GOOD FOR LAWRENCE, GREAT FOR YOU!

GREEN STREETS

LAWRENCE · MASSACHUSETTS

A Health Impact Assessment of the Lawrence Green Streets Program

March 2017

APA SUSTAIN

GROUNDWORK CHANGING PLACES CHANGING LIVES

Groundwork Lawrence

Acknowledgements

The American Planning Association's Sustainable Communities Division, in coordination with the Massachusetts Chapter of the American Planning Association, developed this Green Streets Health Impact Assessment in cooperation with Groundwork Lawrence. This volunteer service project was a collaborative effort between a number of local and state planning and public health professionals. Thanks to the following APA-SCD team members who contributed their time, expertise and knowledge to the success of this HIA:

Angela Vincent, AICP, Merrimack Valley Planning Commission
Neil Angus, AICP CEP, LEED AP, Devens Enterprise Commission
Malithi Fernando, Steer Davies Gleave
Sang Cho, Harvard Graduate School of Design
Halley Reeves, MA Department of Public Health
Noemie Sportiche, Metropolitan Area Planning Commission
Kim Lundgren, Kim Lundgren Associates
Edward Sanderson, CDMSmith
Jan Henderson, AICP, Planner, MASCO
Peter Lowitt, FAICP, Devens Enterprise Commission
Karla Chaffee, Robinson + Cole
Karen Kao, Independent Consultant

Special thanks to Heather McMann, Lesly Melendez and Brad Buschur at Groundwork Lawrence for their support and guidance throughout this process. The APA-SCD team would also like to thank CRJA Landscape Architects and Leslie Brandt of the USDA Forest Service for their assistance with reviewing street tree species, development of the planting recommendations, and the climate change vulnerability assessment of trees in the Boston Region.

Table of Contents

List of Figures:

List of Tables:

Executive Summary

The physical environment in which people live is an important determinant of human health. Green infrastructure elements such as street trees can impact energy usage, stormwater management, air quality, microclimate, and aesthetics in neighborhoods. But these elements can also play an important role in the mental health, physical activity, and social interaction of residents within these neighborhoods. In late 2015, Massachusetts planners and members of the American Planning Association's Sustainable Communities Division (APA-SCD) partnered with Groundwork Lawrence (GWL) on a volunteer service project to measure the health benefits of GWL's Green Streets Program. Throughout 2016, the APA-SCD conducted a Health Impact Assessment (HIA) to analyze the potential health benefits of street tree planting in the Arlington and South Common neighborhoods within the City of Lawrence, Massachusetts. The result was a comprehensive assessment and evaluation of the physical, environmental and social impacts of street tree planting in Lawrence.

This report provides an overview of the Green Streets Program HIA process, including the research that was conducted, a summary of findings, recommendations and the resources that were developed by the APA-SCD team to assist GWL in meeting their Green Streets Program goals. The report details each of the six key steps involved in conducting an HIA:

1. Screening
2. Scoping
3. Assessing risks and benefits.
4. Developing recommendations.
5. Reporting
6. Monitoring and evaluating

Each step was conducted collaboratively between the APA-SCD and GWL team throughout the project, with regular check-ins to ensure the correct data was collected, the findings were relevant and the final recommendations were realistic and applicable for GWL and the Green Streets Program. In addition, several public engagement workshops were conducted to collect input on the actual and perceived health concerns in the Arlington and South Common neighborhoods. The data collection, combined with community input, helped the APA-SCD team evaluate how the concerns identified might be impacted through the planting of additional street trees. The top health concerns that the APA-SCD team uncovered included cancer, obesity, diabetes, stress/mental health, substance abuse and crime. The APA-SCD Team's research identified four priority impact areas where street trees could have the greatest impact on the overall health of the community:

1. Environmental: Street trees provide a number of ecosystem services in an urban environment such as wildlife habitat, stormwater management, air filtration, regulation of micro-climate and carbon sequestration.
2. Physical and Mental Health: Street trees and greenery in urban environments have proven to have rehabilitating impacts on the physical and mental health of the population.
3. Social Cohesion: Street trees create more aesthetically pleasing and inviting streetscapes that help promote more opportunities for beneficial interactions between community residents, businesses and organizations.
4. Housing/Energy: Street trees contribute to a reduction in energy demand in buildings by providing shading in the summer to reduce cooling loads and allowing sunlight in the winter to reduce mechanical heating loads. Tree canopies can also lower wind speeds and reduce overall summertime air temperatures, which can also impact energy demand in nearby housing.

After six months of research, workshops, and meetings with GWL, APA-SCD developed a set of recommendations that included policies, activities, and tools that would help GWL show residents how the planting of street trees could positively impact the top health concerns in Lawrence neighborhoods and further promote and support implementation of the Green Streets Program. The recommendations focused on creative communication methods that could be used to engage residents, enact policies to protect and preserve existing trees, and provide additional metrics to measure the economic, social and environmental successes of the Green Streets Program. Some of the key recommendations developed by the APA-SCD team include:

- Development of additional messaging focused on existing health issues in Lawrence and how street trees can help;
- Implementation of a friendly tree planting competition between South Common and Arlington neighborhoods;
- Development of a Tree Stewardship Program;
- Utilization of online tools to track and monitor project success;
- Adoption of a Tree Preservation/Protection Ordinance for private properties and a Street Tree Bylaw/Ordinance for public trees.

The APA-SCD also provided GWL with a number of resources to support the recommendations above, including:

- Detailed environmental analysis of proposed street tree planting species and recommendations based on the health-related opportunities and constraints for each street tree type (stormwater management, energy efficiency, carbon dioxide absorption, reduction of particulate matter and ozone, pollen production, and more);
- A list of trees species that will be more vulnerable or more resilient to a changing climate;
- An infographic, a tagline and logo to help brand the Green Streets Program and directly promote the health benefits of street trees;
- Educational messaging that focuses on promoting how planting more street trees can impact some of the priority health issues in Lawrence and linking some of the key benefits that residents already associate to street trees. This deliverable also includes tools for communicating these messaging suggestions.

Good for Lawrence,
Great for You!

¡Bueno para Lawrence,
Mejor para Ti!

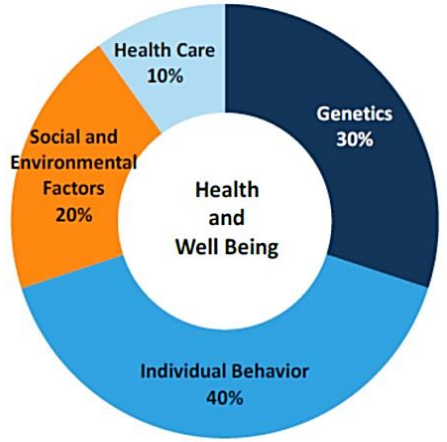
The ultimate goal for the APA-SCD was to provide simple, easy to use, but effective strategies to help GWL achieve the energy efficiency goals of the Green Streets Program but at the same time, applying a health lens to further support the overall acceptance of the program in Lawrence. The APA-SCD team also wanted to create a final product and resources that could be adaptable and used by any community or organization as a tool to promote the importance of green infrastructure elements such as street trees to improve the health and well-being of neighborhoods and local residents.

As part of the reporting step of this HIA, the APA-SCD team plans to share this report with not only GWL, but other communities and state agencies in Massachusetts, as well as the American Planning Association. The APA-SCD will utilize a variety of outreach methods, including this report and a podcast to share the process and results to a larger audience.

Introduction

1.1: Health and the Built Environment

Planning to protect the public's health, safety and welfare began in the 19th Century as a tool to address poor sanitation, overcrowded, dark urban tenements and poor working and living conditions. Efforts to improve health in the United States have traditionally looked to the health care system. Research has demonstrated that improving population health and achieving health equity requires broader approaches that address social, economic, and environmental factors that influence health.[1]



SOURCE: Schroeder, SA. (2007). We Can Do Better —Improving the Health of the American People. *NEJM*. 357:1221-8.

The physical environment in which people live is an important determinant of health. Although there are other important factors such as individual behavior, socioeconomic status, and genetics which can influence personal health, the built environment also plays a key role. For example, lack of sidewalks or inconvenient bus service affects our travel decisions and may negatively impact our ability to walk or take alternative forms of transportation, which in turn can lead to a car-based, more sedentary lifestyle and higher levels of air pollution. Table 1.0 highlights some of the general connections between certain development attributes and their potential impacts on public health.

Table 1.0 – Relationships between Development Attributes and Health Impacts

Development Attributes	Potential Health Impacts
Density and mix of Land Uses	Walkability/physical activity, social interaction
Accessibility (universal design, sidewalks, bike lanes)	Safety, walkability/physical activity
Connectivity (street network, access to community resources such as parks and open spaces)	Walkability/physical activity, social interaction, automobile use (GHG emissions)
Green Infrastructure (street trees, parks, open space)	Air quality, mental health benefits (views of green), physical activity
Community gardens	Social interaction, mental health, diet, nutrition
Lighting levels	Crime/safety, comfort
Impervious surfaces	Urban Heat Island/air quality

[1] Artiga, S. and Heiman, H. Beyond Health Care: The Role of Social Determinants in Promoting Health and Health Equity (2015)

Recognizing the social, economic and environmental relationships between community planning and health can help us design and redevelop our towns and cities and include elements that maximize people's health, wellness and experience. Introducing additional green infrastructure elements such as more street trees can lead to more pedestrian-friendly development while concurrently addressing traffic congestion, air quality, as well as public health and safety.

Street trees have significant social, economic and environmental benefits for urban areas. As a result, many cities and towns are incorporating more of these green infrastructure elements into their built environments. As illustrated in Figure 1.0, green infrastructure elements such as street trees can impact energy usage, stormwater management, air quality, microclimate and aesthetics, as well as mental health, physical activity, and social interaction.

Figure 1.0 - Street Tree Benefits

Reduce home heating and cooling costs through the shading and insulating

Raise property value

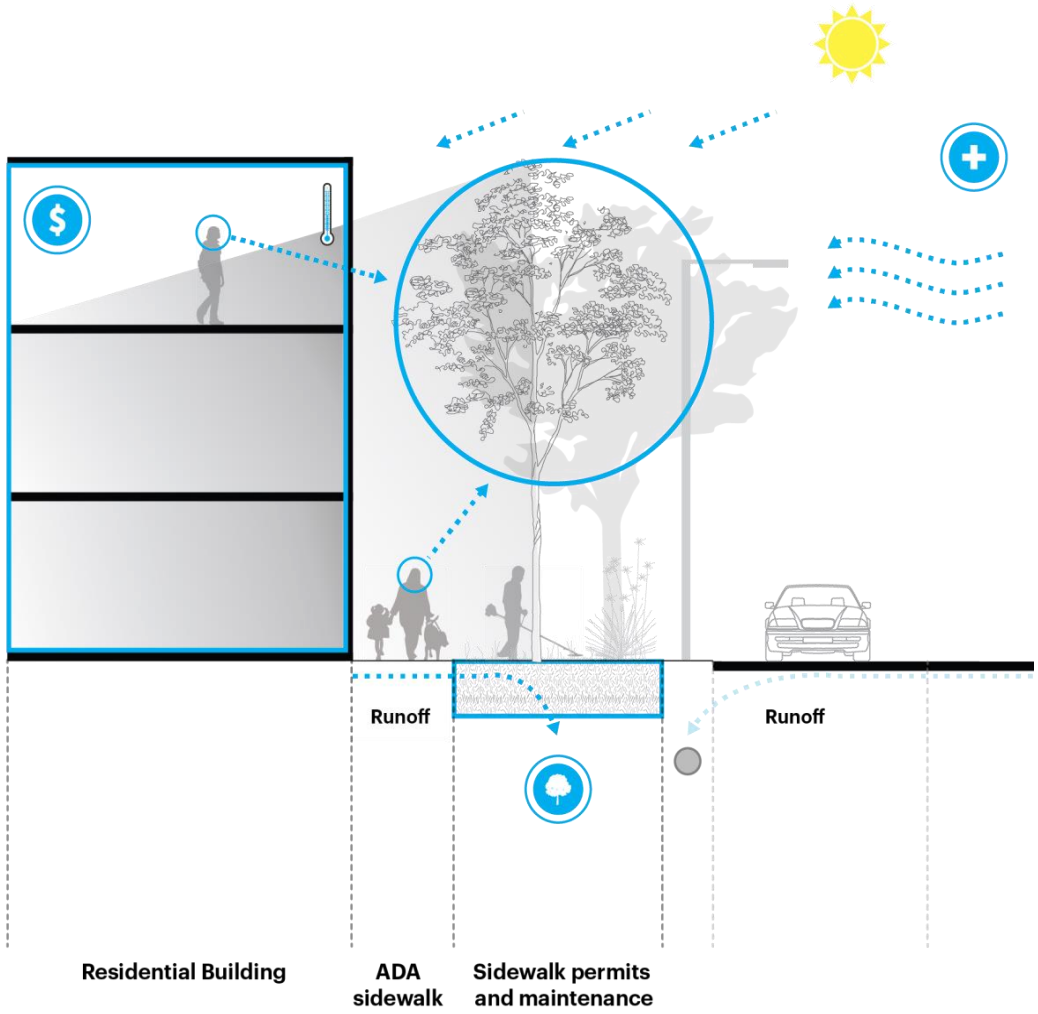
Improve water quality through reduction of urban runoff into local waterways

Improve air quality through reduction in airborne contaminants

Improve water quality through reduction of urban runoff into local waterways

Enhance mental wellbeing

Reduce urban heat island effect



Source: APA-SCD team, 2016

1.2 APA-SCD Service Project Program

In late 2015, Massachusetts planners and members of the American Planning Association's Sustainable Communities Division (APA-SCD) approached Groundwork Lawrence (GWL) about engaging in a volunteer service project that would help promote a more sustainable community in Lawrence. After several discussions between the GWL staff and APA-SCD volunteers, the two organizations decided on a project to measure the health benefits of the GWL's Calles Verdes/Green Streets Program. The program is designed to reduce household heating and cooling energy use by increasing tree canopy cover in urban residential areas. The Calles Verdes/Green Streets Program is funded by the Commonwealth of Massachusetts Greening the Gateway Cities Program (GCCP). GCCP is a partnership between the Executive Office of Energy and Environmental Affairs, the Department of Conservation and Recreation, the Department of Energy Resources, and the Department of Housing and Community Development, along with local municipalities and local community based organizations. Cities like Lawrence that have a lower tree canopy, older building stock, higher wind speeds, and a large rental population are prioritized by the GGCP. Trees are planted by crews from the local community in which the program operates. One of the primary drivers for this program is to help reduce energy costs in the Arlington and South Common neighborhoods in Lawrence. To help accomplish their project goal of planting 2,400 trees over the next three years, the APA-SCD proposed to measure and creatively communicate the multiple benefits of street trees – beyond just energy efficiency. To do this, the APA-SCD used the Health Impact Assessment model to evaluate existing health conditions in Lawrence and look at how increased tree canopy coverage in the two targeted neighborhoods could contribute towards mitigation of some of those existing negative health conditions.

Groundwork Lawrence, Inc. (GWL) is a 501(c)3 nonprofit organization located in Lawrence, Massachusetts that is committed to "changing places and changing lives" through on-the-ground projects that help to transform local communities by engaging the whole community – residents, youth, nonprofits, city government and businesses – in the planning and realization of its projects. GWL's mission and operations are premised on the understanding that environmental conditions are inextricably linked to the economic and social health of a neighborhood. To accomplish its mission, GWL leads and supports a variety of partnership-driven efforts that bring together the public, private and nonprofit sectors to solve complex environmental problems.

This project and report provides a complete review of the Green Streets Program Health Impact Assessment process, including the research that was conducted, a summary of findings, recommendations and a series of deliverables that were developed by the APA-SCD team to assist GWL in meeting their Green Streets Program goals.

2.0 Health Impact Assessment Overview/Methodology

2.1 What is a Health Impact Assessment?

A Health Impact Assessment (HIA) is defined as "a combination of procedures, methods and tools by which a policy, program or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population" (WHO,

Gothenburg Consensus, 1999). An HIA is different from a public health assessment, a health risk assessment, and an environmental impact assessment. These are typically focused on the health effects of exposure to certain elements. HIAs are used to help evaluate the potential impacts of a plan, project or policy on the health of a population and the potential distribution of those impacts within the population. It is not a new concept but one that has become more important as we recognize the linkages between neighborhood design and how it can influence public health. It is not just what we eat, but where we live and how we live that affects our physical and mental health. HIAs are a tool to comprehensively assess and evaluate not just the physical impacts, but the potential social and mental health impacts that a plan, project or policy may or may not create. The GWL Green Streets Program HIA was an inclusive process that involved residents, business leaders, community groups, local politicians, planners and public health professionals. This process was vital to the success of this HIA.

2.2 Why an HIA?

Although focused on energy efficiency because of the program funding requirements, GWL recognized the multiple benefits of street trees beyond energy efficiency and saw the HIA process and the APA-SCD assistance as an opportunity to further engage the local communities around their work and help foster additional support for their street tree planting program through research, education, awareness, recommendations and a series of deliverables that this HIA helped produce.

2.3 HIA Process Overview

There are six major steps to an HIA:

1. Screening (identifying plans, projects or policies for which an HIA would be useful),
2. Scoping (identifying which health effects to consider),
3. Assessing risks and benefits (identifying those people impacted and how they may be affected),
4. Developing recommendations (suggesting changes to programs, projects or policies to promote positive health effects or to minimize adverse health effects),
5. Reporting (presenting the results to decision-makers), and
6. Monitoring and evaluating (determining the effect of the HIA on the decision).

HIAs can be a valuable tool to help communities make more informed choices about improving public health through and to help ensure a more comprehensive evaluation of any plan, project, policy or program. The end result is a set of recommendations to increase positive health outcomes and minimize adverse health outcomes. The APA-SCD, in consultation with GWL, developed a work plan that mapped out each of these steps, what was involved, and which team members were responsible for completing each step and when. The remainder of this report provides details on each of these key steps.

3.0 Screening

The screening phase assesses the value in conducting an HIA. In late 2015, the APA-SCD approached GWL about engaging in a volunteer service project that would promote a more sustainable community in Lawrence. In January of 2016, the APA-SCD put together a team of professional planners and health experts and met with GWL to review their current initiatives to determine if there was an opportunity to assist GWL. We reviewed a number of projects that GWL was working on, including:

- The Spicket River Greenway Project: Placemaking project along the Spicket River to connect a specific node along the Greenway with the adjacent neighborhoods.
- Grocery store: GWL was investigating the possibility of conducting an HIA to study the positive health impacts of building a grocery store in an area of Lawrence that is considered a "food desert".
- Green Streets Tree Planting Program: Supported by funding from the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA), this program is aimed at improving energy efficiency in residential neighborhoods in Lawrence by increasing the tree canopy cover along streets and on properties. GWL has set a goal to plant 2,400 trees over the next three years, with a focus on the Arlington and South Common neighborhoods in Lawrence.

Both GWL and the APA-SCD agreed that the Green Streets Program could benefit most from an HIA by helping to further identify and promote the multiple social, economic and environmental benefits of street trees in an urban environment. The results of the HIA could be used to augment GWL's community education and outreach initiatives and creatively foster additional community support and participation in the program. For these reasons, the APA-SCD team decided it would be beneficial to move forward with an HIA for the Green Streets Tree Planting Program (hereinafter Green Streets Program).

4.0 Scoping

The scoping phase involves planning and designing the HIA, identifying which health effects to consider, and developing a work plan. While the Green Streets Program was initially focused on energy efficiency, the APA-SCD and GWL recognized the multiple benefits of street trees and vegetation in general in urbanized areas and saw this HIA as a way to strategically expand the promotion of the program and gain additional neighborhood support for its implementation. The Green Streets Program targets the neighborhoods of Arlington and South Common because of a lack of existing street tree canopy and the need to reduce household energy costs.

The APA-SCD Team met with GWL to devise a work plan that would be tailored to GWL and their specific needs. After several meetings, GWL and the APA-SCD team agreed on a six-step HIA work plan and timeline as depicted in Figure 1.2 and summarized hereafter.

1. *Conduct a Baseline Assessment.* The APA-SCD team developed a baseline assessment of existing street tree canopy cover and public health conditions by gathering existing information provided by the City of Lawrence or GWL (i.e., GIS data, Census information, existing studies and reports). Site visits were also conducted.
2. *Analyze Economic, Social and Environmental Health Benefits of Street Trees in Urban Areas.* Conducted a literature review of the economic, social and environmental benefits of street trees with a focus on the goals and objectives of the Green Streets Program. This analysis also included a review of the Green Streets Program goals and metrics (e.g., number of trees to be planted per year, the location of the trees, the type of trees to be planted, etc.).
3. *Host Public Informational Sessions in Arlington and South Common Neighborhoods.* The goal of these events was to educate the neighborhoods about the health and energy saving benefits of planting street trees in the community and engage attendees in activities like visual preference surveys. The events were an opportunity to test various messaging about trees and tree planting, and understand which health issues the neighborhoods are most concerned about and how trees may be able to help. The agenda was developed through a collaborative process with GWL. The events were open house-style.
4. *Assess the Findings.* The APA-SCD team compiled all the research and community feedback and assessed the information to develop a list of recommendations that would assist GWL in achieving their tree planting goal.
5. *Develop Deliverables:* To assist with future planting seasons of the Green Streets Program, the APA-SCD proposed to tailor and finalize several resources for GWL's use, including:

Figure 1.2 – APA-SCD HIA Work Plan/Timeline

   a. Maps of the aforementioned scenarios, resources and materials needed, infrastructure considerations, and any other identified throughout Step 1.
   b. Health Benefits of Tree Planting Educational Materials: tailored messaging, campaign ideas, graphics, statistics, etc.
   c. Ideas for tracking the progress of the Green Streets Program, including potential design concept and tools for tracking the success of the program and a list of recommended metrics to track.

These deliverables were developed in concert with the GWL staff to ensure their usability and relevance to the organization's capacity and skills. Tools or resources that were developed were introduced to the GWL at a final debrief meeting to ensure familiarity and understanding of the resources that were handed off.

6. *Finalize the Report:* The APA-SCD documented the entire HIA process and created this report which was provided to GWL and APA National. A podcast on the HIA process and future educational sessions at planning conferences will also be pursued. See the Deliverables section for additional details.

5.0 Findings/Assessment

In determining which health impacts to consider in this HIA, the APA-SCD team reviewed existing conditions in Lawrence and the two focus neighborhoods of Arlington and South Common. This included extensive research on existing health-related data at both the city and neighborhood scale, a number of meetings with GWL to collect background data, as well as a number of site visits to each of the neighborhoods. APA-SCD and GWL met on a regular basis throughout this entire process to keep up-to-date and track progress.

5.1 Existing Conditions

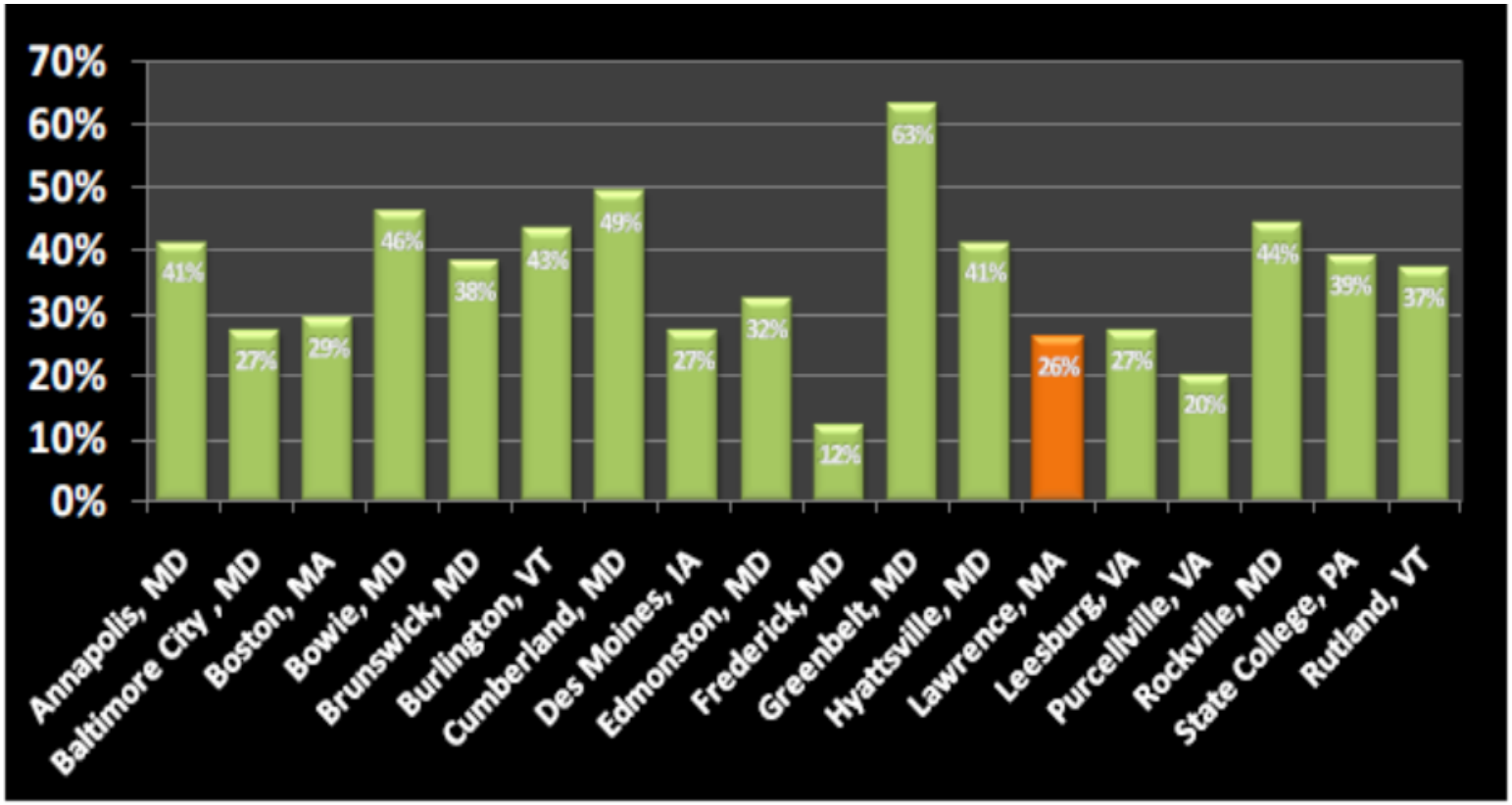
Lawrence is a 7.4 square mile gateway city in northeast Massachusetts and a former mill town that is home to over 78,000 residents with a large Hispanic immigrant population and a disproportionately high percentage of low-income and minority communities. There is a large Spanish speaking population in Lawrence. From a health, wellness and safety perspective, Lawrence has infant mortality and infectious disease rates that are above the state average. Motor vehicle deaths and suicide rates in Lawrence are lower than the state average, however homicides are more than triple the state average. While cancer rates in Lawrence are generally lower than the state average, cardiovascular disease rates are higher. Urban revitalization has been underway in Lawrence for a number of years now, converting the numerous old mill buildings along the Merrimack River into commercial, residential, and educational uses. Due to its industrial history, density, and proximity to I-495, Lawrence is exposed to higher than normal levels of ozone and particulate matter which likely contributes to reduced air quality. The Massachusetts Department of Public Health Community Information Profile Health Status Indicators Report for Lawrence contains additional details on all these health indicators and is a useful resource for establishing baseline health conditions in Lawrence.[2]

A 2010 urban tree canopy analysis of Lawrence conducted by the University of Vermont and the US Forest Service found that approximately 26% of its total land area was covered by tree canopy.[3] This is slightly below average compared to cities of similar size in other states, as shown in Figure 2.0.

[2] MA Dept. of Public Health – Health Status Indicators: http://www.mass.gov/eohhs/docs/dph/masschip/health-indicators/h-o/hsicity-townlawrence.rtf

[3] Source: University of Vermont, UTC Report. http://nrs.fs.fed.us/urban/utc/

Figure 2.0 – Tree Canopy Cover for Cities of Similar Size to Lawrence – 2010



Source: University of Vermont, UTC Report. http://nrs.fs.fed.us/urban/utc/

This project included an analysis of the Arlington and South Common neighborhoods in Lawrence. Figure 3.0 depicts the location of the Arlington and South Common neighborhoods in Lawrence. Arlington is located just north of the downtown core and borders the City of Methuen to the north and Route 28 to the west. The Spicket River borders and flows through the southern portion of Arlington. The land use in Arlington is predominately residential with a few business district strips located along Lawrence Street and Park Street. South Common is located south of the downtown core and borders the industrial areas along the Merrimack River to the north, the Shawsheen River and Interstate 495 to the east, and Route 28 and the MBTA Commuter Rail and freight rail line to the west. South Common is also primarily residential, with small business districts located mainly along portions of South Union Street and Route 114. Both Arlington and South Common are densely developed with limited tree canopy cover remaining within the neighborhoods. The following is a snapshot of the demographics within each neighborhood.

