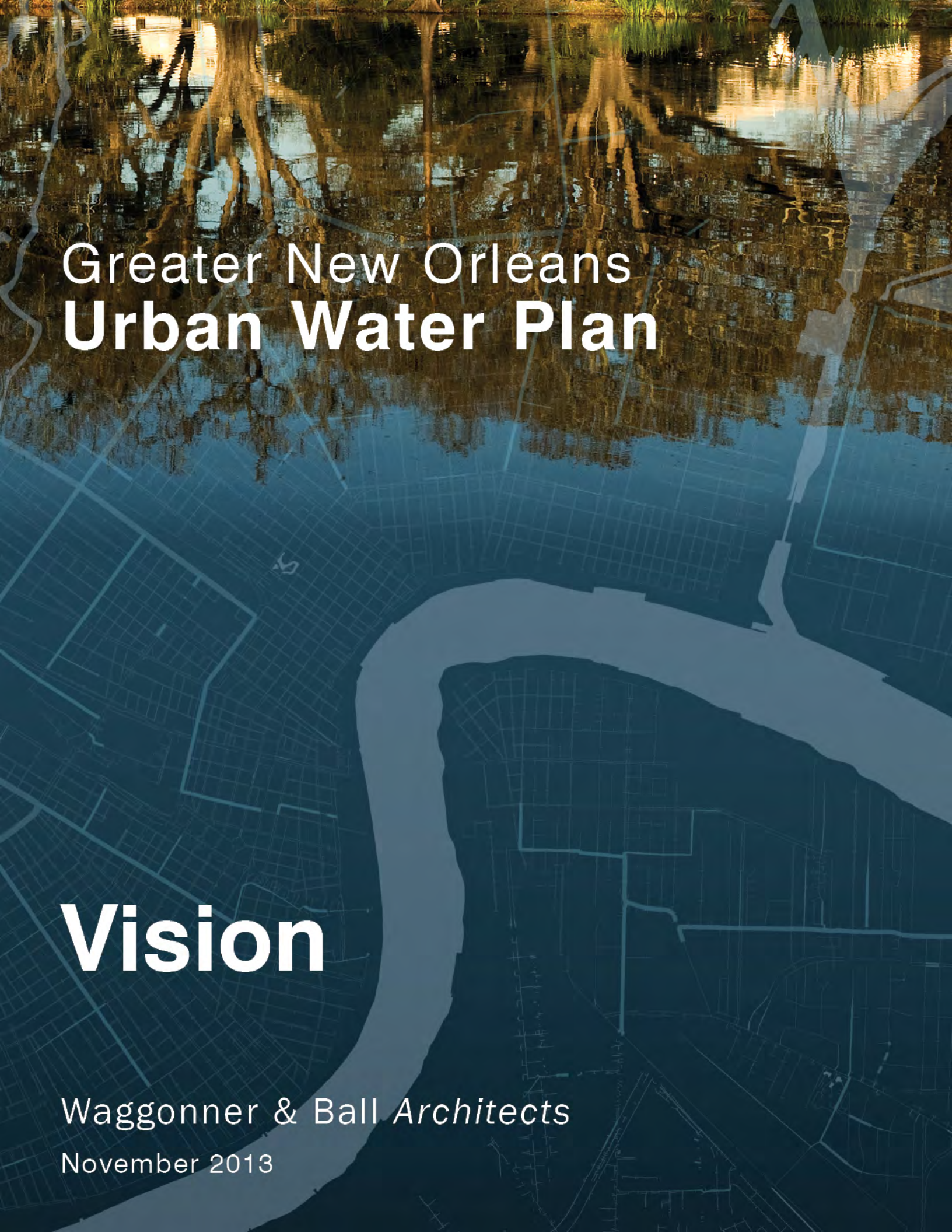




Greater New Orleans **Urban Water Plan**

Vision

Waggonner & Ball *Architects*

November 2013

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New Orleans was founded between the Mississippi River and Lake Pontchartrain almost 300 years ago to take advantage of the region's water resources. The region remains vital to the nation's economy.

1,250,000 cubic feet per second

Maximum flow of the Mississippi River past New Orleans, or about 8 Olympic-sized swimming pools every second

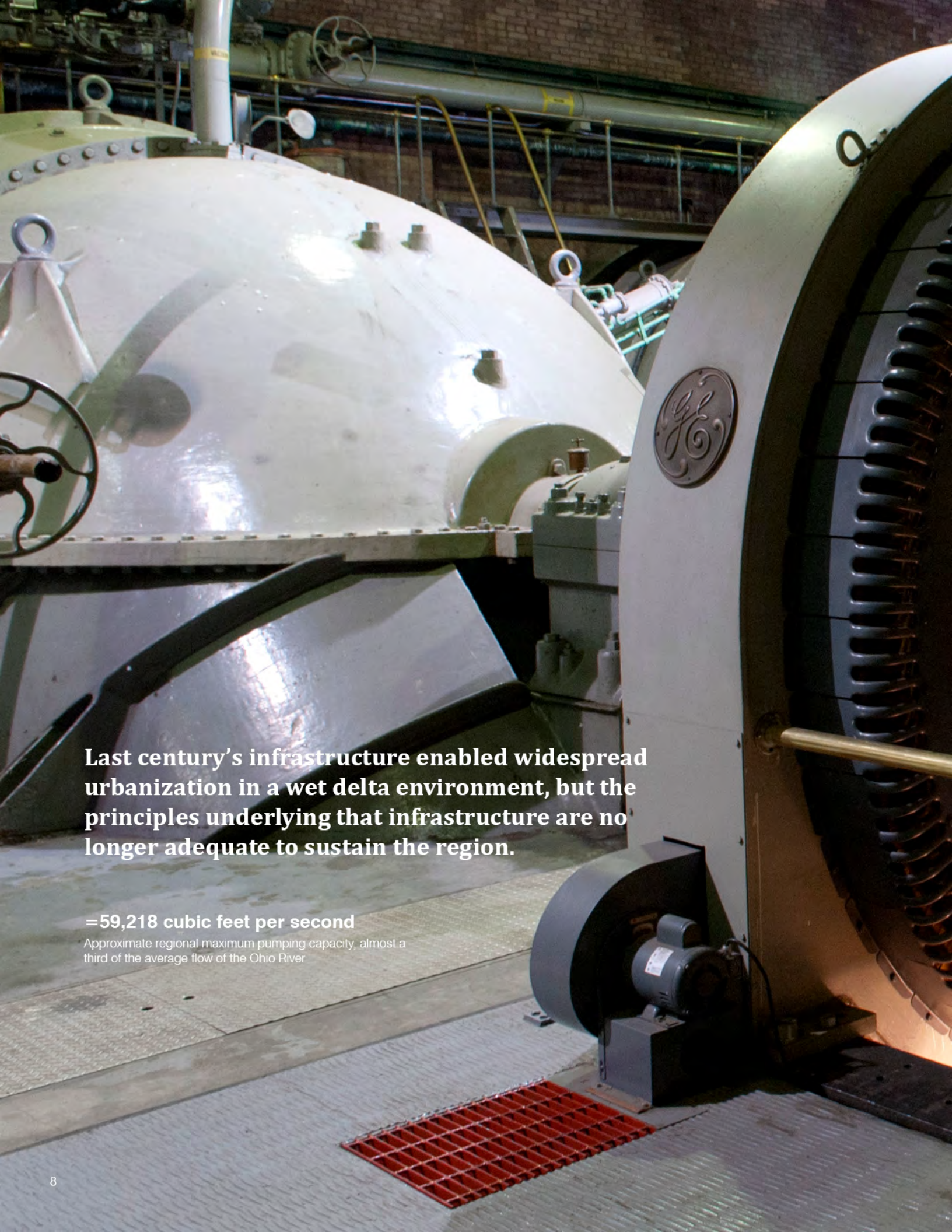


Greater New Orleans has always contended with flooding from rainfall, and now faces new challenges, including changing climate, rising seas, and human-induced sinking of the land.

+23 feet

Elevation of existing hurricane protection levees along Greater New Orleans' lakefront

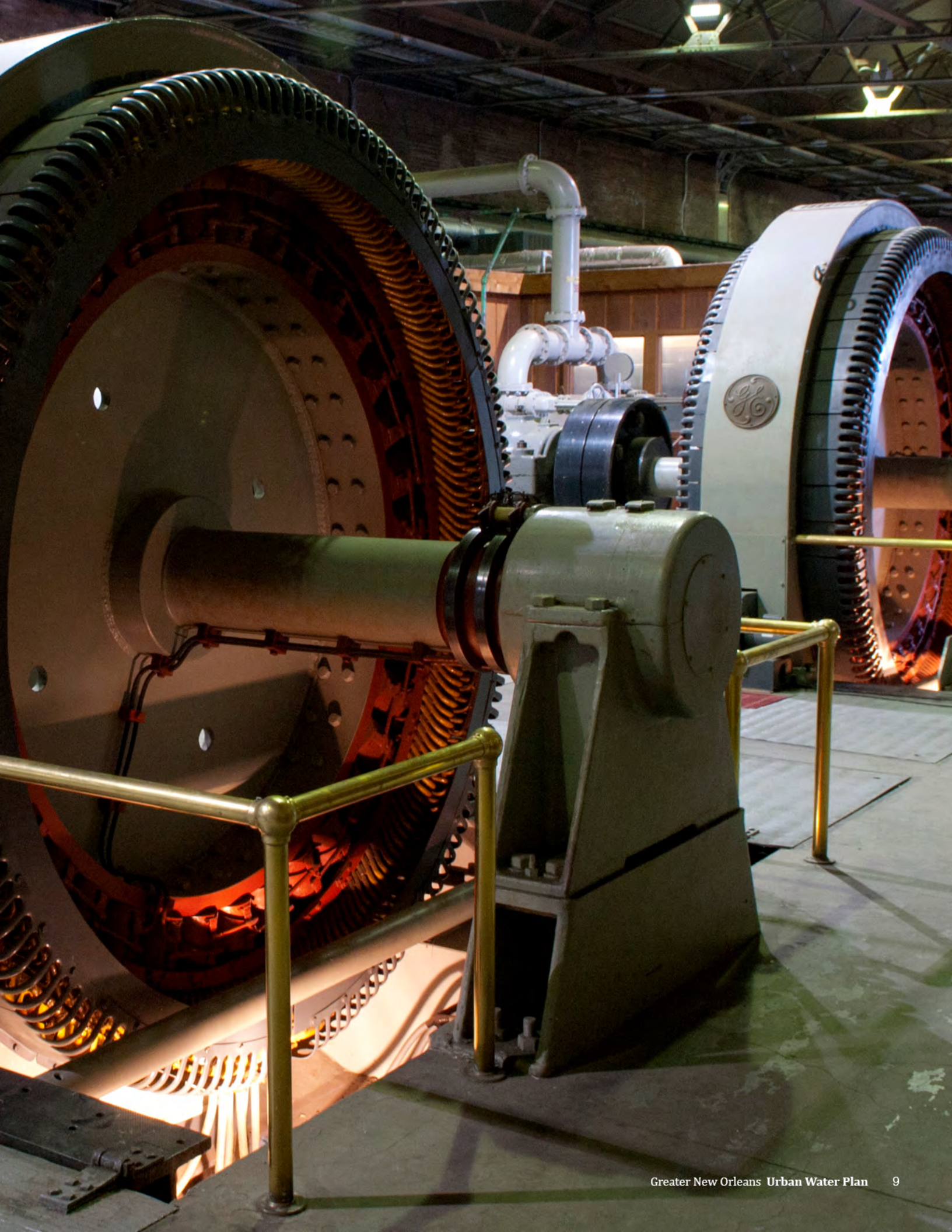




Last century's infrastructure enabled widespread urbanization in a wet delta environment, but the principles underlying that infrastructure are no longer adequate to sustain the region.

=59,218 cubic feet per second

Approximate regional maximum pumping capacity, almost a third of the average flow of the Ohio River





A photograph of a flooded park area. In the foreground, several large, mature trees with thick trunks stand in shallow, murky water. The water reflects the surrounding greenery. In the background, a playground with yellow and blue equipment is visible, along with a green fence and more trees. The scene is brightly lit, suggesting a sunny day.

A new approach to water—the regions’s most abundant natural asset—is the foundation for building a safe, prosperous and beautiful future on the Mississippi River Delta.

