



The Return on Investment (ROI) of Green Infrastructure Projects in the Urban Environment

Introduction

Cities and our urbanized areas of Pennsylvania are facing a multitude of environmental and infrastructure problems, from crumbling roads to inadequate sewage treatment to the health and safety of their citizens. As we look for solutions to this multitude of problems, one approach stands out among others: the use of green infrastructure systems.

We often don't think of green infrastructure – the use of trees and plants – when we think of traditional infrastructure development such as roads, bridges, schools and hospitals and other public works. Rather than address urban environmental concerns as an afterthought to traditional infrastructure repair and replacement, we should build the environmental solution into projects from the beginning through the use of green infrastructure components. In many cases, the return on investment (ROI) of green infrastructure will be greater than traditional "bricks and mortar" solutions.

Moreover, green industry jobs are a good job-creating investment, providing a range of opportunities, from semi-skilled to managerial, with a well-defined career path for professional growth. The green industry is a \$150 billion economic sector that is projected to grow over the long term.

Urban Forestry: Economic Impact and Jobs in the Cities

American's city tree infrastructure -- our urban forests -- is under immense stress and strain. Media outlets have noted that in the past few decades Washington has lost half its tree cover; San Diego's is off about a quarter; the cover in cities in Michigan, North Carolina and Florida has fallen to about 27% of what it once was; Chicago and Philadelphia are just 16%. Ed Macie of the U.S. Forest Service has stated, "Urban deforestation compares with what's going on in the world's rain forests." (Time Magazine, 2007)

Revitalizing the vanishing green infrastructure of American cities impacts the economy of the cities significantly. Researchers from the University of Florida and the University of Tennessee found that new tree infrastructure increases city property values by 3-7% in raw numbers, and from 5% to 11% in perception. (Hall, Hodges and Haydu, 2005) Furthermore, the researchers noted the following:

Trees sold to municipalities for use in urban forest settings (e.g. parks and other recreational areas) have other economic and environmental benefits beyond those mentioned above. Once they have been installed into the urban landscape, they can result in substantial energy savings; reduction of atmospheric carbon dioxide; improved air quality; reduction of stormwater runoff and hydrology; and enhanced aesthetic benefits.

Consumer surveys have found that preference ratings increase with the presence of trees in the commercial streetscape. In contrast to areas without trees, shoppers indicated that they shop more often and longer in well-landscaped business districts, and were willing to pay more for goods and services.... Research in public housing complexes found that outdoor spaces with trees were used significantly more often than spaces without trees. By facilitating interactions among residents, trees can contribute to reduced levels of domestic violence, as well as foster safer and more sociable neighborhood environments. (Hall, Hodges and Haydu, 2005)

Despite the losses, urban forestry continues to create jobs in the cities, and could have a far greater impact with increased support.

Statistics have demonstrated that like the green industry itself, urban forestry provides job opportunities for a wide range of potential employees, both skilled and unskilled. This includes public-sector positions: in 2002, there were 262,242 full-time parks and recreation employees across the nation, with projections for growth. (Hall, Hodges and Haydu, 2005) The current economic downturn greatly threatens these jobs, while new investments could strengthen the prospects for urban forestry employment and economic development in the cities.

Water Quality and Stormwater Runoff

Highways, buildings, parking lots and other impervious development produces stormwater runoff that produces flooding, carries pollutants into streams and warms water. These impacts can be mitigated by the use of designed plantings to reduce runoff and filter water before it enters streams.

Compounding this problem is that Pennsylvania's two largest cities (as well as many others), have combined sanitary/storm sewer systems that create enormous quantities of polluted water during storm events.

A 2007 paper by the University of Pittsburgh Center for Healthy Environments and Communities reported:

The "Three Rivers" area of Pittsburgh has approximately 317, combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs)--more than any other city in the United States, which release untreated municipal waste directly into receiving water during wet weather events (National Research Council, 2005). An estimated 16 billion gallons of sewage and stormwater are discharged yearly into receiving streams and main stem rivers in the Allegheny County Sanitary Authority (ALCOSAN) sewershed.

Plant-based green infrastructure systems can help to alleviate this problem by reducing the amount of stormwater discharged into sewage treatment systems. The Philadelphia Water Department estimates that it can afford to spend up to \$260,000 per acre on green infrastructure projects (green roofs, bioswales, rain gardens, etc.) rather than continue to

treat the stormwater that otherwise would flow from these project areas into their combined sanitary/stormwater system.

