**Council Meeting Date:** April 18, 2011 **Agenda Item:** 7(a)

# CITY COUNCIL AGENDA ITEM

CITY OF SHORELINE, WASHINGTON

| | |
|---|---|
| **AGENDA TITLE:** | Shoreline Urban Tree Canopy Assessment |
| **DEPARTMENT:** | Planning & Development Services |
| **PRESENTED BY:** | Paul Cohen, Senior Planner<br>Juniper Nammi, AICP, Associate Planner<br>Joseph W. Tovar, FAICP, Director |

**PROBLEM/ISSUE STATEMENT:**

In early 2010, the City Council directed Planning Commission and staff to propose updated development regulations for trees and provided direction on nine decision modules for this topic. The first decision module was to:

> *Establish a baseline urban forest canopy citywide. This baseline would provide the context for the Council to make a policy decision, most likely in 2010, about a long-range City target for desired tree canopy. The target could be no-net loss of a citywide percentage of canopy or an increase or decrease of some magnitude, keyed to specific schedules. With such a baseline and target in place, the City could then monitor the overall City canopy, say every 5 years, to assess its health and identify any further programs or code amendments as needed.*

Staff obtained a $10,000 grant from the Washington State Department of Natural Resources Urban & Community Forestry program to complete this baseline assessment. Consultants from AMEC Earth & Environmental, Inc. were contracted to complete an Urban Tree Canopy (UTC) Assessment for the City of Shoreline. The results of this assessment will be presented tonight for Council's consideration.

**FINANCIAL IMPACT:**

Staff obtained a $10,000 grant from the Washington State Department of Natural Resources Urban & Community Forestry program to complete this baseline assessment. There are no additional financial implications at this time for this project.

**RECOMMENDATION**

No action is required at this time as this item is before the Council for information only.

Approved By: City Manager JU City Attorney ___

## INTRODUCTION

City Council, Planning Commission and staff revisited the City's tree regulations in 2009 and 2010. One of the reasons for considering revisions to these regulations was public perception that the City is losing significant trees and tree canopy at a significant rate. The Shoreline Environmental Sustainability Strategy also provides strategic direction on urban forest and tree canopy management under Guiding Principle 8: Proactively manage and Protect Ecosystems and Key Program Strategy 10: Structure and prioritize natural resources enhancement.

Council requested a baseline measure of tree canopy to provide context for the pending tree regulation amendments. This report and presentation is the requested baseline measure and additional analysis of the City's tree canopy prepared by AMEC Earth & Environmental, Inc.. AMEC Earth & Environmental, Inc. and their project manager for this tree canopy assessment have conducted over 20 urban tree canopy assessments for municipalities across the country and including work for Seattle, Mercer Island, Renton and Thurston County.

No Council direction has been given regarding amendments to the tree regulations and Council is scheduled to revisit this topic in early May 2011.

## BACKGROUND

City Council was last updated on the tree code amendment process in May 2010. No decisions or direction were provided at that time as it was an information only presentation.

Since that time Planning Commission met two times to discuss the proposed tree code amendments in July and October of 2010. On October 21, 2010, the Planning Commission decided to postpone recommendations on staff's proposal until the Council provided further direction.

The tree code update is one of the major objectives for 2010-2011 Council Goal 1:

> *Implement the adopted Community Vision by updating the Comprehensive Plan and key development regulations in partnership with residents, neighborhoods, and businesses.*

Objective: Adopt updated tree regulations, including citywide goals for urban forest canopy.

Current Code Purpose: No net loss of tree cover throughout the City over time.

The UTC Assessment report presented here is the baseline assessment of Shoreline's urban tree canopy that will help inform Council and Planning Commission decision on the tree regulations and in setting future goals for UTC.

# DISCUSSION

## A. Limitation of this Assessment

The UTC Assessment conducted for the City of Shoreline by AMEC Earth & Environmental, Inc. does provide an accurate assessment of total tree canopy citywide, based on 2009 orthophotography, 4-band imagery as well as an analysis of the UTC by land use category. This assessment also includes information on other land cover types including shrubs, grass/vegetation, open water and impervious surfaces. This assessment is based on computer image analysis, not field inventory or verification.

The tree canopy assessment carried out for the City of Shoreline was primarily limited by budget. Many cities in the region such as Seattle and Renton have conducted more detailed assessments of their tree canopy which required budgets upwards from $30,000. More detailed assessment could be completed for the City if additional resources were identified.

This analysis does not provide information on species diversity, forest health or a tree by tree count of tree canopy. As this assessment was done in the context of evaluating the City's tree code and possible amendments, it focuses on the extent and value provided by the tree canopy and does not evaluate the value of other types of vegetation such as shrubs, forest understory or grass.

## B. Results

Shoreline has 31% tree canopy coverage as of July 2009. This is a slight increase in canopy from 1992, estimated at 30%, and essentially the same as in 2001, estimated at 31%. No discernable loss of tree canopy has occurred over the past 17 years.

Overall Shoreline has 56% vegetative cover comprised of grass, shrubs, and trees. Almost three quarters of Shoreline's tree canopy is located in the low density residential zones, an area that represents approximately two thirds of the total land area in the City. Approximately 46% of the City is impervious surfaces, including approximately 2% known to be located below existing tree canopy.

The consultant estimated the maximum possible urban tree canopy. The methodology developed by the US Forest Service Northern Research Station assumes that trees could be added to all vegetated and impervious surface areas in the City excluding roads and buildings. This estimation is the maximum tree canopy that could be obtained if trees were planted in all areas where it is biophysically possible to plant a tree. They estimate at an additional 44% tree canopy is possible, over the existing 31% existing canopy citywide. This figure is largely academic rather than practical because it does not take into consideration factors such as personal homeowner preferences, underlying land uses, solar access, recreational field designations, or parking requirements.

Possible UTC does provide insight into which land use areas may provide the biggest opportunities to increase tree canopy. The costs of maintaining the existing tree canopy, let alone increasing it, are significant. In 2003, the City undertook an Urban Forest Plan project, which inventoried 14,226 trees on the City's right-of-way throughout the City, not including the Highlands and most of Innis Arden. The Plan also provides management recommendations and identified potential planting sites. This Plan estimated an annual maintenance cost for these trees at approximately $470,000, including pruning, hazard removal and replacement.

Significant tree management issues, such as the threat of tree loss due to invasive species and planting and management needs to provide a healthy forest understory and ensure diverse tree replacement as these forests age, have also been identified in the City's major forested parks. The Parks Department has just started implementing vegetation management plans for these parks, and projects can range in cost from a few thousand to $10,000 per park per year to address restoration sites of approximately one quarter acre.

Adding 1% to the existing tree canopy would take approximately 6,000 trees with a mature crown diameter of 30-feet and this increase alone could provide a stormwater benefit of almost $500,000 (based on the CITYgreen estimate model) and would sequester an extra 35 tons of carbon every year.

Reaching a possible long-term goal of 40% total tree canopy would require maintaining the existing tree canopy *and* adding approximately 46,000 trees at an average 30-foot crown diameter. Based on the 2003 Urban Forest Plan, the average planting cost per tree was $264 per tree. At that rate, planting 46,000 trees would cost over $12 million, plus the additional maintenance costs for those trees.

In an effort to quantify the monetary value to the City of the public benefits provided by tree canopy, the value of these ecosystem services was estimated using a nationally accepted modeling tool – CITYgreen developed by American Forests. Shoreline's 2009 tree canopy provides:

- Approximately $460,000 in indirect cost savings due to air quality improvement;
- 770 tons of annual carbon sequestration (removal of carbon from the atmosphere and storage as new tree growth);
- $900,000 annual cost savings for stormwater storage capacity that does not have to be built; and
- Reductions of 3% to 10% in regulated stormwater pollutants, when compared to the scenario of no tree cover, in a typical 2 inch, 24 hour storm.

## C. Unanswered Questions

This UTC Assessment provides an accurate citywide tree canopy estimate of 31% in 2009 and provides gross estimates of possible tree canopy increase as well as estimated values for the ecosystem services provided by this tree canopy. This information can inform City Council, boards and commissions and staff in future decision-making regarding tree canopy goals, regulations, and management policies. However, a number of questions remain unanswered that may be important to consider with these tree management decisions.

The City's information on the composition (tree species and sizes) of the UTC is limited to the inventory of street trees completed for approximately three quarters of the City's right-of-ways in 2003 and the vegetation studies completed for Hamlin, Shoreview, Boeing Creek, and South Woods parks in 2008. It is not known whether there has been any change in tree species diversity, nor how or why this might have changed.

Similarly, the City's information on the health of our trees and associated understory vegetation is limited to these ROW and park studies. No information is available on the health or management needs for trees on private property or public schools and campuses.

## D. UTC Goal Discussion

An Urban Tree Canopy goal combined with regular (5-10 year) assessment of the UTC is a common management tool utilized by cities to determine if their programs, policies, and regulations are achieving the desired outcome.

Shoreline's current tree regulations set a goal in the purpose statement of "No net loss of tree cover throughout the City over time." Based on the results of this UTC Assessment, the current regulations are achieving this goal.

The City of Shoreline's Environmental Sustainability Strategy and this Urban Tree Canopy Assessment both discuss an urban tree canopy goal recommended for metropolitan areas in the Pacific Northwest by the non-profit, conservation organization, American Forests. American Forests recommends an *average* tree canopy of 40% for the Pacific Northwest region. This average includes a range from 15 to 50% over central business districts (15%), urban residential zones (25%) and suburban residential zones (50%).

Both the Sustainability Strategy and the UTC Assessment recommend considering adoption of an increased UTC goal for the City; however, determining whether an average of 40% makes sense for the City is a policy decision that should take into consideration existing and allowable land uses in the City, the amount of tree canopy that is biophysically possible, and other competing uses and services that may not be compatible with trees.

AMEC recommends reassessing the UTC every five years. At the same time, the City has not seen any significant change to the urban tree canopy in the past

20 years. If no substantive change is made to the canopy goal or the tree regulations or other tree management and education programs, then the status quo is likely to continue. A 10 year reassessment period should be adequate for confirming whether tree canopy is being maintained or not. However, if the City decides to aim for an increase in UTC and/or substantively change the regulations, management policies or programs with the intent of influencing the total tree canopy in the City, a more frequent assessment period of five to seven years would be recommended to determine whether City programs, policies and/or regulations are having the desired results.

### E. Policy Implications

The primary purpose of Council's direction in 2009 was to establish a baseline tree canopy measure so that after 5-10 years another assessment could be made to determine whether our canopy is increasing or decreasing. Based on that comparison the City could determine whether our tree regulations were adequate. In response to this purpose and based on the no loss of canopy findings, should the City amend the tree regulations standards for tree cutting, preservation and planting on private property?

A secondary purpose of the Council's direction in light of the UTC baseline, was to evaluate whether the City should maintain the existing no net loss UTC goal or consider adopting a new goal that would increase the tree canopy over a reasonable amount of time and the subsequent policy, programmatic, and regulatory to gradually meet that goal? If a new goal were to be considered, does the American Forests recommendation of an average 40% UTC make sense for Shoreline?