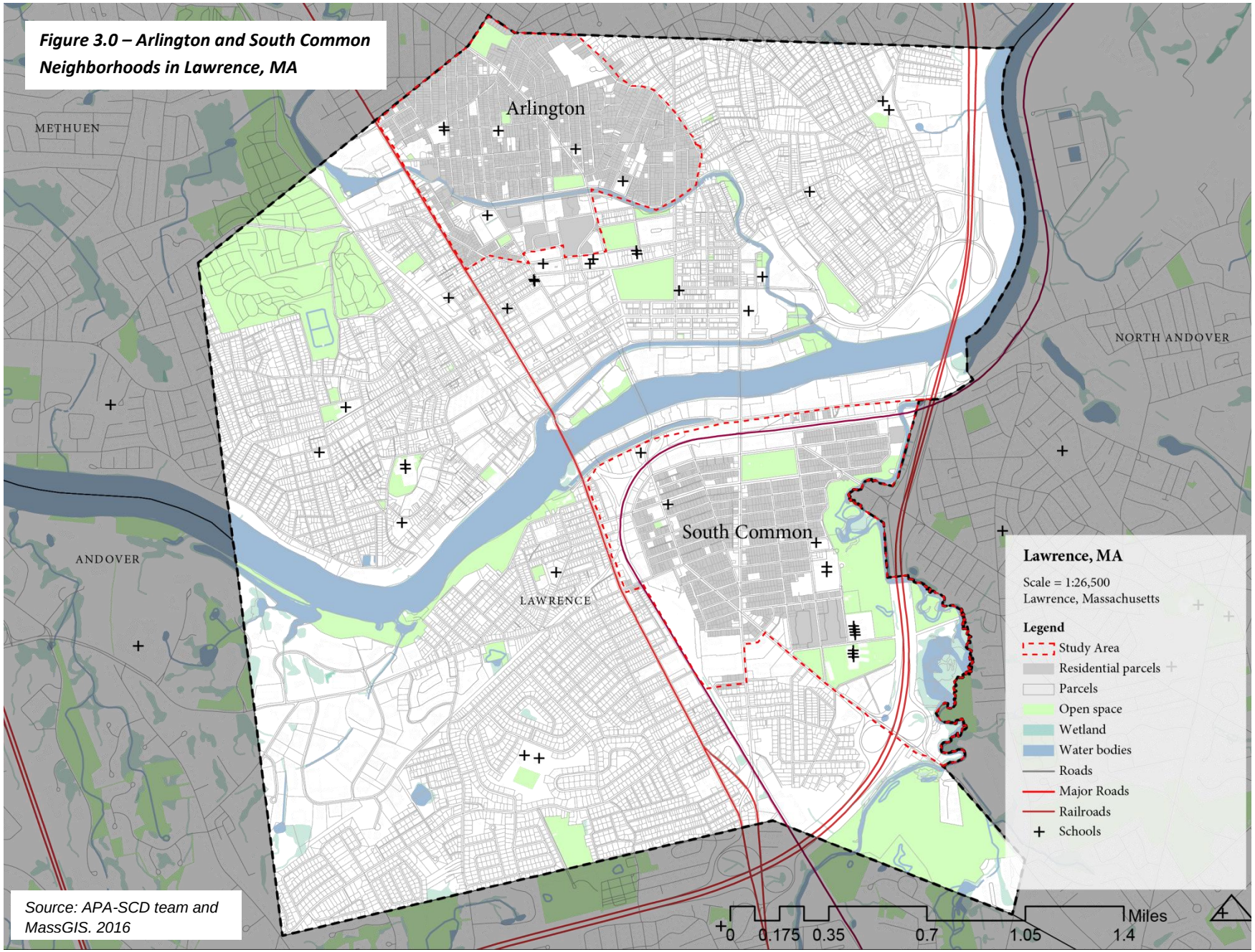


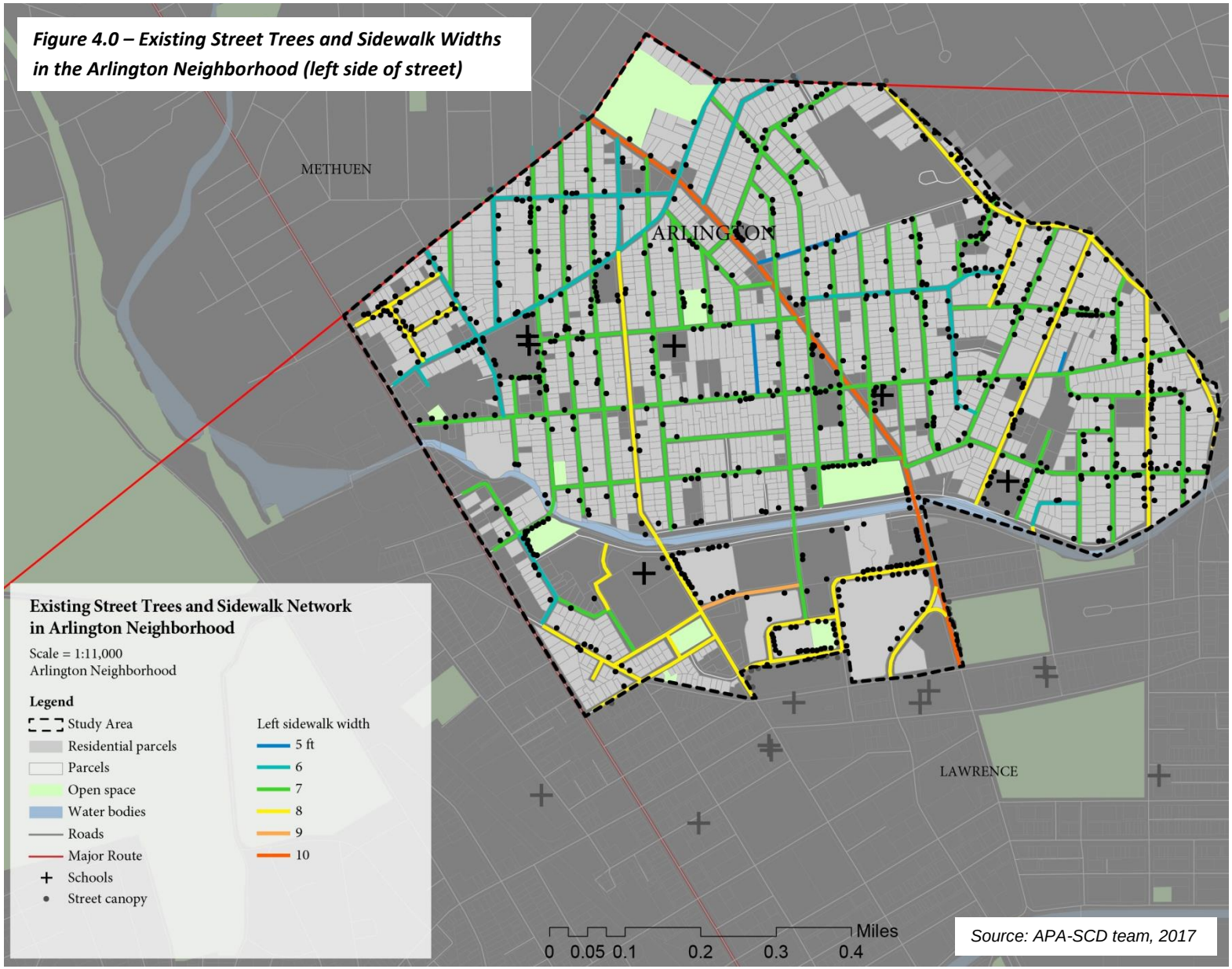
Figure 3.0 – Arlington and South Common Neighborhoods in Lawrence, MA

Source: APA-SCD team and MassGIS. 2016

Arlington:

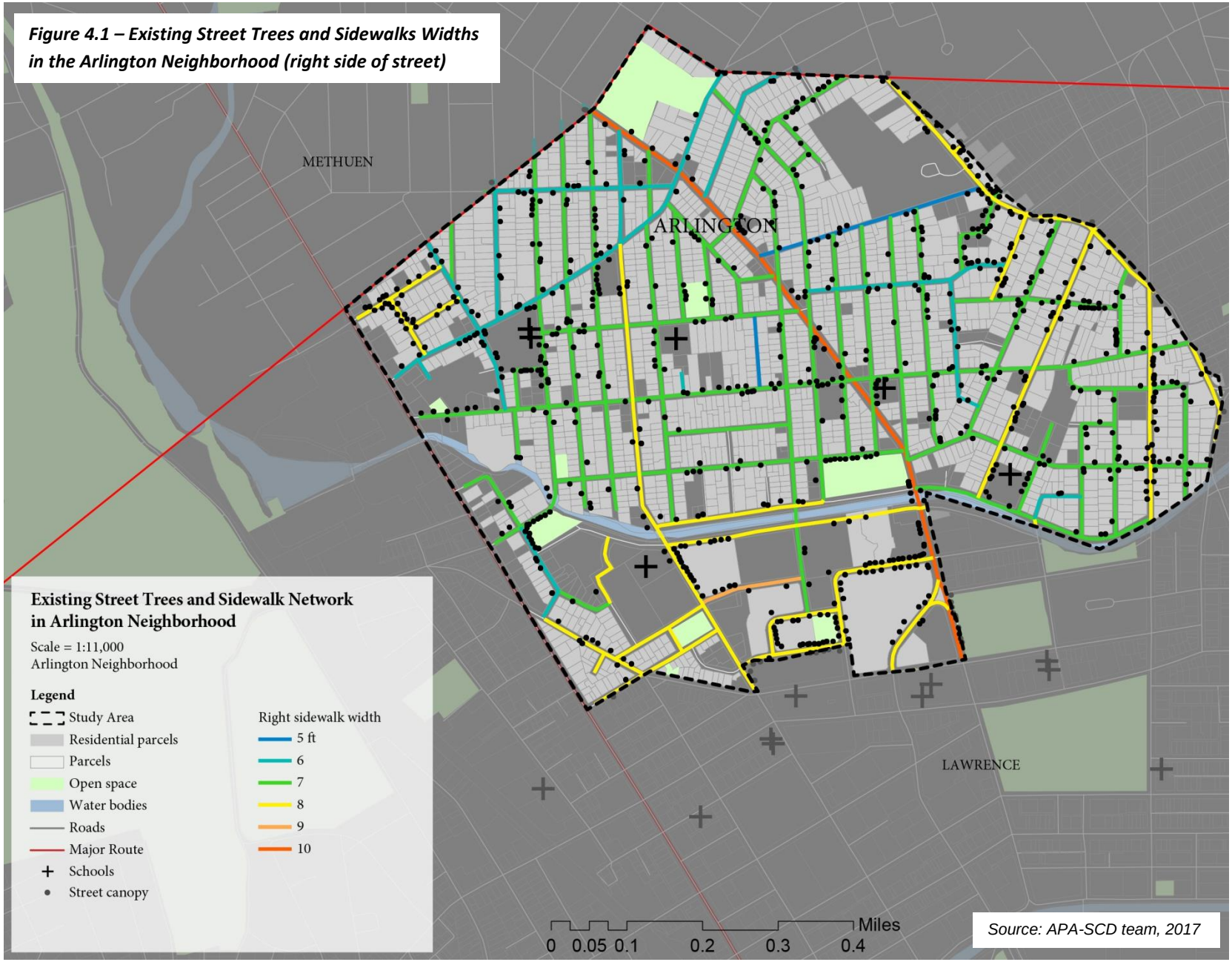
The Arlington neighborhood is approximately 0.9 square miles and is bounded by East Street to the north and Haverhill Street to the south. Arlington contains approximately 21,000 residents (almost evenly split males vs. females), approximately 89% of which are classified as a racial minority. A large portion of the dwelling units in the Arlington neighborhood are rental units (~76%). Just under 24% of the dwelling units are owner-occupied. Like the rest of Lawrence, Arlington residents are exposed to higher than normal levels of ozone and particulate matter which contribute to poor air quality. There are approximately 950 street trees in the Arlington neighborhood.

Figure 4.0 – Existing Street Trees and Sidewalk Widths in the Arlington Neighborhood (left side of street)



Additional demographics for the Arlington neighborhood can be found in Appendix A of this report.

Figure 4.1 – Existing Street Trees and Sidewalks Widths in the Arlington Neighborhood (right side of street)



South Common:

The South Common neighborhood is a little bigger and less dense than the Arlington neighborhood with approximately 1.2 square miles of land bounded by the Merrimack River to the north and I-495 to the southeast (see Figure 5.0). South Common contains approximately 10,300 residents (with ~1,000 more females than males), approximately 84% of which are classified as a racial minority. A large portion of the dwelling units in South Common neighborhood are rental units (~73%). Just over 27% of the dwelling units in South Common are owner-occupied (slightly more than the Arlington neighborhood). The South Common residents are exposed to higher than normal levels of ozone and particulate matter due to South Common's close proximity to I-495. There are approximately 900 street trees in the South Common neighborhood, which helps offset some of these emissions, but additional coverage could help further mitigate this exposure. Additional demographics for the South Common neighborhood can be found in Appendix A of this report.

Figure 5.0 – Existing Street Trees and Sidewalk Widths in the South Common Neighborhood (left side of street)

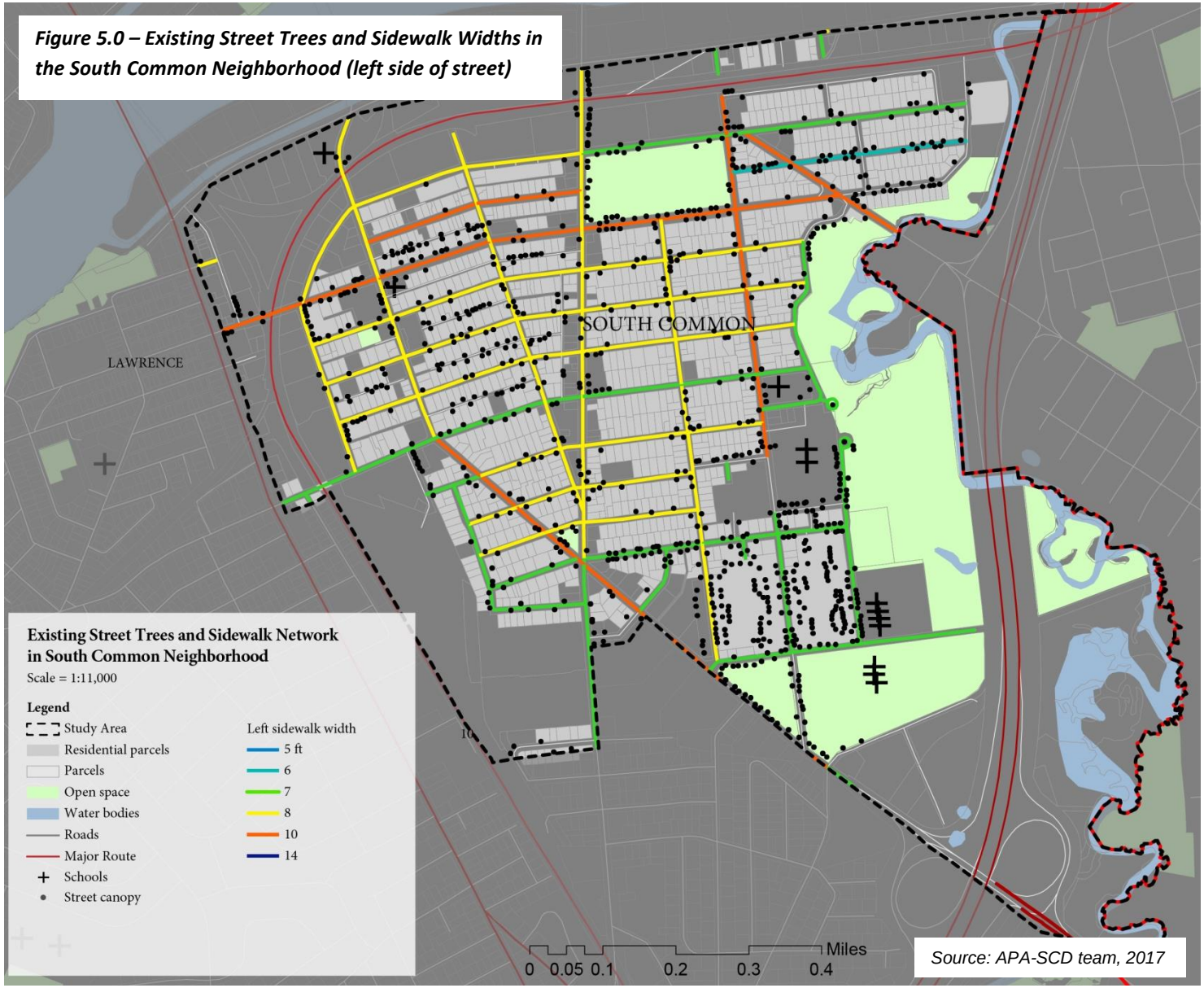
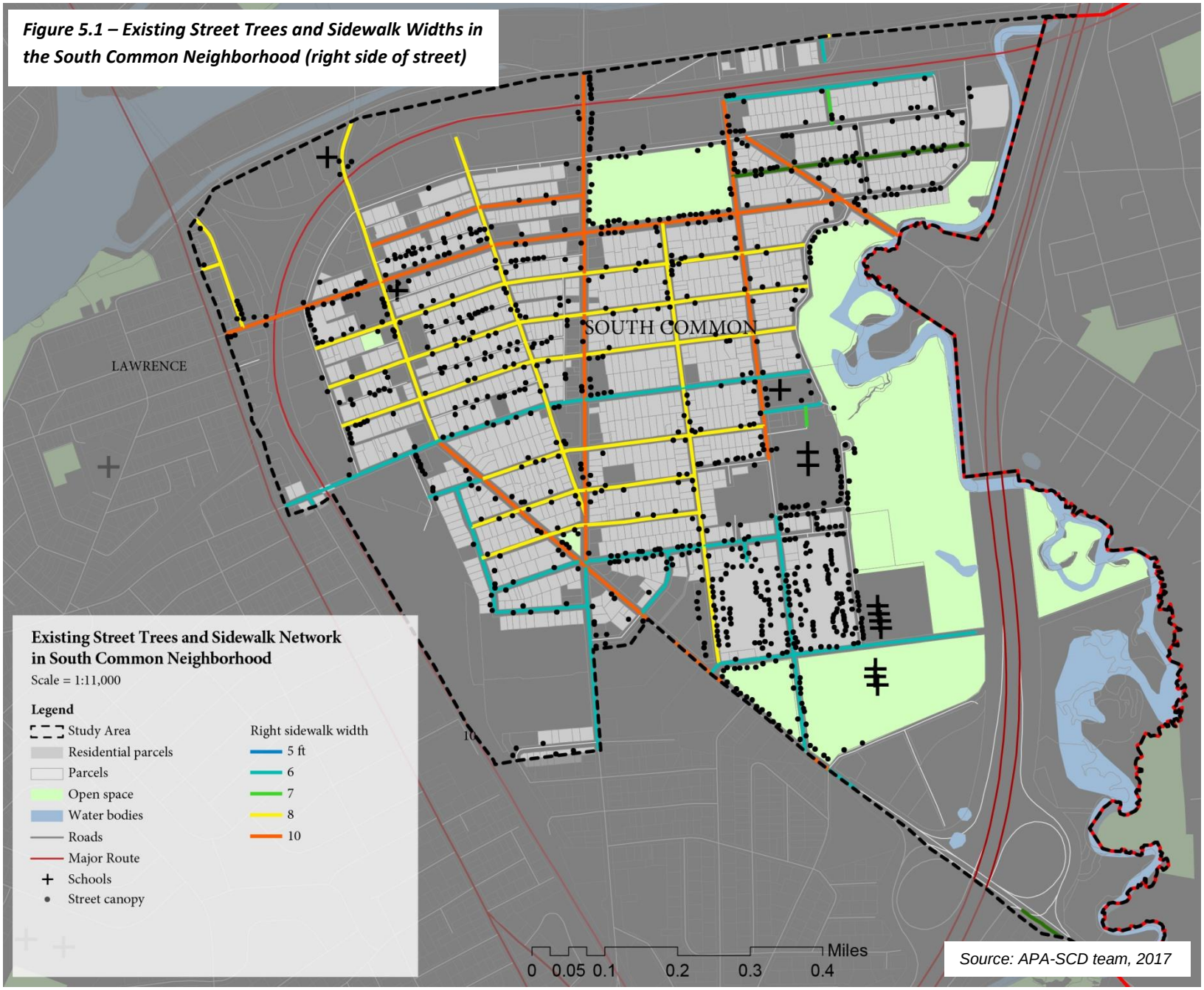


Figure 5.1 – Existing Street Trees and Sidewalk Widths in the South Common Neighborhood (right side of street)



Source: APA-SCD team, 2017

In comparison to the Arlington neighborhood, South Common has more street trees, accessible open space and a more open and connected network of sidewalks. Table 2.0 presents a side-by-side comparison of existing conditions in each neighborhood in comparison with Lawrence as a whole.

Table 2.0 – Existing Statistics for Lawrence and Green Streets Neighborhoods

Existing Conditions	Lawrence	Arlington	South Common
Population	77,364	16,442	11,644
Population Density (per sq. mile)	15782	25,140	7,723
Minority Population	63,666	14,680	9,320
Percentage Minority	82%	89%	80%
Number of Households	27,890	5,299	3,788
Housing Units Built Before 1950	16,292	5,274	2,405
Per Capita Income	16,812	14,223	18,911
Land Area (sq. miles)	7	0.64	1.53
Environmental Conditions			
Street tree count	26% (2010)	+/- 950	+/-900
EJ Index for Traffic data (state percentile)	89	89	93
EJ Index for PM2.5 (state percentile)	92	96	95
EJ Index for Ozone (state percentile)	92	95	95
EJ Index for NATA Diesel PM (state percentile)	91	94	95
EJ Index for NATA Air Toxics Cancer Risk (state percentile)	92	95	94

Source: American Community Census: https://www.census.gov/programs-surveys/acs/ 2010-2014 and GIS analysis by APA-SCD team, 2016.

The state percentile values in Table 2.0 were calculated by the EPA based on block group data. These percentiles provide perspective on how the Arlington and South Common neighborhoods compare to Lawrence, and the nation as a whole. For example, ozone levels in Lawrence are at the 93rd percentile nationwide, this means that only 7% of the US population is exposed to higher levels of ozone than the average person in Lawrence. See Appendix A for additional details.

The APA-SCD consulted with public health professionals in the assessment phase. Using both qualitative and quantitative methods, this information was analyzed and used to help understand the existing social, economic and environmental conditions in these neighborhoods and establish a baseline for the Green Streets Program HIA.

5.2 Existing Health Risk Factors in Lawrence

Understanding the existing health risk *factors* affecting a community is important to gain insight into the existing *conditions* in a community. In addition to information provided from GWL, the APA-SCD team used several resources to identify the existing health risk factors in Lawrence. Those sources included: Our Healthy Mass www.ourhealthymass.org (OHM); Community Health Needs Assessment http://www.communitycommons.org/chna/ (CHNA); and the 2016 Community Benefits Report by Holy Family Hospital in Methuen https://holyfamily-hospital.org/sites/default/files/Holy%20Family%20Hospital%20-%20FY%202016%20Community%20Benefits%20PlanFINAL.pdf (HFH), adjacent to Lawrence; and Massachusetts Community Health Information Profile http://www.mass.gov/eohhs/researcher/community-health/masschip/health-status-indicators.html (CHIP). Additional health data sources are also referenced in the footnotes. The existing risk factors in Lawrence identified in these reports include:

1. *Hospitalization and death rates:* Between 2008-2010, there were approximately 1,285 deaths in Lawrence (658.2 per 100,000 population. (622.3 - 694.2). These are important indicators of the overall physical health of a community. These indicators come from the Hospitalization Discharge and State Mortality datasets. Hospitalizations of any kind are costly events on many levels. Reducing the number of hospitalizations as a result of chronic disease will help bring down the costs of medical care. (Source: CHIP)
2. *Air Quality and Cardiovascular disease*: According to the HFH Report, Lawrence had the highest hospitalizations of asthma attacks in 2012 and 2013, compared to the surrounding communities serviced by HFH. Chronic obstructive pulmonary disease (COPD) is another respiratory health concern in the region. (Source: CHNA). CHIP reports that there were 137 cardiovascular disease deaths in 2010. Studies have cited housing quality as a major contributor to the prevalence of asthma in the region, however research also suggests that proximity to high vehicle traffic corridors such as I-495, coupled with the lack of vegetation in neighborhoods can contribute to reduced air quality and higher rates of cardiovascular disease.
3. *Obesity:* In 2013, the HFH reported that 68.8% of adults in Lawrence were overweight and 31.3% were classed as obese compared to 27.7% in the United States. Obesity rates in children were also high (44.6% overweight or obese). A study by the United Health Foundation estimates that by 2018, assuming the current trends continue, the medical costs related to obesity will be about $344 billion. This would account for 21% of the nation's direct health care spending[4]. Statistics from Weight of the Nation in 2012 indicate that over one-third of adults and 12.5 million children (ages 2 to 19 years) are obese. Those who are most at risk for obesity and related diseases are minority groups, individuals with a low income, and individuals with a low education level. Obesity is significant risk factor that can contribute to chronic disease such as diabetes. Lawrence has a higher proportion of adults diagnosed with diabetes (10.6%) than the state (7.5%)[5].
4. *Access to open space:* Proximity to active and passive recreational open spaces can influence opportunities for physical activity and provide avenues to increase access to healthy food. This is also a significant risk factor that can contribute to chronic disease such as

[4] Source: http://www.unitedhealthfoundation.org/
[5] Source: http://theweightofthenation.hbo.com/films/main-films/Consequences

obesity and diabetes.[6] Figure 4 shows that most of the homes within the South Common neighborhood are within a ¼ mile walk of a park or green space. Figure 5 shows that there are some isolated areas where residents are more than a ¼ mile from any parks/green space.

5. *Access to healthy foods:* Healthy eating and access to healthy foods are significant risk factors that can also contribute to chronic disease such as obesity and diabetes. There are a total of 10 supermarkets in Lawrence. GWL hosts a Farmers Market in North Common and Sullivan Park every Wednesday and Saturday through October.[7]
6. *Cancer rates*: In 2010, there were 79 deaths related to cancer (Source: CHIP). According to HFH, breast, prostate, colorectal, lung, and oral cancers were most prevalent in Lawrence.
7. *Mental health*: This topic emerged as a major health concern among residents and key informants in the region. A survey conducted as part of the HFH study found that mental health, including depression and distress/anxiety and hypertension, was one of the top 5 health concerns from community residents. The co-existence of mental health issues and chronic health conditions is an issue that compounds the impact on public health (source: CHNA). In 2009, Lawrence had the highest rate of mental disorder-related ED visits (5,425.2 per 100,000 population).
8. *Crime and violence*: The CHNA cited crime in the region as a major concern and stressor for residents and an issue that contributes to negative perceptions of communities in the region. The prevalence of drug use in the region, which could be seen in public spaces was also a concern. Rates of violent crime (994.2 per 100,000 population) and property crime (3,228.7 per 100,000 population) in the region are highest in Lawrence. This is well above statewide rates which are 428.4 per 100,000 population violent crime and 2,258.7 per 100,000 population for property crime.
9. *Substance Abuse:* There were 1,214 admissions into DPH-funded alcohol and other drug-related treatment programs in 2013 (source: CHIP).
10. *Safety:* In 2010 there were 15 deaths in Lawrence as a result of motor vehicle-related injuries, suicides and homicides (source: CHNA).
11. *Social Vulnerability:* Refers to the human factors within a community that negatively affect its ability to manage circumstances harmful to health. The social vulnerability index compares and ranks every community in the US at the census tract level, on many social factors. These factors, including poverty, lack of car access and crowded housing are further grouped into four related themes. Each community receives a separate ranking for each of the four, as well as an overall ranking. Lawrence, including the Arlington and South Common neighborhoods are ranked in the highest vulnerability (top 4th).[8]

As part of the assessment phase of this HIA, the APA-SCD team conducted a thorough literature review to assess the strength of evidence on the economic, social and environmental benefits of street trees and vegetation in urbanized areas. There was a wealth of information on many of the more traditional benefits of street trees (air quality, stormwater, urban heat island, energy savings), but many of the social

[6] Source: http://www.pewtrusts.org/~/media/assets/2013/03/01/hiaofparktrailandgreenspaceplanningingreenvillesc.pdf
[7] Source: http://www.groundworklawrence.org/farmersmarket
[8] Source: Agency for Toxic Substances & Disease Registry, 2016 https://svi.cdc.gov/

benefits (mental health, well-being, crime) were more difficult to find. The APA-SCD Team's research identified four priority impact areas – those areas that have the greatest impact on the overall health of the community, given the existing conditions in Lawrence and the two neighborhoods of Arlington and South Common. Based on information collected from GWL, demographics, the community health assessments, and scientific literature review, the four priority impact areas are:

1. *Environmental:* Air quality, water quality and urban heat island impacts are prevalent in Lawrence and the neighborhoods of Arlington and South Common. Street trees and other types of green infrastructure provide a number of ecosystem services in an urban environment such as wildlife habitat, stormwater management, air filtration, regulation of micro-climate and carbon sequestration. All these factors also provide opportunities for climate change mitigation and adaptation.
2. *Physical and Mental Health*: the population of Lawrence has a higher than average percentage of residents who suffer from obesity, diabetes, asthma and other respiratory diseases, in addition to mental health illnesses such as depression and anxiety. Street trees and greenery in urban environments have proven to have rehabilitating impacts on the physical and mental health of the population.
3. *Social Cohesion*: While there is a great deal of community support through organizations such as GWL, research has demonstrated that there is a correlation between the number of street trees and the amount of community interaction as more aesthetically pleasing and inviting streetscapes help promote more opportunities for positive and beneficial interactions between community residents, businesses and organizations. Street trees also create a sense of enclosure which helps slow down traffic speeds, which can lead to improved safety and security in neighborhoods.
4. *Housing/Energy:* Trees in an urban environment, including street trees have been proven to contribute to a reduction in energy demand in adjacent buildings by providing shading in the summer to reduce cooling demand and shedding their leaves and allowing sunlight in the winter to reduce heating demand. Tree canopies can also lower wind speeds and reduce overall summertime air temperatures (reduced urban heat island), which can also impact energy demand in nearby housing.

5.3 Summary of Research/Literature Review for Each Priority Impact

The APA-SCD team conducted in-depth research and developed a summary table to classify and rank the strength of evidence and correlation - how specific/relevant the research was to the priority impact area topics and the GWL Green Streets Tree Planting Program specifically. This assisted the APA-SCD team in identifying key elements within each of the priority impact areas which in turn helped inform the findings and recommendations in this HIA. These rankings also helped the APA-SCD team in developing messaging deliverables to GWL (communicating the benefits of planting streets trees to the residents in the Arlington and South Common Neighborhoods). The complete table is included in Appendix B.

The in-depth literature review and research uncovered a great deal of information supporting the environmental, social and economic benefits of street trees. The following is a summary of the street tree research that was found by the APA-SCD team to have a direct correlation to the priority impact topic areas and the neighborhood feedback from the community events:

1. *Environmental:* Trees in an urban environment can have a significant impact on air quality and provide an abundance of ecological services. A study by the University of Washington estimated the total annual removal of ozone, particulate matter, NO_2, SO_2, and carbon monoxide by urban trees across 55 U.S. cities was 711,000 metric tons, representing $3.8 billion in public value.[9] A 2009 analysis found that an urban street with street trees has a 60% reduction in street level particulate matter compared to an urban street with little or no street trees.[10] A single mature tree can store 50 to 100 gallons of water during large storms.[11] Street trees can reduce up to 30% of runoff from a typical rainfall event through absorption and evaporation. Tree root systems can absorb up to another 30%, resulting in reduced stormwater runoff and potential flooding.

