

Maximizing Stormwater Benefits Using Green Infrastructure in Apex, NC:

A Codes and Ordinances Audit for Integrating Trees into
Stormwater Management Programs and Reducing
Imperviousness

July, 2018



Maximizing Stormwater Benefits Using Green Infrastructure in Apex, NC; A Codes and Ordinances Audit for Integrating Trees into Stormwater Management Programs and Reducing Imperviousness

Table of Contents

Table of Contents	2
Overview	4
Introduction:	6
Tree Protection	6
Tree Health and Protection.....	6
Tree Inventory.....	6
Collaboration with Developers	7
Choosing Tree Protection Mechanisms During Construction.....	7
Tree Protection Fence Type	8
Tree Protection Fence Location	8
Tree Protection Signage.....	8
Special Trees such as Champion, Heritage or Witness Trees	8
Data Collection and Management	9
Data Collection.....	9
Urban Tree Canopy	9
Tree Removal and Record.....	10
Data Management and Usage	10
Management of Urban Forest Canopy Data using Software	10
Staff Use of Urban Forestry Data	11
Codes and Ordinances	11
Tree Canopy Requirements by Zoning District	11
Tree Care Ordinance Which Specifies Maintenance.....	11
Public Tree Planting Requirements.....	12
Tree Planting Standards (DBH, Condition, Soil Volume etc.).....	12
Tree Planting Species Selection	13
Reducing Impervious Surfaces from Oversized Streets and Parking Requirements	13
Variable Space Sizing.....	13
Number of Parking Spaces	14
Structured Parking	14

Stormwater Management	14
Stormwater Integration and Utility Fees	14
Complete Green Streets.....	14
Stormwater Utility Fee.....	15
Stormwater Management Guidelines.....	15
Human, Fiscal, and Tree Planting Resources	16
Human Resources/Staff	16
Tree Citizen Advisory Panel.....	16
Community and Inter-Governmental Integration	Error! Bookmark not defined.
Community Engagement and Education	16
Re-purposing Urban Wood	16
Funding	16
Yearly and Contingency Budgeting	16
Grant Acquisition	17
Planning Documents	17
Urban Forest Management Plan Creation	17
Community Values of Trees	17
Urban Forestry Goals	18
Detailing Maintenance Items.....	18
Forestry Emergency Response Plan.....	18
Next Steps:.....	18
Appendixes:.....	19
Appendix A – Bibliography.....	19
Appendix B – Charts Analyzing Tree Canopy Coverage	20

Overview

As part of a six-state pilot study to assist municipalities in integrating trees into their stormwater management programs, the Green Infrastructure Center (GIC) Inc. has conducted an evaluation of Apex's Codes and Ordinances. Codes and ordinances were evaluated to determine the extent they minimize impervious surfaces and facilitate infiltration of stormwater by trees. The GIC is a nonprofit organization that assists communities with evaluating, mapping and planning for conservation of their green infrastructure. The views and opinions represented in this report are those of GIC and do not necessarily represent the views and opinions of the Apex, NC government.

The analysis for this project is intended to be used by the town to reduce the severity and impacts from stormwater runoff, to promote urban forestry, and expand the town's tree canopy. **Implementing best practice strategies outlined in this document will also help Apex become a more sustainable and livable community.** Staff should determine which recommendations are best suited for immediate implementation and which recommendations require longer term plans of action in order to achieve or are not suitable to implement in the town. Staff should recommend codes/ordinance/practice changes to Town Council for adoption.

The work for this publication was funded through a sub-recipient grant awarded by the USDA Forest Service through the North Carolina Department of Agriculture and Consumer Services, North Carolina Forest Service to Apex. The GIC is the technical services consultant for the project and the project partner. The contents do not necessarily reflect the views or policies of the USDA Forest Service, nor does mention of trade names, commercial productions, services or organizations imply endorsement by the U.S. Government.

The project's goal is to help municipalities improve forest conservation and management to enhance stormwater uptake. To do this, the GIC:

- Partnered with Apex staff to form a technical review committee knowledgeable about Apex's urban tree canopy,
- Mapped tree canopy and land cover to understand the extent of the town's tree canopy,
- Evaluated potential planting areas to inform future canopy goals,
- Held two community education workshops,
- Reviewed model ordinance language and made policy recommendations for using trees to meet stormwater regulations,
- Discussed whether and how to use the canopy data to inform planning for the town's Municipal Separate Storm Sewer Systems (MS4) requirements, and
- Wrote a case booklet highlighting the process and outcomes of the Trees and Stormwater Project in Apex.

Adapting codes and ordinances to use native vegetation for more effective stormwater management allows communities to treat their stormwater in a more cost-effective manner. Using more ecologically sound methods (trees and vegetation) reduces the impact of the contributors to stormwater runoff (impervious cover) by intercepting, infiltrating, and cleaning stormwater. Stormwater carries a multitude of pollutants into surface water thereby decreasing water quality, and if not infiltrated,

increases standing water and flooding. The top recommendations to improve forest care in Apex based on this study are listed as follows in priority order:

Recommendations:

1. Use the GIC's stormwater uptake calculator to determine the benefits of maintaining or increasing tree canopy goals by watershed.
2. Work with developers to shrink the development footprint to minimize impervious surface.
3. Conduct a land cover assessment every four years to catalog and compare tree canopy change.
4. Require tree removal permits on lots with single family homes.
5. Include software to track the condition of public trees as well as their removal or addition as part of an urban forestry program.
6. Require tree canopy coverage percentages by land use.
7. Allow tree plantings in rights-of-ways (ROWs).
8. Require and enforce 600, 1,000 and 1,500 cubic feet soil volume planting requirements for small, medium, and large trees respectively.
9. Prioritize funding for essential forestry maintenance activities.
10. Develop an Urban Forestry Management Plan (UFMP) which includes statistics on the values that trees provide to the community, measurable and achievable urban forestry goals, and action steps required to achieve those goals, along with a detailed list of maintenance items and frequencies.
11. Develop a forestry emergency response plan.
12. Revitalize the Tree Citizen Advisory Panel (TreeCAP) program and hold regular meetings with TreeCAP members.
13. Adopt a complete green streets policy.
14. Remove the extra spaces requirement when using variable space sizing in parking lots. Add parking maximums to the current minimums required by the UDO.
15. Create a stormwater utility and associated fee which provides offset credits for tree planting
16. Adopt best practices recommendations for trees during construction for fencing and signage.
17. Develop a program for heritage or witness trees.

Staff should review this memo and determine whether any of these recommendations can be utilized to update the town's codes, ordinances and practices.

Introduction:

Land development generally results in an increase in impervious surface, which increases the amount of stormwater runoff. As stormwater runs off of impervious surfaces it picks up contaminants, which increase the pollution of surface and ground waters. Since the impervious surface doesn't absorb the water, the runoff causes an increase in flooding, which results in property damage and other public safety hazards. Reducing the amount of impervious surfaces is critical to ending the source of the problem. Unavoidable runoff should also be treated to the maximum extent possible to facilitate infiltration, storage and cleansing.

One acre of pavement releases 36 times more runoff than an acre of forested land. During a rainfall event of one inch, one acre of forest will release 750 gallons of runoff, while a parking lot will release 27,000 gallons (PennState Extension). Retaining the forest cover in and around the town and better treating stormwater runoff with natural vegetation provides myriad benefits to the town including reduced flooding, beautification of neighborhoods, shopping districts, parks, and all town spaces, increased ground water storage, and providing habitat for pollinators such as the Monarch Butterfly . Reducing the amount of stormwater entering the town's storm drain system can result in cost savings, as less volume needs to be handled and treated.

The GIC studied existing codes, ordinances and policies to determine which ordinances promote impervious surface and which promote stormwater infiltration. Codes, ordinances, and practices that increase green space and vegetation allow for more stormwater infiltration.

This report analyzes relevant sections of the following town documents:

- Unified Development Ordinance,
- Design and Development Manual,
- the Planning section of the town's website,
- the *Peak Plan 2030*,
- the *Town of Apex Annual Operating Budget 2016 – 2017*,
- the *North Carolina Department of Environmental Quality Stormwater Design Manual*, and
- the *Town of Apex Engineering Standards*.

Data were gathered through analysis of town codes and policies as well as meetings with town staff. An accompanying spreadsheet provided to the town details the codes reviewed and relevant findings based on a comparison with nationwide best practices identified by GIC.

Tree Protection

Tree Health and Protection

Tree Inventory

Tree protection begins with tree inventory. A tree inventory contains information about the type, age, and caliper of existing trees on a site. When new development is proposed, the Town of Apex Unified Development Ordinance (UDO) only requires inventories of those trees in Resource Conservation Areas (RCA), landscape buffers, riparian buffers, and 50 feet from the property line. Many trees on-site are not inventoried, therefore town planners do not know about these trees and they cannot protect them. Instead, include all trees onsite (hardwoods, softwoods, and understory species 24", 18" and 8",

respectively) and all trees 50 feet from the property line in inventory requirements. See Excel 'Tree Care and Protection Sheet', Row 1.

Collaboration with the Development Community

A great deal of tree planting or preservation opportunities can be determined through constructive collaboration with developers. The town currently holds pre-application meetings, monthly review committee meetings, and pre-construction meetings with representatives from each town department. These meetings could be used to identify more opportunities to preserve trees on development sites.

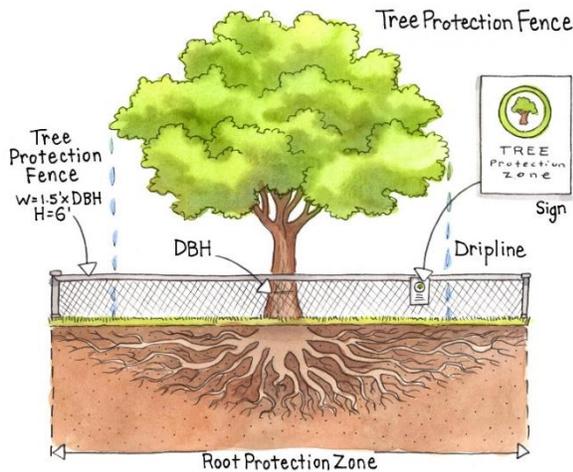
An example of a municipality already doing this is Alpharetta, Georgia. Staff hold a pre-development conference which allows all parties to explore ideas for tree conservation before extensive funds are spent on land planning. Conferences involve a representative from each department (e.g. planning, engineering, forestry) for their projects and this process has found many opportunities to avoid tree loss. This includes training developers in the city's tree ordinances and providing guidance on how to protect their trees. Many developers are willing to cooperate in such ventures, as houses often sell for a premium on a well-treed development.