In response to the secondary purpose and based on the difference between the 1992-2009 UTC of 31% and the recommended goal of 40%, should the City initiate programs that will increase the planting of trees?

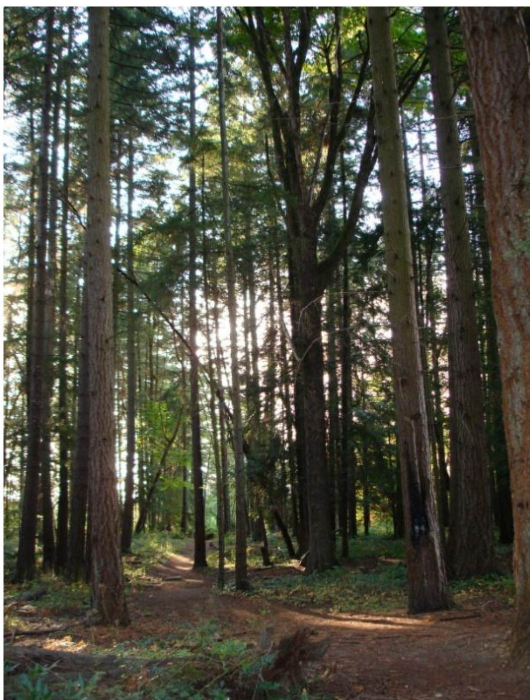
## RECOMMENDATION

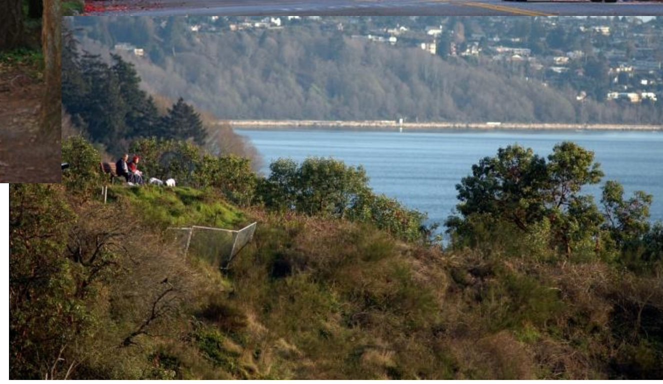
No action is required at this time as this item is before the Council for information only.

### ATTACHMENTS

Attachment A: Shoreline, WA – Urban Tree Canopy Assessment – Completed March 2011

# Shoreline, WA
# Urban Tree Canopy Assessment
**- Completed March 2011 -**






**Prepared for:**
City of Shoreline, Washington

**Prepared by:**
Ian Hanou
Senior GIS Project Manager
AMEC Earth & Environmental

# Introduction

Figure 1: Shoreline City Boundary (Google)

The City of Shoreline envisions itself as a community of families, safe neighborhoods, cultural diversity, active partnerships, quality businesses, natural resources and responsive government. Trees have always been an important element of this community and were identified as a top priority by citizens during the initial City incorporation effort. To better realize this vision, the City Council set a goal in 2007 to "Create an Environmentally Sustainable Community."

In July 2008, City Council adopted the Shoreline Environmental Sustainability Strategy which includes a commitment to:

- Being stewards of our community's natural resources and environmental assets;
- Promoting development of a green infrastructure for the Shoreline community;
- Measurably reducing waste, energy and resource consumption, carbon emissions and the use of toxics in city operations; and
- Providing tools and leadership to empower our community to work towards sustainable goals in their businesses and households.

The overall health and long-term management of our urban tree canopy is an important piece in achieving environmental sustainability as a community. Our trees and other vegetation provide numerous environmental services, including reducing surface water runoff, contributing to carbon sequestration and overall air quality, mitigating urban heat island effect, buffering noise and visual impacts between developments, providing habitat for local wildlife, and are an essential part of the aesthetic of our urban landscape. Alternatives to engineered "grey" infrastructure that include green infrastructure such as trees don't carry the stigma of single function solutions and have greater capacity and cost-benefit ratio.

The City of Shoreline is continuing a multi-pronged approach to the long-term stewardship of our urban forests. The Public Works Department started in 2003 with an inventory and management plan for trees in the City's Right-of-Way. This inventory and management plan has guided the City's stewardship of street trees over the past seven years. Even today, when making decisions about maintenance, removal and planting of trees the City uses the 2003 inventory and management plan to inform these decisions. In 2009 the City's surface water management regulations were updated, including provisions for protecting trees in the low impact development standards. Public Works is currently revisiting the standards and policies for management of trees located on the City's Right-of-Way. The Parks, Recreation and Cultural Services Department is responsible for management of the trees in the City's parks and recently completed detailed inventories and vegetation management plans for four of the City's largest parks – encompassing 184 acres of urban forest.

At the beginning of 2009, the Planning and Development Services Department was tasked with updating the City's tree ordinance in response to recommendations in the City's Sustainability Strategy, comments and concerns from residents, and direction from City Council and the Planning Commission. The City Council specifically directed the Planning Commission and staff to:

> *"Establish a baseline urban forest canopy city-wide. This baseline would provide the context for the Council to make a policy decision … about a long-range City target for desired tree canopy. The target could be no-net loss of a city-wide percentage of canopy, or an increase or decrease of some magnitude, keyed to specific schedules. With such a baseline and target in place, the City could then monitor the overall City canopy, say every 5 years, to assess its health and identify any further programs or code amendments as needed."*

Shoreline City Council's 2010-2011 Goal 1 is to "Implement the adopted Community Vision by updating the Comprehensive Plan and key development regulations in partnership with residents, neighborhoods and businesses." This goal explicitly identifies adopting "updated tree regulations, including citywide goals for urban forest canopy" as a priority task. A baseline measure of Shoreline's tree canopy is essential to accomplishing this directive.

The purpose of this assessment was to provide a sound scientific basis for ongoing regulation and management of the urban tree canopy (UTC) on public and private property using the latest mapping technologies and canopy assessment protocols. The objective was to map the City of Shoreline's UTC and perform an initial, first-order assessment to calculate the value of the urban forest based on the benefits they provide to the community. This information will serve as the benchmark from which to measure the success of planning and urban forestry programs and to educate the public about the many benefits of trees.

## Major Findings

In 2011, AMEC Earth & Environmental was contracted to conduct an analysis of the City of Shoreline's existing urban tree canopy and compare the results with analysis of 30-meter resolution national data available for 1992 and 2001. Shoreline has 30.6% tree canopy coverage (based on 2009 imagery). This is a slight increase in canopy from 1992, estimated at 30%, and essentially the same as in 2001, estimated at 31%. Overall Shoreline has 55.7% green cover comprised of grass, shrubs and tree cover. Almost three quarters of Shoreline's tree canopy is located in the low density residential zones, an area that represents approximately two thirds of the total land area in the City.

This study further identified Shoreline's "possible urban tree canopy" using methodology developed by the U.S. Forest Service Northern Research, and commonly used in UTC analysis. Possible UTC, split into Possible Vegetation UTC and Possible Impervious UTC, was defined as the areas where it is biophysically possible to plant trees, meaning all grass and open space vegetation and impervious area after excluding buildings, roads, and water bodies. This measurement takes into account all areas where it is biophysically possible to establish tree canopy, and while covering all of this area with trees may be unrealistic, it is a good tool for assessing what areas have the most availability. Land use should always be taken into account when using these numbers too, as schools and parks will have fields used for recreational purposes that are not suitable for tree planting, yet are included in Possible UTC estimates. The total Possible UTC is 3282 acres potentially available for planting, or 44.3% of area in addition to the 30.6% of existing UTC. This is comprised of 1609 acres (21.7%) of unforested vegetation, and 1673 acres (22.6%) of unforested impervious areas, such as parking lots.

The analysis also quantified some of the environmental and economic benefits of the City's tree canopy using CITYgreen software. Shoreline's 2009 tree canopy provides approximately $460,000 in indirect cost savings due to air quality improvement, 770 tons of annual carbon sequestration (removal of carbon from the atmosphere and storage as new tree growth), $900,000 annual cost savings for stormwater storage capacity that does not have to be built, and reductions of 3% to 10% in regulated stormwater pollutants, when compared to the scenario of no tree cover, in a typical storm.

## Shoreline 2009 Land Cover at a Glance

**Total City Area: 7,412 acres**

**Total Tree Canopy: 30.6% (2,270 acres)**

**Shrub Cover: 3.4% (253 acres)**

**Grass/Vegetation: 21.7% (1,612 acres)**

**Water: < 0.1% (24 acres)**

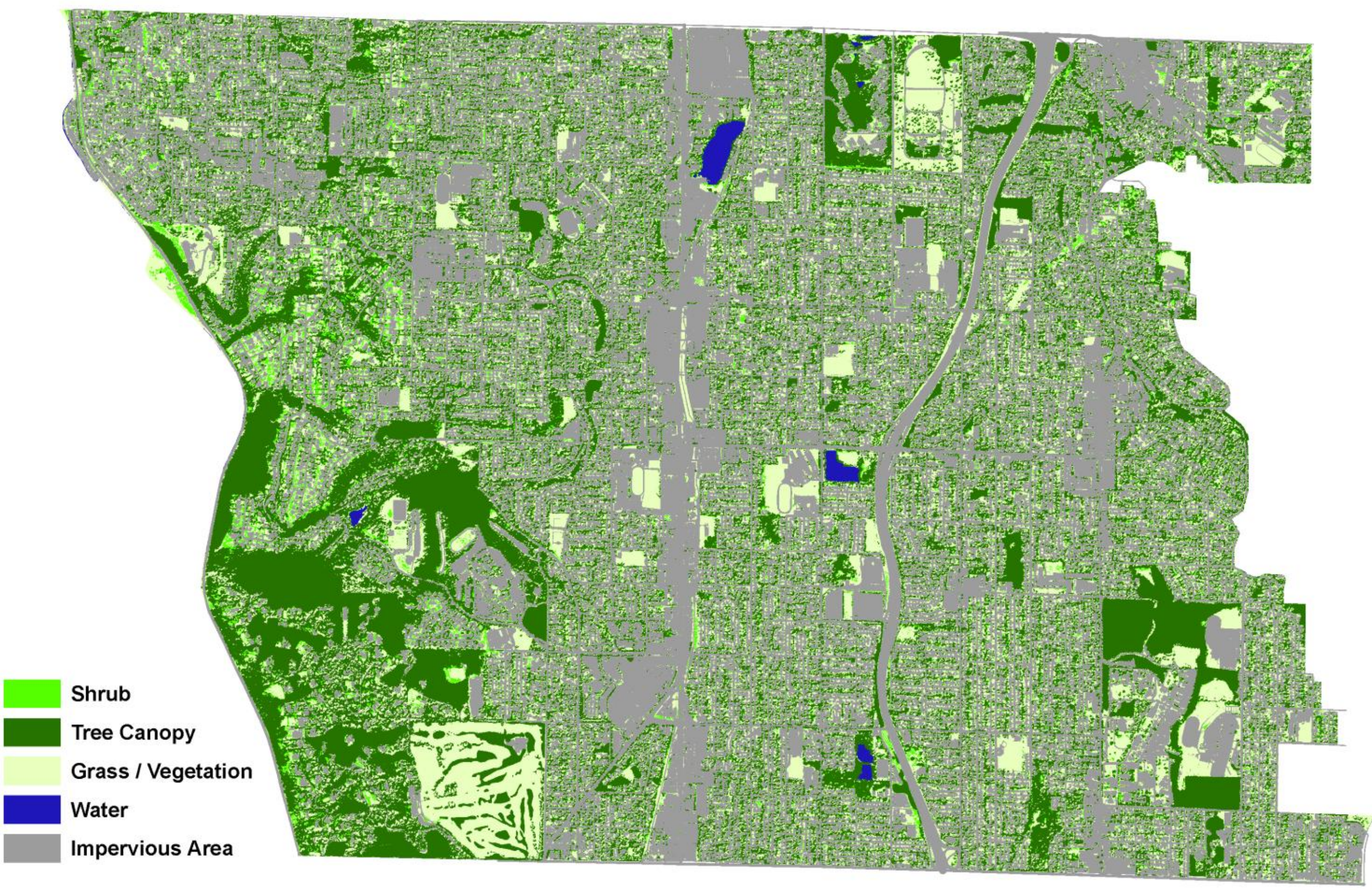
**Impervious Area: 46.2% (3,427 acres).**
**(1.6%, 138 acres, is under tree canopy)**