   Trees and vegetation also help to lower surface and air temperatures through shading and evapotranspiration. Evapotranspiration is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants. Shaded surfaces can be 20–45°F cooler than unshaded surfaces. Evapotranspiration can add to the cooling effect in the summer by reducing peak temperatures by as much as 2–9°F. This also helps extend the life of road and sidewalk surfaces by reducing the amount of expansion and contraction from extreme temperature variations.

   Tree vegetation also has health and well-being benefits for people. A person standing in direct sunlight takes 20 minutes to burn. However, under a tree providing 50% coverage it takes 50 minutes to burn, and under full shade it takes 100 minutes.[12] Tree canopies can also have noise buffering effects. The USDA estimates that trees, combined with shrubs, can reduce up to 50% of noise to the human ear.[13]

   Street tree canopies not only provide shade, they also act as a natural wind block, lowering wind speeds and reducing summertime air temperature. This can help reduce energy demand in nearby buildings which indirectly contributes to improved air quality. The leaves, branches and trunks of street trees provide a canopy, root structure and setting for important insect and bacterial life below the surface. Above the surface, they provide biomass, nutrients and habitat for birds and other wildlife.

---

[9] http://depts.washington.edu/hhwb/Thm_Risk.html

[10] Towards a Better Tomorrow: Street Trees and Their Values in Urban Areas, Kadir and Othman. 2012

[11] Fazio, Dr. James R. "How Trees Can Retain Stormwater Runoff." Tree City USA Bulletin 55. Arbor Day Foundation (from Alliance for Community Trees, Benefits of Trees and Urban Forests.)

[12] Purdue University. "Trees Could Affect Land Use, Reduce Skin Cancer." San Diego Earth Times. Mar. 2003. (from Alliance for Community Trees, Benefits of Trees and Urban Forests.)

[13] USDA National Agroforestry Center. "Is Agroforestry a Solution to the Southeast's Poultry Waste Overload?" Inside Agroforestry 1998.
Web: http://www.unl.edu/nac/ia/spring98/spring98.txt

Lower surface air temperatures help to reduce ground level ozone levels which can reduce respiratory illnesses such as asthma and COPD. Street trees have been found to absorb up to nine times more pollutants than more distant trees, converting those harmful gasses back into oxygen and other useful gasses. Studies have found that children living in areas with more street trees tend to have a lower prevalence of early childhood asthma. Higher street tree densities have also been associated with a higher prevalence of allergies to tree pollen which can have negative health effects on people. Decreases in urban forest canopy have been associated with an increase in mortality related to cardiovascular and lower respiratory tract illness.[14] A recent study reviewed by the Washington Post discusses how planting trees in cities can save thousands of lives and that it is a cost-competitive way to address some of the world's temperature and pollution problems and improve the lives of inhabitants in the process.[15] All of these environmental benefits of street trees combined can play a significant role in helping neighborhoods and cities adapt to the varying weather patterns associated with climate change.

2. *Physical and Mental Health:* Mental stress can lead to unhealthy habits, obesity, immune system suppression and cardiovascular disease, cancer, stroke, depression, asthma, and other severe health problems. Street trees and increased tree canopy in neighborhoods can significantly reduce stress levels and aid in recovery from illness.[16] In laboratory research, visual exposure to settings with trees produced significant recovery from stress within five minutes, as indicated by changes in blood pressure and muscle tension.[17] Visual access to street trees and green space have also proven to help combat ADD and ADHD symptoms and improve concentration and productivity. This natural calming effect of street trees can also help reduce stress levels of drivers and help contribute fewer instances of "road rage", further improving the safety of streets and neighborhoods.[18]

3. *Social Cohesion:* Street trees can enhance the aesthetic character of a neighborhood and contribute to a more welcoming and inviting streetscape. Trees provide a general softening of the urban environment and also provide a screen for utility poles, light poles, on-street and off-street parking and other features that create visual pollution. The aesthetics of tree-lined streets and green spaces have been shown to have positive psychological benefits including lower rates of stress, blood pressure and mental illness.

   Street trees provide a number of safety enhancements, including the reduction of solar glare, defining of road edges and more of a sense of enclosure which helps guide motorists and allows them to better assess their speed. Studies have shown that tree-lined streets have

[14] Lovasi, G.S., et al. Urban Tree Canopy and Asthma, Wheeze, Rhinitis, and Allergic Sensitization to Tree Pollen in a New York City Birth Cohort. Environ Health Perspect. 2013; 121(4): 494–500. doi: 10.1289/ehp.1205513

[15] https://www.washingtonpost.com/news/energy-environment/wp/2016/11/02/how-planting-trees-in-cities-can-save-thousands-of-lives/?utm_term=.5f8463147026

[16] Hutchinson, Alex, How Trees Calm us Down http://www.newyorker.com/tech/elements/what-is-a-tree-worth, 2015

[17] A Dose-Response Curve Describing the Relationship Between Urban Tree Cover Density and Self-Reported Stress Recovery. Environment & Behavior Journal, 2014 - https://www.dropbox.com/s/8vycat9f5la2tiz/JiangLiLarsenSullivan2015.pdf?dl=0

[18] The Triple-Bottom Line Benefits of Street Trees. Devens Enterprise Commission, 2013

contributed to safer conditions for drivers and pedestrians as the sense of enclosure that street trees provide results in motorists using greater caution and can reduce vehicle speeds by as much as 15 mph which can also result in fewer accidents. Slower vehicle speeds can also contribute to noise reduction (slower vehicle speeds reducing engine and tire noise). The leafy vegetation of street tree canopies can also absorb a great deal of noise. Spaces with trees have been shown to attract larger groups of people—as well as more mixed groups of youth and adults. Tree planting and maintenance responsibilities for trees (watering, raking leaves, pruning, etc.) also offer opportunities for increased social interaction among residents.

Research is also uncovering a direct relationship between the amount of trees in a neighborhood and the level of social interaction among residents. In buildings with trees close by, surveys have indicated that people report significantly better relations and a stronger feeling of unity and cohesion with their neighbors, more so than residents who have few or no trees around them.[19] Although not directly related to just street trees specifically, additional studies have found that dense areas with high levels of greenery tend to have lower crime rates. Street trees fronting a house had a measurable impact on reduced crime rates, most likely due to the increased levels of social interaction among residents.[20] All of these impacts help to provide increased opportunities for more positive and beneficial interactions between community residents, businesses and organizations.

4. *Housing/Energy:* Trees in an urban environment, including street trees have been proven to contribute to a reduction in energy demand in buildings. The USDA Forest Service estimates that trees properly placed around buildings can reduce air conditioning needs by 30% and can save 20–50% in energy used for heating. The shading of an air conditioning unit can increase its efficiency by 10%. Healthy, mature street trees can also add more than $7,000 to a property's value.[21] The biomass produced by trees (leaf litter, broken branches, etc.) is often seen as a nuisance to many residents as well as city and town public works departments. This biomass provides a potential feedstock for local renewable energy facilities such as anaerobic digestion systems. The biomass can also provide a valuable source for local residents who compost – adding to the improved fertility of soils in urban areas. Tree canopies lower wind speeds and reduce summertime air temperatures. These impacts can help reduce premature aging of building materials by minimizing their constant stressing from expansion and contraction due to natural heating and cooling. The greatest energy reduction benefits from street trees to an individual home are realized when tree canopies are established over a neighborhood area. While it can take up to 8 years before homes begin to see energy reduction benefits from street trees due to growth and proximity to dwelling, studies have shown that for every 1% increase in tree canopy above 10%, the energy benefit is 1.9% reduction in energy for cooling and 1.1% reduction in energy for

[19] Sullivan, W.C. and K.E. Kuo. "Do trees strengthen urban communities, reduce domestic violence?" Forestry Report R8-FR 56 USDA Forest Service/Southern Region. (1996). http://www.paluc.org/pdfs/sprawl/health/sprawl_do_trees.pdf

[20] Alliance for Community Trees; The Benefits of Trees and Urban Forests, 2001 http://dunwoodyga.gov/ckeditorfiles/files/Master_Plans/Tree%20Inventory%20and%20Assessment/TI%26A%20-%20Benefits%20of%20Trees.pdf

[21] Donovan, Geoffrey H., and David T. Butry. "Trees in the City: Valuing Street Trees in Portland, Oregon." Landscape and Urban Planning 94 (2010): 77-83. http://www.fs.fed.us/pnw/pubs/journals/pnw_2010_donovan001.pdf

heating.[22] These benefits can result in up to $280 in savings per household in the initial 15 years after planting in neighborhoods of two and three-family homes, which can be found in both the Arlington and South Common neighborhoods. While this may seem insignificant over 15 years, the cumulative impact and subsequent reduction in energy usage, decreased air temperatures and natural filtration are significant.

5.4 Estimated Impacts of GWL Green Streets Tree Planting Program

There are a number of online tools and resources available to assess the environmental benefits of trees in urban areas. One example is i-Tree – a free tool developed by the US Department of Agriculture. I-Tree provides urban and rural forestry analysis and benefits assessment tools that can help communities quantify the structure of trees and forests, and the environmental services that trees provide.[23] Table 3.0 shows the estimated impacts of existing urban trees in Lawrence in 2016 according to i-Tree.

Table 3.0 – Estimated Impacts of Existing Urban Trees in Lawrence* (2016)

Benefit	Removal Rate (lbs/acre/yr)	Value ($/tree/year)
Carbon Monoxide (CO)	0.701	1333.5
Nitrogen Dioxide (NO^2)	7.959	307.18
Ozone (O^3)	49.872	2536.98
Particulate Matter 10 (PM^{10})	8.7	6268.44
Particulate Matter 2.5 ($PM^{2.5}$)	2.506	118976.78
Sulfur Dioxide (SO^2)	3.591	107.82
Carbon Dioxide Sequestered (CO^2seq)	8,303.6	36.29
Carbon Dioxide stored in trees (CO^2stor - not annual)	251,395.4	36.29
Average Annual Stormwater**	1,100 gal/tree	12.00***

* *Source: i-Tree, USDA Forest Service, 2016*

** *Stormwater = 8925 gal/tree/yr. Existing stormwater that falls in Lawrence every year is 6043817984 gallons*

*** *Assumes a stormwater impact fee of $3000/acre and 250 trees/acre.*

According to research conducted by the MA EOEEA, the expected canopy growth of large deciduous trees is 4 inches per year in an urban environment. A 30-year old deciduous tree would have an expected canopy of 500-550 square feet. Because of the slow growth of trees, the full benefits will not be recognized immediately after planting.

[22] Mass Save Proposal: Massachusetts Energy Efficiency New Technology Assessment Residential Technologies, prepared by Massachusetts Executive Office of Energy and Environmental Affairs, October 2014

[23] http://www.itreetools.org/

5.5 GWL Proposed Street Tree Plantings and Their Impacts

GWL provided the APA-SCD team with a list of trees and other vegetation that they are proposing to plant as part of their overall goal of 2,400 trees in 3 years. Because each tree species can provide different environmental benefits, depending on the tree species and its planting location and situation and growth rate, the APA-SCD team reviewed each tree species proposed and provided additional details as part of the research phase. While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). The data in Table 4.0 provides additional insight into which trees might be preferable over others to address not only energy efficiency, but also specific environmental and health related issues. For example, if a neighborhood has more concerns about future flooding, they may want to consider planting more Kentucky Coffeetrees, Japanese Zelkovas and Hackberry as they tend to absorb higher amounts of runoff than other species. These tree species could also have greater impact on energy efficiency due to their canopy sizes and growth rates. Similarly, a neighborhood more concerned about asthma rates and air quality may want to look at planting more Honeylocust due to its tendency to absorb higher amounts of greenhouse gasses and particulate matter – major contributors to smog and poor air quality that can negatively affect people with respiratory illnesses.

Each tree species was evaluated at three lifecycle stages: at initial planting (short-term), at 6-inch caliper (mid-term – roughly 15 years), and at 12-inch caliper (long-term – roughly 30 years). The results presented in Table 4 are estimates using the National Tree Benefit Calculator tool (*http://treebenefits.com)*. The estimated number of years for each tree to reach the caliper size indicated is based on an average annual growth rate of 0.39 caliper inches for all species.[24] The actual growth rate will vary significantly depending on the species, location and situation. The "overall benefits" column includes a general accounting of the economic and environmental benefits produced by urban street-side plantings, including impacts on property values. These figures do not factor in long-term care and maintenance but the social, economic and environmental benefits far outweigh the care and maintenance costs. This information can assist GWL and the residents with selecting trees that are most appropriate for their neighborhood, given the location and situation as well as the existing health conditions in Lawrence. Providing this additional detail can aid in greater community acceptance of street tree plantings and help ensure the long-term success of this planting program. The full list of plantings proposed, along with additional recommendations for planting are included in Table 5.0.

[24] *https://www.fs.fed.us/ne/newtown_square/publications/research_papers/pdfs/scanned/OCR/ne_rp637.pdf*

Table 4.0 – Proposed Street Tree Plantings and Estimated Benefits Per Tree

Street Tree Species	**Estimated Benefits Per Tree**											
	2" caliper (at planting)/ 6" caliper (mid-term ~15yrs.)/ 12" caliper (long-term ~30yrs.)											
	Stormwater (gal)			***Energy (kWh)***			***CO^2 Reduction (lbs.)***			***Ozone Reduction ($)***		
	2"	***6"***	***12"***	***2"***	***6"***	***12"***	***2"***	***6"***	***12"***	***2"***	***6"***	***12"***
Hackberry	107	549	1480	19	54	106	68	218	469	0.11	0.75	2.00
Yellowwood	87	571	1353	4	24	72	25	128	329	0.08	0.58	1.50
Ginkgo (fruitless)	34	245	786	3	19	61	13	88	273	0.05	0.43	1.30
Honeylocust	86	589	1546	6	39	105	32	189	470	0.14	0.92	2.30
Kentucky Coffeetree	107	549	1480	19	54	106	68	218	469	0.10	0.75	2.00
Sweetgum	45	323	1028	3	21	72	13	89	287	0.05	0.45	1.40
Tupelo	87	571	1353	4	24	72	25	128	329	0.08	0.58	1.50
Sourwood (small deciduous)	74	271	579	6	20	43	28	120	305	0.14	0.50	0.95
Sargent Cherry	74	271	579	6	20	43	28	120	305	0.14	0.50	0.95
Higan Cherry	74	271	579	6	20	43	28	120	305	0.14	0.50	0.95
Pagoda (medium deciduous)	87	571	1353	4	24	72	25	128	329	0.08	0.58	1.50
Japanese Tree Lilac	74	271	579	6	20	43	28	120	305	0.14	0.50	0.95
Littleleaf Linden	51	353	937	2	19	63	20	124	327	0.05	0.41	1.30
Japanese Zelkova	107	549	1480	19	54	106	68	218	469	0.11	0.75	2.00

Source: Data compiled from the National Tree Benefit Calculator http://treebenefits.com (based on multi-family residential as the closest use)

Table 4.0 – Proposed Street Tree Plantings and Estimated Benefits Per Tree continued…

Street Tree Species	Estimated Benefits Per Tree											
	2" caliper (at planting)/ 6" caliper (mid-term ~15yrs.)/ 12" caliper (long-term ~30yrs.)											
	Nitrogen Dioxide ($)			*Sulfur Dioxide ($)*			*Particulate Matter[10]($)*			*Overall Benefits ($)*		
	2"	*6"*	*12"*	*2"*	*6"*	*12"*	*2"*	*6"*	*12"*	*2"*	*6"*	*12"*
Hackberry	0.95	2.60	4.80	0.30	0.80	1.60	0.18	0.90	2.10	54	101	162
Yellowwood	0.19	1.35	3.40	0.06	0.43	1.25	0.09	0.61	1.70	41	63	104
Ginkgo (fruitless)	0.13	0.97	2.80	0.05	0.32	1.00	0.06	0.47	1.30	8	32	80
Honeylocust	0.32	2.01	4.90	0.11	0.69	1.70	0.15	0.88	2.40	39	81	147
Kentucky Coffeetree	0.95	2.60	4.80	0.30	0.80	1.60	0.18	0.90	2.10	54	101	162
Sweetgum	0.12	0.95	3.30	0.04	0.36	1.20	0.05	0.47	1.50	15	44	100
Tupelo	0.19	1.35	3.40	0.06	0.43	1.25	0.09	0.61	1.70	41	63	104
Sourwood (small deciduous)	0.31	1.12	2.15	0.09	0.36	0.60	0.14	0.54	1.10	13	30	54
Sargent Cherry	0.31	1.12	2.15	0.09	0.36	0.60	0.14	0.54	1.10	13	30	54
Higan Cherry	0.31	1.12	2.15	0.09	0.36	0.60	0.14	0.54	1.10	13	30	54
Pagoda (medium deciduous)	0.19	1.35	3.40	0.06	0.43	1.25	0.09	0.61	1.70	41	63	104
Japanese Tree Lilac	0.31	1.12	2.15	0.09	0.36	0.60	0.14	0.54	1.10	13	30	54
Littleleaf Linden	0.11	0.94	2.90	0.04	0.33	1.10	0.05	0.44	1.35	31	49	84
Japanese Zelkova	0.95	2.60	4.80	0.30	0.80	1.60	0.18	0.90	2.10	54	101	162

Source: Data compiled from the National Tree Benefit Calculator http://treebenefits.com (based on multi-family residential as the closest use).

5.6 Site Visits and Community Engagement

In order to better understand the existing conditions in the Arlington and South Common neighborhood and establish a baseline, the APA-SCD team met with GWL, conducted site visits in each of the neighborhoods, and took photos to document the existing conditions and streetscapes that were representative of the community. The APA-SCD and GWL also conducted public outreach on street trees by participating in two community events – one held in each of the targeted neighborhoods in Lawrence – South Common and Arlington. During these neighborhood events, GWL introduced members of the APA-SCD Team who spoke about this HIA project and GWL's street tree program and briefly reviewed the multiple benefits of street trees in neighborhoods and how they can contribute to tackling many of these same health concerns. Attendees were provided a copy of "The Benefits of Street Trees in Lawrence" handout produced by the APA-SCD Team which contained facts and figures to support many of these benefits (full copy of the handout is included in Appendix C). These events allowed the APA-SCD team to obtain first-hand information from local residents about the real and perceived health concerns in their neighborhood and to learn about how they feel about the existing conditions and street trees in

general. These events were used as both a data gathering session as well as an educational session – to promote some of the social, environmental and economic benefits of street trees.

Park Street looking west – Arlington neighborhood

Andover Street – South Common neighborhood

Feedback from the residents during these events in each neighborhood was obtained through a dot polling activity, flip-chart/sticky-note exercise, and a visual preference survey. The dot polling activity listed a number of health related issues that were prevalent in Lawrence based on the Community Health Needs Assessment.[25] Attendees were asked to select which health concern they felt was most important. The most prevalent health issues in these neighborhoods in Lawrence were asthma, obesity, cancer and mental health. Attendees recognized all of these health issues but the two that received the most dots were cancer and mental health, with asthma a close third. Attendees were also given the opportunity to provide an alternative health concern.

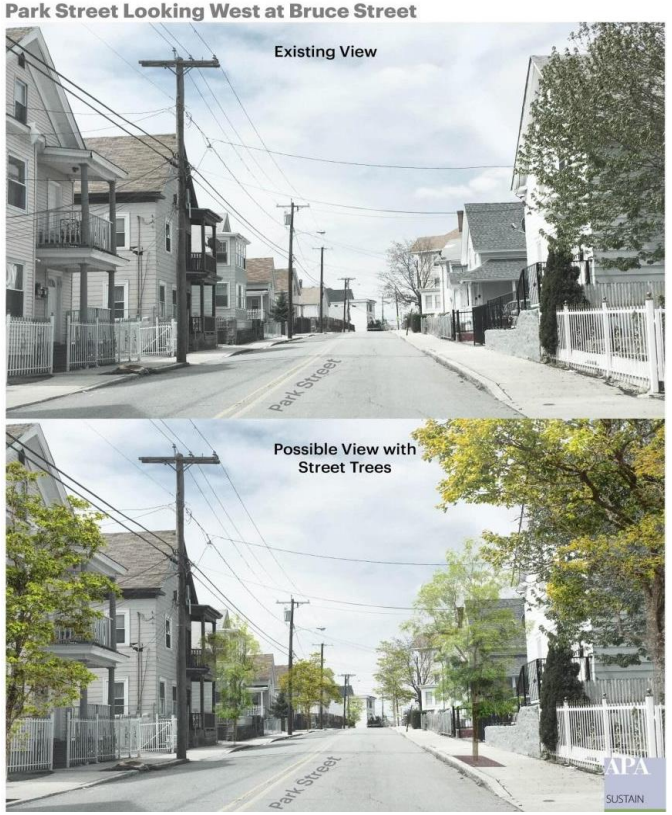
Dot-polling exercise at the Arlington neighborhood community event – Summer 2016

[25] Community Health Needs Assessment: http://www.communitycommons.org/chna/

Word Cloud from resident responses at the Arlington neighborhood community event – Summer 2016

The sticky note exercise used flip charts to display the statement "Street Trees Are….". Attendees wrote down what they felt street trees represented, symbolized or how they made them feel. The majority of responses were passive with key words like "relaxing", "beauty", "refreshing" and "better air quality". But other responses included active terms like "life", "walking" and "shade". Other key words that residents offered were "quality of life", "needed" and "habitat". From the responses the APA-SCD Team created a word cloud that displays all the responses and gives greater prominence to the responses that were given most frequently. From this exercise, the APA-SCD team uncovered a few neighborhood concerns regarding trees – pollen and leaf litter. With existing air quality issues in Lawrence, some residents were concerned about trees producing more pollen that could negatively impact people with allergies. In addition, some existing trees in neighborhoods produce pods and/or fruit, in addition to leaves, that are a nuisance during certain times of the year. Some residents also had concerns about trees blocking views and the roots damaging sidewalks and pavements.

Park Street Looking West at Bruce Street



The visual preference survey included photographs of an existing street in each of the neighborhoods that lacked a significant number of street trees. The APA-SCD team superimposed street trees on the same image and asked attendees which image they preferred and why. The results found that everyone who participated liked the tree-lined streetscapes better, but for different reasons. Aesthetics was the main response but many people also indicated that they liked the idea of bringing nature into their neighborhood. A copy of the visual preference survey photos can be found in Appendix E.

The research and direct community feedback was a key component of the HIA process and provided the APA-SCD team with vital information that assisted in the development of a strong set of recommendations and deliverables to assist GWL in further implementing their Green Streets tree planting program.

5.7 Causal Pathways

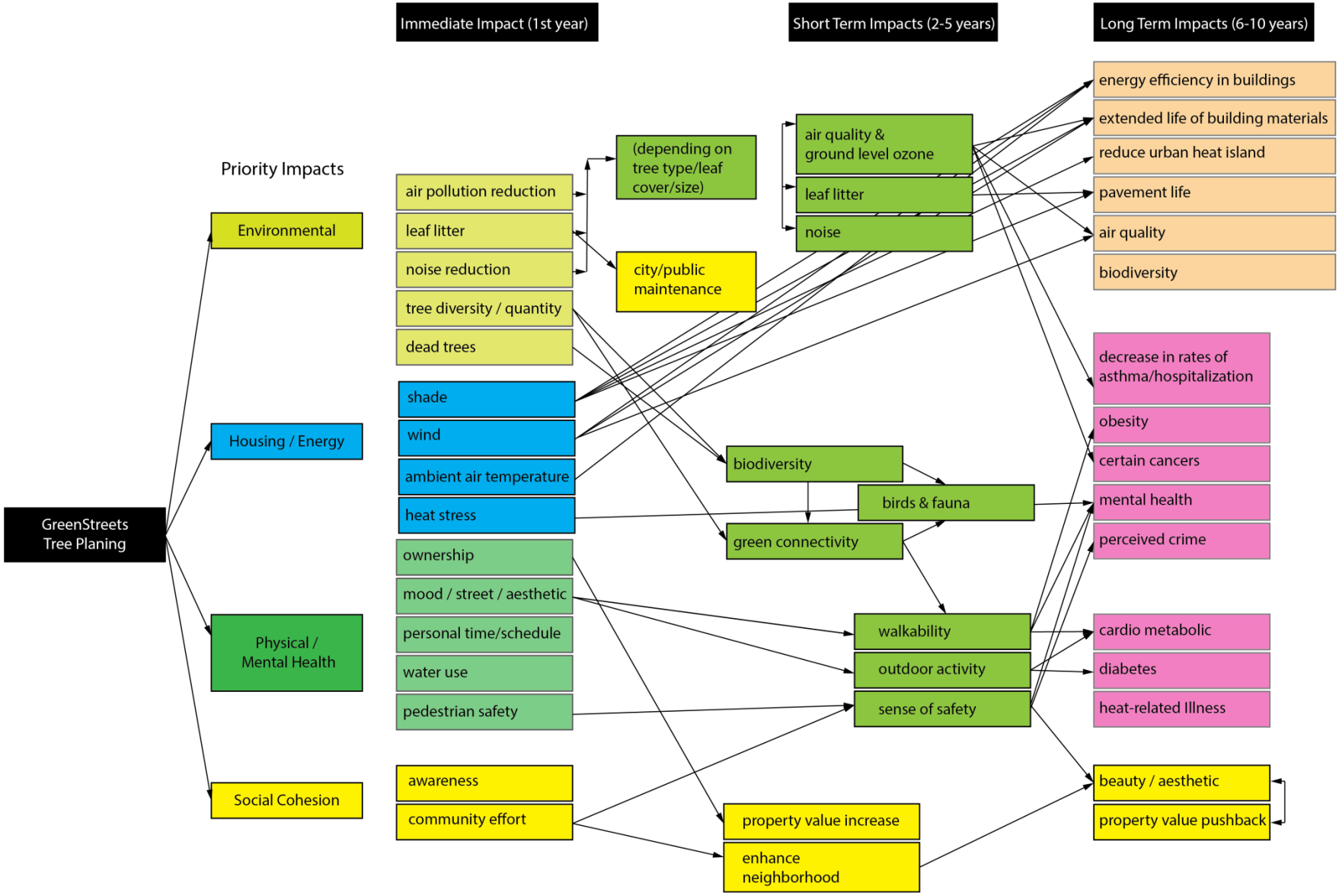
HIAs use Pathway Diagrams to identify, map and predict the links between the proposal and the predicted health outcomes. The APA-SCD team compiled all the research and results from the neighborhood events, and classified key priority impact areas of street trees and developed a Street Tree Pathway Diagram. This Pathway Diagram depicted the causal relationships between trees, the priority impact areas and the associated health impacts in each impact area. Based on the research conducted as part of this HIA, and recognizing that the health benefits that street trees provide vary based on the growth and age of the trees, the APA-SCD team classified the potential health impacts of planting street trees into immediate impacts (first year), short-term impacts (2-5 years) and long-term impacts (6-10 years and greater). The Street Tree Planting Pathway is shown in Figure 7.0.

APA-SCD team members conducting a causal pathways review/exercise – July 2016

While street trees are not the only variable in affecting the health outcomes of the neighborhoods, research conducted as part of this HIA demonstrated that there is a direct correlation between health, the amount of green space and vegetation in a neighborhood; trees have an impact on air quality, microclimate, habitat, social cohesion and mental health.

After compiling the research and community feedback, the APA-SCD team synthesized and critically assessed the information collected during the screening and scoping phase. Research included existing conditions observations and data, community health assessments, literature review, and feedback from GWL and the community. This allowed us to provide GWL with a baseline of existing health conditions in the Arlington and South Common neighborhoods, and estimated projections on the expected short and long-term health impacts from planting 2,400 trees over three years. The research and assessment allowed the APA-SCD team to prioritize health impacts and develop strong recommendations for GWL that will assist them in promoting their Green Streets Program and successfully reaching their goal of planting 2,400 trees over three years. Establishing baseline conditions also helps to measure the impacts of certain actions.

Figure 6.0 – Street Tree Planting Pathway



6.0 Recommendations

Based on the research and assessment conducted as part of this HIA, including the valuable feedback from residents in both the Arlington and South Common neighborhoods, the APA-SCD team developed a number of recommendations that are aimed to assist GWL in raising awareness of the multiple health benefits that street trees could provide in Lawrence and in their ultimate goal of planting 2,400 additional trees. The following recommendations compliment and expand on the recommendations included in the DCR's "The Community Trees of Lawrence, MA – Assessment and Management Plan" (http://groundworklawrence.org/files/library/tree-survey.pdf):

1. ***Create Additional Focused Messaging***

   Development of additional educational and promotional materials that focus on the triple bottom line benefits of street trees (as presented in this report) could help encourage community acceptance and help foster care and responsibility for maintenance, possibly leading to a higher survival rate. Messaging could be included on social media, a webpage or additional printed materials. To help address some of the concerns raised during the neighborhood meetings, specific educational/promotional materials should be developed that focus on mitigating effects of pollen and leaf litter. Examples include: street trees and their ability to filter particulate matter and other pollutants from the air outweighing the amount of pollen they produce; species diversity to avoid planting monocultures, while minimizing pollen and organic litter (fruit, pods, leaves); street trees adding to the biodiversity of the urban ecosystem (some pollen produced is naturally consumed by pollinator insects); viewing biomass that trees produce (leaf litter, broken branches, etc.) as a resource instead of a nuisance - providing a valuable source for the city and local residents who compost and adding to the improved fertility of soils in urban areas.

   Messaging on social media should include use and creation of special hashtags. It is suggested that, at first, to use existing hashtags to create momentum and be consistent with campaigns already out there (i.e., Arbor Day Foundation), but then to create Lawrence-specific hashtags. Those could include: #trees, #greenstreets, #streettrees, #treeoftheweek, #treesarekey, #treesforlife, #healthytrees. Table 7 contains additional communications/messaging recommendations.

