GOVERNING
GREEN

Tracking, Monitoring and Reporting Procedures for the Tree Planting and Canopy Expansion Measure in the adopted Washington Regional Air Quality Plan (SIP)

White Paper
2011

I. Background: Urban Heat Island Mitigation/Tree Planting/Canopy Conservation and Management

Strategic tree planting and tree canopy conservation and management are innovative voluntary measures included in the adopted **Plan to Improve Air Quality in the Washington, DC-MD-VA Region (SIP-STATE IMPLEMENTATION PLAN)** in May, 2007. These measures will achieve area-wide expansion of the tree canopy, providing air quality and other benefits including reductions in ground-level ozone in the metropolitan nonattainment area.

One of the most dramatic improvements achievable from area-wide comprehensive tree canopy conservation and planting is reducing the negative effects of urban heat islands (the rise in temperatures due to an increased number of buildings and impermeable surface areas retaining heat). Strategic placement of trees around homes, buildings, streets, and parking lots increases shade and evapotranspiration, thereby addressing the heat island effect by lowering summertime air temperatures and surface temperatures of asphalt, concrete, and other impervious areas.

SIP Adopted Control Strategy

To achieve reductions in ground-level ozone, government agencies, volunteer organizations, and private landowners must make long-term commitments to conserving existing canopy and planting significant numbers of trees in strategic locations. Under this measure, local governments in the metropolitan nonattainment area commit to:

1. Measure Existing Resources and Track Changes – Initiate and/or enhance efforts to measure, track, and enhance existing urban tree canopy and canopy expansion efforts.

2. Implement Programs to Enhance and Increase Benefits from Trees – Implement urban forestry programs to enhance canopy coverage to reduce summertime air and surface temperatures. Programs include planting trees in strategic locations to cool targeted surfaces and provisions for long-term maintenance. Priority planting sites include locations where buildings, streets, driveways, and parking lots will be shaded by the new plantings.

3. Initiate Public Outreach – The region commits to undertake a public outreach program designed to promote tree and canopy conservation and planting. Local governments, counties, states, and COG will work with volunteer tree planting organizations, school children, property owners, and stakeholder groups of businesses to support tree conservation and planting efforts, conduct educational outreach regarding the benefits of trees and canopy, species selection, tree planting and establishment, and long-term tree maintenance. Efforts will be made to document all conservation and planting efforts including voluntary programs.

4. Develop Regional Canopy Management Plan – Local governments will work to develop a long range plan to enhance tree conservation and planting, and to establish goals for increasing tree canopy coverage between 2010 and 2030 that could lead to lower levels of ground- level ozone pollution. Issues to address include coordination of efforts, tracking of progress in centralized databases, continuation and increases of resources from state and federal sources, involvement of private landowners and businesses, and periodic evaluations and reports.

5. Species Selection – During photosynthesis, trees release secondary metabolic products. Some of these include biogenic volatile organic compounds (BVOCs), precursors to the formation of ozone. In most instances, the improvements in air quality gained from trees outweigh the concerns over additional BVOC emissions. Additionally, large trees are considerably more beneficial for air quality than small trees. Therefore, when planting trees, species should be selected for large-size and long-term survival based on specific site conditions and adjusted, when possible, for low-BVOC emitters.

6. Monitor Programs – Monitor these activities and report periodically. To address the next planning milestone for area air quality planning a Regional Canopy Management plan should be completed and submitted to MWAQC by September 2009.

