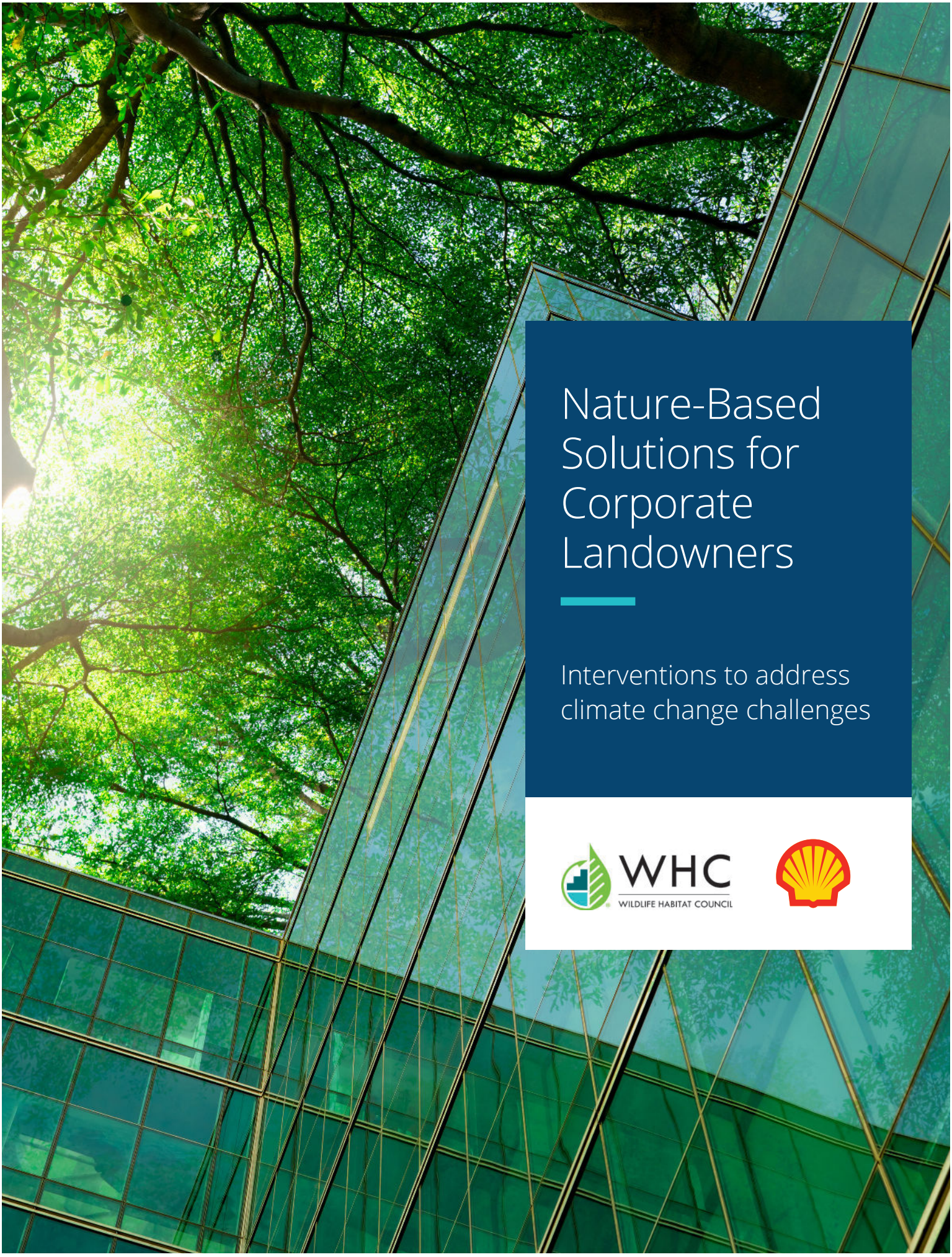


Nature-Based Solutions for Corporate Landowners

Interventions to address climate change challenges

WHC
WILDLIFE HABITAT COUNCIL

Contents

WHC

Introduction

What is a Nature-Based Solution?

Natural and managed ecosystems provide a great range of services on which human well-being depends. **Nature-based solutions** (NbS) are natural methods or interventions for adapting and building resilience to the risks and impacts of climate change. NbS encompass a wide range of actions, such as adapting to climate change impacts, protecting and managing biodiversity, integrating green and blue infrastructure in urban areas and applying ecosystem-based principles to corporate land management.[1]

WHC adopts the International Union for Conservation of Nature (IUCN)'s definition of NbS, which states NbS are "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits."[2]

This catalog focuses on a subset of NbS, sometimes termed Natural Climate Solutions (NCS), which "have been identified as essential to deliver climate mitigation, adaptation, and resilience solutions."[3]

What is Biodiversity?

Biodiversity, or biological diversity, is the variety and variability of life on Earth. Biodiversity is a measure of variation at the genetic, species and ecosystem level.[4]

Scope of this Catalog

Largely due to public opinion and out of necessity, an increasing number of corporate landowners recognize opportunities for acting on climate change and biodiversity loss on their lands. This catalog focuses on challenges and associated potential nature-based solutions for climate change adaptation and resilience (See page 27 for more detailed definitions). WHC has prepared this catalog to translate corporate site-based climate and risk management goals into action.

The objective of this catalog is to provide a tool for corporate leaders and site managers to address environmental and climate challenges by integrating NbS into the management and enhancement of their facilities, land and adjacent communities.

Twenty NbS climate adaptation and resilience interventions are described and ordered according to similar functions and co-benefits. They are divided into four categories:

- Landscape-scale environmental restoration
- Wetlands and coastal management solutions
- Urban and industrial infrastructure
- Rainwater management solutions.

Pages 25-26 present a table of NbS interventions, grouped according to their relevancy to one of these four categories.

1 Taskforce on Nature-related Financial Disclosures (TNFD). 2022. The TNFD nature-related risk & opportunity management and disclosure framework.
2 IUCN. No date. Nature-nased solutions.
3 Malhi et al. 2020. Climate change and ecosystems: Threats, Opportunities, and Solutions. Philosophical Transactions of the Royal Society B, Biological Sciences, Volume 375, Issue 1794.
4 UNEP. No date. What is biodiveristy?

WHC

Climate Change Challenges

This catalog is intended to become a reference for designing an **adaptive response project** when facing environmental and climatic problems. When faced with these challenges, corporate leaders and site managers can start by identifying NbS options that are feasible, appropriate, cost-effective and scalable. Remember that there is rarely only one solution to "fix" a single problem.