   Resources:

   - Street Tree Infographic (see Deliverables section)
   - Use My i-Tree to get nutrition label for a typical tree in each neighborhood https://www.itreetools.org/mytree/

Figure 6.1 – Sample Tree Benefits Nutrition Label

MyTree Benefits

i-Tree

Serving size: 1 trees

Carbon Dioxide (CO_2)	$0.65
CO_2 absorbed each year	64.82 lbs
Storm Water	$10.54
Rainfall intercepted each year	1317 gal.
Air Pollution removed each year	$1.42
Ozone	10.56 oz
Nitrogen dioxide	0.48 oz
Sulfur dioxide	0.00 oz
Large particulate matter**	10.56 oz
Energy Usage each year*	$1.58
Electricity savings (A/C)	61.10 kWh
Fuel savings (NG,Oil)	-4.83 therms
Avoided Emissions	
Carbon dioxide	-1.40 lbs
Nitrogen dioxide	0.00 oz
Sulfur dioxide	0.00 oz
Large particulate matter**	1.12 oz

Benefit are estimated based on USDA Forest Service research and are meant for guidance only:www.itreetools.org

- Appendix C: “Benefits of Street Trees” Handout
- Appendix B: HIA Pathway Research Results
- Sample website (augment existing Green Streets website): http://www.saveitlancaster.com/resources/all-about-trees/street-trees/
- Additional street tree facts summary: Benefits of Street Trees http://www.actrees.org/files/Research/benefits_of_trees.pdf

2. Create a Video about the Green Streets Program

Partner with local schools or the Northern Essex Community College to assist in creating short 2-minute videos to promote the Green Streets Program. The content could include the economic, social and environmental benefits of street trees specific to Lawrence, using the findings of this report and interviews and testimonials of residents from the Arlington and South Common neighborhoods. When complete, the videos could be aired on local cable access, at schools and community events, and imbedded to the project website and on social media. GWL could also use these videos as a model to create tailored versions for each neighborhood.

Resources:

- The Nature Conservancy - example videos that highlight the cooling and cleansing benefits of trees in urban environments: https://global.nature.org/content/healthyair?intc=nature.hp.sp1.

3. Create a Friendly Neighborhood Competition

A little friendly competition is a good way to promote the planting of street trees in Lawrence. GWL could consider developing, as part of a messaging campaign, a competition between South Common and Arlington neighborhoods to see which community can plant the most number of trees in a given time period. Such a competition could be centered around themes such as the energy efficiency goals of GWL’s tree planting grant and how trees can help combat local health concerns and improve the overall environmental quality of Lawrence. The competition could start in the Lawrence school system to gain momentum and traction. Public design charrettes and tactical urbanism projects such as parklets are another way of engaging the community through friendly competition.

Resources:

- Example tree planting competition for flood control: http://actrees.org/news/trees-in-the-news/newsroom/tree-planting-competition-a-boon-for-flood-control/
- Tactical Urbanism: project examples and resources: http://bettercities.net/sites/default/files/Tactical%20Urbanism%20Final.pdf

4. Augment Existing Planting Guidelines

The existing planting guidelines provided by DCR and MA EOEEA provide technical planting requirements but the development of additional planting guidelines will aid in the success of the Green Streets Program and help alleviate some of the concerns of residents (pavement damage, blocking of views, etc.). Those guidelines could address the types of trees that should be planted and where, species that are resilient to a changing climate, bed preparation, installation, and amount of water needed for each type of tree. Trees

should be selected based on species biodiversity, appropriateness for the region, location and situation (urban, drought tolerant, salt resistant, root system, low pollen, low/no shedding of fruit or debris/messy litter). Trees should also be located to maximize energy efficiency benefits and so as not to obstruct visual access for drivers. The development of these additional guidelines will aid in neighborhood acceptance of trees and help ensure maximum success of the Green Streets Program.

Resources:

- "Tree Canopy Cover in Residential Areas" - MassSave Proposal, Massachusetts Energy Efficiency New Technology Assessment; Residential Technologies, October 21, 2014 (see Appendix D of this report).
- The Community Trees of Lawrence, MA; Assessment and Management Plan. DCR Urban Forestry Program: http://groundworklawrence.org/files/library/tree-survey.pdf
- Table 5.0 - Selected Street Tree Species Benefits and Constraints (Deliverables section of this report).
- Climate Change tool for urban forestry: https://adaptationworkbook.org/
- Climate Change Vulnerability of Trees Common to the Boston Region or Likely to Gain Habitat (see Appendix F)

5. ***Develop a Tree Stewardship Program***

Gaining neighborhood support and acceptance of street tree plantings is a critical component to ensuring the success of this program and to maximize the economic, environmental health and social benefits. Development of an "adopt a tree" program along with training and guidance on how to care for the trees would aid in neighborhood acceptance of trees, promote social interaction and can even help reduce crime as people spend more time outside (more eyes on the street). This could also be developed as a dashboard which will report on the progress of the program and even allow residents to interact with it by reporting potential issues with a tree in their neighborhood. See the New York City Street Tree Map in the Resources section for an example of this kind of interactive tool.

Resources:

- Alliance for Community Trees: http://actrees.org/news/trees-in-the-news/research/stewardship-success-how-community-group-dynamics-affect-urban-street-tree-survival-and-growth/
- New York City Street Tree Map: https://tree-map.nycgovparks.org/ (click on the 'learn' button on the top there are lots of tips on how to care for street trees. If you zoom in on the map you can see each tree, its species, a photo, etc.).
- Partner with Arbor Day Energy Savings Tree Program http://arbordayest.org/. Can provide advice from certified arborists. Flexible tailored programs for cities and town and organizations.

6. ***Use i-Tree for Monitoring***

Once street trees have been installed, GWL could use the street tree plantings and their impacts (Table 4.0 in the Findings section of this report) to estimate the overall impacts of their plantings. GWL and the City of Lawrence could use this information and free online tools such as i-Tree to track, manage and monitor street trees and canopy cover and the resulting energy, economic and environmental impacts that influence the social, mental, and physical health of Lawrence residents. GWL Lawrence could consider

engaging residents and youth by collecting this data as part of an AmeriCorps service project. These metrics could then be used for additional public education and awareness and even future grant opportunities.

Resources:

- i-Tree (http://www.itreetools.org/): free on-line program that can be used to track and measure the progress of tree planting and its impacts on the urban environment.
- Tree keeper - http://www.davey.com/natural-resource-consulting/urban-forestry-consulting/urban-forestry-management-software/tree-keeper/ – for tracking and managing tree planting.
- https://www.opentreemap.org/map/ – for tracking and managing tree planting.
- National Tree Benefit Calculator: on-line tool to ID the benefits of individual street trees - http://treebenefits.com/calculator/

7. Adopt a Tree Preservation/Protection Ordinance in Lawrence

Coordinate with City of Lawrence and the State Department of Conservation and Recreation (DCR) to spearhead efforts to develop tree protection standards for new development/redevelopment projects, beyond street trees. These standards are aimed at reducing clear-cutting of existing vegetation and preserving and protecting sizable trees on private property. GWL could utilize the educational resources developed as part of this HIA to assist with raising support and awareness of the economic, social and environmental benefits of trees in an urban environment – which in turn could lead to increased support for the adoption of such a tree ordinance. The DCR also has incentive programs that could aid in the acceptance of a tree preservation ordinance on private properties (see Appendix G).

Resources:

- Modify the existing Landscape Ordinance in Lawrence to create a mechanism for developers to pay into a "Tree Trust" to help fund tree plantings as recommended in the draft Lawrence Urban Renewal Plan (https://lawrencetbd.com/).
- Town of Wellesley, MA Tree Protection and Preservation Zoning Bylaw (enacted July 1, 2011): http://www.wellesleyma.gov/Pages/WellesleyMA_Planning/ZB/XVIE.pdf
- The City of Cambridge Tree Ordinance: https://tinyurl.com/cambridgetreeordinance
- Lowell, MA Tree Article: http://ecode360.com/12360659 (contains preservation and protection standards but the above Town codes are more detailed for tree preservation during planning, design and construction on private properties

8. Adopt a Street Tree Bylaw/Ordinance

Use the results of this HIA and work with allies in the neighborhood and local government to continue to push for the passage of a street tree bylaw/ordinance and creation of a formal removal replacement, care and maintenance program with the City of Lawrence and the Board of Park Commissioners to support the protection and long term health of street trees. Coordination with other town agencies such as the Public Works Department is also key to ensure successful passage and implementation of a street tree

ordinance. Recommendation #9 contains additional funding a support resources that could be used to support the passage, implementation, and ongoing management of both a tree preservation ordinance and a street tree ordinance.

Resources:

- Lowell, MA Tree Preservation/Protection Article (not specific to street trees but could still apply):http://ecode360.com/12360659
- Seattle Department of Transportation example/template: http://www.seattle.gov/transportation/docs/Street%20Tree%20Manual%20WEB.pdf
- International Society of Arboriculture: http://www.isa-arbor.com/education/onlineResources/treeOrdinanceGuidelines.aspx
- Existing Massachusetts Tree Laws:
  - MGL 87 Section 1-14 Shade Trees (covers the cutting, planting and penalties for removal of trees in and on the boundaries of public rights of ways) -https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXIV/Chapter87
  - MGL 242 Section 7: Willful trespass to trees, etc.; damages: Penalties for removal of trees. https://malegislature.gov/Laws/GeneralLaws/PartIII/TitleIII/Chapter242/Section7

9. Seek Additional Funding and Support

There are a number of funding and grant opportunities that could provide GWL and the City of Lawrence with additional technical and financial assistance to continue to implement the Green Streets Program. By applying a health lens to street tree planting, grant and funding opportunities can go beyond the typical energy efficiency opportunities and include local hospitals (for helping to achieve local health benefits specific to Lawrence) and urban renewal programs/projects.

Resources:

- Establish a "Tree Trust" to fund urban tree planting as recommended in the draft Lawrence Urban Renewal Plan https://lawrencetbd.com/.
- Recruit Interns from the Green Corps Program to assist with community awareness and support for tree planting http://greencorps.org/about.html . AmeriCorps is another resource: https://www.nationalservice.gov/programs/americorps
- Eagle Eye Institute (urban stewardship project support) http://eagleeyei.org/eagle-eyes-programs/urban-stewardship-project/
- Recovery assistance from ice storms, hurricanes and other natural disasters: http://masstreewardens.org/urban-forest-strike-team/
- Massachusetts Department of Conservation and Recreation's Urban and Community Forestry Challenge Grants: http://www.mass.gov/eea/agencies/dcr/conservation/forestry-and-fire-control/urban-and-community-forestry-challenge-grants.html
- The Home Depot Foundation Community Impact Grants: up to $5,000 to 501(c)3 organizations that are using volunteers to improve the physical health of their community. https://corporate.homedepot.com/grants/community-impact-grants
- TD Green Streets Grant Program - $20,000 grants in support of local forestry projects in low- to moderate-income neighborhoods (municipal grant): https://www.arborday.org/programs/tdgreenstreets/grant-information.cfm
- Arbor Day Foundation: https://www.arborday.org/ Energy Saving Trees Program: http://energysavingtrees.arborday.org/#Home

7.0 Deliverables

Through this HIA process, the APA-SCD team developed a number of deliverables to assist GWL with implementation of the recommendations in this report:

Deliverable #1: Tree Species Analysis and Recommendations

GWL's goal of planting 2,400 trees over 3 years includes both street trees and yard trees. Because of the highly developed nature of both the Arlington and South Common neighborhoods, there is limited area in which to plant additional street trees. Overhead power lines, sidewalks, lack of or poor soil conditions, minimal front yards and proximity to the street are all constraints for planting street trees. As part of this HIA, the APA-SCD team engaged the services of certified Landscape Architect to review the tree planting list that was provided by GWL with an eye towards the existing neighborhood conditions. Building off of the findings in *Table 4.0 – Proposed Street Tree Plantings and Estimated Benefits Per Tree,* the team developed Table 5.0 which lists some of the environmental and health-related opportunities and constraints for each street tree type based on the research conducted as part of this HIA. Climate change is also a factor to consider. Appendix F contains a list of trees that, as climate change progresses, will be more vulnerable and/or more resilient as the climate zones shift. These are all important details to consider when planting each type of tree and these details could be used to assist GWL in messaging and gaining additional community support for the program.

Table 5.0 – Selected Street Tree Species Benefits and Constraints

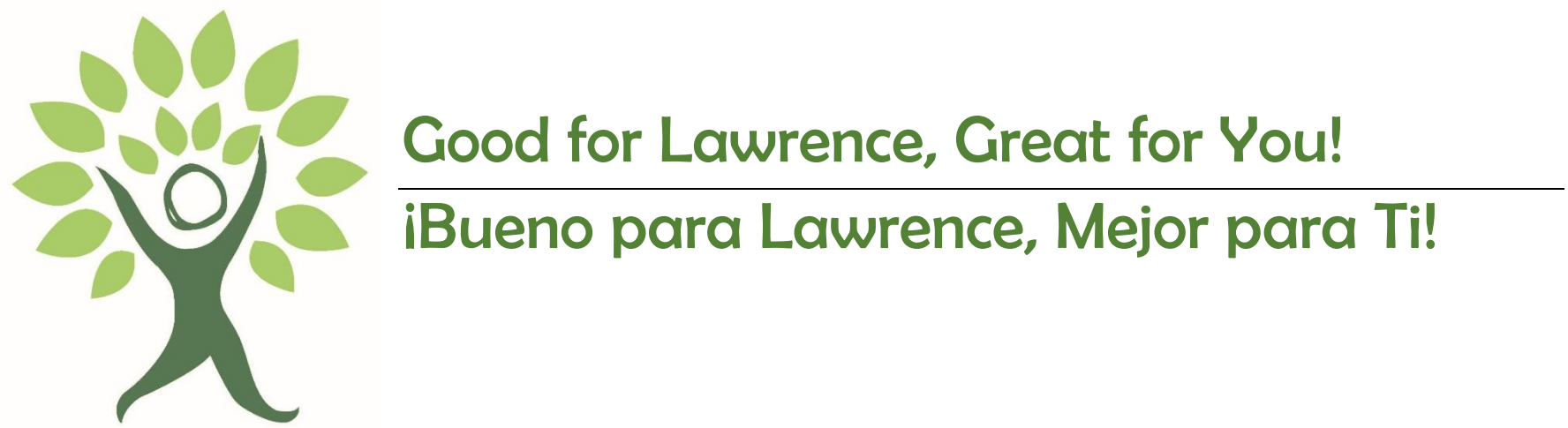
Botanical	Common Name	Tolerate Urban Conditions	Salt Spray	Soil Salt from Deicing	Drought	Native to MA	Storm water mgmt.*	Energy Efficiency*	Overall Air Quality*	Notes
Celtis occidentalis	Hackberry	Yes	Moderate	Good	Tolerant	Yes	Best	Best	Best	Requires wide tree lawn, produces galls
Cladrastis kentukea	Yellowwood	Yes	Moderate	Moderate	Moderate	Yes	Better	Good	Better	
Ginkgo biloba	Ginkgo (fruitless)	Yes	Moderate	Moderate	Tolerant	No	Good	Good	Good	Get fruitless variety
Gleditsia 'Skyline'	Honeylocust	Yes	Moderate	Good	Tolerant	No	Better	Better	Best	Thornless, nearly fruitless variety. High energy efficiency benefits as tree gets larger.
Gymnocladus dioicus	Kentucky Coffeetree	Yes	Tolerant	Tolerant	Tolerant	Yes	Best	Best	Best	
Liquidambar styraciflua	Sweetgum	Yes	Tolerant	Tolerant	Tolerant	Yes	Good	Good	Good	Prickly balls can be messy. Rotundifolia is fruitless – less mess.
Nyssa sylvatica	Tupelo	Yes	Moderate	Moderate	Moderate	Yes	Better	Good	Best	Wide tree lawns
Oxydendrum arboretum	Sourwood	Yes	Moderate	Unknown	Moderate	Yes	Good	Good	Good	Small. Lower Ozone reduction. Good under power lines
Prunus sargentii	Sargent Cherry	Yes	Moderate	Tolerant	Intolerant	No	Good	Good	Good	Small. Lower Ozone reduction. Good under power lines.
Prunus subhirtella 'autumnalis'	Higan Cherry	Yes	Tolerant	Tolerant	Tolerant	No	Good	Good	Good	Small. Lower Ozone reduction. Prone to suckering.
Styphnolobium japonicum	Pagoda Tree	No	Moderate	Tolerant	Tolerant	No	Better	Good	Better	
Syringa reticulate	Japanese Tree Lilac	Yes	Tolerant	Tolerant	Intolerant	No	Good	Good	Good	Small. Lower ozone reduction. Good under power lines.
Tilia cordata 'Greenspire'	Littleleaf Linden	Yes	Intolerant	Moderate	Tolerant	No	Good	Good	Good	Not ideal close to road.
Zelkova serrata	Japanese Zelkova	Yes	Moderate	Tolerant	Tolerant	No	Best	Best	Best	
Zelkova serrata 'City Sprite'	Japanese Zelkova 'City Sprite'	Yes	Tolerant	Tolerant	Tolerant	No	Best	Best	Best	Small. Good under power lines.

Green: recommended street trees; any red highlights are caveats for their use. Note that "small" indicates a smaller tree that could be useful for streets with overhead wires or narrow neighborhood streets. They would be much less successful on broader streets where a large tree is needed to create a sense of volume under the tree canopy.
Red: caveats for the use of the recommended street trees.
Grey: reasons for the tree not being recommended for street tree planting. No evergreens are recommended.
** - Rankings based on data compiled based on Table 4.0 and is from http://treebenefits.com*

Appendix D includes the complete list of plantings with planting details and considerations, in addition to tree planting specifications from MA EOEEA.

Deliverable #2: Infographic, Tagline and Logo

Two other deliverables for this project include an infographic, a tagline and logo. The infographic (see Figure 7.0) visually spells out the benefits of street trees by season, to educate residents of the year-round impact trees make on quality of life and their environment. This was provided in English as well as Spanish. The APA-SCD also wanted to create something simple and catchy that GWL can use to brand the entire program, but that particularly spoke to the health benefits of street tree planting. The "tree-guy" logo can be used individually, or with the tagline (in English or Spanish): Good for Lawrence, Great for You! / ¡Bueno para Lawrence, Mejor para Ti!



Deliverable #3: Educational Messaging

The research and data contained within this HIA, as well as the input received from residents, uncovered the following priority health areas in Arlington and South Common neighborhoods:

1. Substance Abuse
2. Mental Health
3. Cancer
4. Chronic Disease (Asthma/Diabetes/Obesity)

It is also important to note that residents in these two neighborhoods described what they felt the main benefits of trees were. The most popular responses during the community events that were held include:

1. Relaxing
2. Walking
3. Beauty
4. Quality of Life
5. Refreshing
6. Safety

Figure 7.0: Infographic

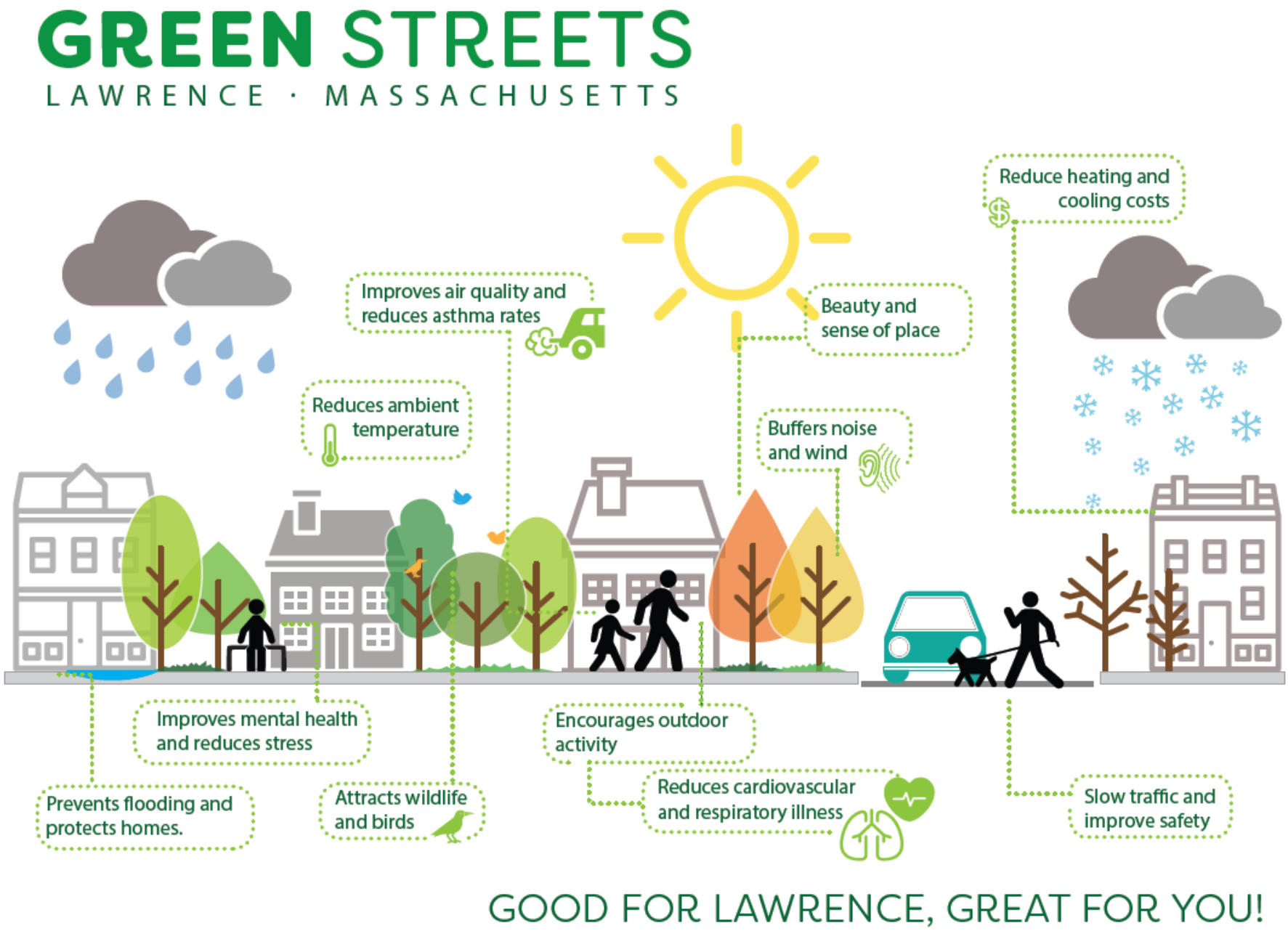


Figure 8.0: Infographic

Keeping in mind the specific health concerns expressed in the two neighborhoods, the APA-SCD team developed messaging that will resonate with the residents (see Table 6.0) by incorporating their responses to how they felt about trees. The "Suggested Messaging" column can be used in pamphlets, on the website, via social media, on billboards, in presentations to the neighborhoods or other constituents, or paired with any of the Communication Tools recommended in Table 7.0.

Table 6.0 – Suggested Messaging for Green Streets Program

Element	Specific Health Concern	Suggested Messaging
Air Quality	Asthma/Allergies	Did you know?? A large contributor to asthma is caused by pollutants in the air from industry, cars, and buildings. Street trees can lower the amount of these pollutants by up to 60%. OR Lawrence has one of the highest rates of asthma in the state. This is caused by air pollution from industry, cars, and buildings. Street trees can lower the amount of this pollution by up to 60%, and improve the quality of life in Lawrence.
Walking	Obesity/Asthma/ Mental Health	Street trees have been shown to increase physical activity, reducing the risk of obesity; improve air quality, reducing asthma and other respiratory illnesses, and reduce stress for those that are surrounded by them. Have you spent time with your street tree today?
Quality of Life	Social interaction	Street trees create a more inviting environment which can bring people together through relaxing outdoor activities. A community that knows each other and engages with each other regularly is safer and healthier.
Refreshing	Shade/heat stroke	During the hot summer days, appropriately placed street trees can be a refreshing change that will keep you cool while walking home or waiting for the bus.
Safety	Physical/Mental Health	Street trees create the appearance of a smaller space, which has been shown to reduce vehicle speed on the street and create a safer route for pedestrians.
Beauty	Natural Environment	Street trees attract birds and other wildlife. Improve biodiversity of urban environments.
Safety	Crime/Violence	Street trees beautify the neighborhood and help get more people outside and active which can promote more social interaction and help to reduce stress levels which can lead to fewer incidents of crime and violence. More street trees can also signal that the neighborhood is cared for and being watched carefully (more "eyes on the street").

The APA-SCD Team recommends testing these messages to see which ones resonate best with the residents. The message testing should not be something that is particularly labor or time intensive, but just enough to get a good sense if the message is understood by the audience and is something that makes them want to know more. Some suggested testing methods include:

- **One-on-One Interviews or Focus Groups**
  - During the "door-knocking" being conducted by the GWL Green Streets staff
  - At the Mayor's Health Task Force meetings
  - At the Senior Center

- **Online Tools**
  - Create and Share Links to an Online Survey- Survey Monkey and Type Form are two good, free options to create surveys (also refer to section 9.1 of this report for survey recommendations)
  - Email blasts through Constant Contact or MailChimp
  - Leverage the Facebook pages “We are Lawrence” and GWL’s own page
- **Partner Networks**
  - With GWL partners such as Lawrence Community Works

Once the messaging is confirmed, GWL should discuss how best to communicate it to the audience. In Table 7.0, the APA-SCD Team outlined some suggestions for effective communication tools for GWL. Please note: APA-SCD recommends that the tools in Table 7.0 should all include a reference that the City of Lawrence is designated as a Tree City by the Arbor Day Foundation’s Tree City USA Program. Messaging around the Tree City designation could look like this:

Did you know that Lawrence is part of the Tree City USA Program? The City will work to plant more trees every year. Have you gotten yours? Check out ….

Table 7.0 – Communication Tool Suggestions

Tools	Suggested Applications
Infographics	Illustrates the multiple health benefits of street trees
Brochure	For a brochure, it is recommended to focus in on one specific health concern. There are simply too many benefits of trees to cram into one place. It becomes overwhelming for the reader.
Interactive Art Display	Something that community members can create either in a group or individually at a meeting. This can be accomplished a number of ways. One approach is to have a large (6 feet or so) paper or cardboard cutout taped to a wall and provide a basket full of various materials- fabric, duct tape, paper, markers, crayons, old game pieces, etc.- and ask each person to add pieces to the tree to represent some value they feel they get from the tree.
Word Cloud	Take a poll of residents either online or in-person asking about the benefits they believe they get from trees and then use that word cloud in materials.
Social Media	Facebook and Twitter are great ways to get the message out, encourage participation and change behaviors. Start hashtags to further promote #GreenStreets; #TreesForLife; etc…
Website	A dedicated website for this campaign could house many of the recommendations in this report including: the Friendly Competition, the Video, the iTree results, the Stewardship Program, etc. New York City example: Street Tree Map: https://tree-map.nycgovparks.org/

Additional messaging resources are available on-line from the Arbor Day Foundation at: https://www.arborday.org/energysavingtrees/toolkit/ .

8.0 Reporting

This report provides a detailed summary of goals and metrics, list of tree benefit resources, baseline/existing conditions assessment of Lawrence and Arlington and South Common, health benefits of trees, projection data and initial ideas for how to communicate the benefits of tree planting. This report should assist GWL in promoting their Green Streets Program and street tree planting in Arlington and South Common.

8.1 Promotion of Green Streets Program HIA

In addition to presenting the report and deliverables to GWL, the following outreach methods will be undertaken by the APA-SCD team in 2017 to promote this project, its methodology, and results so others can learn from this work:

- Presentations to Lawrence City Boards (Planning Board, Mayor's Health Task Force, etc.) and Arlington and South Common neighborhood groups
- Meet with Executive Office of Energy & Environmental Affairs and the State Department of Public Health about promoting this Program and the HIA process Statewide
- Give presentations at
    - Groundwork USA monthly meetings
    - Massachusetts Smart Growth Alliance (May 2017 in Worcester)
    - Massachusetts Association of Planning Directors Conference (June 2017 in Pittsfield, MA)
    - Southern New England American Planning Association Conference (October 2017 in Providence, RI)
- Meet with Gateway Cities Director (Ben Foreman)
- Publish articles in the National APA magazine (Planning), the APA-MA Chapter newsletter, and the APA Sustainable Communities Division newsletter
- Develop podcast through the Sustainability Action Series (https://soundcloud.com/sastalk)

In addition to helping GWL, APA-SCD hopes this project will help other communities and planners learn about the importance of HIA's, the process, and how an HIA could help address similar issues in their own neighborhoods, towns and cities.

9.0 Monitoring and Evaluation

The "Findings" Section of this HIA established a summary of the existing conditions in Lawrence, including specific data in each of the priority impact areas (environmental, social cohesion, mental health and housing). This summary information could be used as a baseline to track and monitor the overall health of the neighborhoods as the GWL Green Streets Program evolves. The data in Table 4.0 provides additional insight into which trees might be preferable over others to address not only energy efficiency, but also specific environmental and health related issues and could be used as a tool for future evaluation of the estimated impacts vs. actual impacts

over time. Based on the research results and the pathway diagram, GWL may wish to consider analyzing and comparing estimated benefits with actual conditions in year 5 and 10 after the street tree planting. This type of evaluation would make an excellent case study and help foster continued support for urban tree planting in Lawrence and throughout cities and town across the country. The data could also be used to support existing and future grant opportunities for additional tree planting, park development and other green infrastructure elements in Lawrence.

In addition, all of the recommendations were combined into a spreadsheet (see Table 8) to track their implementation, including: the date of tracking, the cost associated for each task, the internal "champion" in charge of the task, stakeholders and partners necessary to accomplish the task, and the percentage complete. This spreadsheet will be provided to GWL electronically with the final deliverables.

Table 8.0 – Implementation Spreadsheet

Green Streets Lawrence Implementation Plan

Recommendation	Measure Progress on Recommendation on [date]	Cost ($, $$, $$$)*	GWL Champion	Stakeholders/ Partners	% Done	Notes
1. Focused Messaging		$				
Step 1:						
2. Video about the Green Streets Program		$$				
Step 1:						
3. Friendly Neighborhood Competition		$				
Step 1:						
4. Augment Planting Guidelines		$				
Step 1:						
5. Tree Stewardship Program		$$				
Step 1:						
6. Use i-Tree for Monitoring		$				
Step 1:						
7. Tree Preservation Ordinance		$				
Step 1:						
8. Street Tree Bylaw/Ordinance		$				
Step 1:						

** Note: these estimates do not include staff time: $ = <$100, $$ = $101-900, $$$ = >$1,000*

9.1 Resident Feedback Opportunities for Continuous Program Improvement

The ongoing success of any community initiative requires listening to people's questions and concerns and offering opportunities for community participation and feedback throughout. To help ensure an ongoing connection with the participating communities and to help monitor the effectiveness of any programming developed as part of the GWL Green Streets Program, GWL could develop short questionnaires that could be distributed at various community meetings/events and/or posted on the Green Streets Program website, Facebook, or provided in person to those who are planting and/or receiving the trees. These opportunities for feedback can not only help improve the delivery of the program but also help further raise awareness of the program and its triple-bottom line benefits. Questionnaires should include contact information for who to go to for questions, surveys of people that have planted trees.

