



# Green Infrastructure: Engineering to Benefit Business and Biodiversity

*Living solutions to environmental challenges on corporate lands*

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*Green roofs with vegetation can insulate, filter water and treat air in urban landscapes.*

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While we depend on the earth's resources for our products, we also ensure that our sites are safe and that we protect habitats during the life of our operations and beyond. We also work closely and transparently with our neighbors and stakeholders. I am pleased with the progress we have made, but we must continually look for ways to improve our performance. Not only is it the right thing to do from a corporate social responsibility standpoint, it is an essential part of growing our business going forward.

*Patrick James  
Vice President, Environment, Safety and Health  
Lehigh Hanson*

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# Introduction

Nature is the original engineer. It harnesses solar energy for food, heals itself through growth, and has a wide variety of security systems to protect against predators and other invaders. Many biological-engineered solutions are species-specific, but at a macro level nature also engineers solutions that benefit a wide range of species, including humans. Today, when nature is a key component of a human-engineered solution, it is called green infrastructure.

Green infrastructure is an approach to mitigating environmental challenges using living-engineered solutions - vegetation, soils and natural processes – or other constructs. Most frequently, green infrastructure is used to meet the challenge of stormwater management, using vegetation to slow, filter and absorb runoff. Additional challenges that can be met with green infrastructure might include thermal insulation for buildings, carbon sequestration, and reducing wildlife-vehicle impacts on roadways. Green infrastructure might consist solely of green space, as in a rain garden, or can involve a creative combination of vegetation and engineered features, such as with green roofs.

While some definitions of green infrastructure are broadened to contain all of nature, this white paper will focus on engineered solutions.

Like most engineered solutions, thoughtful design can enhance the experience and improve the outcome. A basic rain garden may mitigate stormwater runoff, but a well-designed rain garden using a diversity of native flowering plants can also provide habitat for birds and insects where such habitat is scarce. When considering the urban canopy, not all trees offer equal shade opportunities and not all trees are equal when it comes to providing for the birds, bats and other species that forage, nest and roost in trees. A green roof can be designed to contain a narrow list of plants resilient to a harsh environment, or it can be designed for seasonal interest and maximum habitat benefit.

In fractured landscapes where nature remains only in small, managed patches, green infrastructure provides an opportunity to not only mitigate environmental concerns but also to increase green, productive places across the built environment.

The implementation of green infrastructure solutions has been driven mostly by government, led by wastewater agencies and sustainable development groups, and focused on the public realm. Business can contribute effective solutions and innovation in this arena. Every parking lot at an office location or manufacturing site can be transformed with rain



*A well-designed rain garden can provide habitat for birds and insects where such habitat is scarce.*

gardens. Every operations facility can use bioswales to address intermittent or cyclical flooding events, and every single corporate location can benefit from an expanded tree canopy. Well-designed green infrastructure solutions are resilient and cost-effective, requiring less maintenance than typical hardscape solutions. In jurisdictions with taxes on stormwater runoff, green infrastructure solutions save money by reducing the tax burden.

There are numerous strategies that can be used for integrating green infrastructure into commercial, industrial and other corporate landscapes. While the specific techniques, project scale and designs will vary from location to location, the principles of green infrastructure are universally applicable. Therefore, green infrastructure is remarkably versatile as a solution for corporate landscapes.

The following pages describe some of the more common types of green infrastructure projects, with accompanying case studies of corporate conservation programs that have successfully applied these solutions and passed the rigorous review process of WHC Conservation Certification.

**Each case study will demonstrate how the private sector can mitigate environmental concerns while increasing green, productive spaces across the built environment.**

# Rain gardens

One of the most commonly-implemented types of green infrastructure is the rain garden. Rain gardens are planted landscapes designed to collect, filter and treat stormwater runoff. The water quality benefits of rain gardens have been well-studied — rain gardens have been shown to remove suspended solids,<sup>1</sup> oil and grease,<sup>2</sup> excess nitrogen<sup>3</sup> and several heavy metals<sup>4</sup> from runoff.

When their design incorporates native vegetation, rain gardens can greatly benefit biodiversity; pollinators and songbirds can benefit from the nectar, seeds, berries, leaves, stems, and cover provided by the native plants in rain gardens.

Rain gardens are a versatile project for corporate facilities — they can be designed in a variety of shapes and sizes to fit a site's stormwater management needs, available space and desired landscaping aesthetic.

Rain gardens are also very accessible for employee volunteers. While the design requires engineering knowledge to facilitate adequate stormwater management, the resulting garden is a concept with which most people have some familiarity, making it easier to encourage employee involvement in installation and maintenance.

