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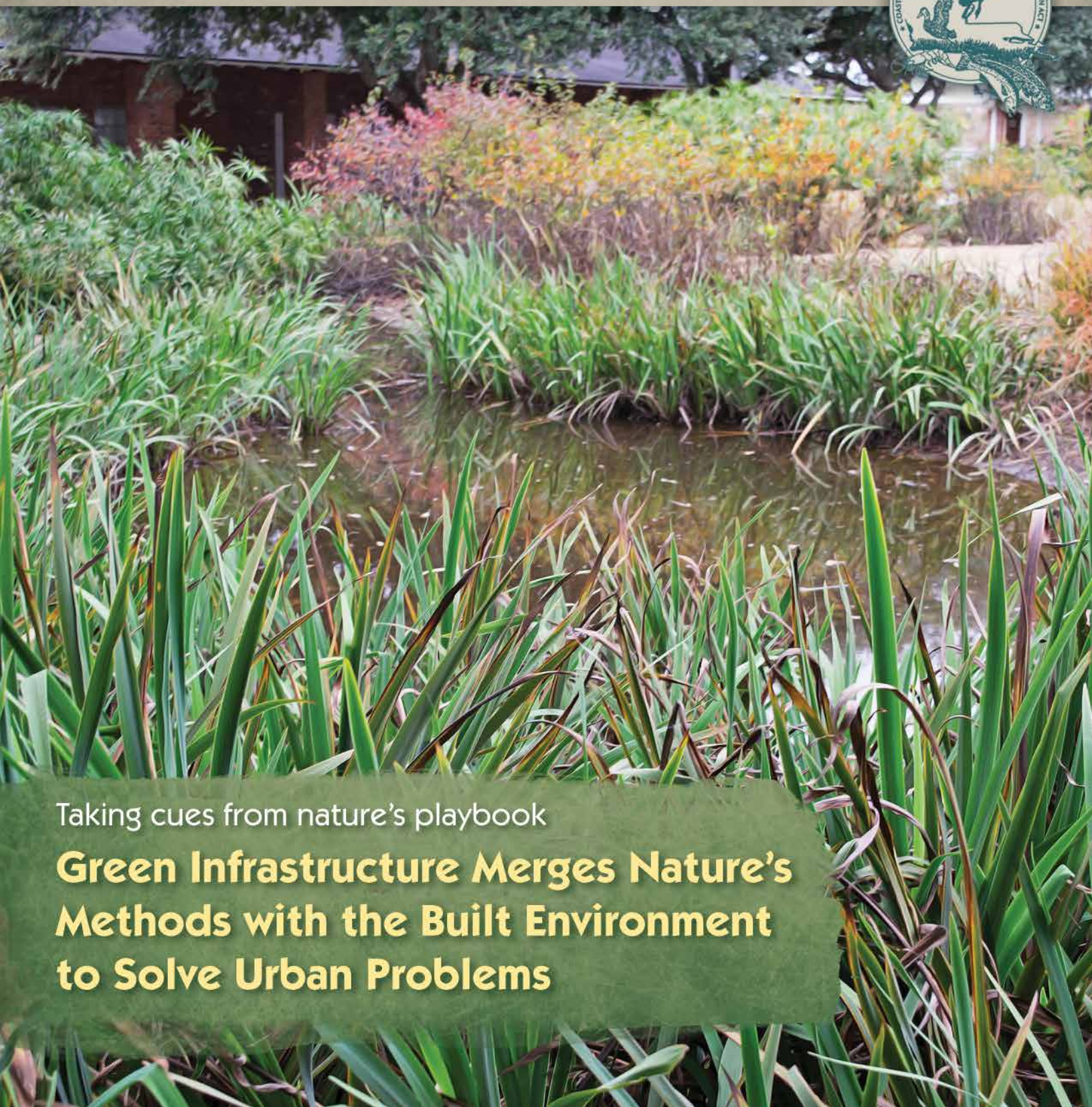
WATER MARKS

Louisiana Coastal Wetlands Planning, Protection and Restoration News

April 2018 Number 57



Taking cues from nature's playbook

Green Infrastructure Merges Nature's Methods with the Built Environment to Solve Urban Problems

April 2018
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This legislation funds wetlands restoration and enhancement projects nationwide, designating nearly $80 million annually for work in Louisiana. The state contributes 15 percent of total project costs.

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ABOUT THIS ISSUE'S COVER . . .

A New Orleans high school created a wetland system to solve drainage problems, serve as an educational centerpiece and beautify the grounds. The sustainable landscape design collects and stores stormwater runoff to improve water quality while reducing its quantity.

Photo credit belongs to Dana Brown & Associates, Inc.