We have an excellent model that proves the effectiveness of using plants for this purpose, the Conservation Reserve Enhancement Program (CREP), but have not deployed it to mitigate runoff from parking lots, streets, highways and other development. Pennsylvania now leads the country with 165,000 acres enrolled in CREP. CREP uses plants to protect water resources from agricultural runoff. Without so-called "riparian buffers," (the area along streams and rivers with native plants and trees) to slow stormwater runoff, hold the soil and filter surface water flowing to the stream, the water quality of a stream can degrade quickly.

Plants, in fact, are small water treatment and purification machines. First, a dense colony of plants in the path of stormwater can slow surface runoff, allowing soil, sediment and other impurities to simply drop out or be caught in the plant stems and roots before entering the stream. Second, plants encourage the infiltration of water into the soil by slowing stormwater's progress to the stream, plus the roots of the plants loosen the soil and create a multitude of small fissures through which the water can infiltrate. Third, the plants themselves take up nitrogen and phosphorus, which are good for the plants, but can be bad for the stream in excess. Fourth, the plants host an entire ecosystem of micro and macro invertebrates, bacteria, fungi and other organisms that operate in the soil and water to convert pollutants to harmless and even useful simpler compounds.

Getting stormwater to infiltrate into the ground, rather than run directly into a stream, provides enormous water quality benefits. The soil is a marvelous water purification system that we take for granted. When water percolates slowly through the soil to the water table, it is filtered physically as small particles are trapped in soil layers and biologically as natural bacteria go to work on organic pollutants. Plus, since ground water provides 25% of the drinking water supply in Pennsylvania, recharging the aquifer is a good thing too. Plants are the key to facilitating this infiltration process.

Trees play a significant role in slowing stormwater runoff and increasing infiltration. A recent study by the US Forest Service (USFS) determined that about two-thirds of the rain falling on a tree in a half inch rain event was held by the leaves and branches of tree where it slowly dripped to the ground after the event or evaporated back into the air. Another study by the USFS found that the tree canopy in Salt lake City, Utah in a one inch rainstorm over twelve hours, reduced surface runoff by about 11.3 million gallons, or 17%.

The lessons we have learned from the CREP program can be applied to any development to protect streams and ground water. Instead of planning to direct stormwater off the highway and into a stream as quickly as possible, we should be designing appropriate placement of meadows, bioswales, beds, trees and other plantings to slow and absorb rain water. If the highway adjoins a stream, a riparian tree, shrub and plant buffer along that stream will slow, filter and reduce the temperature of stormwater and that may flow to the stream from the highway.

Carbon Sequestration

Escalating global temperatures are an increasing concern among climatologists, economists and government officials. Even private sector companies are assessing their vulnerability to increasing temperatures, ocean levels and erratic weather. Two strategies for slowing the rising temperatures involve either reducing the production of green house gases, primarily CO² produced by burning fossil fuels (oil, coal, natural gas) or converting the CO² now in the air to solid or liquid carbon compounds.

The process of converting atmospheric CO² to solid or liquid compounds is called "carbon sequestration." There are a variety of high tech solutions being explored for sequestering atmospheric CO², such as liquefying it and pumping it underground under high pressure. But probably the simplest, most effective and most efficient way to sequester atmospheric CO² is to let plants do that work for us.

Plants are carbon sequestration machines. They take in carbon dioxide from the atmosphere and with energy gained from sunlight through photosynthesis convert the CO² to complex sugar compounds and pure oxygen. The complex sugar compounds are converted further by the plant into cellulose, energy and other molecules required by the plant. The oxygen is expelled as waste.

But some plants do carbon sequestration better than others. Annuals, for example do little carbon sequestration over their life cycle. Once an annual plant dies at the end of the season, its carbon is slowly released back into the atmosphere as natural decomposition processes take over. Perennial grasses, forbs and herbaceous plants do a better job, since their root systems persist in the ground and thereby sequester some carbon year to year, although their tops die back and annually decompose into simpler molecules, including carbon dioxide. In research being conducted in Kansas, deep-rooted prairie grasses, forbs and herbaceous perennials have been found to sequester as much as 1/3 of a ton of carbon per acre per year (Rice, 2002).

One of the most efficient plant systems for sequestering carbon is a young tree. Young trees sequester carbon at a comparatively high rate, converting CO² into wood as they grow. A tree will be a net user of CO² for most of its life as it continues to grow. As a tree matures its will continue to sequester the carbon held in its wood, but its ability to convert CO² slows with its growth. Eventually, when a tree dies, it will release its carbon dioxide back into the atmosphere slowly, if it decays naturally, quickly, if it is burned as fuel, or for a much longer period if it is converted to lumber or furniture.