Some common climate-related challenges include:

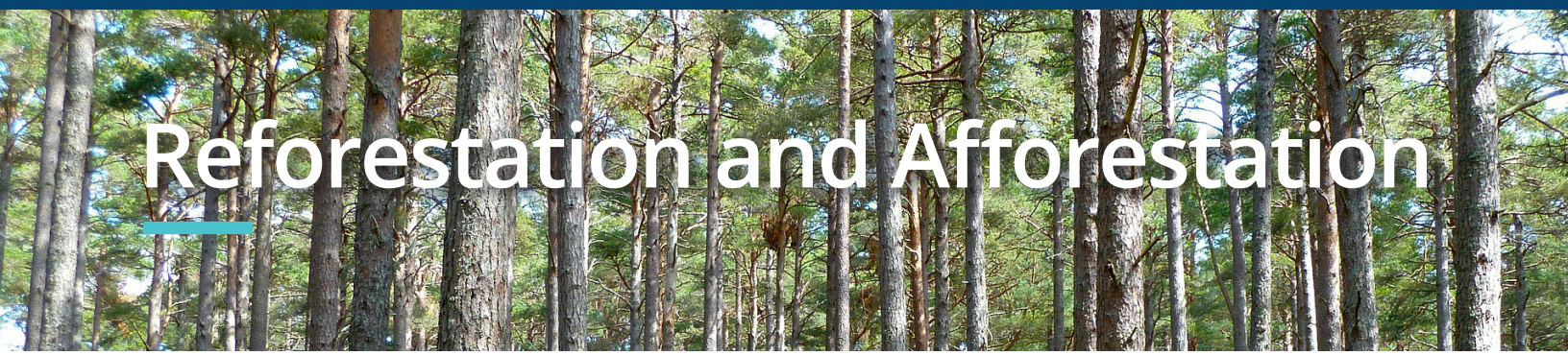
- Unusually heavy, unpredictable rainfall and flooding
- Increased frequency of landslides
- Unusual and/or unseasonal heat or cold waves of greater intensity and/or longer duration
- Prolonged and unseasonal drought
- More frequent and seemingly spontaneous forest wildfires
- Reduction and loss of terrestrial and marine biodiversity
- Sustained and escalating sea-level rise and warming ocean temperatures
- Increased and more severe coastal erosion

Taking Climate Action on Corporate Lands

There are many options for private sector NCS engagement, including:

- **Investing in soil health:** The private sector has significant amounts of soil under its control. Globally, well-managed soils have a potential to sequester 5.5 billion tonnes of CO_2 per year.[1]
- **Making smart forestry decisions:** Companies can look at their own lands and explore how to contribute to local watershed or ecosystem health, to the local community, or to a municipal or regional canopy goal.
- **Incorporating green infrastructure:** Green infrastructure designed to absorb storm surges, natural buffers designed to protect structures and softened or stabilized shorelines that can accept rising sea levels can all lessen the burden on communities that are at greatest risk from climate-related events.
- **Integrating NbS with SDGs:** There is a need for an "all of the above" approach to the twin environmental crises of climate change and biodiversity loss, as well as solutions that will also address inequities in health, education and access to resources. The power of the UN's sustainability development goals (SDGs) is in the recognition that all global challenges are interconnected.
- **Mainstreaming nature into operations:** Viewing nature as a tool instead of something to be handled could change land management across all corporate landholdings and help mainstream biodiversity. By adopting a "with nature" approach, an operation can assess its nature needs and opportunities, allowing companies to show they are focusing their corporate responsibilities on the planet and humanity, starting on their own premises.
- **Incorporating education and public awareness:** Initiatives like nature interpretation centers or STEM curricula focusing on NbS and climate change allow a company to showcase NbS interventions, enable the public and employees to learn from the solutions, show corporate goodwill by example and encourage community engagement.

1 Science Alert. 2020. Earth's soil could absorb 5.5 billon tonnes of CO2 annually, if we get it right.



Reforestation and Afforestation

OVERVIEW

Reforestation (planting trees in an area where the number of trees has decreased) and *afforestation* (planting new trees in a location where there previously were no trees) are two methods of expanding forest habitats. Habitat fragmentation is a major threat to biodiversity as it restricts wildlife movement. Adding vegetation to expand an existing habitat or connecting areas of fragmented forest habitat is a great way to provide a larger, more contiguous space for wildlife.

BENEFITS

- Improves property aesthetics.
- Stabilizes soil, preventing erosion.
- Absorbs air pollutants.
- Filters and absorbs stormwater runoff.
- Provides wildlife habitat and connectivity.
- Sequesters carbon and reduces greenhouse gases.
- Reduces heat island effect in urban areas.

CONSIDERATIONS

- The plants and/or trees selected should be native to the region.
- New plantings need to be watered regularly throughout the first growing season. New trees may require regular watering for a few growing seasons until the roots are fully established.
- Tree shelters can be placed around new trees to prevent herbivores from damaging or browsing on young trees.
- Plantings will need maintenance each growing season.

CASE STUDY

TOYOTA MOTOR MANUFACTURING

HUNTSVILLE, ALABAMA, USA

Toyota's afforestation program at their Huntsville, Alabama site aims to restore habitats, protect the local ecosystem and educate employees on sustainability. Originally a field used for cotton harvesting, the five-acre area has been transformed through the planting of 2,700 trees in 2008. The afforestation efforts have resulted in decreased land erosion as well as an increase in wildlife. Monitoring at least four times a year ensures tree survival and continued growth.

Invasive Species Management

OVERVIEW

Invasive species are non-native organisms that overtake an environment and cause harm, usually by outcompeting native species for resources (e.g., water, space, sunlight, nutrients) leading to habitat simplification (loss in biodiversity). Invasive species threaten biodiversity and habitat health and quality alike. Removing invasive plants on facility grounds is an easy way to make room for native plants, thus improving the overall health and diversity of the local landscape.

Invasive species management may take the form of:

- Preventing invasive species from being introduced into an area.
- Early detection-rapid response (EDRR), which involves monitoring in areas where infestation is likely to occur.
- Controlling the spread of invasive species by physically removing them and restoring the habitat once they are eradicated.

BENEFITS

- Creates a healthier natural landscape.
- Provides habitat for native wildlife.
- Improves biodiversity.
- Increases property values.
- Reduces maintenance costs

CONSIDERATIONS

- If time and budget allow, native plants should be established in areas where invasive plants were removed to prevent regrowth.
- Routine checks will be required to remove regrowth of invasive plants in the project area.

