Urban Forest Benefits Report

District 12-Saint Anthony Park

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Saint Anthony Park is located in the northwest corner of Saint Paul, north of the Interstate 94 corridor and adjacent to Highway 280. At approximately 1,538 acres, the neighborhood comprises 4.2% of the city's 35,931 acres. While land use varies across the district, nearly half of the land area is industrial supported by major regional rail and highway infrastructure and the district's central location between downtown Saint Paul and Minneapolis. The Saint Anthony Park 10 year plan identifies land use as 50% industrial, 20% residential (estimated up to 30%), 8% commercial, and 2.5% park land with the remaining divided among transportation and other land uses.

The urban forest within District 12 has been the focus intense management and monitoring by Saint Paul Forestry and the Minnesota Department of Agriculture after the discovery of emerald ash borer (EAB) in May of 2009. This invasive pest has the potential to dramatically alter the canopy structure of the district and impact the environmental benefits provided by the forest by infesting and killing ash trees which currently make up a substantial and important part of the street tree population.

In the spring of 2010, an update to the tree inventory was performed cataloging all street trees in district 12 recording the species type, size, and condition of each tree. This information was then entered into iTree[1] to calculate the current environmental services being provided by the urban forest and their associated economic value. With potential structural changes due to EAB possible in the short term, two additional scenarios were assessed to calculate the projected environmental benefits resulting from a total loss of the 484 boulevard ash trees as well as the value of the urban forest at the initial planting of replacement trees. Values generated were then compared to the current benefits being provided by street trees to project the potential changes that may occur with the spread of EAB.

Using inventory data collected in the spring of 2010, the annual environmental benefits provided by the street tree canopy of District 12 were calculated using iTree. The following results are a summary of the findings.

Saint Anthony Park Benefits Summary	
District land area	1,536 acres
Number of street trees	3,127
Street tree canopy area	44 acres
Energy reduction	$80,484
Carbon sequestered	851,081 pounds
Total carbon stored	9.8 million pounds
Air pollutants removed	772 pounds
Air pollutants avoided	4900 pounds
Stormwater runoff avoided	3.4 million gallons
Aesthetic/Other benefits	$94,789
Total annual benefit	$294,671

Table 1: Benefits summary

[1] Tree benefit model available through the USDA Forest Service

Forest Structure

Species Distribution:

Saint Anthony Park has 3127 boulevard trees based on the inventory data collected during the spring of 2010. Within this population five tree types form 77% of the street canopy including maple (30%), ash (16%), oak (11%), linden (11%), and hackberry (9%). Norway maple is the most prevalent maple and accounts for 16% of the total street canopy in District 12. Other species such as elm, honeylocust, and ornamental trees including serviceberry and ironwood comprise a small percentage of the urban forest and could be more widely planted to increase overall species diversity which is currently diminished by the large percentage of maples. The emerald ash borer is likely to cause a decline in the ash tree population and planning for increased species diversity will be vital to the long term stability of the urban forest while reducing potential canopy losses in the future.

The loss of ash trees due to the emerald ash borer would shift forest diversity, increasing the maple population to 37% of the street tree canopy

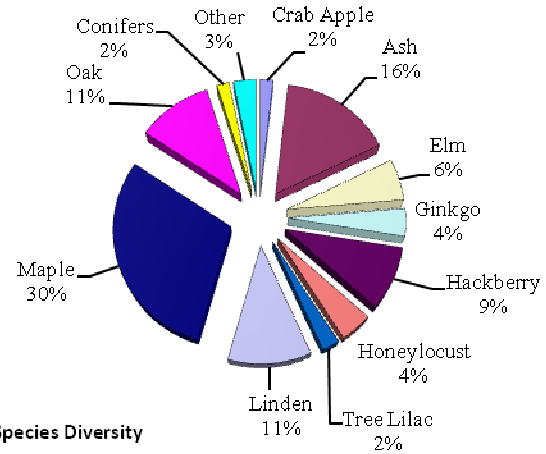


Figure 1: District 12 Species Diversity

Size Distribution:

The age structure of boulevard trees measured by diameter size reveals a relatively even distribution of trees between 1 and 18 inches with a downward trend line as diameter increases. Overall, 86% of street trees are 18 inches or less in diameter with the largest percentage between 4 and 6 inches. Trees above 19 inches comprise 14% of the population while those larger than 24 inches represent only 5% of street trees.

