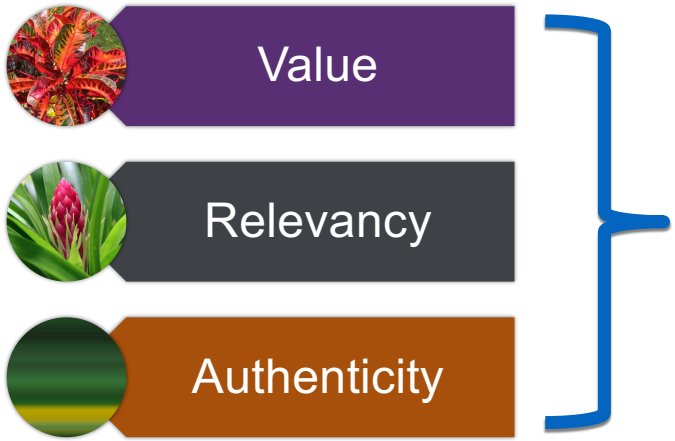
Sociohorticulture: Our value proposition for the future

Dr. Charlie Hall (c-hall@tamu.edu)

People, regardless of age or any other demographic characteristic, want things that enhance the quality of their lives!

What defines Quality of Life?



Social Well-Being
Physical Well-Being
Psychological Well-Being
Cognitive Well-Being
Environmental Well-Being
Spiritual Well-Being

= QOL

The Power of Plants!

Economic Benefits

- Beautification draws customers & reduces shopping stress
- Boosts occupancy rates
- Generates tourism revenue
- Job creation from increased services demanded
- Reduced health care costs
- Increased property values
- Tax revenue generation
- Reduced street repairs and maintenance costs
- Upgrade effects of surrounding areas
- Revenue from educational programs & special events

Environmental Benefits

- Carbon sequestration
- Improved air quality
- Attracts wildlife and promotes biodiversity
- Energy cost savings associated with heating / cooling
- Reduced heat and cold damage
- Offsets heat islands
- Reduced noise pollution
- Reduced soil erosion
- Reduced storm water runoff
- Improved water quality
- Reduced urban glare
- Effective windbreaks
- Increased biodiversity

Health/Well-being Benefits

- Improved concentration and memory retention
- Enhanced learning capacity
- Plants generate happiness
- Reduced stress and depression
- Health and recreation benefits
- Accelerates healing process
- Therapeutic effects of gardening
- Improves relationships / compassion
- Improved human performance / energy
- Medicinal properties
- Improved mental health
- Reduced community crime
- Traffic safety / driver satisfaction


carbon
footprint


O2
O2
O2
O2
O2

Remediation of air pollution by trees

Pollutant	Removal (metric tons)	Value (million US $)
Ozone (O_3)	305,100	2,060
Particulate Matter (PM_{10})	214,900	969
Nitrogen dioxide (NO_2)	97,800	660
Sulphur dioxide (SO_2)	70,900	117
Carbon Monoxide (CO)	22,600	22
TOTAL	*711,300*	*3,828*

Source: (Nowak, Crane, & Stevens, 2006).

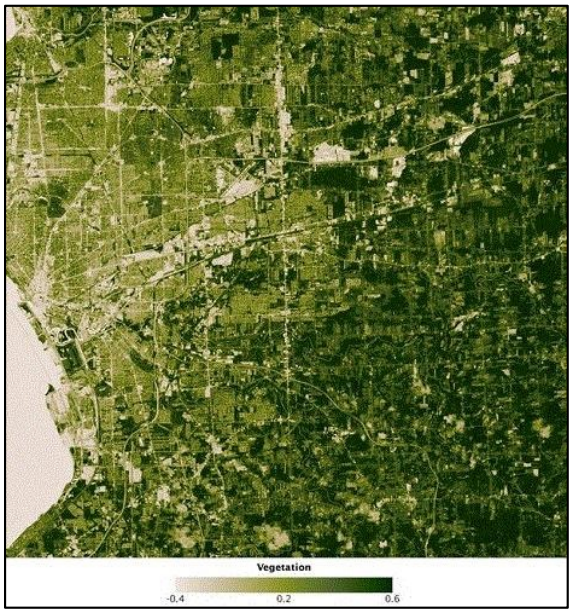
Estimated Value of Trees in U.S. Urban Parks

- Structural value = $300 billion
- Air temperature reduction = unknown, but likely in the billions of dollars per year
- Air pollution removal = $500 million per year
- Reduced ultraviolet radiation = unknown, but likely substantial
- Carbon storage (trees): $1.6 billion
- Annual carbon removal (trees): $50 million per year

Office plants decrease sick time by 14%.

$2,200 reduction in average annual health care costs per adult.

Plant-filled rooms contain 50-60% fewer airborne molds and bacteria than rooms without plants.



The results of an eight-year study showed that women living in areas with more vegetation had a **12% lower mortality rate** than women living in areas with the least vegetation.

Green spaces = physical activity!

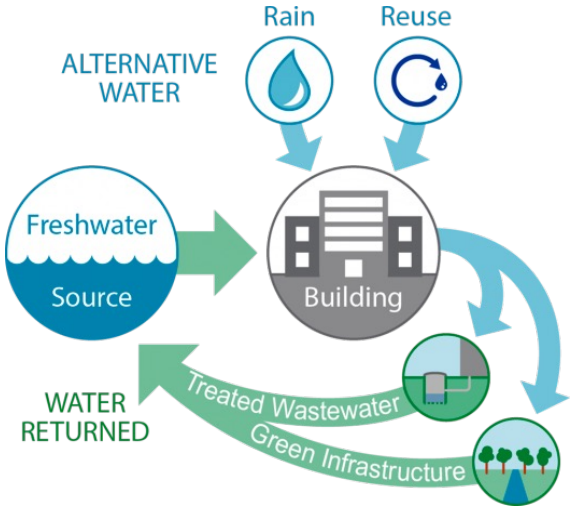
Shoppers spend 9 to 12% more.

