FINAL REPORT

CAMBRIDGE URBAN FOREST CANOPY ASSESSMENT

August 2005

City of Cambridge
Community Development Department

Project Team

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Acknowledgements

All of the following individuals contributed information and support for the urban forest canopy assessment. In the Community Development Department, Cliff Cook assisted with software installation; Brendan Monroe answered innumerable questions about ArcView and designed the sampling grid. Yvette Williams was the primary project intern and conducted several of the field surveys as well as background research. Abby DeWolfe and Jack Murphy, as environmental interns, assisted with field surveys.

At the Department of Public Works, Larry Acosta, former City Arborist, helped conceive the project. Catherine Woodbury provided information on stormwater management.

Jeff Amero of the MIS Department acquired the CITYgreen software on the City's behalf and assisted with the acquisition of the high-resolution digital imagery.

David Bloniarz of the Northeast Center for Urban and Community Forestry provided technical assistance in designing the assessment and helped recruit a project intern.

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Executive Summary

The Urban Forest Canopy Assessment was conducted to develop a baseline estimate of the tree canopy cover in Cambridge and to estimate the value of environmental benefits provided by the urban forest. Typically, urban forests provide a wide range of environmental benefits to communities that go beyond their ornamental function, although their value is not immediately obvious. Air pollution mitigation, stormwater runoff reduction, uptake and storage of carbon, energy conservation, moderation of the urban heat island effect, and landscape enhancement are all benefits provided by urban forests.

To estimate the canopy cover and value of environmental services, the assessment was conducted by sampling 34 randomly selected plots comprising a total of 119 acres, or 2.9 percent of Cambridge's land area. Individual trees were mapped using high-resolution digital aerial imagery and field surveys. Tree attribute data was collected for each tree, including species, diameter, height class, understory growth, growing conditions, and tree health.

The data was analyzed using the CITYgreen® software package developed by American Forests, a non-profit education organization. CITYgreen calculates the canopy area in each sample plot and estimates the environmental benefits based on various models. The data from each sample plot was aggregated and then extrapolated to the entire city.

The assessment estimates that Cambridge's urban forest canopy covers 20% of the city's land area, exclusive of surface water areas. When undeveloped areas of the city, such as the Alewife Reservation are excluded to factor out areas that lack pavement and structures, then the cover area decreases to about 18%. This coverage estimate is likely typical of the developed parts of Cambridge. This amount of cover area is comparable to other U.S. cities.

CITYgreen estimates that the Cambridge urban forest removes about 171,500 pounds of air pollutants annually, which with respect to nitrogen oxides is equivalent to offsetting about 5.2 million vehicle miles every year or taking 416 cars traveling 12,500 miles off the road annually. The financial value of this benefit in terms of avoided health costs is about $171,000 annually.

The largest benefit estimated by CITYgreen is the mitigation of stormwater runoff. The city's trees mitigate over 3.8 million cubic feet, or 28.7 million gallons, of stormwater annually. This volume is equivalent to covering an NFL regulation football field with 66 feet of water. If the urban forest did not exist, the City would have to replace the storage volume, which is estimated to cost $7.3 million if underground storage tanks had to be used.

The total estimated value of annual environmental services is about $7.5 million. This estimate does not account for the energy savings, carbon storage, enhancement of the walking environment, or property value enhancements also provided by the trees in Cambridge.

Possible future steps that could be taken to better understand the extent, distribution, and health of the urban forest include:

- Consider use of remote sensing techniques to evaluate the urban forest using data from satellite imagery. Working with adjacent and nearby cities, a regional assessment could be performed.
- Conduct an evaluation of tree cover in parking lots to evaluate different planting schemes and inform possible modifications to landscaping requirements or municipal facility plans.
- Periodically repeat the analysis described in this report. The results of this report provide a baseline for tree canopy cover and the value of urban forest services. With electronic data loggers, field collection of tree attributes and computer data processing could be relatively rapid.

Objectives of the Assessment

Urban forests provide a wide array of environmental benefits to the community that improve the quality of life of residents and reduce costs to property owners and City government. But the benefits of urban forests are not immediately obvious. The Urban Forest Canopy Assessment was undertaken to estimate the extent of Cambridge's urban tree canopy and the value of the benefits.

The idea to conduct the assessment grew out of discussions during the preparation of the Climate Protection Plan. Cambridge has a goal to reduce greenhouse gas emissions by 20 percent below 1990 levels by 2010. The urban forest can help reduce GHG emissions by reducing the urban heat island effect and shading buildings, which in turn reduces energy consumption for cooling, and sequesters carbon dioxide.

The assessment can be used for the following purposes:

- Benchmark the urban forest canopy coverage;
- Estimate the reduction of stormwater runoff, carbon storage, and air pollution mitigation benefits of the urban forest, including the resulting financial value.