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Bart Everson

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DEVELOPING BETTER WAYS TO MANAGE URBAN WATER

Green Infrastructure: a Natural Approach to Flood Control

Water pipes, sewer conduits, pumps and concrete drainage channels — water management infrastructure is seldom pretty, and in today's world of extreme weather events, it can be overwhelmed and rendered ineffective. Rainfall and storm surges commonly exceed the capacity of these drainage systems, a cause of flooding throughout Louisiana's cities. Moreover – and ironically – the evacuation of flood water also depletes stores of groundwater, causing soils to sink with consequent damage to buildings, roads and bridges.

After Hurricanes Katrina and Rita, however, decision makers began to reconsider how the region designs its infrastructure. "The hurricane was a watershed event," says Andrea Galinski, a coastal resources scientist with the Louisiana Coastal Protection and Restoration Authority. "It proved how insufficient our planning was, for both the present and the future. The tragedy gave Louisiana impetus to develop a new approach, to adopt the concept of 'green' infrastructure that uses natural processes to reduce the risk of coastal floods."

More than a tweak

Engineers and landscape architects see green infrastructure as much more than the tweaking of a technique; they see it as a comprehensive new approach. "In the recent past we've thought of water as an obstacle, a nuisance," says Danielle Duhe, a landscaper designer in

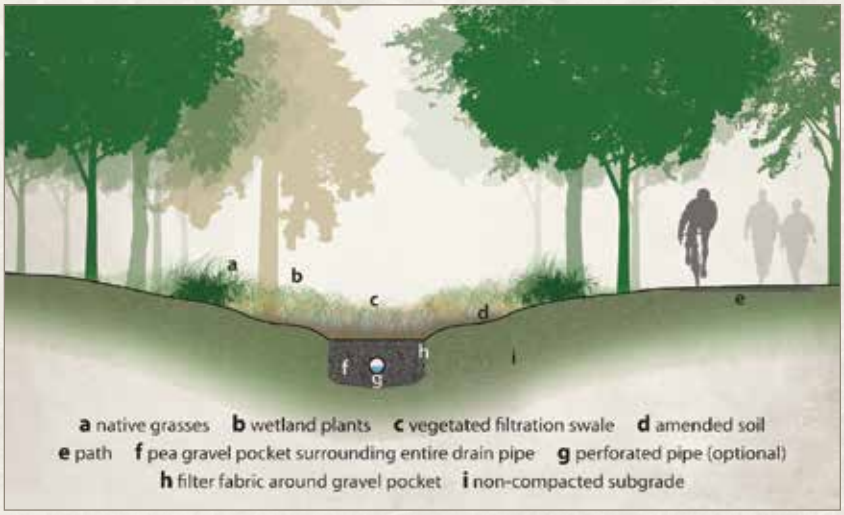


Image created by Dana Brown & Associates, Inc.

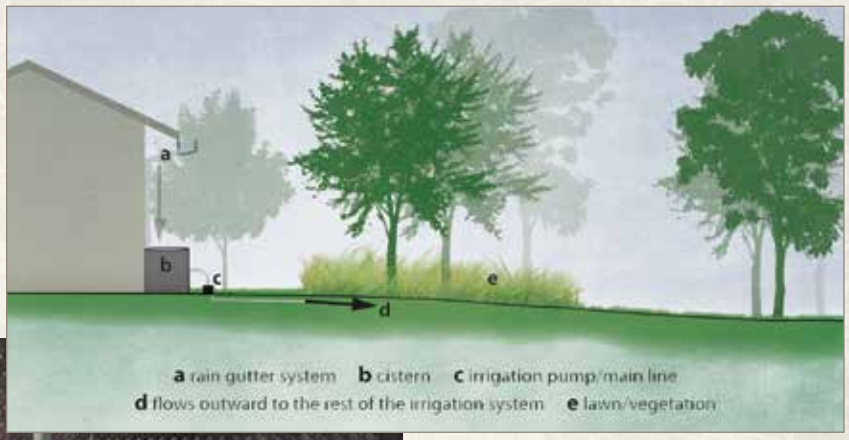
Louisiana metropoles are looking at underutilized spaces, such as street medians and vacant lots, with an eye toward their potential development as green infrastructure. While enhancing a neighborhood's visual appeal, a vegetated bioswale between two lanes of a roadway, as pictured above, reduces stormwater runoff, improves water quality and provides cooling shade.

New Orleans who specializes in stormwater management. "We moved away from embracing it, from using the city's canals for transportation. The city's new urban water plan encourages us to think about water differently, to learn to live with it instead of fighting it, to make space for it and to work with natural hydrological cycles."

This change in attitude hasn't occurred just among engineers. Throughout the coastal region Louisianans have begun to see things differently. Marnie Winter worked in Jefferson Parish for the better part of four decades and served as the assistant director of the parish's Department of Environmental Affairs. "The public used to perceive nature-based solutions as inferior to hard infrastructure – to pumps and levees," she says. "But over the past several years people have started thinking about smarter and more economical ways to handle floods. Because of sea-level rise, we will always need to have hard, or 'gray' infrastructure, but we're beginning to see how we can mix green and gray infrastructure together for greater sustainability. For instance, wetlands in front of a levee attenuate the destructive action of waves and storm surge, reducing wear on the hard structure."