## **Monsanto's Chesterfield site in Missouri includes a rain garden designed specifically to benefit monarch butterflies and other pollinators.**

*Chesterfield, the company's global hub for research and development and agricultural innovation, comprises 210 acres adjacent to the Missouri River. A \$400 million expansion, which began in 2013, offered many opportunities to create green spaces, including several rain gardens that were created to address stormwater runoff following the construction of a new parking garage and building.*

*The project team aligned its efforts with Monsanto's company-wide commitment to monarch conservation and with local initiatives for pollinator conservation. Employees planted the rain gardens with native wildflowers, including 100 milkweed seedlings to benefit monarch butterflies.*

*The team engages local middle school students in education about green infrastructure and stormwater management, including a project in which the team helps students develop stormwater management designs, sharing real-world experience and offering advice on best practices.*



Students from the Grand Rapids Child Discovery Center at the Wayland Warehouse during an educational field trip.

**Two ITC facilities, the Wayland Warehouse and the Belleville Warehouse on Michigan’s southern peninsula, have installed rain gardens using similar strategies.**

*The Wayland and Belleville conservation programs, both of which have been WHC-certified since 2014, are focused around rain gardens that help manage stormwater runoff while also providing habitat. These rain gardens were similarly designed and installed with the assistance of landscape contractors. A mix of sand, compost, topsoil and mulch was used to support plant growth as well as provide adequate drainage to capture runoff. Both gardens were planted with native vegetation that provides valuable food and habitat cover for wildlife such as pollinators and songbirds. The plant species were chosen for their aesthetic value and for their tolerance of fluctuating conditions. The site teams added nest boxes for chickadees and wrens, and nest tube bundles for native bees to further benefit wildlife using the garden. The two teams also partnered to present educational workshops about the rain gardens for local schools and community groups.*

*At the 20-acre Belleville property, the rain garden encompasses 4,600 square feet and is designed with*

*three basins to intercept and filter stormwater runoff from the building’s roof and parking lot. The garden was initially planted with over 1,100 native wildlife-friendly plants, including swamp milkweed, purple coneflower, black-eyed Susan, and little bluestem, and an additional 64 plants were added in 2016. The garden was installed in June 2012, and the site’s landscaping contractors continue to monitor and maintain it monthly.*

*The rain garden at the 9-acre Wayland Warehouse facility comprises 700 square feet and is designed to capture thousands of gallons of stormwater runoff from the building’s roof. The garden was installed in 2012 and was expanded in 2016 with an adjoining 1,200-square-foot upland garden. The plant species selected include pollinator-friendly species such as purple coneflower, boneset, sneezeweed, blue flag iris, cardinal flower, great blue lobelia, marsh blazing star, and black-eyed Susan. The team also added signage about the garden’s benefits to wildlife and water quality in April 2013. A landscaping contractor monitors and maintains the gardens monthly during the growing season.*

# Bioswales

Bioswales are vegetated channels that retain and treat stormwater runoff as it moves from one place to another. Although bioswales provide a bioretention function similar to rain gardens, they are designed as linear features with a gentle slope that allows runoff to flow through the swale, rather than as depressions for simply collecting runoff. They sometimes connect to an overflow feature such as a detention pond in case of heavy rainfall.

Planting native, deep-rooted vegetation in a bioswale enhances both its stormwater management and biodiversity values. The native plants slow and filter runoff, and encourage infiltration as it flows through the swale, while also providing valuable food, shelter and breeding habitat for a variety of wildlife species.

As linear features, bioswales are well-suited for construction alongside parking lots and roads. Many corporate facilities already have grassy or gravel swales present near parking lots or other runoff-prone areas. These swales can easily be converted to bioswales with the addition of native grasses, wildflowers and shrubs, enhancing their effectiveness at managing stormwater while also creating valuable habitat for pollinators, songbirds and other wildlife.



Interpretive signs at Navitas House help visitors understand the bioswale's importance.

**At DTE Energy's Downtown Detroit Headquarters Complex in Michigan, rehabilitation of an old building in a densely developed area of the city presented an opportunity for creating a bioswale to help manage stormwater runoff.**

Located on 20 acres in downtown Detroit, the site's conservation program includes Navitas House, a three-story, 32,000 square-foot Art Deco building that was purchased in 2012 as part of DTE Energy's investment in the community. The renovation of Navitas House, home to 140 employees, included installation of a 6,000-square-foot bioswale. The bioswale was planted with numerous grasses and wildflowers, all of which are native to Michigan and were selected for their value to pollinators and birds. In such a densely occupied area of the city, the bioswale provides an

important pocket of habitat. It also lifts some of the burden of stormwater management from the already-stressed city wastewater system by filtering and absorbing runoff from the area around Navitas House.

The Navitas House bioswale location is highly visible and well-trafficked by employees, area residents and visitors alike. Interpretive signs help visitors to the site understand why such green solutions are important in an urban setting.

The site stands as a symbol of DTE Energy's urban revitalization efforts in Detroit and the neighborhood the company has called home for more than a century.