62 inches

Average annual rainfall across Greater New Orleans

A photograph of a park scene at dusk or dawn. Large, mature trees with dense foliage line a path. In the foreground, a calm body of water reflects the trees and the sky. A few people are visible in the background, including one person walking a dog. The lighting is warm and golden, creating a peaceful atmosphere.

**"The true eye of the earth is water:
In our eyes it is water that dreams."**

Gaston Bachelard, early 20th century French philosopher

Background

Greater New Orleans Urban Water Plan

In 2010, the State of Louisiana's **Office of Community Development - Disaster Recovery Unit** funded **Greater New Orleans, Inc. (GNO, Inc.)** to develop a Comprehensive, Integrated and Sustainable Water Management Strategy for the east banks of Orleans and Jefferson Parishes and St. Bernard Parish using federal Community Development Block Grant - Disaster Recovery funds from the **Department of Housing and Urban Development**. The study was developed over the course of two years by **Waggonner & Ball Architects** and a team of local and international, including Dutch, water management experts. The outcome is the Greater New Orleans Urban Water Plan, a vision for long-term urban water management in the 21st century, and effectively the first regional urban water plan of its kind in the United States. The Urban Water Plan provides a roadmap for improving management of flood and subsidence threats, while creating economic value and enhancing quality of life. This plan works with Louisiana's 2012 Coastal Master Plan and the region's levee system in creating multiple lines of defense.

Greater New Orleans, Inc.

GNO, Inc. is the regional economic development organization that serves to coordinate, consolidate, and catalyze economic development activity in Southeast Louisiana. The GNO, Inc. mission is to create jobs and wealth in the Greater New Orleans community. The GNO, Inc. vision is for the Greater New Orleans region to fulfill its potential as one of the best places in the country to grow a company and raise a family. GNO, Inc. supports a multi-faceted approach, including advocating for federal, state and regional policies and programs, to mitigate the effects of stormwater on the region's safety, quality of life, and economic vitality. Moreover, GNO, Inc. is working with government, industry, economic development, and education partners to nurture and grow a vibrant emerging environmental industry sector that will create jobs and revenues locally while addressing environmental challenges in the region and nation.

Waggonner & Ball Architects

Waggonner & Ball Architects is a broad-based architecture and planning firm with 30 years experience on a wide variety of projects. The firm is deeply invested in New Orleans' future as one of the nation's most resilient cities. Following Hurricane Katrina, Waggonner & Ball developed the Recovery Framework for St. Bernard Parish, the most devastated portion of Greater New Orleans, and generated plans for four of the thirteen planning districts in the Unified New Orleans Plan. The firm's water-focused work began shortly after Hurricane Katrina, with David Waggonner's trip to the Netherlands in early 2006 as part of a delegation led by U.S. Senator Mary Landrieu. After seeing first-hand the value of the Dutch approach to stormwater management and climate adaptation, Waggonner & Ball initiated a series of **Dutch Dialogues** workshops, co-sponsored by the **Royal Netherlands Embassy** and the **American Planning Association**. These collective efforts and extended interactions between Dutch and American architects, engineers, urban designers, landscape architects, city planners and soils/hydrology experts grew from the participants' unwavering belief that the Greater New Orleans region can survive, prosper, and grow only with a fundamentally different approach to urban water management. Many of the same parties continued this collective effort and formed the **Project Team** for the Urban Water Plan. A full list of firms, institutions, and individuals involved is included in the "References & Project Team" section.



Waggonner & Ball Architects



Acknowledgments



Louisiana Office of Community Development Disaster Recovery Unit (OCD-DRU)

In the aftermath of Hurricanes Katrina, Rita, Gustav, and Ike, the OCD-DRU commissioned the Louisiana Resiliency Assistance Program (LRAP) to establish a comprehensive collection of resiliency resources. The LRAP program is mandated to develop, house and disseminate planning efforts, resources and local best practices to promote, assist and build networks around resilience planning in Louisiana. As the state's central point for hurricane recovery, OCD-DRU manages the most extensive rebuilding effort in American history, working closely with local, state and federal partners to ensure that Louisiana recovers safer, stronger, and smarter than before.



U.S. Department of Housing & Urban Development (HUD)

HUD is working to strengthen the housing market to bolster the economy and protect consumers; meet the need for quality affordable rental homes; utilize housing as a platform for improving quality of life; build inclusive and sustainable communities free from discrimination; and transform the way HUD does business. HUD's CDBG-Disaster Recovery grants are intended to confront housing, business and infrastructure needs beyond those addressed by other forms of public and private assistance.

GNO, Inc. and Waggonner & Ball Architects also wish to acknowledge the regional **Water Management Strategy Advisory Council**, made up of industry, government, economic development, and nonprofit leaders that guided the two-year process. A full list of the individuals and organizations involved is included in the "References & Project Team" section.

Finally, we would like to thank the **Royal Netherlands Embassy**, the **American Planning Association**, and **Senator Mary Landrieu** for their tireless dedication to seeing this effort through from genesis to completion.



Dutch
Dialogues



Kingdom of the Netherlands



American Planning Association
Making Great Communities Happen



Report Organization

The Greater New Orleans Urban Water Plan is a set of reports with cross-referenced information as outlined below. All project information and links to related projects are available online at www.livingwithwater.com.

Vision presents an overview of the Urban Water Plan.

Urban Design is geared towards planning and design professionals. This report tests water planning principles through design drawings at the system, basin, district, and demonstration project scales.

Implementation is geared towards policy-makers, water system managers, and other stakeholders interested in effecting change. The report presents the value and economic impact of the Water Plan and outlines an action plan for implementation that includes prioritization and phasing of proposed strategies, financing tools, policy and community action recommendations, existing jurisdictions, and potential partners.

System Design & Analysis is a set of individual reports geared towards engineers and scientists that describes and analyzes the existing water system, and presents the envisioned framework for an integrated water system. The set includes the following reports:

Water System Design	H+N+S Landscape Architects; Waggonner & Ball
Water System Analysis	Royal Haskoning
Ecological Services Metrics	Dana Brown & Associates; FutureProof
Groundwater Monitoring Network	Deltares
Atlas of Greater New Orleans	Deltares; H+N+S Landscape Architects

Demonstration Projects is a set of individual reports geared towards potential implementers that includes schematic designs and cost estimates.

Mirabeau Water Garden	Waggonner & Ball Architects; FutureProof
Lakeview Floating Streets	Bosch Slabbers Landscape + Urban Design
Lafitte Blueway	Bosch Slabbers; Waggonner & Ball
Elmwood Fields and Water Lanes	Robbert de Koning; Dana Brown & Associates
Canal Street Canal	Dana Brown & Associates
Eastern Water Walk	Dana Brown & Associates
Forty Arpent Canal Zone	Dana Brown & Associates

Design Districts & Urban Opportunities is a set of individual reports geared towards planners and designers that elaborates further the urban design opportunities and district scale designs discussed in the Urban Design report.

Metropolitan Park Zone	Palmhout Urban Landscapes
Palmetto Canal	Palmhout Urban Landscapes
Monticello Canal	Bosch Slabbers Landscape + Urban Design
London Ave. Canal Wetland Park	FutureProof
Hollygrove District	Bosch Slabbers Landscape + Urban Design
Lakeview District	Bosch Slabbers Landscape + Urban Design
Elmwood District	Robbert de Koning Landscape Architect
Veterans District	Robbert de Koning Landscape Architect
Jefferson Basin	Robbert de Koning Landscape Architect
Michoud District	Dana Brown & Associates

Resources & Urban Analysis is a set of individual reports geared towards planners and designers that describes and analyzes the existing urban fabric and provides prototypical solutions replicable under similar topographic, geologic and hydrologic conditions.

Urban Analysis	Palmhout Urban Landscapes
Roadway Retrofits	Dana Brown & Associates
Parking Retrofits	Dana Brown & Associates
Canal Vocabulary	Dana Brown & Associates

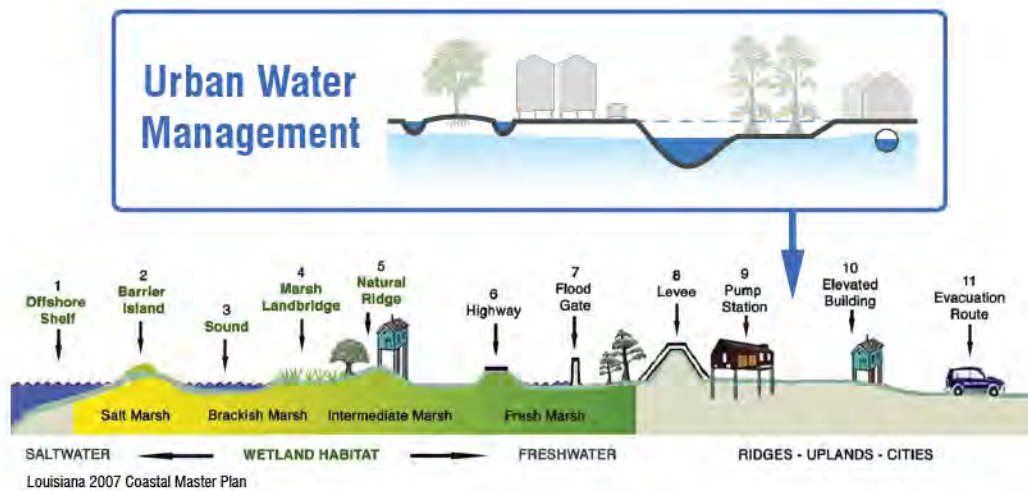


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	Greater New Orleans, anchor of the Mississippi Delta, can prosper and grow as a great delta city in the 21st century.	
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	Over time, the drainage infrastructure that supports the modern city has upset the delicate balance of land and water.	
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	Intense sub-tropical rain overwhelms single-purpose drainage systems. The systems damage the land and obscure the beauty of water.	
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Scope & Approach

The Urban Water Plan focuses on water within the levees of three distinct “hydrological basins” in St. Bernard, Jefferson, and Orleans Parishes, and it employs a layered conceptual framework as the basis for re-examining the region’s past and re-imagining its future.



Urban Water Management as a Line of Defense

Located on the Mississippi River Delta near the Gulf of Mexico, survival in the region requires constant awareness of the forces of water, with “multiple lines of defense” to protect against high water in the Mississippi, hurricanes approaching from the Gulf of Mexico, and intense rainfall due to a sub-tropical climate. The barrier islands, wetlands, and other natural features of the Louisiana coast protect the region from the direct impact of hurricane storm surges. The federal levees and floodwalls at the project area’s perimeter protect human settlement from high river waters and hurricane storm surges. Within the levees, complex systems of canals, pipes, and pumps protect against flooding caused by rainfall. These systems are inadequate to the challenges posed by a changing urban landscape and climate, and are the primary cause of subsidence in the region.

Approaching Water from the Ground Up

The Greater New Orleans Urban Water Plan focuses on water within the levees—primarily stormwater, surface waters, and groundwater—and a new approach to managing these resources. It outlines principles for water management, regional planning, and urban design that are specific to this region, developed out of a process that considers 1) the region’s soils, water, and biodiversity, 2) existing infrastructure networks, and 3) the urban fabric.

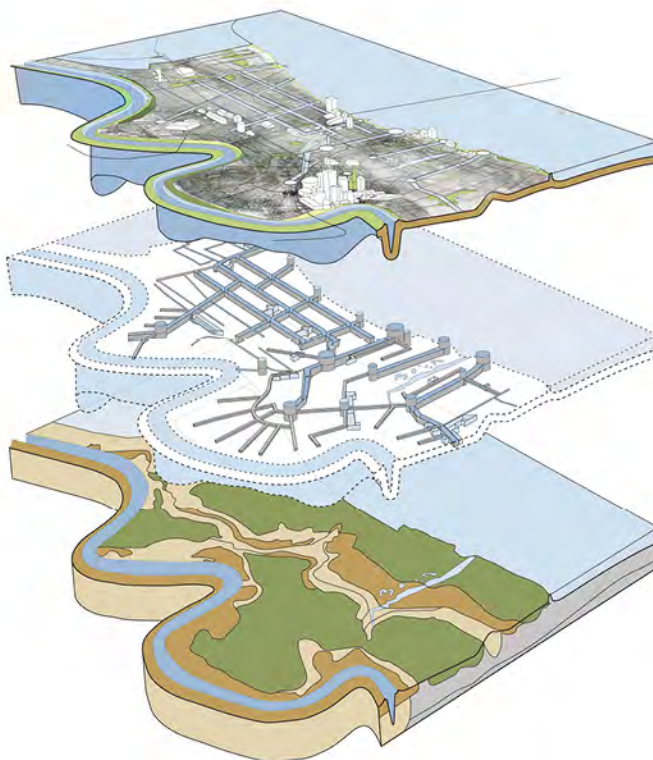


Jefferson-Orleans Basin includes the east banks of Jefferson Parish and New Orleans, west of the Inner Harbor Navigation Canal (Industrial Canal)

Orleans East Basin includes New Orleans East and Bayou Sauvage National Wildlife Refuge

St. Bernard Basin includes New Orleans' Lower Ninth Ward, St. Bernard Parish, Bayou Bienvenue, and the Central Wetlands Unit

Planning Layers



Inhabitation and Land Cover

Infrastructure Networks

Soils, Water, and Biodiversity



A Vital National Asset

Greater New Orleans links America's heartland and the Mississippi River Valley to the Gulf of Mexico, and the rest of the world. It is a vital center of commerce and culture, and is positioned to become a global leader in water management and climate adaptation as well.