Traditionally, trees in the city have been valued for their ornamental function. While this is important, it is not the only or necessarily the most important role of urban trees. Urban forests provide the following benefits to communities:

- Reduce stormwater runoff and nonpoint source pollution
- Reduce air pollution
- Mitigate the urban heat island effect and reduce temperatures
- Shade buildings to reduce energy usage for cooling
- Absorb carbon dioxide and store carbon
- Enhance streetscapes for pedestrians
- Well-placed trees increase property values

Watershed Benefits

Urban forests reduce the amount of stormwater runoff and pollutant loading in surface waters. The leaves, branches, and stems of trees intercept rainfall, which reduces the total volume of runoff and delays the onset of peak flows. Rainfall that is collected on the tree surfaces either evaporates, drips down to the ground, or is absorbed. The effect is particularly significant with smaller storms that do not saturate the storage capacity of the tree. A mature tree can store 50 to 100 gallons depending on its particular characteristics. Trees also increase the capacity of soil to absorb and store rainfall by transpiring water through their leaves and reducing soil moisture.

Water quality is also protected by reducing runoff during smaller rain storms, which is when most pollutants wash off roads and land surfaces. By reducing the volume of runoff, the amount of pollutant loading received by surface waters is reduced.

Communities benefit from reduced stormwater runoff by avoiding the cost of installing the additional stormwater control measures that would be needed in the absence of trees.

Air Quality Benefits

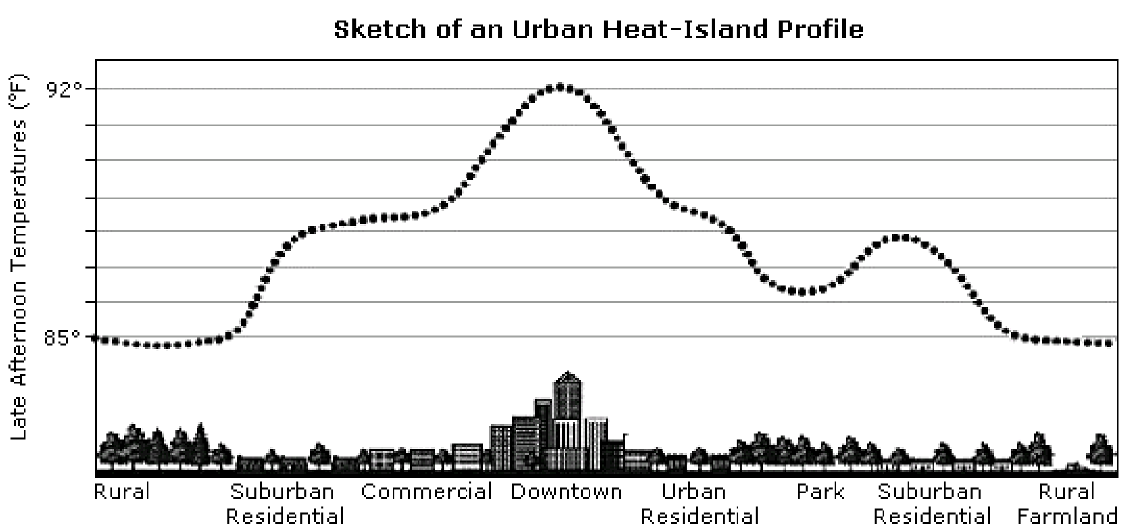
Trees absorb and filter air pollutants. Gaseous pollutants, such as ozone, sulfur dioxide, and nitrogen oxides, are absorbed through leaf surfaces. Particulates are captured by leaf and other tree surfaces.

Trees also reduce air pollution through their shading and temperature reduction functions. The formation of ozone, or smog, is temperature dependent; as temperatures rise, more ozone is created by the reaction of nitrogen oxides and volatile organic compounds. Urban forests reduce local temperatures by transpiring water into the air and shading pavement and buildings. Trees that shade parking spaces also reduce the amount of volatile organic compounds that evaporate from parked vehicles.

Oxygen is also released by trees during photosynthesis. For example, a 32-foot tall mature ash can produce about 260 pounds of oxygen annually. A typical person consumes about 386 pounds of oxygen per year.

Trees are sources of volatile organic compounds (VOCs) that can contribute to ozone formation. However, the air pollution removal and temperature moderating functions of urban forests offset this contribution of VOCs.

Through its air quality improvement functions, trees reduce pollution effects on human health and the social costs of treating those effects.



Energy Benefits

Strategically located trees can increase the energy efficiency of buildings during the summer. Trees located on the west and east sides of buildings can provide shade and reduce the amount of heat absorbed and stored by the building surfaces. During the winter, trees planted as windbreaks can shelter buildings and reduce heat loss. Both functions serve to reduce the energy demands of the building for cooling and heating.

Through its shading and transpiration functions, the urban forest also reduces the urban heat island effect. Urbanized areas are generally warmer than surrounding areas due to heat absorption by buildings and paved surfaces. This is why vegetation tends to grow earlier and later in cities than in suburban and rural areas. In the Boston urban area, plant growth has been found to start 2 to 5 days earlier and stop 5 to 8 days later compared to outlying areas. The urban forest moderates the urban heat island effect, generally reducing the ambient temperature as much as 6 to 8 degrees F during the summer, which in turn reduces the amount of energy needed to run air conditioners.