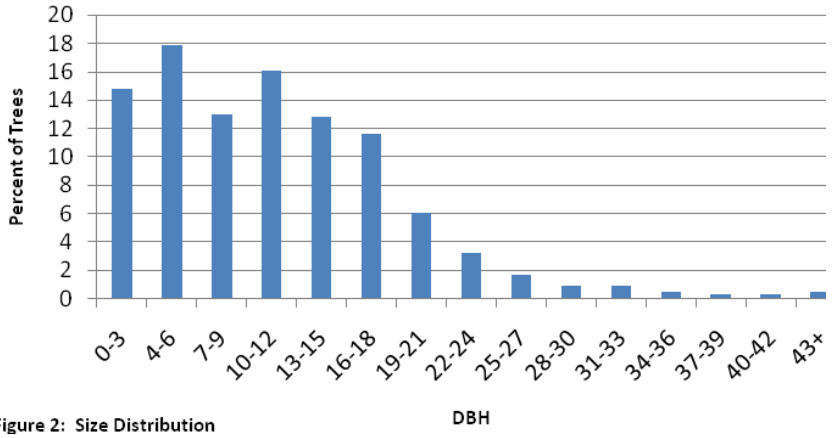


Figure 2: Size Distribution

Closer examination of the 8 most common species shows that with the exception of maples, ash, and ginkgo, most species are being planted to maintain species diversity similar to current levels and have relatively even populations across size categories. Changes that can be expected include the loss of ash trees across all size categories due to the introduction of the emerald ash borer, the loss of ginkgo trees as they reach senescence (ginkgo trees are no longer planted due to fruit production which is considered a nuisance due to its odor), and an increase in elms as a percentage of the canopy due to the availability of Dutch elm disease resistant cultivars. Maples will likely remain a large percentage of the urban canopy limiting overall species diversity.

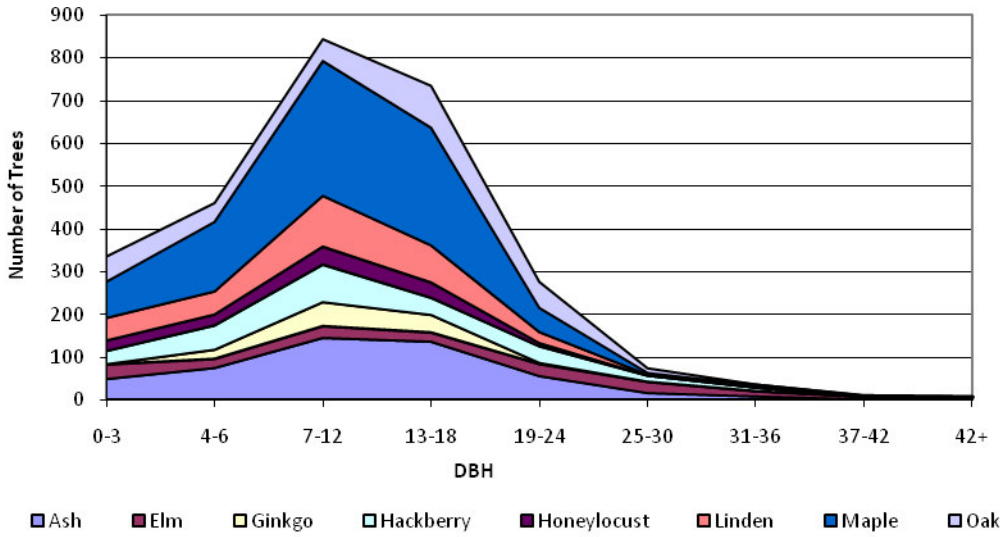
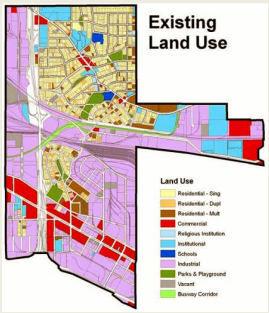


Figure 3: Major Species Size Distribution

Trees in Saint Anthony Park are in good condition with 96.2% rated as fair to excellent, 3.2% considered in poor condition, and .6% identified as dead.