The mixture presents economic benefits as well. "Maintenance of green infrastructure is frequently less expensive than pipes that require repair and pumps that break down. Ponds may have to be cleared of sediment to remain functional, but they operate as a natural system," says Winter. "All problems can't be solved with green infrastructure, but it often offers benefits similar to gray infrastructure at a reduced cost."

Green infrastructure has the added advantage of enhancing the quality of urban life, transforming unsightly hard infrastructure into attractive landscape elements. "We are designing and building playgrounds with subsurface detention basins," says Duhe. "Under normal conditions the area is dry, providing a field for kids to play on, but in extreme rain events it collects water and holds it temporarily. When the drainage system is able to accommodate the volume, the stormwater is slowly released." Duhe cites another example, a retention



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Homeowners who manage rainfall on their property make a difference in addressing the problem of stormwater runoff. Installing gravel drainage ditches, planting rain gardens and using barrels and cisterns to capture rainwater are measures that reduce shallow, street flooding and alleviate pressure on a township's "gray" infrastructure of pipes and pumps.

Photo credits belong to Dana Brown & Associates, Inc.

Designed to function as a natural wetland, a section within New Orleans' City Park produces customary environmental benefits such as water infiltration, erosion control, water purification and wildlife habitat while doubling as an interactive educational exhibit. Volunteers helped to plant native species to create an area within the city's boundaries that stays true to the local natural environment.

pond that stays constantly wet, holding water to release slowly. Adding fountains to the pond transformed a potentially drab infrastructure component into an attractive landscape feature.

"Greening" a city block by block

Since businesses and homes occupy most of the space in an urban area, commercial and residential buildings that adopt green infrastructure principles and methods contribute significantly to a city realizing its infrastructure goals. Installing innovations such as permeable pavement, which allows water to seep through and infiltrate the ground instead of being channeled into storm drains, and green roofs, which support vegetation atop buildings, can dramatically increase on-site retention of runoff and slow the flow of water during intense rainfall events. Simple measures taken by homeowners, such as installing gravel drains and capturing rainwater in barrels or cisterns, reduce the volume of stormwater flowing into the streets. Even small rain gardens, planted with species that thrive in wet conditions, moderate water release while gracing the environment with attractive vegetation that may also feed pollinators, birds and other backyard wildlife.

Sometimes implementing green infrastructure means merely leaving things alone. Retaining mature trees at new development sites preserves their many ecological services, including water filtration, groundwater recharge, erosion prevention and energy conservation. Maintaining the natural banks of water bodies – and constructing new drainage pathways that mimic them – slows water flow, reduces siltation in receiving water bodies, and provides neighborhood recreational corridors. "Blueways," as such urban waterways are called, present opportunities for communities to enhance the functionality of their infrastructure while beautifying neighborhoods and increasing prospects for residents to enjoy nature.

The Case for Urban Wetlands

Fundamentally, wetlands are green infrastructure—they reduce the severity of flooding, provide rainwater drainage and purify water. To demonstrate their feasibility and value as infrastructure, urban areas are establishing wetlands within their boundaries. For example, Jefferson Parish has created a marsh island in its largest park and has installed bioswales and native plants to manage stormwater. New Orleans has redesigned a section of the New Orleans City Park as a wetland. It is planted with a variety of native species that promote the natural wetland functions of filtering water and providing wildlife habitat.

"We are strengthening the resiliency of our community by building resilient systems," says Mart Black, the coastal restoration director in Terrebonne Parish. "No one part of our strategy alone provides protection. Wetlands, both within and outside of our levees, are critical. Without them, we are simply a community behind a wall." WM

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Learning to live with a natural system

Transforming Water from a Menace into an Amenity

"Hurricanes grab the headlines, but Louisianans live daily with 'nuisance' flooding," says Danielle Duhe, a landscape designer in Louisiana specializing in stormwater management. In a city like New Orleans, where a five-inch rainfall within a 24-hour period is not uncommon, nuisance flooding means impassable streets, overwhelmed storm drains and frequent road closures.

"Relying on traditional, or gray, infrastructure – concrete and pipes – a city below sea level has to pump out every drop of rain that falls," says Duhe. While the practice can clear streets of standing water, it creates other problems: Intercepting rainwater before it filters through the soil fails to remove pollutants and prevents groundwater from being replenished. Dwindling reserves of groundwater deplete drinking water supplies and accelerate subsidence, the settling of soil. As the ground sinks and caves in, foundations of buildings fracture, sidewalks crack, and potholes develop in roadways.