Climate Protection Benefits

Trees absorb carbon dioxide, which is the primary greenhouse gas causing global climate change. The absorbed carbon is stored, or sequestered, until the tree dies and decomposes. Urban forests also help reduce emissions of greenhouse gases by reducing the demand for energy produced by powerplants, as described above.

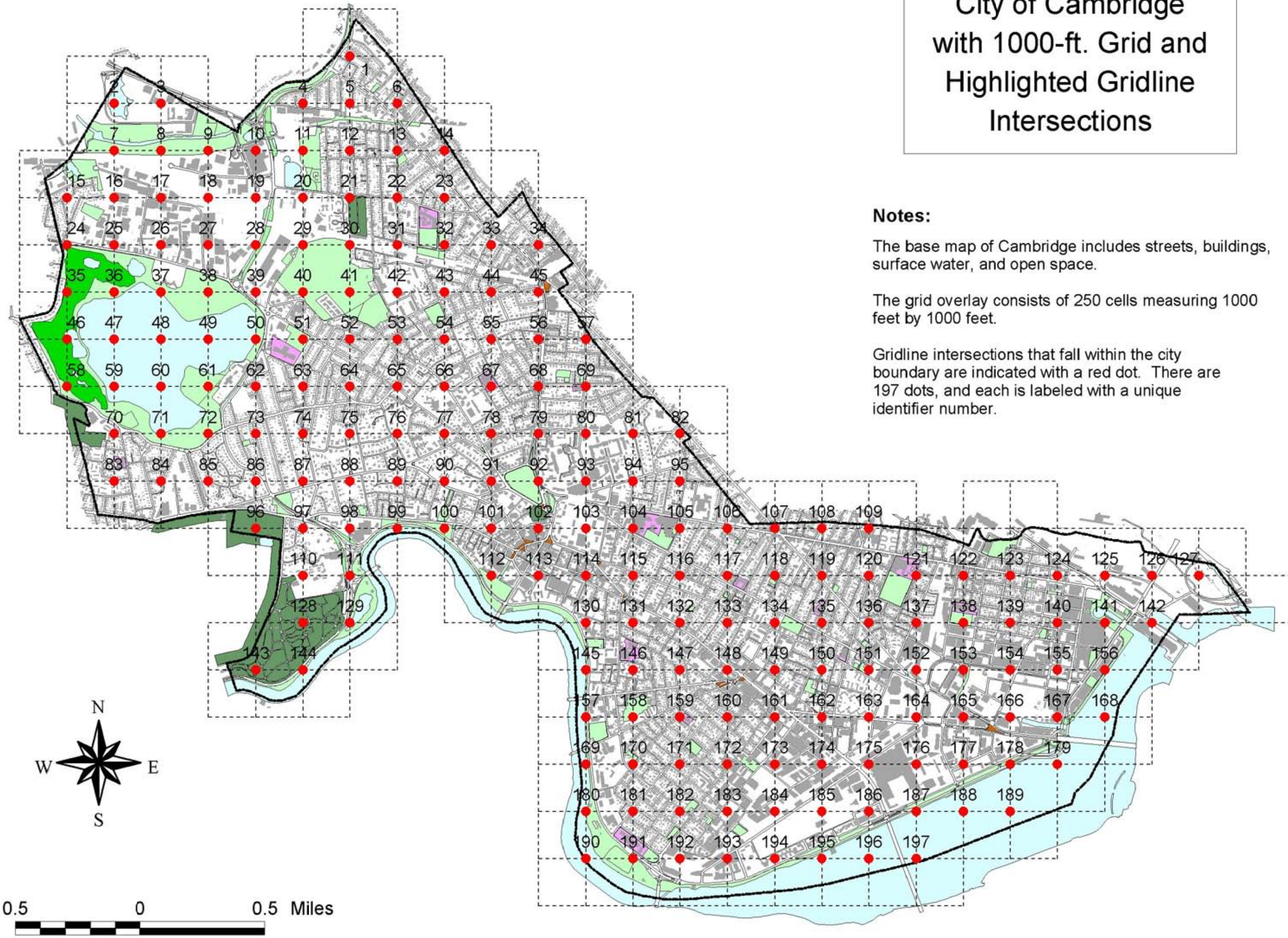
Methodolgy

To estimate the extent of the urban forest canopy and the environmental benefits it provides, the CITYgreen® (version 5.1) software produced by American Forests was utilized. CITYgreen works as an extension of ArcView, which is the geographic information system (GIS) software created by ESRI. The study approach was based on a random sampling of Cambridge's urban forest, collection of field data from sample areas, mapping sample area boundaries and tree locations in CITYgreen, and analysis of the data with CITYgreen. The analytical results of each sample area were aggregated and extrapolated to estimate the urban forest canopy and environmental benefits citywide.

