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PROTECTION

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MEMORANDUM

To: Emma Melvin, American Littoral Society

From: The Center for Watershed Protection, Inc.

Date: March 8, 2019

Re: Summary of Research Related to Socioeconomic Benefits of Green Infrastructure

According to the U.S. Environmental Protection Agency (EPA), "Green infrastructure (GI) uses vegetation, soils, and other elements and practices to restore some of the natural processes required to manage water and create healthier urban environments. At the city or county scale, green infrastructure is a patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the neighborhood or site scale, stormwater management systems that mimic nature soak up and store water (USEPA, 2019)". By incorporating natural features into the built environment, green infrastructure not only provides stormwater management, but also multiple social and economic benefits or services that has made it an increasingly popular strategy in recent years. Recent research has teased out some of the economic impacts of having quality, well-managed green spaces near where people live, work, learn and play in cities. The results add up to billions of dollars of annual cost savings in our nation, including $11.7 billion in avoided health care costs, $1.3 billion in high school graduates' lifelong incomes, and $928 million in avoided costs resulting from crime (Wolf, 2016).

In April 2007, the EPA signed a statement of intent supporting and encouraging the municipal use of GI to meet federal regulatory standards. The use of GI will be important to address Municipal Separate Storm Sewer System (MS4) permit requirements. This technical memo provides a summary of the socioeconomic benefits of GI that are secondary benefits to help address other municipal goals.

The Center for Watershed Protection (Center) reviewed publications related to the socioeconomic benefits of green infrastructure. Many of the publications are summaries of the existing literature and in some cases reference the same published literature. This technical memo is not designed to be an exhaustive review of all published literature given that the reviewed publications already refer to the prominent sources of literature. Instead, it summarizes the commonly identified socioeconomic benefits of green infrastructure, including health, social cohesion, safety, property values, and jobs and business. In addition, the Center developed a case study on the City of Camden, NJ GI program titled Camden Stormwater and Resources Training

(SMART). The City of Camden's SMART program serves as a model program that can be adapted to other cities on using GI to address water quality issues in addition to socioeconomic concerns. The case study is presented first followed by the summary of socioeconomic GI benefits.

Camden Stormwater and Resources Training (SMART)

The City of Camden, New Jersey (the City) is located along the Delaware River across from Philadelphia, Pennsylvania. Both cities discharge untreated sewage into local waterbodies from combined sewer overflows (CSOs) that pollute the local waterways. In 2010, the City formed the Camden Stormwater and Resources Training (SMART) through a partnership with the Rutgers Cooperative Extension (RCE) Water Resources Program, and the Camden County Municipal Utilities Authority (CCMUA). This program includes installing green infrastructure, gray infrastructure projects (i.e., includes the pipes, pumps, ditches, and detention ponds engineered to manage stormwater) in neighborhoods, stormwater management policy, and training community leaders, businesses, and local citizens on the benefits of green infrastructure and installation techniques. It was designed to improve quality of life, environmental and economic health of the region and provides many benefits to the City beyond water quality that include:

- Preventing neighborhood flooding
- Reducing combined sewer overflows
- Creating sustainable green jobs
- Improving air, water and climate quality
- Developing environmental policy
- Increasing property values
- Providing economic development opportunities
- Adding recreational amenities and open space
- Beautifying neighborhoods

This pilot program was initiated to address the water quality impacts of CSOs as well as localized concerns of flooding, and sewer backups in basements. Workshops were held to educate residents on the benefits of GI projects and provide valuable input on locations of localized flooding and other areas where GI projects could address these concerns. Using this information, RCE developed a city-wide assessment of opportunities to install rain gardens, rain water harvesting and other GI projects throughout the City. To ensure the success of the program, partnerships were formed with several community non-profit organizations to enhance capacity to build GI projects through education of residents on GI, mobilization of volunteers, etc.

Within the first year, eight demonstration projects were constructed throughout the City, including 11 rain gardens designed to capture, treat, and infiltrate over 800,000 gallons of stormwater each year. There are many socioeconomic benefits that can result from the SMART program that includes greening vacant lots and the creation of a jobs training program to design, build and maintain the GI projects. More information about the program is found at their website http://www.camdensmart.com/.

Socioeconomic Benefits of Green Infrastructure

Health

The presence of green infrastructure contributes to improved mental and physical health outcomes. The link between personal well-being and nature is often described as the "biophilia hypothesis," which claims that humans have an innate attraction to the outdoor environment due to our evolutionary background that allows us to thrive when we have contact with nature (House et al., 2016; Wolf, 2008). Wolf (2008) noted that the motivation to pursue nature and physical activity is complex. People in cities often feel stressed and a person is more likely to prefer a natural environment to take a walk for a restorative experience rather than a built environment. When a greater percentage of the living environment is greenspace, people in large cities perceive themselves to be generally healthier, are inclined to be more active, and claim the ability to relax faster.