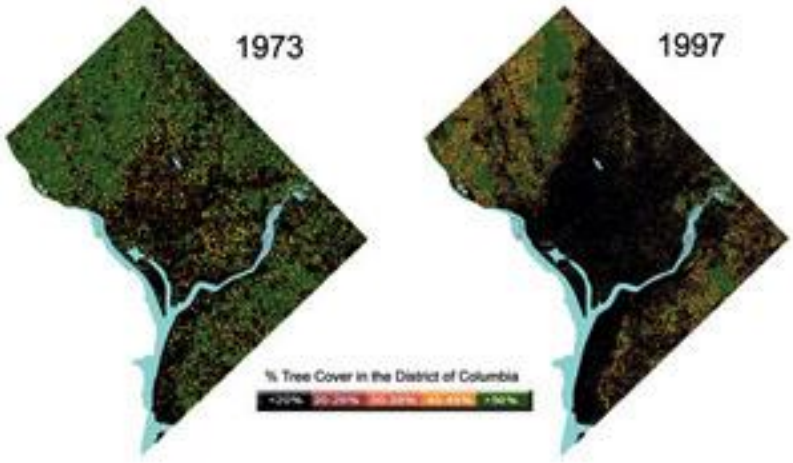
This White Paper proposes a plan to provide the basis for tracking, monitoring and reporting actions carried out locally which implement planning and planting canopy expansion as called for in the State Implementation Plan (SIP). The regulatory guidance for this draft is provided by the EPA's position on emerging or voluntary and bundled

measures (EPA 2004/5). Such measures have strict definitions: “A voluntary measure is a measure or strategy that is not enforceable against an individual source,” while “an emerging measure is a measure or strategy that does not have the same high level of certainty as traditional measures for quantification purposes” (EPA 2004). A measure can be both voluntary and emerging, e.g. new steps taken by a local government (voluntary) to reduce the heat island effect (emerging). The Washington area has been a leader in “bundling” a group of innovative SIP measures (EPA 2005) which can be identified, described and quantified but whose benefits are not credited because of “uncertainties” in measurement or implementation. Tree planting programs fall into this area. Tree-planting programs used in a SIP differ from traditional programs not only because of their proposed scope but also because the achievement of this new objective must be tracked and measured against a future state of the forest resource. The change in the size and maturity of the projected canopy cover is the source of the air-quality benefits, which may provide “weight of evidence “that additional air quality benefits are being achieved.

Baseline Commitment The most critical first step is to stop forest loss. Forest loss can be sharply reduced through establishing local forest conservation goals, but ultimately the extent of development and expanding impervious surface cover will determine the regions ability to meet its canopy cover goals. Area jurisdictions support a wide variety of techniques for enhancing urban forests and increasing canopy cover.

These include:

- Conserve priority forests
- Restore forest remnants
- Reforest public land
- Reforest private land
- Maintain existing forest canopy
- Prevent forest loss during development
- Reduce forest fragmentation and parcelization
- Include street trees in new development landscaping



Analysis of low-resolution satellite imagery conducted by American Forests in 1999 showed a dramatic decline in overall tree canopy in the District of Columbia from 1974 to 1997.

II. Importance of the Topic

The scientific basis for including tree planting in a SIP stems from models of air-quality benefits expected from urban tree canopies. For these model projections, a future forest condition is assumed (e.g., increase in tree cover by 10%), and then the impact of the forest change is modeled to determine its impact on air quality. To verify the modeling projections, air planners are required to use the best available science (EPA 2004). This requirement implies using the best area forest cover data available, tracking the implementation of specific strategies cited in the SIP and verifying that the tree changes modeled are actually attained in the future. For SIP tree-planting programs, three properties form probable tracking and verification opportunities because they will significantly influence modeled benefits:

• Planting —documentation of the number, location and species of trees planted
• Survival—documentation of the number of planted trees that survive through time
• Canopy expansion —documentation of surviving canopy cover and comparison with original baseline and modeled projections

For large areas, measuring these three properties in a statistically valid manner will constitute a significant commitment of time, effort and potential expense. Whether tree planting is being included as an emerging or a voluntary measure (or both), however, the EPA explicitly requires such verification.

Tree planting differs from traditional regulatory SIP measures since tree canopy impacts take much longer to achieve and will increase through time as the trees grow. The proposed plan envisions lasting tracking measures that monitor the effort and thus verify the benefits being claimed from the tree resource over at least 20-30 years. The

EPA specifies that the benefits "should reflect the schedule on which the measures are being put in place and [tree] growth rates over time" (EPA 2004). *The primary purpose of program tracking is to quantify the amount of actual reductions realized through the program and to serve as a basis for adjustments to the amount of emission reductions available if the original estimates of emission reductions are not being achieved*. (EPA 2004) In other words, survival and canopy expansion must meet planning expectations, or the state may be required to enact SIP adjustments to offset any increased mortality or decreased canopy. Therefore, reliable and well-founded procedures to verify the status of regional tree cover is are an essential component of any plan that includes tree planting.