## Key Terms:

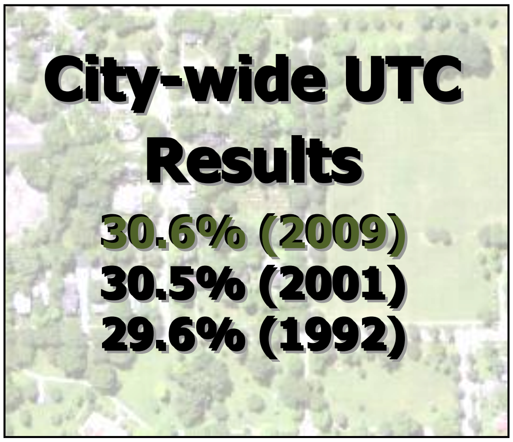
GIS – Geographic Information Systems
AOI – Area of Interest, referring to the study or project area
Urban tree canopy (UTC)* – the layer of leaves, branches, and stems of trees that cover the ground when viewed from above using aerial or satellite imagery
Land Cover* – features on the earth mapped from aerial or satellite imagery, such as trees, grass, water, and impervious surfaces
Possible UTC Vegetation * – grass or shrub area that is theoretically available for the establishment of tree canopy.
Possible UTC Impervious * – for this project this consisted of parking lots where it is theoretically possible to establish tree canopy

*Source: USDA Forest Service and/or University of Vermont Spatial Analysis Laboratory

Figure 2: Shoreline Land Cover Data – 5 class map



# Shoreline Land Use and Urban Tree Canopy Trends




The City of Shoreline Urban Tree Canopy (UTC) assessment is based on Geographic Information Systems (GIS) analysis of July 2009 Orthophotography Satellite imagery. Through this process the existing land cover was classified into five categories: Tree Canopy, Shrub, Grass/Dry Vegetation, Impervious, and Open Water. This land cover data analyzed the UTC along with the general land use categories found in Shoreline (see Figure 3) and totals for the City as a whole. The methodology for this analysis is summarized in Appendix A.

National Land Cover Data 1992 and 2001, available from the US Department of Agriculture, was used to obtain rough estimates of historic tree cover for the Shoreline area. At 30 meter resolution, this data is more generalized than the land cover data generated for 2009 from the 2-foot resolution, satellite imagery. Despite the coarseness of the data, the total canopy estimates for the Shoreline city limits can be broadly compared to the 2009 results and indicate that there has been no significant change to the percent urban tree canopy since 1992. More detailed information on the U.S. Forest Service's i-Tree Vue software, process and results of the tree canopy for 1992 and 2001 is available in Appendix B. Historic Aerial photo images over the past 65 years are included in Appendix C.

When compared with other municipalities in the Puget Sound region, Shoreline has a reasonable urban tree canopy.

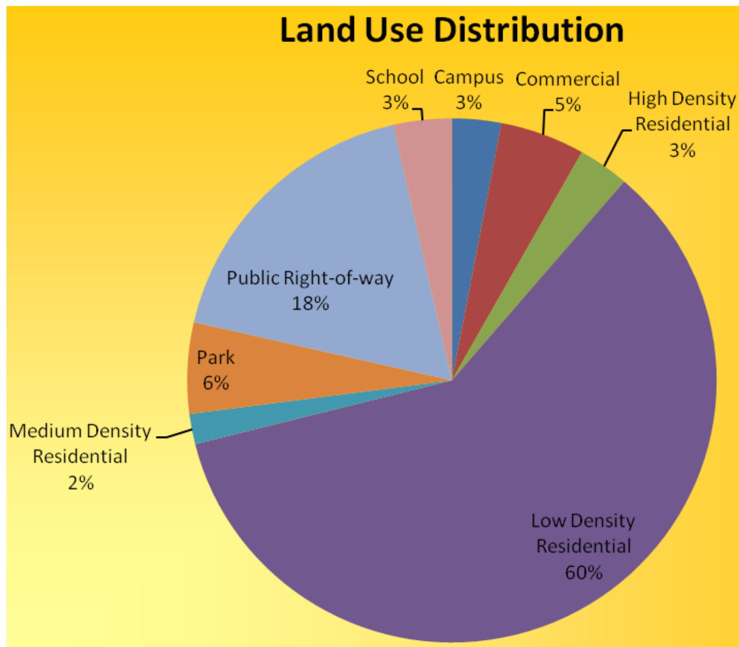
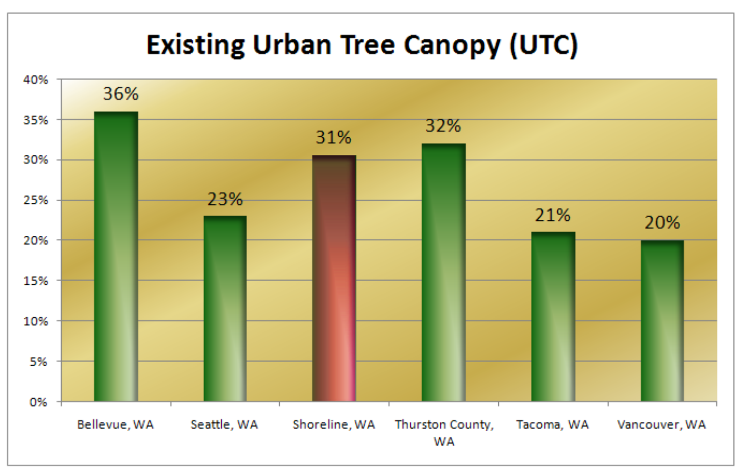



Figure 3. Percent Distribution of Land by General Land Use Types in Shoreline

Figure 4. Comparing Shoreline's Existing UTC to that of other Pacific Northwest communities



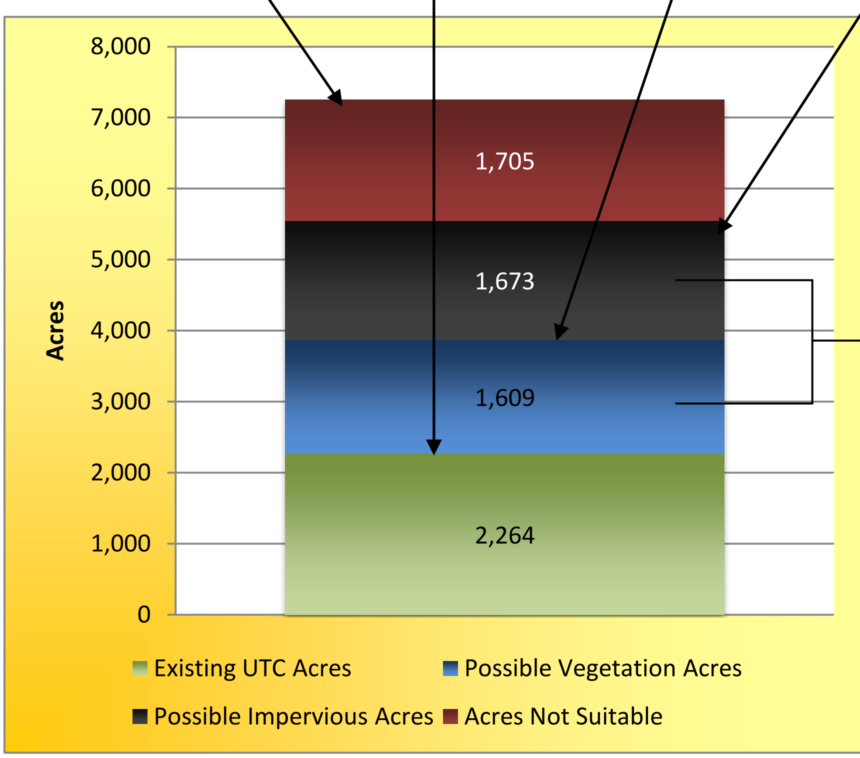
### Possible UTC Results

In addition to existing tree canopy, the 2009 land cover analysis roughly estimated how much existing impervious (parking lots) and existing shrub and grass vegetation could possibly be replaced with tree canopy. This estimate of additional Possible UTC at 44.3% is high because it does not take utility corridors, proximity to intersections, property owner preference, park and school areas that are dedicated to recreational fields, or the underlying zoning into consideration. Possible UTC may also be under-valued slightly for the areas where trees can overhang roads and buildings, which make up for some of the realistic error. This number is a cost-effective way to identify areas where increase in UTC could be viable, and can be used to focus outreach to property owners in high Possible UTC areas or to target City education and tree planting programs.

Table 1 below illustrates the acres and percent of Shoreline that were analyzed to be existing tree canopy, unsuitable for tree canopy (roads and buildings) or possible grass, shrub and impervious areas where tree canopy could be established.

Table 1. UTC Metrics for the City of Shoreline

| Total Acres | Not Suitable Acres | Not Suitable % | Existing UTC Acres | Existing UTC % | Possible UTC Vegetation Acres | Possible UTC Vegetation % | Possible UTC Impervious Acres | Possible UTC Impervious % | Total Possible UTC Acres | Total Possible UTC % |
|---|---|---|---|---|---|---|---|---|---|---|
| 7,412 | 1,705 | 23.0 | 2,264 | 30.6 | 1,609 | 21.7 | 1,673 | 22.6 | 3,282 | 44.3 |




Possible UTC, split into Possible Vegetation UTC and Possible Impervious UTC, was defined as the areas where it is biophysically possible to plant trees, meaning all grass and open space vegetation and impervious area after excluding buildings, roads and water bodies (U.S. Forest Service Northern Research Station).

There are 1,673 + 1,609 (3,282) acres of "Possible UTC Planting Acres".