Highways produce carbon, first by the construction process, but more significantly over time with the carbon dioxide produced by combustion of petroleum-based fuels by the vehicles using the highways.

Table 1. Carbon dioxide emissions from building one lane-mile of urban highway over 50 years

Construction, building materials, and maintenance	3,500 tons
Net congestion relief	-7,000 tons
Additional vehicle travel on the facility	90,000 tons
Induced vehicle travel off the facility	30,000-100,000 tons
TOTAL	116,500-186,500 tons

Source: http://www.sightline.org/research/energy/res_pubs/analysis-ghg-roads

A mile of highway produces from 2,330 - 3,730 tons per year of CO². Conversely, a healthy tree stores about 13 pounds of carbon annually -- or 2.6 tons per acre each year. An acre of trees absorbs enough CO₂ over one year to equal the amount produced by driving a car 26,000 miles (Nowak, 1993).

By including trees and meadows of deep-rooted perennial grasses and herbaceous plants as a part of highway design, either within or adjacent to the right-of-way or in areas removed from the project, at least a part of the carbon produced by a highway project can be offset.

Air Quality

Beyond the carbon sequestration issue, plants and trees have a positive impact on the air we breathe. As mentioned above, plants produce oxygen as a by-product of their existence in our environment. Its part of that wonderful symbiotic relationship that plants have with animals: plants give off oxygen as a waste product and we need oxygen to survive.

Highways and vehicles produce a plethora of air pollutants. But we are learning that plants and especially trees have a much more positive impact on our air quality than we once realized. Studies (Coder, 1996) have shown the following air quality benefits of urban trees:

- A sixty percent reduction in street level particulates on tree-lined streets vs. streets with no trees;
- Reduction in nitrogen dioxide, sulfur dioxide, carbon monoxide, cadmium, chromium, nickel and lead levels;
- Reduction in noise by up to 50%;

In addition, trees, plants and lawns have huge impacts on temperatures and energy use, especially in urban areas. A landscape lowers local air temperatures by transpiring water and shading surfaces. Because trees lower air temperatures, shade buildings in the summer, and block winter winds, they can reduce building energy use and cooling costs. The US Forest Service estimates that the evaporation cooling effect from one large tree is equivalent to the cooling produced by ten room-sized air conditioners! In a residential setting, well-placed trees can reduce energy use by 10-30% compared to a similar home on an open lot.

Biodiversity

Landscapes adjacent to highways provide the opportunity for increasing biodiversity. Ecological systems are more robust and are able to rebound from stresses if they are more diverse. Recent research, especially that of Doug Tallamy (2007) at the University of Delaware, is showing that landscapes designed with attention to plant selection that includes regional natives can have a dramatic positive effect on the biodiversity of that area.

Most areas adjacent to highways are not now designed with an eye toward increasing biodiversity. As the plant palette that we use in landscapes adjacent to highways narrows, we unwittingly also determine the fate of many species of butterflies and birds that have relied on the native plant communities for their survival. Tallamy has compiled the research that connects plant selection with the wildlife communities that rely on these plants.

Highway development has reduced habitat for many species, but by careful attention to plant selection in the design of adjacent landscapes, we can restore the ecological balance that once existed in these places. The result can be highway landscapes that provide aesthetic value to the traveler as well as environmental value to the butterflies and birds.

Opportunities with Highways

We can achieve the environmental benefits outlined above by more creative and thoughtful use of highway rights-of-way, including road sides, interchange infields and median strips. The land that is a part of our highways is a public resource that is greatly underutilized to provide cleaner air, cleaner water and to reduce net carbon emissions. In the United States, we have an estimated 4 million miles of roads with 60 million acres of right of way, which now is largely managed by mowing and spraying with herbicides as an afterthought and nuisance (Thompson, 2006). Federal transportation policy should incorporate a component

that incorporates better use of this resource in new projects and converts existing rights-of-way to improve the ecological services they provide.

In urban areas and along corridors where the right-of-way does not permit development of robust ecological services, projects can be planned in the adjoining neighborhoods, parks and other public spaces to accomplish similar objectives.

The State of Delaware is leader in improving the ecological services provided by its highway rights-of-way. Through its "Livable Delaware" initiative, DelDOT has developed standards for roadside plantings and maintenance that consider the ecological services that these areas could provide if planted and maintained properly.