Implementing principles of green stormwater management, or green infrastructure, addresses both the episodic condition of too much surface water after rain showers and the routine condition of too little subsurface water. By retaining and storing rainfall in the vicinity of where it lands, green infrastructure

- uses natural processes to direct water flow
- slows the rate of stormwater runoff
- reduces transport of rainwater out of the city, thus relieving pressure on pipes and pumps
- increases penetration of rain into soil, recharging groundwater

Bayou Monte Sano is visible to every traveler passing through the Baton Rouge Metropolitan Airport terminal. Previously straightened and lined with riprap and concrete, the bayou was redesigned to reflect Louisiana's ecological identity and to restore the area's hydrologic system. Although space was limited, designers were able to introduce a more natural, sinuous course with gently sloping banks planted with native vegetation tolerant of wetness when the bayou is full and flowing and of dry conditions during periods of drought.

- moistens and stabilizes the soil, reducing subsidence

To realize these advantages, New Orleans and other regional entities have developed blueprints for their future that recommend adapting elements of green infrastructure design.

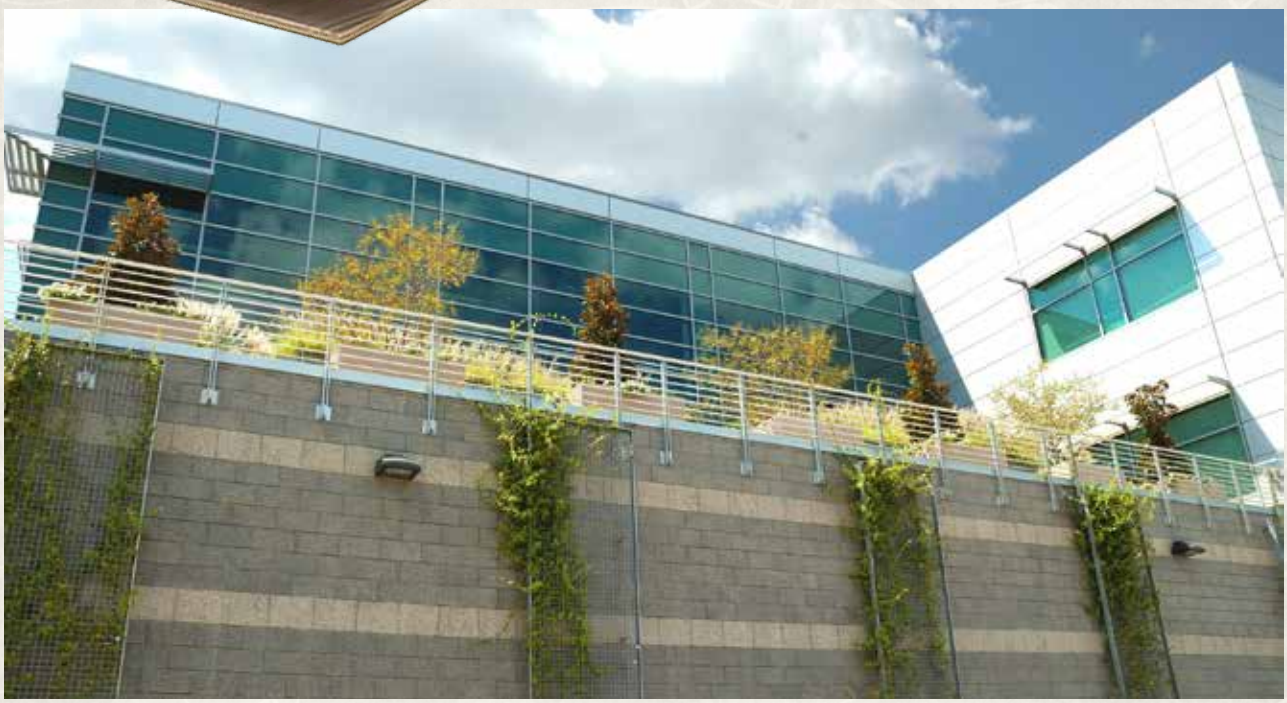
Journey of two raindrops

To examine how green infrastructure changes water management in a city like New Orleans, imagine rain falling from two clouds. Cloud One Raindrop falls into an area with traditional, or gray, infrastructure. Cloud Two Raindrop progresses through green infrastructure.

On their way down from their clouds, both raindrops absorb some atmospheric pollutants. Cloud One Raindrop lands on a hard-surface roof covered with shingles or a similar material. It slides into a galvanized gutter and into a downspout. On its way to the ground it absorbs synthetic organic compounds and heavy metals that add to its pollutant load.

Cloud Two Raindrop also lands on a rooftop, but the building has installed a green roof. While protecting the structure from water damage, as do conventional roofs, the green roof is fashioned from an impervious membrane covered with soil and living plants that absorb and filter water. The green roof system

- reduces runoff, relieving pressure on drainage and pump systems
- improves air quality, as its plants remove air particulates and produce oxygen
- cools air, as plants absorb heat energy and as water evaporates from their leaves



Green roofs can absorb moderate rainfall, provide insulation, and – in some situations – offer city dwellers a relaxing, vegetated space to enjoy. Careful construction sacrifices none of the functions of a traditional roof while contributing to stormwater management and creating a rooftop oasis.

