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What *Is* Green Infrastructure?

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Green infrastructure is defined and perceived in various ways, depending on the setting. This article provides a clearer understanding of the term as it is applied at the intersection of natural and built environments.

According to some, "green infrastructure" was first coined in the early 1990s as a means of elevating the status of natural systems to equal or above what has been viewed as traditional infrastructure. If professionals look comprehensively at the root of the term, then they may discover that definitions based on personal understanding may not be complete. What some have declared to be infrastructure is often simply a reflection of their own relatively limited experiences.

Generally speaking, infrastructure could be viewed as including the basic physical and organizational structures and facilities needed for the operation of a society or enterprise. This basic definition of infrastructure is timeless. However, it also allows for what constitutes an element of infrastructure to adapt to the operational needs of society as those needs also inevitably change over time. Unlike the fixed general definition of infrastructure, the face of infrastructure changes with nearly every generation.

The "green" of green infrastructure simply connects the term to the natural environment (Figure 1). More specifically, it represents the application of advancements in knowledge and the application of natural materials and processes in delivering infrastructure services. It also hints at current infrastructure needs and expectations of today.

Low-impact development, or LID, is sometimes used interchangeably with green infrastructure. The essential intent and benefits are similar, but there is a clear distinction between the two terms. Low-impact development is an approach to delivering infrastructure that minimizes impacts to the natural environment. Green infrastructure describes the elements that are being preserved or constructed.

Infrastructure—the basic physical and organizational structures and facilities needed for the operation of a society or enterprise

Green—of, or related to, the natural environment

Green Infrastructure—structures and facilities that utilize natural materials and/or natural processes to deliver services to help meet the current needs of society

FIGURE 1 Definition of green infrastructure.

Stormwater control measures—sometimes known as best management practices—are utilized to implement low-impact development and green infrastructure. Stormwater control measures include structural elements, such as permeable pavements and bioswales, as well as nonstructural approaches, such as designing new development to reduce the percentage of impervious surfaces (*1*).

Green infrastructure may represent built (or engineered) elements or describe preserved, protected, or restored natural ecosystems necessary to help meet society's current demands. Engineered green infrastructure elements may include bioretention swales and cells, permeable pavements, green roofs, rainwater harvesting facilities, and constructed wetlands. Natural green infrastructure might include healthy forests, natural wetlands, riparian buffers, and rivers and streams.

Natural green infrastructure often provides benefits—or ecosystem services—such as provisioning, regulating, and cultural services. Examples of benefits associated with these services are included in Figure 2. Some of the social, environmental, and economic benefits of engineered green infrastructure are also included in Figure 2.

Photo: Barry Fagan

Dappled with sunlight, Alabama's Chief Ladiga Trail represents a nonstormwater-related function of green infrastructure. Its natural setting provides all of the ecosystem benefits that go along with healthy forests.

Photo: Barry Fagan

Pervious concrete surrounds the softscape of a bioretention planter, which serves a vital function on this Nashville, Tennessee, street. Natural materials, such as vegetation and soil, and natural processes, such as infiltration, detention, transpiration, and evapotranspiration, help manage stormwater runoff.

- Food, raw materials, and energy supply
- Water treatment and purification
- Urban stormwater quantity and quality management
- Flood mitigation
- Subsidence mitigation and groundwater recharge
- Air pollution abatement and quality enhancement
- Heat island reduction
- Energy cost reductions
- Increased urban biodiversity
- Animal, pest, and disease control
- Greenhouse emissions reduction
- Carbon sequestration
- Climate resiliency
- Infrastructure sustainability
- Community placemaking for recreation and social connection
- Therapeutic, cultural, and spiritual services
- Educational services
- Varied physical and mental health benefits to humans with associated cost reductions
- Enhanced social mobility and connectivity
- Increased property values

FIGURE 2 Benefits of green infrastructure and other ecosystem services

The "green" descriptor also serves to differentiate nature-based infrastructure elements from more traditionally constructed gray infrastructure, such as closed storm sewer systems and ditches with rigid linings. For example, in the context of the infrastructure service of managing stormwater and wastewaters, gray infrastructure often describes those constructed facilities that do not incorporate natural processes or natural materials or do not provide collateral benefits associated with greener solutions.

Green infrastructure tends to reduce negative stormwater runoff-related effects of development through infiltration, transpiration, evapotranspiration, retention, detention, and peak flow rate attenuation. Gray infrastructure may cause these effects of development to increase. Green infrastructure also helps to reduce the negative societal impacts of heat, air, and noise pollution by providing shade, dispersing and diluting airborne pollutant concentrations, and buffering noise.

The work of those who manage and deliver infrastructure where natural and built environments meet must reflect a mindset of flexibility, stewardship, and a holistic view of societal needs. Advancements in the awareness of the benefits of green infrastructure and in the technology of its application have created more opportunity than ever to maximize returns on infrastructure investment.

REFERENCE

1. National Research Council of the National Academies. *Urban Stormwater Management in the United States.* National Academies Press, Washington, D.C., 2009.