CASE STUDY

ONTARIO POWER GENERATION WESTERN WASTE MANAGEMENT FACILITY & BRUCE COMPLEX

TORONTO, ONTARIO, CANADA

In order to enhance biodiversity and support native turtle populations, Ontario Power Generation utilizes innovative technologies to manage invasive phragmites at their facility near Lake Huron. Their use of aquatic machinery to cut phragmites in deep water allowed them to clear over 40 hectares of phragmites between 2018 and 2020. Annually, the team uses drones to monitor areas where phragmites were treated.

WHC

Forest and Fire Management

OVERVIEW

Forest management strategies like selective thinning and controlled burns support the health and productivity of a forest.[1] Selective thinning is a process by which trees are removed to allow more sunlight to penetrate the canopy and provide space for other trees to grow. Controlled burns involve intentionally and methodically setting fire to certain sections of forest (broadcast burning) or piles of vegetation (pile burning).

BENEFITS

- Returns nutrients to the soil, improving its health.
- Prevents wildfires, in the case of controlled burns.
- Supports tree and plant growth for species that have a required fire regime to thrive or reproduce.

CONSIDERATIONS

- Work with your local fire agency and forestry department to develop an appropriate burn plan or forestry management plan.
- When planning a controlled burn, take weather conditions into account and inform the public when and where the burn will take place.

CASE STUDY

AMERICAN TRANSMISSION COMPANY HEADQUARTERS

WAUKESHA, WISCONSIN, USA

In 2015, American Transmission Company held a prescribed burn at their Wisconsin headquarters. The burn was conducted throughout the prairie habitat as well as along several infiltration and detention basins. The goal of this prescribed burn was to encourage the growth of native species and remove invasives species and was used in combination with other methods of invasive species management such as chemical control.

1 North Carolina Forestry Assocation. No date. Forest management basics.

WHC

Soil Rehabilitation and Structural Soils

OVERVIEW

Soil rehabilitation restores the soil's structure, composition and nutrient density to a healthy state through planting native species or applying organic compost to reduce soil toxicity. Grasses are ideal for soil rehabilitation as their penetrating roots aid in soil aeration. *Structural soils* are a medium, such as a mixture of gravel made of crushed stone and soil, that can be compacted while allowing roots to grow.

BENEFITS

- Makes the soil more conducive to nutrient uptake.
- Improves biodiversity, particularly in plant species.
- Stabilizes carbon in the soil and increases CO_2 storage.
- Increases water storage capacity.
- Reduces the risk of erosion.
- Reduces soil compaction, allowing for better root structure and plant health.

CONSIDERATIONS

- For the first two to three years, monitor nutrient content — particularly carbon — as an effective proxy to determine soil quality.
- Plant plugs instead of seeding, as seeds take time to germinate and do not prevent soil erosion.

CASE STUDY

CRESTWOOD MIDSTREAM FBIR GRASSLAND RECLAMATION

FORT BERTHOLD INDIAN RESERVATION, NORTH DAKOTA, USA

As part of their reclamation efforts for three pipeline rights-of-way located in the Fort Berthold Indian Reservation in North Dakota, Crestwood Midstream planted native grasses over 16 acres. Their goal is to increase the stability of the topsoil while enhancing biodiversity. In addition to the native species plantings, Crestwood also managed the area for invasive weeds.

WHC

Riparian and Waterbody Enhancement

OVERVIEW

Natural waterbodies and stormwater retention ponds can both be enhanced with native riparian plants. Healthy vegetative buffers are an important component to any wetland habitat, as they filter and absorb stormwater runoff, prevent erosion and flooding and provide valuable wildlife habitat.

Waterbody enhancement may take the form of:

- Preserving freshwater ponds for migratory birds.
- Inserting coarse woody debris or root balls in streams or coastal environments.
- Installing reefs or Reef Balls.
- Incorporating eco-concrete, sea walls, tidal pools or eco-enhanced concrete blocks.
- Utilizing beaver-friendly practices that allow this keystone species to naturally impact local hydrologic regimes and landscapes.
- Planting, restoring or enhancing vegetative buffers next to water bodies or in wetlands.
- Removing invasive species.

BENEFITS

- Provides critical successional wildlife habitat.
- Filters and absorbs stormwater runoff.
- Reduces potential flooding.
- Stabilizes soil, preventing erosion.
- Expands wetland areas, increasing water filtration and permeation.
- Creates natural wildlife breaks.
- Restores endangered species and increases biodiversity.
- Stores carbon in the soil.
- Reduces storm flooding damage.

CONSIDERATIONS

- Plants should be deep-rooted, native to the region and adapted to wet conditions.
- Different plant species require varying levels of water. Consult with your local plant/seed supplier for help choosing the appropriate plants.
- New plantings need to be watered regularly throughout the first growing season.
- Features like basking logs and rock piles will provide habitat for turtles, frogs and birds.

CASE STUDY

FREEPORT TYRONE

TYRONE, NEW MEXICO, USA

Since 1994, Freeport-McMoran has managed the riparian land in the vicinity of the Gila River. To protect the vegetation that provides habitat for the endangered southwestern willow flycatcher, the team restricted grazing at the nearby U-Bar Ranch to winter and spring months. Monitoring has shown that the riparian areas surrounding the U-Bar Ranch have one of the largest breeding populations of flycatchers in the United States.

WHC

Living Shorelines

OVERVIEW

Living shorelines are a natural and effective shoreline stabilization technique that reduces erosion and general damage to the shoreline while also providing essential ecosystem services to surrounding aquatic and terrestrial wildlife. They have a tendency of being significantly more resilient than hardened shorelines (seawalls, bulkheads, etc.), as the latter structures make adjacent areas susceptible to erosion, are high maintenance and provide little to no habitat. For example, 75% of bulkheads were damaged during Category 1 Hurricane Irene, while marshes and sill designs accumulated sediment.[1] Living shorelines can be composed of both soft and hard elements.

They can take the form of:

- Native vegetation only, which breaks small waves and is suitable for low-wave energy sites.
- Oyster reefs.
- Anchored large wood to hold the toe of existing vegetated slope, which is suitable for most areas except high-wave energy sites.
- Rock sills installed parallel to the shore with vegetation planted behind it, creating an excellent barrier to higher energy waves.

BENEFITS

- Reduces shoreline flooding and erosion.
- Stabilizes shoreline and acts as a storm barrier.
- Provides habitat for aquatic wildlife.
- Improves water quality and stores nutrients.
- Is more resilient than hardened shorelines.