Selection of Sample Areas

A 1000-foot grid map of the city was created (see figure 1), which had 197 possible sample locations. Using a Web-based random number generator (www.random.org), the list of locations was ordered randomly. Some of the locations fell on areas of open water and were eliminated.

City of Cambridge with 1000-ft. Grid and Highlighted Gridline Intersections



Notes:

The base map of Cambridge includes streets, buildings, surface water, and open space.

The grid overlay consists of 250 cells measuring 1000 feet by 1000 feet.

Gridline intersections that fall within the city boundary are indicated with a red dot. There are 197 dots, and each is labeled with a unique identifier number.

CDD GIS: d:\projects\citygreen\treegrid.apr

The assessment sought to sample two percent of the city's land area of 4,101 acres, which is the total area (4563 acres) of Cambridge minus the area of surface water.[1] Therefore a total sample coverage area of 82 acres was needed. Based on precedents from similar assessments, sample plots of 2 acres in size were sought. Therefore, about 41 sample plots of 2 acres each were needed. Actual sample plot sizes were influenced by physical factors encountered in the field; many plots were larger than 2 acres. Also, due to difficulties in collecting data from some sample areas, 34 samples were completed. In the end, data was collected from samples plots that covered a total of 119.76 acres representing 2.9 percent of the city's land area.

Surveys of Sample Areas

The City acquired high-resolution digital color aerial imagery based on a flyover performed in September 2000 when trees were still in leaf. The boundaries of each sample area were mapped within CITYgreen. The location and canopy of each tree in each sample area were drawn and a map was produced for use in the field surveys.

Project staff visited each sample area to verify the presence of each tree, locate trees that were not clearly seen in aerial photographs (i.e., some trees were too small, fell within shadow areas, or were obstructed by larger trees), and the extent of the canopy. For each verified location, the attributes of each tree were recorded on forms.

Tree Attributes
Tree species
Diameter at breast height (DBH)
Height class
Health class
Understory growth
Growth conditions

Geographic Information System

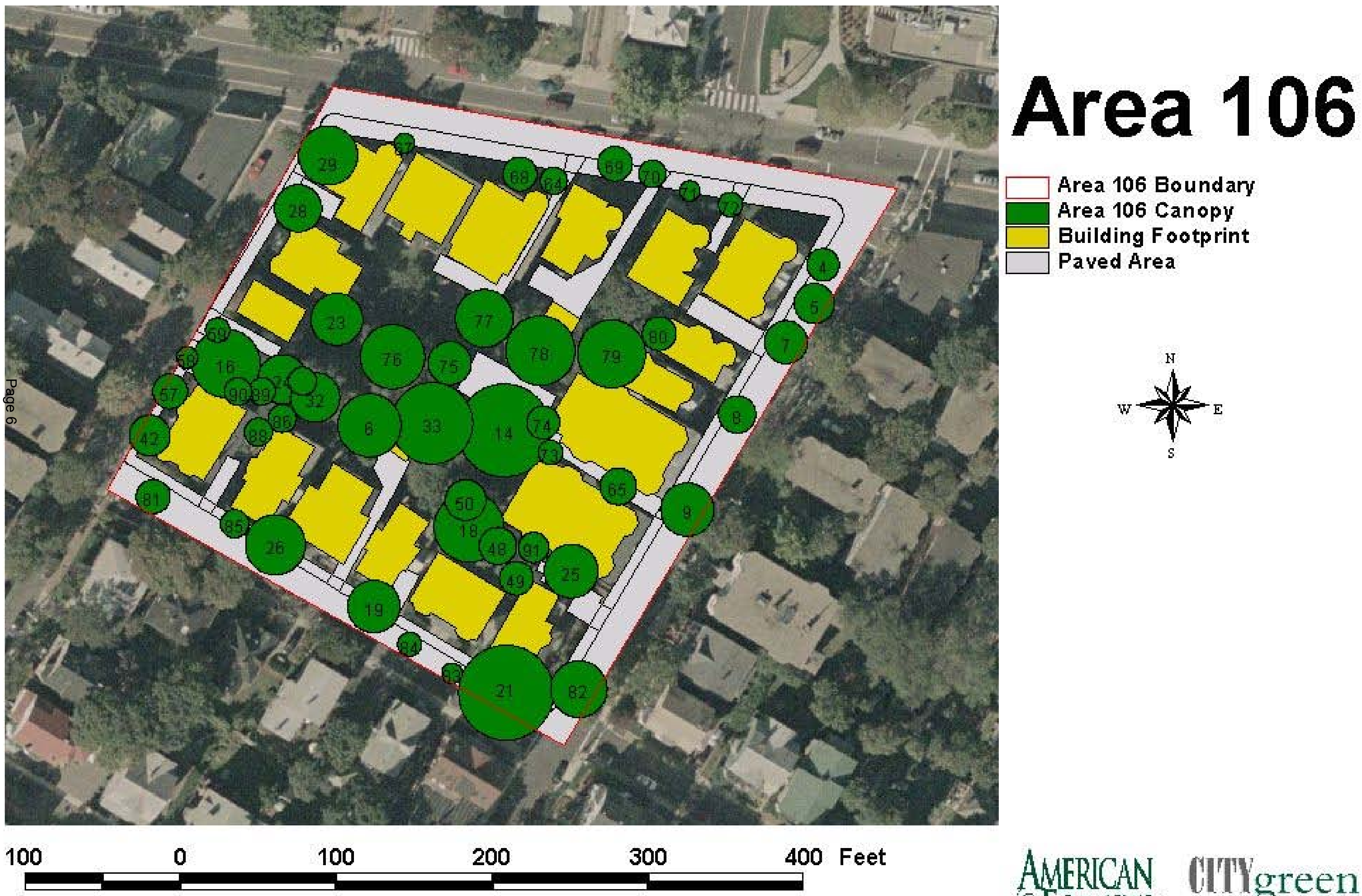
Upon the completion of each sample area survey, the GIS database was updated. Locations and extent of canopy were corrected. The attributes of each tree were updated in the CITYgreen database. Additional GIS coverage layers for building footprints and paved areas were added to account for the impervious area in each sample area.