Background image courtesy of Google

1

Building the Delta City

A MODEL FOR URBAN WATER

The abundance of stormwater, groundwater, wetlands, and waterways in the Mississippi River Delta is a distinct regional advantage. Over three centuries, however, Greater New Orleans has reshaped itself with an approach to drainage and flood mitigation that pushes these valuable assets out of sight and out of mind. Long-term resilience requires adapting this approach and existing water management systems. The Greater New Orleans Urban Water Plan provides a science-, engineering-, and design-based framework for these adaptations, emphasizing the value of water as a critical component of stable soils and ecological health, as an important resource for industry and growth, and as a basic element of the region's cultures and quality of life.

Building the Delta City

A MODEL FOR URBAN WATER

In finding the means to thrive in a place of economic and cultural importance—but also one of weak soils and ecological instability—Greater New Orleans can become a world leader in climate-adaptive design and water resource management.

A Region on the Rise

Greater New Orleans has a three hundred year history of adaptation. Located at the confluence of the Mississippi River and the Gulf of Mexico, New Orleans and the region have always been the “Gateway to the Americas.” Constant flows of people and commerce have shaped its remarkable cultures. The urban design, infrastructure, buildings, governance, food, and music of the area all speak to this proud history.

Greater New Orleans possesses a 100-year hurricane protection system—the envy of other coastal cities. But with more than sixty inches of rain each year and growing risk posed by climate change, last century’s overmatched drainage infrastructure is insufficient to meet present and future challenges. The consequences of the current approach to water management—removing stormwater as fast as possible—are visible in sinking land and broken infrastructure.

With the Urban Water Plan, Greater New Orleans can address directly these challenges and make better use of its water assets, while bringing innovations in engineering, planning, and design to other coastal regions where robust water infrastructure is critical to survival and economic prosperity.

Water Out of Balance

A new approach to urban waters is critical to the region’s future. The current approach to rainfall is to pave, pipe, and pump, resulting in a hardened landscape that sheds massive quantities of runoff into single-purpose drainage systems. This paradigm exacts enormous costs on the region and its residents, in the form of flooding, subsidence, excessive energy use, and the loss of water assets.

Flooding, Subsidence, and Climate Change

For the inhabitants of Greater New Orleans—a low-lying area that receives over five feet of rainfall each year—flooded streets are an all-too-familiar aspect of life. Even the tremendous pumping capacities



Problems

- 1** Drainage systems are regularly overwhelmed by too much runoff.
- 2** Excessive pumping causes the land to sink by lowering groundwater levels.
- 3** Critical water assets are wasted, hidden behind walls, buried underground, or pumped out of the city.



Opportunities

- 1** Increase long term safety by limiting localized flooding and subsidence.
- 2** Create new economic development opportunities with safe, attractive waterways and water infrastructure.
- 3** Improve quality of life by integrating clean, healthy, and accessible water into public spaces and new development.

Rainfall-induced flooding and subsidence will cost Greater New Orleans an estimated **\$10.2 billion** over the next 50 years.



Avoiding Water

With current stormwater management practices, water is a nuisance that damages property and poses a threat to life and property (top). Pumping it out, however, obscures the value that water can provide to communities and to the environment (above).

of the region's drainage systems are not adequate to the challenge of keeping residents' feet dry. But bigger pumps and larger pipes are not viable solutions. Even doubling the pumping capacity of New Orleans, for example, would take care of only forty percent of the excess runoff from a ten-year storm.

Existing drainage systems lower groundwater levels and cause the ground to sink. This subsidence raises the costs of property ownership, doing business, and providing services, as the region contends with shifting ground, failing foundations, and crumbling streets. The resulting damage to infrastructure makes pumping ever more difficult.

At the same time, climate change threatens to raise the frequency of extreme weather events, including both intense storms and prolonged periods of drought. If the region continues to sink even as the waters of the Gulf of Mexico and Lake Pontchartrain rise, residents and economic assets will occupy an increasingly precarious place where pumping stormwater and keeping floodwaters out both become more difficult over time.

A New Approach

The Urban Water Plan complements the work of the Louisiana Coastal Master Plan and ongoing planning processes throughout Greater New Orleans as a roadmap for addressing the region's urban water challenges. It builds upon existing flood protection systems by broadening the concept of "multiple lines of defense" to include urban water management. It provides a science-, engineering-, and design-based approach to transforming existing drainage systems and the urban landscape using proven strategies and technologies, as well as insights in planning and design developed through the Dutch Dialogues workshops and the two-year Urban Water Plan process.

The Urban Water Plan is also a living document created to inspire and guide long-range planning and strategic investments for the next fifty years. The plan includes systems proposals, district



Wasted Water

Greater New Orleans throws away a resource many cities desperately need, wasting stormwater plus the resources expended on pumping. Fast-flowing water collects pollutants as it runs off streets—waterways are treated more like dumping grounds than community assets. The region's current water management paradigm, captured by the phrase "pave, pipe and pump," removes water from the landscape and throws off the water and soils out of balance.



Realizing the projects proposed in the Urban Water Plan would yield an estimated **\$22.3 billion** in positive economic impact over the next 50 years.



Making Space for Water

Existing parks and open spaces, vacant lots, and underutilized public rights-of-way provide opportunities for safely storing water and enhancing the urban landscape. A photograph showing water beneath the canopy of live oaks in City Park (top), and a rendering of the proposed Lafitte Blueway (above) illustrate the qualities that water can bring to public spaces.

plans, designs for demonstration projects, and implementation strategies that are structured as practical retrofits rather than as wholesale replacements. They embody the following principles:

Live with Water: Water is a fact of life on the delta. Making space for water and making it visible across the urban landscape allows it once again to be an asset to the region.

Slow and Store: Stormwater moving fast is hard to manage. Holding it where it falls, slowing the flow of water across the landscape, and storing large volumes of rainfall for infiltration and other uses are fundamental strategies for managing stormwater. Pump stations are activated when necessary, rather than as a default every time it rains.

Circulate and Recharge: Surface waters and groundwater move naturally across and within every delta. Incorporating surface water flows and higher water levels into everyday water management improves groundwater balance, water quality, and the region's ecological health.

Work with Nature: The region's diverse flora and fauna already store, filter, and grow with water. Integrating these natural processes with mechanical systems enhances the function, beauty, and resilience of the region's water infrastructure and landscape.

Design for Adaptation: Change is constant on the delta. Designing systems for dynamic conditions, and to support diverse uses, economic development, and environmental restoration maximizes the value of necessary water infrastructure investments.

Work Together: Water knows no boundaries. Collaborations across neighborhood, cultural, and political boundaries and developing solutions at all scales—from individual properties to regional networks—are prerequisites for building a stronger future.



Rooted in Water

The flow of water shaped where and how the city developed and continues to influence the region's industry, music, foodways, and recreation. Greater New Orleans can build on this long history of adaptation in order to prepare for the future.



Dutch Lines of Defense

1 in 10,000 year protection

Greater New Orleans' urbanized basins are similar to the landscape of the Netherlands, where low-lying land, much of which is below sea level as well, is ringed by high ground, natural and man-made levees and ridges that organize the land and settlement into distinct polders, or low-lying basins protected on all sides by "dikes" (levees). Water levels are maintained with mechanical devices such as sluices, gates, and pumps.

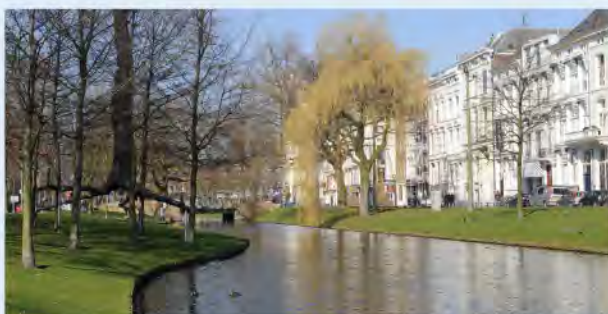
A combination of external and internal flood measures help the Dutch achieve "1 in 10,000 year" protection—only most intense storms can overcome their defenses (Greater New Orleans, in contrast, has 1 in 100 year protection). In addition to levees, there are also regional networks of barriers (Delta Works and Zuiderzee Works) and neighborhood-scale features such as scenic canals and water-storing parks. Though Dutch storms are smaller and occur less frequently than those experienced along the Gulf Coast, Dutch designers and engineers are global leaders in climate-adaptive design and water management. There is much to learn from their centuries of experience managing stormwater and groundwater.



100 year protection The Maeslant Barrier, a Delta Works project outside Rotterdam, is the city's first line of defense, closing to stop storm surges from the North Sea.



70 year protection Inside Rotterdam, levees are incorporated into the urban fabric as inhabitable public spaces.



1.5 year protection Internal water management in Rotterdam is beautiful and provides storage capacity for managing stormwater.

Buoyant Land, Living Water

The Urban Water Plan tells a story about the region's future that is **rooted in its history**. The story is built along lines drawn through the landscape, each following the flow of water and the contours of the land. From Uptown to Bucktown, Lafitte to Lakefront, or Poydras to the Gulf, each of these "critical connections" is a narrative, a design-based framework with which to understand the potential that the region has to rediscover its water assets, stabilize its ground, increase shared value, and prepare it for the challenges of the future.

