

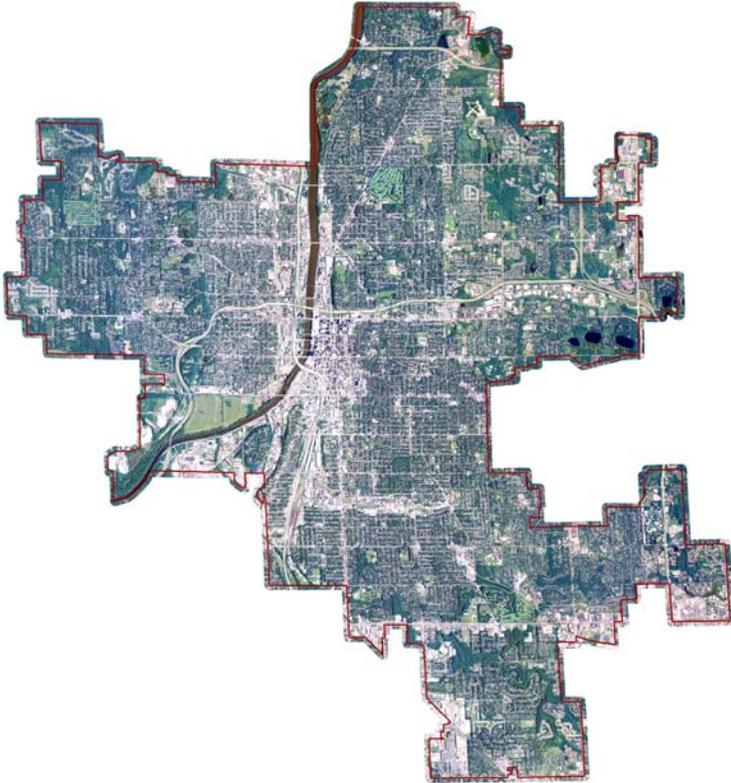
Urban Forest Ecological Services Assessment

City of Grand Rapids, Michigan

Rod Denning, Research Associate
Ben Sanborn, Student Intern

Annis Water Resources Institute
Grand Valley State University
Lake Michigan Center
Muskegon, MI

City of Grand Rapids
Kent County, Michigan



Scale 1:10,000
0 0.25 0.5 1 1.5 2 Miles

Grand Valley State University
Annis Water Resources Institute
Information Services Center
Data Source:
MAP 2000 orthophotography
Map Created Aug. 2008

Sept. 2008

TREE CANOPY ASSESSMENT

Total Area (City): 29,020 Acres (45.3 sq. miles)

Total Tree Canopy Cover: 10,029 Acres (15.7 sq. miles)

Percent Tree Canopy: 34.6%

NOTE: The tree canopy is the layer of leaves, branches, and tree trunks that covers the ground when viewed from above.

Tree Canopy data development method

The tree canopy data layer was created using Feature Analyst (Visual Learning Systems, Inc. – Overwatch Geospatial, Textron Systems), an assisted feature extraction software that integrates machine learning technology into the GIS database creation workflow. The extraction was based on the use of a one meter resolution, true color, leaf-on, 2005 orthophoto from the National Agriculture Imagery Program, U.S. Department of Agriculture.

After the final extraction, manual editing procedures were also included to identify missing target trees and to remove false identifications. An effort was also undertaken to remove the portion of the tree canopy that has been eliminated as a result of EAB tree removals. The final data layer resulted in a very accurate mapping of individual trees and extensive forested areas throughout the City of Grand Rapids.