Studies generally show that green infrastructure can relieve stress and improve general wellness among city residents. Encounters with nature and green spaces help to prevent and mitigate stress, anxiety, and depression, as well as boost attention capacity and improve performance on cognitive memory assessments. Access to green views can improve coping with stressful urban environments, with even passive experiences like viewing nature from an office window or walking by trees, parks, and gardens helping people recover from daily and chronic stressors (Georgia Forestry Commission, 2019; House et al., 2016; Kondo et al., 2015; Wolf, 2008). Social science research shows that visual contact with trees and greenery helps hospital patients recover more quickly (Wolf, 2004). Lovasi et al. (2008) found that asthma rates among children fell by 25% for every 343 trees per km^2 and theorize that more trees aid air quality or simply encourage children to play outside, although the true reason for their finding is still unclear. Children with ADHD were also found to concentrate better following a 20-minute walk in an urban park than they do after equivalent walks in other urban settings (House et al., 2016).

Trees and other elements in nature and green infrastructure encourage physical activity, including outdoor recreation and active modes of transport, such as walking and cycling (Georgia Forestry Commission, 2019; House et al., 2016; Wolf, 2008). One study found that residents living in areas with more green space were more than three times as likely to be physically active, and approximately 40% less likely to be overweight or obese than those living in the least green settings. Walking trips to task destinations such as stores and coffee shops are more attractive and therefore more frequent when there are natural features in the neighborhood, including street trees. In neighborhoods with less vegetation, people judge distances to be greater than they actually are, perhaps leading to decisions not to walk (House et al., 2016; Wolf, 2008). A study of senior citizens in Japan found that having space for taking walks and the presence of parks and tree-lined streets near the residence were significant predictors of higher survival over the following five years (Wolf, 2008).

Most of the existing research focuses on the relationship between green space and physical activity. However, the link to health outcomes, such as reduced rates of obesity, heart disease, and other chronic illnesses, is still being developed. A study by Kondo et al. (2015) did not find a

strong correlation between green infrastructure and health outcomes related to stress levels, high blood pressure, and cholesterol in the City of Philadelphia. Although the majority of studies reviewed found a positive health benefit from green infrastructure, additional research is needed to confirm the findings and further explore the aspects of green infrastructure that generate the most positive health outcomes.

Social Cohesion

Green spaces promote social interaction and enhances the strength of social ties among neighbors by drawing people out to a shared space where they have an opportunity to interact with one another (House et al., 2016). This can strengthen the social capital for a neighborhood, resulting in lower crime rates, improved sense of wellbeing, and greater feelings of safety. Social psychologists have shown that people in cities behave differently from those in rural areas integrated with nature in part because they live in crowded, noisy places or in places that lack open space (Sullivan and Kuo, 1996). In communities with strong social ties, the elderly experience lower rates of mortality, reduced suicide rates, reduced fear of crime, and better physical health. Similarly, the youth are less likely to participate in behaviors such as smoking, drinking, gang involvement, or drug use, as close-knit communities are better equipped to provide guidance and model behaviors (House et al., 2016).

Sullivan and Kuo (1996) interviewed women living in Chicago public housing to evaluate the effects of trees on social behavior. In buildings with trees, people reported significantly better relations with their neighbors, a stronger feeling of unity and cohesion, and a greater feeling of safety compared to buildings without trees. Outdoor spaces with trees are used significantly more often than identical spaces without trees and people are more likely to see and interact with their neighbors. Residents from buildings with trees also reported using more constructive less violent ways to deal with conflict in their home. The authors theorize this is due to having neighbors that can be called on for support as an alternate way of dealing with frustration.

Safety

The majority of studies reviewed show that green infrastructure reduces violence, aggression, assaults, vandalism, and reduces crime in general. One possible explanation is the "broken windows theory" that disordered and disinvested urban environments promote criminal activity. These blighted urban environments are seen as an indication that no one cares, and that illegal activity will be tolerated. In addition, environmental factors, such as vacancy, physical decay, noise, pollution, and crowding, can provoke a physiological stress response that can aggravate aggression and violence. Inverse to the broken windows theory, the "cues to care" theory is based on the idea that visible maintenance of shared spaces presents a sign of social capital and cohesion that might deter criminals. Green infrastructure projects on streets, sidewalks, and adjoining open spaces show that the environment is well cared for and surveilled, making it a less ideal place for criminal activity (Bogar and Beyer, 2015; Kondo et al., 2016; Troy et al., 2016). Greening an urban area can also increase the number of people that walk, run, or bike as described above under Health above, which increases potential witnesses for criminal activity, making it less appealing (Kondo et al., 2016).