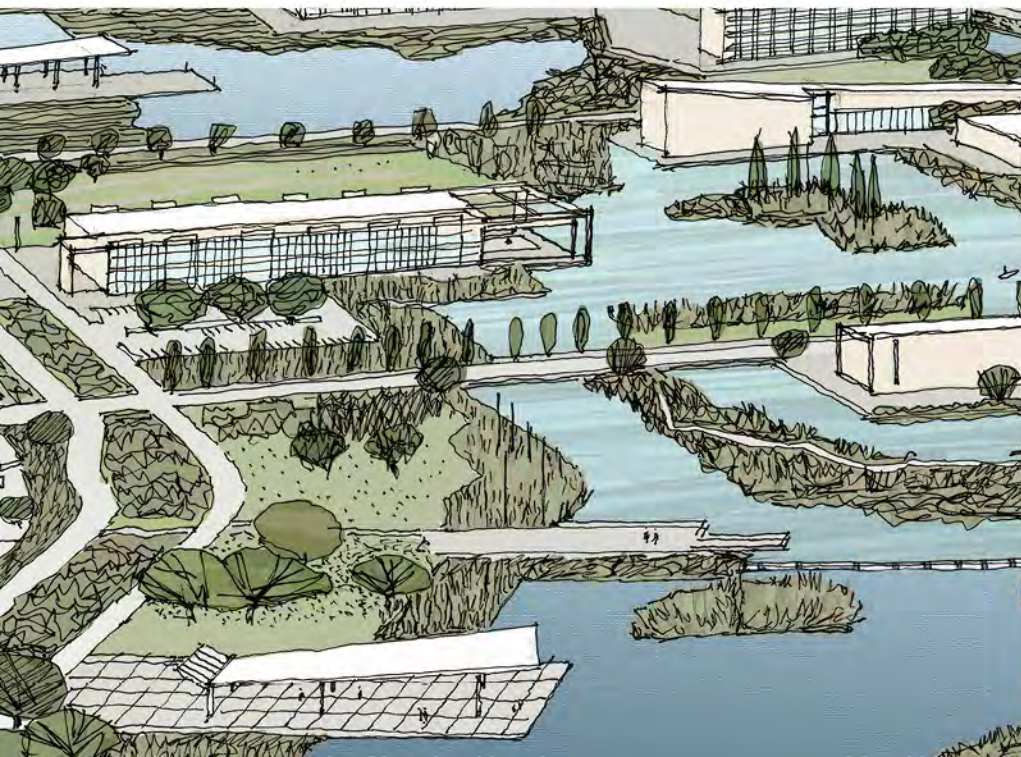
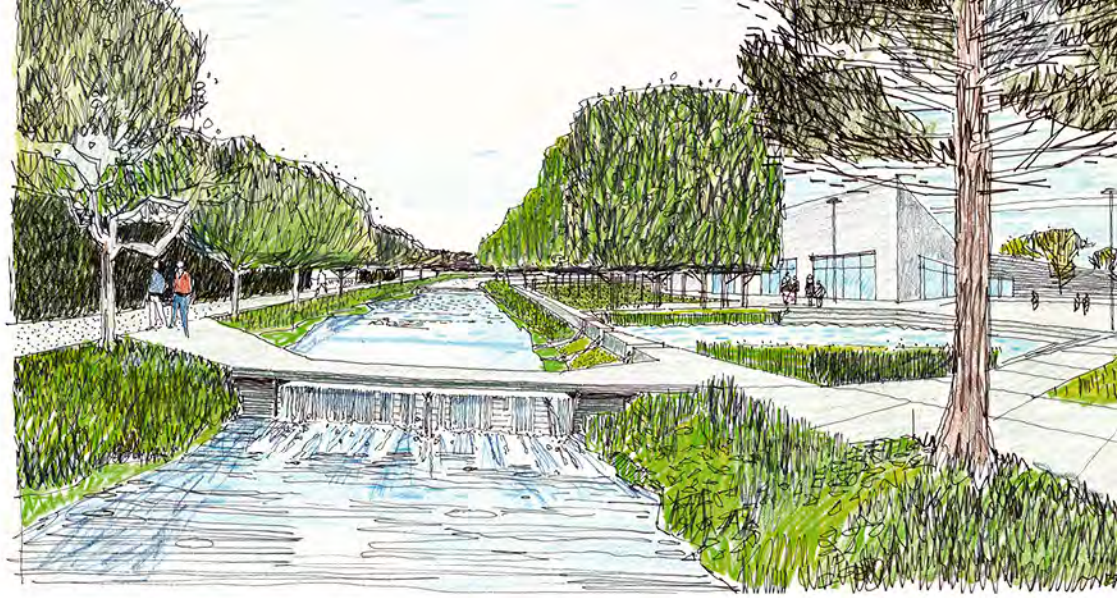
Stormwater, surface water, and groundwater must be managed together, as resources for enhancing public spaces, revitalizing neighborhoods, strengthening habitats, and providing opportunities for economic growth.

Homes and businesses, streets and highways, waterways, parks, and wetlands are integrated into a living water network suited to the demands of the 21st century. The resulting urban environment is greener and cooler, with more trees and water-loving plants, and with acres of parklands that safely store stormwater and allow it to soak into the ground. Parking lots and streets allow the ground to absorb water, and runoff from rooftops is cleaned and collected for later use. Waterways function as transportation corridors and public spaces as the region's canals and the bayous once did, and new waterfront development zones provide amenities for residents, visitors, and businesses. Circulating canal networks, new water sources, and integrated wetlands, along with a regional groundwater monitoring network, enable for the first time the management of groundwater and surface waters for soil stability and ecological health.

The region's diverse stakeholders—one firm step at a time and with a deep commitment to working together—can achieve this vision and establish Greater New Orleans as a global leader in living and prospering with water.

Projects at All Scales

Greater New Orleans can be transformed from the ground up, with retrofits ranging from the improvement of individual streets and canals to the construction of vast strategic parklands and integrated wetlands.



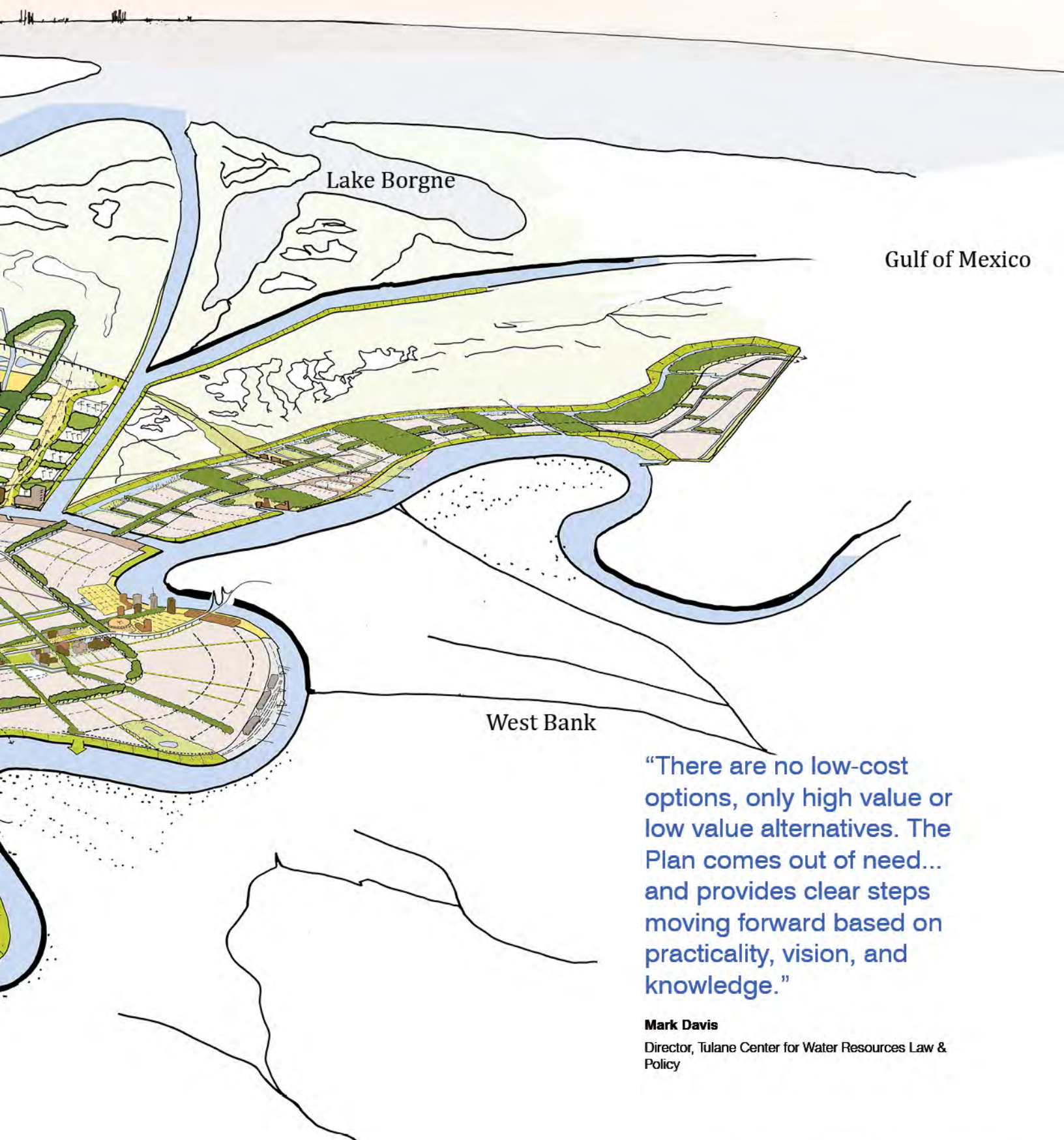
Greater New Orleans will have public **plazas, parks, wetlands, and streets** to safely hold water and make it available for ecological, recreational, and industrial uses.

Water & Urban Design

A REGIONAL PLAN

The Greater New Orleans Urban Water Plan integrates infrastructure planning and urban design across three hydrological basins. It proposes a new investment model for public works, wherein spending on streets, canals, pump stations, and stormwater detention basins enhances the public spaces that are so vital to life in the region, and yields opportunities for economic growth and development. Proposed retrofits strengthen the function of existing water systems, make use of undervalued water assets, and enhance key corridors. The Urban Water Plan is a comprehensive vision for the region in the 21st century, built as much on each basin's history, geology, and geography, as it is on shared challenges and opportunities.





“There are no low-cost options, only high value or low value alternatives. The Plan comes out of need... and provides clear steps moving forward based on practicality, vision, and knowledge.”

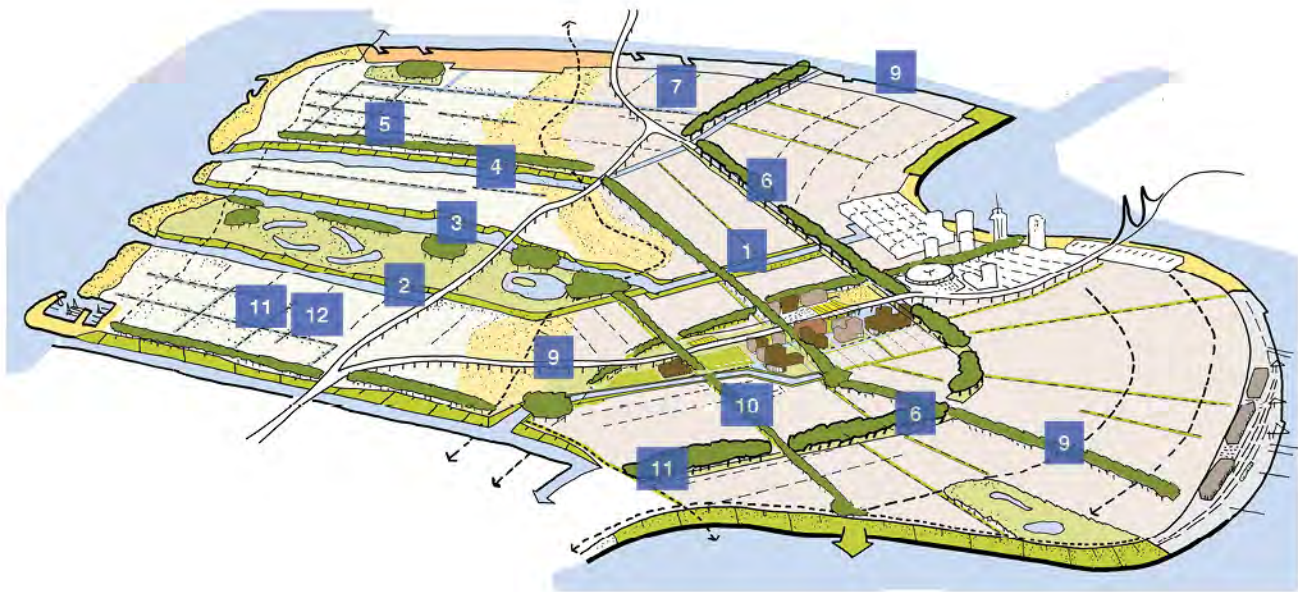
Mark Davis

Director, Tulane Center for Water Resources Law & Policy

Jefferson-Orleans Basin

ORLEANS PARISH, WEST OF THE INDUSTRIAL CANAL

The Urban Water Plan proposes the restoration of the city's canals to prominence as historic water corridors, each of which provides the city's residents with access to new water-based amenities in the form of blueways, greenways, water plazas, and parklands. A finer grain of investment—in the form of street retrofits and strategic adaptations of vacant lots and underutilized public rights-of-way—reduces localized flooding, improves soil stability, and provides environmental benefits to every neighborhood in the city.



- | | | | | |
|-------------------------|------------------------|----------------------------------|--------------------|---------------------------------------|
| 1. Lafitte Blueway | 4. London Avenue Canal | 7. Desire Parklands | 9. Uptown Streets | 11. Hollygrove & the Monticello Canal |
| 2. Orleans Avenue Canal | 5. Filmore (Gentilly) | 8. Inner Harbor Navigation Canal | 10. Palmetto Canal | |
| 3. Bayou St. John | 6. Claiborne Corridor | | | 12. Lakeview |

Canals as Green and Blue Corridors

With floodwalls removed, the primary canals are significant public assets, with parks, trails, docks, and waterfront development in place of the ditches and barren concrete structures that carry stormwater today.



Storage in Vacant Lots & Underutilized Properties

Vacant lots, blighted properties, highway edges, and other publicly-owned rights-of-way are converted into large-scale water storage areas.