Residential land use accounts for 20% of the district's land area while supporting 85% of the tree cover. In comparison, industrial lands account for 50% of the land area but only 10.5% of the canopy.

Image: St Anthony Park Community Plan

Land Use:

Land use within Saint Anthony Park has been identified as 50% industrial, 20% residential, 8% commercial, and 2.5% park land with the remaining in transportation or other land uses (District Community Plan). Street tree distribution is highest in residential areas (85.1%) followed by industrial (10.55%) and small commercial (4.16%).

Tree planting sites are located primarily on turf covered boulevards in both residential and industrial areas with the exception of the commercial area on Como Avenue near Carter and Doswell Avenues and along Pelham Boulevard in South Saint Anthony where sidewalk cutouts exist. Boulevards are generally wide and support good tree growth with only a few narrow planting boulevards of 1-4 feet. These are located along major roadways including Como Avenue and Raymond Avenue as well as Territorial Road and Hampden Avenue within the industrial areas. In contrast, many of the streets in North Saint Anthony have generous planting boulevards that are 8 feet wide or greater and relatively low traffic volumes. These locations would support species that require larger rooting zones and better soil conditions including sugar maple, oaks, buckeye, pine, serviceberry, and other ornamental trees.

Canopy Cover:

Saint Antony Park occupies approximately 1536 acres of land in Saint Paul. While streets are a significant percentage of overall land use, boulevards and street trees are a minor portion of the overall urban forest. Within District 12, street trees form a canopy of approximately 44 acres or 2.9% of total land area. Tree cover is heavier in the residential neighborhoods of the district and less in the industrial areas where large buildings and transportation infrastructure restrict available tree planting locations. Once the full urban canopy assessment is complete the value of street tree cover can be compared to the total canopy value for District 12.

Importance Value:

Trees with a large total leaf surface area and broad canopy spread provide the greatest benefits.

Ash trees are the most important tree species while maples are the most important genus in District 12 based on population size and canopy area.

In order to compare the relative economic value of the environmental benefits contributed by each species in the urban forest an importance value is assigned by iTree. This number is determined by averaging the total number of trees, the total leaf area, and the overall canopy cover provided by each species.

Within Saint Anthony Park, maples received the highest importance value rating of 27.97 points due to their large presence in the urban canopy, 903 trees representing nearly 30% of canopy cover and 1.35 million square feet of leaf area. Ash was rated second with an importance value of 17.3 and a leaf area approaching one million square feet. Despite the relatively small number of elm trees in District 12, this species was ranked fourth due to the large amount of canopy coverage they provide (10.4%) and large leaf area approaching 836,000 square feet, or 16 % of the district total.

Japanese tree lilacs and crabapple trees received the lowest value with .8 and .9 respectively. This is primarily due to their small leaf area and structure which is less able to intercept large volumes of stormwater or sequester and store large amounts of carbon. Their value in the landscape should not be over looked however as they are able to be planted in locations larger trees cannot and provide additional aesthetic and design benefits.