III. Tracking Strategy and Verification tasks

A. Planting

The basic requirement for the proposed SIP canopy expansion programs is to verify the number of trees that are actually planted, their location and, where possible, the species. This verification is done for various reasons, including air benefits, quality control, oversight and cost containment. Within a SIP, such verification is paramount. Since the region has included a potential claim for pollution mitigation from new canopy, that measure must be tracked.

B. Survival

Research on urban tree mortality has demonstrated that a substantial number of trees planted will not survive. The survival rate can be estimated for modeling purposes, but it cannot be known exactly without field verification because too many unpredictable factors influence mortality rates. Well-established programs*1 that have been planting urban trees on a large scale report survival rates routinely as a means of measuring the return on planting and cost effectiveness (e.g., SMUD 2004). Because the SIP population's projected canopy size relies critically on the number of trees that survive from the sum of all program planting, verification of the changing size of regional canopy will be reported periodically.

C. Canopy Expansion

Surviving new trees grow at various rates to realize the modeled air quality benefits. All models extrapolate from field data (as in Figure 2) to produce generalized growth curves for various species. These curves, and the species they represent, derive from tree growth and species mix for different regions. Climate, species mix and geography will alter the actual air quality benefits achieved. To verify that the actual growth rates in a given jurisdiction match those used in local goals, and tracked through program reporting, it will be necessary to monitor canopy expansion over time using periodic (3-5 year intervals) flyover data.

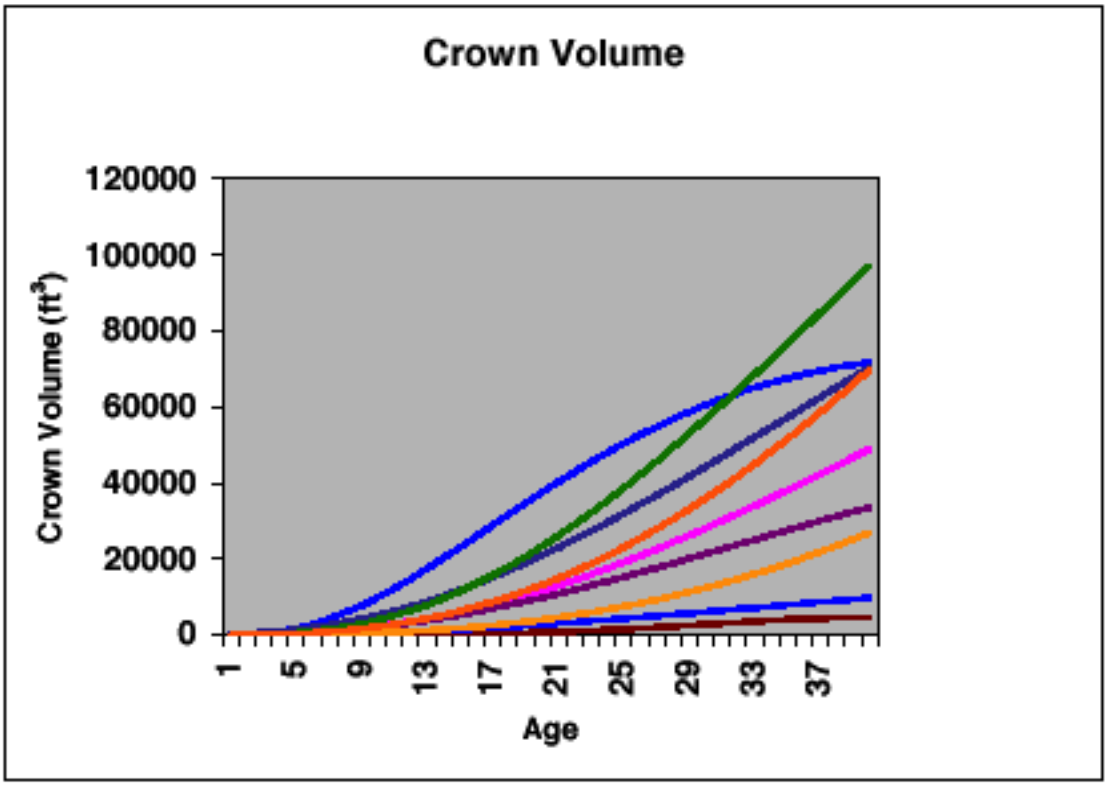


Figure 2 Crown volume modeled for nine common municipal tree species. These data have been used to calculate annual air benefits in the Pacific Northwest (McPherson et al. 2002)