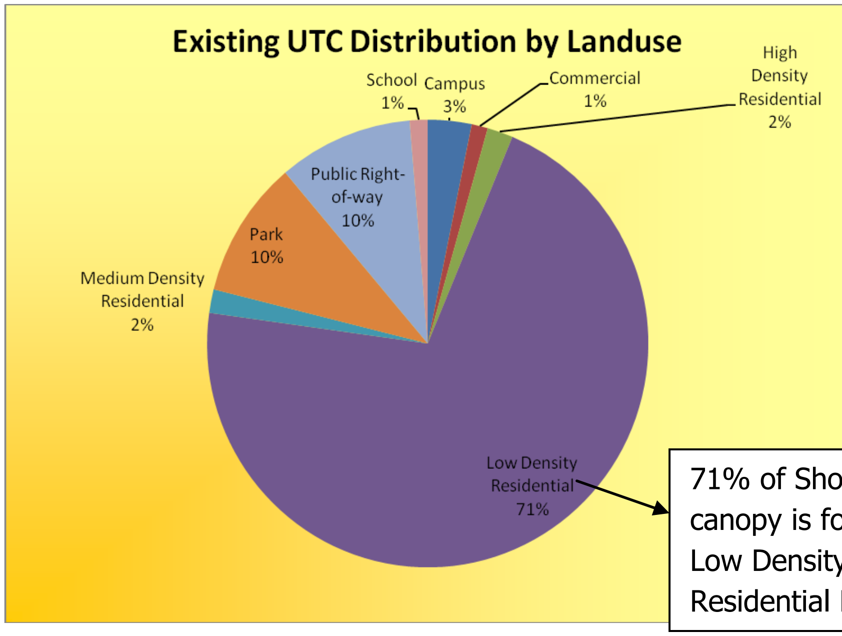
Figure 5. Overall Summary of UTC Assessment

## UTC Results by Land Use Category

Almost three quarters of Shoreline's tree canopy is located in the low density residential zones, an area that represents approximately two thirds of the total land area in the City.

Parks and Right-of-Way represent 20% of the tree canopy, with the balance in the remaining land use areas.

Figure 6. Distribution of Existing UTC by General land use Type




71% of Shoreline's canopy is found in Low Density Residential LU

Table 2. Existing and Possible UTC Metrics within Each General Land Use Category

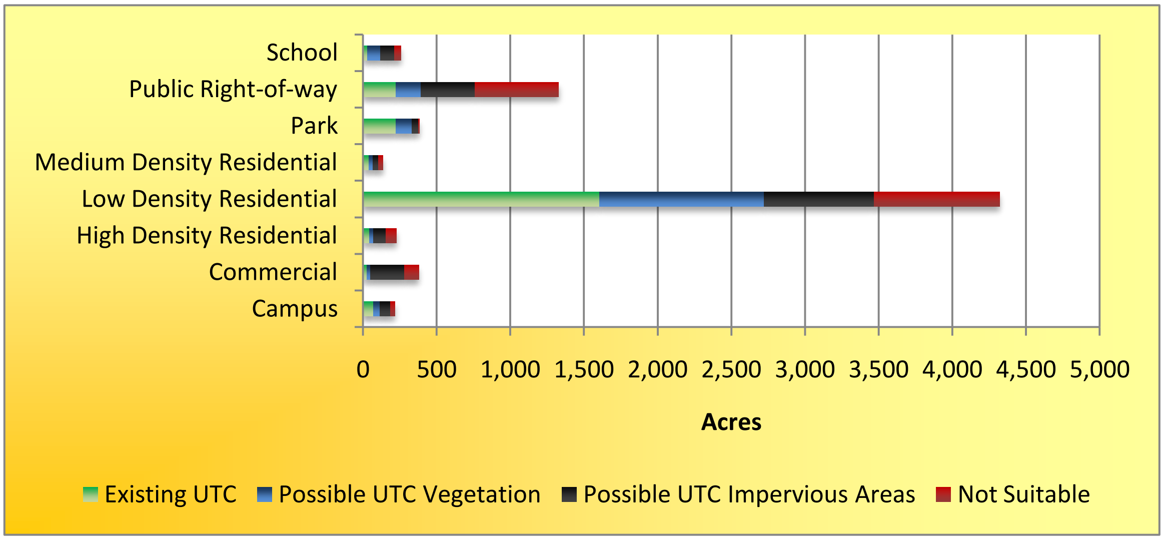
| Land Use | Total Acres | Not Suitable | Not Suitable % | Existing UTC | Existing UTC % | Possible UTC Vegetation | Possible UTC Vegetation % | Possible UTC Impervious | Possible UTC Impervious % | Total Possible UTC | Total Possible UTC % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Campus | 222 | 31 | 13.9 | 72 | 32.6 | 44 | 19.8 | 70 | 31.4 | 114 | 51.2 |
| Commercial | 382 | 99 | 25.9 | 27 | 7.0 | 23 | 6.0 | 230 | 60.2 | 253 | 66.2 |
| High Density Residential | 231 | 71 | 30.8 | 43 | 18.5 | 29 | 12.7 | 85 | 36.9 | 115 | 49.7 |
| Low Density Residential | 4,431 | 851 | 19.2 | 1,606 | 36.2 | 1,117 | 25.2 | 746 | 16.8 | 1,864 | 42.1 |
| Medium Density Residential | 138 | 32 | 23.1 | 39 | 27.9 | 30 | 21.9 | 36 | 26.0 | 66 | 47.9 |
| Park | 417 | 7 | 1.7 | 225 | 54.0 | 106 | 25.5 | 45 | 10.7 | 151 | 36.2 |
| Public Right-of-way | 1,325 | 568 | 42.9 | 223 | 16.9 | 170 | 12.8 | 368 | 27.8 | 537 | 40.6 |
| School | 263 | 46 | 17.5 | 30 | 11.3 | 90 | 34.1 | 93 | 35.3 | 182 | 69.4 |
| **Total** | | **1,705** | | **2,264** | | **1,609** | | **1,673** | | **3,282** | |

* 36% of all Low Density Residential Property Area is covered by Trees

* 66% of all Commercial Property Area is indicated as Possible UTC. Commercial zones have parking and access requirements that must be met, however, and are allowed up to 90% hardscape.

Figure 7 below, compares the total acres of existing UTC, Possible UTC and not suitable for UTC by general land use category. While the model estimates that an additional 66.2% of all commercial areas might be available for new tree canopy, the total acres is relatively small. Even if these estimates are double the area that realistically could have tree canopy added, from a total acreage perspective the biggest gains City-wide could be made in the Right-of-Way and in Low Density Residential Zones (R-4 and R-6).

Figure 7. Acres of Existing UTC, Possible Vegetation UTC, Possible Impervious UTC and Not Suitable Metrics by Land Use Type




This study does not look at the overall health, composition or age of the existing urban tree canopy. For example, the recent vegetation study in Hamlin Park indicates that a significant portion of the forested area does not have healthy understory vegetation and little to no new trees that will replace the existing canopy as it dies due to age, disease, or other events.

# Ecosystem Services Analysis

Trees, as green infrastructure, provide a wide variety of public benefits, including stormwater volume and quality improvement, air quality improvement, carbon removal from the atmosphere, and more. These benefits are referred to as ecosystem services. Grass and shrubs also provide ecosystem services, but to a lesser extent than trees. The benefits of these vegetative covers were not analyzed in this study. In the absence of trees, a municipality often has to provide similar services to protect the public, through construction of stormwater and water quality infrastructure or through regulation of uses that might generate these problems.

The ecosystem services, or environmental benefits, that trees and forests provide in cities are quantifiable in a variety of ways. Some techniques involve field data collection and statistical modeling to extrapolate environmental and economic benefits of urban tree canopy such as energy savings, air pollution removal and property value increase. In an effort to quantify the value to the City of Shoreline provided by tree canopy, the value of these ecosystem services was estimated using a nationally accepted modeling tool – CITYgreen developed by American Forests. This is just a baseline assessment, and a more detailed assessment is recommended, but outside of the scope of this project.

CITYgreen
calculating the value of nature

### Assumptions

In this model, trees are 'removed' to show the impact on air quality, lost carbon storage and sequestration benefits, additional stormwater runoff and the percent change in contaminant loading (water quality). The water quality and quantity components require that a replacement land cover be used to replace trees in the model, as land cover that is more impervious than trees will increase runoff and pollutant loading, often more than a grass or shrub land cover (as assumed here), depending on factors such as soil type and the specific replacement land cover class chosen.

CITYgreen does not take into account species composition, height, or DBH of trees. Instead, the model uses US Forest Service data on trees and applies a per unit area value/benefit for air quality and carbon storage/sequestration, based on the species/size/composition of trees in various reference city. Seattle was used as the reference City for this analysis. The CITYgreen results an estimate based on the best science, but some assumed values. More in-depth analysis can be done, but falls outside the scope of this project.

### Results

Shoreline's urban tree canopy contributes multiple environmental benefits to the community, including air and water quality improvement, stormwater quantity reductions, and carbon storage. For more detailed information on the basis for these estimates refer to Appendix D.

*Air Pollution Removal*

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10) in their leaves, urban trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. The current UTC improves air quality for the residents of Shoreline by approximately 203,000 lbs of these pollutants per year, valued at $457,000 in indirect cost savings such as avoided health care expenditures.

Figure 8. Pounds of air pollutants removed by tree canopy annually and estimated cost savings.

| | Lbs. Removed/yr | Dollar Value |
|---|---|---|
| *Carbon Monoxide:* | 12,202 | $5,208 |
| *Ozone:* | 67,113 | $206,186 |
| *Nitrogen Dioxide:* | 30,506 | $93,721 |
| *Particulate Matter:* | 63,046 | $129,318 |
| *Sulfur Dioxide:* | 30,506 | $22,894 |
| **Totals:** | **203,373** | **$457,326** |

*Carbon Storage and Sequestration*

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree's dry weight is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and carbon sequestration rates of trees in Shoreline to be:

Total Tons Stored: 98,175.44
Total Tons Sequestered (Annually): 764.32

This estimate does not directly account for tree removal, but is based on the estimated tree canopy.