	Number of Trees	Percent	Leaf Area	Percent	Canopy Cover	Percent	Importance Value
Maple	903	28.9	1,352,651	25.9	562,900	29.1	27.9
Ash	484	15.5	997,722	19.2	334,592	17.3	17.3
Oak	320	10.2	558,409	10.7	222,764	11.5	10.8
Elm	168	5.4	835,841	16.1	202,034	10.4	10.6
Crabapple	72	2.3	5,356	0.1	8,547	0.4	0.9
Tree Lilac	62	2	2,579	0	5,635	0.3	0.8

Table 2: Highest (4) and lowest (2) Importance Values

Canopy Benefits

Annual Benefits:

Reference page 8 for a complete list of environmental and economic benefits provided by street trees in District 12

Street trees provide a total of $294,671 worth of environmental services to residents in District 12 and form an important part of the green infrastructure network of Saint Paul. This value is substantial considering that it accounts for trees found along the public right of way and does not include the large population of trees planted in parks or on private property. This represents an average annual economic value of $94.23 per tree.

When accounting for the five primary benefits iTree uses to calculate these values including energy, air quality, carbon, stormwater, and aesthetics the trees with the largest economic benefit are Silver Maple ($188.96/tree), Pin Oak ($149.00/tree), Elm ($143.10/tree), and Green Ash ($111.81/tree). Japanese Tree Lilacs contribute the smallest environmental benefit valued at $9.32/tree. As a whole, maple and green ash are the largest providers of environmental benefits due to their large population size.

Energy Savings:

Planting trees that provide afternoon shade and reduce winter winds can reduce energy demand in buildings. While street trees provide less direct shading, they reduce urban air temperatures and wind speeds.

One of the most direct benefits of urban trees is their ability to mitigate microclimate conditions within the metropolitan region and reduce energy expenses for property owners. By providing shade in the summer months and reducing wind speed in the winter trees reduce the demand for cooling and heating services.

In Saint Anthony Park this environmental service totals $80,484 per year in energy and natural gas savings, reducing energy demand by 460 mWh per year and natural gas usage by 62,000 Therms. While these are estimates, the savings provided are substantial and reduce the amount of carbon released into the atmosphere from utilizing these energy sources.

Trees with the largest canopies including elms ($38.11/tree) and silver maples ($38.90/tree) provide the largest per tree benefit while maples provide the largest cumulative benefit due to their wide spread planting across the neighborhood. Unsurprisingly, small trees provide the smallest energy saving. Their role should not be overlooked however, as they provide effective shade in areas where larger species may not have room to grow.

Air Quality:

Urban air quality is often reduced due to pollutants, particulate matter, and the urban heat island effect which can increase the formation of ozone. Trees are able to mitigate air pollution through deposition and by altering local microclimates, reducing energy demand and the emissions associated with its production.

Boulevard trees in Saint Anthony Park remove 772 pounds of air pollutants through deposition while also reducing energy demand eliminating the release of 4,903 pounds of emissions annually at an estimated value of $15,388 per year. Elm ($8.42/tree) and silver maple ($7.89/tree) provide the greatest environmental and economic benefit followed by pin oak ($6.23/tree), hackberry ($6.08/tree), Norway maple ($5.66/tree),

and ash ($5.61/tree). Most of this value is generated by avoiding the production of harmful emissions.

Trees do release Biological Volatile Organic Compounds (BVOC) which can increase urban ozone levels and the presence of particulate matter (Owen). However, while BVOC emissions from trees may cause increases in ozone production, their presence is beneficial and may actually reduce overall ozone formation by lowering air temperatures and altering wind patterns which effect air pollution levels (Nowak).

Carbon Sequestration and Storage:

Reducing carbon emissions is one of the critical environmental issues facing urban areas. A well maintained urban forest is able to mitigate atmospheric carbon levels by sequestering carbon dioxide and storing it in plant biomass.

Currently, street trees in Saint Anthony Park are storing 9.8 million pounds (4,900 tons) of carbon with an estimated economic value of $73,512. Ash tree biomass comprises the largest share of carbon storage within the district at nearly 1000 tons, or 20% of total stored carbon followed by Norway maple at 686 tons, or 14% of the total. Individually, silver maple ($60.83/tree) and elm ($58.46/tree) provide the greatest amount of storage per tree due to their large size at maturity.