IV. Tracking and Verification Methods

Both the process and the outcome of program tracking will be improved if a functional database is set up prior to installation. The proposed database should minimally contain **this key data:**

- **Who -** Unique identifiers for each Tree planting Program (tool) or Group doing the planting
- **What -** Species data (common and botanical names)
- **When - date** planted
- **Where -** Location data (GIS Location preferred)
- **Number planted**

It should be recognized that the design and maintenance of a database for the SIP measure is a significant task. Because large numbers will be involved, it will require staff or volunteers with relevant training and experience, Furthermore, the associated costs will need to be budgeted during the upcoming present planning phase. Note each local jurdisction must also provide outreach to local volunteer groups, which addresses these data needs together with other volunteer expectations.

With a carefully designed and maintained means of data control, the field work of verification and the office work of analysis will be more efficient and reliable. Furthermore, a database system can be used as a basis of local data collection forms and may be adapted for handheld PDAs or pen-based tablets that will render data acquisition both faster and more accurate. In addition to aiding data acquisition, such means will help meet quality control components commonly required by most programs to verify the accuracy of reported data. Where large tree populations are involved, verification of individual program data is difficult and a statistically valid sampling scheme may be required.

V. Elements for Tracking Strategy for SIP Measure

A. Baseline Data

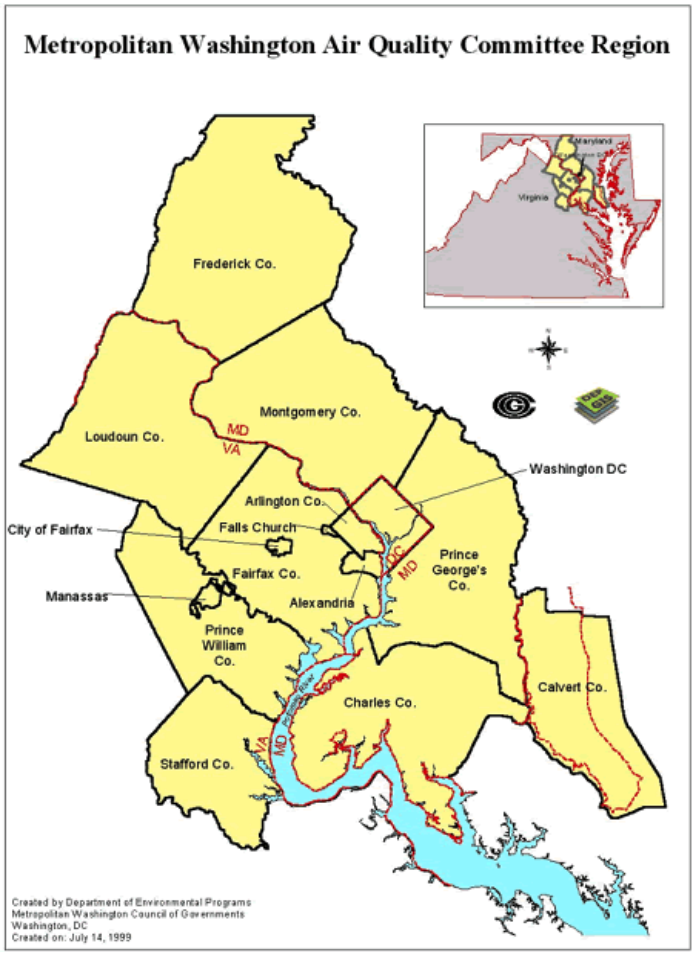
The base year proposed is 2002. The best baseline will be existing data within the air management planning area verified by appropriate local government planning staff. Inclusion of this measure in the SIP will strongly encourage local canopy goals in each jurisdiction as part of their Comprehensive Plan/Master Plan process. The Metropolitan Washington Council of Government's Air Quality Committee will collect and assemble area base line data for the planning area.