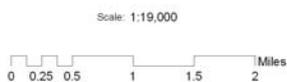
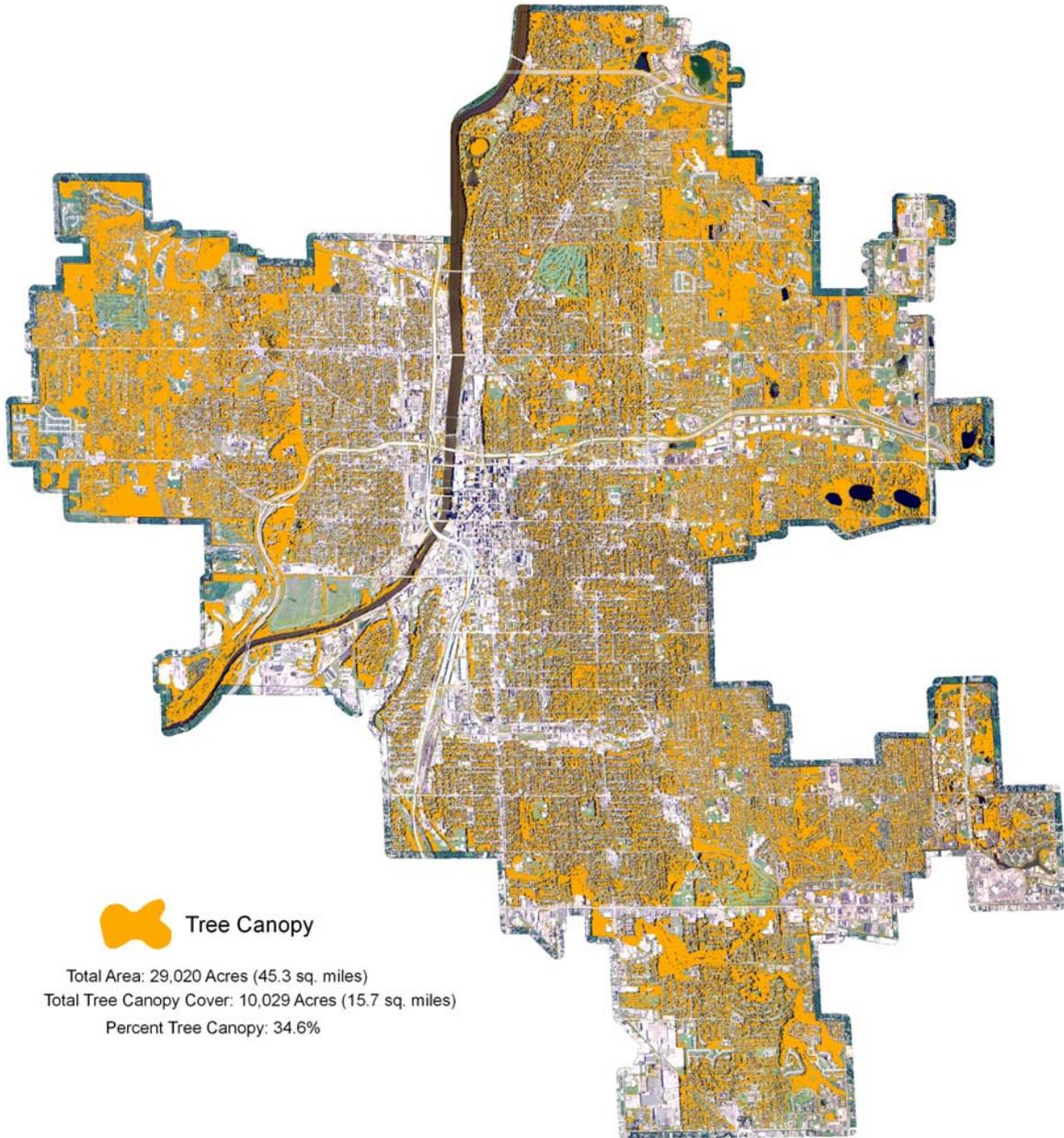
Map 1 on the next page shows the distribution of the urban forest canopy within Grand Rapids.

Sept. 2008

Map 1.

Urban Forest Canopy

City of Grand Rapids
Kent County, Michigan



Data Source:
Tree canopy cover developed by GVSU-AWRI, based on USDA
NAIP, 2005 orthophotography, and feature extraction tools provided
by Feature Analyst software.

Grand Valley State University
Annis Water Resources Institute
Information Services Center

Map Created Aug. 2008

Required for input into the CITYGreen model is a detailed data layer of the land cover and use distribution within the City. Map 2 on the next page shows this data layer generalized into 11 categories. Table 1 shows the area for each cover/use class. This data layer was created by combining the urban forest canopy data and existing land use data for the City.

Table 1. Land Cover and Use Data (required as an input to the CityGreen model)

COVER AND USE CLASS	ACRES	% Cover
Commercial/Business/Institutional	3376	11.6
Industrial	1623	5.6
Open Space w/ Grass Cover	1635	5.6
Parking Lots - Impervious	264	0.9
Residential	7126	24.6
Roads & Road ROW	4354	15.0
Shrubs w/ Ground Cover	156	0.5
Trees - Mostly Natural	4629	16.0
Trees w/ Grass & Turf Understory	3947	13.6
Trees w/ Mostly Impervious Understory	1452	5.0
Water Area	457	1.6
Total Area	29020	100.0

Table 2 below indicates the percent tree canopy for existing land use categories as identified by City of Grand Rapids existing land use data.

Table 2. Existing Land Use – Percent Urban Forest Canopy

Land Use	Acres	Tree Canopy - Acres	UTC %
Commercial	1345	130	9.7
High Density Residential	128	36	28.1
Industrial	1756	203	11.6
Medical Facility	225	74	32.9
Mixed Commercial/Residential	50	8	16.0
Multi-Family Residential	2090	701	33.5
Office	315	75	23.8
Parking Lot	276	22	8.0
Parks	1857	959	51.6
Public/Quasi Public	3016	803	26.6
Single Family	10146	4681	46.1
Vacant Lots	1448	789	54.5
	22652	8481	

Note: the extent of the existing land use data does not include water areas, roads, and road right-of-ways.