It will also be necessary to actively promote the implementation of development designs that minimize loss of urban forest canopy and habitat. Without additional prodding, developers may not consider alternative site layout options to find the one that removes the least amount of natural resources. In Apex, staff has pre-application meetings, monthly review committee meetings and pre-construction meetings with developers. During these meetings conversations are occasionally had about altering site layouts to save more green infrastructure but it is not the norm. Encourage site designs which save more trees and thereby require less constructed stormwater mitigation. See Excel 'Tree Care and Protection Sheet', Row 12.

Choosing Tree Protection Mechanisms During Construction

Tree damage sustained during construction poses a significant threat to a locality's tree canopy coverage. Such coverage provides a variety of important environmental benefits including uptake and filtration of stormwater, provision of clean air, and decreased heating and cooling costs. For more information on tree benefits see the corresponding Trees and Stormwater case study booklet.

There are many tree protection mechanisms, each one designed for a specific purpose. Many developers don't know which tree protection mechanism is best to use in a particular site situation and need guidance. Apex could provide additional best practice guidance beyond current text which says 'protection measures must adhere to generally accepted good design standards and practices'. See Excel 'Tree Care and Protection Sheet', Row 9.



Tree Protection Fence and Signage

Tree Protection Fence Type

The most common form of tree protection is tree protection fencing. It is a physical barrier that keeps people and machines out of tree's critical root zones during construction. However, some municipalities only require plastic orange fencing and wooden stakes. This type of fencing can be removed or trampled easily and makes tree protection efforts less effective. Trees slated for protection may suffer development impacts such as root compaction and trunk damage. Instead, require sturdy metal chain link fencing in high risk areas and for extremely highly valued trees (such as Champion, Heritage, and Witness trees) and use orange plastic fencing in

lower risk areas (such as along woodland at the edge of a development property). Apex requires plastic orange fencing with metal stakes, but has used larger chain-link fencing on select projects that require more protection.

Tree Protection Fence Location

Small roots at the radial extents of the tree root area uptake water and absorb nutrients. Protection of the small fibrous roots is critical for the optimal health of a tree. The UDO requires tree protection fence to extend only to one foot per tree diameter at breast height (DBH) inch, omitting protection for part of the tree most involved in stormwater uptake. Instead, tree protection fencing is recommended to be placed at a distance of 1.5' from the tree trunk per inch of diameter at breast height (DBH) of the tree in order to best protect trees and their functions. See Tree Care and Protection Sheet, Row 13.

Tree Protection Signage

Tree protection signage communicates how work crews should understand and follow tree protection requirements. It also informs 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 has a tree protection sign that prohibits entering the tree protection area. Signage text can be written in English and Spanish to ensure access if information by most within the community. Spacing should be at 50 feet so ensure the signage is seen more readily. See Excel 'Tree Care and Protection' Sheet, Row 8.

Special Trees such as Champion, Heritage or Witness Trees

Protection of heritage and witness trees adds a cultural and aesthetic component to urban forestry while also protecting more trees. Heritage and witness trees can commemorate historical events which hold great significance to a community. These trees are not currently protected in Apex codes. The town should draft and adopt codes which protect heritage and witness Trees. The state of Arizona has developed a program entitled 'Arizona's Magnificent Trees' to define, catalog, and educate citizens about champion, heritage, and witness trees in the state. To see more information about that program, visit <https://dffm.az.gov/forestry-community-forestry/urban-community-forestry/recognition/recognition-programs/magnificent-trees-directory>

North Carolina also maintains a list of champion trees at http://ncforestservice.gov/Urban/tree_detail.asp?Tree_ID=45

See Excel 'Tree Care and Protection Sheet', Row 34.

Recommendations:

1. Expand the tree inventory requirements to include all significant trees onsite and all trees 50' from the property line.
2. Work with developers to shrink the development footprint to minimize impervious surface.
3. Require the use of sturdy chain link tree protection fence in high risk areas (such as near heavy construction equipment) and for protection of champion, heritage, and witness trees.
4. Use the full spectrum of tree protection devices (combined tree protection and root pruning and root aeration).
5. Increase the critical root zone to 1.5' away from the tree trunk per DBH" of the tree. A smaller root zone can be determined on a case by case basis guided by construction activities occurring onsite and site constraints.
6. Design and use tree protection signage which summarizes the do's and don'ts of working near and around tree protection zones. Decrease required distance between signage from 200 feet to 50 feet.
7. Draft and adopt codes which protect champion, heritage and witness trees.

Data Collection and Management

Data Collection

Urban Tree Canopy

Image analysis produced as a part of this grant determined that Apex's urban tree canopy was 58.5% in peak growing season of 2016 (June – September) in the incorporated area. For more information on how the tree canopy coverage was derived, see the Trees and Stormwater case booklet for Apex.

Although Apex's tree canopy is relatively high, the town is rapidly developing and large tracts of forested land are under significant development pressure. In addition, the tree canopy is not evenly distributed throughout the town so some watersheds fall below 58.5% tree canopy (see Table One at right).

Watershed	Percent Tree Canopy
Beaver Creek	50.6%
Big Branch	75.2%
Crabtree Creek	50.4%
Middle Creek	47.9%
Swift Creek	61.0%
White Oak Creek	84.8%
Williams Creek	49.5%

Table One: Tree Canopy Coverage by Watershed

As the town continues to develop, on-going data collection and goal setting are important for maintaining tree canopy coverage. Regular updates of the tree canopy also allow for analysis of change over time. Canopy coverage should be updated every four (4) years since 'leaf on' imagery is available from the National Agricultural Imagery Program (NAIP) every two (2) years. Analyses conducted ever

four to five (4-5) years is recommended to show significant changes in a municipality's canopy coverage. The canopy data can be utilized strategically to calculate the full suite of ecosystem services trees provide (e.g. removal of pollutants and reduction of urban heat island effect) as well as determining the best places to concentrate planting efforts to gain further benefits. See 'Tree Care and Protection Sheet', Row 21.

