy map and updates to track canopy change over time and prioritize increasing canopy by neighborhoods to restore lost canopy. The town can use the canopy data, analysis and recommendations and stormwater calculator tool to continue to create a safer, cleaner, cost-effective and more attractive environment for all.

Next Steps

An urban forest management plan is another key plan the town should develop to ensure that it has detailed and actionable processes to care for and manage its trees. Grant funding is available from the Rhode Island Division of Forest Environment's Urban and Community Forestry Program for such activities. A key aspect of urban forest management is integrating urban forestry within emergency response plans. This should be coordinated with the Rhode Island Emergency Management Agency and adjacent communities who share similar concerns about storm debris and removal or repurposing. Given the many benefits that trees provide (increased groundwater infiltration, soil stability, and reduced runoff and flooding, shade and better air quality), the town should plan for funding and replacement tree plantings following natural disasters. Codifying trees as green infrastructure to mitigate stormwater and erosion will make them eligible for replacement under FEMA's Public Assistance grants. Tree inventory data (location, species, trunk diameter, photo) the town collects will support the necessary documentation to claim a tree as eligible for reimbursement if lost or damaged by a federally-declared storm or other natural disaster. Including tree maintenance records and expenditures as part of the town's asset management system will demonstrate the role trees play as critical green infrastructure.

Lastly, it is recommended that the town conduct a land cover assessment every four to six years to compare tree canopy change over time and track progress towards maintaining its 51% coverage goal. Keeping tree canopy coverages at levels that promote public health, walkability, and clean water is vital for livability and for meeting state water quality standards. Regular updates to land cover maps allow for this analysis and planning to take place and to identify and address negative trends as well. These and other practices, implemented to provide long term care, protection and best planting practices for the urban forest, will help ensure that investments in town trees will pay dividends for reducing stormwater runoff as well as clean air and water, lower energy bills, higher property values and natural beauty long into the future.

Appendixes

Appendix A: Land Cover Analysis Methods

This section provides technical documentation for the methodology used to classify land cover and create Potential Planting Spots (PPS) and Potential Canopy Area (PCA) scenarios for the town. Land cover classifications are an affordable method for using aerial or satellite images to obtain information about large geographic areas. Algorithms are trained to recognize various types of land cover based on color and shape. In this process, the pixels in the raw image are converted to one of several types of pre-selected land cover types. In this way, the raw data (the images) are turned into information about land cover types of interest, e.g., what is pavement, what is vegetation. This land cover information can be used to gain knowledge about certain issues; for example: What is the tree canopy percentage in a specific neighborhood?

Method

Satellite imagery from the National Agricultural Imagery Program (NAIP) distributed by the USDA Farm Service Agency was classified to determine the types and extent of different land covers in Barrington.

1. Canopy maps were created using the NAIP imagery, captured in 2021. Current LiDAR data was not available at the time of classification, so we used an ArcGIS extension called Feature Analyst to identify the tree canopy. Feature Analyst employs machine learning for feature classification, and we trained it to complete the classification by digitizing canopy samples, which were then fed to the learning model, along with NDVI (Normalized Difference Vegetation Index) values calculated from the NAIP imagery.
2. Once we had an accurate canopy classification, we proceeded with obtaining the remaining land cover classes:
3. **Tree Canopy over impervious** are canopy features that overlapped Impervious surfaces primarily created from existing vector data.
4. **Wetlands** were identified using the National Hydrography Dataset.
5. **Wooded wetlands** were identified based on where NDVI is above 0 OR feature height is above 10 ft and intersects NWI water/wetland.
6. **Turf/Pervious** are features identified as "green" or typically above 0 in NDVI but were not identified as canopy by Feature Analyst.
7. **Impervious surfaces** were created by buffering road centerlines, along with building footprints.
8. **Bare earth** is sometimes confused with Impervious surfaces, but typically had a NDVI value closer to 0.

A Confusion matrix was run to test the accuracy of the canopy data which resulted in ....