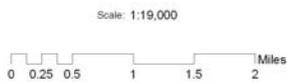
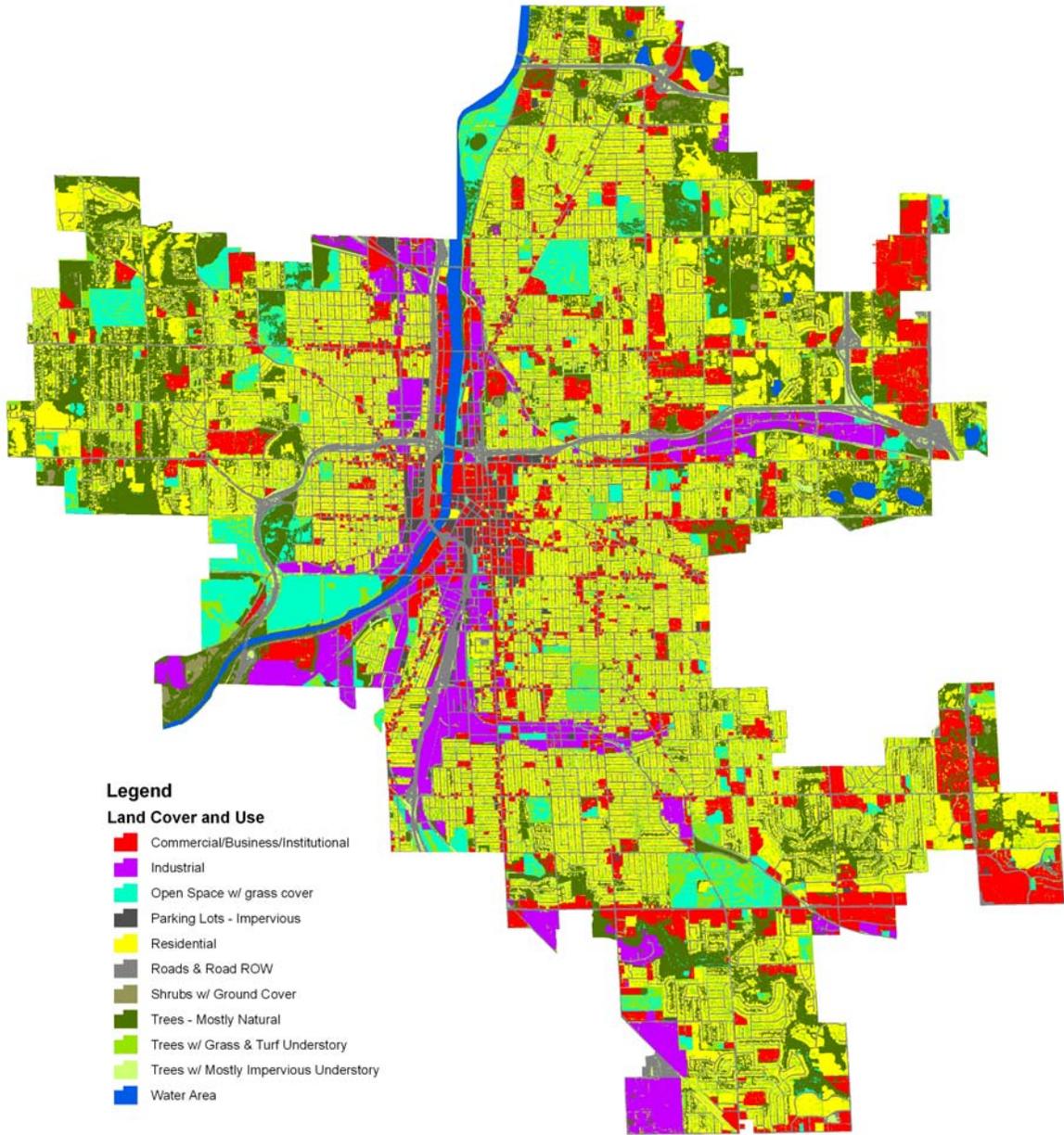
Sept. 2008

Map 2.

Land Cover and Use

City of Grand Rapids

Kent County, Michigan



Data Sources:
Map based on tree cover developed by GVSU-AWRI
Land Use by the City of Grand Rapids Planning
Generalized for use in CITYGreen model by American Forests, 2008.

Grand Valley State University
Annis Water Resources Institute
Information Services Center

Map Created Aug. 2008

Map 3 on the next page shows the urban tree canopy coverage that overhangs the road and road right-of-way network for the principal arterial roads within the City. Table 3 below indicates the “greenest” principal arterial roads within the City.