*Stormwater*

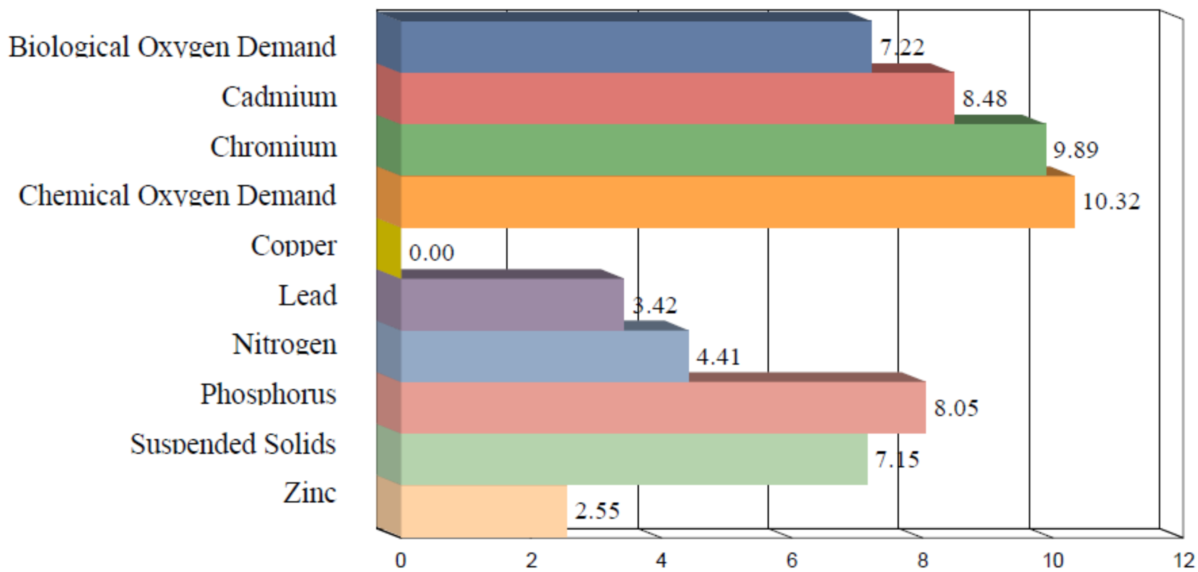
Shoreline's tree canopy slows stormwater and decreases the amount of stormwater storage needed by approximately 3.4 million cubic feet during a 2-year, 24-hour storm event. Based on a construction cost of $3/cubic foot this is valued at $10.3 million, or $900,000 annually over 20 yrs at 6%. Actual stormwater infrastructure construction costs for the City of Shoreline were not available at the time of this analysis so this amount is based on similar studies for cities in the Puget Sound region.

*Water Quality*

Cities must comply with Federal clean water regulations and Shoreline has developed a plan and adopted new regulations in 2009 to improve the quality of their streams and rivers. One way new development in Shoreline can meet these new standards is through the preservation of existing trees on site.

Trees filter surface water and prevent erosion, both of which maintain or improve water quality. The CITYgreen model estimates the change in the concentration of the pollutants in runoff during a typical storm event given the change in the land cover – in this case the difference between existing landcover with or without the existing tree canopy. Shoreline's existing 30.6% tree canopy is estimated to reduce pollutants and water quality indicators such as cadmium, chromium, lead, nitrogen and phosphorus and chemical and biological oxygen demand by 3 to 10% in a typical 2 inch, 24-hour storm event.

Figure 9. Percent reduction in Contaminant Loading with existing UTC vs. no tree canopy.




## Setting Urban Tree Canopy Goals

American Forests recommends an overall goal of 40% canopy in Pacific Northwest communities. This metric is based on assessing and comparing land use, environmental quality goals, and existing canopy, where suburban areas are expected to have a 50% canopy and more urban areas near 25%. With 31%, Shoreline is in a good position to start to work towards that goal. The first 1% percent increase would take approximately 6,000 trees with a mature crown diameter of 30 feet and would be a very realistic goal to start with. This increase alone would provide a stormwater benefit increase of almost $500,000 (from CITYgreen), and sequester an extra 35 tons of carbon every year.

Reaching the long-term goal of 40% would mean maintaining the existing tree canopy <u>and</u> adding approximately 46,000 trees to the canopy at an average 30-foot crown diameter. While a 40% canopy is biophysically an attainable goal, it may be more realistic for budgetary and management reasons to set a more conservative goal of 35% unless significant support is realized. Along with planting of street trees and increasing the vegetation in public parks and schools, the City should consider an outreach program to educate the public on increasing the canopy on their property, as much of the potential canopy lies within private land. Cooperating with commercial and residential land owners will be crucial in maintaining and achieving canopy goals. Low density residential, parks, and public right-of-way also represent the biggest opportunities for maintaining and augmenting the existing tree canopy. It may benefit the city to perform a survey among its constituents on the desire to increase tree canopy on their property. 30.6% tree canopy cover may sound like a lot, but once it is realized how many possible planting spots exist around the City, more support can be garnered in the form of volunteers and backing from citizen organizations.

It is recommended a tree canopy study be performed every 5 years. This allows for a proper assessment of urban tree canopy improvement programs, development pressure over time, and how close the City is to its UTC goal. If possible, similar photographic data and analysis processes should be used, for the best comparison to the data generated in this project.

# Conclusion

With 31% existing UTC, Shoreline has average or slightly above-average tree canopy cover compared with other similar-sized communities in the Puget Sound Region. This canopy provides social, environmental, and economic benefits, some of which have been assessed for the first time through this project.

Shoreline is dedicated through its Forevergreen sustainability program to ecological health and to setting a canopy goal for increasing canopy to a realistic level over a reasonable time frame. The data from this assessment and subsequent analysis will help meet the mission of this program. Using the tools and data provided, the City can communicate to the public the value of trees along with where, how and why to improve planting and maintenance programs. These results and data products should be used by the City of Shoreline and other stakeholders involved in green infrastructure development as a starting point for more detailed environmental studies, comprehensive planning, GIS analyses and targeted urban forestry implementation/outreach programs. Setting up an incentive program and providing the public with information and instruction on how to best site and plant their trees will not only help reach Shoreline's canopy goal, but also get the City's constituency directly invested in this program to improve Shoreline as a sustainable and green community.

## About AMEC Earth & Environmental, Inc.

AMEC Earth & Environmental (AMEC) is a leading full-service environmental engineering and construction/remediation services firm in North America, providing environmental and geotechnical engineering and scientific consulting services. AMEC is a focused supplier of high-value consultancy, engineering, and project management services to the world's energy, power and process industries. We are one of the world's leading environmental and engineering consulting organizations. Our full service capabilities cover a wide range of disciplines, including environmental engineering and science, geotechnical engineering, water resources, materials testing and engineering, surveying, information management (GIS, remote sensing, database/application development) and program/project management.

Funding assistance provided by the USDA Forest Service and the Washington State Department of Natural Resources Urban and Community Forestry Programs.

# APPENDIX A.  2009 Urban Tree Canopy Methodology

## Summary

GIS and remote sensing technologies offer powerful analysis and decision support tools for managing urban natural resources.  All UTC projects have at least 5 main elements in common regarding data inputs and outputs.  These are: high-resolution imagery, supporting GIS layers from the community, land cover data, geographic boundaries in which to summarize tree canopy acres and percent cover, and reporting of the results through tables, graphs and maps. Urban Tree Canopy and Possible UTC are assessed at the larger-scale land use level and at the individual parcel level.  The accuracy of this data is extremely high, and the delivered data can be manipulated using GIS programs by the community.

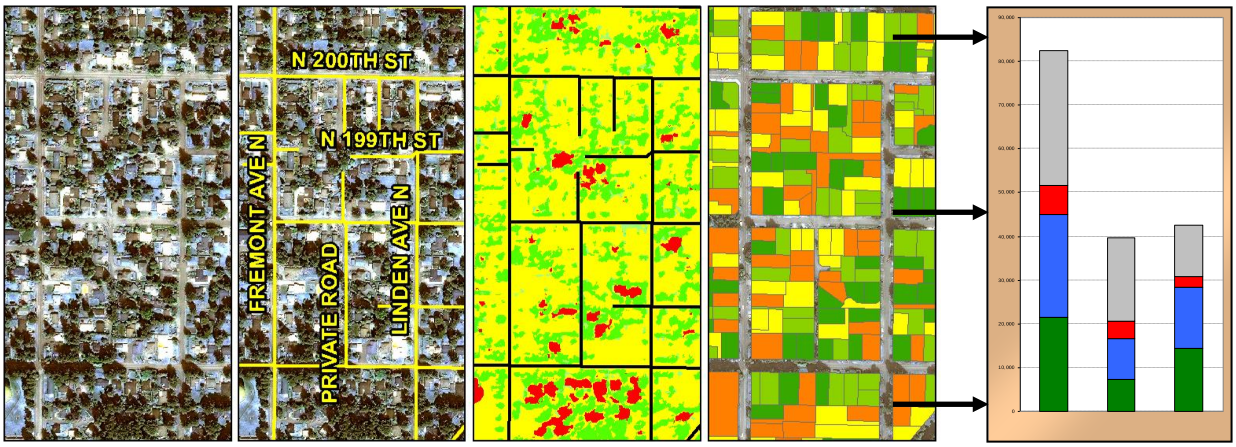
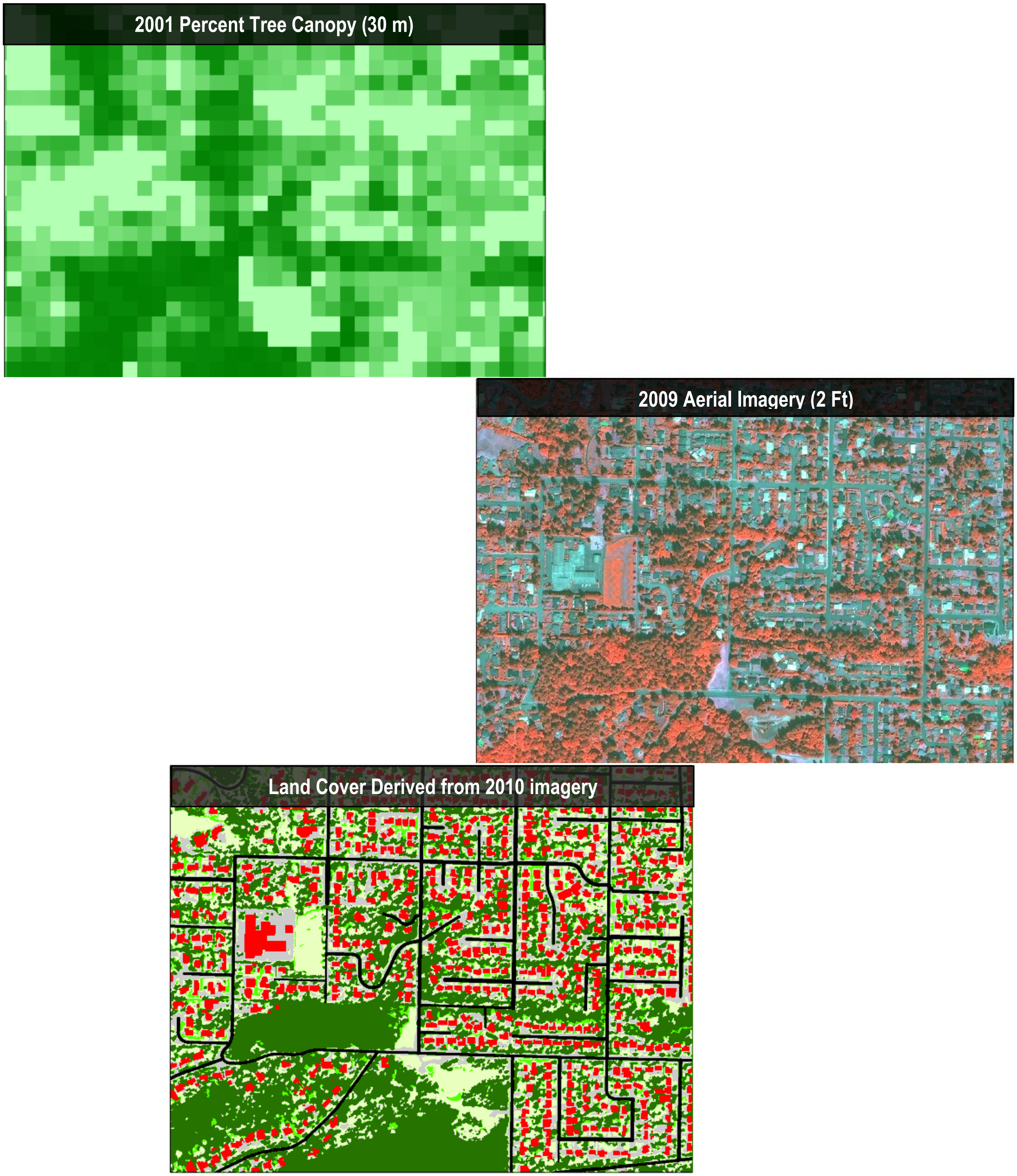