B. Tracking Database

Each state should designate a 'canopy banker' within its Urban Forestry program staff to interact with multiple agencies/programs responsible for protecting, clearing, maintaining, and planting trees. This coordinator would be responsible for future outreach efforts and keeping the 'canopy balance' database. Air planning targets would be established by cumulative goals/efforts of jurisdictions within the area and reported using data forms developed for this purpose. Note setting up an AQP AREA (State)-wide accounting datebase would also provide the basis for carbon accounting.

C. Coordination

1. Metropolitan Washington Air Quality Committee



The Metropolitan Washington Air Quality Committee (MWAQC) (see Map) is the entity certified by the mayor of the District of Columbia and the governors of Maryland and Virginia to prepare an air quality plan for the DC-MD-VA Metropolitan Statistical Area under Section 174 of the federal Clean Air Act Amendments of 1990. MWAQC members are elected officials of COG member jurisdictions plus members from Charles, Calvert, and Stafford counties; the air management and transportation directors of the District of Columbia, Maryland, and Virginia; members of the Maryland and Virginia General Assemblies; and the chair of the Transportation Planning Board.

The MWAQC Technical Advisory Committee provides technical guidance to the Metropolitan Washington Air Quality Committee (MWAQC). (ADD)

2. The Center for Chesapeake Communities (CCC)

CCC will coordinate the drafting of the **Regional Canopy Management Plan** and **Baseline Report** in cooperation with **regional Work group chaired by Mike Knapp Fairfax County Forester.** Working with local governments to develop a plan to enhance tree conservation and planting, and to encourage jurisdictional goals for increasing tree canopy coverage between 2014 and 2034 reports the group will draw on the data elements described in this paper and frame the issues for a strategy to achieve an overall expansion of UTC in the Metro region by at least 5% development of a centralized database recommend a Web tool for tracking planting. Working with partner forestry agencies and air quality planners the Work group will recommend the needed resources from state and federal sources to provide continuity to these efforts for SIP reporting and involvement of private landowners and businesses.

3. Local Governments

In addition to wanting sound tracking procedures included with a tree-planting measure in the SIP, EPA requires that local foresters/planners set up a tracking schedule. This schedule is only as practical for tree installation, as the time horizon for verifying survival and growth. It goes well beyond the present SIP attainment date of 2010. Since the effectiveness of this measure is being projected into the future when canopy cover will be large enough to return significant air quality benefits, the 18-month deadline should be used to establish the database and verify tree planting. The further EPA recommendation that the measure be reviewed at least every three years should be adapted to determine survival rates, and the subsequent intervals to monitor canopy growth rate and a long-term maintenance plans. Note, the EPA allows the MWAQC to request additional time to complete the evaluation if an initial 18 months is insufficient (EPA 2004/5).

4. NGO Volunteer Planting Efforts

Dramatic tree loss has occurred throughout the region over the past 40 years the causes are widespread as well and include budget shortfalls and neglect, tree-unfriendly design and development practices, ineffective tree protection during construction, and physical damage and diseases such as Dutch Elm Disease. Today there is clear recognition that only with public engagement support can these causes be addressed. In addition public lands alone are insufficient to provide the planting areas needed to achieve the canopy expansion needed to provide significant air quality improvements and heat island relief.

The region must now engage significant help from concerned citizens through local environmental and religious groups, the business community and regional non-profits like **Casey Trees** in the District of Columbia. Here are some other examples:

- DC Schoolyard Greening Consortium
- Religious Partnerships for the Anacostia
- DC Greenworks
- Earth Conservation Corps
- Green Spaces for DC
- Washington Parks and People
- National Capital Area Federation of Garden Clubs
- UDC Cooperative Extension Service
- DC Gardening News

Note 1. A full list of Maryland programs that require, support or encourage tree planting is available from the Center for Chesapeake Communities.