Table 3.

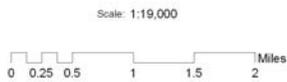
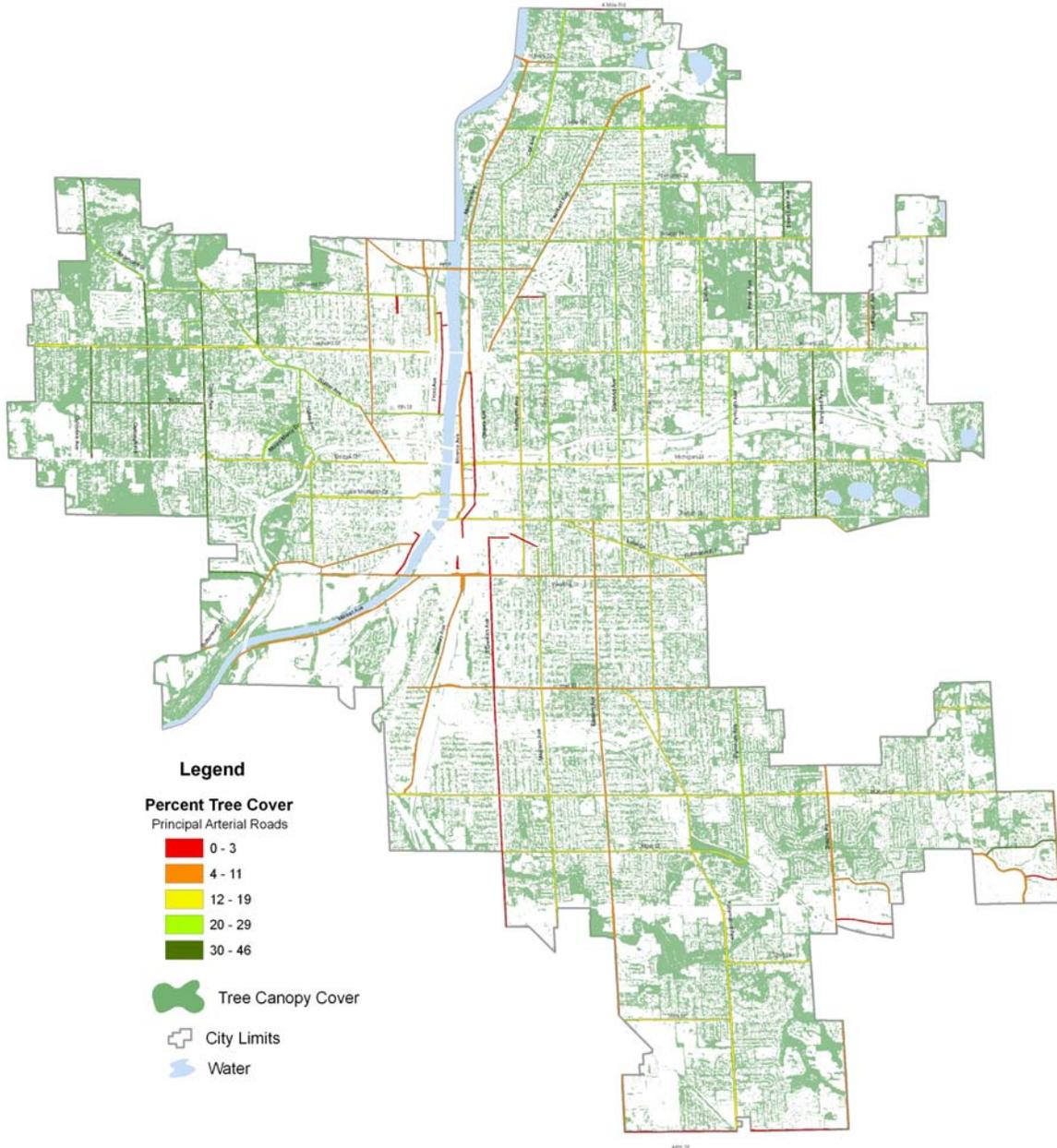
Road Name	Tree Canopy (Acres)	% - Tree Canopy
7th St	3.5	46.1
Collindale Ave	4.0	44.6
Elmridge Dr	1.8	44.3
Oakleigh Rd	5.2	43.9
O'Brien Rd	2.0	43.9
Perkins Ave	3.2	40.3
Bristol Ave	2.2	36.0
Camelot Dr	1.8	34.0
Maryland Ave	5.4	33.9
Covel Ave	6.4	33.0
Dean Lake Ave	1.3	31.7
Coit Ave	7.6	28.7
Aberdeen St	3.7	27.2
Ball Ave	4.4	26.8
3 Mile Rd	5.9	25.0
Walker Ave	4.0	23.8
Richmond St	6.5	22.7
Valley Ave	3.2	22.3
Robinson Rd	1.2	21.8
Diamond Ave	6.0	21.7
College Ave	4.2	21.6
6th St	1.2	20.6

Map 3.