Resources:

- North Bay Hydro Tree Planting Program Customer Satisfaction Survey 2015 https://www.surveymonkey.com/r/FX65DQT
- "Trees and People"—A research design for evaluating the outcomes of neighborhood and nonprofit urban forestry:
- City of Santa Barbara Community Tree Survey: http://www.santabarbaraca.gov/civicax/filebank/blobdload.aspx?blobid=35290
- Does Planting Trees Improve Neighborhoods? (Appendix M in the following link contains the sample questions) https://ostromworkshop.indiana.edu/pdf/seriespapers/2013s_c/ForestryGroup_paper.pdf

---

The APA-SCD Team hopes this report will assist GWL in advancing the goals of the Green Streets Program and provide additional resources to ensure ongoing success. This report documented the entire HIA process in detail and can serve as a guide for other communities interested in understanding and evaluating the holistic benefits of street trees in an urban environment. This HIA process is adaptable and can be used as a tool to promote healthier neighborhood development through street trees and other green infrastructure elements. The APA-SCD Team thanks GWL for their support and guidance throughout this process.

APPENDICES

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

Summary of ACS Estimates	2010 - 2014
Population	17,386
Population Density (per sq. mile)	25,911
Minority Population	15,558
% Minority	89%
Households	5,571
Housing Units	5,828
Housing Units Built Before 1950	3,382
Per Capita Income	14,971
Land Area (sq. miles) (Source: SF1)	0.67
% Land Area	99%
Water Area (sq. miles) (Source: SF1)	0.00
% Water Area	1%

	2010 - 2014 ACS Estimates	Percent	MOE (±)
Population by Race			
Total	17,386	100%	434
Population Reporting One Race	16,761	96%	1,160
White	5,822	33%	325
Black	1,165	7%	287
American Indian	45	0%	53
Asian	157	1%	87
Pacific Islander	0	0%	12
Some Other Race	9,572	55%	396
Population Reporting Two or More Races	625	4%	205
Total Hispanic Population	15,004	86%	456
Total Non-Hispanic Population	2,382		
White Alone	1,828	11%	219
Black Alone	261	2%	84
American Indian Alone	0	0%	12
Non-Hispanic Asian Alone	157	1%	87
Pacific Islander Alone	0	0%	12
Other Race Alone	53	0%	47
Two or More Races Alone	82	0%	83
Population by Sex			
Male	8,305	48%	271
Female	9,082	52%	297
Population by Age			
Age 0-4	1,696	10%	123
Age 0-17	5,209	30%	199
Age 18+	12,178	70%	241
Age 65+	1,690	10%	172

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race. N/A means not available.
Source: U.S. Census Bureau, American Community Survey (ACS) 2010 - 2014.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

	2010 - 2014 ACS Estimates	Percent	MOE (±)
Population 25+ by Educational Attainment			
Total	9,919	100%	271
Less than 9th Grade	2,525	25%	129
9th - 12th Grade, No Diploma	1,293	13%	94
High School Graduate	2,909	29%	179
Some College, No Degree	2,228	22%	133
Associate Degree	348	4%	49
Bachelor's Degree or more	964	10%	96
Population Age 5+ Years by Ability to Speak English			
Total	15,690	100%	417
Speak only English	2,204	14%	178
Non-English at Home[1+2+3+4]	13,486	86%	349
[1]Speak English "very well"	6,139	39%	240
[2]Speak English "well"	2,118	14%	136
[3]Speak English "not well"	2,666	17%	192
[4]Speak English "not at all"	2,563	16%	182
[3+4]Speak English "less than well"	5,229	33%	261
[2+3+4]Speak English "less than very well"	7,347	47%	293
Linguistically Isolated Households*			
Total	2,370	100%	101
Speak Spanish	2,333	98%	100
Speak Other Indo-European Languages	0	0%	20
Speak Asian-Pacific Island Languages	37	2%	30
Speak Other Languages	0	0%	12
Households by Household Income			
Household Income Base	5,571	100%	110
< $15,000	1,759	32%	110
$15,000 - $25,000	1,101	20%	100
$25,000 - $50,000	1,181	21%	81
$50,000 - $75,000	714	13%	70
$75,000 +	816	15%	73
Occupied Housing Units by Tenure			
Total	5,571	100%	110
Owner Occupied	1,221	22%	72
Renter Occupied	4,351	78%	121
Employed Population Age 16+ Years			
Total	12,712	100%	337
In Labor Force	8,019	63%	265
Civilian Unemployed in Labor Force	1,399	11%	159
Not In Labor Force	4,693	37%	232

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race. N/A means not available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2010 - 2014.

*Households in which no one 14 and over speaks English "very well" or speaks English only.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

	2010 - 2014 ACS Estimates	Percent	MOE (±)
Population by Language Spoken at Home*			
Total (persons age 5 and above)	15,690	100%	417
English	N/A	N/A	N/A
Spanish	N/A	N/A	N/A
French	N/A	N/A	N/A
French Creole	N/A	N/A	N/A
Italian	N/A	N/A	N/A
Portuguese	N/A	N/A	N/A
German	N/A	N/A	N/A
Yiddish	N/A	N/A	N/A
Other West Germanic	N/A	N/A	N/A
Scandinavian	N/A	N/A	N/A
Greek	N/A	N/A	N/A
Russian	N/A	N/A	N/A
Polish	N/A	N/A	N/A
Serbo-Croatian	N/A	N/A	N/A
Other Slavic	N/A	N/A	N/A
Armenian	N/A	N/A	N/A
Persian	N/A	N/A	N/A
Gujarathi	N/A	N/A	N/A
Hindi	N/A	N/A	N/A
Urdu	N/A	N/A	N/A
Other Indic	N/A	N/A	N/A
Other Indo-European	N/A	N/A	N/A
Chinese	N/A	N/A	N/A
Japanese	N/A	N/A	N/A
Korean	N/A	N/A	N/A
Mon-Khmer, Cambodian	N/A	N/A	N/A
Hmong	N/A	N/A	N/A
Thai	N/A	N/A	N/A
Laotian	N/A	N/A	N/A
Vietnamese	N/A	N/A	N/A
Other Asian	N/A	N/A	N/A
Tagalog	N/A	N/A	N/A
Other Pacific Island	N/A	N/A	N/A
Navajo	N/A	N/A	N/A
Other Native American	N/A	N/A	N/A
Hungarian	N/A	N/A	N/A
Arabic	N/A	N/A	N/A
Hebrew	N/A	N/A	N/A
African	N/A	N/A	N/A
Other and non-specified	N/A	N/A	N/A
Total Non-English	N/A	N/A	N/A

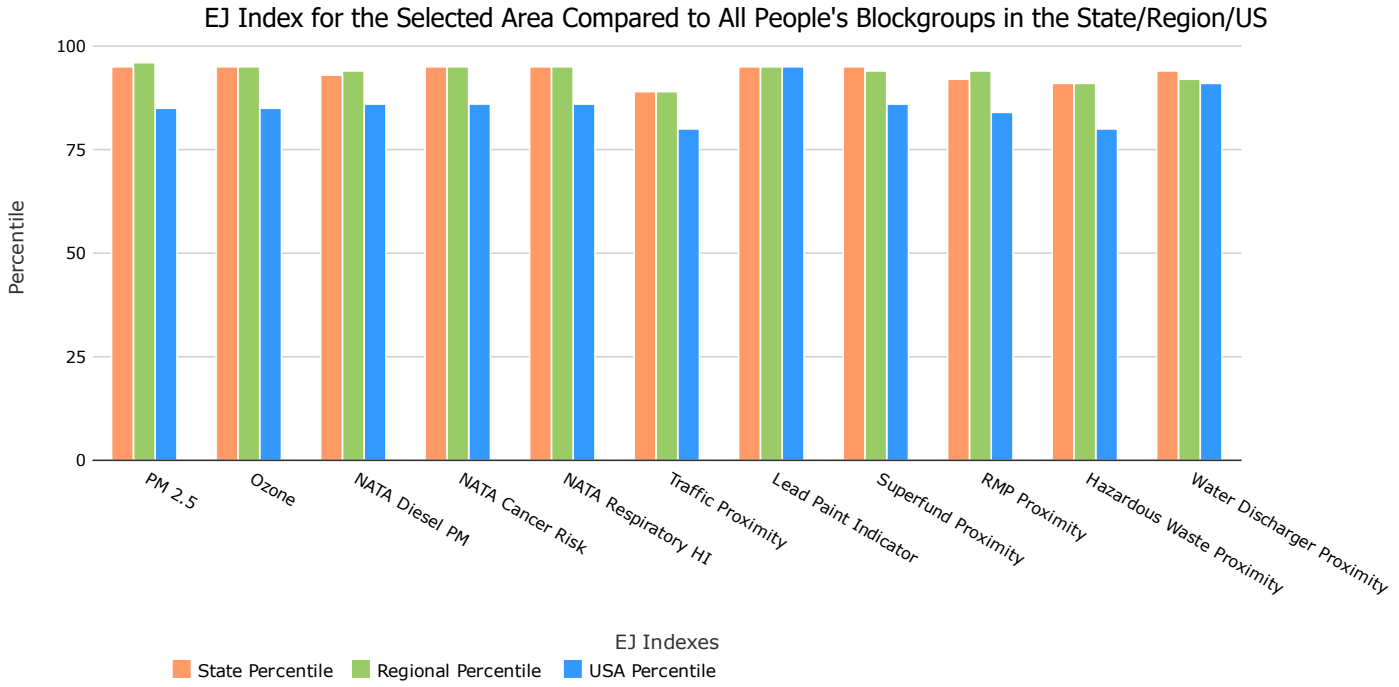
Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race. N/A means not available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2010 - 2014.
*Population by Language Spoken at Home is available at the census tract summary level and up.

Save as PDF

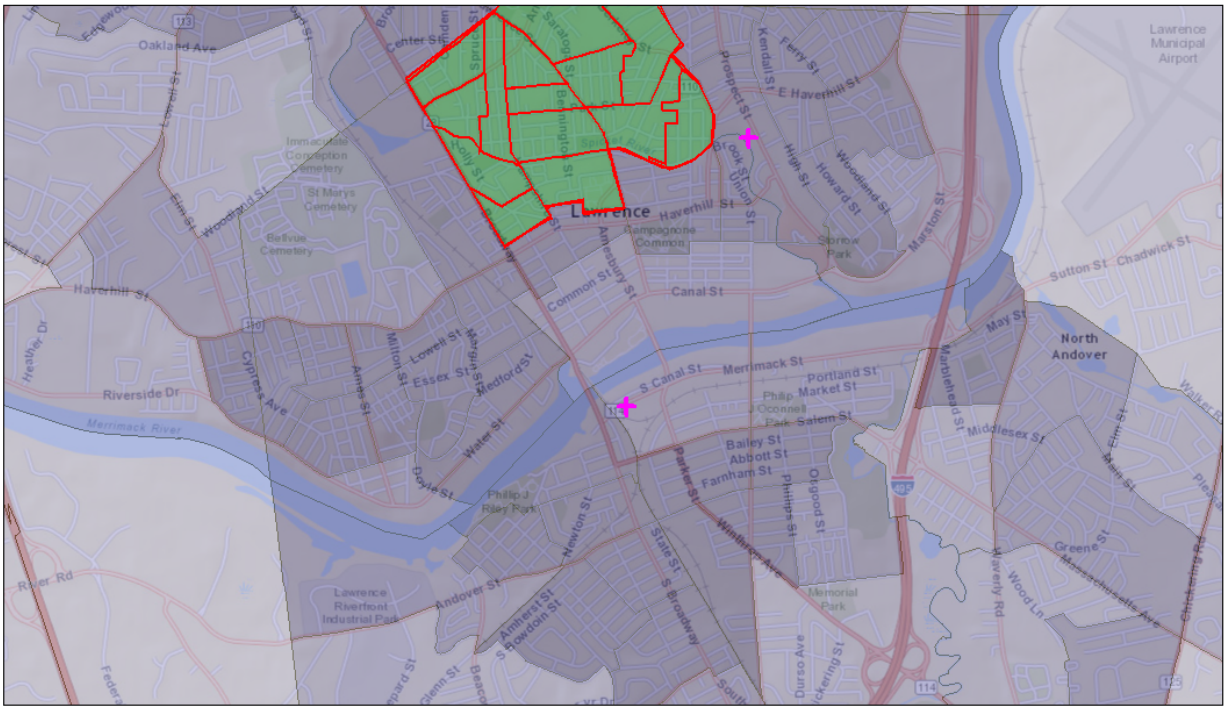
EJSCREEN Report (Version 2016)

the User Specified Area
MASSACHUSETTS, EPA Region 1
Approximate Population: 17,386
Input Area (sq. miles): 0.68

Selected Variables	Percentile in State	Percentile in EPA Region	Percentile in USA
EJ Indexes			
EJ Index for Particulate Matter (PM 2.5)	95	96	85
EJ Index for Ozone	95	95	85
EJ Index for NATA* Diesel PM	93	94	86
EJ Index for NATA* Air Toxics Cancer Risk	95	95	86
EJ Index for NATA* Respiratory Hazard Index	95	95	86
EJ Index for Traffic Proximity and Volume	89	89	80
EJ Index for Lead Paint Indicator	95	95	95
EJ Index for Superfund Proximity	95	94	86
EJ Index for RMP Proximity	92	94	84
EJ Index for Hazardous Waste Proximity+	91	91	80
EJ Index for Water Discharger Proximity	94	92	91



This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports.



Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	0
National Pollutant Discharge Elimination System (NPDES)	0

Selected Variables	Value	State Average	Percentile in State	EPA Region Average	Percentile in EPA Region	USA Average	Percentile in USA
Environmental Indicators							
Particulate Matter (PM 2.5 in µg/m^3)	8.76	8.38	67	8.06	84	9.32	34
Ozone (ppb)	41.9	42.3	39	42.8	38	47.4	19
NATA* Diesel PM (µg/m^3)	1.04	0.869	73	0.711	80-90th	0.937	60-70th
NATA* Air Toxics Cancer Risk (risk per MM)	43	35	82	33	80-90th	40	60-70th
NATA* Respiratory Hazard Index	2	1.6	77	1.5	80-90th	1.8	60-70th
Traffic Proximity and Volume (daily traffic count/distance to road)	130	290	58	320	59	590	55
Lead Paint Indicator (% pre-1960s housing)	0.66	0.52	63	0.46	72	0.3	84
Superfund Proximity (site count/km distance)	0.093	0.17	54	0.16	54	0.13	64
RMP Proximity (facility count/km distance)	0.28	0.36	69	0.3	75	0.43	65
Hazardous Waste Proximity (facility count/km distance)+	0.066	0.11	41	0.12	48	0.11	49
Water Discharger Proximity (count/km)	0.32	0.36	66	0.43	62	0.31	76
Demographic Indicators							
Demographic Index	77%	25%	97	24%	97	36%	93
Minority Population	89%	25%	96	22%	96	37%	90
Low Income Population	65%	25%	94	26%	94	35%	89
Linguistically Isolated Population	43%	6%	99	5%	99	5%	99
Population with Less Than High School Education	38%	10%	96	10%	97	14%	93
Population under Age 5	10%	5%	88	5%	89	6%	82
Population over Age 64	10%	14%	29	15%	26	14%	35

*The National-Scale Air Toxics Assessment (NATA) is EPA's ongoing, comprehensive evaluation of air toxics in the United States. EPA developed the NATA to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that NATA provides broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. More information on the NATA analysis can be found at: https://www.epa.gov/national-air-toxics-assessment.

+The hazardous waste environmental indicator and the corresponding EJ index will appear as N/A if there are no hazardous waste facilities within 50 km of a selected location.

For additional information, see: www.epa.gov/environmentaljustice

EJSCREEN is a screening tool for pre-decisional use only. It can help identify areas that may warrant additional consideration, analysis, or outreach. It does not provide a basis for decision-making, but it may help identify potential areas of EJ concern. Users should keep in mind that screening tools are subject to substantial uncertainty in their demographic and environmental data, particularly when looking at small geographic areas. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports. This screening tool does not provide data on every environmental impact and demographic factor that may be relevant to a particular location. EJSCREEN outputs should be supplemented with additional information and local knowledge before taking any action to address potential EJ concerns.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

Summary of ACS Estimates	2010 - 2014
Population	10,316
Population Density (per sq. mile)	9,577
Minority Population	8,693
% Minority	84%
Households	3,223
Housing Units	3,535
Housing Units Built Before 1950	2,291
Per Capita Income	18,656
Land Area (sq. miles) (Source: SF1)	1.08
% Land Area	100%
Water Area (sq. miles) (Source: SF1)	0.00
% Water Area	0%

	2010 - 2014 ACS Estimates	Percent	MOE (±)
Population by Race			
Total	10,316	100%	523
Population Reporting One Race	10,002	97%	1,156
White	3,307	32%	297
Black	731	7%	173
American Indian	23	0%	21
Asian	485	5%	208
Pacific Islander	0	0%	12
Some Other Race	5,455	53%	445
Population Reporting Two or More Races	315	3%	89
Total Hispanic Population	7,787	75%	519
Total Non-Hispanic Population	2,529		
White Alone	1,624	16%	233
Black Alone	255	2%	149
American Indian Alone	10	0%	19
Non-Hispanic Asian Alone	485	5%	208
Pacific Islander Alone	0	0%	12
Other Race Alone	83	1%	88
Two or More Races Alone	72	1%	69
Population by Sex			
Male	4,969	48%	340
Female	5,348	52%	286
Population by Age			
Age 0-4	846	8%	112
Age 0-17	3,254	32%	213
Age 18+	7,063	68%	286
Age 65+	516	5%	89

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race. N/A means not available.
Source: U.S. Census Bureau, American Community Survey (ACS) 2010 - 2014.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

	2010 - 2014 ACS Estimates	Percent	MOE (±)
Population 25+ by Educational Attainment			
Total	5,617	100%	293
Less than 9th Grade	1,171	21%	140
9th - 12th Grade, No Diploma	602	11%	89
High School Graduate	2,129	38%	199
Some College, No Degree	1,314	23%	132
Associate Degree	322	6%	81
Bachelor's Degree or more	401	7%	141
Population Age 5+ Years by Ability to Speak English			
Total	9,470	100%	487
Speak only English	2,156	23%	229
Non-English at Home[1+2+3+4]	7,314	77%	398
[1]Speak English "very well"	3,576	38%	266
[2]Speak English "well"	1,274	13%	142
[3]Speak English "not well"	1,196	13%	149
[4]Speak English "not at all"	1,268	13%	200
[3+4]Speak English "less than well"	2,464	26%	235
[2+3+4]Speak English "less than very well"	3,738	39%	273
Linguistically Isolated Households*			
Total	823	100%	123
Speak Spanish	720	88%	114
Speak Other Indo-European Languages	34	4%	43
Speak Asian-Pacific Island Languages	63	8%	50
Speak Other Languages	5	1%	14
Households by Household Income			
Household Income Base	3,223	100%	130
< $15,000	678	21%	88
$15,000 - $25,000	624	19%	101
$25,000 - $50,000	987	31%	142
$50,000 - $75,000	394	12%	64
$75,000 +	539	17%	114
Occupied Housing Units by Tenure			
Total	3,223	100%	130
Owner Occupied	776	24%	97
Renter Occupied	2,447	76%	133
Employed Population Age 16+ Years			
Total	7,472	100%	412
In Labor Force	4,682	63%	280
Civilian Unemployed in Labor Force	567	8%	124
Not In Labor Force	2,790	37%	303

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race. N/A means not available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2010 - 2014.

*Households in which no one 14 and over speaks English "very well" or speaks English only.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

	2010 - 2014 ACS Estimates	Percent	MOE (±)
Population by Language Spoken at Home*			
Total (persons age 5 and above)	9,470	100%	487
English	N/A	N/A	N/A
Spanish	N/A	N/A	N/A
French	N/A	N/A	N/A
French Creole	N/A	N/A	N/A
Italian	N/A	N/A	N/A
Portuguese	N/A	N/A	N/A
German	N/A	N/A	N/A
Yiddish	N/A	N/A	N/A
Other West Germanic	N/A	N/A	N/A
Scandinavian	N/A	N/A	N/A
Greek	N/A	N/A	N/A
Russian	N/A	N/A	N/A
Polish	N/A	N/A	N/A
Serbo-Croatian	N/A	N/A	N/A
Other Slavic	N/A	N/A	N/A
Armenian	N/A	N/A	N/A
Persian	N/A	N/A	N/A
Gujarathi	N/A	N/A	N/A
Hindi	N/A	N/A	N/A
Urdu	N/A	N/A	N/A
Other Indic	N/A	N/A	N/A
Other Indo-European	N/A	N/A	N/A
Chinese	N/A	N/A	N/A
Japanese	N/A	N/A	N/A
Korean	N/A	N/A	N/A
Mon-Khmer, Cambodian	N/A	N/A	N/A
Hmong	N/A	N/A	N/A
Thai	N/A	N/A	N/A
Laotian	N/A	N/A	N/A
Vietnamese	N/A	N/A	N/A
Other Asian	N/A	N/A	N/A
Tagalog	N/A	N/A	N/A
Other Pacific Island	N/A	N/A	N/A
Navajo	N/A	N/A	N/A
Other Native American	N/A	N/A	N/A
Hungarian	N/A	N/A	N/A
Arabic	N/A	N/A	N/A
Hebrew	N/A	N/A	N/A
African	N/A	N/A	N/A
Other and non-specified	N/A	N/A	N/A
Total Non-English	N/A	N/A	N/A

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race. N/A means not available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2010 - 2014.
*Population by Language Spoken at Home is available at the census tract summary level and up.

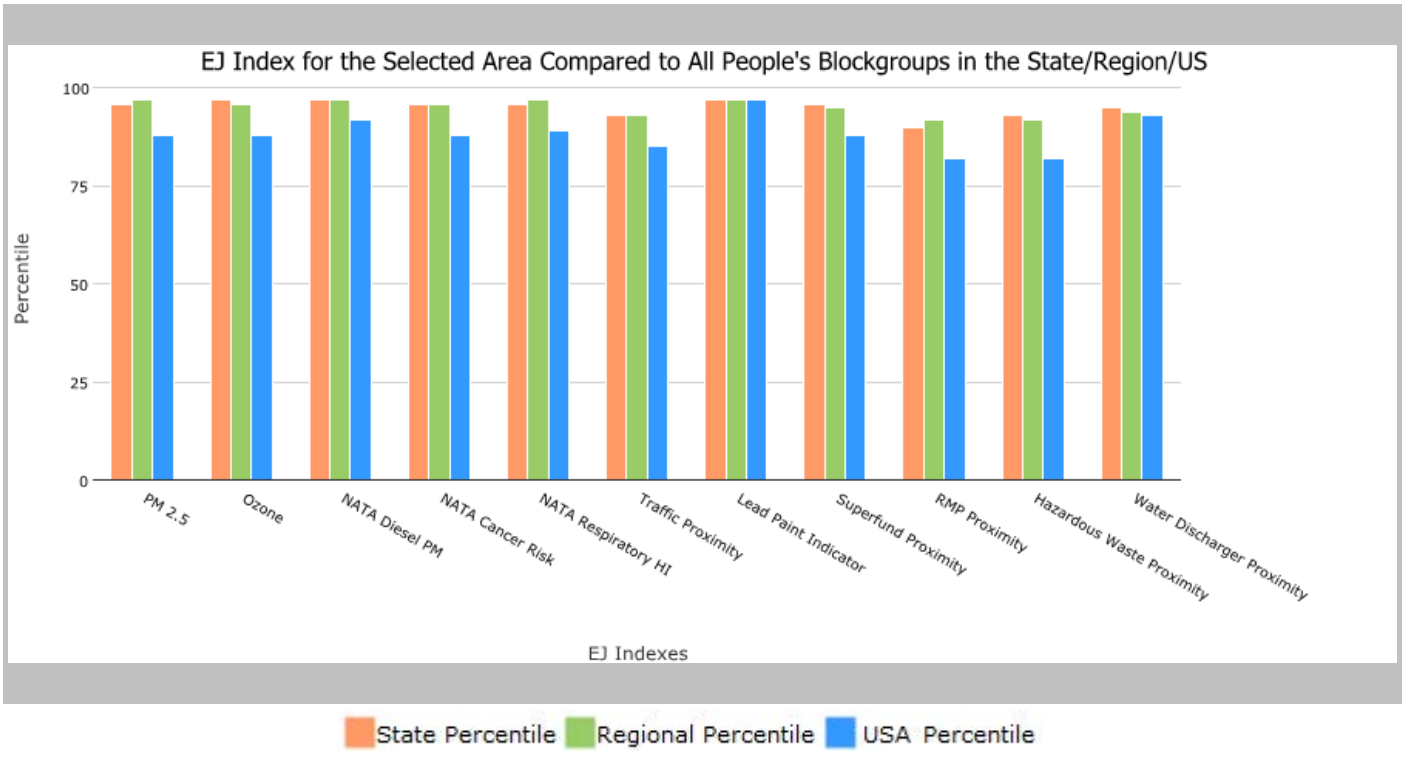
EJSCREEN Report (Version 2016)

the User Specified Area, MASSACHUSETTS, EPA Region 1

Approximate Population: 10,316

Input Area (sq. miles): 1.14

Selected Variables	State Percentile	EPA Region Percentile	USA Percentile
EJ Indexes			
EJ Index for PM2.5	96	97	88
EJ Index for Ozone	97	96	88
EJ Index for NATA* Diesel PM	97	97	92
EJ Index for NATA* Air Toxics Cancer Risk	96	96	88
EJ Index for NATA* Respiratory Hazard Index	96	97	89
EJ Index for Traffic Proximity and Volume	93	93	85
EJ Index for Lead Paint Indicator	97	97	97
EJ Index for Superfund Proximity	96	95	88
EJ Index for RMP Proximity	90	92	82
EJ Index for Hazardous Waste Proximity+	93	92	82
EJ Index for Water Discharger Proximity	95	94	93



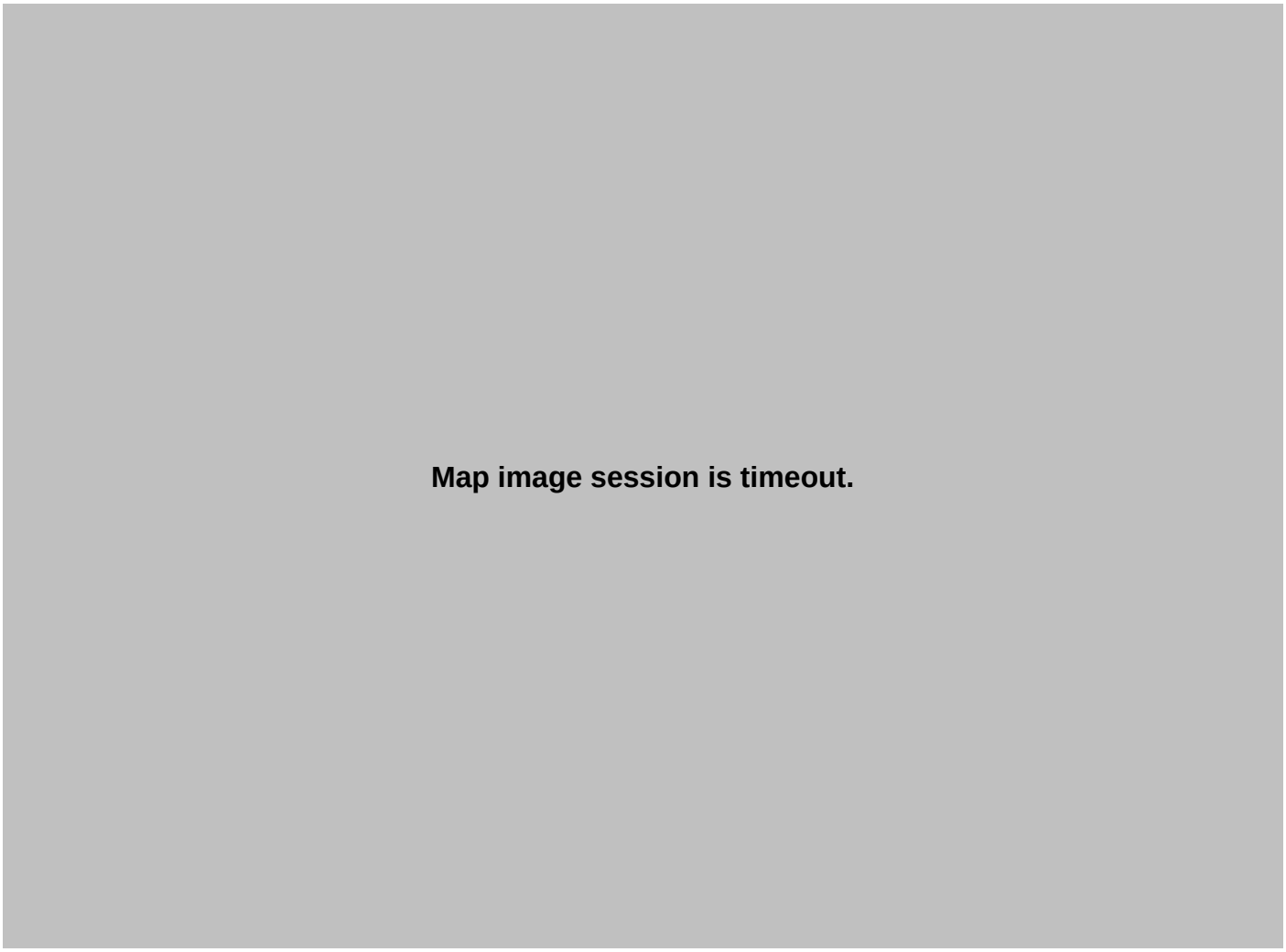
This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports.