CONSIDERATIONS

- In the first year or two, maintain vegetation and structures.
- Consider regional and site-specific differences including habitat type, wave energy and geologic setting.
- Coordinate with government and non-government entities to discuss site characteristics and needs.
- Implement methodologies that minimize or avoid channelward encroachment.

CASE STUDY

WIN WASTE INNOVATIONS

SAUGUS, MASSACHUSETTS, USA

The living shoreline at Bear Creek Sanctuary comprises approximately 32 acres, with two acres of shrublands added in 2020 to expand the upland transitional zone area 20 feet inland, thereby offsetting the projected sea-level rise. This proactive expansion gives the habitat and wildlife a better chance at adapting to continued increases in sea level. WIN Waste Innovations is focused on developing a healthy coastal habitat for birds, and species like gray catbird and yellow warblers have been consistently observed at the shoreline.

1 Gittman, R.K., Popwich, A.M., Bruno, J.F., and Peterson, C.H. 2014. Marshes with and without sills protect estuarine shorelines from erosion better than bulkheads during a category 1 hurricane. Ocean & Coastal Management 102, 94-102.

WHC

Vernal Pools

OVERVIEW

Vernal, or "ephemeral," pools are depressions in the earth that fill with water in the spring or rainy season and then eventually dry out. These temporary freshwater features are a choice breeding and nursery area for amphibians and serve important lifecycle needs for many aquatic invertebrates.

BENEFITS

- Provides seasonal, fish-free wildlife habitat.
- Creates critical breeding pools for amphibians and invertebrates.
- Filters and absorbs stormwater runoff.
- Provides habitat connectivity.
- Controls flooding and erosion.

CONSIDERATIONS

- Vernal pools should be constructed in low areas that collect rain. Additional excavating will be needed so that pools hold water long enough for amphibian and insect larvae to develop fully (at least 90 days in the spring/early summer).[1]
- If natural water-retaining areas are not present, instead line a depression with a thick plastic liner and cover it with a thin layer of soil.[2]
- Vegetation should be planted in and around the pool to prevent erosion.[3] The plants or seed mix selected should be deep-rooted, native to the region and adapted to wet conditions.
- Plantings need maintenance each growing season.
- Structural elements of the vernal pool should be checked for damage at least once a year and repaired as needed.

CASE STUDY

CRH DUFFERIN AGGREGATES ACTION QUARRY
CONCORD, ONTARIO, CANADA

Dufferin Aggregates Acton Quarry constructed two vernal pools to enhance on-site breeding habitat for amphibians. Stumps, logs and twigs were added to the pools to provide cover and protection for egg masses, and native plants and trees were planted along the pool perimeters to control erosion and provide additional wildlife habitat. Since the pools were first constructed, over 10 different amphibian species have been identified, and several egg masses are seen each year.

1 *Biebighauser, T. 2002. A guide to creating vernal ponds.*
2 *Ibid.*
3 *Ibid.*

WHC

Urban Corporate and Community Forestry

OVERVIEW

Urban forestry is the planning and management of trees, forests and related vegetation within communities to create or add value. Urban forests are dynamic ecosystems that provide critical benefits to people and wildlife. Forested areas help filter air and water, control stormwater, conserve energy and provide animal habitat and shade.

Tree plantings are a great way to beautify a property and provide wildlife habitat. Additionally, trees' abilities to sequester carbon, cool the surrounding area, increase the soil's health and water permeability capacity and absorb pollution make planting them an effective nature-based solution in the fight against climate change.

BENEFITS

- Provides a cooling effect in the summer months and serves as a windbreaker in the winter months, thereby reducing heating and cooling costs.
- Improves property aesthetics.
- Reduces soil erosion.
- Increases property values.
- Absorbs air pollutants.
- Filters and absorbs stormwater runoff.

CONSIDERATIONS

- Trees selected should be native to the region, as native trees will be adapted to local conditions and require less maintenance.
- Newly planted trees need regular watering until they establish into the ground and develop stronger root systems. This should be done every 7-10 days during the growing season. New trees should also be watered at least once per month during the dormant season, on days when temperatures are above 40°F and there is no snow or ice on the ground.[1,2]
- Tree shelters can be placed around new plantings to deter herbivores from browsing them.
- Plant the most mature trees your budget allows for optimal success.

CASE STUDY

BUZZI UNICEM STOCKERTOWN PLANT

STOCKERTOWN, PENNSYLVANIA, USA

Along with local partners, Buzzi Unicem manages a demonstration chestnut tree orchard in Pennsylvania's Lehigh Valley, a rapidly industrializing region between Philadelphia and New York City. To address habitat loss and educate local students about the environment, Buzzi Unicem created the Hercules Meadow in 2013. Part of this 20-acre habitat was set aside as a chestnut tree demonstration orchard where students helped with the initial planting and continue to conduct annual inventories and collect data on tree growth and wildlife use.

1 *Duffey, L., and M. Hoff. 2008. Appendix one: how to plant saplings and seedings and care for a tree. In: All about Minnesota's forests and trees: A primer.*
2 *Lang, J. 2019. Winter tree watering tips.*

WHC

Native Landscaping

OVERVIEW

Formal landscaping on corporate sites often uses non-native, ornamental plant species. While attractive, these plants provide little to no value for native wildlife and require more maintenance with irrigation, fertilizers, pesticides, mowing and other maintenance.

Native landscaping enhances aesthetics, reduces chemical treatments and saves on maintenance costs and emissions from gas-powered landscape equipment. Phase native plants into existing landscaping as non-native plants die, enhance bare land with native plantings or replace non-native installations with native plants. Including native flowering plants allows a garden to provide resources like nectar and pollen for native pollinators (e.g., butterflies, bees, hummingbirds).

BENEFITS

- Requires minimal maintenance once the plants are established, as native plants are adapted to the local environmental conditions, saving time and money on maintenance activities.
- Provides wildlife habitat.
- Yields immediate and visible results.
- Increases environmental awareness for the community.
- Supports local pollinators.
- Increases pollination of other plants.
- Stabilizes soil, preventing erosion.
- Absorbs stormwater runoff.
- Reduces irrigation and fertilizer needs.
- Filters and detoxifies pollutants in the air and water runoff.
- Reduces greenhouse gas emissions by reducing landscape equipment needs.

CONSIDERATIONS

- New plantings need to be watered regularly throughout the first growing season.
- Plantings will need maintenance each growing season.
- Plant “groups” of any species being installed to improve pollinator foraging efficiency.