References

CTLA [Council of Tree and Landscape Appraisers]. 2002. Guide for plant appraisal. 9th edition. Champaign, IL: ISA.

Center for Chesapeake Communities Five Tools for integrating Tree Canopy expansion into State Air Quality Planning. A planning strategy November 2005

EPA [United States Environmental Protection Agency]. 2004. Incorporating Emerging And Voluntary Measures In A State Implementation Plan (SIP) and Guidance on Incorporating Bundled Measures in a State Implementation Plan August, 2005 Online document: http://www.epa.gov/ttn/oarpg/t1/memoranda/evm_ievm_g.pdf

FIA [Forest Inventory and Analysis]. 2003. Tree Crown Condition Indicator. FIA Fact Sheet Series. Online document: http://www.fia.fs.fed.us/library/fact-sheets/p3-factsheets/Crowns.pdf

Measurement and Prediction of Tree Growth Reduction from Tree Planting Space Design in Established Parking Lots. Journal of Arboriculture 30(3):154-164. Husch, Bertram, Beers, Thomas W., and Kershaw, John A., Jr. 2003. Forest mensuration. 4th ed. Kozlowski, Theodore T., and Pallardy, Stephen G. 1997. Physiology of woody plants. 2nd ed. San Diego/London: Academic.

McPherson, E.G., S.E. Maco, J.R. Simpson, P.J. Peper, Q. Xiao, A. VanDerZanden, and N. Bell. 2002. Western Washington and Oregon Community Tree Guide: Benefits, Costs and Strategic Planting. International Society of Arboriculture, Pacific Northwest Chapter, Silverton, OR. Pp. 76.

SMUD [Sacramento Municipal Utility District]. 2004. Shade Tree Program Quality Assurance Inspection Results for January- June 2004. Sacramento, CA:SMUD.

Thompson, Stephen K. 2002. Sampling. 2nd ed. Wiley Series in Probability and Statistics. New York: Wiley.

Other technical information is available at http://www.treescleanair.org/.

This White Paper was written By Gary G. Allen gallenbay@aol.com
for the Center for Chesapeake Communities, June 2008. *In addition to the sources above it is uses technical figures and a research base developed for the National Tree Trust by Jerry Bond, Davey Resource Group*

The Appendices below draw from work done by Sacramento Tree Foundation for their Green Print program.

Appendix A

Baseline Report

Current canopy cover data from each jurisdiction
Projected number of trees planted per year,
List of jurisdictional Canopy Goals
Estimate of annual canopy loss by jurisdiction
Available data on regional tree health, age and species diversity
Number and location of identified planting sites
List of Ordinances in place
Local Maintenance standards
Local budget commitments to tree planting and maintainance

Appendix B

Regional Canopy Management Plan

Data collection Form

Every tree counts! Please use our online **tree counter tool** (**WEB ADDRESS**) to record your efforts and watch the numbers grow with your trees. The XXX will track number of trees, types (to monitor regional diversity), and the individual jurisdiction totals.

- **Required Field**

***Your Information**
- o First Name
- o Last Name
- o Email Address

*(Providing your email address is helpful. If you provide it, we can send a thank you note and provide additional information.)

***Tree Planting Location**

- o Address
- o Jurisdiction*
- o Zip Code*

About Your Tree Planting
- o Date of Planting (Example: 4/25/2008)*
- o Total Number of Trees Planted*
- o Number of Each Species Planted

Species 1
Species* Name

Number of this species planted, ETC

If you've planted more than four different species of trees, please submit an additional report to describe the number of additional species planted (and only include species represented in each individual report in the total number planted).

Appendix C

Regional Canopy Management Plan Report

Street and Sidewalk Trees

Street and sidewalk trees are the signature trees of a community. The image, character and values of a community are displayed daily by the presence and quality of public street trees, or by their absence. While representing an estimated 7 to 10% of urban trees, street trees account for up to 20% of the urban forest canopy.

Goal
In our region the street tree planting could exceed xxx trees.