Green Roofs on Public Buildings

Green roofs, building roofs that actually use living plants as the exposed surface, are very prevalent in Europe, but are just now catching on in the United States. Literally any building can be designed with a green roof. The advantages to a green roof are that it can reduce energy use by moderating temperature on the roof and surrounding areas. It also can dramatically reduce storm runoff volume and peak flow rate by holding and releasing stormwater slowly. A green roof can also restore the ecological and aesthetic value of urban open space by replacing a stark conventional roof with a green, softer roof line. Last, a green roof will protect conventional roofing systems, typically doubling the service life of the underlying waterproofing membrane.

As a matter of public policy PLNA recommends that any new public building be designed with an energy-saving, stormwater managing green roof.

Residential Landscapes

Curb appeal. That's what it's all about in residential real estate values. Does a home look good from the street and invite people in? If you can't get prospects in the front door, you can't sell the house.

And how do you generate curb appeal? Landscaping is one of the keys. Landscaping that is consistent with the tone of the neighborhood and that creates an aura of owner attention and care provides the best return on investment for the homeowner. Landscaping that is properly done can add 10%-15% to the value of a home (Niemiera 2007 and Behe 2005).

The greatest return on landscaping investments are those features that increase the utility of the home to the homeowner as well as adding aesthetic appeal. Patios, decks and outdoor kitchens, for example, in scale with the home with a view toward the landscaped area of the yard typically offer a high return on dollars invested.

But beyond resale value, landscaping, particularly trees, provides other economic benefits as well. Properly placed deciduous trees can reduce the summer heat load on a house by 10% to 30%, cutting air-conditioning costs. Additionally, well-placed evergreens can reduce winter heating requirements by a similar percentage, acting as a break against cold winter winds. And as the trees grow and mature, so do the savings.

And mature trees have intrinsic economic value. While the appraised value of a tree depends on many variables, the Council of Tree & Landscape Appraisers (CTLA) estimates that a mature tree in a residential landscape can have a value of from \$1,000 to \$10,000.

Commercial Landscapes

To a certain extent, some of the same principals that apply to residential landscapes also apply to commercial landscapes in terms the value of the real estate itself. The landscape is a reflection of the owner's level of care for his property and a proxy for how he maintains his buildings. This not only translates in to increased value at the time of sale, but also produces higher rents and lower vacancy rates over the period of ownership.

According to a study by Professor Joel Goldsteen, at the University of Texas, Arlington, landscape amenities had the highest correlation with occupancies of any other architectural and urban design variables evaluated. His conclusion was "landscaping amenities pay back the developer as evidenced by the higher occupancies (and rents) clearly justifying the investment." A shopping center in San Diego cites landscaping as the reason for high occupancy and the ability to charge rental rates that are double those of other shopping plazas. The carefully designed project uses landscaping to create a refuge in the midst of a busy shopping area. A Chicago developer points to unique interior landscaping in glass-roofed atriums as a major selling point and reason the building occupancy rates are 21% above the national level.

But in addition to the real estate value impact, there is also a growing body of research that shows that a well-maintained commercial landscape can have a positive influence on consumer buying behavior in retail shopping areas. In a Wall Street Journal article by Lucinda Harper, entitled "Landscapers Help Spruce Up Main Street," several revitalization efforts around the nation were cited where landscape was key to creating a sense of community and bolstering the local economy. The city of Valdosta, Georgia, according to Harper, had tried everything from incentives to restoring the facades of buildings only to find that \$9 million in landscaping brought shoppers to the district who spend longer periods of time, which in turn, brought more shops.

Public Buildings, Landscaped Environments and Human Performance

Recent studies are demonstrating dramatic improvement in human performance and behavior when a landscaped environment is incorporated into hospitals, schools, workplaces and neighborhoods. Access to landscaped environments have been shown to reduce hospital stays for patients, improved the recovery of cancer patients, improve the performance of students in schools, and reduce sick leave usage among office workers.

Hospitals, Health Care and Assisted Living Facilities

There have been a number of studies that have related the presence of a landscaped environment to human health. Studies have found that the presence of plants, or quite simply the ability to see plants, can reduce pain sensation, lower blood pressure and help patients heal faster. Not only does the impact of plants translate to less human suffering and better health, but it also means fewer drugs and lower healthcare costs. Any design of a hospital or health care facility should incorporate the benefits of the landscaped environment on patient well-being.

Researcher Roger Ulrich (1984) found positive changes in medical outcomes resulting directly from people being able to see plants. Ulrich compared the hospital records of patients recovering from gall bladder surgery in a suburban Philadelphia hospital and found those with a view of a group of trees spent less time in the hospital than those looking out at a brick wall (7.96 days vs. 8.70 days). Equally important: the patients required fewer and less potent drugs to remain comfortable.