CLASS VALUE	Tree Canopy	Pervious	Water*	Impervious	Bare Earth	Wetland	Total	Accuracy	Kappa
Tree Canopy	50	1	0	0	0	0	51	98.0%	0
Pervious	0	23	0	1	1	0	25	92.0%	0
Water	0	0	2	0	0	1	3	66.7%	0
Impervious	0	0	0	14	0	0	14	100%	0
Bare Earth	0	0	0	0	0	0	0	0.0%	0
Wetland	0	0	0	0	0	7	7	100.0%	0
Total	50	24	2	15	1	8	100	0.0%	0
P_Accuracy	1	0.96	1	0.93	0	.88	0	96.0%	0
Kappa	0	0	0	0	0	0	0	0.0%	0.94

The result of this confusion matrix allowed GIC to determine that the overall land cover classification had an accuracy of 96%.

Note: Bare earth is easily misidentified with pervious surfaces. Curve numbers in the TSW Calculator are similar and this does not affect analysis. In some places, sidewalks or golf cart paths were identified as bare earth under canopy. There are few places like this, and the overall area of the class is small – so the percentage may appear high.

NAIP Imagery from 2021 was used for the land cover classification.

NAIP Image 2021

Potential Planting Area (PPA)

Potential Planting Spots (PPS)

Potential Canopy Area (PCA)

Potential Planting Area Dataset

The Potential Planting Area dataset has three components. These three data layers are created using the landcover layer and relevant data in order to exclude unsuitable tree planting locations or where it would interfere with existing infrastructure.

- **Potential Planting Area (PPA)**
- **Potential Planting Spots (PPS)**
- **Potential Canopy Area (PCA)**

The Potential Planting Area (PPA) is created by selecting the landcover features that have space available for planting trees, then eliminating areas that would interfere with existing infrastructure.

Initial inclusion selected from GIC-created land cover pervious surfaces class.

Exclusion features applied:

- The pervious surfaces were buffered in 10 ft. from all impervious surfaces including buildings and roads.
- Playing fields (i.e.: baseball, soccer, football) as well as golf courses, cemeteries, airports and other incompatible land uses were identified where visually possible. (Digitized by GIC)
- Power Line Corridors and Major Road Median exclusions were created by buffering their representative line data.
- Once this initial phase was completed, the Potential Planting Area data were reviewed by the town and manually edited to best represent town expectations of where planting was allowed (e.g., not on play fields). In addition, areas that were known to be planned for development were removed.

This additional work to exclude known areas that cannot be planted resulted in a more accurate and realistic calculation of plantable areas and the number of new trees that can be added.

Potential Planting Spots. The Potential Planting Spots (PPS) are created from the PPA. The potential planting areas (PPA) are run through a GIS model that selects spots a tree can be planted depending on the size tree's that are desired.

- Tree planting scenarios were based on a 20 ft. and 40 ft. mature tree canopy with a 30% overlap. Therefore, the planting spots are 16 ft. and 32 ft. apart respectively.

Potential Canopy Area. The Potential Canopy Area (PCA) is created from the PPS. The possible planting spots are given a buffer around each point that represents a tree's mature canopy. First, larger canopy trees are digitally added, followed by smaller trees in the remaining spaces. Planting spots were assigned a buffer of 10 or 20 ft. to result in 20 and 40 ft. tree canopy that overlaps by 30%. This reduces gaps that would be found at the corners of adjacent circles and reflects the reality that trees overhang and intermingle with adjacent trees.

Appendix B: Trees to Offset Stormwater Calculator

The trees and stormwater calculator (TSW) tool developed by GIC uses modified TR-55 curve numbers to calculate stormwater uptake for different land covers, since they are widely recognized and understood by stormwater engineers. A canopy interception factor is added to account for the role trees play in interception of rainfall based on location and planting condition (e.g., trees over pavement versus trees over a lawn or in a forest).

Tree over street

Trees over forest

Tree over lawn

Tree over parking lot

Cities usually use TR-55 curve numbers developed by the Natural Resources Conservation Service (NRCS) to generate expected runoff amounts. The modified TR55 curve numbers (CN) provided by GIC includes a factor for canopy interception. Cities can use the stormwater calculator tool for setting goals at the watershed scale for planting trees and for evaluating consequences of tree loss as it pertains to stormwater runoff. Curve numbers produced for this study can be utilized in the town's modeling and design reviews.

Tree canopy reduces the proportion of precipitation that becomes stream and surface flow, also known as water yield. A study by Hynicka and Divers (2016) modified the water yield equation of the NRCS model by adding a canopy interception term (Ci) to account for the role that canopy plays in capturing stormwater, resulting in:

$$R = \frac{(P - C_i - I_a)^2}{(P - C_i - I_a) + S}$$

Where **R** is runoff, **P** is precipitation, **Ia** is the initial abstraction (the fraction of the storm depth after which runoff begins), and **S** is the potential maximum retention after runoff begins for the subject land cover **(S = 1000/CN – 10)**.