Shoppers' WTP = +17% more.

7% higher rental rates + higher occupancy


2 million jobs in the U.S.


• $1.09 per $1.00 invested
• Adjacent to parks +8 to 20%
• Trees = +3 to 15%



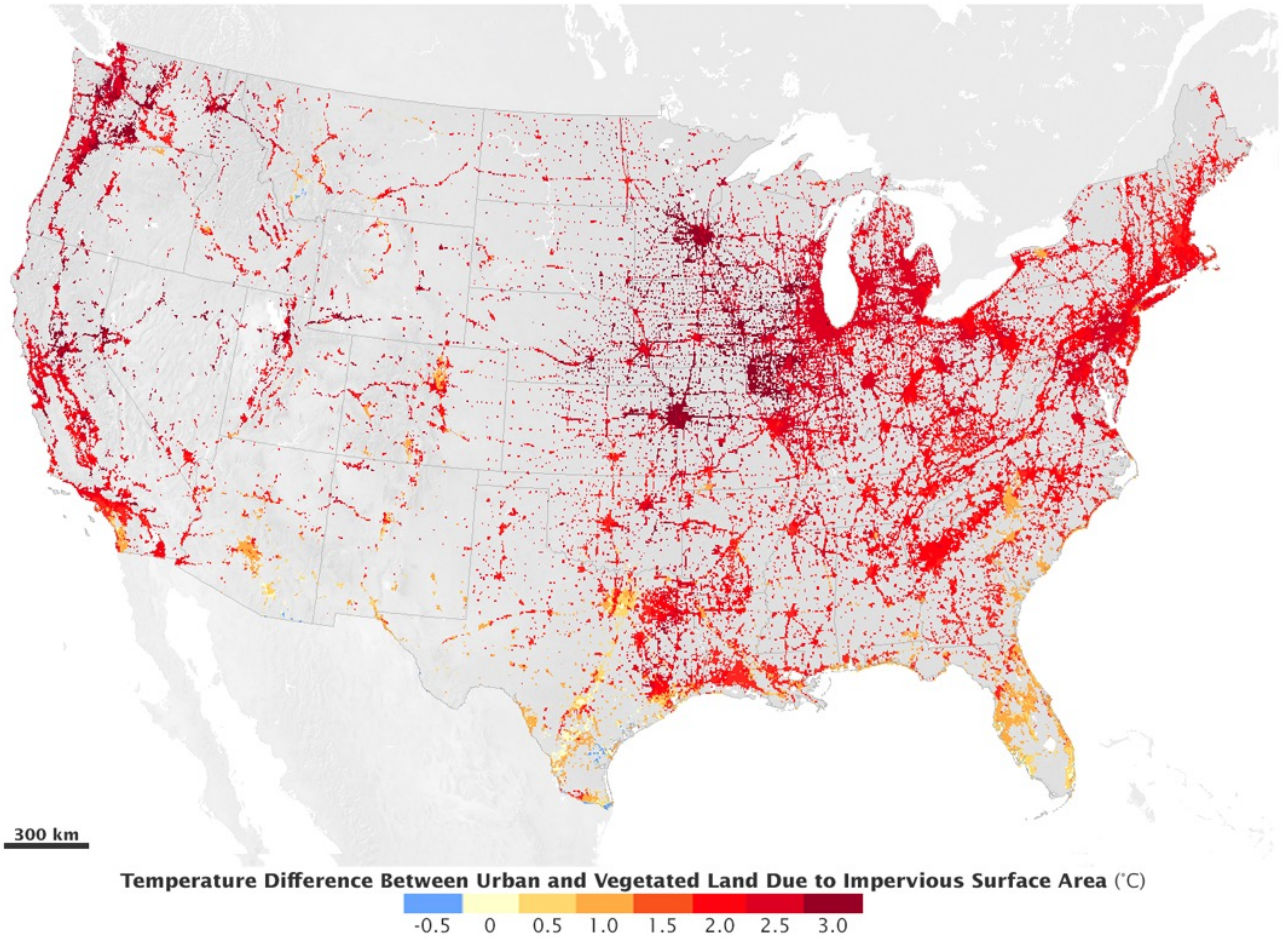
Net zero water use

Alternative Water use

+

Water Returned

Total Water Use



Researchers found that when the area of the impervious surfaces reaches 35% of the total (the other 65% being vegetation cover), things go haywire. Up until that point, the urban area stays at a constant 1.3˚C above the surrounding area. Above it, that difference increases as the vegetation is stripped away, "reaching 1.6°C warmer by 65% urbanization." That might not sound like much, but one degree is enough to push up air-conditioning use by up to 20%.

A mature tree canopy reduces air temperature by about 5-10° F and also reduces the internal temperatures of nearby buildings.

A 25-foot tree reduces the annual heating and cooling costs of a typical residence by 8-12%

Tree canopy reduces 1” rain runoff by 17%

A 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.

Shade provided by trees reduces the need for maintenance and repaving. A study from US Davis found that, 20% shade on a street improves pavement condition by 11%, which is a 60% savings for resurfacing over 30 years.

Green spaces improve mental health.

- Nature reduces stress, provides attention restoration, provides a sense of belonging and self worth, and reduces symptoms of aggression and crime.