Translating that into economic terms, a University Of Michigan study found that average cost of the last day of stay for a hospital patient was \$432 (Taheri et al, 2000) Assuming that the average reduction in hospital stays could be reduced by 0.74 days as in the Ulrich study and the annual number of hospital discharges was 34.9 million in the U.S. in 2006 (DeFrances, et al, 2008), that would equate to a potential savings of over \$11 billion over a year to the U.S. healthcare system, insurers and individuals.

A study of breast cancer patients used walks and other exposure to the natural environment for 120 minutes per week before and after breast cancer surgery to help women maintain and regain their mental and emotional strength (Cimprich & Ronis, 2003). The study found that the group having the exposure to the natural environment was significantly better than the control group, which had no such exposure, even after controlling for other variables such as age, education and other health problems.

A University of Arkansas study found that women age 50 and older who gardened at least once a week had higher bone density than those who jogged, walked, swam or did aerobics. Lori Turner, assistant professor of health sciences at the university, says weight-bearing exercise is known to help women maintain healthy bones. According to Turner (2001), "being outside also gives bones an extra boost from the Vitamin D derived from sunlight."

The American Heart Association (AHA) recommends 30–60 minutes of aerobic exercise three to four times per week to promote cardiovascular fitness. The National Institute of Health (NIH) recommends that adults accumulate at least 30 minutes of moderate activity most days of the week. Moderate activities include pleasure walking, climbing stairs, gardening, yard work, moderate to heavy housework, dancing and home exercise. Regular physical activity reduces the risk of dying prematurely from cardiovascular disease. Gallup Polls put gardening as the No. 1 adult leisure-time activity.

Regular gardening, like other moderate physical activities, offers a list of short- and long-term health benefits. Table 1 offers some of the more important benefits.

Table 2. Gardening as Exercise.

Short-Term Benefits

- More energy and stamina
- Stronger bones and muscles
- Cope more easily with daily stress
- Be less preoccupied with your weight
- Relax and sleep more soundly

Long-Term Benefits

- Reduced risk of
 - High blood pressure
 - Heart disease
 - Stroke
 - Obesity
 - Adult-onset diabetes
 - Osteoporosis
 - Depression
 - Colon-cancer
- Increased likelihood of continued independent living in later life

Source. Go for Green. (n.d.).

Dutch researchers (Maas, Verheij, Groenewegen, de Vries, & Spreeuwenberg,, 2006) found a strong tie between general public health in an area and the amount of green space in that environment. Not only was there a strong correlation between greenery and the health of residents in an area, but the more urbanized an area, the greater the impact green space had on the general health of the population in that area.

Finally, in an article summarizing what we know about the interaction between human health and the natural world, a team of health scientists from Deakin University in Melbourne, Australia wrote,

Natural areas can be seen as one of our most vital health resources. In the context of the growing worldwide mental illness burden of disease, contact with nature may offer an affordable, accessible and equitable choice in tackling the imminent epidemic, within both preventative and restorative public health strategies. (Maller et al., 2005)

Table 3. A summary of evidence supporting the assertion that contact with nature promotes health and well-being.

What the Research Demonstrates With Certainty	Evidence*		
	A	T	E
There are some known beneficial physiological effects that occur when humans encounter, observe or otherwise positively interact with animals, plants, landscapes or wilderness.	✓	✓	✓
Natural environments foster recovery from mental fatigue and are restorative.	✓	✓	✓
There are established methods of nature-based therapy (including wilderness, horticultural and animal-assisted therapy among others) that have success in healing patients who previously had not responded to treatment.	✓	✓	✓
When given a choice, people prefer natural environments (particularly those with water features, large old trees, intact vegetation or minimal human influence) to urban ones, regardless of nationality or culture.		✓	✓
The majority of places that people consider favorite or restorative are natural places, and being in these places is recuperative.	✓	✓	✓
People have a more positive outlook on life and higher life satisfaction when in proximity to nature (particularly in urban areas).	✓	✓	✓
Exposure to natural environments enhances the ability to cope with and recover from stress, cope with subsequent stress and recover from illness and injury	✓	✓	✓
Observing nature can restore concentration and improve productivity.	✓	✓	✓
Having nature in close proximity, or just knowing it exists, is important to people regardless of whether they are regular "users" of it.	✓	✓	✓

Note. A = Anecdotal; T = Theoretical; E = Empirical
Source. Maller et al. (2005).