CASE STUDY

BASF COATINGS TECHNICAL SUPPORT CENTER

WHITEHOUSE, OHIO, USA

The 15 ft² formal garden at BASF Coatings Technical Support Center - Whitehouse is one of the first things visitors see as they enter. With the goals of increasing biodiversity and highlighting native plants, this garden includes up to eighteen native plant species, and moving forward, the team wants to include more flowering plants to attract pollinators. The inclusion of native species keeps maintenance needs relatively low.

WHC

Miyawaki Micro-Forests

OVERVIEW

Miyawaki forests take their name from Dr. Akira Miyawaki, a Japanese botanist who invented this methodology of developing forest environments on a small scale. Micro-forestry involves analyzing and improving the soil of a forest through amendments. Up to 100 local species are then planted densely and randomly to mimic how they would grow in the wild. This method allows trees to grow 10 times faster than they would in a traditional forest, and once the micro-forest is established, it no longer requires maintenance.[1]

BENEFITS

- Requires less space than larger forests.
- Provides significant biodiversity.
- Grows and stabilizes faster than traditional forests.
- Sequesters CO_2.
- Reduces stormwater runoff.

CONSIDERATIONS

- Weed and water the site for the first 2-3 years.
- Micro-forests are particularly well-suited for urban environments.

CASE STUDY

WM-MICHELIN CAMPGROUND NATURAL AREA

LOUISVILLE, KENTUCKY, USA

At the WM-Michelin Campground Natural Area in Kentucky, employees, contractors and partners maintain an urban forest atop a closed landfill. Employees started by removing invasive honeysuckle plants and then planted three-gallon trees on the northern slope of the landfill. They chose landfill-tolerant trees such as black gum and red maple, as well as trees with shallow roots like green ash. The trees grew quickly, resulting in a closed canopy, and monitoring has shown the presence of deer, raccoons and native birds.

1 *JSTOR Daily. 2019. The Miyawaki method: A better way to build a forest?*

WHC

No-Mow Zones

OVERVIEW

Allowing grasses to grow taller or using an appropriate native seed mix to convert turfgrass into a native grassland habitat will save on time and lawn maintenance costs, attract and provide more resources for wildlife and reduce emissions from landscaping equipment.

BENEFITS

- Needs little to no maintenance once established.
- Eliminates expensive, high-maintenance lawns.
- Provides wildlife habitat.
- Decreases carbon emissions and air pollution.
- Filters and absorbs stormwater runoff.
- Reduces eco-footprint.
- Stabilizes soil, preventing erosion.

CONSIDERATIONS

- Long-term maintenance will entail occasional mowing to prevent woody vegetative growth.
- Mow outside of the avian nesting season to prevent harm to grassland birds.
- Mowing in a rotational scheme of 1/3 each year creates a natural succession in plant growth that supports wildlife at different life-stages.

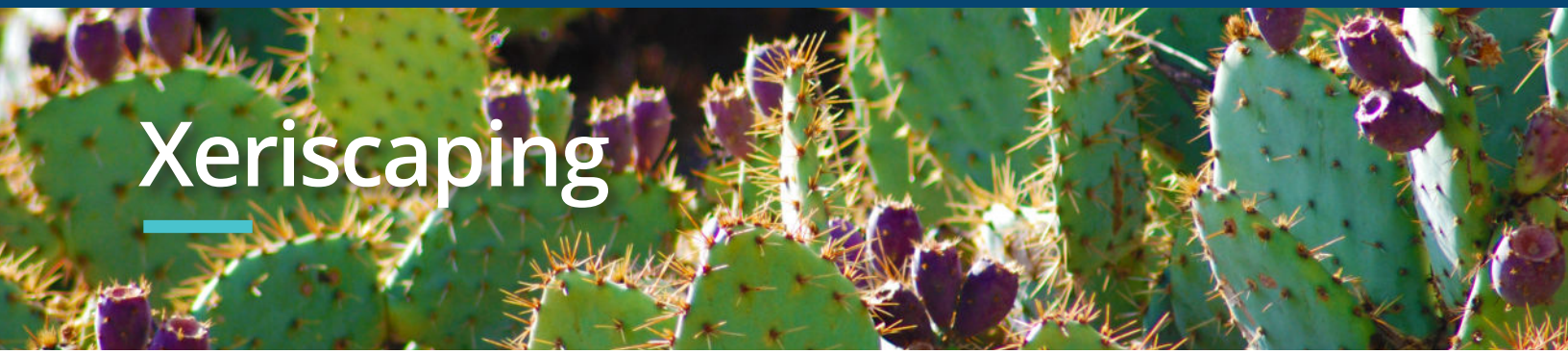
CASE STUDY

EXELON PEPCO TRANSMISSION RIGHTS-OF-WAY

WILMINGTON, DELAWARE, USA

Exelon's Pepco Transmission Rights-of-Way (ROW) comprise over 300 miles of electric transmission lines, covering 10,000 acres of land. In order to protect the area's natural resources, Exelon has worked to manage on-site trees and vegetation to reduce hazards to their operations while maximizing biodiversity and wildlife habitat. As part of their efforts to enhance riparian areas throughout the ROW, the team established several areas as no-mow zones and installed signage indicating as such.

WHC



Xeriscaping

OVERVIEW

Xeriscaping is a landscaping practice that arranges native, drought-resistant plants in efficient, water-saving ways, reducing or eliminating the need for irrigation. This is a common practice in drier regions susceptible to drought or for facilities practicing water conservation or those in dense, urban areas where water permeation is poor and temperatures are typically higher due to the heat island effect.

BENEFITS

- Provides habitat for wildlife.
- Improves property aesthetics.
- Saves water and reduces eco-footprint.
- Yields immediate and visible results.
- Reduces maintenance.

CONSIDERATIONS

- Plants should be native to the region and adapted to dry conditions.
- Supplemental watering will still be required each year, especially throughout the first growing season while plants are still establishing.
- Plantings need maintenance each season.

CASE STUDY

STELLANTIS ZARAGOZA

ZARAGOZA, SPAIN

The goal of the xersicaped garden at Stellantis' Opel facility in northeastern Spain was two-fold: to create a natural space for employees to enjoy and to incorporate native species that are well-adapted to the site's climate and would support pollinators. Covering nearly 1.4 acres, the garden includes 18 plant species and eight native species such as rosemary and English lavender. The garden is managed through pruning, watering and adding soil, and these strategies have led to a pollinator presence on-site.

Corporate and Community Gardens

OVERVIEW

A corporate garden is an on-site green space dedicated to growing fruits and vegetables. Gardens in urban areas can provide produce for local communities who may otherwise be unable to easily access fresh foods (e.g., food deserts). Gardens featuring native plants support native wildlife and can also foster community connections to traditional, indigenous foods and heritage.