Street Retrofits

Small scale retrofits—including the insertion of bioswales and permeable pavement in public rights-of-way—catch rain where it falls, reducing the burden on neighborhoods and drainage pump stations downstream.



Jefferson-Orleans Basin

JEFFERSON PARISH

The insertion of water retention features and tree plantings along Metairie's grid of boulevards and in commercial districts, improvements to canal banks, and the construction of parklands that store and filter stormwater bolster soil stability and the basin's capacity for safely handling intense rainfall. Additionally, the Urban Water Plan proposes investing in the Airline Corridor as an important hydrological boundary, and also as a critical connection joining the Airport to downtown New Orleans and the rest of the region.



1. Louis Armstrong International Airport
2. Airline to City Center

3. Elmwood Fields and Water Lanes
4. Hoey's Basin

5. 17th St. Canal
6. Canal St. Canal

7. Veteran's Canal
8. Kenner Parklands

9. LaBranche Wetlands
10. Lake Pontchartrain

Canals and Boulevards

Many of Jefferson's canals are currently unsightly stagnant ditches with low water levels, and are reimagined as vital assets with improved water level management, enhanced aesthetics, and spaces for public access and recreation.



Peeling Back Pavement in Commercial Districts

Improvements to streets, parking lots, and other underutilized spaces are the basis for retrofits that increase stormwater infiltration rates, reduce runoff, and provide shade and cleaner air in commercial areas.



Water Storage in Strategic Parklands

Swaths of vacant land along the Airline Corridor and in Kenner's lowlands provide water storage as wetlands, waterways, and floodable open spaces.



Orleans East Basin

ORLEANS PARISH, EAST OF THE INDUSTRIAL CANAL

New dry-weather water sources, constant flows, and parklands built around storage and wetland features augment the storage capacity and function of the basin's existing lakes, canals, and pump stations. Together with a new waterfront commercial and recreational district in the heart of the basin, and stronger connections to the Bayou Sauvage National Wildlife Refuge, the Urban Water Plan's proposed retrofits lift the profile of New Orleans East as a distinctive place to establish a home and business.



- | | | | | |
|-------------------------|----------------------|---|----------------------------------|-------------------------------|
| 1. Chef Menteur Highway | 3. Heart of the East | 5. Lincoln Beach and Lake Pontchartrain | 6. Bayou Sauvage Wildlife Refuge | 7. Bayou Michoud |
| 2. Dwyer Canal | 4. Morrison Canal | | | 8. Gulf Intracoastal Waterway |

New Water Features that Supplement Existing Lakes

The addition of wetlands, lateral canals, and connections between the basin's existing lakes to the lowland canal network increases the storage capacity of the network, which reduces flood risk and the need for pumping.



New Waterfront & Commercial Districts

In the heart of the basin, large, vacant areas that were once regional shopping destinations become sites for commercial and mixed-use redevelopment, with public waterways, lush vegetation, and improved runoff management.



Improved Connection to Bayou Sauvage

Restoring flows from the basin's canal network into Bayou Michoud and Bayou Sauvage National Wildlife Refuge strengthens the hydrology and ecology of the entire basin and connects the heart of the basin to the refuge's natural habitats.



St. Bernard Basin

ST BERNARD PARISH AND THE LOWER NINTH WARD

Restored wetland habitats, linear parklands, and a combination of urban blueways and neighborhood-scale water features build upon the basin's existing canal network and ecological assets. The Urban Water Plan's proposals enhance soil stability and environmental quality across the basin, while enhancing the identity of St. Bernard and the Central Wetlands Unit as a primary gateway to local wetlands and the Gulf of Mexico.



1. Lower Ninth Ward of New Orleans

2. Bayou Bienvenue
3. Chalmette

4. Forty Arpent Zone
5. Central Wetlands Unit

6. Violet Canal

7. Bayou Terre aux Boeufs

Blueways, Parklands, and Wetlands

Increasing the area's stormwater storage capacity with a new waterway, floodable recreational areas, and wetland basins reduces pumping needs and improves groundwater management.



Wetlands Restoration

A wetlands assimilation project and new flows of freshwater into the Central Wetlands Unit enable the restoration of the cypress forest that once existed there, providing a significant restored habitat, wetland buffer, and recreational amenity for the region.



A Gateway to the Wetlands and the Gulf

Restoring the flow of water through Bayou Terre aux Boeufs enhances the beauty and ecological vitality of Lower St. Bernard.







**“In many languages,
time and weather are the same word.”**

Peter Mettler, director and writer, in *The End of Time*



Louisiana's Wetlands

Greater New Orleans was made out of the muddy waters and soft soils of southeast Louisiana's bayous, swamps, marshes, and estuaries.

2 Living on Thick Water

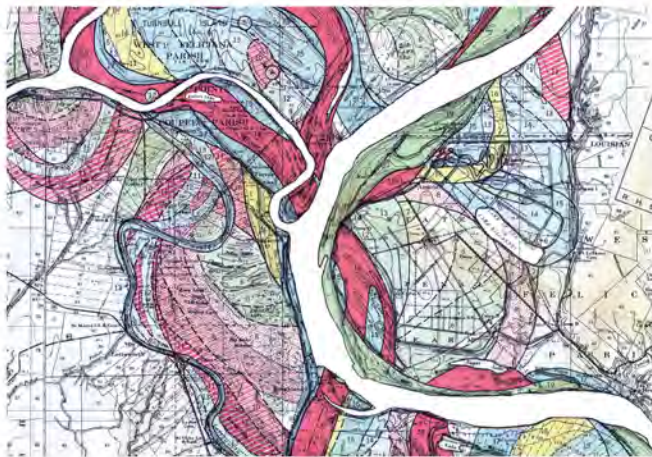
READING THE LANDSCAPE

The Mississippi River formed the delta through the deposition of layer after layer of sediment. The addition of organic materials to this newly formed land created the thick, unstable muck upon which Greater New Orleans exists. The river remains a constant force pushing upon the southern perimeter of the region. The brackish waters of Lake Pontchartrain rise and fall with the tides, and the lake itself is a pathway for storm surges to reach the region's northern edge. Utilities and industries access deep aquifers, while the manipulation of surface waters raises and lowers the water table, fundamentally changing the region's soils and ground elevations.

Living on Thick Water

READING THE LANDSCAPE

The flow of water from North America's largest watershed towards the Gulf of Mexico continues to shape the Louisiana coastline today. Patterns of development, land use, and construction have altered the landscape, as have twentieth century technologies for hurricane protection and drainage technologies. The existing landscape is the result of a long battle to overcome the limits of the region's geography, fought between natural forces and a powerful will to live and work here.



Landscape in Flux

The Mississippi River historically changed course, until the advent of federal levees in the 20th century. The U.S. Army Corps of Engineer's Harold Fisk's maps of the Mississippi, drawn in 1944, overlay the historic courses of the river, with the present channel indicated in white.

Image courtesy of the US Army Corps of Engineers

The Forces of Water

Greater New Orleans is built on the Mississippi River Delta, a place of flowing water, tidal fluctuation, and shifting soils. New Orleans became the "Queen City of the South" because it commands a critical location at the mouth of the Mississippi, a location indispensable for global commerce and access to the Mississippi River Valley, which drains forty percent of the land mass of the lower forty-eight states. To the north lies the estuary of Lake Pontchartrain, which provides an additional means of access to the Gulf of Mexico. Regional wetlands host an abundance of the flora and fauna critical to the region's culture and economy, and double as natural buffers that protect the region's man-made levees and floodwalls from the direct impact of hurricane winds and storm surges.

Estuary: a partially enclosed body of water where freshwater from rivers and streams mixes with salt water from the ocean

The presence of Bayou St. John in New Orleans further reduces the distance between river and lake. With the construction of the Carondelet Canal in 1794, fishers and traders could transport goods by boat from the Gulf of Mexico, through the Rigolets Pass into Lake Pontchartrain, down Bayou St. John, and all the way to northern edge of the French Quarter.

Neither Bayou St. John nor the long-removed Carondelet Canal is used for navigation purposes today. The construction of the Inner Harbor Navigation Canal (also known as the Industrial Canal) in 1923, the Gulf Intracoastal Waterway in 1936, and the Mississippi River Gulf Outlet in 1968, however, all speak to the continued importance of shipping and industry to the regional economy. Each of these channels was designed to improve waterborne navigation, providing more direct access from the Mississippi to the Gulf. At the same time, each of these channels severed marshes, ridges, and bayous, permanently altering flows of water and nutrients, and thus the ecology of the region.

High Ground & Low Ground

While waterways and water bodies define the edges of the urbanized settlement, the areas in between consist of fine gradations of alluvial soils deposited over centuries by the region's waterways that formed high ground and low ground.

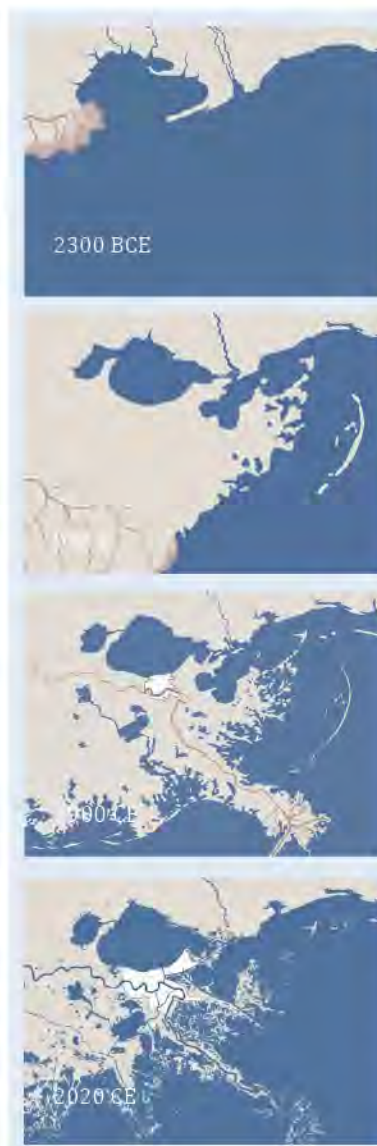
Before European settlement and the construction of artificial levees and floodwalls along the lower Mississippi, the River and its distributaries overflowed their banks each spring. The heaviest soils settled out close to the riverbanks, while finer-grained soils were deposited as the velocity of the floodwaters lessened the farther the water flowed away from the watercourse. Year after year, this land formation process—erosion in reverse—created the characteristic profile of the Mississippi River Delta, where there is high ground with relatively stable soils next to natural waterways, and ground that slopes away down the backslope of that natural levee and into broad lowlands with silty soils.

The average elevation of Metro New Orleans is 5.9' below sea level (NASA 2007).

Greater New Orleans has such a profile, with the addition of artificial levees and accelerated levels of subsidence exaggerating natural differences between high ground and low ground. Even so, no single point in the region reaches higher than 11 feet above mean sea level, and close to half of the region is below sea level. Because of these characteristics, elevation holds great significance throughout the region. When Hurricane Katrina struck in 2005, two feet was the difference between disaster and good fortune.

Clay, Sand & Muck

When architect Benjamin Latrobe came to New Orleans in 1819, he said of the swamps that surrounded the city: "Mud mud mud." (Wilson 1951) Not all mud is created equal, however. The soil types particular to any given location determines many aspects of everyday life: some soils drain more poorly than others, and some soils are stable and suitable for construction while others are prone to subsidence if their water content is not properly managed.



Delta Formation A Changing Coastline

Around 2300 BCE, the Mississippi changed course, moving west toward present-day New Orleans. The river's annual floods deposited silt along the south side of present-day Lake Pontchartrain, building up land and resulting in the modern day Chandeleur Islands (0 BCE).

Because the construction of artificial levees has disrupted the river's natural processes of annual flooding and silt deposition, the river can no longer change course or deposit fresh sediments in Louisiana's wetlands. Seven hundred more square miles of land could disappear by 2020 if land loss continues unchecked, making Greater New Orleans more vulnerable to rising sea levels. (Swenson 2007)



High Ground Along the River

Because the sediment carried by the Mississippi River gradually builds up along the river's banks, the river is the highest feature in the delta landscape.

Pine Island Barrier Sands

Sand Near the Surface

Pre-dating the formation of the Mississippi River delta, Pine Island barrier sands mark the former edge of the Louisiana coast. In a swath stretching from Bayou Sauvage to Elmwood, the sand layer is at or near the surface. The sand provides opportunities infiltrating stormwater back into the ground.