Boulevard trees in District 12 currently store 9.8 million lbs of carbon and annually sequester 850,000 lbs. Elm and silver maple sequester and store the most carbon due to the large size of these trees

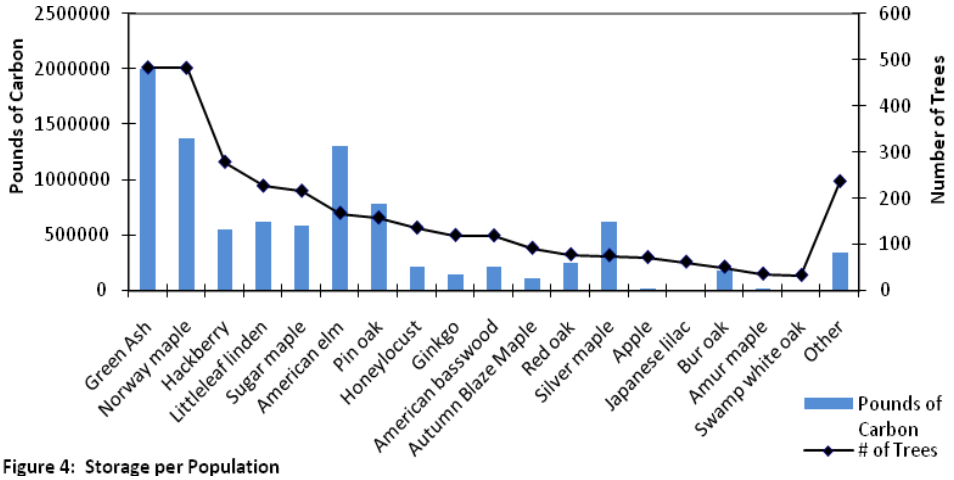


Figure 4: Storage per Population

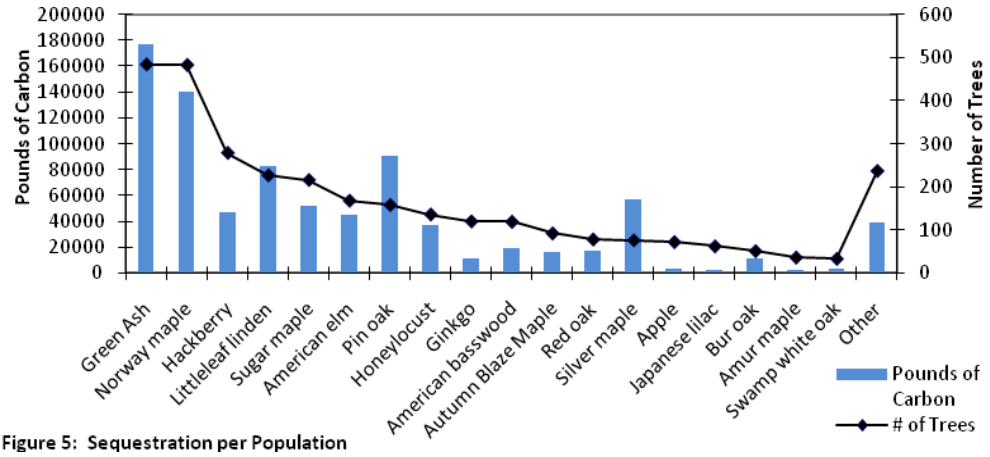


Figure 5: Sequestration per Population

Annual uptake of atmospheric carbon in District 12 sequesters 850,000 pounds of carbon each year with an estimated economic value of $6,383. Most of this is stored as woody biomass with 47,184 pounds (5%) returned to the atmosphere via decomposition. Silver maples again provide the largest per tree benefit due to their fast growth rate and large size followed by pin oak of which the population in Saint Anthony Park is comprised primarily of large, mature trees. Ash trees, as a group, sequester the most carbon at 176,886 pounds annually, or 20% of the district total.

In addition to sequestering carbon directly from the atmosphere, trees provide shade and mitigate local microclimates reducing energy demand, avoiding an estimated 772,411 pounds of carbon emissions from power plants that would otherwise be released to produce this energy. In total the trees in Saint Anthony Park reduce atmospheric carbon by nearly 1.58 million pounds annually through sequestration and pollution avoidance at an economic value of $11,787.