BENEFITS

- Provides wildlife habitat.
- Boosts employee morale.
- Targets corporate social responsibility goals.
- Helps address food deserts in urban areas.
- Improves corporate reputation.

CONSIDERATIONS

- Set up an office green team to organize the efforts.
- A section of the garden can be set aside for ornamental native flowering plants to provide habitat for pollinators.
- Native fruit and nut trees can be planted to connect community residents to traditional, seasonal foods.

CASE STUDY

GLAXOSMITHKLINE SHERWOOD CAMPUS

RICHMOND, VIRGINIA, USA

The landscaped habitat at GlaxoSmithKline's Sherwood Campus encompasses 4.1 acres. In addition to a bee garden, monarch garden and pollinator garden, the site also provided space for a community garden where employees could grow fruits and vegetables in a total of 40 raised garden beds. Employee gardeners had the choice to water their crops using in-ground irrigation or rain barrels. Employees were responsible for the maintenance of the plots, while GlaxoSmithKline provided water and amended soil.

Bioremediation

OVERVIEW

Bioremediation is the process of neutralizing or removing pollutants from soil, water or air using living organisms. *Phytoremediation* occurs when plants immobilize contaminants and prevent further dispersal or absorb organic contaminants. *Mycoremediation* is a process by which fungi break down metallic or organic contaminants into inactive forms.

BENEFITS

- Does not require the use of toxic chemicals.
- Requires little equipment, labor and energy.
- Creates few waste byproducts.

CONSIDERATIONS

- Environmental conditions such as temperature, pH, nutrients and food must be maintained in order for the process to take place.
- It may take several months to years for the process to complete.
- In some cases, it may be necessary to remove and safely dispose of plants once contaminant absorption is complete.
- There is a risk of microbial degradation causing the creation of compounds that are more mobile and/or toxic than their parent compound.

CASE STUDY

KINDER MORGAN HARTFORD STREET TERMINAL

TAMPA, FLORIDA, USA

Starting in 2012, Kinder Morgan collaborated with phytoremediation experts to use a 6-acre urban forest to remove nitrate and ammonia from the groundwater at their Hartford Street Terminal site. The project first required the removal of invasive species and topsoil amendments before native trees and hybrid varieties of poplar and willow, known for their phytoremediation capacities, could be planted. Monitoring has shown that that ammonium and nitrate levels in the groundwater are stabilizing.

Floating Wetlands

OVERVIEW

Floating wetlands are small artificial islands that allow aquatic plants to grow in water that is usually too deep for them. The plant roots grow through a platform and into the water, forming a dense network of roots that provide a large surface area for microbes to thrive, absorb excess nutrients and even break down contaminants.

BENEFITS

- Reduces water pollution.
- Reduces the incidence of algal blooms.
- Serves as shelter/habitat for wildlife.
- Provides a source of food and shade.
- Sequesters carbon.

CONSIDERATIONS

- Be selective when choosing plants to avoid invasive spread.
- Use native perennial plants.
- Crowns of plants should be pruned and composted.
- Do not apply pesticides.

CASE STUDY

SHELL

VERMILION BAY, LOUISIANA, USA

In 2019, Shell introduced a pilot program that recycled plastic bottles from the 2018 New Orleans Jazz and Heritage Festival into floating wetlands in Vermillion Bay, Louisiana. The plastic was woven into a mat containing perforated cups into which volunteers planted approximately 5,000 native grasses such as mangrove and smooth cord grass. These floating islands are anchored to the bottom of the bay, and as the roots of the plants grow, they will filter the water and provide habitat for aquatic wildlife. Eventually, these manmade islands will look almost identical to the surrounding natural shore.

Roof Modifications

OVERVIEW

Roof modifications such as green and blue roofs can provide a number of climate resilience benefits. A green roof is an extension of an existing roof with a layer of vegetation planted on a waterproofing system installed over a flat or slightly slanted roof. Green roofs have, at minimum, one layer of vegetation, a lightweight growth medium composed of a small amount of organic material and mineral aggregates, a drainage layer with a filter fabric and a waterproof, root repellent system.

The two primary types of green roofs are extensive and intensive. *Extensive* green roofs can support up to 25 lbs. of vegetation and have thin soil with little to no irrigation required. *Intensive* green roofs support up to 150 lbs. of vegetation and include a deep soil irrigation system that is more favorable to plants.

Blue roofs integrate a water-detention flow control system that allows a roof to store water temporarily. This system is designed to filter contaminated water that would typically run off and impact surrounding watersheds. Blue-green roofs store water during heavy rainfall while also cleaning it utilizing the blue roof filtering system and soil/vegetation.

BENEFITS

- Sequesters carbon.
- Manages stormwater.
- Enhances water quality of runoff.
- Improves air quality.
- Decreases heat island effect.
- Reduces noise pollution.
- Provides habitat and a water source for wildlife.
- Has insular properties to cool and heat buildings.
- Reduces eco-footprint.

CONSIDERATIONS

- Insurance is needed, particularly for intensive roofs, both for potential damage to the building from plants and from potential sagging due to weight.
- Roof must be flat or slightly slanted.
- There is the risk of damaging the waterproofing membrane.

CASE STUDY

DAVEY RESOURCE GROUP WSSI NATIVE HABITAT

GAINESVILLE, VIRGINIA, USA

At Davey Resource Group's Gainesville, VA site, a 3,626-ft² green roof was designed and installed to better insulate the building and to manage and support wildlife. The plants used are mostly native (along with some non-invasive sedum) and offer a range of bloom times, providing year-round habitat for pollinators. The roof is also used as a demonstration site to educate others on low-impact development practices.

Green Architecture

OVERVIEW

Green architecture practices can help to address climate change challenges. *Living fences* are one example that use closely spaced shrubs and trees to create an enclosure. The vegetation provides a natural windbreak and serves as a movement corridor for wildlife.

Green façades are created by growing climbing plants up and across the walls of a building. Façades feature climbing plants that weave in and around mesh, wire or cables, whereas living walls use potted plants that are rooted to the wall itself.

Living walls are walls covered with a layer of vegetation. These walls include a vertically applied growth medium (e.g., soil) as well as an integrated hydration system. Unlike in green façades, plants are rooted to, and supported by, the wall itself.

BENEFITS

- Stabilizes soil, preventing erosion.
- Absorbs air pollutants.
- Filters and absorbs stormwater runoff.
- Sequesters carbon and reduces greenhouse gases.
- Decreases heat island effect in urban areas.
- Reduces energy costs.