Major factors determining **CN** are:

- The hydrologic soil group (defined by surface infiltration rates and transmission rates of water through the soil profile, when thoroughly wetted)
- Land cover types
- Hydrologic condition – density of vegetative cover, surface texture, seasonal variations
- Treatment – design or management practices that affect runoff

This new approach allows for more detailed assessments of stormwater uptake based on the landscape conditions of the town's forests. It distinguishes whether the trees are within a forest, a lawn setting, a forested wetland or over pavement, such as streets or sidewalks because the conditions and the soils in which the tree is living affect the amount of water the tree can intercept and infiltrate.

The analysis can be used to create plans for where adding trees or better protecting them can reduce stormwater runoff impacts and improve water quality. This methodology was developed and tested in 13 communities in the south under a grant from the Southern Region of the USDA Forest Service. For more about the project, please visit: https://gicinc.org/projects/resiliency/trees-and-stormwater/

Appendix C: Bibliography

_____ Appendix: Hynicka, Justin, and Marion Divers. “Relative reductions in non-point source pollution loads by urban trees.” in Cappiella, Karen, Sally Claggett, Keith Cline, Susan Day, Michael Galvin, Peter MacDonagh, Jessica Sanders, Thomas Whitlow, and Qingfu Xiao. “Recommendations of the Expert Panel to Define BMP Effectiveness for Urban Tree Canopy Expansion.” (2016).

_____Runoff and infiltration graphic. EPA Watershed Academy Website. Accessed September 01, 2022: https://cfpub.epa.gov/watertrain/moduleFrame.cfm?parent_object_id=170

_____“Complete Green Streets. Smart Growth America.” Website accessed September 01, 2022: https://smartgrowthamerica.org/what-are-complete-streets/

_____ Penn State Extension, Trees and Stormwater: Website accessed Jan. 1. 2020 https://extension.psu.edu/the-role-of-trees-and-forests-in-healthy-watersheds

_____“Stormwater to Street Trees.” U.S. Environmental Protection Agency, September 2013. EPA report # EPA 841-B-13-001. Web site accessed September 01, 2022: https://www.epa.gov/sites/production/files/2015-11/documents/stormwater2streettrees.pdf

Akbari, Hashem, Melvin Pomerantz, and Haider Taha. “Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas.” in *Solar energy*, Vol. 70, No. 3 (2001): pp295-310.

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

Benedict, Mark A. and Edward T. McMahon, “*Green Infrastructure: Smart Conservation for the 21st Century*.” Washington, D.C., Sprawl Watch Clearing House, May 2002. Accessed September 01, 2022: http://www.sprawlwatch.org/greeninfrastructure.pdf

Booth, Derek B., David Hartley, and Rhett Jackson, “Forest cover, impervious-surface area, and the mitigation of stormwater impacts.” in JAWRA *Journal of the American Water Resources Association*, Vol. 38, No. 3 (2002): pp 835-45.

Cappiella, Karen, Sally Claggett, Keith Cline, Susan Day, Michael Galvin, Peter MacDonagh, Jessica Sanders, Thomas Whitlow, and Qingfu Xiao. “Recommendations of the Expert Panel to Define BMP Effectiveness for Urban Tree Canopy Expansion.” (2016).

Climate Project.” *Urban ecosystems* 1, no. 1 (1997): 49-61.

Correll, Mark R., Jane H. Lillydahl, and Larry D. Singell. "The effects of greenbelts on residential property values: some findings on the political economy of open space." *Land economics* 54, no. 2 (1978): 207-217.

Duryea, Mary L., and E. L. I. A. N. A. Kampf. "Wind and Trees: Lessons Learned from Hurricanes: FOR 118/FR173, 9/2007." EDIS 2007, no. 20 (2007).

Dwyer, John F., E. Gregory McPherson, Herbert W. Schroeder, and Rowan A. Rowntree. “Assessing the benefits and costs of the urban forest.” in *Journal of Arboriculture*, Vol. 18 (1992), pp 227-34

Ernst, Caryn, Richard Gullick, and Kirk Nixon. "Conserving forests to protect water." *Am. Water W.* Assoc 30 (2004): 1-7.