Benefits

Maximize the canopy shade cover of streets and roadways in order to:

- Lower the ambient air temperature to achieve healthier air quality.
- Interception and absorb air pollutants to achieve public health goals.
- Lower the surface air temperature of hard surfaces to reduce the adverse effects of urban heat islands.
- Increase the life span of asphalt streets and roadways resurfacing savings.
- Reduce Stormwater Runoff
- Contribute to traffic calming.
- Increase walkability and bicycle use

Strategy

Wherever feasible achieve highest percentage of street and roadway shading, as measured on the summer solstice.

Tactics

- Plant largest of species of trees with the widest spreading canopy in every appropriate and possible location.

- Street trees should be planted 30 to 40 feet on-center, allowing for visual clearance at intersections and other safety considerations.

Findings

The envelope of air along streets register the highest levels of pollutants and toxic particulate matter posing threats to the communities' young and senior citizens whose lungs are most vulnerable to air pollution.

Local Government Tree Potential for Streets and Sidewalks

PLACE - CANOPY GOAL- TREE POTENTIAL- SPECIFICATIONS- BENEFITS

Parking Lot Shade Trees

Parking lots occupy approximately 10% of the urban and urbanizing landscape representing a significant expanse of impervious surfaces. On hot summer days surface temperatures can be reduced by as much as 37 degrees F by shade trees, resulting in the reduction of cabin temperatures by 47 degrees F and fuel tank temperatures by nearly 7 degrees F. By increasing shading by 50% evaporative hydrocarbon emissions from parked vehicles can be reduced by 2% (1ton/day), resulting in annual air quality savings of millions of dollars.
Shaded parking spaces are welcomed oases to workers and business customers. One university study found increased sales and repeat customers for commercial businesses with shaded parking lots.

Goal

In our region the parking lot shade tree planting goal could exceed XXX trees.

Benefits

Maximize the canopy shade cover of parking lots in order to:

- Lower the ambient air temperature to achieve healthier air quality.
- CO2 reduction
- Save energy by cooling
- Mitigate storm water runoff
- Enhance business opportunities
- Enhance customer comfort

Strategy

Wherever feasible, design, install and maintain 50% canopy cover for parking lots.

Tactics

- Adopt parking lot shade tree ordinance.
- Adopt recommended parking lot shade tree list and planting guidelines.
- Require landscape architects to certify ordinance compliance.
- Require monitoring and tree replacement programs.

Findings

Shaded parking lots with 50% canopy reduce ambient air temperatures 4 to 6 degrees F.

Volatile organic compounds (VOC) reductions of up to 2% can be contributed to 50% canopy shade.

Local Government Tree Potential for Parks

PLACE- CANOPY GOAL - TREE POTENTIAL- SPECIFICATIONS – BENEFITS

Park Trees - Canopy Goal 50%

Parks are a defining element of our neighborhoods, communities, towns and cities. Parks are where we recreate, relax and identify with a strong sense of place, be it neighborhood playgrounds, ball fields, community gardens, greenways, trail or open space areas. Parks play a significant role in our urban forest as areas for native as well as ornamental vegetation, habitat, water features and connectivity of neighborhoods and people.

Goal

In our region the parks' planting goal could exceed XXX trees.

Benefits

Maximize the canopy shade cover of parks in order to:

- Maximize active and passive recreation opportunities
- Lower the ambient air temperature to achieve healthier air quality.
- CO2 reduction
- Maintain water quality
- Help prevent skin cancer

Strategy

Design and select tree canopy for parks to maximize health and safety values.

Tactics

- Adopt park designs by landscape architects.
- Maximize citizen involvement in park design.
- Create opportunities for volunteer planting, monitoring and stewardship.
- Prioritize large tree canopy plantings.

Findings

Parks are a highly valued community asset that provide multi-benefits

Appendix D

Key Reference -- Effects of Urban Forests and their Management on Human Health and Environmental Quality

USDA Forest Service
Northeastern Research Station
c/o SUNY ESF
5 Moon Library
Syracuse, NY 13210
(315) 448-3200

Current Studies
http://www.itreetools.org/
Tree Species selector to improve air quality

This White paper was prepared by:
Gary G Allen
Center for Chesapeake Communities
192 Duke of Gloucester Street
Annapolis, MD 21401
Cell 301 717 1579
Office 410 267 8595
Fax 410 267 8597