The conservation program at Navitas House has been WHC-certified since 2000.

## Green roofs

Green roofs, also called living roofs and vegetated roofs, are roofs that are partially or completely covered with vegetation. Green roof designs generally include a layer of soil or other growing medium and hardy vegetation that can withstand extreme conditions on a roof, as well as other components to protect the building below and direct excess runoff. The vegetation and growing medium together help to absorb rainfall, slow the remaining runoff, and filter out pollutants.<sup>5</sup> For example, green roofs can absorb nitrogen, and some designs appear to rapidly neutralize acid rain.<sup>6</sup>

Green roofs also reduce energy costs by providing shading, evaporative cooling, and interception of sunlight. This benefit is often overlooked and undervalued, but computer modeling indicates that as climate change raises building surface temperatures, green roofs will make a dramatic difference in mitigating this increase, particularly in urban centers with little green space.<sup>7</sup>

Furthermore, green roofs can provide biodiversity benefits. Even in urban areas, green roofs planted

with native vegetation can attract native bees. This benefit is multiplied when there is additional green space nearby that also provides habitat.<sup>8</sup>

Buildings of all types are suitable for green roof applications, including those in commercial, industrial and highly urban settings.<sup>9</sup> New construction can be enhanced by incorporating a green roof into the building design, and many existing buildings can even be retrofitted with certain types of green roof designs.

**Exelon's Pepco WaterShed Center for Sustainability in Rockville, Maryland is a model home designed to demonstrate green infrastructure and sustainable building features, including a green roof.**

*The conservation program at the Pepco WaterShed Center for Sustainability is centered around a 900-square-foot building which was constructed by students from the University of Maryland. It is designed to serve as an educational demonstration of a sustainable home, including water- and energy-saving features inside the home and green infrastructure*



*This Pepco model home is designed to serve as an educational demonstration of a sustainable home.*

*features incorporated into the landscape. The model home includes a 400-square-foot green roof that helps to absorb and filter rainfall. Excess rainwater is directed to the constructed wetlands, which helps to further filter out pollutants. The green roof is planted with six different varieties of native, drought-resistant sedum, which provide valuable habitat for pollinators. The employee team assists graduate students from the University of Maryland in collecting research data on the green roof's water and energy balance. Among their findings, the team has found that plant cover on the roof reduces the summer roof temperatures*

*by 20° to 60° Fahrenheit. The green roof's habitat is complemented by using native species in the site's rain garden and constructed wetland.*

*Education is an integral component of this program. The team uses the building to teach students and visitors about topics such as sustainable living, wetland habitats, recycling, energy and water conservation, erosion caused by stormwater runoff, and how runoff from pervious surfaces differs from runoff from impervious surfaces. The program was first certified by WHC in 2014.*

Although green roofs like this one are most commonly planted with sedums due to their hardiness, simple growth needs and high evapotranspiration rates, the use of only one type of plant limits a green roof's benefit to local biodiversity. This is particularly true in locations with no native species of sedum. Fortunately, advances in green roof technologies mean companies can use a greater range of vegetation in their green roofs. Projects such as the green roof at the American Society of Landscape Architects' headquarters in Washington, D.C.,<sup>10</sup> as well as studies of green roof vegetation,<sup>11</sup> demonstrate that many other types of plants such as cacti, grasses, vines and wildflowers can also be successfully used to create functional green roofs that are both attractive and wildlife-friendly.

## Green walls



*Green walls can integrate habitat into building design without occupying valuable space.*

Green walls, also called living walls, are walls that are partially or completely covered by vegetation, using soil or another growing medium to facilitate vegetative growth. They provide many of the same benefits as green roofs, helping to absorb and filter rainwater and greywater, reduce energy costs for heating and cooling of the building, and improve air quality.

Green walls that utilize native vegetation provide a creative way of integrating habitat into building design without occupying valuable space. This can be particularly important in an urban context where land for green space is limited.<sup>12</sup>

Green walls come in a variety of designs, from simple climbing vines growing up a wall, to more complicated modular and hydroponic systems.<sup>13</sup>

**Green walls need not be expensive or complicated, as evidenced by the team at Bridgestone Americas Neumaticos de Monterrey. They partnered with schools to create low-cost green walls using native species and readily-available materials.**

*The Bridgestone Neumaticos de Monterrey conservation program encompasses 190 acres in the*

*town of Ciénega de Flores in northern Mexico. The site team works both on and off the property to restore the submontane scrub ecosystem, engaging families and students in habitat enhancement projects that also incorporate education. For one of these initiatives, the team collaborates with local educators to create green walls at schools using recycled plastic bottles and native plants grown in the facility's greenhouse. Students help collect and decorate the bottles, and plant them with vegetation and a mixture of soil, compost, perlite, and peat moss before hanging them on an exterior wall of the school.*