Fazio, James R. “How trees can retain stormwater runoff.” in *Tree City USA*, Bulletin 55 (2010): pp1-8.

Federal Emergency Management Agency (FEMA), 2020, Public Assistance Program and Policy Guide, Version 4, Effective June 1, 2020.

Gregory, J.H., Dukes, M.D., Jones, P.H. and Miller, G.L., 2006. Effect of urban soil compaction on infiltration rate. *Journal of soil and water conservation*, 61(3), pp.117-124.

Gregory, Justin H., Michael D. Dukes, Pierce H. Jones, and Grady L. Miller. "Effect of urban soil compaction on infiltration rate." *Journal of soil and water conservation* 61, no. 3 (2006): 117-124.

Kuehler, Eric, Hathaway, Jon, and Tirpak, Andrew, “Quantifying the benefits of urban forest systems as a component of the green infrastructure stormwater treatment network.” in *Ecohydrology*, Vol. 10, No. 3 (2017).

McPherson, E. Gregory, and Muchnick, Jules, “Effect of street tree shade on asphalt concrete pavement performance.” in *Journal of Arboriculture*, Vol. 31, No. 6 (2005) p303-10.

McPherson, E. Gregory, David Nowak, Gordon Heisler, Sue Grimmond, Catherine Souch, Rich Grant, and Rowan Rowntree. “Quantifying urban forest structure, function, and value: the Chicago Urban Forest Climate Project.” *Urban ecosystems* 1, no. 1 (1997): 49-61.

Meenakshi, Rao, L.A. George, T. N. Rosenstiel, V. Shandas, A, Dinno, "Assessing the relationship among urban trees, nitrogen dioxide, and respiratory health," *Environmental Pollution*, Volume 194, November 2014, Pages 96-104 https://phys.org/news/2014-09-trees-asthma-respiratory-diseases.html

Nowak, David John, E. Robert III, Daniel E. Crane, Jack C. Stevens, and Jeffrey T. Walton. "Assessing urban forest effects and values: Washington, DC’s Urban Forest." Resour. Bull. NRS-1. Newcity Square, PA: US Department of Agriculture, Forest Service, Northern Research Station, 24 p. 1 (2006).

Nowak, D.J., and Greenfield, E.J., 2012 “Tree and impervious cover change in U.S. cities.” in *Urban Forestry & Urban Greening*, Vol. 11 (2012); pp21-30. https://digitalcommons.unl.edu/usdafsfacpub/240/

Nowak, et al, (2010). *Sustaining America’s Urban Trees and Forests*. https://www.fs.usda.gov/nrs/pubs/gtr/gtr_nrs62.pdf

Roman, Lara A., Battles, John J., and McBride, Joe R. , “Determinants of establishment survival for residential trees in Sacramento County, CA.” in *Landscape and Urban Planning*, Vol. 129 (2014): pp22-31.

Roman, Lara A., and Frederick N. Scatena. "Street tree survival rates: Meta-analysis of previous studies and application to a field survey in Philadelphia, PA, USA." *Urban Forestry & Urban Greening* 10, no. 4 (2011): 269-274.

Souch, C. A., and Souch, C., “The effect of trees on summertime below canopy urban climates: a case study Bloomington, Indiana.” in *Journal of Arboriculture*, Vol. 19, No. 5 (1993): pp 303-12.

Tilt, Jenna H., Unfried, Thomas M., and Roca, Belen, “Using objective and subjective measures of neighborhood greenness and accessible destinations for understanding walking trips and BMI in Seattle, Washington.” in *American Journal of Health Promotion*, Vol. 21, No. 4, Suppl (2007): pp 371-9.

Wang, Jun, Endreny, Theodore A., and Nowak, David J., “Mechanistic simulation of tree effects in an urban water balance model.” in *JAWRA – Journal of the American Water Resources Association*, Vol. 44, No. 1 (2008): pp 75-85.

Wells, Nancy M., “At home with nature: Effects of ‘greenness’ on children’s cognitive functioning.” in *Environment and Behavior*, Vol. 32, No. 6 (2000): pp 775-95.

Xiao, Qingfu, E. Gregory McPherson, Susan L. Ustin, Mark E. Grismer, and James R. Simpson. “Winter rainfall interception by two mature open-grown trees in Davis, California.” in *Hydrological processes*, Vol. 14, No. 4 (2000): pp763-84.