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The New Orleans Redevelopment Authority saw opportunities to transform abandoned properties into stormwater management lots. Capable of holding up to 80,000 gallons of water, the converted lots detain or retain rainwater as close as possible to where it falls, removing runoff from streets and minimizing local flooding. As an additional benefit, neighborhoods enjoy the new, public green spaces of the redesigned lots.

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- mitigates the urban heat island effect, a condition of city and suburban developments soaking up and trapping heat
- reduces greenhouse gases; insulating buildings naturally, green roofs reduce demand for air conditioning and lower energy use
- provides a serene, natural, accessible retreat for city-dwellers and animals

Down the spout

At the end of the downspout Cloud One Raindrop splashes onto pavement. Joining millions of other raindrops, it streams toward the street, picking up gasoline and motor-oil pollutants, lawn fertilizer and pesticide residue, trash and sediment along the way. While awaiting its turn to tumble into a stormwater drain, the raindrop pools together with its compatriots to form puddles that deepen into standing water, rise over the curb and flood the street and sidewalk. Hours, or even days, may pass before Cloud One Raindrop's puddle is sucked into the drain; flushed through pipes; mechanically pumped over levees and into a lake, bay or canal; and continues its course to the ocean.

If the green roof upon which it falls does not need watering, Cloud Two Raindrop may be channeled into an open downspout that doubles as an architectural water feature. Reaching the ground this raindrop falls through a pervious surface and into an underground storage basin. In the commercial and civic buildings likely to shoulder the cost of green roofs, rainwater storage often feeds an irrigation system that maintains plantings around the building and in parking areas. While purifying rainwater of pollutants, the plants add aesthetic value and beautify the paved expanses of conventional lots.

Every drop falling to good use

An underground irrigation system is not Cloud Two Raindrop's only possible destination. It could be coaxed by gravity into a bioswale, a ditch or low area often constructed alongside a sidewalk or street. Planted with native species adapted to the region's climate and resistant to local pests and diseases, bioswales use vegetation to moderate the speed of moving water and to reduce its load of sediment and pollutants. Absorbing low water flows, bioswales replenish groundwater. In heavier rain events, they convey runoff directly to receiving areas – to pumping stations or to water bodies.

Any number of containment structures can function as stormwater storage basins. Like bioswales, which are wet or dry according to rainfall, detention ponds provide temporary storage, holding storm runoff and discharging it slowly into the drainage system. Detention ponds can be constructed so that a permeable skin allows water to seep into the basin during storm events, but during dry times its surface can be used as a playground, sports field, picnic area, or another venue for community gatherings.

In contrast, retention ponds are basins designed to stay wet and to hold water indefinitely. Built with capacity to accommodate sudden influxes of stormwater, retention ponds impede the quick flow of runoff into the drainage system, thus allowing the load in downstream pipes to abate before upstream water flows into them. As a landscape feature, retention ponds can provide a community with an aesthetic asset while recharging groundwater.

Runoff solutions, from wetlands to rain barrels

While Cloud One Raindrop's luck to fall on an impervious roof may doom it to misfortune, it need not be so. Even small measures enacted by individual homeowners contribute to green water management. If Cloud One Raindrop's gutter run ends in a rain barrel or a French drain, the raindrop is kept off the street and its potential mischief is curtailed. "Residential actions add up," says Duhe. "While gravel trenches, cisterns and rain gardens would have little effect in a hurricane, during daily rain showers these measures help reduce shallow, local flooding and relieve pressure on the pump system."

On the other end of the scale, natural areas of an acre or more can be designed to function as urban wetlands. As a part of a drainage and stormwater management system, urban wetlands additionally

- provide flood protection, serving as retention basins in heavy rainfall
- furnish sites for groundwater renewal
- perform water purification functions
- offer aviary, pollinator and aquatic wildlife habitat

"Pipes and pumps are designed to get rid of water fast," says Ryan Mast, the director of New Orleans' Office of Resilience and Sustainability. "On the other hand, by capturing water, making use of it and slowing its removal, green infrastructure integrates a living water system into our communities." WM

While many urban dwellers value the tranquil sites that the New Orleans' City Park offers, few think about the ecological services that these settings provide: Vegetated banks slow water currents, reducing pressure on the city's "gray" infrastructure and giving plants opportunity to absorb water and cleanse it of pollutants. Slow-moving streams replenish groundwater. Trees provide cooling shade. Wildlife find food and shelter along waterways, enriching the natural environment and the urban dweller's experience of it.