Green spaces are key to recovering from stress.

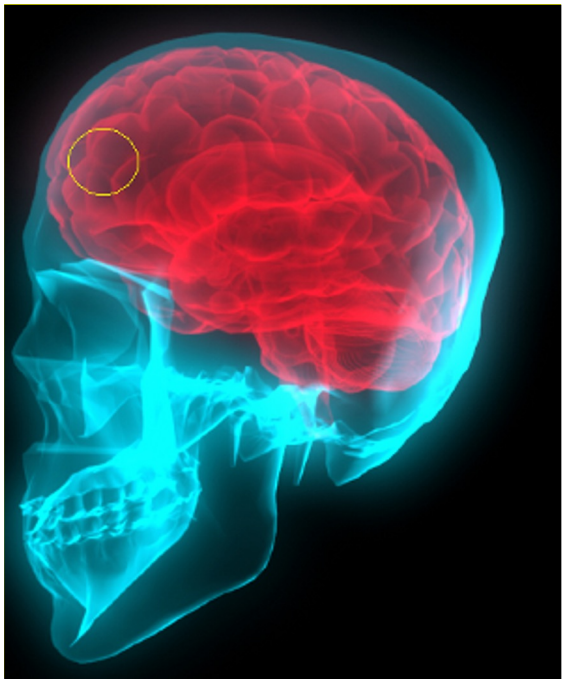
- The response from looking at greenery causes a rapid reduction in stress (**blood pressure, muscle tension, pulse rate**) usually within minutes of exposure to nature and is most obvious when the body is already stressed.

a) b) c)

From EEG studies, alpha waves (more calming) are highest in a), second highest in b), and lowest in c)

When we come into contact with green spaces, our concentration levels are dramatically improved.

- The natural environment allows us to **restore and boost our concentration** levels :
  - We are **away** from day-to-day routine.
  - We have opportunities to be **fascinated** when in green spaces.
  - Gives us a feeling of **exploration & adventure**.



The benefits occur in the right frontal cortex of the brain

ADD/ADHD
symptoms
are reduced

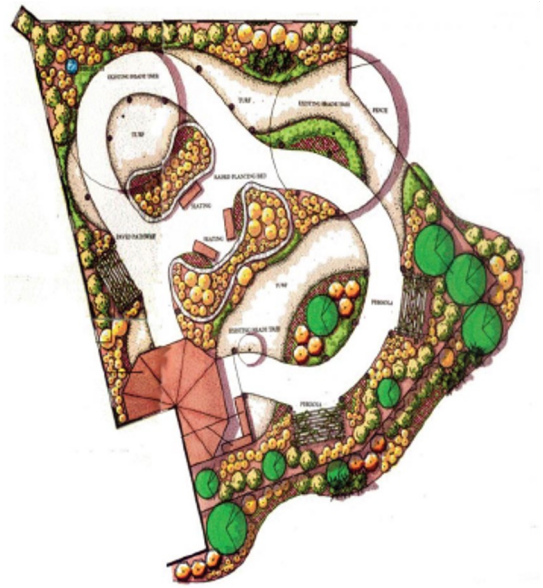
Perform better

Remember more

Creativity is EnHaNceD!

Odor	Cognitive Performance	Stress	Mood
Lavender	**Improved concentration and computational accuracy** (Sakamoto et al., 2005; Diego et al., 1998)	**Reduced stress and anxiety** (Toda & Morimoto, 2008; Lehrner et al., 2005)	**Increased relaxation** (Diego et al., 1998) **Improved mood** (Lehrner et al., 2005)
Peppermint	**Enhanced attention, alertness, arousal, memory, and task performance** (Warm et al., 1991; Moss et al., 2008; Barker et al., 2003)	**Increased eustress and reduced distress** (Toda & Morimoto, 2011)	
Rosemary	**Enhanced alertness and quality of memory** (Moss et al., 2003; Moss & Oliver, 2012; Diego et al., 1998)		**Stimulated and improved mood** (Sayorwan et al., 2012)
Citrus	**Improved scholastic performance** (Akpinar, 2005)	**Reduced stress and anxiety** (Matsumoto, Asakura, & Hayashi, 2013; Lehrner et al., 2005; Goes et al., 2012)	**Stimulated and improved mood** (Warrenburg, 2005; Lehrner et al., 2005)
Cypress		**Reduced blood pressure** (Chen et al., 2015)	**Improved mood and comfort** (Chen et al., 2015; Ikei, Song, & Miyazaki, 2015)
Vanilla			**Relaxed and improved mood** (Warrenburg, 2005)