Figure 10. UTC Analysis Process

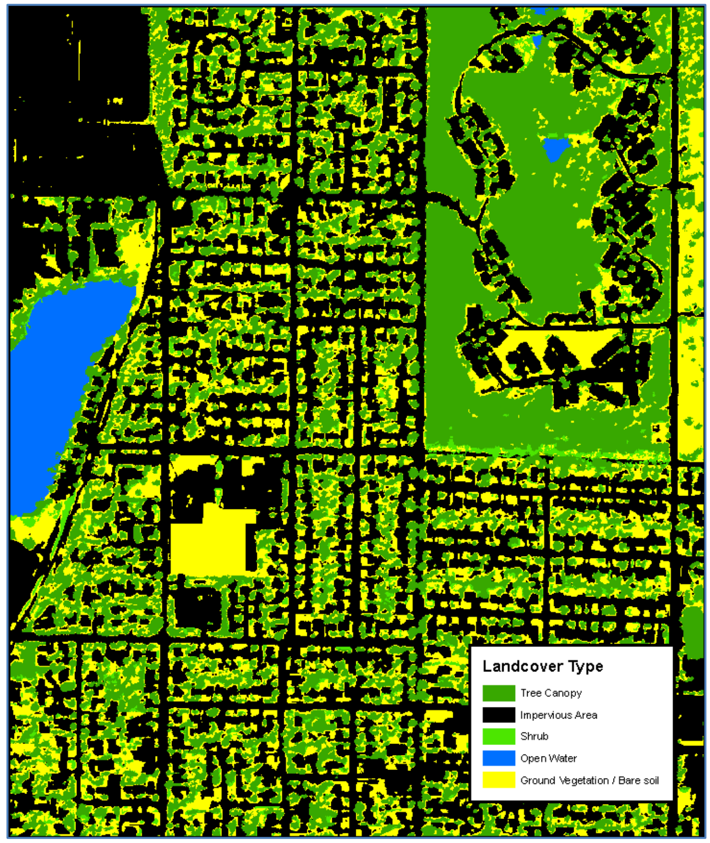
For this project, the City of Shoreline provided AMEC with the following GIS layers: city boundary, parcels, land use, parks, watersheds, hydrology (lakes and streams) and impervious surfaces (buildings, streets).  Imagery was acquired by the city through eMap International, and this 2-foot, 4-band multispectral image was used for classification of trees and other land cover.

AMEC analyzed the multispectral imagery using a technique known as geographic object-based image analysis (GEOBIA) and developed a 5-class land cover dataset that included tree canopy, shrubs/vegetation, grass/ground cover, water and impervious surfaces.  The GEOBIA approach provided a highly automated and cost-effective method for feature extraction by using algorithms that leverage spectral, spatial, textural, and contextual features in imagery, as well as incorporation of datasets provided by the City.  The classification was refined with a manual quality assurance / quality control (QA/QC) process to finalize the land cover.  Prior to this study, 2001 Land cover data was the only data available for assessing canopy cover.  The images below illustrate how the increased resolution of imagery allows for a much more accurate land cover map.  Figures 3-6 show more detailed examples of the results from this process.

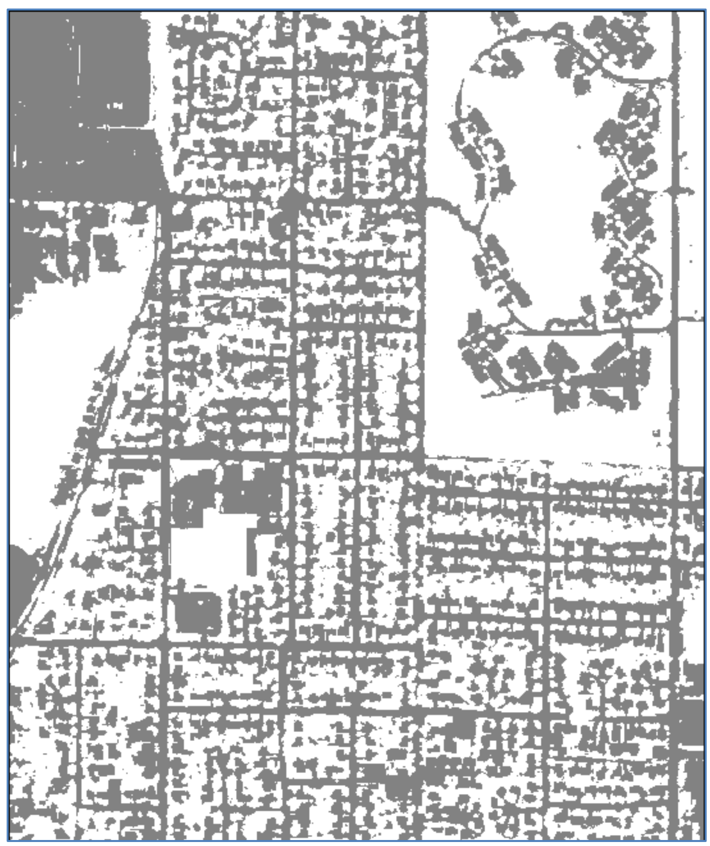
Figure 11. Comparison of 2001 data resolution and 2009 assessment data resolution. This increase in resolution allows for extremely accurate analysis of the tree cover, where the 2001 data can merely approximate the canopy cover



Figures 12 and 13. Color infrared aerial imagery and 5-class land cover data.

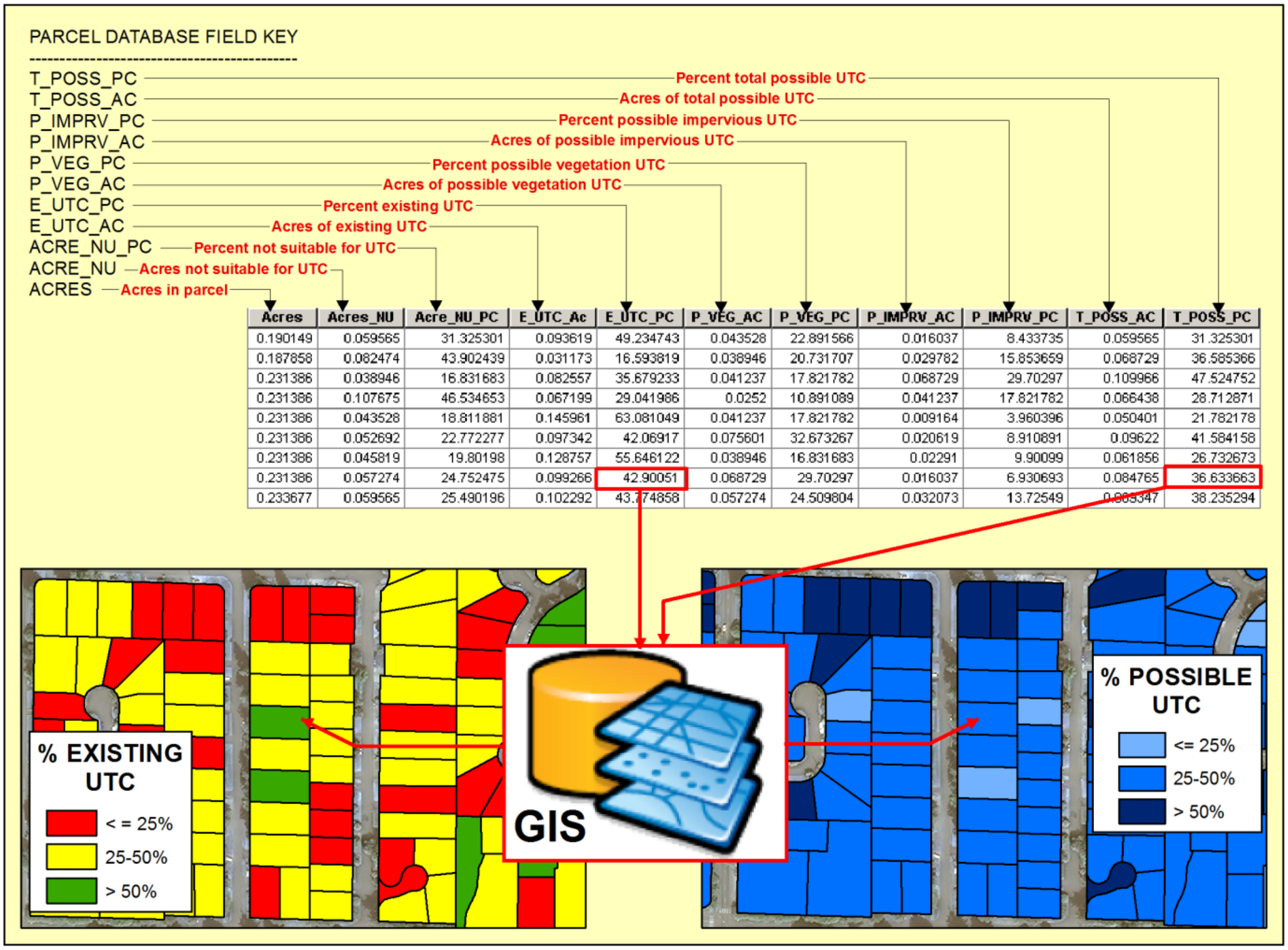



Figures 14 and 15. Trees and Impervious land cover data.