Groundwater is water that flows slowly underground, keeping soil wet and stable by filling in spaces between soil particles.

A useful categorization of shallow soil layers in the New Orleans region distinguishes between clay, sand, and muck. The size of the soil particles is the primary determinant of soil type. Sand, for example, has the largest particles, and provides for the best stability and drainage characteristics. While significant sand layers underlie large parts of New Orleans, especially in the form of the Pine Island Beach Trend (relic beach deposits from over 4,000 years ago), the city's characteristic soil types are clay and muck. Clay particles are smaller than those of sand and drain poorly. They can shrink and swell with fluctuations in moisture content. Muck denotes the fertile but highly organic soils that exist in drained wetlands, which characterizes much of the region's inhabited areas. Mucks are soft, unstable, and must remain saturated to prevent compaction and oxidation, which causes subsidence through the irreversible loss of organic matter in soils (Independent Levee Investigation Team 2006).

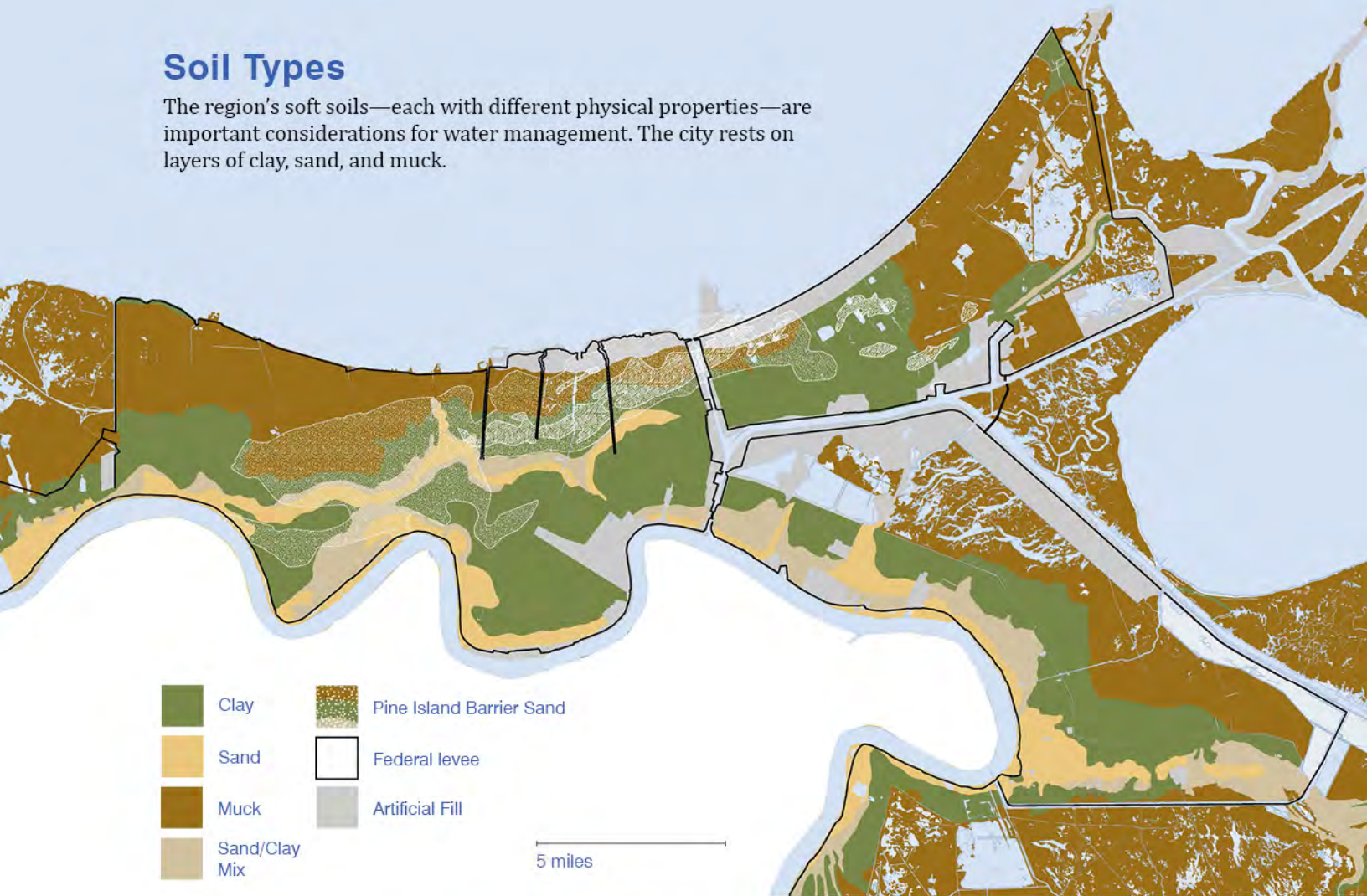
Subsidence is the sinking and compaction of land that occurs when organic soils dry out.

Asphalt and concrete behave differently poured over sand than over clay, and running a fragile utility through sinking muck poses difficult engineering challenges. Furthermore, the presence of sand and clay at different locations enables or retards the flow of groundwater, with important consequences for the stability of levees and floodwalls, groundwater levels, and the water quality of regional aquifers.

Soil Oxidation: the decomposition and compaction of organic matter that occurs in the presence of oxygen. Oxidation is a primary cause of subsidence in Greater New Orleans, in areas where highly organic soils with lowered water tables are exposed to oxygen.

Soil Types

The region's soft soils—each with different physical properties—are important considerations for water management. The city rests on layers of clay, sand, and muck.



Clay

A variety of clay soil types make up the areas closest to the banks of the Mississippi and its associated tributaries and distributaries. Clay soils are fine grained, with small air pores, and are typically poorly drained. They may contain varying amounts of organic material.



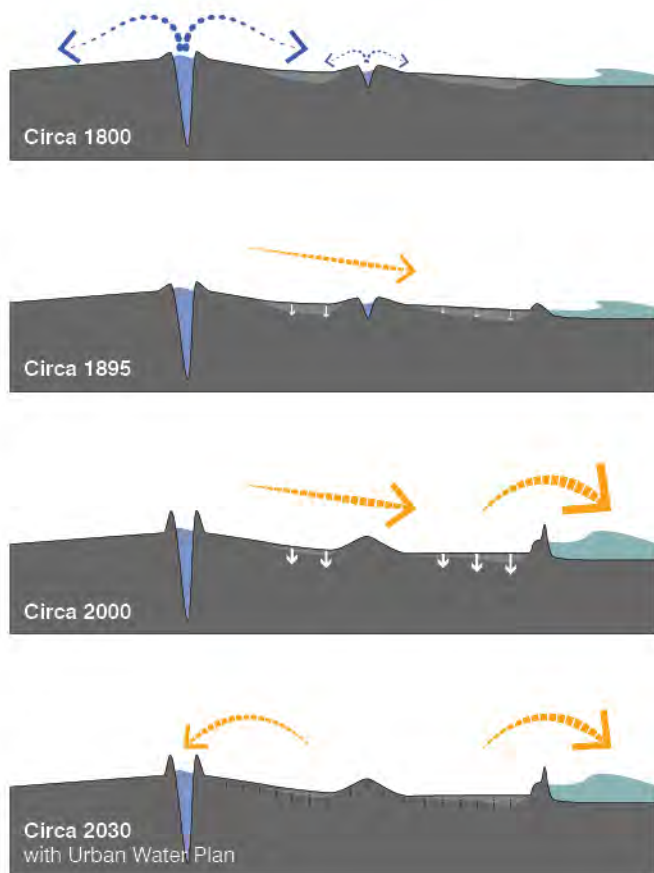
Sand

Sandy soils consist of larger-grained particles, which give sand layers the best drainage characteristics that are available in the Greater New Orleans. The most prominent sand layer in the region is a former barrier island that lies just beneath the surface of the city, indicated in the map above with white stippling.



Muck

Formed through the artificial drainage of swampland, muck may contain larger decomposing organic elements ranging from cypress stumps to shells. Mucks provides poor drainage and poor retention capacity, and require special care, as they are especially prone to subsidence.



A Shifting Landscape

The construction of artificial levees along the riverfront and lakefront, and the installation of perimeter pump stations have reshaped the landscape of Greater New Orleans into distinct hydrological basins. In the sequence above, blue arrows indicate natural overbank flooding, orange arrows indicate the flow of stormwater under forced drainage, and white arrows indicate the forces of subsidence acting on the landscape.

Inhabiting the Delta

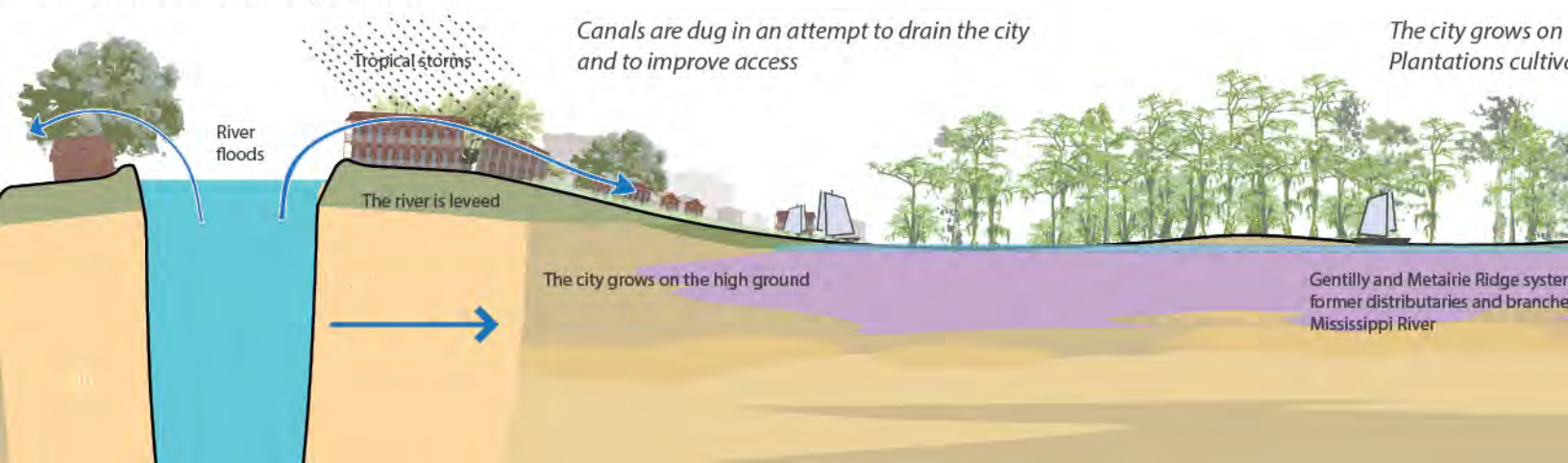
The pipes, canals and pumps that comprise the area's modern drainage infrastructure have enabled the expansion of the Greater New Orleans from the confines of the French Quarter and the historic city into the expansive footprint that it occupies today. But they have also altered the landscape. European settlers first settled the high ground of the Mississippi River levee. The advent of forced drainage in the twentieth century made it possible to settle what had once been impenetrable swamp, but has also caused the land to sink. The construction of federally-funded floodwalls at the region's perimeter protects residents from storm surge, but also makes the job of draining stormwater more difficult.

High & Mostly Dry

The relationship between Greater New Orleans and its water has been challenging from the start. New Orleans was founded on the natural levee of the Mississippi, while the extensive use of local ridges for transportation— along roadways now known as Old Metairie Road, Gentilly Boulevard, Chef Menteur Boulevard, Bayou Road in Orleans Parish, and Bayou Road in St. Bernard Parish—in the earliest periods of the region's colonization speak to the wider significance of high ground in ordering human settlement and commerce.

Until the invention of the Wood screw pump in 1913, New Orleanians could only live on high ground, the relatively dry **natural levees** of the Mississippi and its distributaries.