Tree Removal and Record

As the majority of land in a municipality is privately owned, protection of trees on private property is critical. Requiring a tree removal permit for large trees (over 24" DBH) is one strategy for retaining tree canopy coverage in a community. Apex currently requires tree removal permits for all sites except those with single-family homes and sites with approved site plans. Provided that Apex codes are modified to inventory all significant trees on-site, lots with approved site plans will have already been reviewed for environmental assets by planners and can logically be excluded but sites with single-family homes should be reviewed by staff planners before tree removals occur. Require permits for tree removals on all private lots, including single-family homes. In addition, phase out the practice of mass grading and allow trees to remain on single family lots until building permits are issued for the new homes. See Excel 'Monitoring Progress' sheet, Row 8.

Recommendations:

1. Conduct a land cover assessment every four (4) years to catalog and compare tree canopy change.
2. Require tree removal permits on lots with single-family homes.
3. Phase out the practice of mass grading. Allow trees to remain on single-family lots until building permits are issued for the new homes.

Data Management and Usage

Management of Urban Forest Canopy Data using Software

Data is required for efficient management of the urban forest. Thanks to Apex Planning forethought, staff has access to aerial imagery updated every three (3) months through a service called NearMap. Site-scale landscape changes are easily seen with the imagery but information about the urban forest that could be used in planning is lacking. Instead, urban forestry data collection should provide detailed, quantifiable information. For example, Philadelphia uses software to collect tree data such as date planted, field observation date, GPS location, species, DBH, tree health and condition, and management actions taken. Some examples of software used for urban forestry data management are Arbor Pro, Collector for ArcGIS, Open Data Kit, Open Tree Map, Tree Keeper and Tree Plotter. Each of these packages have been evaluated for ability to enter geospatial data, customizability of data fields, ability to upload existing data in bulk, mobile access, and interoperability with other systems (Roman et al. 2016). While this software is typically used for trees on municipality property and makes up only a small percentage of the urban forest, this data is invaluable for tracking and mitigating tree risks, especially to pedestrians and property, and planning for tree planting projects. See Excel 'Monitoring Progress' Sheet, Rows 6 and 10.

Staff Use of Urban Forestry Data

Keeping tree canopy coverage at levels that promote public health, walkability, and groundwater recharge in neighborhoods and watersheds is vital. This kind of planning is made possible when municipality staff have access to spatial tree canopy data and can model future development and growth scenarios. For example, planning and development staff could require retention of healthy tree clusters to keep tree canopy coverage at goal levels by watershed when site plans are proposed. GIC developed a stormwater calculator that models uptake and runoff from current and proposed land covers. It can show an estimate of how much stormwater runoff will be produced by adding impervious surfaces and losing trees in a watershed. It can also show an estimate of how much stormwater runoff can be mitigated by reducing impervious surfaces and planting trees in a watershed. Use the stormwater uptake calculator to maintain or reach tree canopy goals by watershed. Integrate planning for trees in all planning and development activities.

Recommendations:

1. Develop an urban forestry program that includes software to track the condition of public trees as well as their removal or addition.
2. Use the GIC's stormwater uptake calculator to determine the benefits of maintaining or increasing tree canopy goals by watershed.
3. Integrate planning for trees in all planning and development activities.

Codes and Ordinances

Tree Canopy Requirements by Zoning District

Trees improve quality of life in communities. 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). Applying minimum canopy coverage requirements by land use assures quality of life for all in a community regardless of socioeconomic status. For example, the city of Manassas, VA has tree canopy requirements by zoning district. See link here:

https://www.manassascity.org/DocumentCenter/View/22322/ART_07?bidId=. In Apex, there is currently no requirement for minimum canopy coverage but there are instead penalties for removing canopy without a permit (see Tree Removal and Record section above). To assure quality of life for all in a community, add a requirement in Apex codes and ordinances for minimum tree canopy coverage by zoning district. See 'Tree Care and Protection' Sheet, Row 10.

Recommendations:

1. Require tree canopy coverage percentages by land use.

Tree Care Ordinance Which Specifies Maintenance

A tree care ordinance should specify tree maintenance requirements and schedules. For example, prohibiting the practice of tree topping and flush cutting as well as requiring preventative pruning can be parts of a tree care ordinance. Requiring proactive maintenance in an ordinance can reduce emergency tree care instances in the town. See Excel 'Tree Care and Protection' Sheet, Row 20.

Recommendation:

1. Write tree maintenance ordinance and include a clause prohibiting tree topping and flush cutting.

Public Tree Planting Requirements

Street trees shade and cool streets and sidewalks making southern urban locations cooler, walkable, and bikeable. In addition, shaded pavement has a longer lifespan thereby reducing maintenance costs associated with roadways and sidewalks (McPherson and Muchnick 2005). Unfortunately, trees are not permitted in the ROW per current Apex code. One subdivision was granted an exception and is allowed to plant street trees but this is not the norm. The myriad benefits of street trees are not realized in the town. As long as sufficient soil volume is provided for trees, allow their planting in the ROW. In addition, allow homeowners/ occupiers to request tree planting in ROWs adjacent their homes. See Excel 'Tree Care and Protection' Sheet, Rows 28 and 29.