With an increased awareness of the role carbon plays in global climate change and the potential ramifications extending from increased atmospheric carbon levels, these benefits should be considered in the development of a more sustainable Saint Paul.

Stormwater:

Trees are an important part of Saint Paul's green infrastructure system and have the ability to intercept significant amounts of rainfall before it falls on impervious surfaces and becomes runoff. Preventing runoff has multiple economic and environmental benefits that include water quality improvements by reducing pollutants entering local water bodies through stormwater runoff, increased infiltration rates, and volume load reductions on stormwater infrastructure. Tree canopies are most effective at reducing runoff from small rain events as well as the initial rainfall of larger storm events.

Currently, trees in Saint Anthony Park intercept an estimated 3.4 million gallons of water annually with an economic value of $92,000. Trees with a large canopy including silver maple ($68.25/tree) and elm ($56.18/tree) provide the greatest per tree benefit due to the amount of leaf area and canopy spread available to capture rainfall. The greatest contribution to stormwater reductions are provided by ash trees ($36.61/tree) which as a group intercept 653,806 gallons or 19% of the total volume intercepted.

Street trees intercept 3.4 million gallons of rainfall, improving regional water quality by reducing runoff which carries nutrients and pollutants. Combined with other stormwater best management practices including rain gardens, trees can form an effective green infrastructure system.