Circa 1800 A Challenging Site





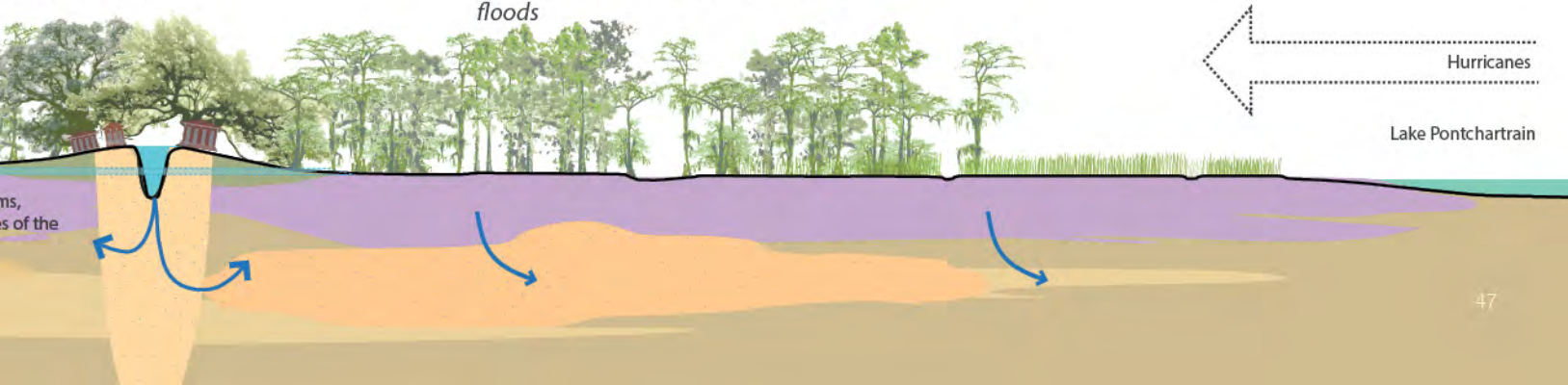
A History of Living With Water

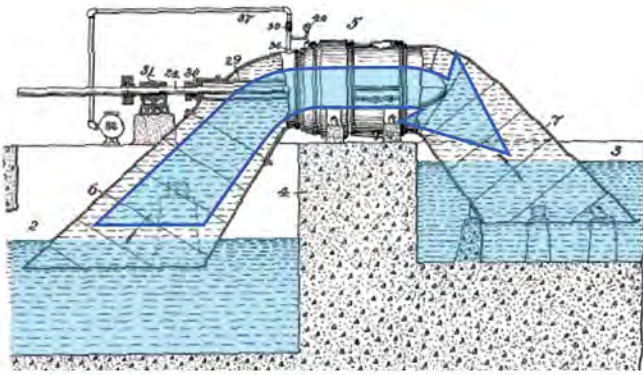
In the past, residents living without comprehensive floodwalls and pumping systems learned to live with water. From lakefront camps (left) to raised buildings from the French Quarter to St. Bernard Parish (above, right), residents knew how to live above the water and provide spaces where water could flow.

Top image courtesy of the Historic New Orleans Collection

the high ground along the river
ate the backslope

The young city is continuously challenged
by tropical storms, hurricanes and river
floods





The Pump that Drained the World

The Wood screw pump, invented in 1913 by A. Baldwin Wood, the first superintendent of the Sewerage & Water Board, was the first pump efficient and reliable enough to make possible the draining of large low-lying areas in New Orleans and other cities. It also enabled New Orleans' first drainage master plan to be carried out. The image above describes the flow of water through a Wood screw pump.



New Orleans' First Water Plan

The 1895 Drainage Master Plan established the Sewerage & Water Board and paved the way for development in the 20th century. This first plan sought to alleviate flooding by draining runoff along the present-day Claiborne corridor into Bayou Bienvenue.

Drainage problems were evident in New Orleans early on. Even with the construction of the first artificial levees along the banks of the Mississippi, springtime regularly brought with it floodwaters from the river. Heavy rainfall created its own challenges and caused much misery in the form of flooded streets, soggy ground, standing water, and diseases associated with the damp and with stagnant waters.

New Orleanians dug gutters, ditches, and canals with which to drain rainfall by gravity from inhabited areas and into largely unoccupied backswamps, with drainage aided by underpowered paddle wheels. In addition, builders lifted structures up on piers, so that the floodwaters that were so common in the region's early history could wash beneath buildings without causing severe damage.

First Drainage Master Plan

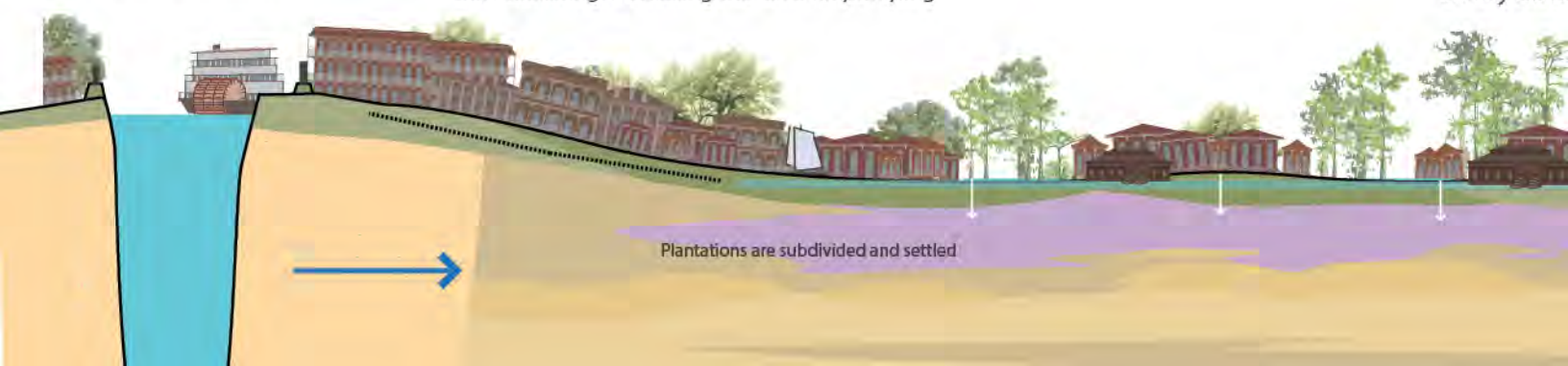
In 1893, the Drainage Advisory Board, which became New Orleans' Sewerage & Water Board, was formed to devise better solutions to the drainage problems the city faced. The board adopted the region's first drainage master plan in 1895. The plan called for the construction of large pump stations, drainage canals, and buried concrete culverts. Covering up and expelling both groundwater and stormwater appeared to be the best solution for reducing flood risk and eliminating the menace of mosquito-borne illnesses. In 1913, city engineer Albert Baldwin Wood designed the Wood screw pump, which revolutionized drainage in New Orleans and around the world. Installing banks of these new pumps across the city made the

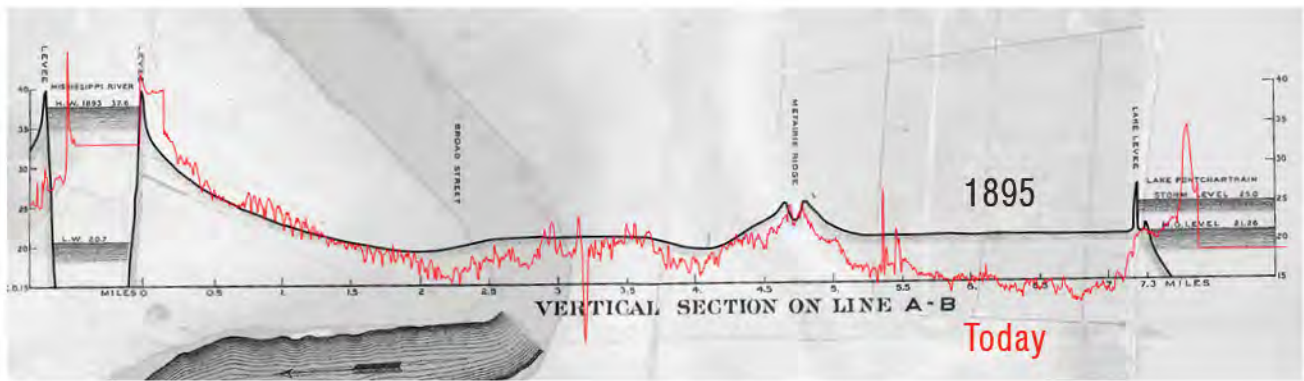
Circa 1895 *The Draining of the Backswamp*

The Mississippi River is increasingly embanked

Oxidation due to dewatering causes the ground to start subsiding, increasing the need for pumping

In the 1920s, the city succeeded





realization of the 1895 Drainage Master Plan possible by increasing the total drainage capacity of the city by a factor of twenty between 1899 and 1937 (Haydel 1995). This new pumping technology allowed New Orleans to expand into former wetlands drained by the new pumps.

The Sewerage & Water Board of New Orleans and the Wood Screw Pump are products of the **1895 Drainage Master Plan**, a civic effort that transformed the city with a new approach to managing rainfall and groundwater.

Pumping Sinks the Land

The 1895 Drainage Master Plan codified a drainage paradigm that accelerates the flow of groundwater and stormwater out from inhabited areas. Today, life below sea level is possible only with the operation of powerful pumps, grouped into arrays that have the capacity to lift tens of thousands of acre feet of water out of the region's three hydrological basins over the course of a single hour.

But in continually removing water from

Century of Subsidence

Rapid subsidence, or sinking of the land, occurred when the pumps were first installed, and it continues today. The black line labeled "1895" indicates the height of land in that year; the red line shows the lower elevations of those same areas today. Some areas have subsided almost ten feet, with the potential to subside further.

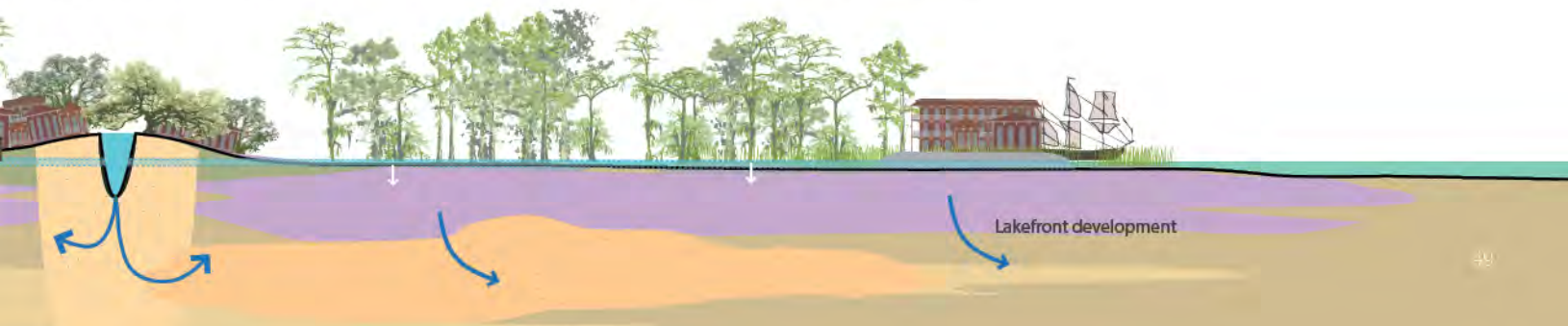


Faster Faster

"Hard" drainage infrastructure, like the concrete canal above, was a sign of progress. But it also lowered the surrounding water table because the impervious concrete lining prevents the absorption of water by surrounding soils.

new drainage pumps at the edge of
successfully drain the backswamp

The city prospers, but suffers from
outbreaks of malaria and yellow fever





Perimeter Protection

Levees and hurricane protection features lower the cost of flood insurance. Maintenance and continued investments are necessary to maintain the level of safety that these defenses provide today. With these defenses, the largest residual or remaining risk to Greater New Orleans residents is from flooding due to excess rainfall, which can only be addressed through improvements in urban water management.

the ground, pumps destabilize local soils and cause areas that were once swamp or marsh to sink. Uneven streets and potholes, failing infrastructure, and broken foundations are some of the more immediately appreciable consequences of this subsidence. Deep organic soil layers indicate the potential for continued subsidence if new approaches to managing stormwater and groundwater are not adopted.