CONSIDERATIONS

- The plants selected should be native to the region.
- New plantings need to be watered regularly throughout the first growing season.
- Plantings may take several years to reach full height and will need maintenance each growing season.
- Façades and living walls can become an education or community engagement opportunity.
- Façades can grow in containers at varying heights, or all containers can start at the ground.
- The living wall's structural integrity should be checked occasionally and repaired as needed. The underlying wall should also be checked to detect any build-up of condensation or moisture.[1]

CASE STUDY

GENERAL MOTORS WORLD HEADQUARTERS

DETROIT, MICHIGAN, USA

The team at General Motor's World Headquarters at the Renaissance Center stacked 13 4' x 5' planters made of reused shipping crates to create a living wall across the rooftop deck. Not only does this wall protect their other rooftop habitat projects, but it also provides increased habitat for pollinators in a small, urban space. This aesthetically pleasing and functional piece of green architecture is featured in building tours to educate and inspire visitors.

1 *TruVert Vertical Garden Solutions. No date. Living wall maintenance.*

Water Detention and Retention Ponds

OVERVIEW

Stormwater runoff can be managed through the installation and maintenance of detention and retention ponds. While *retention ponds* hold a permanent pool of water and *detention ponds* do not, both provide a fundamental role in preventing flooding and erosion by storing and slowing stormwater runoff.

BENEFITS

- Controls flooding.
- Saves millions in stormwater cost repairs.
- Serves as a water source for wildlife.
- Provides habitat.
- Improves collected water quality if properly designed (retention ponds).

CONSIDERATIONS

- A large land area is needed.
- Water quality is at risk if ponds are not adequately designed.
- Retention ponds can be a drowning hazard.
- An emergency outflow area is essential to prevent erosion around the basin edge in case of extreme weather events.

CASE STUDY

SHELL WOODCREEK CAMPUS

HOUSTON, TEXAS, USA

The pollinator garden at Shell's Woodcreek Campus was designed to accommodate outdoor meeting spaces and to encourage employee wellness. By planting native plants like milkweed, Shell provided a vital food source to keep pollinators coming back to the site. The project also involved replanting native grasses and plants around the water detention ponds on-site that serve as a water source for wildlife. A waterfall feature connecting the ponds adds to the site's aesthetics.

Rain Gardens

OVERVIEW

Rain gardens use deep-rooted, wet-tolerant plants to catch and absorb rainwater as it runs off higher elevations. The garden's absorption reduces the erosion, water pollution and flooding that often accompany runoff from impervious surfaces such as roofs, sidewalks and parking lots.

BENEFITS

- Filters, slows and absorbs stormwater runoff.
- Reduces potential flooding.
- Stabilizes soil, preventing erosion.
- Resolves areas with standing water after rainfall occurs.

CONSIDERATIONS

- The plants selected should be deep-rooted, native to the region and adapted to periodic wet conditions.
- Place rain gardens at least 10 feet away from buildings in a low spot that collects water after heavy rain.[1]

CASE STUDY

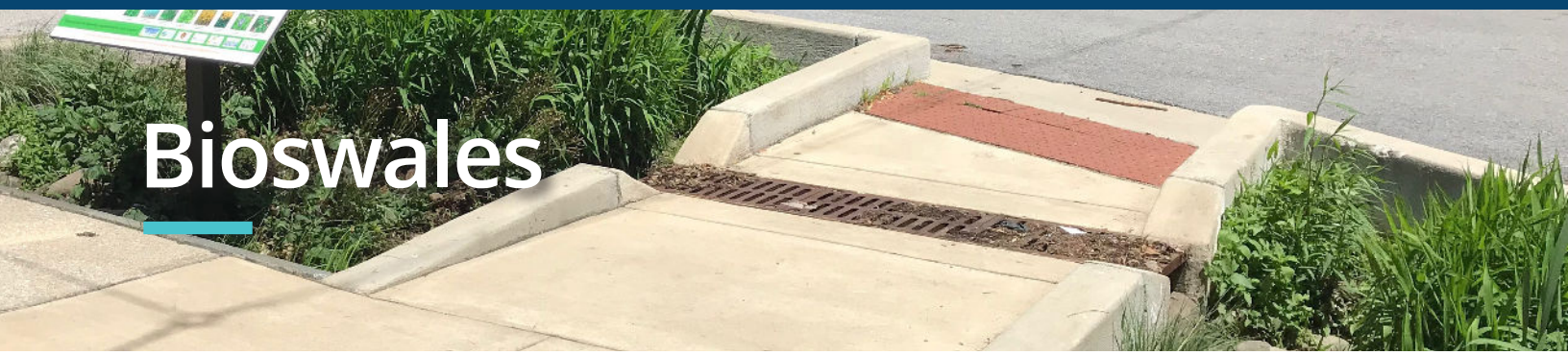
ITC WAYLAND WAREHOUSE

WAYLAND, MICHIGAN, USA

The 700-square-foot rain garden at ITC's Wayland Warehouse facility captures thousands of gallons of stormwater runoff from the building's roof. A combination of sand, compost, topsoil and mulch helps plants grow and provides drainage to capture runoff. The team also selected pollinator-friendly native plants like purple coneflowers, blue flag iris and black-eyed Susan. Interpretative signage informs visitors and employees alike about how the rain garden benefits local wildlife and water quality.

1 *United States Department of Agriculture. 2014. Rain garden fact sheet.*

WHC



Bioswales

OVERVIEW

Bioswales take the form of a ditch or depression, often characterized by the vegetation growing in it, which in turn is determined by the conditions on-site. It can be divided into several layers, the first consisting of thick vegetation like grasses or shrubs and enhanced soil. The second layer includes gravel, scoria or baked clay pellets enclosed in geotextile to allow rainwater to drain off and prevent clogging. A drain tube or infiltration pipe is located underneath this second layer so that any excess water from heavy rainfall in the bioswale can be directed to overflows.

BENEFITS

- Requires little maintenance.
- Enhances local water quality, collecting silt, pathogens, metallic and organic compounds.
- Recharges groundwater.
- Reduces the need for retention ponds, which can take substantial space.
- Enhances local air quality.
- Reduces heat stress.
- Works well even in extreme weather conditions.
- Provides habitat for wildlife such as pollinators.
- Enhances biodiversity.
- Reduces flooding events during heavy rainfall, particularly in urban areas.

CONSIDERATIONS

- Dimensions should be large enough that water from heavy rainfall is absorbed in the ground within 24 hours.
- Take local climate, rainfall patterns, site size, budget and vegetation into account.
- Use exclusively native species that have dense and deep root systems and tolerate very wet and very dry conditions.
- Avoid installing downhill in areas experiencing erosion to prevent excess sediment accretion.
- Bioswales should not be installed in areas with high water tables (where groundwater can reach the bottom of the bioswale).