## Analysis of UTC Metrics

Figure 7. Structure and Symbolizing of Existing and Possible UTC Metrics by Parcel and an Accompanying Screenshot of the Parcels UTC Attribute Table




| Acres | Acres_NU | Acre_NU_PC | E_UTC_Ac | E_UTC_PC | P_VEG_AC | P_VEG_PC | P_IMPRV_AC | P_IMPRV_PC | T_POSS_AC | T_POSS_PC |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.190149 | 0.059565 | 31.325301 | 0.093619 | 49.234743 | 0.043528 | 22.891566 | 0.016037 | 8.433735 | 0.059565 | 31.325301 |
| 0.187858 | 0.082474 | 43.902439 | 0.031173 | 16.593819 | 0.038946 | 20.731707 | 0.029782 | 15.853659 | 0.068729 | 36.585366 |
| 0.231386 | 0.038946 | 16.831683 | 0.082557 | 35.679233 | 0.041237 | 17.821782 | 0.068729 | 29.70297 | 0.109966 | 47.524752 |
| 0.231386 | 0.107675 | 46.534653 | 0.067199 | 29.041986 | 0.0252 | 10.891089 | 0.041237 | 17.821782 | 0.066438 | 28.712871 |
| 0.231386 | 0.043528 | 18.811881 | 0.145961 | 63.081049 | 0.041237 | 17.821782 | 0.009164 | 3.960396 | 0.050401 | 21.782178 |
| 0.231386 | 0.052692 | 22.772277 | 0.097342 | 42.06917 | 0.075601 | 32.673267 | 0.020619 | 8.910891 | 0.09622 | 41.584158 |
| 0.231386 | 0.045819 | 19.80198 | 0.128757 | 55.646122 | 0.038946 | 16.831683 | 0.02291 | 9.90099 | 0.061856 | 26.732673 |
| 0.231386 | 0.057274 | 24.752475 | 0.099266 | 42.90051 | 0.068729 | 29.70297 | 0.016037 | 6.930693 | 0.084765 | 36.633663 |
| 0.233677 | 0.059565 | 25.490196 | 0.102292 | 43.774858 | 0.057274 | 24.509804 | 0.032073 | 13.72549 | 0.089347 | 38.235294 |

Alongside Analysis performed on the land use level, individual parcels were also analyzed for percentage tree canopy and possible planting area. This will allow the planning department to better assess where to focus outreach and target individual parcels for potential tree planting to increase the homogeneity of the canopy.

### Existing and Possible UTC Assessment Process

Using the land cover classes described in the previous step, AMEC developed a series of geoprocessing models to calculate the area and percent of Existing and Possible UTC in both GIS and Excel format (see Figure 4 below). Existing UTC was defined as all area covered by trees and forest. Portions of this model were developed by the US Forest Service Northern Research Station and the University of Vermont Spatial Analysis Laboratory.

UTC GIS modeling workflow:

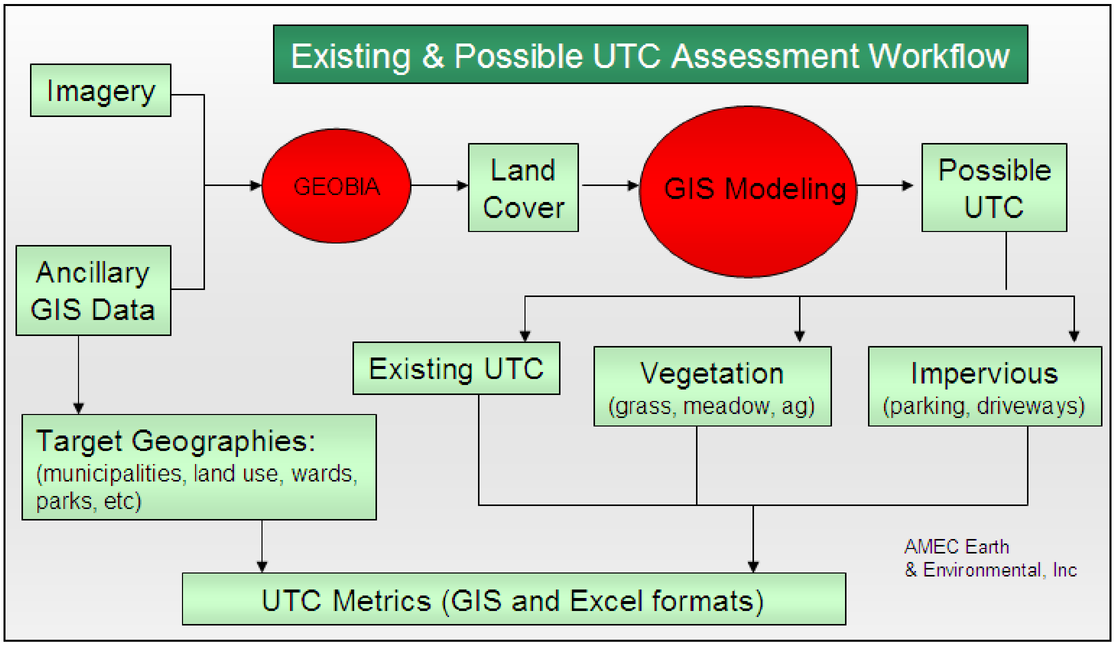



Figure 8. UTC GIS modeling workflow

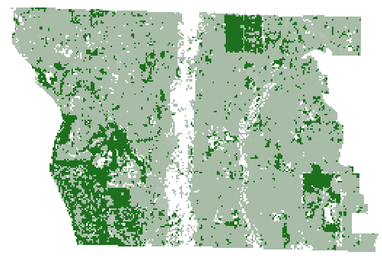
# APPENDIX B. 1992 and 2001 i-Tree Vue Urban Tree Canopy

The City of Shoreline was interested in comparing the current tree canopy to historical canopy percentages. Because of the limitations of historical data, a landcover assessment as detailed as the 2009 assessment is unfeasible, however, using derived land cover data, a fairly good canopy cover estimate can be obtained, along with rough estimates on the historical benefit of tree canopy on pollution and runoff mitigation.

### i-Tree Vue Analysis: Comparing current tree canopy to historical cover

i-Tree Vue allows a user to obtain rough estimates of canopy and impervious land cover based on coarse 30 Meter resolution land use data provided by the U.S. Department of Agriculture. Along with percent cover, an estimate of the annual benefits and current value of the urban forest can also be assessed. For Shoreline, data from 1992 and 2001 were analyzed using this program.

Figure 18. 1992 Canopy Cover



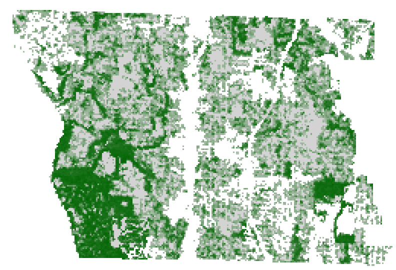
1992 iTree Vue analysis

| | Area (acres) | Percentage of total area |
|---|---|---|
| Total Area | 7412 | |
| Impervious Cover | 2701 | 36.60% |
| Existing Tree Canopy | 2187 | 29.60% |
| Available Planting Space | 2207 | 29.90% |

| | Weight (short tons) | Benefit per ton | Total Benefit |
|---|---|---|---|
| Carbon Storage | 88010 | $20.68 | $1,820,047 |
| Carbon Sequestration | 2901 | $20.68 | $59,993 |
| CO Pollution Removal | 4.2 | $1,276.41 | $5,361 |
| NO2 Pollution Removal | 12.3 | $8,986.57 | $110,535 |
| O3 Pollution Removal | 33 | $8,986.57 | $296,557 |
| SO2 Pollution Removal | 10.5 | $2,199.92 | $23,099 |
| Particulate Matter Removal | 19.4 | $6,000.12 | $116,490 |

| | |
|---|---|
| Overall Benefit: | $2,432,081 |
| Annual Pollution Removal Benefit: | $612,034.38 |

Figure 19. 2001 Canopy Cover



2001 iTree Vue analysis

| | Area (acres) | Percentage of total area |
|---|---|---|
| Total Area | 7412 | |
| Impervious Cover | 2881 | 38.87% |
| Existing Tree Canopy | 2261 | 30.50% |
| Available Planting Space | 2308 | 31.14% |

| | Weight (short tons) | Benefit per ton | Total Benefit |
|---|---|---|---|
| Carbon Storage | 91776 | $20.68 | $1,897,928 |
| Carbon Sequestration | 3026 | $20.68 | $62,578 |
| CO Pollution Removal | 4.4 | $1,276.41 | $5,616 |
| NO2 Pollution Removal | 12.8 | $8,986.57 | $115,028 |
| O3 Pollution Removal | 34.4 | $8,986.57 | $309,138 |
| SO2 Pollution Removal | 10.9 | $2,199.92 | $23,979 |
| Particulate Matter Removal | 20.2 | $6,000.12 | $121,202 |

| | |
|---|---|
| Overall Benefit: | $2,535,469 |
| Annual Pollution Removal Benefit: | $637,541.54 |

While development seems to have been strong in the period between 1992 and 2001, along with the current tree canopy of 30.6% the tree canopy seems to have stabilized around 30%. These values are approximates, however, and comparisons between the 2009 data and future canopy assessments will provide a more accurate picture of the trend in canopy growth in Shoreline. This data is generalized, and can therefore not be compared to the more detailed CITYgreen data.

# APPENDIX C. Historic aerial photos illustrating visual change in tree canopy since 1944

The following aerial photo images illustrate the change in Shoreline's tree canopy over the past 65 years.

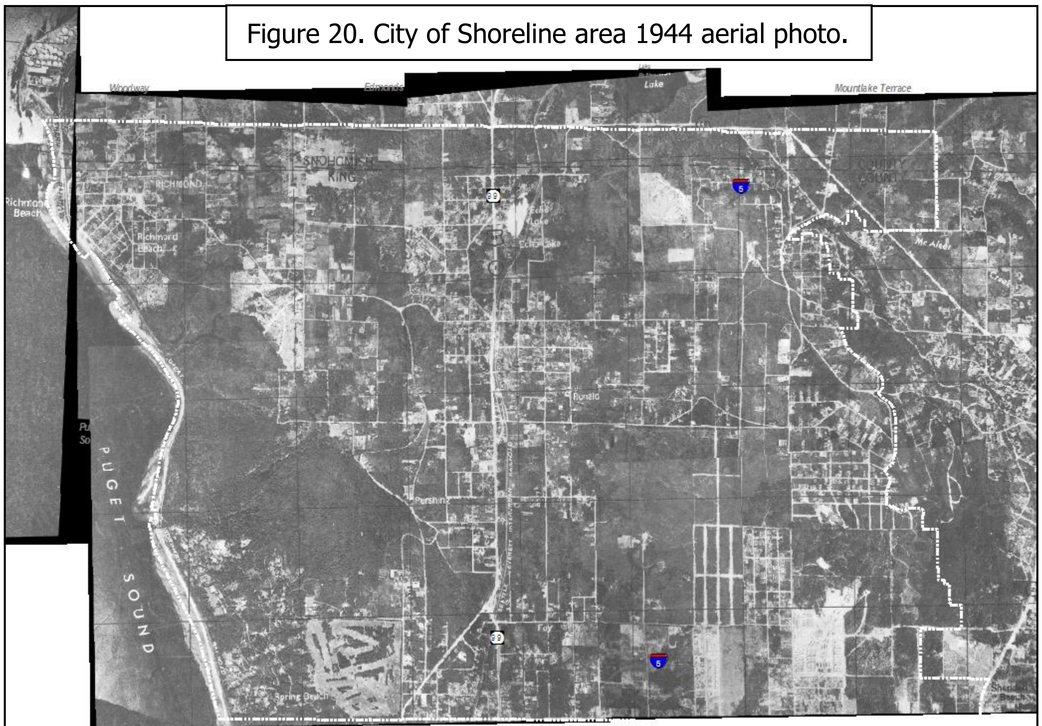



Figure 20. City of Shoreline area 1944 aerial photo.