Road & Road ROW - Tree Canopy Coverage

City of Grand Rapids

Kent County, Michigan



Data Sources:
Tree cover developed by GVSU-AWRI, 2008.
Road and ROW based on parcel ROW, City of Grand Rapids, 2008.

Grand Valley State University
Annis Water Resources Institute
Information Services Center

Map Created Sept. 2008

Sept. 2008

Table 4 below indicates the percent of urban tree canopy by organized neighborhood associations within the City.

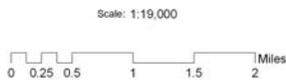
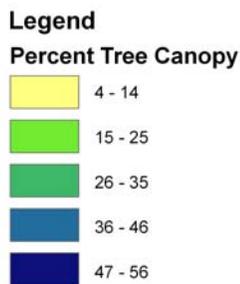
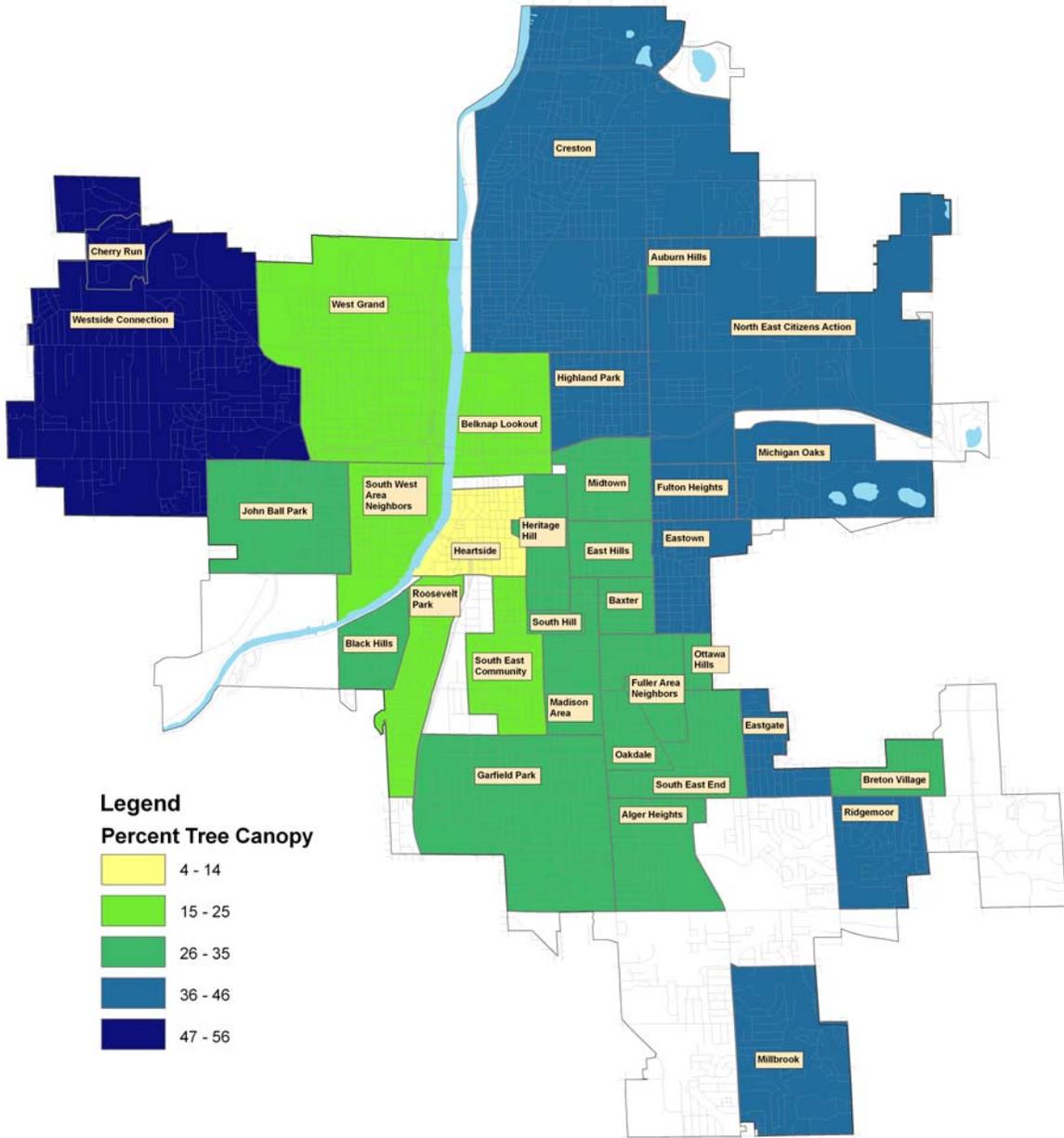
Table 4.