PLNA recommends that the building designs for public and quasi-public buildings (hospitals, schools, government office buildings, assisted living facilities, etc.) incorporate adjacent landscaping as part of the overall building design.

Workplace

A number of studies (we have reviewed only a few here) report a variety of positive effects of plants both within the office environment and when visible to employees through windows to the outdoor landscape. Not only do plants improve employee morale, attitude

and productivity, but they also reduce the reported incidence of employee illness and fatigue. A study by Professors Rachel and Steven Kaplan at the University of Michigan found that workers with a view of trees and flowers experienced less job pressure and were more satisfied with their jobs than those who had no outside view or only a view of buildings. The employees with views of plants also reported fewer headaches and illnesses.

Similarly, a study of office conditions by the U.S. Army Corps of Engineers found that productivity, employee attitudes and perceptions were positively correlated with the amount of plants in the work place. The most negative employee response was found in an office setting with no plants, an improved employee response was found in a setting with a moderate number of plants, and the highest positive response was in an office with many plants. (Larson et al., 1998).

A European study of employee satisfaction looked at three variables connected with windows: The general illumination levels, sunlight penetration and the view through the window. The study found that sunlight penetration and a view of natural elements (trees, vegetation, plants and foliage) had a positive impact on employee job satisfaction and morale. The general illumination level provided by the window was found to have no impact (Leather, Pyrgas, Beale, & Lawrence, 1998).

As Kaplan and Kaplan found in their study of employees, Fjeld, Veiersted, Sandvik, Riise, and Levy (1998) from the University of Norway horticulture department found that plants in the workplace actually reduced reported symptoms of illness and fatigue 23 percent to 30 percent in a controlled study of office environments with and without plants.

These studies report a variety of positive effects of plants both within the office environment and when visible to employees through windows to the outdoor landscape. Not only do plants improve employee morale, attitude and productivity, but they also reduce the reported incidence of employee illness and fatigue. A 2005 survey by CCH Inc., a Riverwoods, Ill.-based provider of information services, found that unscheduled absences cost companies \$660 per employee per year. A reduction in this cost by interior plantscaping can offset the cost of plant maintenance and lead to better morale in the workforce.

Schools and Children

As with adults, plants and landscapes have an enormous positive impact on children, especially regarding their classroom learning capabilities and behavior. Plants and green environments have been shown to reduce the behavioral problems in children diagnosed with Attention Deficit Disorder. Learning is improved in classrooms with a view to a landscaped outdoor environment. Children's play is more diverse, and their socialization improves on playgrounds that are near or integrated with natural landscape elements, such as trees or a wooded area (Lindholm, 1995).

Andrea Faber Taylor (2001) conducted a study of children with severe attention deficit disorder to see if the "greenness" of their play area affected their behavior while playing and after playing in that environment. Faber Taylor found that the ADD symptoms were worst in a room without windows, engendering extreme ADD behaviors that lasted for days. On the other hand, green play areas (i.e., those with grass, trees and landscaping) seemed to reduce the ADD behaviors, and the children were reported to be calmer and more focused the day after playing in the green area.

In a review of the all the studies relating to the impact of nature and landscapes on children, Faber Taylor (2006) concluded that:

While we wait for more carefully controlled studies providing evidence of a causal relationship (between natural environments and children) current evidence suggests that the general hypothesis may be correct: contact with nature is supportive of healthy child development in several domains—cognitive, social and emotional. Until proven otherwise, we can continue to assume, just as they need good nutrition and adequate sleep, children may very well need contact with nature. (pg. 136)

Neighborhoods and Crime

Mayor Richard Daley of Chicago is pouring millions into making Chicago the “Greenest city in America.” But his claim is more than hype. For years, Daley has invested in the positive impact of planting trees in neighborhoods, putting perennial gardens in industrial areas and changing out the “color” in planters and street median plantings three times a season.

Several years ago, PLNA president Gregg Robertson was on a tour of Chicago with the then just retired director of the city’s Bureau of Forestry, Robert Benjamin. The Chicago Bureau of Forestry has responsibility for all things green in Chicago. After an impressive tour of an industrial district where street trees, parking-lot median plantings and street-side flower beds were in flower-show condition, Robertson asked him how the city justified spending so much on the city’s green initiatives. His reply, “Because it lowers crime, the test scores of kids in these neighborhoods go up, and the neighbors take ownership of the streets. In the long run, the city saves money, is a better place to live and attracts business and tourists.”