Analysis and Results

CITYgreen quantifies the environmental benefits within a sample area based on the data provided and models internal to the software. For this project, each of the 34 sample areas was analyzed individually, then the results were aggregated. Then a factor of

[1] See Christopher J.Luley, *Final Report to the USDA Forest Service on the Storm Damage Assessment Protocol*, January 2001.

Area 106


Area 106 Boundary
Area 106 Canopy
Building Footprint
Paved Area
N
W
E
S
100
0
100
200
300
400
Feet

34.2435 was applied to the aggregated results from 2.9% of Cambridge's land area to extrapolate an estimate of the environmental benefits for the entire city.

For each sample area, CITYgreen calculated the amount of impervious area (buildings, roads, sidewalks, driveways), amount of open area (assumed to be grass and shrubs), and the area of tree canopy cover.

CITYgreen quantified the environmental benefits in terms of air pollution reduction, carbon storage and sequestration, and stormwater storage. The financial value of air pollution and stormwater attenuation is also estimated.

Air Pollution

CITYgreen estimates the removal in pounds of ozone, sulfur dioxide, nitrogen dioxide, particulate matter 10 microns and less, and carbon monoxide. A dollar value based on externality costs reflects avoided public health costs.

The software determines a pollutant removal rate by multiplying the deposition velocity by the pollution concentration. Removal rates are estimated for Boston, based on local data. The Boston area removal rates were used for Cambridge.

Carbon Storage and Sequestration

CITYgreen quantifies the removal of atmospheric carbon dioxide and the storage of carbon. Based on the tree diameter data, the software estimates the age distribution of trees within a study area and assigns a multiplier factor for carbon storage and for carbon sequestration rates. The factors are multiplied with the study area size and the percent tree cover to yield the storage and sequestration estimates.

A dollar value is not assigned for this function by CITYgreen. However, it is possible to estimate the value of carbon sequestration by using factors such as the cost per ton of carbon offset set by emission trading markets or by the cost of installing and operating emission control systems.

Stormwater

CITYgreen incorporates the TR-55 Urban Hydrology for Small Watersheds model developed by the USDA Natural Resources Conservation Service. For the analysis, information about local rainfall patterns, soil type, and site characteristics were entered. CITYgreen calculates the quantity of stormwater runoff, the time of concentration, and peak flow and determines the volume of runoff. A 2-year, 24-hour storm is assumed.

CITYgreen determines the additional volume of stormwater that would have to be managed in the absence of trees in the study area. To evaluate the cost of managing the additional volume, a factor of $22 per cubic foot of stormwater was used. Due to the high-density nature of Cambridge's land use pattern, there is little opportunity to construct above-ground detention/retention basins. Underground storage tanks are typically installed to mitigate stormwater runoff, at a cost of $1 million to $2 million per acre-foot of storage.[2] The $22 per cubic foot factor is based on the lower end of the range. The annual cost savings provided by trees is based on financing over a 20-year period at a 6% interest rate.

Results

Each of the 34 sample areas were analyzed individually by CITYgreen. The results were then aggregated and a factor of 34.2435, which is based on the aggregate sample area (119.76 acres) as a percentage of the total city land area (4,101 acres), was applied to determine the citywide estimates. The results for each sample area are presented in Appendix A. The summary results are presented below.