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GROWING GREEN

Aquatic Plants on Duty: Slowing, Storing, Draining, Cleansing

What's in the water?

In a 21st century industrialized country, the likely answer is a lot of contaminants. Analyzing a water sample from a lazy Louisiana bayou or a backwater swamp into which urban stormwater is pumped divulges the water's downriver journey. As runoff from cropland, it picked up agricultural fertilizers and pesticides. Draining into water bodies it soaked up condensation of airborne particles contaminated with factory residue. Sluicing through city streets, it absorbed petroleum-based pollutants and swept partially treated sewage, decomposing pet waste, heavy metals, litter and other tainted matter into an urban drainage system. Pumped through traditional, or gray, stormwater management operations into canals, bayous, lakes and rivers, the water – along with its contaminants – may make its way to the Gulf of Mexico, where its nutrients create the dead zone, an area of low oxygen about the size of New Jersey in which fish and other marine life cannot survive.

Such a load of contamination in water can overwhelm even nature's powerful cleaning mechanisms. From an environmental perspective, the ground itself is the advance guard for treating polluted water. Filtering water as it percolates through it, soil traps suspended debris and "scrubs" water clean of metals and sediment. Additionally, soil harbors bacteria and supports microbial communities capable of breaking down waterborne biological and chemical contaminants.

Louisiana's wetlands are rich in native plant species that perform multiple ecological services, such as slowing water currents, curbing erosion and removing pollutants. Many lovely native shrubs and flowers thrive in rain gardens, providing beauty as well as environmental benefits.

Dwarf palmetto

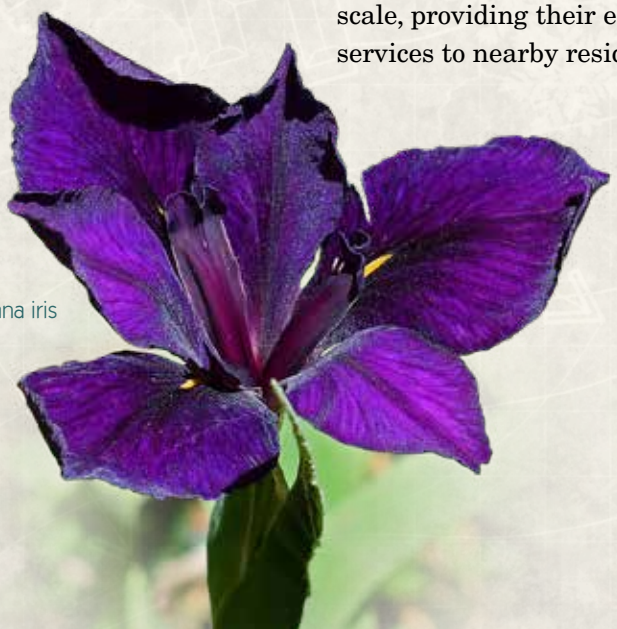
Rain lily

However, in a natural water purification system, plants are the foot soldiers, the worker-bees. If the mantra of green stormwater management is "slow, store and drain," vegetation does double duty. In drainage corridors and receiving areas, stems, trunks and other vegetative mass interrupt currents and slow the water's velocity. Water has time to sink into the soil and renew groundwater reserves. Slowing the speed of drainage protects pumps and other control structures from receiving a sudden and overwhelming volume of water. Mitigating the force of moving water, plants shield shorelines and reduce erosion. Preventing sediment from washing into the water reduces turbidity that negatively affects micro-organisms and aquatic plant life, important constituents in a robust and functional aquatic ecosystem.

Like straws, plants large and small suck up water, reducing its volume and storing it in their trunks, stalks and leaves. In concentrations, some of the nutrients essential for plants, such as nitrate, ammonium and phosphate, render water poisonous for human consumption and injurious to aquatic life. By absorbing these chemicals, plants cleanse the water and contribute to healthy aquatic ecosystems. If a plant cannot use a pollutant, it may still provide a cleansing service by trapping it in its root system and retaining it where organisms can render it harmless through metabolic processes

Plantings large and small

While the idea of water-purifying plants may conjure visions of wetland grasses undulating in a sea breeze, plants effective in cleansing water can grow as well in urban areas large and small. Where land is available – in parks or vacant lots acquired for the purpose – built or restored urban wetlands replicate coastal ecosystems on a small scale, providing their ecological services to nearby residents.


Louisiana iris

Water-purifying plants grow also in little areas tucked into the urban landscape and that are only periodically wet. Bioswales – low, marshy depressions with gently sloping sides – are frequently constructed in parking lots or alongside city streets. Residential rain gardens, sometimes as small as a tub or a basin, purify runoff captured from roofs and driveways. Planted with native vegetation able to withstand cycles of periodic flooding and drying, acclimatized to local conditions and resistant to plagues and pests, these landscape features, like their larger, indigenous counterparts, remove waterborne contaminants.