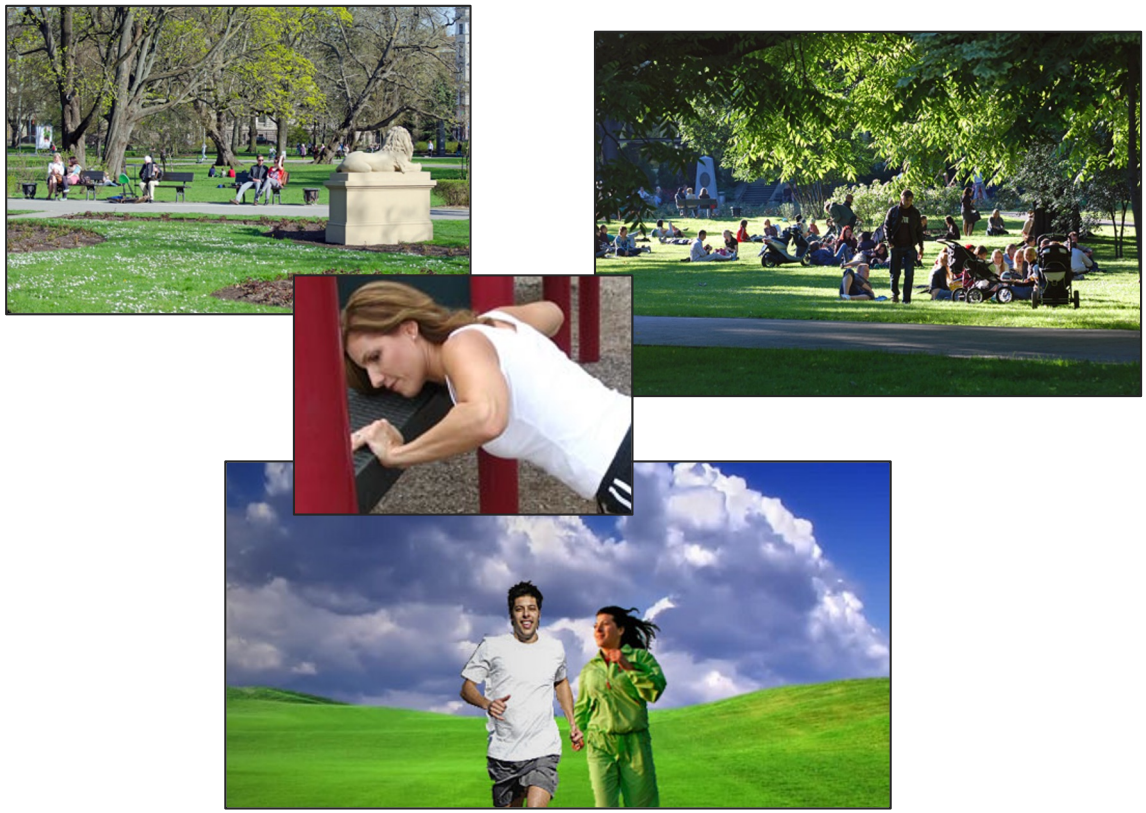
Table 1. Exposure to natural scents has been observed to have psychophysiological effects. When designing for an olfactory experience, desired responses and odor concentrations should be considered in the context of users, settings, and time of day.



ALZHEIMER'S WING IN HOLT, MICHIGAN:
STUDIES UNDERTAKEN AT THE FACILITY REVEALED THAT EXPOSURE TO NATURE NOT ONLY HELPS PATIENTS, BUT STAFF TOO. EMPLOYEES WHOM ARE LESS PRONE TO BURNOUT CAN IMPACT HR COSTS.

Patients who have access to healing gardens are **less likely** to display aggression or experience injuries as well as **improved sleep** patterns, **balanced hormones**, and **decreased agitation**.

Green spaces increase physical activity.



People use green spaces to be more active – so green spaces improve physical health.

- Being within access to green spaces can increase levels of physical activity.
- Senior citizens live longer with more space to walk and with nearby parks and tree-lined streets near where they live.
- For every 10% increase in green space, there was a reduction in health complaints equivalent to a reduction in age of five years.

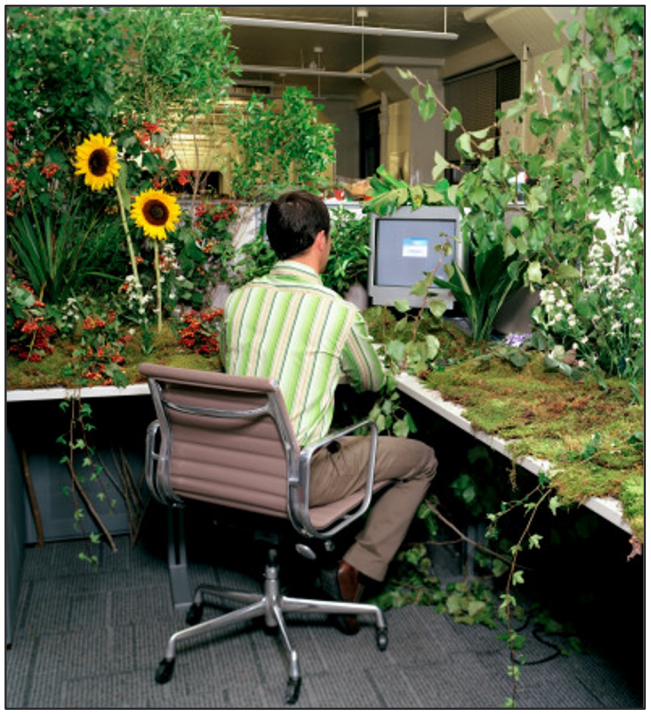
People who live in green neighborhoods have, on average, **lower blood pressure**, lower rates of cardiovascular disease, and **lower rates of cardiovascular mortality**.

Greenness enhances immune functioning response.

Decreases VOC's

Task performance increases

Decreased absenteeism



Reduced Obesity

Greenness counters the adverse effects of stress on energy metabolism, insulin secretion, and inflammatory pathways and stimulates the release of anti-diabetic hormones adiponectin and DHEA and normalizes elevated blood glucose.

Green spaces encourage social interactions.