Table 1
Tree Canopy Assessment Summary Results

Land Statistics	
City land area	4,101 acres
Urban forest canopy area	814.99 acres
Urban forest canopy cover	20.03%
Impervious area	2,588.12 acres
Open space area	1,530.34 acres
Annual Air Pollution Removal	
Ozone removed	25,651.5 pounds
Sulfur dioxide removed	8,788.59 pounds
Nitrogen dioxide removed	15,945.14 pounds
Particulate matter removed	19,504.06 pounds
Carbon monoxide removed	2,434.03 pounds
Air pollution removal value	$171,544.12
Annual Carbon Mitigation	
Carbon storage	37,175.41 tons
Carbon sequestration	296,548.6 pounds
Annual Stormwater Mitigation	
Peak stormwater storage mitigation	3,839,756.44 cubic feet
Stormwater benefit	$7,368,167.67
TOTAL ANNUAL BENEFIT	$7,508,310.51

[2] Based on communications with William Pisano, engineering consultant with MWH, Inc.

Discussion

Most of Cambridge's surface area is impervious, consisting of buildings and pavement (roads, driveways, sidewalks, etc.). Including the area covered by surface water, 56.7% of the city is impervious surface. The urban forest canopy cover overlays parts of the impervious surface and parts of the vegetated surface. Cambridge's urban forest canopy cover of 20 percent is comparable to other urban areas. Table 2 shows reported canopy cover for other cities.

Table 2
Comparison of Urban Forestry Canopy Cover

Atlanta, Georgia	32.9%
Philadelphia, Pennsylvania	21.6%
Boston, Massachusetts	21.2%
Oakland, California	21.0%
Cambridge, Massachusetts	**20.0%**
Baltimore, Maryland	18.9%
New York, New York	16.6%
Chicago, Illinois	11.0%

In the Cambridge analysis, two sample areas were located in large open spaces, one in the Alewife Reservation and the other in the Fresh Pond golf course. When these two sample areas are removed from the analysis, the average urban forest canopy cover decreases to 18.4%. This figure probably represents the typical canopy cover for the developed parts of the city. Canopy cover ranges from 6% to 89%, with the highest cover occurring in undeveloped portions of the city. The highest amount of canopy cover for a developed area with streets and structures was 49%.

In this study, the air quality benefits provided by the urban forest were assessed in terms of direct removal of pollutants. Trees remove an estimated 72,323 pounds of five air pollutants annually. The significance of the individual air removal rates varies. For example, the removal of nitrogen oxides can be compared to offsetting the NOx emissions of 5,207,981 vehicle miles traveled by "average" cars, or removing 416 cars that each travel 12,500 miles annually from the road[3]. In comparison, the removal of carbon monoxide is equivalent to offsetting the CO emissions of 52,873 average vehicle miles, or 4 average cars. The financial benefit of $171,544 is based on an externality cost for air pollution used in state regulatory proceedings. The assessment does not account for the indirect removal of air pollutants attributable to the urban forest. Shading provided by trees reduces the summer heat load on buildings and decreases the demand for electricity to run air conditioning. The urban forest also moderates ambient temperatures through shading and evapotranspiration, also reducing the cooling needed by buildings. Therefore, the calculated financial benefit underestimates the full financial benefit.

[3] Based on U.S. Environmental Protection Agency, *Emission Facts: Average Annual Emissions and Fuel Consumption for Passenger Cars and Light Trucks*, April 2000.

The stormwater services provided by the urban forest are the most significant. According to CITYgreen, Cambridge's trees mitigate 3,839,756 cubic feet or 28,723,369 gallons of peak stormwater runoff annually. This is equivalent to covering an NFL regulation football field (360 feet by 160 feet) with water 66 feet in depth. If the trees were removed, the City would have to install this amount of storage volume to maintain current conditions, otherwise increased flooding would result. The replacement value is estimated to be $7,368,167.

In total, CITYgreen estimates financial benefits over $7.5 million annually from stormwater and air pollution services. However, there are additional environmental services that are not accounted for by CITYgreen.

Cambridge's urban forest sequesters or absorbs 296,548 pounds of carbon dioxide every year. Carbon dioxide is the primary greenhouse gas tied to human-induced global warming. Trees also store an estimated 37,175 tons of carbon, which is equivalent to 136,432 tons of carbon dioxide. CITYgreen did not estimate the financial value of carbon dioxide. However, if one utilizes the market value of carbon dioxide offsets, an estimate of value is possible. At the end of April 2005, the Chicago Climate Exchange market value of carbon dioxide was $1.14 per metric ton carbon dioxide, or about $1.25 per ton. Therefore, the stored carbon in Cambridge's urban forests could be valued at about $170,540. The value of carbon dioxide offsets should increase as the market develops, particularly in other countries. It must be noted that there are carbon dioxide emissions associated with maintaining the urban forest (fuel combusted by vehicles and equipment) which would reduce the carbon dioxide mitigation benefit.

There are other benefits that are not quantified by CITYgreen. The urban forest helps save energy. When trees are strategically located, they shade built surfaces and reduce the amount of absorbed heat. While it is difficult to generalize, trees can reduce energy use for summer cooling by up to 25 percent. Properly located trees can also reduce heat loss from buildings in the winter by acting as windbreaks. In addition to shading buildings, the urban forest moderates ambient temperatures by reducing the urban heat island effect. This in turn moderates ambient temperatures, reduces energy use by buildings for cooling, and makes the outdoor environment more pleasant for people.