*At the first green wall installation, over 300 students and parents participated, creating a 3'x8' green wall with 120 native pollinator-friendly plants. The team has since partnered with an additional 350 student and parent volunteers to install green walls and native tree plantings at two other schools in the area.*

*The biodiversity and sustainability goals of the green walls at each school are complemented by native landscaping such as gardens or tree plantings. The team uses the installations to teach the students about pollinators, the three Rs (reduce, reuse and recycle), responsible consumption, carbon dioxide emissions, and climate change.*

# More ways to implement green infrastructure to meet environmental challenges and benefit biodiversity

In addition to the green infrastructure projects already being implemented as part of WHC Conservation Certification programs—rain gardens, bioswales, green roofs and green walls—there are many more ways to implement biodiversity-friendly green infrastructure solutions to meet environmental challenges on corporate landscapes, including:

- **Curb cut-outs and stormwater planters** turn curbside trees and gardens into pockets of habitat that collect and infiltrate runoff from streets and sidewalks, while also providing shade and improving air quality. Although typically implemented along municipal roadways, this style of green infrastructure could be easily adapted for the roads and parking lots inside corporate property lines.
- **Strategic tree plantings** can provide many benefits, including improved air quality and temperature regulation, as well as important nesting and foraging habitat for a variety of animals. Native trees with high wildlife value could be strategically planted in locations across corporate landscapes to reduce building and road surface temperatures in the summer, decreasing the energy demands for air conditioning in buildings and cars. Evergreen trees can also provide a buffer against cold winter winds, reducing the energy needed for heating buildings.
- **Engineered wildlife corridors** such as green culverts and green bridges provide wildlife with safe passage across roads and other man-made barriers. These corridors utilize vegetation and other habitat features of two adjoining areas to create a sense of consistency that encourages wildlife to use them. Corporate landscapes with challenges such as wildlife-vehicle collisions and nuisance wildlife may wish to explore use of these corridors to reduce conflicts while also enhancing habitat connectivity.

# A call to action for corporate landowners

Green infrastructure is versatile, beneficial and well-suited to corporate properties of all types — from industrial facilities and suburban corporate campuses, to office buildings in dense urban areas.

As the case studies in this white paper demonstrate, green infrastructure can easily be designed to benefit both businesses and biodiversity. Although such conservation activities can lead to additional costs, companies can achieve a return on investment through improved reputation and the resulting benefits.

Third-party recognition programs for these activities, such as WHC Conservation Certification, can be beneficial to companies in managing risk, communicating outcomes and meeting biodiversity goals. The WHC standard is designed to provide tangible data on company's conservation activities that go above and beyond compliance. In doing so, WHC Conservation Certification helps companies demonstrate a long-term commitment to managing quality habitat for wildlife, conservation education and community outreach initiatives.

**Through green infrastructure best practices, companies can deliver resilient and cost-effective solutions to environmental concerns, while creating a positive impact on biodiversity.**



*Fallen trees and rocks are strategically placed to improve ecological function of a restored stream in Washington D.C.*

### **Corporate landowners can engage in the following actions when exploring the use of green infrastructure solutions for their lands:**

- Assess the environmental challenges on the property that may be addressed with green infrastructure. Are there any areas that experience heavy stormwater runoff or flooding issues? Are there roads with frequent wildlife-vehicle collisions? Are heating or cooling costs high, or are there any parts of the building that seem to heat up quickly in the summer or always seem cold in the winter?
- Evaluate whether your facility can install wildlife-friendly green infrastructure to lower or even eliminate the burden of municipal stormwater fees or rain taxes, exceed regulatory requirements for stormwater management, or boost property values.
- Download the free WHC Green Infrastructure Project Guidance to assist you in designing a green infrastructure project that will both address your environmental challenges and provide meaningful benefit to biodiversity. The Project Guidance describes how to build a sound green infrastructure project and offers strategies to strengthen programs for greater outcomes.
- Implement green infrastructure activities that aid in, or contribute to, an environmental goal.
- Demonstrate the success of your facility's green infrastructure projects by seeking WHC Conservation Certification, a rigorous, third-party standard. Through the WHC Green Infrastructure theme, WHC Conservation Certification recognizes and incentivizes a variety of green infrastructure projects, including those discussed in this white paper.

## Endnotes

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Download the Green Infrastructure Project Guidance and other Project Guidances at [wildlifehc.org/project-guidances](http://wildlifehc.org/project-guidances)

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WHC can help support green infrastructure activities that benefit biodiversity, from the design and planning, to the implementation and management of a program. We do so through a framework that connects business drivers, stakeholder and community relations, and ROI to positive environmental outcomes. For more information, please contact us at [strategyandplanning@wildlifehc.org](mailto:strategyandplanning@wildlifehc.org).

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