Recommendation:

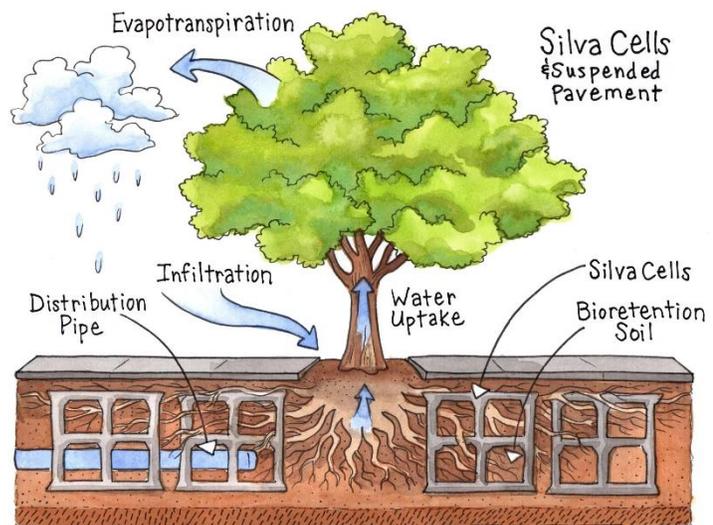
1. Allow and require tree plantings in rights-of-ways (ROWs).
2. Develop a program whereby homeowners/occupiers can request trees be planted by the town in the ROW adjacent their home.

Tree Planting Standards (DBH, Condition, Soil Volume etc.)

Tree planting standards are not specified in the codes and ordinances governing the majority of Apex. GIC recommends adoption of ANSI standards for all tree care operations in Apex. See Excel 'Tree Care and Protection' Sheet. Row 19.

In urban environments, many trees do not survive to their full potential 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.

At a minimum, canopy trees require 1000 cubic feet of soil volume to thrive. Apex requires a minimum area for tree islands but does not address volume. This does not ensure adequate, three dimensional, soil volume as tree wells can be too shallow. Instead, require 600, 1,000 and 1,500 cubic feet of soil for small, medium, and large trees, respectively as recommended by the Environmental Protection Agency (Stormwater to



Silva Cells and Suspended Pavement

Street Trees 2013). In areas where space is tighter or where heavy uses occur above, structural soils and suspended pavement can be used to stabilize and direct tree roots.

Recommendations:

1. Adopt ANSI standards for tree care and planting.
2. Require and enforce 600, 1,000 and 1,500 cubic feet soil volume planting requirements for small, medium, and large trees respectively.
3. Use suspended pavement or other similar trade product, to provide adequate soil volume for trees in dense urban conditions.

Tree Planting Species Selection

Species provide varying degrees of ecosystem benefits based on size, species, and planting location. Large trees provide more shade reducing the ‘heat island’ effect and can also take up more stormwater and reduce flooding. Where space permits, plant large canopy trees. In smaller spaces where a canopy tree cannot fit, plant understory trees, shrubs, or other smaller vegetation. In open spaces that have enough soil volume to support canopy trees and that lack overhead wires, such as grass strips along roads, efforts should be made to plant canopy trees instead of smaller understory trees such as crepe myrtles. Review landscape designs during the development process to ensure canopy trees are being planted where space allows and smaller trees are planted where less space is available.

In addition town planting lists should be updated to ensure native species are being used as often as possible and that non-native invasive species are prohibited. Divide species into three categories (small, medium, and large trees) to match the categories for soil volume requirements. See Excel ‘Reducing Impervious Surfaces’ Sheet, Row 26.

Recommendation:

1. Plant canopy trees whenever possible. Plant understory trees only when site constraints require smaller vegetation.
2. Update town planting lists to include mostly native species and exclude non-native invasive species. Divide tree species into three categories (small, medium, and large trees) to match the categories for soil volume requirements.

Reducing Impervious Surfaces from Oversized Streets and Parking Requirements

Impervious surfaces are a barrier to stormwater infiltration. Apex is experiencing rapid development and therefore increasing in overall imperviousness. Some of the negative effects of urbanization on stormwater infiltration can be minimized if land development and tree planting regulations are revised to increase stormwater uptake in these urban areas.

Variable Space Sizing

With an increase in vehicle types and sizes, some parking spaces should be designated and designed for smaller cars. Making some spaces smaller means there is less total impervious surface in Apex. Current Apex code allows compact car spaces only if the developer provides more than the minimum number of required parking spaces. This creates more impervious surface, effectively creating more stormwater

runoff. Remove the requirement for additional parking spaces if compact spaces are a component of parking lot design. See 'Reducing Impervious Surfaces' Sheet, Row 20.

Number of Parking Spaces

Excessive parking standards have exponential negative effects on stormwater volume generation, especially in urban environments. It is good practice to ensure that parking requirements are consistent with demand. This is important as certain trends point to declining automobile ownership due to cost of ownership, availability of ride-hailing apps, and delivery services. National standards as well as local studies are useful for determining parking demand by land use.

Previously, Apex parking requirements were set as minimums which then allowed for excessive impervious surfaces. On July 17, 2018 Apex revised parking standards to include minimums and maximums. In addition, additional tree plantings are now required when the parking maximums are exceeded. GIC supports these code revisions as they have the potential to prevent excessive parking lot size, thereby limiting imperviousness and contributing less stormwater runoff. See Excel 'Reducing Impervious Surfaces' Sheet, Row 17.