Neighborhood Association	Total Acres	UTC Acres	% UTC
Cherry Run	220	124	56
Westside Connection	3176	1607	51
Michigan Oaks	820	371	45
Highland Park	439	180	41
Eastgate	268	107	40
Creston	3591	1428	40
Millbrook	863	336	39
North East Citizens Action	2597	953	37
Ridgemoor	474	173	36
Fulton Heights	239	87	36
Easttown	391	139	36
Ottawa Hills	79	28	35
Baxter	158	56	35
Auburn Hills	17	6	35
John Ball Park	779	273	35
Breton Village	241	84	35
South East End	989	340	34
Alger Heights	524	178	34
Madison Area	397	134	34
Garfield Park	1461	469	32
Heritage Hill	302	93	31
Fuller Area Neighbors	148	44	30
East Hills	236	68	29
Oakdale	196	56	29
Midtown	357	102	29
Black Hills	257	73	28
South Hill	65	18	28
West Grand	1926	443	23
Belknap Lookout	602	134	22
South East Community	473	103	22
Roosevelt Park	447	89	20
South West Area Neighbors	671	118	18
Heartside	396	17	4

Map 4 on the next page shows the percent of urban tree canopy by neighborhood associations within Grand Rapids.

Percent Urban Tree Canopy By Neighborhood Associations

City of Grand Rapids - Kent County, Michigan



Data Sources:
Tree canopy data developed by GVSU-AWRI, 2008.
Neighborhood data, City of Grand Rapids, Planning Dept., 2008.

Grand Valley State University
Annis Water Resources Institute
Information Services Center

Map Created Sept. 2008

FINAL CITYGreen MODEL RESULTS – City of Grand Rapids

Based on a Total Tree Canopy of: 10,029 Acres (34.6%)

Air Pollution Removal Results – Table 1.

By adsorbing and filtering out pollutants in their leaves, urban trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rates of trees within a defined study area for the pollutants listed below. To calculate the dollar value of these pollutants, economists use “eternality” 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 the each state Public Services Commission.

Table 1.

Air Pollution Removal		
Air Pollutant	Pounds Removed per year*	Money Saved from Removal
Carbon Monoxide	17,880	\$7,631
Ozone	295,023	\$906,375
Nitrogen Dioxide	107,281	\$329,591
Particulate Matter: Less than 10 microns	196,682	\$403,428
Sulfur Dioxide	44,700	\$33,546
Total	661,566	\$1,680,570
*Nearest Air Quality Reference City – Milwaukee, WI		

TOTAL VALUE OF SERVICES: \$1,680,570 annually

Carbon Removal and Sequestration Results – Table 2.

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 within a defined study area.

Table 2.

Amount of Carbon Stored in the Trees:	438,494 Metric Tons
CCX – CFI @ \$3.60 metric ton	\$1,578,578
Additional Amount Stored Each Year	3414 Metric Tons
CCX – CFI @ \$3.60 metric ton	\$12,290

Note: Dollar values based on market value established by the Chicago Climate Exchange, Aug. 28, 2008.

TOTAL VALUE OF SERVICES: \$1,578,578

TOTAL VALUE OF SERVICES ANNUALLY: \$12,290

Stormwater Runoff Results – Table 3.

The CITYgreen software calculates the volume of runoff generated from a 2-year 24-hour storm event. For the City of Grand Rapids such a storm event would be 2.37”. The runoff generated from this storm event would need to be contained by stormwater facilities if all of the trees were removed from the city. This volume multiplied by local construction costs (per cubic feet) calculate the dollars saved by the urban 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 USDA, NRCS to represent the potential for stormwater runoff within a drainage area. Curve numbers range form 30-100. The higher the curve number the more runoff will occur. CITYgreen determines a curve number for the existing land cover condition and generates a curve number for the condition if the trees were remove and replaced by additional impervious surfaces. The change in curve number reflects the increase in the volume of stormwater runoff.

Table 3.