EJSCREEN Report (Version 2016)

the User Specified Area, MASSACHUSETTS, EPA Region 1

Approximate Population: 10,316

Input Area (sq. miles): 1.14



Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	0
National Pollutant Discharge Elimination System (NPDES)	0

EJSCREEN Report (Version 2016)

the User Specified Area, MASSACHUSETTS, EPA Region 1

Approximate Population: 10,316

Input Area (sq. miles): 1.14

Selected Variables	Value	State Avg.	%ile in State	EPA Region Avg.	%ile in EPA Region	USA Avg.	%ile in USA
Environmental Indicators							
Particulate Matter (PM 2.5 in µg/m^3)	8.78	8.38	69	8.06	85	9.32	35
Ozone (ppb)	41.9	42.3	37	42.8	37	47.4	19
NATA* Diesel PM (µg/m^3)	1.44	0.869	88	0.711	90-95th	0.937	80-90th
NATA* Cancer Risk (lifetime risk per million)	42	35	80	33	80-90th	40	50-60th
NATA* Respiratory Hazard Index	2.1	1.6	80	1.5	80-90th	1.8	70-80th
Traffic Proximity and Volume (daily traffic count/distance to road)	290	290	76	320	75	590	68
Lead Paint Indicator (% Pre-1960 Housing)	0.71	0.52	69	0.46	77	0.3	87
Superfund Proximity (site count/km distance)	0.094	0.17	54	0.16	55	0.13	64
RMP Proximity (facility count/km distance)	0.18	0.36	55	0.3	62	0.43	51
Hazardous Waste Proximity+ (facility count/km distance)	0.067	0.11	43	0.12	49	0.11	49
Water Discharger Proximity (facility count/km distance)	0.36	0.36	69	0.43	65	0.31	78
Demographic Indicators							
Demographic Index	74%	25%	96	24%	96	36%	90
Minority Population	84%	25%	95	22%	95	37%	87
Low Income Population	63%	25%	93	26%	93	35%	87
Linguistically Isolated Population	25%	6%	94	5%	96	5%	95
Population With Less Than High School Education	32%	10%	93	10%	94	14%	89
Population Under 5 years of age	8%	5%	79	5%	81	6%	72
Population over 64 years of age	5%	14%	8	15%	7	14%	11

* The National-Scale Air Toxics Assessment (NATA) is EPA's ongoing, comprehensive evaluation of air toxics in the United States. EPA developed the NATA to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that NATA provides broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. More information on the NATA analysis can be found at: https://www.epa.gov/national-air-toxics-assessment.

+ The hazardous waste environmental indicator and the corresponding EJ index will appear as N/A if there are no hazardous waste facilities within 50 km of a selected location.

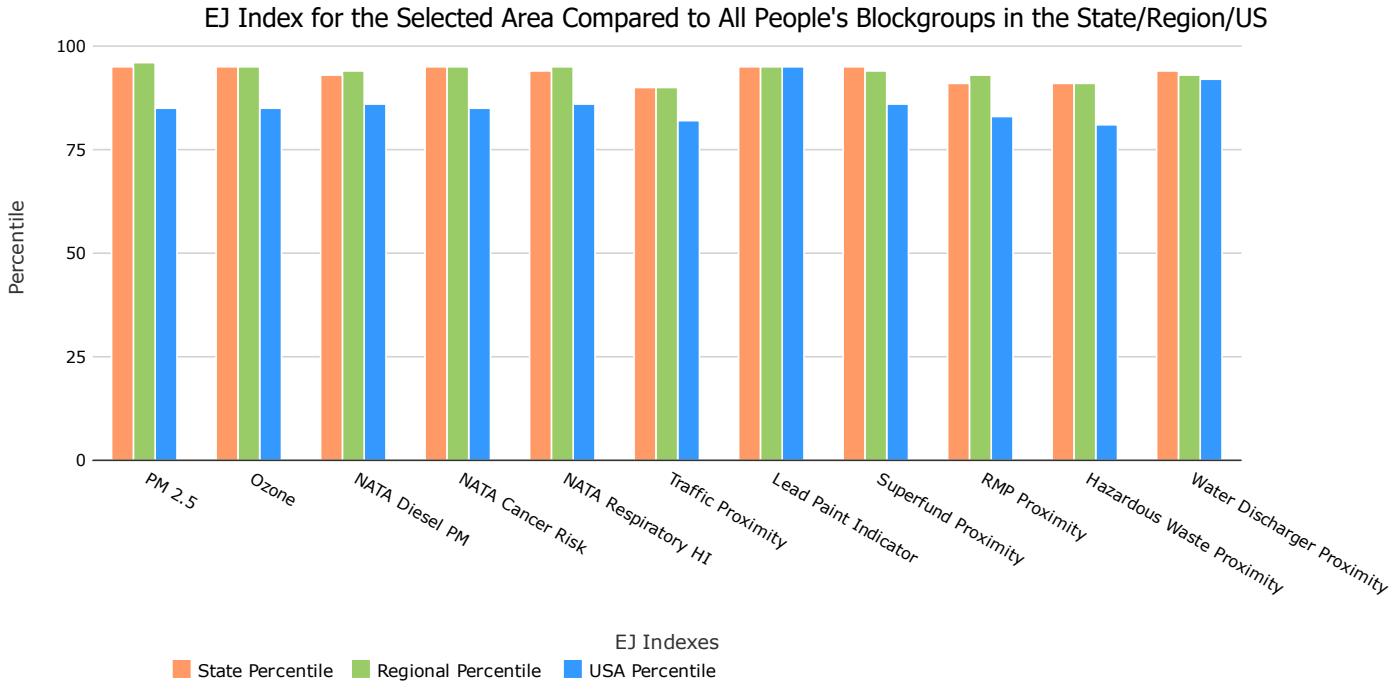
For additional information, see: www.epa.gov/environmentaljustice

Save as PDF

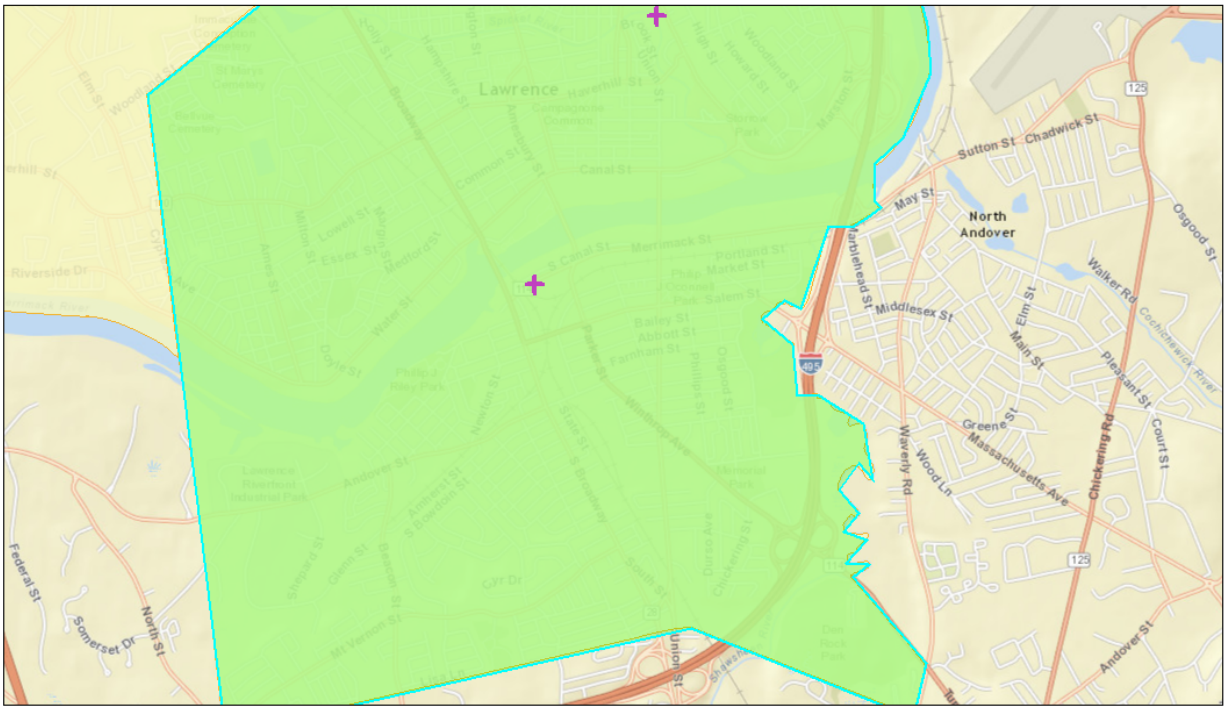
EJSCREEN Report (Version 2016)

the User Specified Area
MASSACHUSETTS, EPA Region 1
Approximate Population: 77,343
Input Area (sq. miles): 7.42

Selected Variables	Percentile in State	Percentile in EPA Region	Percentile in USA
EJ Indexes			
EJ Index for Particulate Matter (PM 2.5)	95	96	85
EJ Index for Ozone	95	95	85
EJ Index for NATA* Diesel PM	93	94	86
EJ Index for NATA* Air Toxics Cancer Risk	95	95	85
EJ Index for NATA* Respiratory Hazard Index	94	95	86
EJ Index for Traffic Proximity and Volume	90	90	82
EJ Index for Lead Paint Indicator	95	95	95
EJ Index for Superfund Proximity	95	94	86
EJ Index for RMP Proximity	91	93	83
EJ Index for Hazardous Waste Proximity+	91	91	81
EJ Index for Water Discharger Proximity	94	93	92



This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports.



Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	0
National Pollutant Discharge Elimination System (NPDES)	0

Selected Variables	Value	State Average	Percentile in State	EPA Region Average	Percentile in EPA Region	USA Average	Percentile in USA
Environmental Indicators							
Particulate Matter (PM 2.5 in µg/m^3)	8.77	8.38	68	8.06	85	9.32	35
Ozone (ppb)	41.9	42.3	38	42.8	37	47.4	19
NATA* Diesel PM (µg/m^3)	1.05	0.869	74	0.711	80-90th	0.937	60-70th
NATA* Air Toxics Cancer Risk (risk per MM)	41	35	78	33	80-90th	40	50-60th
NATA* Respiratory Hazard Index	2	1.6	75	1.5	80-90th	1.8	60-70th
Traffic Proximity and Volume (daily traffic count/distance to road)	200	290	68	320	67	590	62
Lead Paint Indicator (% pre-1960s housing)	0.67	0.52	65	0.46	73	0.3	85
Superfund Proximity (site count/km distance)	0.095	0.17	55	0.16	56	0.13	65
RMP Proximity (facility count/km distance)	0.24	0.36	65	0.3	71	0.43	61
Hazardous Waste Proximity (facility count/km distance)+	0.068	0.11	45	0.12	50	0.11	50
Water Discharger Proximity (count/km)	0.34	0.36	68	0.43	64	0.31	77
Demographic Indicators							
Demographic Index	70%	25%	94	24%	94	36%	88
Minority Population	82%	25%	94	22%	94	37%	86
Low Income Population	57%	25%	90	26%	90	35%	82
Linguistically Isolated Population	27%	6%	95	5%	96	5%	96
Population with Less Than High School Education	32%	10%	93	10%	94	14%	89
Population under Age 5	8%	5%	81	5%	83	6%	73
Population over Age 64	9%	14%	25	15%	22	14%	31

*The National-Scale Air Toxics Assessment (NATA) is EPA's ongoing, comprehensive evaluation of air toxics in the United States. EPA developed the NATA to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that NATA provides broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. More information on the NATA analysis can be found at: https://www.epa.gov/national-air-toxics-assessment.

+The hazardous waste environmental indicator and the corresponding EJ index will appear as N/A if there are no hazardous waste facilities within 50 km of a selected location.

For additional information, see: www.epa.gov/environmentaljustice

EJSCREEN is a screening tool for pre-decisional use only. It can help identify areas that may warrant additional consideration, analysis, or outreach. It does not provide a basis for decision-making, but it may help identify potential areas of EJ concern. Users should keep in mind that screening tools are subject to substantial uncertainty in their demographic and environmental data, particularly when looking at small geographic areas. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports. This screening tool does not provide data on every environmental impact and demographic factor that may be relevant to a particular location. EJSCREEN outputs should be supplemented with additional information and local knowledge before taking any action to address potential EJ concerns.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

Summary of ACS Estimates	2010 - 2014
Population	77,343
Population Density (per sq. mile)	11,169
Minority Population	63,645
% Minority	82%
Households	26,326
Housing Units	27,887
Housing Units Built Before 1950	16,289
Per Capita Income	18,675
Land Area (sq. miles) (Source: SF1)	6.92
% Land Area	100%
Water Area (sq. miles) (Source: SF1)	0.00
% Water Area	0%

	2010 - 2014 ACS Estimates	Percent	MOE (±)
Population by Race			
Total	77,343	100%	602
Population Reporting One Race	74,951	97%	1,809
White	29,067	38%	398
Black	5,403	7%	287
American Indian	272	0%	53
Asian	2,543	3%	470
Pacific Islander	0	0%	12
Some Other Race	37,666	49%	589
Population Reporting Two or More Races	2,392	3%	215
Total Hispanic Population	58,570	76%	588
Total Non-Hispanic Population	18,773		
White Alone	13,698	18%	375
Black Alone	1,755	2%	225
American Indian Alone	70	0%	43
Non-Hispanic Asian Alone	2,543	3%	470
Pacific Islander Alone	0	0%	12
Other Race Alone	313	0%	88
Two or More Races Alone	393	1%	83
Population by Sex			
Male	36,811	48%	402
Female	40,532	52%	493
Population by Age			
Age 0-4	6,522	8%	144
Age 0-17	21,629	28%	241
Age 18+	55,714	72%	370
Age 65+	6,872	9%	172

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race. N/A means not available.
Source: U.S. Census Bureau, American Community Survey (ACS) 2010 - 2014.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

	2010 - 2014 ACS Estimates	Percent	MOE (±)
Population 25+ by Educational Attainment			
Total	46,013	100%	359
Less than 9th Grade	8,857	19%	140
9th - 12th Grade, No Diploma	5,655	12%	167
High School Graduate	14,702	32%	265
Some College, No Degree	11,308	25%	168
Associate Degree	2,669	6%	102
Bachelor's Degree or more	5,490	12%	164
Population Age 5+ Years by Ability to Speak English			
Total	70,821	100%	555
Speak only English	16,579	23%	455
Non-English at Home[1+2+3+4]	54,242	77%	515
[1]Speak English "very well"	27,296	39%	303
[2]Speak English "well"	9,147	13%	174
[3]Speak English "not well"	9,662	14%	192
[4]Speak English "not at all"	8,136	11%	200
[3+4]Speak English "less than well"	17,798	25%	261
[2+3+4]Speak English "less than very well"	26,946	38%	293
Linguistically Isolated Households*			
Total	7,155	100%	123
Speak Spanish	6,639	93%	114
Speak Other Indo-European Languages	148	2%	43
Speak Asian-Pacific Island Languages	293	4%	51
Speak Other Languages	75	1%	82
Households by Household Income			
Household Income Base	26,326	100%	182
< $15,000	5,853	22%	131
$15,000 - $25,000	4,082	16%	126
$25,000 - $50,000	6,992	27%	210
$50,000 - $75,000	3,977	15%	151
$75,000 +	5,423	21%	136
Occupied Housing Units by Tenure			
Total	26,326	100%	182
Owner Occupied	7,364	28%	140
Renter Occupied	18,962	72%	166
Employed Population Age 16+ Years			
Total	58,290	100%	550
In Labor Force	37,008	63%	378
Civilian Unemployed in Labor Force	5,000	9%	159
Not In Labor Force	21,282	37%	309

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race. N/A means not available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2010 - 2014.

*Households in which no one 14 and over speaks English "very well" or speaks English only.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-mile radius
Description:

	2010 - 2014 ACS Estimates	Percent	MOE (±)
Population by Language Spoken at Home*			
Total (persons age 5 and above)	70,821	100%	555
English	N/A	N/A	N/A
Spanish	N/A	N/A	N/A
French	N/A	N/A	N/A
French Creole	N/A	N/A	N/A
Italian	N/A	N/A	N/A
Portuguese	N/A	N/A	N/A
German	N/A	N/A	N/A
Yiddish	N/A	N/A	N/A
Other West Germanic	N/A	N/A	N/A
Scandinavian	N/A	N/A	N/A
Greek	N/A	N/A	N/A
Russian	N/A	N/A	N/A
Polish	N/A	N/A	N/A
Serbo-Croatian	N/A	N/A	N/A
Other Slavic	N/A	N/A	N/A
Armenian	N/A	N/A	N/A
Persian	N/A	N/A	N/A
Gujarathi	N/A	N/A	N/A
Hindi	N/A	N/A	N/A
Urdu	N/A	N/A	N/A
Other Indic	N/A	N/A	N/A
Other Indo-European	N/A	N/A	N/A
Chinese	N/A	N/A	N/A
Japanese	N/A	N/A	N/A
Korean	N/A	N/A	N/A
Mon-Khmer, Cambodian	N/A	N/A	N/A
Hmong	N/A	N/A	N/A
Thai	N/A	N/A	N/A
Laotian	N/A	N/A	N/A
Vietnamese	N/A	N/A	N/A
Other Asian	N/A	N/A	N/A
Tagalog	N/A	N/A	N/A
Other Pacific Island	N/A	N/A	N/A
Navajo	N/A	N/A	N/A
Other Native American	N/A	N/A	N/A
Hungarian	N/A	N/A	N/A
Arabic	N/A	N/A	N/A
Hebrew	N/A	N/A	N/A
African	N/A	N/A	N/A
Other and non-specified	N/A	N/A	N/A
Total Non-English	N/A	N/A	N/A

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race. N/A means not available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2010 - 2014.
*Population by Language Spoken at Home is available at the census tract summary level and up.

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

This table summarizes the literature review the APA SCD team conducted as part of the research and assessment phase of the GWL Green Streets Tree Planting Program HIA. This table was used to classify and rank the strength of evidence and correlation - how specific/relevant is the research to street tree impacts and the GWL Green Streets Tree Planting Program specifically. This assisted the APA SCD team in identifying key elements within each of the priority impact areas that helped inform the findings and recommendations in this HIA. These rankings also helped the APA SCD team in developing messaging deliverables to GWL (communicating the benefits of planting streets trees to the residents in the Arlington and South Common Neighborhoods).

Ranking Key:

0 : speculative. The impacts are supported by expert opinion but the direct correlation to street trees is weak.
+ : probable. The impacts relate to street trees and community stakeholder input and are supported by scientific studies.
++: definite. The impacts relate directly to street trees and community stakeholder input and are based on studies or scientific literature that supports causal relationships.

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Environmental	Air Quality	Estimated total annual air pollution removal (of ozone, particulate matter, NO2, SO2, and carbon monoxide) by urban trees across 55 U.S. cities is 711,000 metric tons, representing $3.8 billion in public value.	http://depts.washington.edu/hhwb/Thm_Risk.html	++	
	Air Quality	Urban heat island effect: Parks can be up to 2°F cooler than the surrounding urban area in the day. Large numbers of trees and expansive green spaces across a city can reduce local air temperatures by up to 9°F.	http://depts.washington.edu/hhwb/Thm_Risk.html	+	
	Air Quality	City residents who live adjacent to green space have lower levels of illness and disease than other people of similar income levels. Physical environments that promote good health may reduce socioeconomic health inequalities.	http://depts.washington.edu/hhwb/Thm_Risk.html	0	
	Air Quality	"It's estimated an urban street with street trees has a 60% reduction in street level particulates (a type of air pollution from the burning of fuel) compared to an urban street with little or no street trees, (Johnson, 2009)	http://ac.els-cdn.com/S1877042812004004/1-s2.0-S1877042812004004-main.pdf?_tid=a68226cc-7fe5-11e6-929c-00000aab0f02&acdnat=1474453680_784fbf001acd9ee49b093b268b4e89f7 Towards a Better Tomorrow: Street Trees and Their Values in Urban Areas, Kadir and Othman.	++	
	General	General - According to the US Forest Service, a large tree with a trunk diameter 10 times larger than a small tree (76.2 cm vs. 7.62 cm, i.e., 30 inch vs. 3 inch diameter at breast height) produces 60-70 times the ecological services (McPherson et al, 1994); approaching 2 orders of magnitude increase!	http://www.ingentaconnect.com/content/wef/wefproc/2012/00002012/00000005/art00054 The Urban Forest is Broken: Rethinking Street Trees as Urban Infrastructure Peter MacDonagh, The Kestrel Design Group, Inc. and University of Minnesota Thomas Smiley, Bartlett Lab and Clemson University David Bloniarz,	++	

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Environmental continued....	Shade/Heat Island	USDA Forest Service Urban Natural Resources Institute Transpiration draws heat from the air to change the water in the vegetation into water vapor, so in addition to providing stormwater benefits, transpiration also decreases ambient air temperature and reduces the urban heat island effect. Trees in Davis, California, parking lots, for example, reduced asphalt temperatures by as much as 36° F, and car interior temperatures by over 47° F (Scott et al 1999)	http://www.ingentaconnect.com/content/wef/wefproc/2012/00002012/00000005/art00054 The Urban Forest is Broken: Rethinking Street Trees as Urban Infrastructure Peter MacDonagh, The Kestrel Design Group, Inc. and University of Minnesota Thomas Smiley, Bartlett Lab and Clemson University David Bloniarz,	+	This article relates to the benefits of street trees in a parking lot, but does not directly relate to community stakeholders such as adjacent homeowners
	Stormwater Quality	The presence of vegetation substantially improves TP and TN retention, as vegetated media is much more effective than unvegetated media at removing PO4 from solution and preventing NO3 leaching from media (e.g. Henderson et al 2007, Lucas and Greenway 2007a, 2007b, 2008, May et al 2006). Not only has vegetation been shown to significantly improve nutrient removal, trees also benefit from the nutrients in stormwater (May et al 2006), with greater height growth and root density compared with those irrigated with tap water.	http://www.ingentaconnect.com/content/wef/wefproc/2012/00002012/00000005/art00054 The Urban Forest is Broken: Rethinking Street Trees as Urban Infrastructure Peter MacDonagh, The Kestrel Design Group, Inc. and University of Minnesota Thomas Smiley, Bartlett Lab and Clemson University David Bloniarz,	+	This article relates to the benefits of vegetation and trees, but does not directly relate to community stakeholders such as adjacent homeowners
	Stormwater Quantity	Urban trees provide a range of benefits to communities, including moderating storm-water runoff and increasing property values.	http://www.fs.fed.us/pnw/ruwit/papers/donovan/TheEffectofTreesonCrime.pdf The Effect of Trees on Crime in Portland, Oregon, Geoffrey H. Donovan and Jeffrey P. Prestemon	+	
	Stormwater Quantity	Urban forest can reduce annual stormwater runoff by 2–7 percent, and a mature tree can store 50 to 100 gallons of water during large storms - Fazio, Dr. James R. "How Trees Can Retain Stormwater Runoff." Tree City USA Bulletin 55. Arbor Day Foundation (from Alliance for Community Trees, Benefits of Trees and Urban Forests.)	http://www.actrees.org/files/Research/benefits_of_trees.pdf	++	
	Air Quality	In study show canopy coverage associated with higher prevalence of allergic sensitization to tree pollen for children living in New York City.	Lovasi, G.S., et al. Urban Tree Canopy and Asthma, Wheeze, Rhinitis, and Allergic Sensitization to Tree Pollen in a New York City Birth Cohort. Environ Health Perspect. 2013; 121(4): 494-500. doi: 10.1289/ehp.1205513	+	
	Air Quality	A study conducted in US counties with radical tree loss may increase in mortality related to cardiovascular and lower-respiratory-tract illnesses.	Donovan, G.H., D.T. Butry, Y.L. Michael, J.P. Prestemon, A.M. Liebhold, D. Gatziolis, and M.Y. Mao. The Relationship Between Trees and Human Health: Evidence from the Spread of the Emerald Ash Borer. 2013; American Journal of Preventive Medicine 44, 2:139-145.	+	

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Environmental continued....	Air Quality	Trees clean the air by absorbing carbon dioxide, sulphur dioxide, nitrous oxides and other pollutants, and also shade cars and parking lots, reducing ozone emissions from vehicles. -	http://www.actrees.org/files/Research/benefits_of_trees.pdf McPherson, Gregory, James Simpson, Paula Peper, Shelley Gardner, Kelaine Vargas, Scott Maco, and Qingfu Xiao. "Coastal Plain Community Tree Guide: Benefits, Costs, and Strategic Planting". USDA, Forest Service, Pacific Southwest Research Station. (2006) (from Alliance for Community Trees, Benefits of Trees and Urban Forests.)	+	
	Air Quality	The tree canopy of New York City, removes 1,973 tons of air pollution annually at a value of $9.24 million. - Nowak, David, Daniel Crane, and Jack Stevens. "Air pollution removal by urban trees and shrubs in the United States." Urban Forestry and Urban Greening. 4 (2006) (from Alliance for Community Trees, Benefits of Trees and Urban Forests.)	http://www.actrees.org/files/Research/benefits_of_trees.pdf	+	Discusses tree canopy, not street trees in particular
	Shade	A person standing in direct sunlight takes 20 minutes to burn. However, under a tree providing 50% coverage it takes 50 minutes to burn, and under full shade it takes 100 minutes before one to get a sunburn. - Purdue University. "Trees Could Affect Land Use, Reduce Skin Cancer." San Diego Earth Times. Mar. 2003. (from Alliance for Community Trees, Benefits of Trees and Urban Forests.)	http://www.actrees.org/files/Research/benefits_of_trees.pdf	++	
	Noise	Trees absorb high frequency noise which are most distressing to people. - McPherson, Gregory, James Simpson, Paula Peper, Qingfu Xiao, Dennis Pettinger, and Donald Hodel. Tree Guidelines for Inland Empire Communities. Rep. Western Center for Urban Forest Research and Education, USDA Forest Service, Pacific Southwest Research Station, 2001. (from Alliance for Community Trees, Benefits of Trees and Urban Forests.)	http://www.actrees.org/files/Research/benefits_of_trees.pdf	+	
	Noise	Planting "noise buffers" composed of trees and shrubs can reduce 50% of noise to the human ear. - USDA National Agroforestry Center. "Is Agroforestry a Solution to the Southeast's Poultry Waste Overload?" Inside Agroforestry 1998. (from Alliance for Community Trees, Benefits of Trees and Urban Forests.)	http://www.actrees.org/files/Research/benefits_of_trees.pdf	++	
	Air Temperatures	Trees and vegetation lower surface and air temperatures by providing shade and through evapotranspiration. Shaded surfaces may be 20–45°F cooler than peak temp of unshaded materials. Evapotranspiration, helps reduce peak summer temperatures by 2–9°F. -	http://www.actrees.org/files/Research/benefits_of_trees.pdf Trees and Vegetation | Heat Island Effect | US EPA." US Environmental Protection Agency. (from Alliance for Community Trees, Benefits of Trees and Urban Forests.)	++	
	Wind	Evergreens serve as windbreaks and in the winter save 10-50% on heating costs. - Trees Save Energy. Maryland Department of Natural Resources. (from Alliance for Community Trees, Benefits of Trees and Urban Forests.)	http://www.actrees.org/files/Research/benefits_of_trees.pdf	0	Not sure how many evergreens Groundwork Lawrence will plant

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Environmental continued....	Leaf litter	Simply planting street trees without consulting homeowners would be a mistake, as homeowners place different values on different types of trees. Indeed, some homeowners do not like trees of any type: they block views, drop leaves, and can damage pavements. For these reasons, a subsidy or property-tax break might be an appropriate way to increase the number of street trees. Homeowners would be free to choose the number and type of trees they prefer (given the constraints of the site)	http://www.fs.fed.us/pnw/pubs/journals/pnw_2010_donovan001.pdf? Trees in the City: Valuing street trees in Portland, Oregon, Geoffrey H. Donovan, David T. Butry	++	Directly discusses street trees and interacting with the community
	Air Quality	Estimated total annual air pollution removal (of ozone, particulate matter, NO2, SO2, and carbon monoxide) by urban trees across 55 U.S. cities is 711,000 metric tons, representing $3.8 billion in public value.	http://depts.washington.edu/hhwb/Thm_Risk.html	++	
	Urban Heat Island	Urban heat island effect occurs in built up areas. Parks can be up to 2°F cooler than the surrounding urban area in the day.[71] Large numbers of trees and expansive green spaces across a city can reduce local air temperatures by up to 9°F	http://depts.washington.edu/hhwb/Thm_Risk.html	+	
	Disease	Asthma: The effects of urban tree canopy on asthma are complex and include direct beneficial effects on asthma prevalence, potentially beneficial effects due to removal of air pollutants, and harmful effects due to tree pollen.	http://depts.washington.edu/hhwb/Thm_Risk.html	++	
	Disease	COPD: Individuals with myocardial infarction (MI), COPD, congestive heart failure (CHF) or diabetes are at higher risk of death when summer temperature increases; however, the proportion of green surface appears to significantly modify this association. It is possible that green space could lessen the symptoms of COPD and even reduce mortality.	"Expanding Urban Tree Canopy as a Community Health Climate Adaptation Strategy: *A Health Impact Assessment of the Ann Arbor Urban & Community Forest Management Plan*	0	
	Diabetes	There does not appear to be a direct link between Type 2 diabetes and green space. There are links between diabetes and lack of physical activity, which in turn is linked to lack of green space. Green space promotes physical activity and hence has the potential to reduce diabetes symptoms and prevalence.	"Expanding Urban Tree Canopy as a Community Health Climate Adaptation Strategy: *A Health Impact Assessment of the Ann Arbor Urban & Community Forest Management Plan*	0	
	Hypertension	High quality green space was associated with lower systolic blood pressure and lower odds of hypertension. Walking in a natural environment reduced blood pressure while walking in an urban area produced the opposite result. Just sitting in a room with a view of trees or similar green space reduced diastolic blood pressure. Neighborhoods with high quality green space provide the opportunity for spending more time outdoors which could lead to lower blood pressure.	"Expanding Urban Tree Canopy as a Community Health Climate Adaptation Strategy: *A Health Impact Assessment of the Ann Arbor Urban & Community Forest Management Plan*	0	