The data bears out Benjamin’s assertion. A study by University of Illinois, Urbana (Kuo, Bacaicoa, & Sullivan, 1998), found that residents in of Chicago’s Robert Taylor Homes felt safer if the grass was closely maintained and the tree density was increased. This was contrary to police opinions that increased tree density would provide hiding places for criminals and thus make residents feel less safe. In fact, improved landscaping made the residents feel safer.

In another Chicago study by Quo and Stanley (2001), there were dramatically fewer occurrences of crime against both people and property in apartment buildings surrounded by trees and greenery than in nearby identical apartments that were surrounded by barren land. In fact, compared with buildings that had little or no vegetation, buildings with high levels of greenery had 48 percent fewer property crimes and 56 percent fewer violent crimes. Even modest amounts of greenery were associated with lower crime rates. The greener the surroundings, the fewer the number of crimes that occurred.

Greenery lowers crime through several mechanisms. First, greenery helps people to relax and renew, reducing aggression. Second, green spaces bring people together outdoors, increasing surveillance and discouraging criminals. Third, the green and groomed appearance of an apartment building is a cue to criminals that owners and residents care about a property and watch over it and each other.

Green Industry Jobs

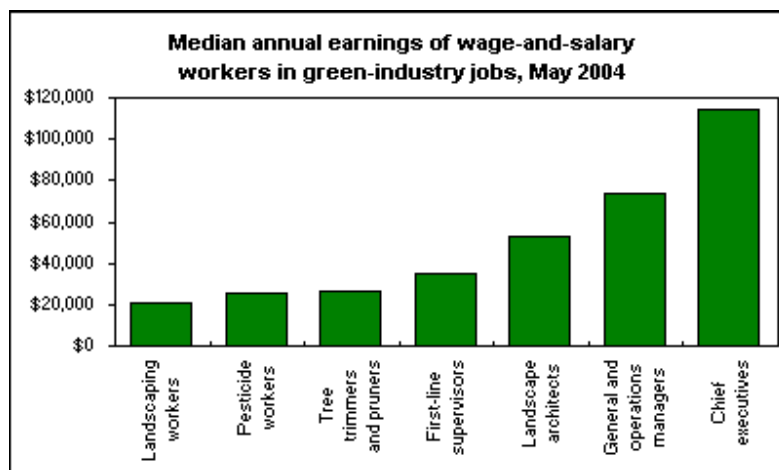
Green industry jobs offer strong prospects to individuals both skilled and unskilled. Once an individual is employed with a green industry firm, opportunities abound for career

advancement. Because the green industry is more labor intensive and hands-on than mechanized, money invested in green industry jobs has a direct impact on hiring.

Kevin M. McCarron of the U.S. Bureau of Labor Statistics notes, "Experience in planning landscapes and installing and caring for plants provides fertile ground for careers." He continues by stating, "Some of these occupations, such as landscape architect, require formal education; others do not. People often start out in grounds maintenance or retail jobs, for example, and work their way, by acquiring either education or experience or both, into occupations that require more skill and offer higher pay." (McCarron, 2005)

The BLS notes that salaries in the green industry range from \$20,420 for entry-level landscaping workers to \$114,680 for chief executives. The chart below demonstrates the pay ranges:

Chart 1



Source: US Bureau of Labor Statistics

McCarron concludes, "Work with plant life is growing—in more ways than one. According to BLS projections, the occupations related to plants and landscaping will gain thousands of jobs between 2002 and 2012. Over this decade, employment for both landscape architects and landscape and greenhouse workers is expected to increase by about 22 percent. That's faster than the average employment growth projected for all occupations." (McCarron, 2005).

A more recent study conducted by the market research firm SBI (2008) found that the green industry market is expected to grow 10 percent in the next five years, despite the recession. In short, green industry jobs offer immediate economic impact for the hiring of a wide range of individuals, skilled and unskilled, and promise long-term career building prospects. The green industry is labor-intensive in nature, rather than machine-based, and will put Americans to work.

Summary

If we build and restore our infrastructure without attention to the green portion of those projects, we will not be getting the full value from those investments and in some cases, exacerbating other problems like stormwater runoff and global climate change. Each aspect

of our infrastructure investments should include a green component to maximize the return on that investment, the economic impact and the long-term investment value.

The Pennsylvania Landscape and Nursery Association (PLNA) is a trade association representing Pennsylvania's \$5.6 billion green industry. Founded in 1904, its 750 members include production nurseries, garden centers, landscape contractors, arborists, interiorscape contractors, florists and other private sector companies in the Northeast's leading horticultural state.