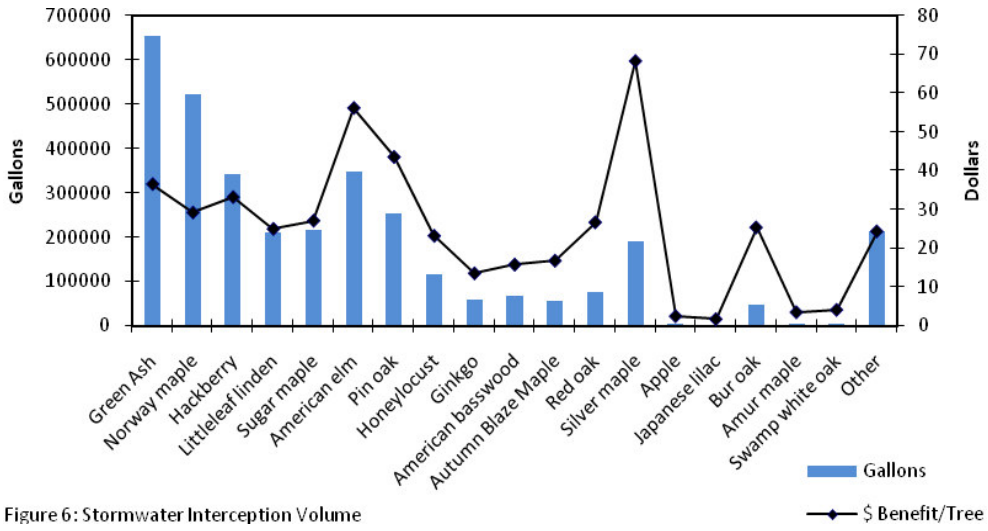


Figure 6: Stormwater Interception Volume

Saint Anthony Park
Street Tree Canopy Assessment Results

	Current	Ash Trees Removed*	With Ash Replacement**
District Land Area	1,536 acres	1,536 acres	1,536 acres
Number of Street Trees	3,127	2,639	3,127
Canopy Area	44 acres	37 acres	37 acres
Percentage of Land Cover	2.9%	2.4%	2.4%
Annual Energy Reductions			
Electricity	460.5 kWh	379.5 kWh	381.3 kWh
Natural Gas	62,096 Therms	51,510 Therms	51,845 Therms
Annual Economic Value	$80,484	$66,595	$66,986
Carbon Reductions			
Stored in Street Trees	9.8 million pounds	7.8 million pounds	7.81 million pounds
Sequestered Annually	851,081 pounds	673,827 pounds	677,179 pounds
Avoided Annually	722,411 pounds	636,520 pounds	639,620 pounds
Annual Economic Value	$11,787	$9,516	$9,564
Annual Removal of Air Pollutants			
Ozone	439.8 pounds	379.8 pounds	379.8 pounds
Nitrogen dioxide	74.5 pounds	64.9 pounds	65 pounds
Particulate matter	238.6 pounds	205.9 pounds	206.2 pounds
Sulfer dioxide	19.8 pounds	17.1 pounds	17.1 pounds
Annual Air Pollutants Avoided			
Nitrogen dioxide	2,191 pounds	1,808.5 pounds	1,818.1 pounds
Particulate matter	319.6 pounds	263.6 pounds	265 pounds
VOC's	305 pounds	251.4 pounds	252.7 pounds
Sulfer dioxide	2,088 pounds	1,720.6 pounds	1,729 pounds
Annual Economic Value	$15,388	$12,665	$12,724
Stormwater Mitigation			
Runoff reductions	3,402,842 gallons	2,747,918 gallons	2,753,651
Annual Economic Value	$92,223	$74,474	$74,629
Aesthetic/Other Benefits			
Annual Economic Value	$94,789	$77,152	$77,991
Total Annual Benefit	$294,671	$240,402	$241,894

**Figures represent the potential loss of ash trees due to the emerald ash borer

**Figures represent the initial values achieved by replacing current ash trees with a diverse selection of 2 inch calliper trees

Aesthetic and Other Benefits:

Trees provide a myriad of social, environmental, and economic benefits, many of which are difficult to quantify through typical measures. In order to account for these additional benefits including increased property values and neighborhood aesthetics iTree calculates an aesthetic/other value. Street trees in District 12 contribute an estimated $94,789 annually to the value of the neighborhood with silver maple ($65.70/tree), pin oak ($53.82/tree), and honeylocust ($51.29/tree)identified as the top three trees according to this analysis. These were followed by linden ($39.91/tree), ash ($36.28/tree), elm ($35.95/tree), hackberry ($30.08/tree), Norway maple ($29.48/tree), and sugar maple ($28.31/tree).

Emerald Ash Borer

Emerald ash borer has the potential to reduce the environmental benefits provided by the street trees of District 12 by 17%, or nearly $50,000 annually.

Emerald ash borer (EAB) was discovered in Saint Anthony Park in May of 2009 and has begun to impact the canopy structure of District 12 with ash tree losses in the neighborhoods surrounding Hampden and Langford Parks. Prior experience from communities in Michigan, Ohio, and Illinois suggest that continued infestations, tree senescence, and tree removal for community safety will reduce, and potentially eliminate, the ash tree population in this neighborhood. This issue is especially concerning as ash trees were identified as the primary tree of importance in Saint Anthony Park and their loss will have a noticeable impact on the capacity of the urban forest to provide ecosystem services to the community.

To better understand the potential impacts, two alternative scenarios were assessed in iTree to calculate the effects EAB will have on the environmental benefits provided by the street tree canopy of district 12. The first scenario removed all ash trees from the inventory representing a complete loss of boulevard ash. The second scenario also removed all ash trees and replaced them with a diverse selection of 2 inch caliper trees, representing a situation similar to the structured removal program currently being utilized across the city to reduce the ash population in advance of the borer.

Results suggest that ash trees play a significant role in providing ecological benefits to the Saint Anthony Park neighborhood and their potential loss would considerably reduce the environmental and economic value of the street canopy including:

- Annual economic benefits would potentially decrease by over $50,000 or nearly 17% to $240,402 with only a slight increase with the initial planting of new trees
- Total carbon stored in woody biomass would decrease by 1,000 tons and the amount of carbon sequestered by street trees annually could decline by 300,000 pounds
- Annual stormwater interception would be reduced by 700,000 gallons
- Removal of air pollutants would decrease by 963 pounds a year
- Aesthetic and other factors would decline by approximately $16,000 annually

A structural change of the urban forest would accompany the loss of ash trees in Saint Anthony Park. Maples, which currently account for 30% of the district's street canopy,

would increase to 37% of the street tree population, significantly above the recommended species level supporting canopy diversity and providing an opportunity for the emergence of insect or disease problems in the future. One such threat is the Asian longhorn beetle which is currently established in the eastern United States. This species is known to cause significant damage to maple trees and could heavily impact the District 12 canopy. Planned reforestation will be an important part of maintaining and increasing species diversity and the benefits provided to the urban ecosystem.