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Environmental continued....	Air Pollution	Air Pollution has been linked with a number of chronic diseases including respiratory disease, high blood pressure, cardiovascular disease, chronic obstructive pulmonary disease (COPD), anxiety, and all-cause mortality. Pollutants removed by urban trees and vegetation include ozone, particulates, nitric oxide, sulfur dioxide, carbon monoxide and carbon dioxide. Both gaseous and particulate air pollution has been linked to asthma development and exacerbations in many studies; while persons with COPD were at increased risk of death related to elevated ozone and PM10 particulate levels.	"Expanding Urban Tree Canopy as a Community Health Climate Adaptation Strategy: *A Health Impact Assessment of the Ann Arbor Urban & Community Forest Management Plan*	0	
	Micro-climate	Tree canopy lowering wind speeds and reducing summertime air temperature. For every 1% increase in tree canopy above a minimum 10% canopy cover, the energy benefit is 1.9% reduction in energy for cooling, and 1.1 % reduction in energy for heating.	Tree Canopy Cover In Residential Areas – MA EOEEA, 2010	++	
	Disease	Higher Street Tree Density associated with lower prevalence of early childhood asthma. Children living in areas with more street trees have lower prevalence of asthma	Lovasi, G.S., Quinn, J.W., Neckerman, K.M., Perzanowski, M.S., Rundle A.	++	
	Allergies	Increase canopy coverage associated with higher prevalence of allergic sensitization to tree pollen.	J Epidemiol Community Health. 2008;62(7):647-9. doi : 10.1136/jech.2007.071894	++	
	Disease	Decrease urban forest canopy = increase in mortality related to cardiovascular and lower-respiratory-tract illness in counties with radical tree loss.	Lovasi, G.S., et al. Urban Tree Canopy and Asthma, Wheeze, Rhinitis, and Allergic Sensitization to Tree Pollen in a New York City Birth Cohort. Environ Health Perspect. 2013; 121(4): 494–500. doi: 10.1289/ehp.1205513	++	
	Air Quality	Urban trees can reduce energy demand, indirectly contributing to improved air quality.	Hartig, T., R. Mitchell, S. de Vries, and H. Frumkin. 2014. Nature and Health. Annual Review of Public Health 35, 1: 207-228.	++	
	Biodiversity	Trees and Biodiversity in Cities	http://e360.yale.edu/feature/urban_nature_how_to_foster_biodiversity_in_worlds_cities/2725/	+	
	Wildlife Habitat	Urban trees 'help migrating birds'	http://www.bbc.com/news/10130458	++	
	Wildlife Habitat	Promoting and preserving biodiversity in the urban forest	http://www.cropprotection.es/documentos/Jardineria/promoting%20and%20preserving%20biodiversity.pdf	+	
	Wildlife Habitat	Non-uniform bird assemblages in urban environments: the influence of streetscape vegetation	http://s3.amazonaws.com/academia.edu.documents/45237759/Non-uniform_bird_assemblages_in_urban_en20160430-7911-12y76it.pdf?AWSAccessKeyId=AKIAJ56TQJRTWSMTNPEA&Expires=1471811196&Signature=4nikQU2Ia%2B4qRKeFnBRP4PPimul%3D&response-content-disposition=inline%3B%20filename%3DNon-uniform_bird_assemblages_in_urban_en.pdf	++	

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Environmental continued….	Multiple	Benefits of Trees and Urban Forests: Traffic calming, extended pavement life, stormwater, air quality, property values - thorough Research List	http://www.actrees.org/files/Research/benefits_of_trees.pdf	++	
	Air Quality/Emissions	Pollution removal from trees in urban environments - facts and figures	https://www.arborday.org/trees/treefacts/	+	
	Green Infrastructure	Planning the Urban Forest: Ecology, Economy, and Community Development	http://www.na.fs.fed.us/urban/planning_uf_apa.pdf	++	

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Mental Health	Physical/Mental health/Well-being	Women living within 800 feet of vegetation had a 12 per cent lower rate of mortality and improved mental health, compared to those living among lower levels of greenness.	Environmental Health Perspectives journal. Harvard School of Public Health	+	
	Physical/Mental health/Well-being	Ann Arbor HIA on trees & health – found strongest correlation in studies with reduction in obesity, mental health distress/stress, asthma.	http://mml.org/resources/educenter/pdf/2014-02-25-green-smith.pdf	++	
	Mental health/ Ecotherapy	How the use of ecotherapeutic approaches can provide a two-pronged system to achieve both individual health (at micro level) and public and environment health outcomes (at macro level). People seeking personal recovery also, through stewardship of green spaces, may achieve unanticipated social capital and natural capital outcomes and thereby meet current multi-disciplinary policy targets. This added social value has not been previously considered as an important dimension in people's well-being and recovery from ill health or social exclusion. Such outcomes emerge from the idea of green spaces becoming a 'product' delivered to the community by people whose pursuit of personal recovery also directly contributes to improved public mental health.	http://www.emeraldinsight.com/doi/abs/10.1108/17465729200700018	+	Abstract. Couldn't open article
	Mental fatigue, concentration and decision making	Women who lived in apartment buildings with trees and greenery immediately outside reported committing fewer aggressive and violent acts against their partners in the preceding year than those living in barren but otherwise identical buildings. Exposure to green surroundings reduces mental fatigue and the feelings of irritability that come with it. The ability to concentrate is refreshed by green views, along with the ability and willingness to deal with problems thoughtfully and less aggressively.	Aggression and violence in the inner city: Impacts of environment via mental fatigue. Environment & Behavior, 33(4), 543-571. Kuo, F.E. & Sullivan W.C. (2001).	0	
	Mortality	Women living within 800 feet of vegetation had a 12 per cent lower rate of mortality and improved mental health, compared to those living among lower levels of greenness.	Recent findings, published in the Environmental Health Perspectives journal by a team at the Harvard School of Public Health		
	Physical Activity	Appealing and easily accessible green environments may motivate and encourage physical exercise. Activity in outdoor green spaces - at any level, intensity, duration, or type – has been associated with mental and physical benefits.	http://depts.washington.edu/hhwb/Thm_Risk.html	0	
	Mental Distress	Access to green space appears to be beneficial, possibly in conjunction with increased physical activity. A positive effect from visual exposure to green spaces on stress was found by a number of studies, and accessibility to green spaces may help reduce stress and benefit children with ADHD.	"Expanding Urban Tree Canopy as a Community Health Climate Adaptation Strategy: *A Health Impact Assessment of the Ann Arbor Urban & Community Forest Management Plan*	0	
	Emotion	Plant Color affecting Emotional and Physiological Responses to Landscapes.	http://www.ctahr.hawaii.edu/kaufmana/downloads/Kaufman%20and%20Lohr%202004.pdf	+	
	Stress	Green space as a buffer between stressful life events and health	http://www.sciencedirect.com/science/article/pii/S0277953610000675	+	

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Mental Health cont...	Well-being	Green infrastructure and its effects on health and psychological well-being.	http://static1.squarespace.com/static/56e9367020c64742fe062659/t/56fd16022fe131ba2aaed188/1459426836832/Implications+for+-+CRN+Study.pdf	+	
	Mental Distress	How Trees Calm Us Down	http://www.newyorker.com/tech/elements/what-is-a-tree-worth	++	
	Depression	How Walking in Nature Prevents Depression	http://www.theatlantic.com/health/archive/2015/06/how-walking-in-nature-prevents-depression/397172/	+	
	Mood	The Relaxing Effect of trees	NC State University Co-op Ex - https://www.ncsu.edu/project/treesofstrength/benefits.htm	+	
	Mood	Trees and Landowner Pride	NC State University Co-op Ex - https://www.ncsu.edu/project/treesofstrength/benefits.htm	+	
	Health	Slower heartbeats, lower blood pressure and more relaxed brain wave patterns when exposed to green.	NC State University Co-op Ex - https://www.ncsu.edu/project/treesofstrength/benefits.htm	+	
	Sound	Sound waves are absorbed by tree leaves and branches. A belt of trees 100 feet wide and 45 feet high can reduce highway noise by 50 percent. Prolonged exposure to noise can cause hypertension, higher cholesterol levels, irritability and aggressive behavior.	NC State University Co-op Ex - https://www.ncsu.edu/project/treesofstrength/benefits.htm	+	
	Concentration	A Systematic Review of Evidence for the added benefits to health from from Exposure to Natural Environments	BMC Public Health, 2010 - http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2924288/pdf/1471-2458-10-456.pdf	0	Greater levels of attention
	Disease	Obesity, physical activity, and the urban environment: public health research needs	BioMed Central - Environmental Health, 2006 - http://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-5-25	0	
	Disease	How and why do individuals make food and physical activity choices?	Nutrition Reviews, 2001 - http://nutritionreviews.oxfordjournals.org/content/59/3/S11	0	
	Stress	Mental stress can lead to unhealthy habits, immune system suppression and cardiovascular disease, cancer, stroke, depression, asthma, and other severe health problems. Tree canopy in communities can significantly aid stress recovery.	A Dose-Response Curve Describing the Relationship Between Urban Tree Cover Density and Self-Reported Stress Recovery. Environment & Behavior Journal, 2014 - https://www.dropbox.com/s/8vycat9f5la2tiz/JiangLiLarsenSullivan2015.pdf?dl=0	++	
	Physical Health	Reducing obesity, encouraging active lifestyles	Green Cities Good Health; University of Washington, Urban Forestry/Urban Greening Research, 2010 - https://depts.washington.edu/hhwb/Thm_ActiveLiving.html	+	
	Mood	Mental Health & Function	Green Cities Good Health; University of Washington, Urban Forestry/Urban Greening Research, 2015 - https://depts.washington.edu/hhwb/Thm_Mental.html	+	

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Social Cohesion	Social Interaction/Safety	People prefer natural over hardscape settings. Urban residents dislike and fear treeless, empty common spaces. The addition of trees and grass dramatically changed their perceptions of those spaces. The presence, number, and location of trees strongly predicted the amount of time that inner-city residents actually spent in outdoor common spaces around urban public housing. Strong community relationships may result in individuals being more likely to work together to achieve common goals (e.g., cleaner and safer public spaces), to exchange information, and to maintain informal social controls (e.g., discouraging crime or other undesirable behaviors). . Communities where residents express high mutual trust and reciprocity have been linked with lower homicide rates. Neighborhoods lacking social cohesion and community wellness conversely, have been related to higher rates of social disorder, anxiety, and depression and can influence public health. Older adults who have more exposure to green common spaces report a stronger sense of unity among residents within their local neighborhood, and experience a stronger sense of belonging to the neighborhood. Signs of stronger communities where there are trees. In buildings with trees, people-report significantly better relations with their neighbors. People report a stronger feeling of unity and cohesion with their neighbors; they like where they are living more and they feel safer than residents who have few trees around them. People feel trees improve quality of life & communities by making people feel calmer.	*Wolf, K.L., and M.A. Rozance. 2013. Social Strengths - A Literature Review. In: Green Cities: Good Health www.greenhealth.washington.edu College of the Environment, University of Washington.*	+	
	Community Effort (planting & maintenance)	Urban green spaces can provide a neutral space within which people come together, social interactions occur (that include people from different backgrounds), and relationships or partnerships take form. While personal goals or desires are achieved, community building and increased social capital also emerge, particularly if people share work on a project or goal. Individual benefits, improved public health, and social resilience are potential positive outcomes.	http://depts.washington.edu/hhwb/Thm_Community.html	+	
	Community Effort (planting & maintenance)	Community garden programs in upstate New York surveyed to identify characteristics that may be useful to facilitate neighborhood development and health promotion. The most commonly expressed reasons for participating in gardens were access to fresh foods, to enjoy nature, and health benefits. Gardens in low-income neighborhoods (46%) were four times as likely as non low-income gardens to lead to other issues in the neighborhood being addressed; reportedly due to organizing facilitated through the community gardens. Additional research on community gardening can improve our understanding of the interaction of social and physical environments and community health, and effective strategies for empowerment, development, and health promotion.	http://www.sciencedirect.com/science/article/pii/S1353829200000137	+	Appears to be a strong correlation between community building and community gardens (similar, but not exactly like tree planting).

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Social Cohesion cont…	Neighborhood beautification	Well-managed vegetation promoting the development of social ties. The presence of trees and grass is related to the rate of use of outdoor spaces, the amount of social activity that takes place within them. Physical features influence social contact among neighbors, and nature plays an important role in creating vital neighborhood spaces. Caring for trees is related to social ties among neighbors. Inner-city residents who spend time in outdoor common spaces caring for flowers, grass, or trees outside of their homes were more likely to have strong social networks with their neighbors.	*Wolf, K.L., and M.A. Rozance. 2013. Social Strengths - A Literature Review. In: Green Cities: Good Health www.greenhealth.washington.edu College of the Environment, University of Washington.*	+	
	Neighborhood beautification	Natural landscaping encourages greater use of outdoor areas by residents. Spaces with trees attract larger groups of people—as well as more mixed groups of youth and adults. More dense groupings of trees and trees that are located close to public housing buildings attract larger groups of people.	https://depts.washington.edu/hhwb/Thm_Community.html	++	
	Social Interaction	This study examines how the availability of nature influences the use of outdoor public spaces in two Chicago public housing developments. Ninety-six observations were collected of the presence and location of trees and the presence and location of youth and adults in semiprivate spaces at one high-rise and one low-rise public housing development. Results consistently indicated that natural landscaping encourages greater use of outdoor areas by residents. Spaces with trees attracted larger groups of people, as well as more mixed groups of youth and adults, than did spaces devoid of nature. In addition, more dense groupings of trees and trees that are located close to public housing buildings attracted larger groups of people. These findings suggest that natural elements such as trees promote increased opportunities for social interactions, monitoring of outdoor areas, and supervision of children in impoverished urban neighborhoods.	http://eab.sagepub.com/content/29/4/468.short	+	
	Social Activity	The presence of trees and grass is related to the use of outdoor spaces, the amount of social activity that takes place within them, and the proportion of social to nonsocial activities they support. Nature plays an important role in creating vital neighborhood spaces.	http://eab.sagepub.com/content/36/5/678.short	+	
	Perceived Crime	Public housing residents with nearby trees and natural landscapes reported 25% fewer acts of domestic aggression and violence. Less graffiti, vandalism, and littering in outdoor spaces with natural landscapes than in comparable plant-less spaces.	69. Greenbaum, S.D. 1982. Bridging Ties at the Neighborhood Level. *Social Networks* 4:367–384.	+	
	Perceived Crime	Apartment buildings with high levels of greenery had 52% fewer crimes than those without any trees. Buildings with medium amounts of greenery had 42% fewer crimes. Street trees fronting a house reduced 44 crime occurrences. The net effect of all trees was a reduction in 33 crimes.	http://dunwoodyga.gov/ckeditorfiles/files/Master_Plans/Tree%20Inventory%20and%20Assessment/TI%26A%20-%20Benefits%20of%20Trees.pdf	++	

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Social Cohesion cont…	Perceived Crime	Residents living in greener surroundings report lower levels of fear, fewer incivilities and less violent behavior. The study also found that the greener a building's surrounding, the fewer reported crimes.	http://www.canopy.org/wp-content/uploads/Public%20Health%20Benefits%20of%20Trees%20%202-15-11.pdf Environment and crime in the inner city: Does vegetation reduce crime? Environment & Behavior, 33(3), 343-367, Kuo, F.E., & Sullivan, W.C. (2002).	0	
	Socio-economic health inequities	City residents who live adjacent to green space have lower levels of illness and disease than other people of similar income levels. Physical environments that promote good health may reduce socioeconomic health inequalities.	http://depts.washington.edu/hhwb/Thm_Risk.html	0	
	Social activity	Green Spaces as mentally healthy places to grow	http://eab.sagepub.com/content/30/1/3.short		
	Social interaction	Associations of neighbourhood greenness with physical and mental health. Walking, social coherence and local social interaction.	http://jech.bmj.com/content/62/5/e9.short	+	
	Social interaction	The social and cultural values, and governance, of street trees	http://www.forestry.gov.uk/pdf/CCST_Social_Report_March2010.pdf/$FILE/CCST_Social_Report_March2010.pdf	++	
	Health and Safety	Neighborhood safety and green space as predictors of obesity among preschool children from low-income families in New York City	http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3748212/		
	Community engagement	Lessons Learned in the Inner City (great article on stakeholder engagement around trees)	http://na.fs.fed.us/urban/hottopics/05_UF_Inner_City_Forum_Aug5.pdf	++	
	Mood	Trees and Privacy	NC State University Co-op Ex - https://www.ncsu.edu/project/treesofstrength/benefits.htm		
	Maintenance	Maintenance and its effect on success of trees. Care needs to go into ensuring that there is enough water at specific times, to be observant of how much it needs (and not to over/under water it), fertilization (if necessary), mulching, and pruning (if necessary).	https://www.ncsu.edu/project/treesofstrength/benefits.htm		GWL should consider this in the development of the project and potentially have ongoing support available for resident questions, online Q&A/FAQs, and maybe even classes. There are a TON of site s about how to care for a tree, so care should be taken to provide consistent information that is simple and does not overwhelm the potential caretaker.
	Maintenance	Homeowner Interactions with Residential Trees in Urban Areas - Attitude towards planting and maintaining trees	Journal of Arboriculture, 2013 - file:///C:/Users/Angierapp/AppData/Local/Microsoft/Windows/INetCache/IE/UR2Z0P4Q/2013.Dec.Dilley_Wolf.ArbUF.pdf	++	
	Social Capital	Community & Social Cohesion and Connections Social Life Under Cover: Tree Canopy and Social Capital in Baltimore, Maryland	Environment & Behavior Journal, 2014 - https://www.dropbox.com/s/wkrlpj2txx4taaf/Holtan%2C%20Dieterlen%2C%20Sullivan%2C%202014.pdf?dl=0	+	
	Safety	Trees and road design, reductions in driver stress and speeds, and crashes	Green Cities Good Health; University of Washington, Urban Forestry/Urban Greening Research, 2010 - https://depts.washington.edu/hhwb/Thm_SafeStreets.html	++	

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Social Cohesion cont…	Safety	Effect of street trees on driving behavior, safety perception, and speed	The Street Tree Effect and Driver Safety; ITE Journal on the Web, 2008; https://www.dropbox.com/s/g7j2pmok9rsjic4/Tree%26Driver_ITE.pdf?dl=0	++	
	Maintenance	Newly planted trees less than three years require 25 gallons of water (1.5 inches of rainfall per week to survive)	Casey Trees DC, 2016 - http://caseytrees.org/get-involved/water/	++	
	Crime/Safety	All crime, violent crime, property crime, burglary, vandalism	The Effect of Trees on Crime in Portland, Oregon; Environment & Behavior Journal, 2012 - https://www.dropbox.com/s/nd7db6fhyca14i3/ja_2012_donovan_001.pdf?dl=0		
	Crime/Safety	Home burglary - the Relation Between Residential Property and Its Surroundings and Day- and Night-Time Residential Burglary	Environment & Behavior Journal, 2014 - https://www.dropbox.com/s/y39sc8jrwplcyvg/The_Relation_Between_Residential_Propert.pdf?dl=0	0	

Appendix B: APA-SCD GreenStreets Lawrence
HIA Pathway Research Results

Priority Impact	Specific Element	Summary of Research	Source	Ranking	Notes
Housing	Shade/Energy	Urban trees reduce energy demand in buildings	Hartig, T., R. Mitchell, S. de Vries, and H. Frumkin. 2014. Nature and Health. Annual Review of Public Health 35, 1: 207-228.	++	
	Wind	UC San Diego's 200,000 trees help reduce energy use by 12,886 megawatt hours by consuming solar energy through the process of "evapo-transpiration" and by blocking winter winds. - 65 Vargas, Kelaine.	http://www.actrees.org/files/Research/benefits_of_trees.pdf "Ecosystem Services and Environmental Benefits of the UC San Diego Campus Forest." Urban Ecos and USCD. (2009). (from Alliance for Community Trees, Benefits of Trees and Urban Forests.)	+	Discusses tree canopy in general, not specifically street trees
	Economic value	Trees in the city: Economic value of street trees in Portland, Oregon	http://www.fs.fed.us/pnw/pubs/journals/pnw_2010_donovan001.pdf	++	Economic value
	General	The Value of Trees: Factors Influencing Homeowner Support for Protecting Local Urban Trees	Environment & Behavior Journal, 2012 - https://www.dropbox.com/s/1gpkx6rg9nvps0j/Jones%20%26%20Davis%202013%20Final.pdf?dl=0	+	

Multiple Benefits of Street Trees in Lawrence

1. ECONOMIC:

Increased property value: realtor estimates of tree-lined streets vs. comparable non tree-lined streets have shown anywhere between 5-18% increase in home/business value. People prefer tree-lined streets!

Reduced Energy Costs: streets and parking lots can increase local temperatures which can significantly impact energy costs to homeowners and consumers. The shade provided from street trees can reduce energy bills for a household by as much as 10%.

Return on Investment: for a planting cost of $250-600, a single street tree returns over $90,000 of direct benefits in the lifetime of the tree.

Extended pavement life: the shade of street trees reduces daily heating and cooling of asphalt and can extend the life of pavement up to 60% longer. This translates into a significant cost reduction for maintaining street systems.

Energy: Biomass from trees is a potential source of renewable energy for Municipalities.

2. ENVIRONMENTAL:

Grey Infrastructure to Green Infrastructure: The leaves, branches and trunks of street trees (green infrastructure) can capture up to 30% of a typical rainfall event through absorption and evaporation. Tree root systems can absorb up to another 30%, resulting in reduced stormwater runoff and potential flooding. This also results in less man-made drainage infrastructure (catch basins, piping, detention ponds).

Climate Change Mitigation: leaves absorb harmful pollutants like carbon dioxide (CO_2), carbon monoxide (CO), volatile organic compounds (VOC), nitrogen oxides (NOx), and particulate matter (PM) such as dirt, dust and soot. Street trees absorb nine times more pollutants than more distant trees, converting those harmful gasses back into oxygen and other useful and natural gasses.

Air Quality: shading provided by trees can reduce local temperatures by up to 15°F, which helps reduce the creation of ground-level ozone – a major contributor to smog & respiratory problems in kids &adults.

Habitat: street trees provide a canopy, root structure and setting for important insect &bacterial life below the surface. Above the surface, they provide biomass, nutrients and habitat for birds &other wildlife.

3. SOCIAL:

Public Safety: street trees help reduce solar glare and define the roadside edge and their canopy cover provides shading and separation from the road that can help protect pedestrians, guide motorists movements and help them better assess their speed. These attributes lead many motorists to exercise greater caution, resulting in reduced speeds (by as much as 15mph) as well as fewer accidents on streets lined with trees.

Public Health: trees reduce UV exposure for pedestrians and have a natural calming effect which can help reduce "road rage", local crime and vandalism, further improving the safety of streets and neighborhoods. Visual access to trees has also been shown to have a rehabilitating impact on our recovery from illness.

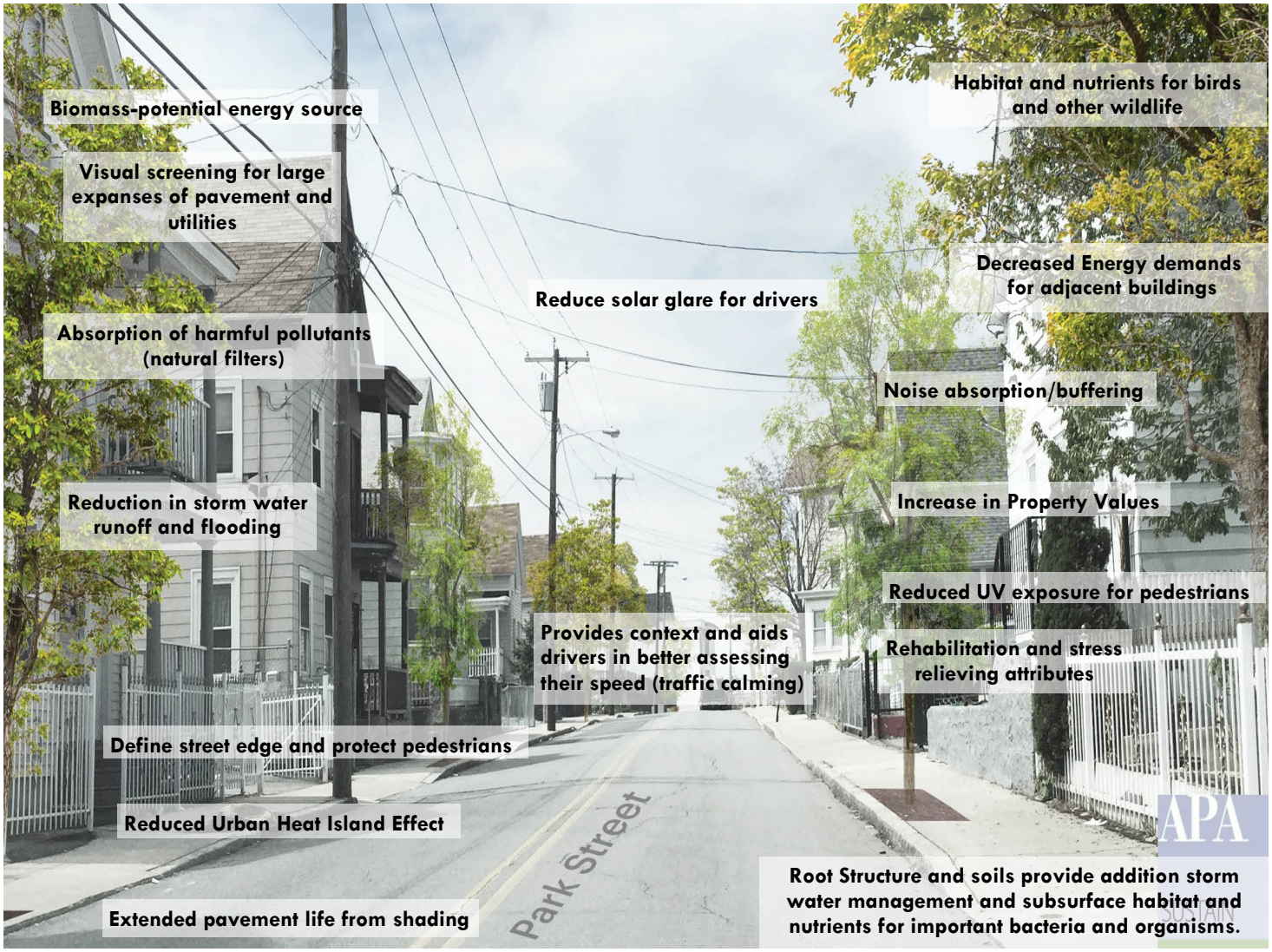
Noise Reduction: slower vehicle speeds as a result of street trees can reduce engine and tire noise. Their leafy vegetation can also absorb a great deal of noise in neighborhoods.

Aesthetics: trees provide a general softening of the urban environment and also provide a screen for utility poles, light poles, on-street and off-street parking and other features that create visual pollution. The aesthetics of tree lined streets and green spaces have been shown to have positive psychological benefits including lower rates of stress, blood pressure and mental illness.