Coneflower

A natural partner for sustainability

Urban development and the building of infrastructure alter the land. A watershed's drainage may be refashioned; the course of natural streams may be redirected to conform to city planning. Human intent and human activity can constrain

Bellwethers of water purity, oysters exemplify the connection between clean water, a healthy environment and a thriving economic sector in coastal Louisiana.

- Although known as "ecological engineers" for their water-filtering capacity, oysters can be overwhelmed by excessive nitrogen in their aquatic habitats and are sensitive to sewage pollution.
- A thriving oyster population depends on clean water. Contaminated water can cause the periodic closure of oyster beds, resulting in economic losses for oyster farmers and related commercial enterprises.
- If a freshwater diversion delivers river water into the wetlands, a 'clean' Mississippi is essential for the health of both oysters and the oyster industry.

Carolina jessamine

KENPEI

Black-eyed Susan

Tim McCormack

Maidenhair fern

nature's capacity to moderate flooding and cleanse water. Ecological services such as storm-surge reduction and water purification may be sacrificed as wetlands are drained and filled with dirt or concrete in the course of urban development.

But regional sustainability relies on managing threats of flood and in maintaining water purity. "Incorporating natural processes into water management procedures brings greater harmony between the landscape and the built environment," says Dale Thayer, assistant director of community development in St. Bernard Parish. "Green infrastructure uses nature's methods to treat stormwater before it enters a municipal drainage system. It provides a barrier between developed areas and the marshes, lakes and estuaries into which we empty our stormwater."

For many in coastal Louisiana, nature as a water purification system is a new model that asks them to embrace water as a constant presence, a potential ally, as well as the defining characteristic of their homeland. WM

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Bringing beauty, recreation and ecological services into the city

Natural Systems Enhance Urban Life While Solving Urban Problems

The character of southern Louisiana is defined by water, from the shores of the world's third longest river system through miles of grassy marshes to its tide-washed southern edge at the Gulf of Mexico. Yet at times managing water has resembled attempts to control a wounded animal, the behavior of which is at best uncertain and at worst mortally dangerous.

In the 21st century, disasters have motivated the region to reconsider its view of "water as an enemy" and to acknowledge its presence, its power for good and ill, and its essential role in the lives of residents.

Planners suggest that adapting green infrastructure that makes space for water increases control over its behavior. Making it again visible in the urban landscape creates an asset that provides aesthetic, recreational and economic values. According to the Sewer and Water Board of New Orleans, "… solutions such as green roofs, bioswales, and pervious pavement … show us … how infrastructure can not only protect us but also beautify our communities. The projects are designed to reduce risk from flooding and subsidence by creating spaces to capture rainwater in the urban landscape. They are designed to beautify neighborhoods, improve health, and provide opportunities for recreation. When all the elements of a neighborhood are working together to reduce risk and enhance development potential, we are really adapting to thrive."

Infrastructure that forms a network of "blueways" for stormwater drainage presents further opportunity to pair community amenities with utility. Planning documents developed by the City of New Orleans and by St. Bernard Parish specify

Embracing the bayou that flows through its heart, the city of Houma, the seat of Terrebonne Parish, has incorporated the waterway into its urban character. A walkway alongside both banks of the bayou joins the Houma Waterlife Museum, showcasing the importance of water to the history and identity of the region, to office buildings and shops, restaurants and other tourist destinations.

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Landscaping on the campus of Woman's Hospital in Baton Rouge, Louisiana, includes more than 30 acres of open green space, five acres of bioswales, and a naturalized lake and wetlands. The water features provide both stormwater management and soothing vistas from patients' hospital rooms.

increasing public access to water features by

- cleaning and planting existing drainage canals to increase their visual appeal and to link neighborhoods and other metropolitan areas together
- redirecting covered streams to be visible above ground as attractive landscape elements
- creating or enhancing waterfront parks and public access to them
- exploring the creation of urban recreational water routes and boating opportunities

While infrastructure must answer day-to-day challenges like dealing with deluges and stormwater, it may simultaneously address the larger challenges of future climate change. "Many green infrastructure projects reduce energy use, with a corresponding decrease in greenhouse gas emissions," says Marnie Winter, who worked as the assistant director of the Department of Environmental Affairs in Jefferson Parish. "Systems that use gravity to drain stormwater out of city streets cost less to operate and maintain than does traditional, 'gray' infrastructure. Allowing rain to penetrate into the ground instead of pumping it out of our urban areas reduces the load on pipes and machinery. Additionally, rain soaking into the ground replenishes groundwater and mitigates subsidence, the process whereby soils settle and sink, causing potholes and undermining the foundations of buildings. Reducing subsidence slows the loss of topographical elevation. Because much of coastal Louisiana is near, or even under, sea level, everything we do to keep the ground from sinking increases our capacity to cope with rising seas."