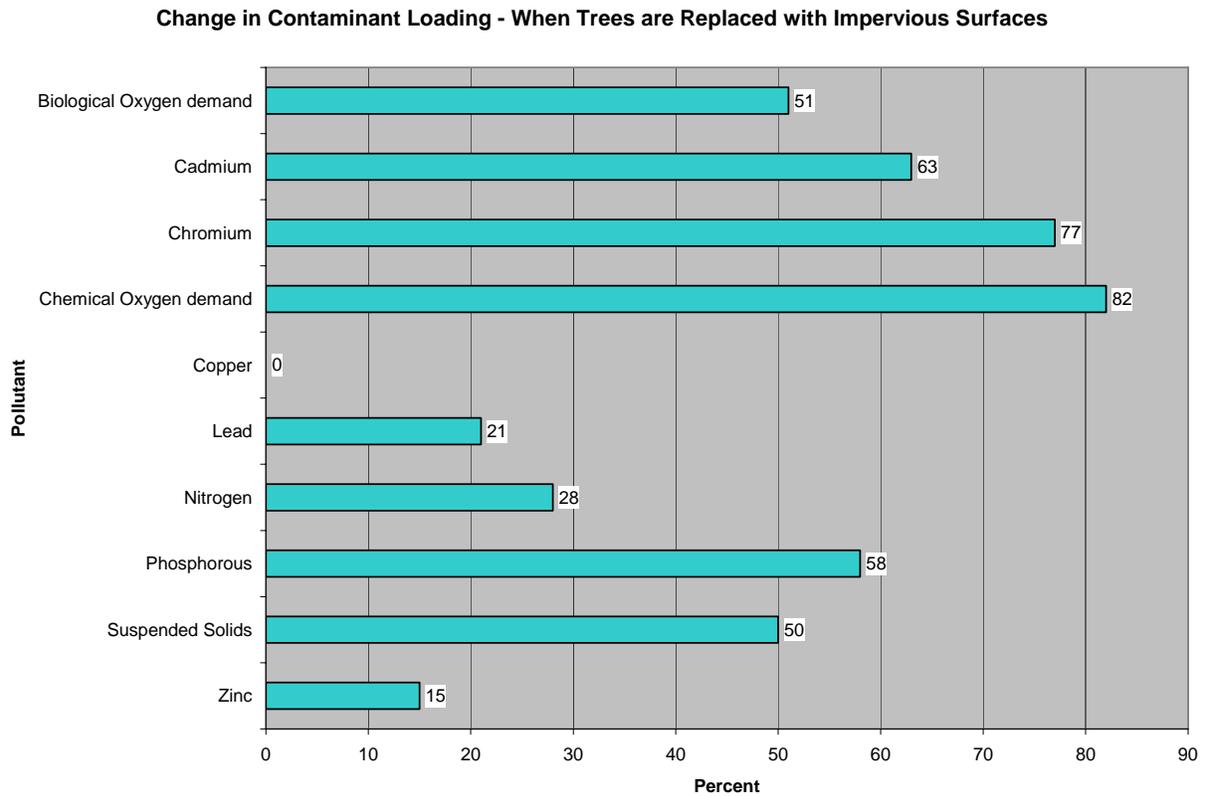
Runoff	
2-year, 24-hour Rainfall event:	2.37 inches
Curve Number of existing conditions:	78
Curve Number if the trees were replace with new impervious surfaces:	89
Additional Stormwater storage volume needed if the trees were replaced with impervious surfaces:	67,075,658 ft ³
Construction cost per ft ³ *	\$5.50
Total Stormwater Savings:	\$368,916,122
Annual costs based on payments over 20 years at 6% interest	\$32,163,789 per year
* Construction costs based on the cost to build an ADS Storm Tech underground pipe detention system to handle the additional stormwater.	

TOTAL VALUE OF SERVICES: \$368,916,122

Water Quality Results – Table 4.

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 storm event given the change in the land cover.

Table 4.



Note: No dollar amounts are calculated for this.

Sept. 2008

FINAL RESULTS SUMMARY – Grand Rapids

Air Pollution Removal: \$1,680,570 annually

Stormwater Runoff Mitigation: \$368,916,122 or \$32,163,789 per year

Carbon Storage: \$1,578,578 (presently stored in the trees) or \$12,290 worth of storage per year

Water Quality Benefits: \$unknown

The City's 35 percent tree canopy provides total dollar ecological benefits of: \$372,175,270!

FINAL CITYGreen MODEL RESULTS Downtown Development Authority Area

TREE CANOPY ASSESSMENT

Total Area DDA: 846 Acres (1.3 sq. miles)

Total Tree Canopy Cover: 36 Acres (0.06 sq. miles)

Percent Tree Canopy: 4.2%

Air Pollution Removal Results – Table 1.

Air Pollution Removal		
Air Pollutant	Pounds Removed per year*	Money Saved from Removal
Carbon Monoxide	64	\$27
Ozone	1,054	\$3,239
Nitrogen Dioxide	383	\$1,178
Particulate Matter: Less than 10 microns	703	\$1,442
Sulfur Dioxide	160	\$120
Total	2,364	\$6,006
*Nearest Air Quality Reference City – Milwaukee, WI		

TOTAL VALUE OF SERVICES: \$6,006 annually

Carbon Removal and Sequestration Results – Table 2.