Facts and Figures from the USDA Forest Service http://www.fs.fed.us/ucf/

Have questions, comments or want more information? Visit the Green Streets Blog: https://hiagreenstreets.wordpress.com/

Multiple Benefits of Street Trees in Lawrence



Facts and Figures:

- "There are about 60– to 200-million spaces along our city streets where trees could be planted. This translates to the potential to absorb 33 million more tons of CO^2 every year, and saving $4 billion in energy costs." —*National Wildlife Federation*
- "The net cooling effect of a young, healthy tree is equivalent to ten room-size air conditioners operating 20 hours a day. Trees properly placed around buildings can reduce air conditioning needs by 30 percent and can save 20–50 percent in energy used for heating." —*USDA Forest Service*
- "Healthy, mature trees add an average of 10 percent to a property's value." —*USDA Forest Service*
- "One acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. This is enough to meet the annual needs of 18 people." —*U.S. Department of Agriculture*
- "Trees can be a stimulus to economic development, attracting new business and tourism. Commercial retail areas are more attractive to shoppers, apartments rent more quickly, tenants stay longer, and space in a wooded setting is more valuable to sell or rent." —*The Arbor Day Foundation*
- "In laboratory research, visual exposure to settings with trees has produced significant recovery from stress within five minutes, as indicated by changes in blood pressure and muscle tension." —*Dr. Roger S. Ulrich Texas A&M University*

APA SUSTAIN

GROUNDWORK CHANGING PLACES CHANGING LIVES

Groundwork LAWRENCE

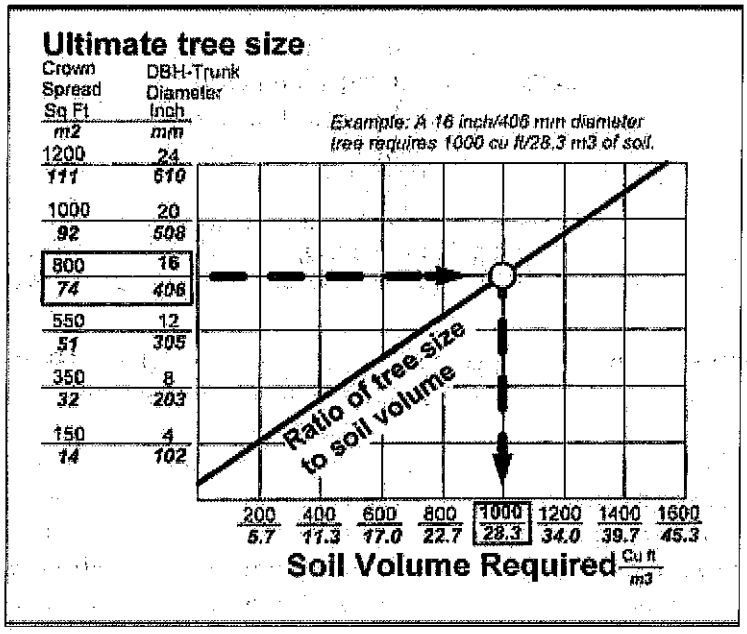
Appendix D - Complete List of Tree Plantings in Lawrence, MA

Botanical	Common Name	Suitable as Street Trees	Tolerate Urban Conditions	Allergens	Street Litter	Salt Spray	Soil Salt from Deicing	Drought	Zone	Native to MA	Notes
Acer campestre 'Fastigiata'	Fastigiate Maple	No									Invasive in some locations in Massachusetts
Acer miyabei	Miyabe Maple	No			Minimal	Tolerant	Intolerant	Tolerant	Yes	No	
Acer rubrum	Red Maple	No	Yes		Minimal	Intolerant	Intolerant	Intolerant	Yes	Yes	
Acer saccharum	Sugar Maple	No	Yes		Minimal	Intolerant	Intolerant	Intolerant	Yes	Yes	Green Mountain
Abies balsamea	Balsam Fir	No									Coniferous evergreen
Abies concolor	White Fir	No									Coniferous evergreen
Abies frasieri	Frasier Fir	No									Coniferous evergreen
Aesculus x carnea	Red Horse chestnut	No			Large nuts	Tolerant	Moderate	Tolerant			
Aesculus hippocastanum	Horse chestnut	No			Large nuts	Tolerant	Good	Intolerant			
Amelanchier 'Autumn Brilliance'	Serviceberry	No			Minimal	Tolerant	Intolerant	Moderate		Yes	
Betula nigra	River Birch	No	Yes	Allergenic						Yes	
Catalpa speciosa	Catalpa	No			Messy	Moderate	Good	Tolerant		Yes	
Carpinus caroliniana	Hornbeam	No				Intolerant	Intolerant	Moderate		Yes	
Carpinus caroliniana 'Fastigiata'	Hornbeam 'Fastigiata'	No				Intolerant	Intolerant	Moderate			
Cedrus atlantica 'Glauca'	Blue Atlas Cedar	No									Coniferous evergreen
Celtis occidentalis	Hackberry	Yes	Yes			Moderate	Good	Tolerant		Yes	Requires wide tree lawn, produces galls
Cercidiphullum japonicum	Katsura	No	Yes					Intolerant			
Cercis canadensis	Redbud	No			Pods	Intolerant	Intolerant	Intolerant		Yes	
Cladrastis kentukea	Yellowwood	Yes	Yes			Moderate	Moderate	Moderate		Yes	
Cornus kousa 'Constellation'	Kousa Dogwood (White)	No	Yes			Moderate	Intolerant	Moderate		No	Failure as street trees in Brookline
Cornus mas	Cornelian Cherry Dogwood	No				Moderate	Intolerant	Intolerant		No	Unsuitable form
Cornus 'Rutgers Hybrid'	Kousa Dogwood (Pink)	No				Moderate	Intolerant	Moderate		No	
Corylus colurna	Turkish Filbert	No	Yes			Intolerant	Intolerant	Tolerant		No	
Crataegus Winter King	Hawthorn	No				Intolerant	Intolerant	Tolerant			
Fagus sylvatica	European Beech	No		Allergenic			Moderate			No	
Fagus 'fastigiate'	Fastigiate Beech	No		Allergenic							
Ginkgo biloba	Ginkgo (fruitless)	Yes	Yes			Moderate	Moderate	Tolerant		No	Get fruitless variety
Gleditsia 'Skyline'	Honeylocust	Yes	Yes				Good			No	Skyline is a thornless, nearly fruitless variety
Gymnocladus dioicus	Kentucky Coffeetree	Yes	Yes			Tolerant	Tolerant	Tolerant		Yes	
Halesia carolinia	Silverbell	No				Intolerant	Intolerant	Intolerant			
Ilex opaca	American Holly	No									Evergreen
Juglans nigra	Black Walnut	No			Large nuts		Good				Large nuts, difficult to transplant
Juniperus virginiana	Eastern Red Cedar	No					Good				Coniferous evergreen
Koelreuteria paniculata	Goldenrain Tree	No					Moderate				Invasive in some locations
Laburnum x waterii	Goldenchain Tree	No			Messy						Suckering, poisonous pods
Larix decidua	Larch	No					Good				Coniferous
Liquidambar styraciflua	Sweetgum	Yes	Yes		Prickly balls	Tolerant	Tolerant	Tolerant		Yes	Rotundifolia is fruitless
Liquidambar styraciflua 'Slender Silhouette'	Sweetgum 'Slender Silhouette'	No	Yes								Spread of only 3-6'
Liriodendron tulipifera	Tuliptree	No				Intolerant	Intolerant	Intolerant		Yes	
Maackia amurensis	Amur Maackia	No				Intolerant	Intolerant	Tolerant		No	
Maclura pomifera 'White Shield'	Osage Orange (fruitless)	No	Yes		Very large fruits	Tolerant	Tolerant	Tolerant			
Magnolia acuminata	Cucumber tree	No				Intolerant	Intolerant	Intolerant			Too wide spreading
Magnolia 'Leonard Messell'	Star Magnolia	No				Moderate	Intolerant	Intolerant			
Magnolia x soulangiana	Saucer Magnolia	No				Moderate	Intolerant	Moderate			
Malus Spp.	List Your Available Crabs	No			Messy		Moderate			No	Fruits vary in size
Metasequoia glyptostroboides	Dawn Redwood	No								No	Coniferous
Nyssa sylvatica	Tupelo	Yes	Yes			Moderate	Moderate	Moderate		Yes	Wide tree lawns
Ostrya virginiana	Hophornbeam	No	Yes			Moderate	Intolerant	Tolerant		Yes	
Oxydendrum arboreum	Sourwood	Possibly, small	Yes			Moderate	Unknown	Moderate		Yes	
Parrotia persica	Persian Parrotia	No				Intolerant	Intolerant	Tolerant		No	
Picea abies	Norway Spruce	No									Coniferous evergreen
Picea glauca	White Spruce	No									Coniferous evergreen

Picea omorika	Serbian Spruce	No							Coniferous evergreen
Picea pungens	Colorado Spruce	No				Good			Coniferous evergreen
Pinus nigra	Austrian Pine	No				Good		No	Coniferous evergreen
Pinus strobus	White Pine	No							Coniferous evergreen
Prunus (varieties)	List Your Available Cherries								
Prunus cerasifera kv	Cherry Plum	No							Invasive in some locations
Prunus sargentii	Sargent Cherry	Yes, small	Yes		Moderate	Tolerant	Intolerant	No	
Prunus subhirtella 'autumnalis'	Higan Cherry	Yes, small	Yes		Tolerant	Tolerant	Tolerant	No	Suckering
Pseudotsuga menziessii	Douglas Fir	No							Coniferous evergreen
Quercus alba	White Oak	No		Allergenic		Good			
Quercus bicolor	Swamp White Oak	No		Allergenic		Moderate			
Quercus long	Fastigiate Oak	No		Allergenic					
Quercus macrocarpa	Bur Oak	No		Allergenic		Moderate			
Quercus palustris	Pin Oak	No		Allergenic					
Quercus palustris 'Green Pillar'	Pin Oak 'Green Pillar'	No		Allergenic					
Quercus rubra	Red Oak	No		Allergenic		Moderate			
Sciadopytus verticillata	Umbrella Pine	No			Tolerant	Tolerant	Intolerant		Coniferous evergreen, less hardy
Sorbus alnifolia	Korean Mountain Ash	No	No						
Stewartia pseudocamellia	Japanese Stewartia	No							Low branching
Styphnolobium japonicum	Pagoda Tree	Yes			Moderate	Tolerant	Tolerant	No	
Styrax japonicus	Japanese Snowbell	No	No						
Syringa reticulata	Japanese Tree Lilac	Yes, small	Yes		Tolerant	Tolerant	Intolerant	No	
Taxodium distichum	Bald Cypress	No				Good			Coniferous
Thuja plicata	Western Red cedar	No							Coniferous evergreen
Tilia americana	American Basswood	No			Intolerant	Intolerant	Moderate		
Tilia cordata 'Greenspire'	Littleleaf Linden	Yes	Yes		Intolerant	Moderate	Tolerant	No	
Tsuga canadensis	Eastern Hemlock	No							Coniferous evergreen
Ulmus americana	American Elm cultivars	No		Allergenic		Good			
Ulmus parvifolia	Chinese Elm	No		Allergenic		Good			
Ulmus x	Elm hybrids	No		Allergenic		Good			
Zelkova serrata	Japanese Zelkova	Yes	Yes		Moderate	Tolerant	Tolerant	No	
Zelkova serrata 'City Sprite'	Japanese Zelkova 'City Sprite'	Yes, small			Tolerant	Tolerant	Tolerant	No	

Soil volume requirements for trees planted in pervious or compacted surfaces

Preparation of planting sites in locations that are currently paved or compacted shall include excavation by hand or machine of a hole to provide at minimum approximately 2 cubic feet of rootable soil volume per square foot of mature tree canopy size, or approximately 1,000 cu. ft. of soil space for large canopy trees. New tree pits should, wherever possible, be established in continuous tree pits extending for at least 100 linear feet, and utilize structural soil to ensure adequate soil macropore space and to reduce the impacts of compaction. Minimum excavation per tree shall follow this chart:



Source: Urban, J.

The portions of the pit to be covered in impermeable surfaces should be filled with structural soil foundation material that conforms with "CU Soil," as patented by Cornell University, patent #5,849,069. The Buyer will specify the amount of CU Structural Soil required for each planting within cut pavements or compacted soils. The product shall be obtained from a licensed producer and proof of such licensing shall be submitted to the Buyer prior to delivery. Structural Soil components shall be mixed by the licensed producer to the following proportions: Component unit of weight (dry) crushed stone: 83%; clay loam: 175; hydrogel: 1 ounce per 200 pounds of stone.

The portions of the pit to be exposed or left as permeable surface shall be replaced with fresh

topsoil of approved loam and native soil. Trees shall not to be planted directly in CU Structural Soil. The tree's root ball shall sit on firm ground. The container shall be removed at the time of planting. The backfill mix shall be approved loam and native soil, adjusted as needed, and placed around the root ball in layers not more than 9", with each layer watered sufficiently to settle before the next layer is put in place. Backfill mix shall be tamped gently under the edges of the root ball and on the sides to assure there are no air pocket voids. Any visible encircling and potentially girdling roots and/or damaged roots shall be pruned.

Trees shall be planted to such a depth that the root flare of the trees shall be at or slightly above grade of the surrounding area. An earthen berm shall be formed around the plant, equal in size to the hole dug for the tree and outside of the disturbed soil area.

Cutting Pavements

Prior to cutting pavements, the Buyer will lay out tree pits. Tree pit locations will be adjusted as directed by the Buyer if unforeseen conflicts occur.

All edges between pavement surfaces to remain and those to be moved shall be sawcut to provide a clean, vertical edge to the full depth of the pavement.

Repaving over Structural Soil foundation material: Installation of Structural Soils may require cutting pavement beyond the final dimensions of the tree pit opening. Once Structural Soils are installed, the Contractor shall repave portions of the excavation area as specified by the Buyer.

Loam

Loam shall be a "fine sandy loam" or a "sandy loam" determined by mechanical analysis and based on the "USDA classifications system." It shall be of uniform composition, without admixture of subsoil. It shall be free of stones greater than two inches (2"), lumps, plants and their roots, debris and other extraneous matter. It shall not contain toxic substances harmful to plant growth. Loam shall contain not less than 4% nor more than 12% organic matter as determined by the loss on ignition of oven-dried samples. CU Structural Soil (as described in section b.v. above) must be used as a base material under impermeable surfaces.

Staking

Staking of newly planted trees shall be at the discretion of the Buyer staff, weighing the environmental conditions of the planting sites, ie, slopes, wind, etc. The Contractor shall be prepared to stake trees that are located on windy or otherwise exposed sites. It is anticipated that the majority of trees will not need staking. Guying wires shall be Arbortape or an approved similar product. Approval shall be made by the Buyer staff. Tree stakes shall be driven to a uniform height into the ground, outside the rootball, in a vertical manner. Stakes shall be removed by the landowner on private property and by the Cities of Fall River, Holyoke or Chelsea, respectively, for trees planted on public property.

Mulching

All plants shall be mulched with a 3" layer of bark or related approved mulch mix at the time of planting. Mulch shall not be colored with dye and shall not be made from construction debris or other refuse materials. This mulch shall entirely cover the area of the planting holes, or saucer around each tree. Saucer shall be the diameter of the tree hole and outside of the disturbed soil area. Mulch entire saucer area, staying clear of trunk and root flares by 2", so that no mulch touches flare.

Watering

Watering Bags shall be used for trees planted on public land. Bags shall accommodate trees of between 1 – 4" caliper, with branches at least 25" from the ground or higher, and be made of polyethylene with nylon webbing, contain two water release points per bag, and be UV stabilized to withstand exposure to sunlight. Fill opening shall fit up to 3" diameter hose, with a 20 gallon bag capacity. The estimated number of bags needed is up to 15% of total trees on the contract.

Park Street Looking West at Bruce Street

Phillips Street Looking North toward South Common

APPENDIX F:

Climate Change Vulnerability of Trees Common to the Boston Region or Likely to Gain Habitat

DRAFT-January 18, 2019

Latin Name	Common Name	Heat/Hardiness Zone Effect[1]	Tree Atlas-Low Emissions[2]	Tree Atlas-High Emissions	Adapt Class-developed/planted sites[3]	Adapt Class-natural areas	Vulnerability-developed/planted sites[4]	Vulnerability-natural areas	Notes[5]
Abies balsamea	Balsam fir	negative	extirpated	extirpated	medium	na	moderate-high	na	
Acer buergerianum	Trident maple	neutral	na	na	high	na	low	na	ALB
Acer campestre	Hedge maple	neutral	na	na	high	na	low	na	ALB
Acer ginnala	Amur maple	negative	na	na	medium	na	moderate-high	na	Invasive, ALB
Acer griseum	Paperbark maple	neutral	na	na	low	na	moderate-high	na	ALB
Acer miyabei	Miyabei maple	neutral	na	na	high	high	low	na	ALB
Acer pensylvanicum	Striped maple	negative	large decrease	extirpated	medium	high	moderate-high	moderate	ALB
Acer platanoides	Norway maple	negative	na	na	high	high	moderate	moderate	invasive, ALB
Acer rubrum	Red maple	neutral	no change	large decrease	medium	high	moderate	low-moderate	ALB
Acer saccharinum	Silver maple	neutral	small increase	large increase	medium	high	moderate	low	ALB
Acer saccharum	Sugar maple	neutral	no change	small increase	medium	high	moderate	low	ALB
Aesculus hippocastanum	European horsechesnut	neutral	na	na	medium	na	moderate	na	ALB
Amelanchier spp.	Serviceberry spp.	neutral	na	na	high	high	low	low	GM
Asimina triloba	Pawpaw	positive	new habitat	new habitat	low	na	moderate	na	
Betula alleghaniensis	Yellow birch	negative	small decrease	small decrease	high	high	moderate	moderate	GM, ALB
Betula lenta	Sweet birch	negative	small increase	small decrease	medium	medium	moderate-high	moderate-high	GM, ALB
Betula nigra	River birch	neutral	na	na	medium	medium	moderate	moderate	GM, ALB
Betula papyrifera	Paper birch	negative	large decrease	large decrease	medium	medium	moderate-high	moderate-high	GM, ALB
Betula populifolia	Gray birch	negative	no change	no change	low	medium	moderate-high	moderate	GM, ALB
Carpinus caroliniana	American hornbeam	neutral	small increase	large increase	high	high	low	low	
Carya alba	Mockernut hickory	positive	large increase	large increase	high	medium	low	low-moderate	
Carya cordiformis	Bitternut hickory	neutral	no change	small increase	medium	medium	low-moderate	low-moderate	
Carya glabra	Pignut hickory	neutral	small increase	small increase	medium	high	low-moderate	low	

Latin Name	Common Name	Heat/Hardiness Zone Effect[1]	Tree Atlas-Low Emissions[2]	Tree Atlas-High Emissions	Adapt Class-developed/planted sites[3]	Adapt Class-natural areas	Vulnerability-developed/planted sites[4]	Vulnerability-natural areas	Notes[5]
Carya illinoinensis	Pecan	positive	NA	new habitat	low	na	moderate	na	
Carya laciniosa	Shellbark hickory	positive	extirpated	large increase	low	medium	moderate	low-moderate	
Carya ovata	Shagbark hickory	positive	small increase	large increase	medium	high	low-moderate	low	
Carya texana	Black hickory	positive	NA	new habitat	low	na	moderate	na	
Castanea dentata	American chestnut	neutral	extirpated	extirpated	low	na	moderate	na	CB
Celtis laevigata	Sugarberry	positive	NA	new habitat	medium	na	low-moderate	na	
Celtis occidentalis	Hackberry	neutral	NA	new habitat	high	high	low	low	ALB
Cercidiphyllum japonicum	Katsura tree	neutral	na	na	low	na	moderate-high	na	ALB
Cercis canadensis	Eastern redbud	neutral	new habitat	new habitat	medium	high	moderate	low	
Chamaecyparis thyoides	Atlantic white-cedar	neutral	no change	no change	high	na	low	na	
Cladrastis kentukea	Yellowwood	neutral	na	na	high	na	low	na	
Cornus Florida	Flowering dogwood	neutral	large increase	large increase	medium	high	low-moderate	low	
Cornus kousa	Kousa dogwood	neutral	na	na	high	na	low	na	
Diospyros virginiana	Common persimmon	neutral	NA	new habitat	high	na	low	na	
Fagus grandifolia	American beech	neutral	no change	no change	medium	medium	moderate	moderate	GM, BBD
Fraxinus americana	White ash	neutral	no change	no change	low	medium	moderate-high	moderate	EAB
Fraxinus pennsylvanica	Green ash	neutral	extirpated	large increase	medium	medium	moderate	moderate	EAB
Ginkgo biloba	Ginkgo	neutral	na	na	high	na	low	na	
Gleditsia triacanthos	Honeylocust	neutral	NA	new habitat	medium	high	low-moderate	low	
Gymnocladus dioicus	Kentucky coffeetree	neutral	na	na	high	medium	low	moderate	
Ilex opaca	American holly	positive	no change	small increase	high	high	low	low	
Juglans nigra	Eastern black walnut	neutral	new habitat	new habitat	medium	medium	low-moderate	low-moderate	
Juniperus virginiana	Eastern redcedar	neutral	large increase	large increase	high	medium	low	moderate	
Koelreuteria paniculata	Golden raintree	neutral	na	na	high	na	low	na	ALB
Liquidambar styraciflua	American sweetgum	positive	new habitat	new habitat	medium	na	low-moderate	na	GM
Liriodendron tulipifera	Tulip tree	neutral	new habitat	new habitat	low	high	moderate	low	GM
Maackia amurensis	Amur maackia	negative	na	na	high	na	moderate	na	
Maclura pomifera	Osage-orange	neutral	NA	new habitat	high	na	low	na	
Malus	Crabapple	neutral	na	na	medium	na	moderate	na	GM, OW

Latin Name	Common Name	Heat/Hardiness Zone Effect[1]	Tree Atlas-Low Emissions[2]	Tree Atlas-High Emissions	Adapt Class-developed/planted sites[3]	Adapt Class-natural areas	Vulnerability-developed/planted sites[4]	Vulnerability-natural areas	Notes[5]
Metasequoia	Dawn redwood	positive	na	na	medium	na	low-moderate	na	
Morus rubra	Red mulberry	positive	no change	small increase	medium	medium	low-moderate	low-moderate	
Nyssa sylvatica	Blackgum/Black tupelo	neutral	large increase	large increase	high	high	low	low	
Ostrya virginiana	Eastern hophornbeam/ironwood	neutral	no change	large increase	high	high	low	low	GM
Oxydendrum arboreum	Sourwood	positive	new habitat	new habitat	high	high	low	low	
Parrotia persica	Persian ironwood	neutral	na	na	high	na	low	na	
Picea abies	Norway spruce	neutral	na	na	medium	na	low-moderate	na	SB, PSB
Picea rubens	Red spruce	negative	large decrease	large decrease	medium	na	moderate-high	na	SB
Pinus clausa	Sand pine	positive	new habitat	new habitat	low	na	moderate	na	SPB
Pinus echinata	Shortleaf pine	positive	new habitat	new habitat	low	na	moderate	na	SPB
Pinus resinosa	Red pine	negative	small decrease	small decrease	low	na	high	na	SPB
Pinus rigida	Pitch pine	negative	no change	no change	low	medium	high	moderate-high	SPB
Pinus serotina	Pond pine	positive	new habitat	new habitat	low	na	moderate	na	SPB
Pinus strobus	Eastern white pine	negative	small decrease	large decrease	low	medium	high	moderate-high	WPBR, SPB
Pinus taeda	Loblolly pine	positive	new habitat	new habitat	medium	na	low-moderate	na	SPB
Pinus virginiana	Virginia pine	positive	new habitat	new habitat	low	medium	moderate	low-moderate	SPB
Platanus occidentalis	American sycamore	positive	NA	new habitat	medium	medium	low-moderate	low-moderate	ALB
Populus deltoides	Eastern cottonwood	neutral	NA	new habitat	low	medium	moderate-high	moderate	ALB
Populus grandidentata	Bigtooth aspen	negative	no change	extirpated	low	high	high	moderate	GM, ALB
Populus tremuloides	Quaking aspen	neutral	large decrease	large decrease	low	medium	high	moderate-high	GM, ALB
Prunus × yedoensis	Yoshino cherry	neutral	na	na	high	na	low	na	
Prunus pensylvanica	Pin cherry	negative	small increase	large increase	low	medium	moderate-high	moderate	
Prunus persica	Peach	neutral	na	na	medium	na	moderate	na	
Prunus sargentii	Sargent cherry	neutral	na	na	medium	na	moderate	na	
Prunus serotina	Black cherry	neutral	no change	no change	low	medium	moderate-high	moderate	
Prunus serrulata	Kwansan cherry	positive	na	na	medium	na	low-moderate	na	

Latin Name	Common Name	Heat/Hardiness Zone Effect[1]	Tree Atlas-Low Emissions[2]	Tree Atlas-High Emissions	Adapt Class-developed/planted sites[3]	Adapt Class-natural areas	Vulnerability-developed/planted sites[4]	Vulnerability-natural areas	Notes[5]
Prunus 'Snowgoose'	Snowgoose cherry	neutral	na	na	high	na	low	na	
Prunus virginiana	Chokecherry	neutral	decrease	extirpated	medium	medium	moderate-high	moderate-high	
Prunus x incamp 'Okame'	Okame cherry	neutral	na	na	high	na	low	na	
Pyrus calleryana	Callery pear	neutral	na	na	medium	na	moderate	na	invasive, GM
Quercus alba	White oak	neutral	small increase	small increase	medium	high	moderate	low	GM, OW
Quercus bicolor	Swamp white oak	neutral	small decrease	large increase	high	medium	low	moderate	GM, OW
Quercus coccinea	Scarlet oak	neutral	small increase	no change	high	high	low	low	GM, OW
Quercus falcata	Southern red oak	positive	new habitat	new habitat	medium	na	low-moderate	na	GM, OW
Quercus imbricaria	Shingle oak	positive	NA	new habitat	high	medium	low	low-moderate	GM, OW
Quercus laevis	Turkey oak	positive	NA	new habitat	medium	na	low-moderate	na	GM, OW
Quercus macrocarpa x robur	Heritage oak	neutral	na	na	high	na	low	na	GM, OW
Quercus marilandica	Blackjack oak	positive	NA	new habitat	medium	na	low-moderate	na	GM, OW
Quercus michauxii	Swamp chestnut oak	positive	no change	no change	medium	na	low-moderate	na	GM, OW
Quercus muehlenbergii	Chinkapin oak	positive	NA	new habitat	medium	medium	low-moderate	low-moderate	GM, OW
Quercus nigra	Water oak	positive	NA	new habitat	medium	na	low-moderate	na	GM, OW
Quercus pagoda	Cherrybark oak	positive	NA	new habitat	medium	na	low-moderate	na	GM, OW
Quercus palustris	Pin oak	negative	new habitat	new habitat	medium	medium	moderate	moderate	GM, OW
Quercus phellos	Willow oak	positive	NA	new habitat	high	na	low	na	GM, OW
Quercus prinus	Chestnut oak	neutral	large increase	small increase	high	high	low	low	GM, OW
Quercus robur	English oak	neutral	na	na	medium	na	moderate	na	GM, OW
Quercus rubra	Northern red Oak	neutral	no change	large decrease	high	high	moderate	moderate	GM, OW
Quercus stellata	Post oak	positive	small increase	small increase	medium	na	low-moderate	na	GM, OW
Quercus velutina	Black oak	neutral	no change	small increase	medium	high	low-moderate	low	GM, OW
Robinia pseudoacacia	Black locust	neutral	large increase	large increase	medium	high	low-moderate	low	
Salix babylonica	Weeping willow	positive	na	na	medium	na	low-moderate	na	GM, ALB
Salix nigra	Black willow	positive	NA	new habitat	low	low	moderate	moderate	GM, ALB

Latin Name	Common Name	Heat/Hardiness Zone Effect[1]	Tree Atlas-Low Emissions[2]	Tree Atlas-High Emissions	Adapt Class-developed/planted sites[3]	Adapt Class-natural areas	Vulnerability-developed/planted sites[4]	Vulnerability-natural areas	Notes[5]
Sassafras albidum	Sassafras	neutral	small increase	large increase	medium	na	low-moderate	na	
Styphnolobium japonicum	Japanese pagoda tree	neutral	na	na	high	na	low-moderate	na	invasive
Syringa reticulata	Japanese tree lilac	negative	na	na	high	na	moderate	na	
Taxodium distichum	Baldcypress	neutral	new habitat	new habitat	high	na	low	na	
Thuja occidentalis	Northern white-cedar	negative	large decrease	large decrease	medium	medium	moderate-high	moderate-high	
Tilia americana	American basswood/linden	neutral	extirpated	small increase	medium	medium	moderate	moderate	GM
Tilia cordata	Littleleaf linden	negative	na	na	high	na	moderate	na	GM
Tilia tomentosa	Silver linden	neutral	na	na	medium	na	moderate	na	GM
Tsuga canadensis	Canadian hemlock	neutral	small decrease	large decrease	low	na	high	na	
Ulmus alata	Winged elm	positive	NA	new habitat	low	na	moderate	na	DED, ALB
Ulmus americana	American elm	neutral	small increase	large increase	medium	high	low-moderate	low	DED, ALB
Ulmus crassifolia	Cedar elm	positive	NA	new habitat	high	na	low	na	DED, ALB
Ulmus parvifolia	Chinese elm	positive	na	na	high	na	low	na	ALB, invasive
Ulmus rubra	Slippery elm	neutral	small decrease	large increase	medium	medium	moderate	moderate	DED, ALB
Zelkova serrata	Japanese zelkova	neutral	na	na	high	na	low	na	

[1]Effect of heat/hardiness zone is positive if zone shift leads to gain in suitable habitat and negative if it leads to reduction in suitable habitat.
[2]Tree Atlas (www.fs.fed.us/nrs/atlas) results are summarized based on projected suitable habitat for the last 30 years of this century vs. current suitable habitat for the Boston region. Change class definitions can be found here: https://www.fs.fed.us/nrs/atlas/products/
[3]Adapt Class has been modified from Matthews et al. 2011 (treesearch.fs.fed.us/pubs/38643).
[4]Vulnerability is determined based on heat/hardiness zone effect, tree atlas projections (where available), and adaptability. Low: species is likely to adapt to future climate conditions in this area. High: species is likely to face considerable stress due to current and future climate changes.
[5]Notes: These factors may make a species more vulnerable or less desirable for planting based on other factors. We note when a species is generally considered invasive. Also noted is if it is a host to a particular pest or disease that can lead to considerable stress or mortality. ALB: Asian longhorned beetle, GM: gypsy moth, CB: chestnut blight, BBD: beech bark disease, OW: oak wilt, SB: spruce budworm, SPB: southern pine beetle, WPBR: white pine blister rust, DED: Dutch elm disease

Note this version is in draft. If you have comments or questions, please contact Leslie Brandt (lbrandt@fs.fed.us)

Technology: Tree canopy cover in residential areas
Submitted by: Massachusetts Executive Office of Energy and Environmental Affairs

Section 3 – Tree Retention

Overview of Program

Retaining existing tree canopy cover for new and existing residences is an additional program under development at EEA, which can be complementary to the tree planting program described in the previous sections of this proposal.

The two primary causes of tree removal associated with new home construction are construction of new subdivisions in forested sites and teardown of existing homes and construction of new homes in existing suburban neighborhoods. In both types of home construction, existing trees are commonly removed. However, in both cases, there are tested construction practices that have been proven to be effective in the protection of mature trees during the construction sites of new homes.

Tree retention brings an additional benefit of timing: each tree that is retained will provide immediate savings for the new homes and continue those savings for many years. Tree retention will focus on parts of the state that have different land-use patterns and demographics.

Incentive Proposal

Tree retention can be implemented with two different approaches – one focused on developers and homeowners and one focused on municipalities. In both cases, the incentive would be a new option for the MassSave field staff to add to their existing tools.

Developer/homeowner incentive:

Developers who are locating large developments in currently forested locations (5 acres or larger) would qualify for a new MassSave incentive if they retain a minimum number of mature trees that would assure a 20% or larger tree canopy coverage in the new neighborhood. A mature tree is defined by a tree with an 8 inch truck or larger that has a full and healthy crown with a height equal or higher than the roof of the adjacent new residence. A tree of this size is estimated to have a canopy size of 435 square feet or 1/100 of an acre. The 5 acre minimum size is required so that residences will benefit from the retained tree canopy coverage of neighboring new homes. In order to assure 20% tree canopy coverage, and based on best practices, the following number of mature trees would need to be retained:

- Quarter (¼) acre lot size: retain a minimum of 5 mature trees per lot
- Half (½) acre lot size retain a minimum of 10 mature trees per lot
- One (1) acre lot size retain a minimum of 20 mature trees per lot

Technology: Tree canopy cover in residential areas
Submitted by: Massachusetts Executive Office of Energy and Environmental Affairs

This proposal would include the support of one urban forester at DCR to work with the Mass Save program to coordinate with municipalities and developers applying for this incentive to check compliance with Best Practices in retaining trees and maintaining the health of these trees for continuing future incentives. The incentive would be $100 per quarter acre lot per year for ten years if all the retained trees are shown to be healthy (each mature tree makes up about 1% of canopy cover for the neighborhood and saves approximately $21 per year in heating and cooling costs as described above). The first year incentive would go to either the developer or the new homeowner and in subsequent years (2-10) it would be up to the homeowner to verify to the DCR urban forester that the trees remain healthy in order to get their incentive. For new homes on half acre lots in new developments over 5 acres in size, the incentive would be $200 per year and for one acre lots the incentive would be $400 per year. The verification to the DCR urban forester could be by field visit the first year (with tree identification tags) and by internet photos in succeeding years.

Municipal Incentive

For smaller developments and re-development of existing residences ("tear downs"), there is a need to have a community-wide commitment to retaining trees on these lots so that the effect on each home would be significant. This incentive would be similar to the "solarize" approach where communities with a minimum number of sign-ups for new solar get an incentive for each sign-up. For the tree retention application, a community would need to pass a by-law that meets the requirements of the DCR urban forester. The DCR urban forester who would work on outreach, education and verification for the developer/ homeowner incentive above could also work with communities interested in adopting a tree retention bylaw. The bylaw would include the retention of a minimum number of healthy, mature trees on small new developments and the re-development of existing residences. Once the community has passed the required by-law, the DCR urban forester would work with the community to verify the number of retained trees and the allocation of the incentives via MassSave. The incentives would be $20 per year per mature tree retained for a 10-year period as long as the trees are verified to be healthy. The verification can be done by the local tree warden working with the DCR urban forester.