A research summary by Wolf (2010) found that among minor crimes, there is less graffiti, vandalism, and littering in outdoor spaces with natural landscapes than in comparable plant-less

spaces. Public housing residents with nearby trees and natural landscapes reported 25% fewer acts of domestic aggression and violence. Public housing buildings with greater amounts of vegetation had 52% fewer total crimes, 48% fewer property crimes, and 56% fewer violent crimes than buildings with low amounts of vegetation. Studies of residential neighborhoods found that property crimes were less frequent when there were trees in the right-of-way, and more abundant vegetation around a house. In a study of community policing innovations, there was a 20% overall decrease in calls to police from the parts of town that received location-specific treatments.

In a study from Baltimore, Troy et al. (2016) conducted detailed lawn surveys of 1,000 houses across Baltimore City and County, then cross-referenced them with data on crimes reported within 150 meters of each property and found 10 statistically significant landscape characteristics. The most powerful indicators of a decrease in crime were having a lawn, the presence of garden hoses or sprinklers, shrubs, tree cover, percentage of pervious area, and the presence of yard trees. The factors most strongly tied to more crime were the number of small street trees, litter, uncut lawn, and a dried-out lawn, which supports the broken windows theory.

Kondo et al. (2016) studied a vacant lot greening program in Youngstown, Ohio and found statistically significant reductions in felony assaults, burglaries, and robberies, with the most significant reductions in burglaries. Cleaning and greening lot stabilization (removal of debris, addition of topsoil and grading, grass seeding and tree planting, fencing, and lot maintenance) was associated most consistently and significantly with reduction in burglaries. Community lot reuse mostly involved community gardens and showed more consistent and significant reduction in violent crimes. Spill-over crime reduction effects were found in contiguous areas around newly treated lots. Another study by Kondo et al. (2015) in the City of Philadelphia found a statistically significant reduction of 18-27% in narcotics possession after green infrastructure construction compared to control sites, where possession indicates the buying as opposed to the selling of narcotics. In comparison, the overall City narcotic possession increased 65% during the study period. Interestingly, no association was found between green infrastructure installation and more serious crimes such as aggravated assaults and gun assaults, which have been established with other greening programs.

Although a reduction in crime is generally seen across most of the studies reviewed, Wolf (2010) cautioned that research findings on the relationship between urban vegetation and crimes, aggressive behavior, and safety are not conclusive and may even seem inconsistent or conflicting. People generally indicate higher preference for settings with higher rates of tree density. However, large shrubs, underbrush, and dense wooded areas are perceived to provide potential cover for criminal activities, by providing criminals a place to hide themselves or illegal goods (Kondo et al., 2015; Wolf, et al., 2010). Troy et al. (2016) note that the type or configuration of urban vegetation matters and that most of the studies finding an inverse relationship between trees and crime are not explicit about the characteristics of vegetation being studied (e.g. height, species, age).

An additional negative effect of urban greening found by Kondo et al. (2016) was significant increases in motor vehicle thefts around greened vacant lots. One potential explanation suggested was that residents felt more comfortable parking cars near lots after they were greened, thus

creating a larger supply of targets. Kondo et al. (2015) also suggested that further research is needed into whether the crime reduction effects due to green infrastructure indicates displacement of the criminal activity or spillover into surrounding areas.

Property Values

Green infrastructure adds value to property through improved aesthetics, proximity to active or passive recreational opportunities, and other local amenities. Trees around homes increase property value and when strategically planted, provide savings on utility bills (Georgia Forestry Commission, 2019). Similarly, high quality landscaping is associated with higher residential land values and commercial building rental rates (Wolf, 2004).

House et al. (2016) reviewed multiple studies related to property values and green space and concluded that green space and tree canopies considerably boost the market value of homes, thus providing important contributions to the overall property tax base in cities. This process is known as the "proximate principle," and is significant for investments in natural infrastructure because, in some cases, the aggregate amount of increased property taxes associated with a particular park or green space may be sufficient to cover the costs of acquiring and developing the natural amenity. Over 30 studies analyzing the effect of parks and open space on residential property values support the proximate principle, with property values up to 20% higher for homes adjacent to parks and open spaces than equivalent homes without proximate natural amenities. Similarly, an analysis of the relationship between tree presence and residential property values found a 7% average price increase among properties with trees over comparable properties without trees (House et al., 2016).