Greenness = greater life satisfaction = 7 years younger

Disaster resilience

The highway from one merchant town to another shall be cleared so that no cover for malefactors should be allowed for a width of two hundred feet on either side; landlords who do not affect this clearance will be answerable for robberies committed in consequence of their default, and in case of murder they will be in the king's mercy. — Statute of Winchester of 1285, King Edward I

Crime Busting Effects

Crime and Nature

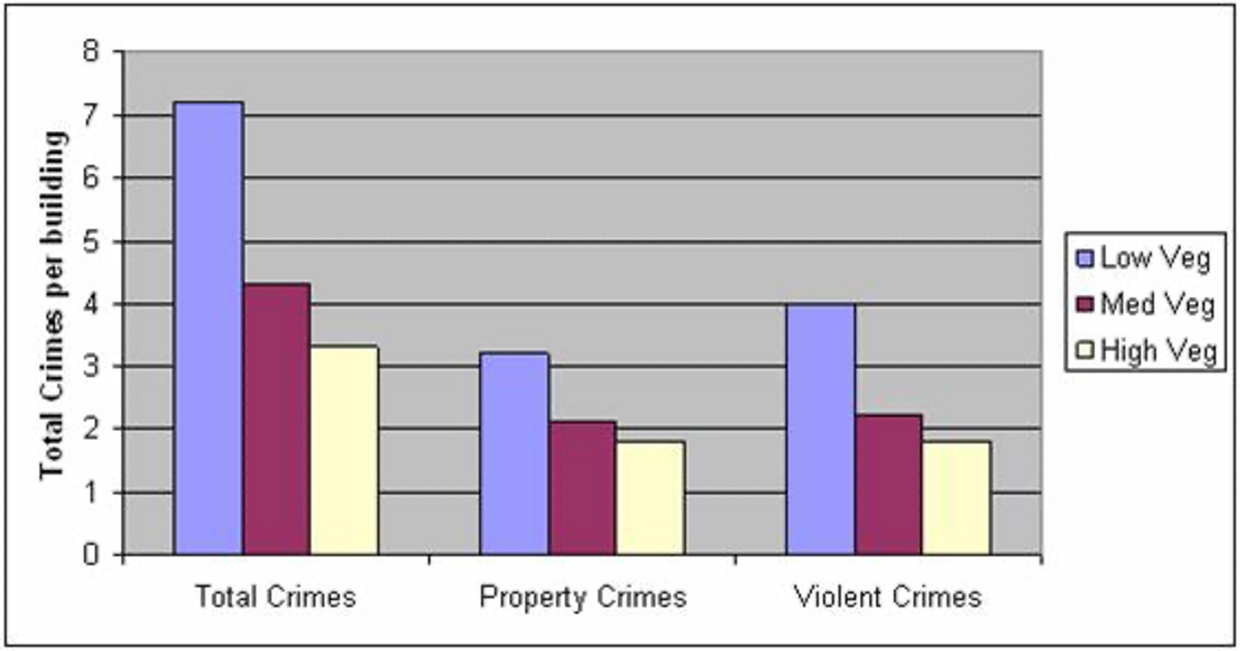
Kuo F, Sullivan WC, (2001) Environment and Crime in the Inner City: Does vegetation Reduce Crime. Environment and behaviour

The results of this study show that those buildings with the highest amount of vegetation had:

52% fewer total crimes

48% fewer property crimes and

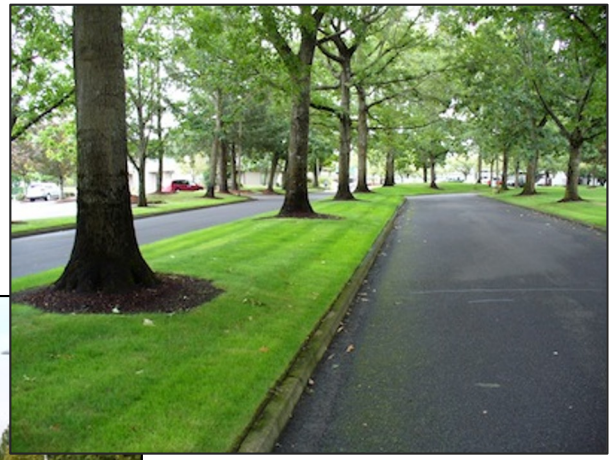
56% fewer violent crimes



Provides career training.

Reduced recidivism rates.

Safer



Drivers

The Power of Plants!

ellisonchair.tamu.edu -- Benefits of Plants

Case studies

ECONOMIC BENEFITS OF GREEN INFRASTRUCTURE


Greetings from
LANCASTER
PA.

Benefit measurement & evaluation: WATER

Green roofs

Tree planting

Bioretention & infiltration

Permeable pavement

Water harvesting

}

Reduced water treatment needs

Reduced gray infrastructure needs

Improved water quality

Reduced flooding

Estimated Value of Avoided Costs for Wastewater Treatment & Storage at 25-Year Implementation*	
Reduced Pumping and Treatment Costs (per year)	$661,000
Reduced Gray Infrastructure Capital Costs	$120,000,000

Benefit measurement & evaluation: Energy

Green roofs
Tree planting
Reduced water treatment

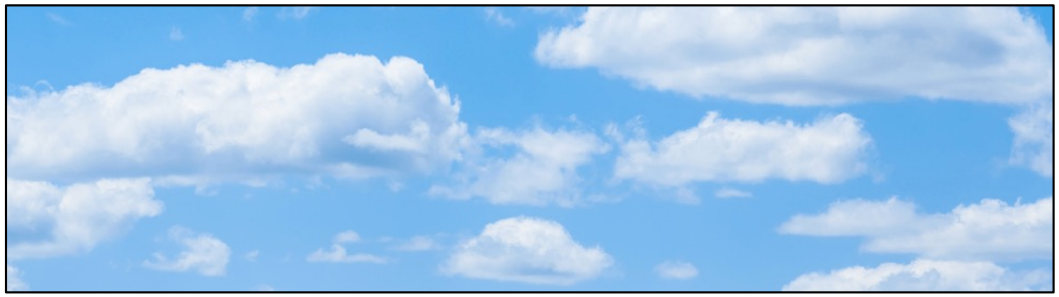
} Reduced heating & cooling
Reduced electricity usage