Amount of Carbon Stored in the Trees:	1567 Metric Tons
CCX – CFI @ \$3.60 metric ton	\$5,641
Additional Amount Stored Each Year	12.2 Metric Tons
CCX – CFI @ \$3.60 metric ton	\$44

Note: Dollar values based on market value established by the Chicago Climate Exchange, Aug. 28, 2008.

TOTAL VALUE OF SERVICES: \$5,641

TOTAL VALUE OF SERVICES ANNUALLY: \$44

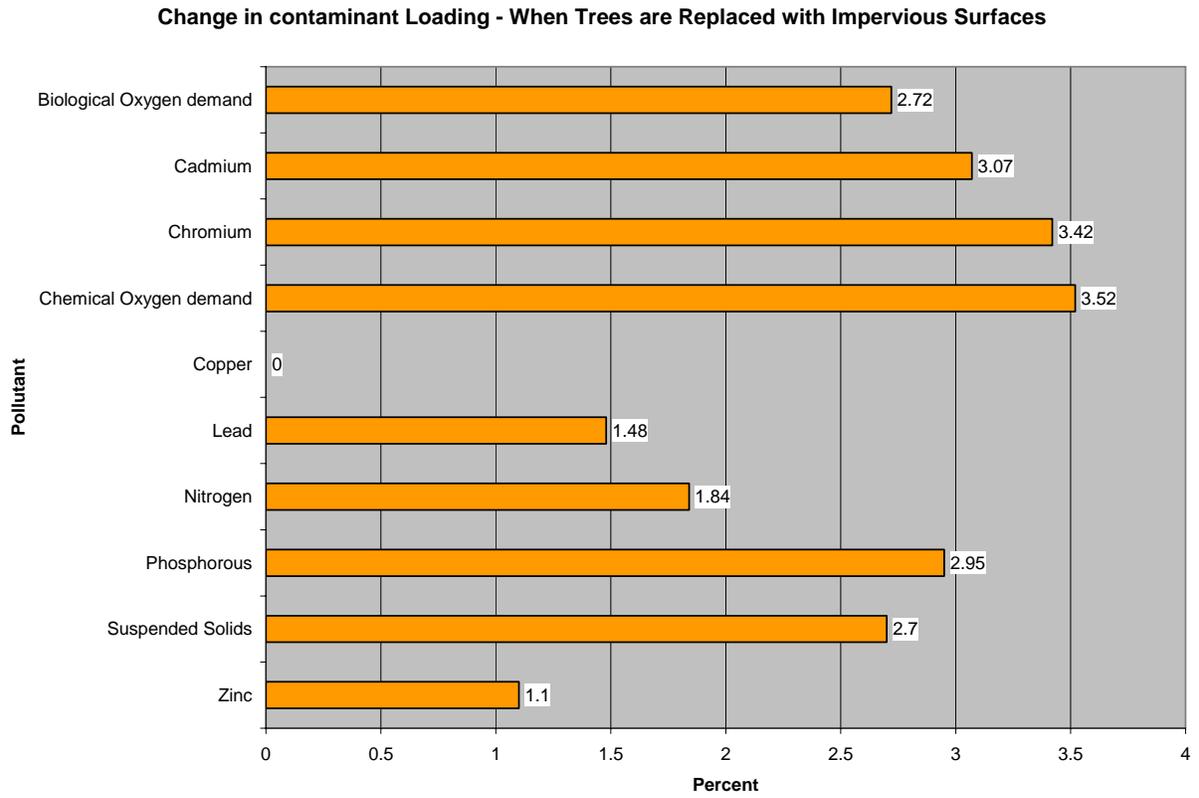
Stormwater Runoff Results – Table 3.

If the 4.2% tree cover canopy were replaced with new impervious surface you would need new stormwater infrastructure to handle an additional 270,383 cu.ft. (based on a 2 year storm event) of stormwater volume, @ \$5.50 per cu. ft. this would require about \$1.5 million dollars worth of new infrastructure to manage this additional runoff.

Runoff	
2-year, 24-hour Rainfall event:	2.37 inches
Curve Number of existing conditions:	93
Curve Number if the trees were replace with new impervious surfaces:	94
Additional Stormwater storage volume needed if the trees were replaced with impervious surfaces:	270,383 ft ³
Construction cost per ft ³ *	\$5.50
Total Stormwater Savings:	\$1,487,108
Annual costs based on payments over 20 years at 6% interest	\$129,653 per year
* Construction costs based on the cost to build an ADS Storm Tech underground pipe detention system to handle the additional stormwater.	

TOTAL VALUE OF SERVICES: \$1,487,108

Water Quality Results – Table 4.



Note: No dollar amounts are calculated for this.