CASE STUDY

DTE DOWNTOWN DETROIT HEADQUARTERS

DETROIT, MICHIGAN, USA

The bioswale at DTE's Downtown Detroit Headquarters Complex provides a much-needed green space for employees and locals to explore while learning about rain gardens. It also contributes to the building's LEED certification by collecting and filtering stormwater runoff, which is particularly useful because of Detroit's lack of green space downtown. Finally, the native vegetation provides habitat for pollinators and birds in this urban environment.

Nature-Based Solutions as Interventions for Climate Impacts, Adaptations and Resilience

Nature-Based Solution	Climate Challenges & Hazards									Co-Benefits												
	Heavy Rainfall	Flooding	Landslides & Erosion	Drought	Wildfires	Heat Waves	Cold Waves	Coastal Erosion	Sea Level Rise	Biodiversity	Air Quality	Water	Temperature	Carbon Sequestration	Soil Health	Urban Agriculture	Energy	Socio-Economic	Recreation	Noise Reduction	Health & Well-Being	Local Engagement
Landscape-Scale Environmental Restoration Solutions																						
Reforestation & Afforestation			✓		✓	✓				✓	✓	✓		✓					✓	✓	✓	✓
Invasive Species Management			✓		✓					✓					✓			✓			✓	✓
Forest & Fire Management					✓					✓				✓	✓							
Soil Rehabilitation & Structural Soils			✓					✓		✓				✓	✓	✓						
Wetlands & Coastal Management Solutions																						
Riparian & Waterbody Enhancement	✓	✓			✓			✓		✓		✓		✓	✓				✓			✓
Living Shorelines		✓						✓	✓	✓		✓										
Vernal Pools	✓	✓		✓				✓		✓		✓										
Urban & Industrial Infrastructure Solutions																						
Urban Corporate & Community Forestry	✓	✓	✓			✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Native Landscaping	✓	✓	✓	✓						✓	✓	✓		✓	✓				✓			✓
Miyawaki Micro-Forests		✓								✓	✓	✓	✓	✓			✓	✓	✓		✓	✓

Cont'd. on next page

WHC

Cont'd. from page 25

Nature-Based Solution	Climate Challenges & Hazards									Co-Benefits												
	Heavy Rainfall	Flooding	Landslides & Erosion	Drought	Wildfires	Heat Waves	Cold Waves	Coastal Erosion	Sea Level Rise	Biodiversity	Air Quality	Water	Temperature	Carbon Sequestration	Soil Health	Urban Agriculture	Energy	Socio-Economic	Recreation	Noise Reduction	Health & Well-Being	Local Engagement
No-Mow Zones				✓	✓					✓	✓	✓		✓	✓		✓					
Xeriscaping				✓		✓				✓		✓	✓				✓		✓			✓
Corporate & Community Gardens										✓						✓		✓	✓		✓	✓
Bioremediation											✓	✓			✓			✓			✓	
Floating Wetlands		✓						✓	✓	✓		✓	✓	✓							✓	
Roof Modifications	✓	✓				✓	✓			✓	✓	✓	✓	✓			✓			✓		✓
Green Architecture	✓			✓		✓	✓			✓	✓	✓	✓	✓	✓		✓					✓
Rainwater Management Solutions																						
Water Detention & Retention Ponds	✓	✓				✓				✓		✓										
Rain Gardens	✓	✓								✓	✓	✓			✓	✓		✓	✓			
Bioswales	✓	✓								✓	✓	✓	✓					✓				

WHC

Definitions

Climate change refers to long-term shifts being recorded in global temperatures and weather patterns. Some climatic shifts are natural (e.g., from solar cycle variations). However, starting with industrialization during the 1800s, the main driver of climate change has been increased human activities, primarily the use of fossil fuels (e.g., coal, oil, gas) to supply the energy needed for industrial growth. Burning fossil fuels has increased the natural levels of atmospheric greenhouse gas emissions (e.g., carbon dioxide, methane) that trap more of the sun's heat and raise global temperatures. Land and forest clearance for settlements and industrial agriculture also release greenhouse gas emissions and exacerbate climate change and its impacts.[1]

The scientific community is in agreement that our planet's climate is undoubtedly changing. This causes severe environmental hazards and social impacts that can be expected to increase into the future. According to the European Union (EU), "action has never been as urgent as today — the Earth's average temperature has already risen roughly 1.2°C above pre-industrial levels…Without action today, adaptation will be costlier and more difficult for the next generations."[2]

Climate adaptation refers to "the process of adjusting to actual or expected climate change and its effects."[3] **Transformative adaptation** is "a strategy that aims to reduce the root causes of vulnerability to climate change in the long-term by shifting systems away from unsustainable or undesirable trajectories."[4] Transformative adaptation recognizes that climate breakdown; the sixth mass extinction of species; ecosystems destruction; air, water and soil pollution; and impacts on our health are all interrelated and should be addressed holistically.

Climate resilience refers to "the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate."[5] While climate resilience is often associated with critical, severe and episodic climatic events (e.g., heat waves, heavy rains and floods, hurricanes), more chronic or prolonged events (e.g., rising sea levels, deteriorating air quality, population migration or "climate refugees") must be addressed as part of any long-term corporate resilience plan. Factoring climate risks into existing frameworks will produce a more climate-resilient business or operation.

1 United Nations Climate Action. No date. What is climate change?
2 European Commission. No date. Climate resilience and adaptation to climate change.
3 Ibid.
4 Giacomo, F., Donatti, C.I., Harvey, C.A., Hannah, L., and Hole, D.G. 2019. Transformative adaptation to climate change for sustainable social-ecological systems. Environmental Science & Policy, Vol 101, pp 116-125.
5 Center for Climate and Energy Solutions. No date. Climate resilience portal.

Advisory Committee

Thank you to the members of our NbS Advisory Committee for their input:

- Jeffrey Cole, Shell
- Tonya Graham, Geos Institute
- Patrick Judd, Environmental Consulting & Technology (ECT)
- Doug Partridge, Arcadis
- Alison Shaw, Action on Climate Team
- Kacia Tolsma, Action on Climate Team
- Joris Voeten, Wageningen Environmental Research (WENR)

Thank you to Shell for underwriting the production of this publication.

WHC can help support a wide spectrum of conservation activities 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 and conservation education outcomes. For more information, please contact us at whcconsulting@wildlifehc.org.

WHC

wildlifehc.org