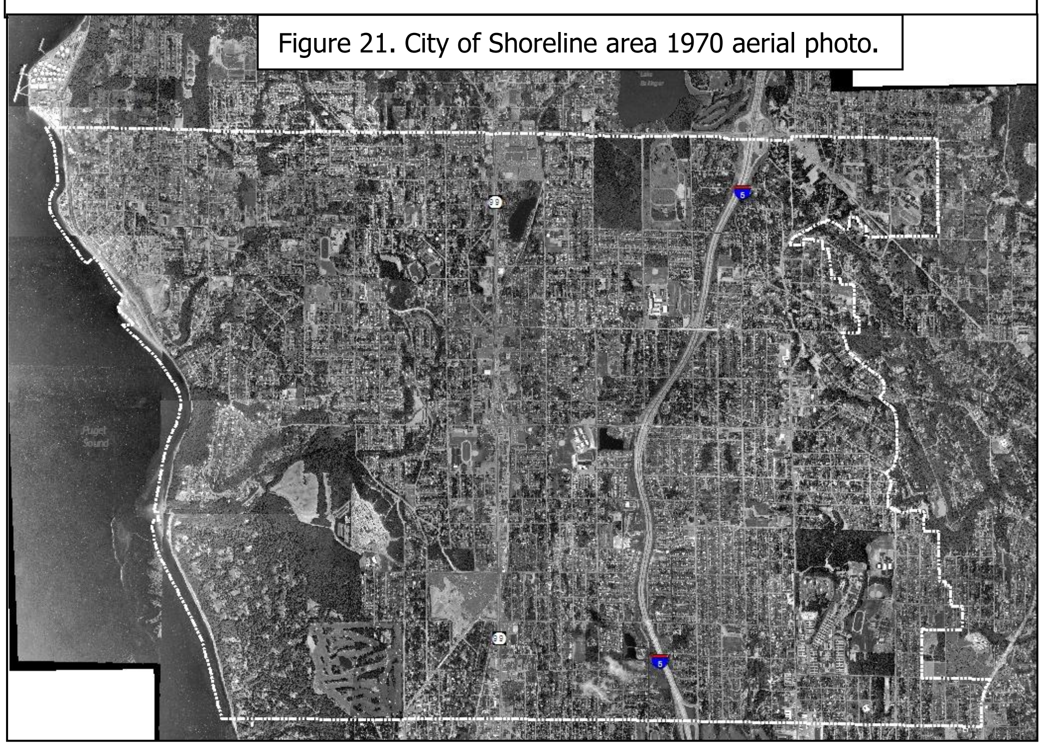
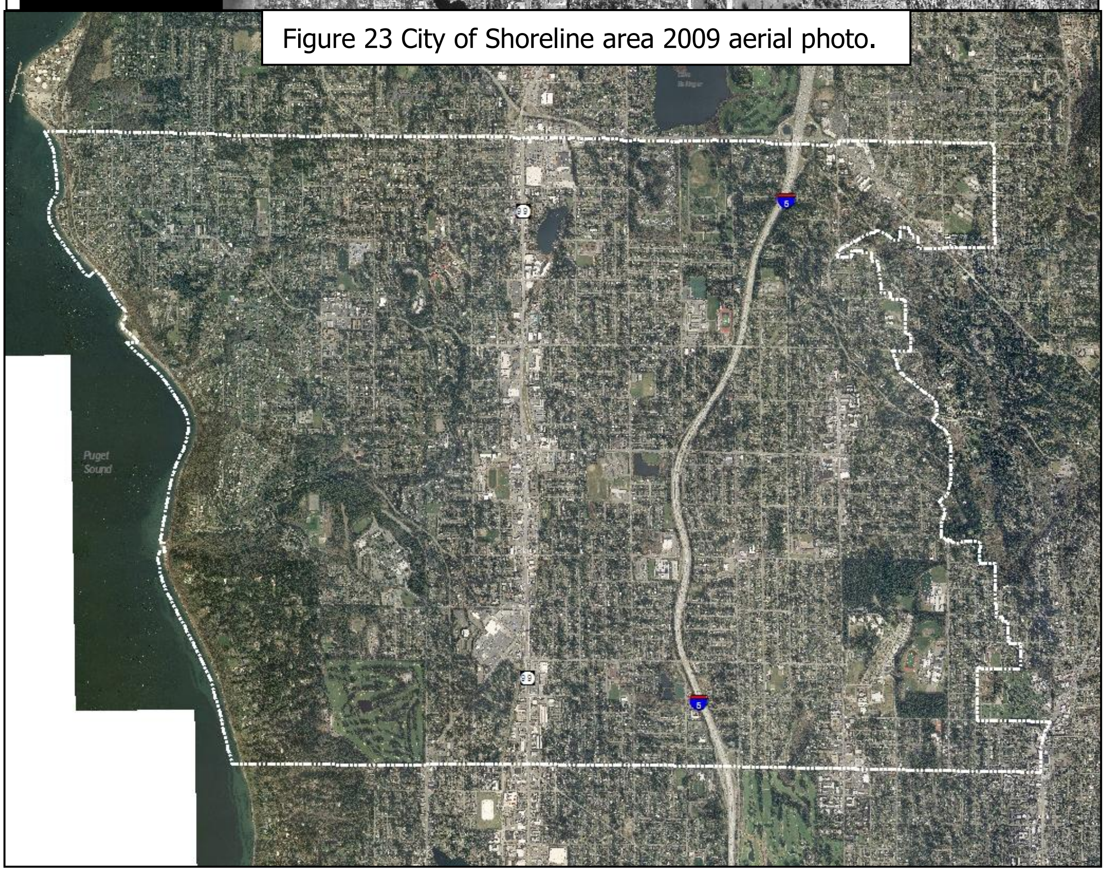


Figure 21. City of Shoreline area 1970 aerial photo.

Figure 22. City of Shoreline area 1993 aerial photo.


Figure 23 City of Shoreline area 2009 aerial photo.



# Appendix D.  Ecosystem Services Analysis Methodology

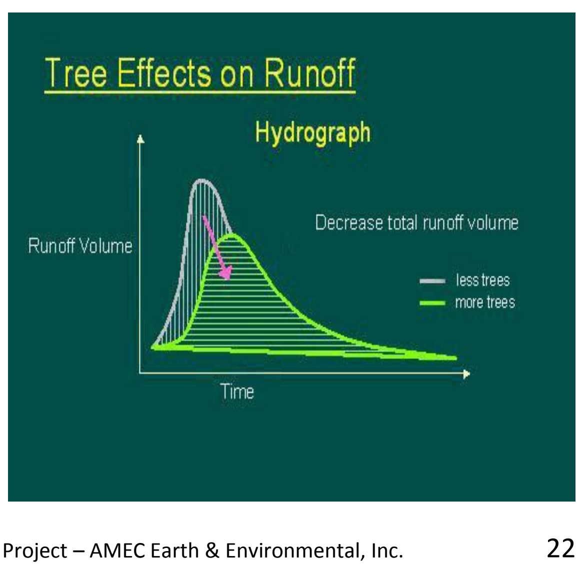
CITYgreen is a software package developed by American Forests that analyzes and calculates the ecological and economic benefits provided by trees and other green space using GIS-based land cover data and environmental models.  It estimates the air pollution removal capacity, carbon storage and sequestration, storm water runoff benefit and water quality impact of urban forests without the need for field data collection.  CITYgreen allows one to use a local reference city for air pollution and carbon storage values with data originating from USDA Forest Service research that has been applied to represent the average benefit per unit area of tree canopy. For storm water and water quality modeling, CITYgreen applies the TR-55 model from the USDA Natural Resources Conservation Service (NRCS) and the long-term hydrologic impact analysis (L-THIA) spreadsheet from the U.S. EPA and Purdue University.  The Curve Number (CN) method as implemented in TR-55 and other programs was created based on plotting curves of rainfall versus runoff for large storms in agricultural watersheds.  It is extremely inaccurate for small storms, which make up the bulk of yearly rainfall.  It is meant to be used to determine the runoff from a single storm, and assumes a soil wetness to start.

### Air Pollution Removal

CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for the pollutants listed below.  To calculate the dollar value of these pollutants, economists use "externality" costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue.  The actual externality costs used in CITYgreen of each air pollutant is set by each state's Public Services Commission.  The values and estimated cost savings are based on data included in the model for the City of Seattle.

### Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass.  Approximately half of a tree's dry weight, in fact, is carbon.  For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs.  CITYgreen estimates the carbon storage capacity and carbon sequestration rates of trees within a defined study area.




### Stormwater

Trees decrease total stormwater volume helping cities to manage their stormwater and decrease detention costs.  CITYgreen assesses how land cover, soil type, and precipitation affect stormwater runoff volume.  It calculates the volume of runoff in a 2-year 24-hour storm event that would need to be contained by stormwater facilities if the trees were removed.  This volume multiplied by local construction costs calculate the dollars saved by the tree canopy. CITYgreen uses the TR-55 model developed by the Natural Resource Conservation Service (NRCS) which is very effective in evaluating the effects of land cover/land use changes and conservation practices on stormwater runoff. The TR-55 calculations are based on curve number which is an index developed by the NRCS, to represent

Figure 1. Shoreline's tree canopy benefits to stormwater quantity.

| **Water Quantity (Runoff)** | | | |
|---|---|---|---|
| *2-yr, 24-hr Rainfall:* | | | |
| *Curve Number reflecting existing* | | | 84 |
| *Curve Number using default replacement* | | | 86 |
| *Additional stormwater storage volume needed:* | 3,431,121 cu. ft. | | |
| *Construction cost per cu. ft.:* | $3.00 | | |
| **Total Stormwater** | **$10,293,364** | | |
| **Annual costs based on payments over 20 years at 6% Interest:** | **$897,422** | **per year** | |

the potential for storm water runoff within a drainage area. Curve numbers range from 30 to 100. The higher the curve number the more runoff will occur. CITYgreen determines a curve number for the existing landcover conditions and generates a curve number for the conditions if the trees are removed and replaced with the user-defined replacement land cover specified in the CITYgreen Preferences. The change in curve number reflects the increase in the volume of storm water runoff. The analysis run here used conservative values to assess the urban tree canopy's overall benefit. The construction cost of $3/cu. ft. is an estimate, and has been reported to be up to $11/cu. ft. in the Puget Sound region.

### Water Quality

Cities must comply with Federal clean water regulations and develop plans to improve the quality of their streams and rivers. Trees filter surface water and prevent erosion, both of which maintain or improve water quality. Using values from the US Environmental Protection Agency (EPA) and Purdue University's L-thia spreadsheet water quality model, American Forests developed the CITYgreen water quality model. This model estimates the change in the concentration of the pollutants in runoff during a typical 2 inch, 24-hour storm event, given the change in the land cover. This model estimates the Event Mean Concentrations of Nitrogen, Phosphorus, Suspended Solids, Zinc, Lead, Copper, Cadmium, Chromium, Chemical Oxygen Demand (COD), and Biological Oxygen Demand (BOD). Pollutant values are shown as a percentage of change.