Recommendations

This report is an initial measurement of the environmental and economic benefits provided by the street trees of Saint Anthony Park. The data found within can assist with coordinating species selection and planning of tree planting activities to maximize future benefits. Additionally, it provides a baseline data set to measure progress for subsequent environmental benefit studies and to compare directly with the city wide canopy assessment currently under development.

In the 2005 District 12 Community Plan (10 year plan), the Saint Anthony Park Land Use Planning Group identified a number of opportunities related to the urban forest. Many of these are addressed in this assessment including stormwater runoff reduction, improving air quality, increasing tree planting along University and Raymond Avenue, increasing species diversity, and planting trees to promote environmental and social benefits across the neighborhood.

Additional recommendations include:

- Increase tree cover in industrial areas, which comprise 50% of the land area of District 12 but only 10% of the canopy, through partnerships with property owners and the use of innovative planting methods within existing boulevards including engineered soils to mitigate pollution, stormwater runoff, and carbon emissions produced in these areas.

- Encourage long term carbon storage through wood utilization programs that produce durable wood products and construction materials.

- Improve boulevard soil conditions when planting by amending existing soils with compost and consider planting practices that loosen compacted soils including the use of spading machines where practical. Improved soil conditions increase tree establishment success by promoting a supportive root zone.

- Increase species diversity by planting trees suited to the wide boulevards found in District 12 including birch, buckeye, coffeetree, oaks, pine, serviceberry, and other underutilized species such as elm and honeylocust. Avoid planting large numbers of maple as these currently form 30% of the canopy.

- Promote the long term health and survival of existing trees as large trees provide the greatest environmental and economic benefit to the community.

Appendix

Values used to determine the value of the street tree canopy in Saint Anthony Park are as follows.

- Electricity was $0.0669/kWh based on the average of summer and winter rates quoted by Xcel Energy on July 6, 2010
- Natural gas was $0.80/therm based on the 31 month average available from CenterPoint Energy on July 6, 2010
- Median home value was entered as $210,000 based on local real estate numbers for 2009 sales data and estimated home values. This number is imperfect but represents a number that accounts for current resale values and estimated home values across the neighborhood.
- Values for air pollution and stormwater interception were based on the information in iTree which has been calibrated to the Midwest by the program. These values are:

CO2 ($/lb)	0.0075
PM10 ($/lb)	2.84
NO2 ($/lb)	3.34
SO2 ($/lb)	2.06
VOC ($/lb)	3.75
Stormwater interception ($/gallon)	0.0271

- Operational costs of city tree management were not entered into iTree due to the multi-year rotational nature of tree care across the city and the inaccuracy of dividing the total annual budget to one individual district. This necessarily limits this report to quantifying only the benefits received from the urban forest without balancing against the costs. Once the complete canopy assessment is complete in late 2010 a full cost benefit calculation can be estimated.

References

City of St Paul, "Saint Anthony Park District 12 Community Plan," sapcc.org/about/plan

Nowak, D.J. et al. "A modeling of the impact of urban trees on ozone," Atmospheric Environment 34 (2000) pp1601-1613

Owen, S.M. et al, "Biogenic volatile organic compounds (BVOC) emission estimates from an urban tree canopy," Ecological Applications 13(4) 2003 pp927-938

USDA Forest Service, iTree Tools for Assessing and Managing Community Forests, www.itreetools.org

This report was prepared by Zachary Jorgensen, as a Minnesota GreenCorps member serving with Saint Paul Forestry. It was completed in July 2010 based on inventory data collected in the spring of 2010.