Estimated Value of Reduced Energy Use at 25-Year Implementation	
Reduced Electricity Use (kWh)	$592,000
Reduced Natural Gas Use (Btu)	$1,776,000
TOTAL (per year)	**$2,368,000**

Benefit measurement & evaluation: Air Quality

Green roofs
Tree planting
Bioretention & infiltration

} Reduced criteria pollutants
Climate change benefits



Estimated Value of Reduced Air Pollutants at 25-Year Implementation	
Reduced NO_2	$285,000
Reduced O_3	$171,000
Reduced SO_2	$238,000
Reduced PM-10	$329,000
TOTAL (per year)	**$1,023,000**

Estimated Value of Reduced CO_2 at 25-Year Implementation	
TOTAL Reduced CO_2 (per year)	**$786,000**

Total Calculated Benefits (at Long-Term 25-Year Implementation)	
Estimated Value from Water Benefits Reduced CSS Gray Infrastructure Capital Costs (one-time) Reduced Pumping and Treatment Costs (per year)	 $120,000,000 $661,000
Estimated Value from Energy Benefits (per year)	$2,368,000
Estimated Value from Air Quality Benefits (per year)	$1,023,000
Estimated Value from Climate Change Benefits (per year)	$786,000
Estimated Value from other Qualitative Benefits	Not calculated
TOTAL **Avoided Capital Costs** **Annual Benefits**	 **$120,000,000** **$4,838,000**

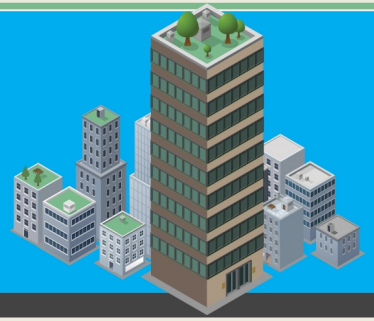
THE BENEFITS OF GREEN STORMWATER INFRASTRUCTURE ON PRIVATE COMMERCIAL PROPERTY

GREEN ROOFTOPS

Apartment buildings with green roofs received a 16% rental premium, according to one study.

Green roofs typically last twice as long as conventional roofs, saving hundreds of thousand of dollars in roof repair/replacement costs.

The green roof on the Target Center Arena in Minneapolis has decreased annual energy costs by $300,000.

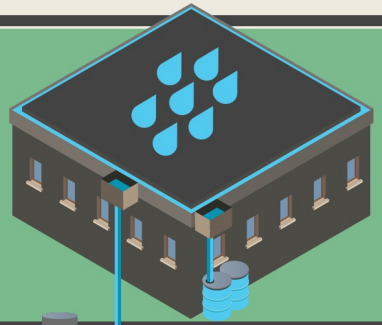


LANDSCAPING
WITH RAIN GARDENS AND BIOSWALES

Well-designed landscaping boosts average rental rates for office buildings by approximately 7 percent

ECO-LABELS

LEED, Sustainable Sites Initiative or other certifications can increase property values, rents, and occupancy rates in commercial office buildings.



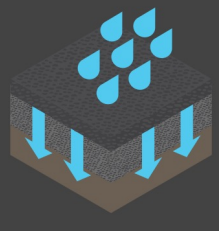
TREE COVER

Trees can reduce building energy demand for heating and cooling by providing shade in summer and blocking wind in winter. Multiple trees on a site can save hundreds of dollars in annual energy costs.

Retail customers are willing to pay 8% to 12% more for products in shopping centers with mature tree canopy.

RAIN BARRELS AND CISTERNS

Capturing rainwater for reuse can help save on water bills for landscape irrigation and other non-potable water uses.



PERMEABLE PAVEMENT

Permeable asphalt, concrete, or paver blocks allow water to seep into gravel and soil below. These systems can have significantly lower maintenance costs than traditional pavement, resulting in lower overall life-cycle costs.

RETAIL CENTER

The figures below present the key assumptions, proposed green infrastructure property improvements, and the resulting benefits for a midsize retail center.

GREEN INFRASTRUCTURE IMPROVEMENTS

40,000-sq.-ft. **green roof**, installed at the end of the life of the existing conventional roof, with green covering 90 percent of surface, or 36,000 sq. ft.

---

50 strategically planted **medium-size trees**, 25 opposite west-facing walls and 25 opposite south-facing walls

---

Bioswales and **rain gardens** that manage 1 inch of runoff from 2,000 sq. ft. of adjacent impervious area

---

72,000-sq.-ft. **permeable-pavement** parking lot

Cisterns to capture runoff from 5,000 sq. ft. of roof area and use for irrigation

BUILDING ASSUMPTIONS
(BEFORE IMPROVEMENTS)

SIZE	40,000 sq. ft.
STORIES	1
ROOF SIZE	40,000 sq. ft.
LOT AREA	128,000 sq. ft.
PERMEABLE AREA (COVERED IN TURF)	4,000 sq. ft.
NUMBER OF STORES	15
ANNUAL RENT	$17 per sq. ft.
ANNUAL RETAIL SALES	$2,182,000 per store

POTENTIAL BENEFITS

Energy savings due to reduced demand for heating and cooling	**$3,560** Annually
Avoided costs for conventional roof replacement	**$607,750** net present value over 40-year analysis period
Tax credit	**$100,000** one-time credit in year of installation
Increased **retail sales**	**$1.2 MILLION** per year
Stormwater **fee reduction**	**$14,020** Annually (projected to increase 6% per year)
Total present value benefits (over 40-year analysis period)	**$24,202,000 +** (including $22,963,800 in increased retail sales, which accrue to the tenants)

NON-QUANTIFIED BENEFITS

Water **conservation**	+
Increased **property value**	++
Reduced infrastructure costs due to use of permeable pavement system	+/U
Reduced crime	+/U
Improved **health and employee satisfaction**	+ (for tenants and employees)
Reduced costs associated with flooding	U

\+ would likely increase net benefits;
\+ \+ would increase net benefits significantly;
U direction of net change is uncertain.