Numerous studies have documented that trees increase residential property values. For example, in Athens, Georgia residential properties landscaped with trees had 3.5% to 4.5% higher sales values. Similarly, trees can enhance retail shopping areas, making them more attractive to shoppers. In a study of office rental rates around Cleveland, Ohio, buildings with good shading had 7% higher rental rates although buildings that were visually screened by trees had negatively impacted rental rates.

Cambridge's urban forest serves the community as a component of the public infrastructure. If the urban forest did not exist, the community would need to expend more financially for stormwater control, health management, and energy. The loss or diminishment of the temperature moderation effect of the urban forest would likely contribute to increased greenhouse gas emissions, which the City seeks to decrease.

Maintaining the urban forest is a shared responsibility between the public and private sectors. Much of the urban forest is located on private property. Periodic assessment of the urban forest can help the City evaluate whether the various mechanisms used to encourage tree plantings and maintenance, as well as preservation of existing trees, is effective.

Possible future steps that could be taken to better understand the extent, distribution, and health of the urban forest include:

- Consider use of remote sensing techniques to evaluate the urban forest. CITYgreen can utilize raster data (machine readable spatial data organized in pixels on imagery) from satellite imagery. It may make sense to work with other communities or the state to conduct such an analysis. Large area analyses have been performed for metropolitan areas such as Washington, DC, Houston, and Atlanta.
- Conduct an evaluation of tree cover in parking lots. CITYgreen can model future tree growth. Different planting schemes could be evaluated to inform possible modifications to landscaping requirements or municipal facility plans.
- Periodically repeat the analysis described in this report. The results of this report provide a baseline for tree canopy cover and the value of urban forest services. With electronic data loggers, field collection of tree attributes and computer data processing could be relatively rapid.