Since parking lots are often sources of excessive impervious surface and the outer portions of lots are seldom or never used, incentives and installation guidance can be provided for developers to use pervious material for spillover parking areas. Review permeable parking technologies, such as permeable pavement, permeable concrete and grass pavers with developers at the plan review stage to identify locations on-site where these technologies are appropriate.

Structured Parking

Providing incentives for developers to employ structured parking (e.g. parking garages) can greatly reduce impervious area. There are no incentives provided in Apex's current code. Considering the increasing development of the town, preparing to increase structured parking is prudent. An incentive should be developed in areas zoned for high-density development. One way to incentivize structured parking is to allow more parking spaces for a development as long as they are placed in structured parking. See Reducing Impervious Areas Sheet, Row 27.

Recommendations:

1. Remove extra spaces requirement when using variable space sizing in parking lots. Add parking maximums to the current minimums required by the UDO.
2. Use pervious materials in spillover parking areas.
3. Encourage the use of structured parking in projected high density areas of the town.

Stormwater Management

Stormwater Integration and Utility Fees

Complete Green Streets

Complete green streets allow for integration of stormwater management and aesthetic goals. By incorporating vegetation as an integral part of the design, they increase stormwater infiltration, create and connect habitat, reduce urban heat island effect, help remove air pollutants, and promote walking and biking. Apex does not currently have a complete green streets policy which would encourage and enforce the installation of Complete Green Streets at development and re-development stages. The

town should develop a policy that includes the following elements: green infrastructure (trees and other vegetation), pedestrian space, bicycle lanes, and stormwater management.

The complete green streets policy should require the incorporation of many types of vegetation. One way to achieve this is by including bioretention islands and adequate planting area for street trees in the street design.

Complete streets policies have been adopted by numerous municipalities in the United States. Smart Growth America reviewed the best complete street policies of 2016. (<https://smartgrowthamerica.org/resources/the-best-complete-streets-policies-of-2016/>). See Excel 'Integration' Sheet, Row 35.

Stormwater Utility Fee

Stormwater utility fees are a mechanism for funding stormwater management based on the amount of impervious surface and stormwater runoff per parcel. Utility fees usually offer credits for reducing the amount of impervious surface and associated stormwater runoff. Many municipal programs offer stormwater credits for tree plantings.

Currently, Apex does not have a stormwater utility fee. If such a program were implemented the town should also offer stormwater credits to property owners who plant trees and/or have a significant amount of tree canopy on their sites (for example, 30%). The town should provide documentation on how to apply for the credit as well as technical construction standards where applicable (e.g. how to build a raingarden). See Excel 'Integration' Sheet, Row 7.

Stormwater Management Guidelines

Apex follows the North Carolina Department of Environmental Quality (NCDEQ) Stormwater Best Management Practices (BMP) Manual. This manual credits permeable pavement, green roofs, Silva Cells™ and many other stormwater management practices, but it does not list tree plantings or forested bioswales as best management practices. Tree plantings, even those with less soil volume, such as street trees, can intercept anywhere from 760 to 4,000 gallons of stormwater per year. As such, forested bioswales should also be permitted for use as best management practices. The town should include tree and forested bioswale credits or create an addendum to the NCDEQ Stormwater BMP Manual which includes these BMPs. Use this addendum in Apex. See Excel 'Integration' Sheet, Rows 30 and 33.

Recommendations:

1. Adopt a complete green streets policy.
2. Create a stormwater utility and adopt a stormwater utility fee to cover stormwater maintenance and offer credit for tree plantings/canopy.
3. Adopt an innovative stormwater management manual which incorporates best management practices for treatment and retention of stormwater that include trees.

Human, Fiscal, and Tree Planting Resources

Human Resources/Staff

Tree Citizen Advisory Panel

The town developed The Tree Citizen Advisory Panel (TreeCAP), a committee intended to provide citizen input on tree programs, management, and regulation. Citizen input is highly encouraged in urban forestry best practices and GIC commends Apex for leading in this way. However, it is unclear whether the TreeCAP program continues. Revitalize the TreeCAP program. See 'Implementation Capacity' Sheet, Rows 6-8.

Recommendations:

1. Revitalize the TreeCAP program and hold regular meetings with TreeCAP members.

Urban Forestry and the Community

Community Engagement and Education

Tree stewards are trained community volunteers who provide training classes, educational programs, and projects in their communities which increase public awareness of trees while teaching about trees and tree care. They are a vital portion of any municipality's urban forestry program. As Apex grows it should develop a tree stewards program to help care for urban tree canopy. Organize a volunteer tree care and advocacy group or expansion of the Master Gardener's expertise to carry out tree planting projects, provide tree care trainings, and increase public awareness of the value and care of trees. See 'Integration' Sheet, Row 26.

Re-purposing Urban Wood

Re-use of urban wood promotes urban forestry, creates community, and provides raw materials for local artisans. Town staff expressed an interest in creating a program re-using urban wood but due to constraints on staff time, have not done so yet. The Southeast Urban Wood Exchange, a program hosted by the North Carolina Urban Forest Council and in partnership with the NC Forest Service's Urban & Community Forestry Program allows users to find urban wood products and post available wood products (<http://www.urbanwoodexchange.org/>). Use the website for re-use of urban wood in the Town of Apex. See 'Integration' Sheet, Row 38.

Recommendations:

1. Devote town resources to organization and training of an Apex tree stewards group.
2. Re-use urban waste wood. Use the Urban Wood Exchange website to post or find out about available urban wood.