Bibliography

- Behe, B., J. Hardy, S. Barton, J. Brooker, T. Fernandez, C. Hall, J. Hicks, R. Hinson, P. Knight, R. McNeil, T. Page, B. Rowe, C. Safley, and R. Schutzki. 2005. Landscape plant material, size, and design sophistication increase perceived home value. *Journal of Environmental Horticulture* 23:127-133.
- Cimprich, B., & Ronis, D. (2003). An environmental intervention to restore attention in women newly diagnosed with breast cancer. *Cancer Nursing*, 26(4), 284–292.
- Coder, Dr. Kim D. (1996), "Identified Benefits of Community Trees and Forests", University of Georgia.
- DeFrances, Carol J, Christine A. Lucas, Verita C. Buie, Aleksandr Golosinskiy. 2006 National Hospital Discharge Survey, *National Health Statistics Reports*, No. 5 July 30, 2008.
- Faber Taylor, A., Kuo, F. E., & Sullivan, W. C. (2001). Coping with ADD: The surprising connection to green play settings. *Environment & Behavior*, 33(1), 54–77.
- Fjeld, T. B., Veiersted, L. Sandvik, G., Riise, & Levy, F. (1998). The Effect of Indoor Foliage Plants on Health and Discomfort Symptoms among Office Workers. *Indoor and Built Environment*, 7, 204–209.
- Hall, Charles R., PhD, University of Tennessee; Hodges, Alan W., PhD, University of Florida; Haydu, John J., PhD, University of Florida. "Economic Impacts of the Green Industry in the United States: Final Report to the National Urban and Community Forestry Advisory Committee". June 3, 2005.
- Leather, P., Pyrgas, M., Beale, D., & Lawrence, C. (1998). Windows in the workplace: Sunlight, view, and occupational stress. *Environment and Behavior*, 30, 739–762.
- Lindholm, G. (1995). Schoolyards: The significance of place properties to outdoor activities in schools. *Environment and Behavior*, 27, 259–293.
- Maas, J., Verheij, R. A., Groenewegen, P. P., de Vries, S., & Spreeuwenberg, P. (2006). Green space, urbanity, and health: How strong is the relation? *Journal of Epidemiology and Community Health*, 60, 587–592.
- Maller C., Townsend M., Pryor A., Brown P. and St Leger L. (2005) "Healthy nature healthy people: 'contact with nature' as an upstream health promotion intervention for populations". *Health Promotion International*, 21: 45-54, December.
- McCarron, Kevin M. (2005) "Careers in the Green Industry". Occupational Outlook Quarterly, Spring 2005.
- Niemiera, Alex X., The Effect of Landscape Plants on Perceived Home Value, Publication Number 426-087, Department of Horticulture, Virginia Tech, September 2007.
- Nowak, David J., (1993). Benefits of Community Trees, *Brooklyn Trees*, USDA Forest Service General Technical Report.

Kuo, F. E., Bacaicoa, M., & Sullivan, W. C. (1998). Transforming inner-city landscapes: Trees, sense of safety, and preference. *Environment and Behavior*, 30, 28–59.

Rice, Charles (2002). Storing carbon in soil: why and how?, *Geotimes*, Web Feature, Retrieved from www.geotimes.org/jan02/feature_carbon.html.

Specialists in Business Information (SBI): <http://www.sbireports.com/Landscape-Services-1804487/>. January 1, 2009.

Taheri PA, DA Butz, LJ Greenfield. Length of stay has minimal impact on the cost of hospital admission. *J Am Coll Surg*. August 2000, 191 (2):123-30.

Tallamy, Douglas W. (2007). *Bringing Nature Home*, Timber Press.

Thompson, Jonathan (2006). Highways And Habitat: Managing Habitat Connectivity And Landscape Permeability For Wildlife, *Science Findings*, 79, 1-6, Pacific Northwest Research Station, US Forest Service.

Time Magazine "Why cities are uprooting trees". Thursday, Jun. 21, 2007

Turner, L. (2001). Gardening: Good for the Bones. *Third Age Health & Wellness Newsletter*. Retrieved from www.thirdage.com/news/archive/ALTO2000421-01.html.

Volz, Conrad Daniel, Frank Houghton, Nancy Sussman, PhD, Diana Lenzner, Devra Davis, Maryann Donovan, Talal El Hefnawy and Patricia Eagon (2007). Channel catfish estrogenicity and sewer overflows; implications for xenoestrogen exposure. Center for Healthy Environments & Communities, University of Pittsburgh, www.chec.pitt.edu.

Wells, N. M. (2000). At home with nature: Effects of "greenness" on children's cognitive functioning. *Environment and Behavior*, 32, 775–795.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, 224, 420–421.