Coastal urban areas are not limiting their vision to waterways; planners envision establishing linear, tree-shaded parks with walkways, bike paths and transit lines that connect urban districts in an energy-saving transportation network. "Transforming utilitarian infrastructure such as streets and sewage systems so that they provide features such as water-absorbing parks increases the desirability of living in a metropolitan area and attracts new residents," says Dale Thayer, assistant director of community development in St. Bernard Parish. "Additionally, waterfront property is premium real estate; turning utilitarian drainage canals into aesthetic attractions multiplies desirable properties and raises their value."

Increasing the urban tree canopy and insulating buildings with vegetated green roofs to

reduce the urban "heat island" effect; providing transportation alternatives to limit vehicular emissions; even supporting locally-based food systems – communities are adopting "green" practices of all kinds. Advocates use parks and other public areas as educational venues to demonstrate plants and landscaping, "green" ideas and materials, that citizens can use to mitigate hazards on their own property. "Changing our approach to infrastructure has encouraged us to re-examine old behaviors and tackle misconceptions about how the natural world works," says Sinead Borchert, community outreach specialist for the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA). "For instance, in the past wetlands were often perceived as a flood threat. If there was one nearby, Gulf communities would be inclined to drain it. Now residents are recognizing the natural protection that wetlands provide. In devising ways to live comfortably with nature while reducing the threats that nature may pose, coastal Louisiana residents are improving the quality of their lives and building a sustainable future."

"Going forward, we have to learn to think differently," says Ryan Mast, the director of New Orleans' Office of Resilience and Sustainability. "We have to change our mindsets about how we address infrastructure challenges. The changes require both new tools and new behaviors. Our goal is to create resilient communities where every individual has the ability to weather stressful events; where every home has adapted measures to reduce the risk of even mild storm damage; and where every neighborhood has the strength economically, socially and environmentally to bounce back quickly from disasters." WM

In a sense, wetlands are the original green infrastructure. Wetlands both inside and outside urban boundaries blunt the initial impact of storm surge; salt marshes reduce wave heights by as much as 72 percent*. Wetland plants shield shorelines and prevent sediment from washing into the water; sediment can cause turbidity that negatively affects micro-organisms and aquatic plant life. Numerous species of animals and birds reside in the wetlands, or depend on them for stopover food and shelter. And for human residents and visitors alike, wetlands offer natural landscapes that can rejuvenate the spirit and stimulate poetic impulses.

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Green infrastructure sounds great – but can we afford it?

While green infrastructure projects promise multiple amenities to the urban dweller, some people question their affordability. Comparing the costs of green vs. traditional infrastructure is complicated for a number of reasons, including

- the infrequency with which environmental services are measured in monetary terms
- the tendency to compare only a single function instead of considering the multiple benefits that green infrastructure delivers
- the variability of land prices and of the range of work required to ready sites for green infrastructure
- the common failure of budgets to offset the frequently high initial costs of green infrastructure by the probable and significantly lower costs of future maintenance

Nevertheless, numerous studies demonstrate green infrastructure's economic viability. A report[1] on reducing stormwater costs issued by the Environmental Protection Agency states that green infrastructure, also called low impact development,[2] has been "shown to be both fiscally and environmentally beneficial to communities." New York City's water management proposal[3] put a price tag on it: Implementing green infrastructure, it determined, cost about 22 percent less than constructing traditional infrastructure.

Additionally, the EPA cited the following benefits that typically are not taken into account in a cost-benefit analysis:

Environmental benefits

- Pollution abatement
- Protection of downstream water resources
- Ground water recharge
- Water quality improvements and reduced treatment costs
- Reduced incidence of combined stormwater-sewer overflows

Economic values and quality-of-life benefits

- Reduced downstream flooding and property damage
- Smaller infrastructure footprint, freeing land for other uses
- Beautification of urban districts, with corresponding increases in real estate values and property tax revenue
- Creation of public spaces that enhance quality of life and encourage public participation in the community
- Regulatory compliance credits, reduced impact fees, simplified permitting processes and other incentives offered by some locales in recognition of the positive benefits that low impact development offers

While the report states that green infrastructure techniques might not always reduce project costs, it cites other possible savings achieved by

- diminishing the area of contiguous land required for stormwater management
- reducing the amount of paving materials needed for roads and driveways
- increasing infiltration or evaporation of roadway runoff by using natural systems such as grassed swales, thereby
  - limiting or eliminating the need for costly curbs and gutters
  - reducing the size and cost of flood-control structures

[1]https://www.epa.gov/sites/production/files/2015-10/documents/2008_01_02_nps_lid_costs07uments_reducingstormwatercosts-2.pdf

[2]http://www.ingentaconnect.com/contentone/wef/wer/2015/00000087/00000009/art00010?crawler=true

[3]http://www.nyc.gov/html/dep/pdf/green_infrastructure/NYCGreenInfrastructurePlan_LowRes.pdf)