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Appendix A

Urban Forest Canopy Assessment Summary Results

AREA	ACRES	CANOPY AREA	CANOPY PERCENT	IMPERVIOUS AREA	OPEN SPACE AREA	OZONE	SOX	NO2	PM	CO	$VALUE	C STORAGE	SEQUESTRATION	PEAK STORAGE MITIGATION	SW COST (@ $22/CF)	SW COST ANNUALIZED (@ $22/CF)	TOTAL ANNUAL SAVINGS (@ $22/CF SW Cost)
5	3.45	0.70	0.20	2.07	1.37	22.16	6.15	13.77	16.85	2.10	$150.33	31.11	100	2756	$60,632.00	$5,286.17	$5,436.50
9	2.02	1.80	0.89	0.00	2.02	56.58	15.72	35.17	43.02	5.37	$383.91	96.88	540	1758	$38,676.00	$3,371.95	$3,755.86
10	2.04	0.12	0.06	1.63	0.41	3.73	1.04	2.32	2.83	0.35	$25.29	5.23	20	0	$0.00	$0.00	$25.29
19	2.31	0.37	0.16	1.53	0.77	11.56	3.21	7.19	8.79	1.10	$78.45	16.24	60	2159	$47,498.00	$4,141.09	$4,219.54
20	2.01	0.25	0.12	1.32	0.70	7.79	2.16	4.84	5.92	0.74	$52.85	7.98	360	1882	$41,404.00	$3,609.79	$3,662.64
23	3.94	0.67	0.17	2.65	1.30	21.06	5.85	13.09	16.01	2.00	$142.88	29.57	100	4447	$97,834.00	$8,529.61	$8,672.49
28	2.36	0.21	0.09	1.89	0.47	6.50	1.80	4.04	4.94	0.62	$44.08	6.65	300	2390	$52,580.00	$4,584.16	$4,628.24
35	2.39	0.77	0.32	0.20	2.19	24.35	6.76	15.14	18.52	2.31	$165.22	41.69	240	1777	$39,094.00	$3,408.39	$3,573.61
51	2.50	0.35	0.14	0.28	2.22	10.89	3.02	6.77	8.28	1.03	$73.88	15.29	60	1523	$33,506.00	$2,921.21	$2,995.09
57	2.61	0.48	0.18	0.70	1.91	15.02	4.17	9.34	11.42	1.43	$101.93	21.09	80	1811	$39,842.00	$3,473.61	$3,575.54
76	2.07	1.01	0.49	1.04	1.03	31.83	8.84	19.79	24.20	3.02	$215.98	43.49	680	2627	$57,794.00	$5,038.74	$5,254.72
83	2.26	0.96	0.42	0.37	1.89	30.23	8.40	18.79	22.99	2.87	$205.14	42.45	140	1746	$38,412.00	$3,348.93	$3,554.07
86	3.08	1.20	0.39	1.60	1.48	37.95	10.54	23.59	28.86	3.60	$257.51	53.29	180	3525	$77,550.00	$6,761.16	$7,018.67
87	2.35	0.92	0.39	1.00	1.35	28.92	8.03	17.98	21.99	2.75	$196.22	40.61	140	2535	$55,770.00	$4,862.28	$5,058.50
88	2.45	1.19	0.49	1.13	1.32	37.44	10.40	23.27	28.47	3.55	$254.01	52.57	180	3029	$66,638.00	$5,809.80	$6,063.81
91	1.75	0.38	0.22	1.03	0.72	12.05	3.35	7.49	9.17	1.14	$8.79	16.93	60.00	1388.00	$30,536.00	$2,662.27	$2,744.06
93	2.73	0.19	0.07	2.28	0.45	5.85	1.62	3.63	4.45	0.55	$39.67	8.21	20.00	0.00	$0.00	$0.00	$39.67
94	2.63	0.66	0.25	1.06	1.57	20.89	5.80	12.98	15.88	1.98	$141.73	28.54	440	2482	$54,604.00	$4,760.63	$4,902.36
95	2.53	0.65	0.26	1.43	1.10	20.45	5.68	12.71	15.55	1.94	$138.76	28.72	100.00	2441.00	$53,702.00	$4,681.99	$4,820.75
98	2.97	0.34	0.11	2.26	0.71	10.57	2.94	6.57	8.04	1.00	$71.71	14.84	60	3022	$66,484.00	$5,796.38	$5,868.09
104	2.77	0.37	0.13	2.30	0.47	11.55	3.21	7.18	8.78	1.10	$78.34	19.77	120.00	2814.00	$61,908.00	$5,397.42	$5,475.76
106	2.78	0.80	0.29	1.73	1.05	25.30	7.03	15.72	19.23	2.40	$171.63	35.52	120.00	2766.00	$60,852.00	$5,305.35	$5,476.98
108	2.83	0.58	0.20	1.16	1.67	18.41	5.11	11.45	14.00	1.75	$124.93	18.86	840.00	2384.00	$52,448.00	$4,572.66	$4,697.59
113	2.41	0.38	0.16	1.84	0.58	11.82	3.28	7.35	8.99	1.12	$80.21	16.60	60.00	2804.00	$61,688.00	$5,378.24	$5,458.45
118	9.93	1.35	0.14	7.23	2.82	42.40	11.78	26.35	32.24	4.02	$287.67	59.53	200.00	9421.00	$208,362.00	$18,165.95	$18,453.62
120	5.63	1.18	0.21	3.56	2.07	37.11	10.31	23.07	28.22	3.52	$251.80	52.11	180.00	4720.00	$103,840.00	$9,053.24	$9,305.04
122	5.51	0.62	0.11	4.21	1.65	19.44	54.00	12.08	14.78	1.85	$131.91	27.30	100.00	6370.00	$140,140.00	$12,218.04	$12,349.95
140	7.15	0.37	0.05	6.72	0.47	11.76	3.27	7.31	8.94	1.12	$79.82	12.05	540.00	8307.00	$182,754.00	$15,933.33	$16,013.15
148	3.76	0.34	0.09	3.49	0.27	10.66	2.96	6.63	8.11	1.01	$72.33	10.92	500.00	4152.00	$91,344.00	$7,963.79	$8,036.12
150	8.74	1.48	0.17	5.78	2.97	46.74	12.98	29.06	35.54	4.44	$317.15	80.03	460.00	9218.00	$202,796.00	$17,680.68	$17,997.83
172	2.73	0.44	0.16	1.66	1.07	13.93	3.87	8.66	10.59	1.32	$94.50	23.85	140.00	2269.00	$49,918.00	$4,352.08	$4,446.58
177	7.03	1.54	0.22	4.65	2.37	48.62	13.50	30.22	36.96	4.61	$329.85	83.24	480.00	6149.00	$135,278.00	$11,794.15	$12,124.00
186	4.02	0.75	0.19	2.51	1.50	23.61	6.56	14.68	17.95	2.24	$160.18	32.25	500.00	3355.00	$73,810.00	$6,435.09	$5,595.27
192	4.02	0.38	0.09	3.27	0.75	11.92	3.31	7.41	9.06	1.13	$80.88	12.21	560.00	4104.00	$90,288.00	$7,871.72	$7,962.60
TOTAL	119.76	23.80		75.58	44.69	749.09	256.65	465.64	569.57	71.08	$5,009.54	1085.62	8660.00	112131.00	$2,467,982.00	$215,169.90	$219,262.44
CITYWI	4101	814.99		2588.12	1530.34	25651.5	8788.59	15945.14	19504.06	2434.03	$171,544.12	37175.41	296548.6	3839756.44	$84,512,309.47	$7,368,167.67	$7,508,310.51
UNITS	Acres	Acres		Acres	Acres	lbs	lbs	lbs	lbs	lbs	dollars	tons	lbs/year	cubic feet	dollars	dollards	dollars
		0.200292															