Funding

Yearly and Contingency Budgeting

A lack of funding resources is the most common complaint among urban forest managers. Asking for more resources is a key to accomplishing urban forestry goals. Funding for trees in Apex is currently based on the previous year's spending and not on current workloads, number of trees to be planted, trimmed, removed, etc. The Town of Apex should develop a yearly budgets for both urban forestry and

utility forestry based on actual workloads and urban forestry planting goals to ensure the health of the urban forest. See 'Implementation Capacity' Sheet, Row 22.

In addition, during economic slowdowns, prioritization of tree maintenance activities is essential. It allows critical tree care activities, such as watering and risk management, to be carried out while less critical items, such as sucker pruning are to be completed at a later date. A contingency budget can be developed for essential tree maintenance items to be met, even during difficult budget cycles. Apex should prioritize forestry activities and develop a contingency budget. See Excel 'Implementation Capacity' Sheet, Row 21.

Recommendations:

1. Develop yearly urban forest budgets based on urban forestry workloads and goals.
2. Prioritize essential forestry maintenance activities and develop a contingency budget.

Grant Acquisition

Grants can help further a municipal urban forestry program by investing time and energy into specific tree related efforts. These responsibilities of finding and applying for grants should be shared between Apex staff and the various community and non-profit groups. Sharing the workload associated with these grants will allow more project funding. See 'Implementation Capacity' Sheet, Row 19.

Recommendations:

1. Devote town staff and community/non-profit organization time to finding and applying for tree related grants.

Planning Documents

Urban Forest Management Plan Creation

An Urban Forest Management Plan (UFMP) details a vision for urban tree canopy. It meshes local government and community interests to proactively manage the urban canopy and provide long term benefits. Apex does not currently have a UFMP, but many of its codes and ordinances include typical UFMP components. These components can be divided into several sections including documentation of the community values of trees, outlining urban forestry goals and developing a maintenance item schedule. Create a UFMP or similar manual. For reference, the City of Binghamton, NY has a well written Urban Forest Management Plan which can serve as a guide for Apex. See: (<http://www.binghamton-ny.gov/sites/default/files/files/City%20of%20Binghamton%20NY%20Urban%20Forest%20Management%20Plan%202010.pdf>)

Community Values of Trees

Communicating the benefits trees provide is essential for obtaining community-wide support for planting and maintenance projects. Some of the benefits that could be emphasized with a UFMP include that street trees are associated with a lower prevalence of early childhood asthma and developments that include green space or natural areas have faster rates of sale and sell and for higher profits than those without (Lovasi et al. 2008; Benedict and McMahon 2006). A UFMP can publicize these benefits to foster greater support for tree care. It can also explain the linkage between a well-maintained urban forest and improved urban resilience. Values of trees should be enumerated and related to each department including Public Works and Parks and Recreation. See Excel 'Plans and Goals' Sheet, Line 6.

Urban Forestry Goals

Clear goals are essential for ensuring urban forest management plans have actionable steps. Prior to the Trees and Stormwater Study, Apex did not have baseline data to help set urban forestry goals. Using the new canopy data from the Trees and Stormwater Grant, the town should set clear urban forestry goals with actionable steps, benchmarks, and a schedule to measure progress on each goal. Forestry goals should be linked to those set out in the Peak Plan 2030 to encourage interdepartmental collaboration. See Excel 'Plans and Goals' Sheet, Line 7.

Detailing Maintenance Items

A list of maintenance items and their approximate volume should be included in an UFMP. Estimates such as this can justify funding requests. An example of a maintenance workload table from Binghamton, New York's UFMP is shown to the right (Urban Forest Management Plan 2010). See 'Plans and Goals' Sheet, Line 13.

	Low Estimate	High Estimate
Street Trees		
Tree/Sites/ Mile	108	131
Stocking Rate	47%	74%
Trees	15,800	30,200
Planting Sites	17,900	10,700
Tree & Stump Removals 1-5%	158	1,510
Priority Prunes 3-10%	474	3,020
Routine Prune 7 year rotation	15,168	25,670
Park Trees		
Trees	//////	6,200
City of Binghamton, NY Maintenance Items and Volume		
Routine Prune 10 year rotation	//////	564
Planting	//////	195

Recommendations:

1. Develop an UFMP which includes:
 - a. statistics on the community benefits of trees,
 - b. measurable and achievable urban forestry goals,
 - c. action steps required to achieve those goals, and
 - d. a detailed list of maintenance items and frequencies.

Forestry Emergency Response Plan

The town does not have a plan for replacing trees lost to natural disasters such as hurricanes or other storms. This means that canopy will decrease over time. Given the many benefits that trees provide, the town should plan for funding and replacement tree plantings following natural disasters. This plan should include processes for data collection for lost trees, funding application procedures through FEMA, and staff management during replanting. See Excel 'Emergency Response' Sheet, Rows 6, 7, and 9.

Recommendations:

1. Develop a forestry emergency response plan.

Next Steps:

Town Council and staff should review this memo and determine which of these recommendations can be utilized to modify or augment the town's codes, ordinances, and practices. These suggestions are not intended to be implemented simultaneously. Instead, they may be adopted gradually as funds are raised or allocated and as staff agree and are trained on new procedures.

Appendixes:

Appendix A – Bibliography

_____ Penn State Extension, Trees and Stormwater

<http://extension.psu.edu/plants/green-industry/landscaping/culture/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 June 01, 2016: <

<https://www.epa.gov/sites/production/files/2015-11/documents/stormwater2streettrees.pdf>>

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

Lovasi, G.S., J.W. Quinn, K.M. Neckerman, M.S. Perzanowski, and A. Rundle. 2008. "Short Report: Children Living in Areas with More Street Trees Have Lower Prevalence of Asthma." *Journal of Epidemiology and Community Health* 62: 647–49.