Present value benefits over 40-year period were estimated on the basis of a 6 percent discount rate, projected CPI, projected increase in electricity and natural gas prices in relation to CPI (based on historical relationship), and 6 percent annual increase in stormwater fees. Improvements assumed to be implemented in 2015. Avoided conventional roof replacement costs were added to net present value of other benefits. Tax credit and stormwater fee reductions are based on available credits and fee structure in Philadelphia; many other localities have similar incentives.

APARTMENT BUILDING

The figures below present the key multifamily building assumptions, the proposed green infrastructure property improvements, and the resulting benefits.

GREEN INFRASTRUCTURE IMPROVEMENTS

8,435 sq. ft. **green roof**, installed at the end of the life ofthe existing conventional roof, with green covering 90 percent of the surface, about 7,600 sq. ft.

---

12 strategically planted **large trees**, 6 opposite a west-facing wall and 6 opposite an east-facing wall

---

Bioswales and **rain gardens** that manage 1 inch of runoff from 2,635 sq. ft. of adjacent impervious area

POTENTIAL BENEFITS

Energy savings due to reduced demand for heating and cooling	**$1,780** Annually
Avoided costs for conventional roof replacement	**$128,160** present value over 40-year analysis period
Tax credit	**$52,720** one-time credit in year of installation
Increased **rental income**	**$77,720** Annually (assuming no vacancies)
Increased **property value**	**$37,500** one-time benefit to property owner at time of sale
Stormwater **fee reduction**	**$1,230** Annually (projected to increase 6% per year)
Total present value benefits (over 40-year analysis period)	**$1,740,000 +**

Present value benefits over 40-year period were estimated on the basis of a 6 percent discount rate, projected CPI, projected increase in electricity and natural gas prices in relation to CPI (based on historical relationship), and 6 percent annual increase in stormwater fees. Improvements assumed to be implemented in 2015. Avoided conventional roof replacement costs were added to net present value of other benefits.Tax credit and stormwater fee reductions are based on available credits and fee structure in Philadelphia; many other localities have similar incentives.

NON-QUANTIFIED BENEFITS

Reduced crime	+/U
Reduced costs associated with flooding	U

\+ would likely increase net benefits;
U direction of net change is uncertain.

BUILDING ASSUMPTIONS (BEFORE IMPROVEMENTS)

SIZE	33,740 sq. ft.
STORIES	4
ROOF SIZE	8,435 sq. ft.
LOT AREA	12,435 sq. ft.
PERMEABLE AREA (COVERED IN TURF)	1,000 sq. ft.
NUMBER OF UNITS	32
MONTHLY RENT	$1,265 per unit

MEDIUM-SIZE OFFICE BUILDING

The figures below present the key office building assumptions, the proposed green infrastructure property improvements, and the resulting benefits.

GREEN INFRASTRUCTURE IMPROVEMENTS

17,900-sq.-ft. **green roof**, installed at the end of life of the existing conventional roof, with green covering 80 percent of the surface, or 14,300 sq. ft. (Remainder of roof is impervious area.)

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20 strategically **planted trees**,10 opposite a west-facing wall and 10 opposite an east-facing wall

---

10,000-sq.-ft. **permeable pavement** parking lot, installed at the end of life of the existing parking lot

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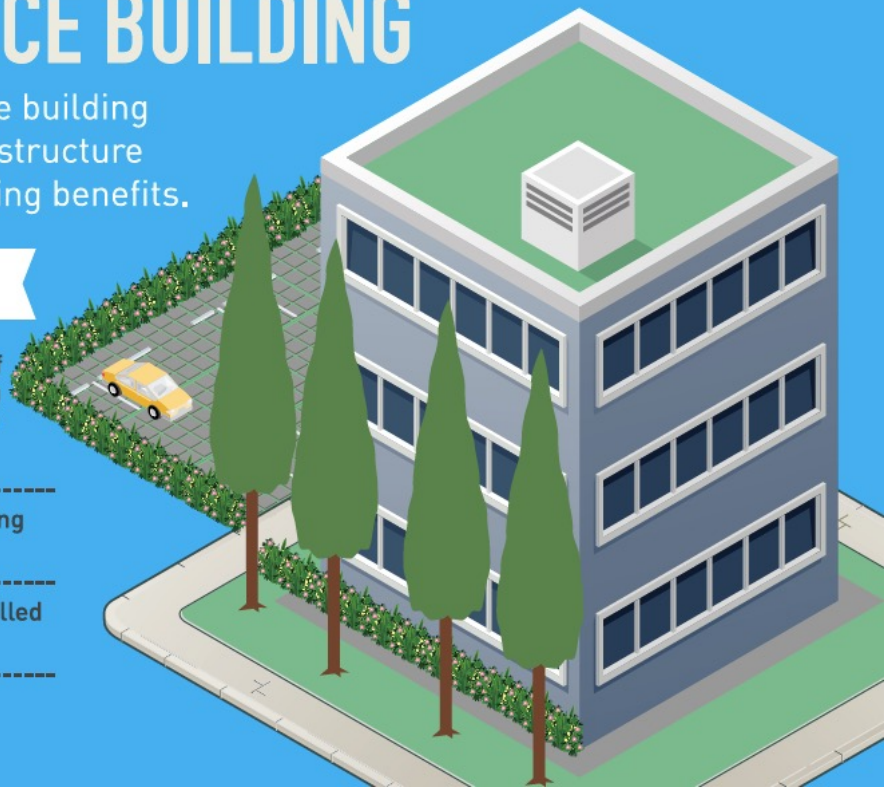
Bioswales and **rain gardens** that manage 1 inch of runoff from 4,700 sq. ft. of adjacent impervious area