The presence of trees can also have a positive effect on the value of neighboring properties. A study led by U.S.D.A. Forest Service researchers analyzed the effects of tree-lined streets on the sale price of houses in Portland, Oregon and found that, on average, the presence of trees adds nearly $9,000 to a house's selling price. Tree-lined streets were also found to positively influence the selling price of houses within a 100-foot range. The effect of tree-lined streets applied to all houses in Portland amounts to a total value of $1.35 billion, which translates into a potential increase of $54 million per year in property tax revenue for the city (House et al. 2016).

Jobs and Business

Studies focused on nature and central business districts find that trees and green space attract shoppers to linger, shop longer, and pay more for products (Georgia Forestry Commission, 2019; Wolf, 2004). Potential customers perceive a message of care and quality from merchants that maintain good landscaping and big trees. House et al. (2016) reviewed several studies related to commercial districts and green space. They found that pedestrian-oriented retail areas experience a 20% to 40% increase in foot traffic and a 22% increase in retail rents. Shoppers are also willing to spend 9% to 12% more for goods and services in central business districts having high-quality tree canopies.

In terms of employment, social science research has shown that visual contact with trees and greenery improves office worker productivity and job satisfaction (Wolf, 2004). Highly educated workers choose cities based on economic, cultural, and lifestyle considerations, including green space as part of the urban environment (House et al., 2016).

References

Bogar, S., and K. Beyer. 2015. Green Space, Violence, and Crime: A Systematic Review. Trauma Violence Abuse. 2: 160-171.

Camden SMART Initiative. No date. http://www.camdensmart.com.

Georgia Forestry Commission. 2019. Tree Benefits: Environmental Benefits of Trees. Retrieved February 13, 2019, from http://www.gfc.state.ga.us/CommunityForests/TreeBenefits.cfm

House, E., C. O'Connor, K. Wolf, J. Israel, & T. Reynolds. 2016. Outside our Doors: the benefits of cities where people and nature thrive. Seattle, WA: The Nature Conservancy, Washington State Chapter, 26 pp. http://www.naturewithin.info/New/2016.2.TNC-Outside_Our_Doors_Report.pdf

Kondo, M., Hohl, B., Han, S., and C. Branas. 2016. Effects of Greening and Community Reuse of Vacant Lots on Crime. Urban Studies. 53(15): 3279-3295.

Kondo, M., S. Low, J. Henning, and C. Branas. 2015. The Impact of Green Stormwater Infrastructure Installation on Surrounding Health and Safety. American Journal of Public Health. 105: e114-e121.

Lovasi G., Quinn J., Neckerman K., et al. 2008. Children Living in Areas with More Street Trees have Lower Prevalence of aAsthma Journal of Epidemiology & Community Health. 62:647-649.

Sullivan, W. C. and, F. E Kuo. 1996. Do Trees Strengthen Urban Communities, Reduce Domestic Violence? Forestry Report R8-FS 56. Human-Environment Research Laboratory Department of Natural Resources and Environmental Sciences University of Illinois at Urbana-Champaign.

Troy, A., Nunery, A., and J.M. Grove. 2016. The Relationship Between Residential Yard Management and Neighborhood Crime: An Analysis from Baltimore City and County. Landscape and Urban Planning. 147: 78-87.

United States Environmental Protection Agency (USEPA). 2018. What is Green Infrastructure? Retrieved February 13, 2019, from https://www.epa.gov/green-infrastructure/what-green-infrastructure.

Wolf, K. 2016. Nature's Riches: The Health and Financial Benefits of Nearby Nature. http://www.naturewithin.info/New/2016.11.Economic_Benefits_of_Nature_in_Cities.KWolf.pdf

Wolf, K. 2010. Crime and Fear - A Literature Review. In: Green Cities: Good Health (www.greenhealth.washington.edu). College of the Environment, University of Washington. https://depts.washington.edu/hhwb/Thm_Crime.html

Wolf, K. 2008. City Trees, Nature, and Physical Activity: A Research Review. Arborist News. 17(1): 22-24. http://www.naturewithin.info/CivicEco/Activity.pdf

Wolf, K. 2004. Trees, Parking and Green Law: Strategies for Sustainability. Stone Mountain, GA: Georgia Forestry Commission, Urban and Community Forestry. http://www.naturewithin.info/Roadside/Trees_Parking_Green%20Law.pdf