McPherson, E. Gregory, and Jules Muchnick. "Effect of street tree shade on asphalt concrete pavement performance." *Journal of Arboriculture* 31, no. 6 (2005): 303.

Roman, Lara A., Jason G. Henning, Matthew McFarland, Dana Dentice, Sarah C. Low, Casey Thomas, and Glen Abrams. "Data management for urban tree monitoring--software requirements." *Philadelphia, PA: Azavea*. 124 p. (2016): 1-124.

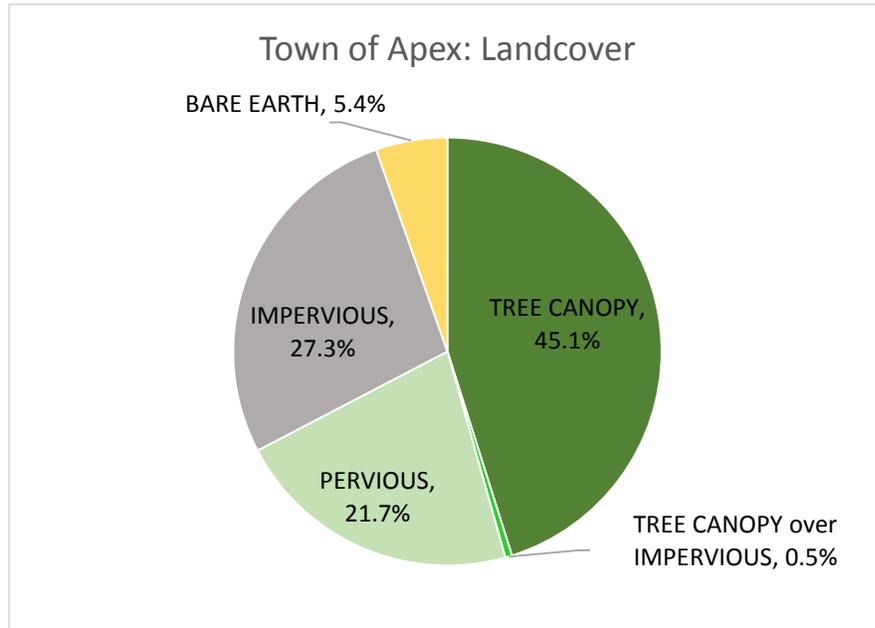
Roman, Lara A., John J. Battles, and Joe R. McBride. "The balance of planting and mortality in a street tree population." *Urban Ecosystems* 17, no. 2 (2014): 387.

Stormwater to Street Trees: http://www.davey.com/media/183712/stormwater_to_street_trees.pdf

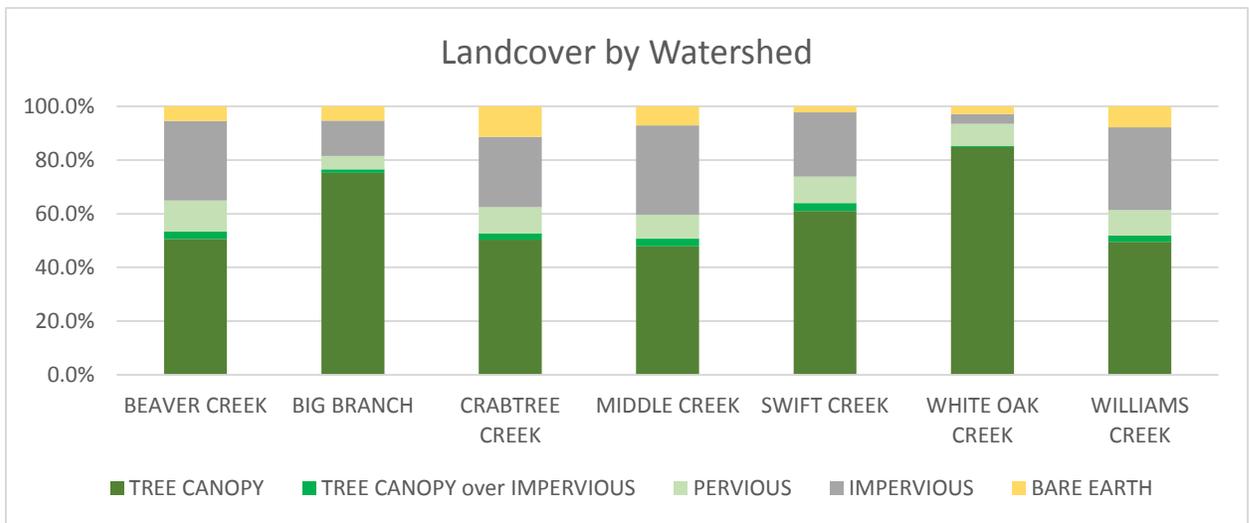
Urban Forest Management Plan City of Binghamton, NY <http://www.binghamton-ny.gov/sites/default/files/files/City%20of%20Binghamton%20NY%20Urban%20Forest%20Management%20Plan%202010.pdf>

Wells, Nancy M. "At home with nature: Effects of "greenness" on children's cognitive functioning." *Environment and behavior* 32, no. 6 (2000): 775-795.

Appendix B – Charts Analyzing Tree Canopy Coverage



Land Cover Assessment



Apex Land Cover Comparison by Watershed