POTENTIAL BENEFITS

Energy savings due to reduced demand for heating and cooling	**$1,630** Annually
Avoided costs for conventional roof replacement	**$271,970** present value over 40-year analysis period
Tax credit	**$67,130** one-time credit in year of installation
Increased **rental income**	**$72,150** annually (assuming no vacancies)
Stormwater **fee reduction**	**$3,490** Annually (projected to increase 6% per year)
Total present value benefits (over 40-year analysis period)	**$1,863,000 +**

Present value benefits over 40-year period were estimated on the basis of a 6 percent discount rate, projected CPI, projected increase in electricity and natural gas prices in relation to CPI (based on historical relationship), and 6 percent annual increase in stormwater fees. Improvements assumed to be implemented in 2015. Avoided conventional roof replacement costs were added to net present value of other benefits.Tax credit and stormwater fee reductions are based on available credits and fee structure in Philadelphia; many other localities have similar incentives.

NON-QUANTIFIED BENEFITS

Increased **property values**	++
Reduced infrastructure costs due to use of permeable pavement system	+
Reduced crime	+/U
Improved **health and employee satisfaction**	+ (for tenants and employees)
Reduced costs associated with flooding	U

\+ would likely increase net benefits;
\+ + would increase net benefits significantly;
U direction of net change is uncertain.

BUILDING ASSUMPTIONS (BEFORE IMPROVEMENTS)

SIZE	53,600 sq. ft.
STORIES	3
ROOF SIZE	17,900 sq. ft.
LOT AREA	32,000 sq. ft.
PERMEABLE AREA (COVERED IN TURF)	1,000
ANNUAL RENT	$19.23 per sq. ft.

Resources

ECONOMIC BENEFITS OF GREEN INFRASTRUCTURE

Resources available regarding the benefits of plants, gardens, and improved landscapes

Summary publications:

1. Economic, Environmental, and Health/Well-Being Benefits Associated with Green Industry Products and Services: A Review (Journal of Environmental Horticulture 29(2):96-103.)
2. An Update of the Literature Supporting the Well-Being Benefits of Plants: A Review of the Emotional and Mental Health Benefits of Plants (Journal of Environmental Horticulture 37(1):30–38.)
3. An Update of the Literature Supporting the Well-Being Benefits of Plants: Part 2 Physiological Health Benefits (Journal of Environmental Horticulture 37(2):63-73.)
4. An Update of the Literature Supporting the Well-Being Benefits of Plants: Part 3 Social Benefits (Journal of Environmental Horticulture 37(4):136–142.)
5. An Update of the Literature Supporting the Well-Being Benefits of Plants: Part 4 Available Resources and Usage of Plant Benefits Information (Journal of Environmental Horticulture 38(2):68–72. June 2020)

These articles can be gleaned for benefits-related information to include in marketing materials and social media posts.

Popular websites summarizing plant benefits:

Plant Benefit Factsheets produced by The Green City – *These factsheets are 4-color and are excellent ready-to-use marketing materials.*
All-America Selections / National Garden Bureau – *Their Facebook page is full of 4-color posting about the benefits of plants.*
Green Cities: Good Health – *Click on a research theme for Fast Facts that are perfect for social media sharing.*
America in Bloom – *This website talks about the benefits of local beautification efforts to Main Street businesses and the entire community. See the Surprising Side of Plants brochure!*
Children and Nature Network – *The C&NN library is one of the best I have seen. You can search by topic and each citation contains a 2-3 paragraph summary. And it's all about the*

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- Webinars
- Distinguished Lecture Series
- Introductory Employee Training Program for Greenhouse Crop Production

CONFERENCES/WORKSHOPS
- Executive Academy for Growth & Leadership (EAGL)

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Sociohorticulture video series

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Stories of Famous People-Plant Interactions

February 18, 2024

Introduction to the Sociohorticulture Video…

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Concluding Comments and Other Resources

February 17, 2024

The Effects of Green Spaces on Health and…

February 17, 2024

Benefits of Green Infrastructure

February 17, 2024

Horticultural Therapy

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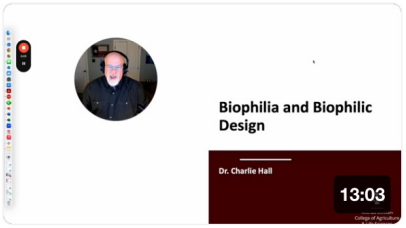
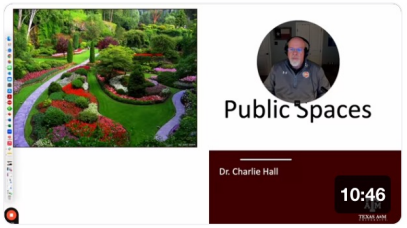


Biophilia and Biophilic design

February 17, 2024



Public Spaces

February 17, 2024