Basin: a depression in the earth's surface that is higher at the edges and lower in the center, that floods without mechanically driven forced drainage; also known as a polder

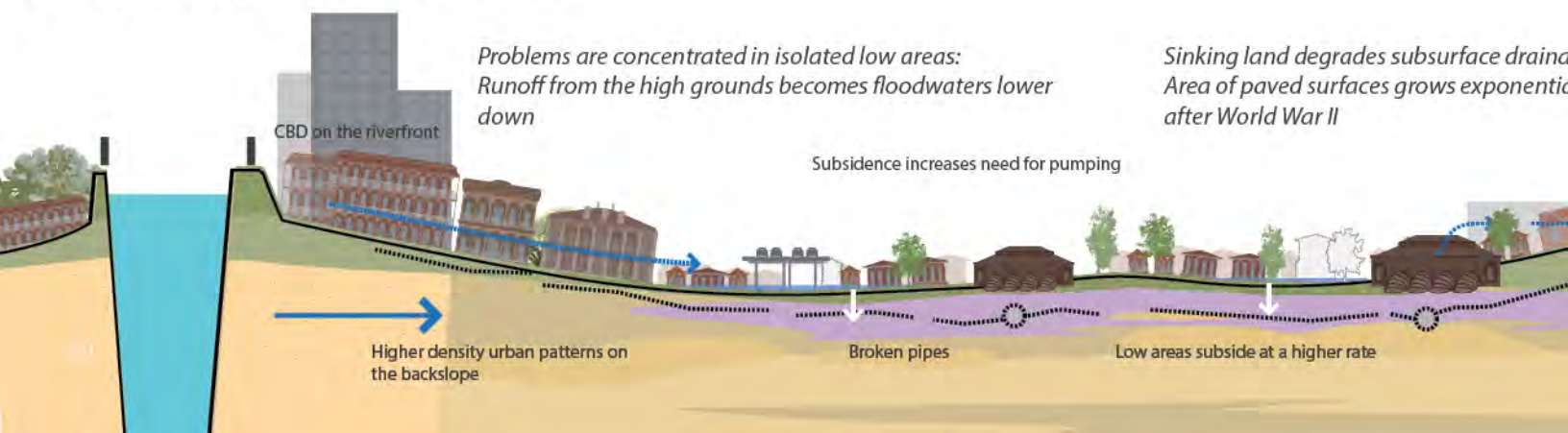
Lifting the Perimeter

In the eighteenth century, individual property owners were responsible for the construction of artificial levees along the Mississippi. The federal government took over responsibility for river flood prevention with the Flood Control Act of 1928, and the Mississippi River is now entirely channelized, held between high levees and floodwalls that prevent it from spilling over its banks or changing course.

Levees along the lakefront became necessary to block storm surge and high tides from inundating the newly settled low ground of the city in the twentieth century. Where tidal wetlands once graded gently into Lake Pontchartrain, a concrete seawall and soils dredged from the lake bottom and piled high behind that seawall were formed into the artificial high ground that forms the lakefront today.

These practices of shaping the land to provide protection from floodwaters give the region its modern-day profile: upturned

Circa 2000 *City Between River and Lake*



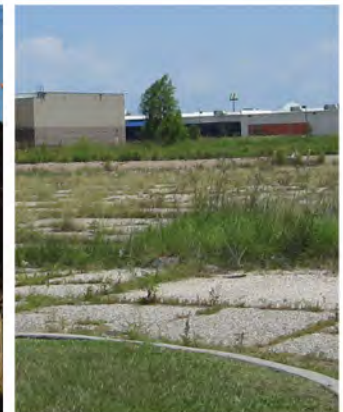
Island City

Perimeter levees & floodwalls surround low ground



edges built to protect a low center against external water, with a few internal ridges extending through low areas within the region's basins.

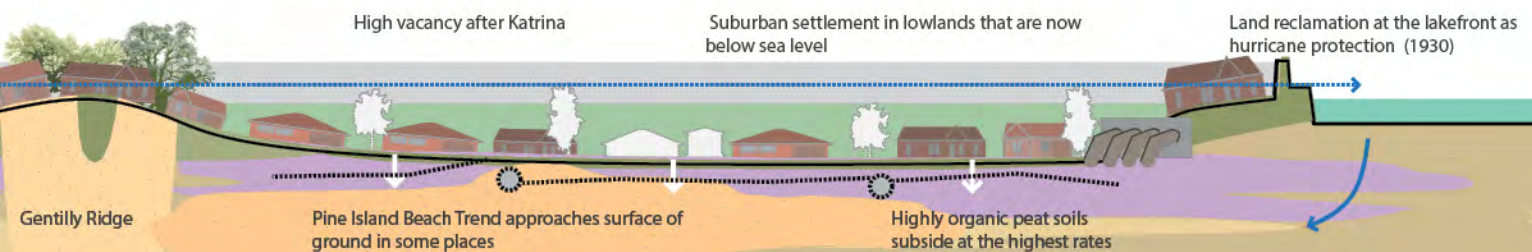
Greater New Orleans' basins are the product of the interactions between natural flows of water and sediments, modern forced drainage, and the artificial high ground of riverfront and lakefront levees constructed over the last three centuries.



Vacancy & Blight

The federal levees that protect Greater New Orleans encompass an urbanized area that once accommodated a larger population. With fewer residents today, vacancy and blight mar parts of the region.

Settling of the soils below sea level and the loss of wetland buffers increase vulnerability to hurricanes, and damages to infrastructure



“Occasionally, a crevasse would develop along the high river bank, diverting a stream of water away from the river and through the backswamp. These “distributaries” formed natural levees of their own... thus forming ridges and eventually dividing hydrological basins into sub-basins.”

Richard Campanella

From *Bienville's Dilemma*



An Island City

Greater New Orleans is becoming more and more an island, a walled fortress clinging to a disappearing delta. It is approachable only by bridge, plane, or boat.

Photo: NASA Earth Observatory

Landscape Types

The region's basins can be further defined according to landscape types. That is, each house, each neighborhood, and each district in the Urban Water Plan area is situated on the backslope of the river levee, on a ridge, in a bowl, or in a lowland area.

Early settlements such as Rivertown in Kenner, Carrollton, the French Quarter, and Old Arabi were all situated on the **backslope**, known colloquially as the “Sliver by the River.” This more stable land follows the curves of the Mississippi as it winds its ways towards the Gulf. Half a mile to one-and-a-half miles wide, the backslope is largely above sea level and its clay and silty clay soils are less prone to subsidence than the organic soils of the bowls and lowlands.

Backslope, known colloquially as the “Sliver by the River,” is the more stable land along the Mississippi River. This area is largely above sea level.

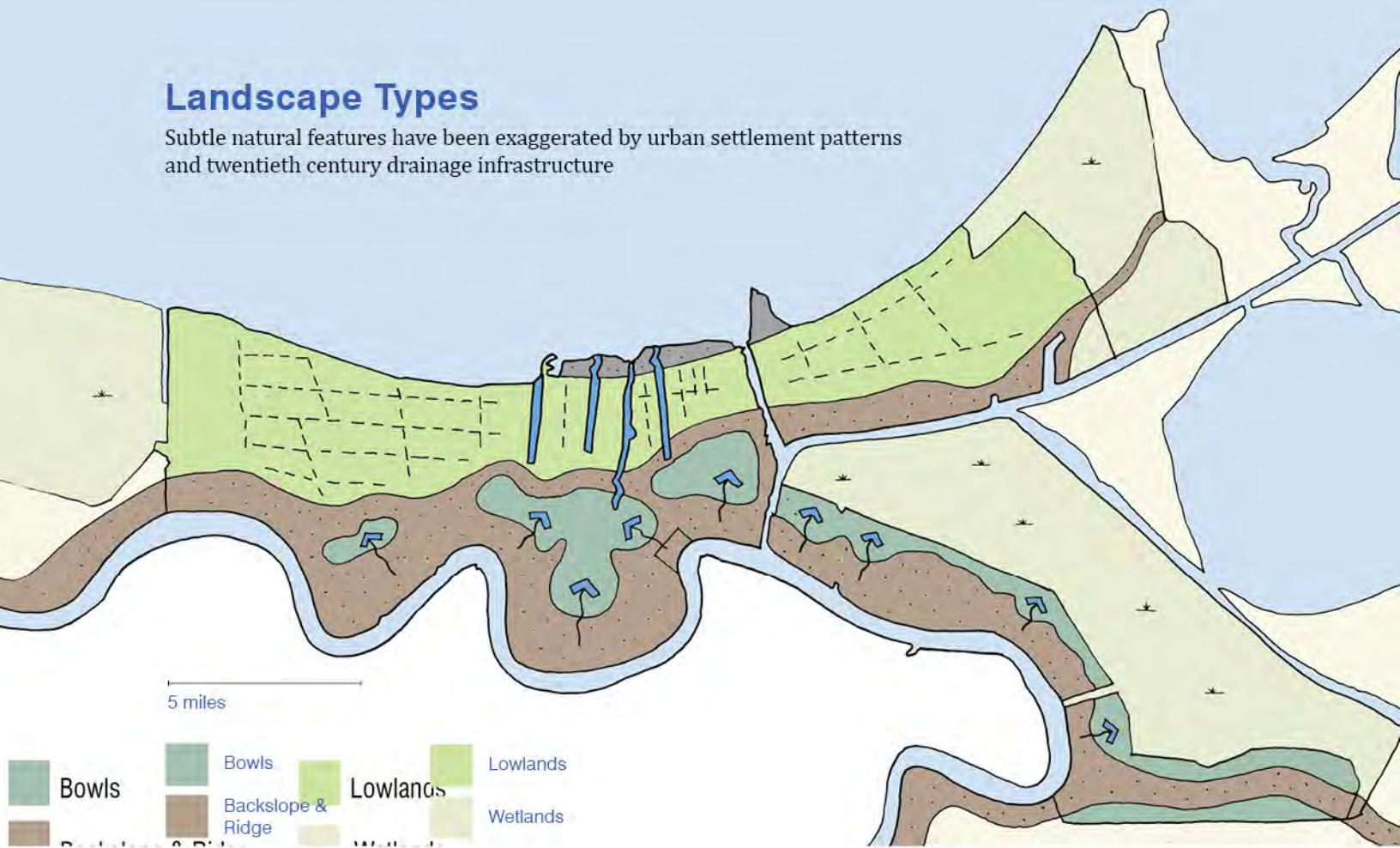
A number of **ridges** constitute the remaining high ground of the city. Like the Mississippi, Bayou St. John, Bayou Metairie, and the Bayou Terre aux Boeufs created natural levees that snaked across the landscape as the waterways overflowed their banks and deposited fresh sediments over many centuries. A number of those bayous are now filled in, high ground without the hydrologic functions of a bayou.

A ridge is a natural levee formed when waterways overflow their banks, deposit fresh sediment, and create high ground.

Neighborhoods such as Broadmoor, Hollygrove, and Desire occupy what are commonly referred to as the **bowls** of the city. These areas of low ground sit between the high ground of the Metairie and Gentilly Ridges, and the backslope that forms an arc from Carrollton to the French Quarter. When the river overflowed its banks or roared through a crevasse in the region's early history, the bowls would be the first to fill up and the last to dry out. Today, the region's bowls lie largely below sea level, and are entirely dependent on pumps for staying dry. As drained swampland,

Landscape Types

Subtle natural features have been exaggerated by urban settlement patterns and twentieth century drainage infrastructure



Bows

These areas of low ground and typically suburban development are situated between the backslope and local ridges. Once uninhabitable swampland before the introduction of forced drainage and urbanization in the 20th century, these areas have highly organic soils that are prone to subsidence.



Lowlands

Formerly swampland, these low-lying areas have highly organic soils that are prone to subsidence, with a loss of over 10 feet in elevation in different areas over the last half century. The settling of the lowlands began in the 20th century after the introduction of forced drainage.



Backslope

High ground that slopes away from riverbanks towards the lakefront, this stretch of more stable, drier ground was the first area to be settled by Europeans in the 18th century. The backslope is largely above sea level, and has clay and silt soils that are less subsidence-prone.



Wetlands

Lowlands and bowls all used to be wetlands. These rich ecosystems surround the city, and are also integrated into the urbanized landscape where impounded behind levees and floodwalls. They serve as natural buffers to storm surge, critical habitats, and recreational amenities.



Ridge

Geologic remnants of old river courses and distributaries, ridges are strips of relatively stable clay and silty clay soils. Like the backslope, ridges also served as sites for early settlements. Today, Old Metairie Road and Gentilly Boulevard trace the curves of their namesake bayous.

“Those living in the city....felt as if they were living on an island in the middle of a mud puddle.”

18th century observer in New Orleans



The Hardened Landscape

The paved surfaces that are common to urbanized areas prevent stormwater from infiltrating into the ground.

the bowls have organic soils with high subsidence potential.

Bowls are areas of low ground that sit between the high ground of ridges and the backslopes. Bowls lie largely below sea level.

Lowlands lie between the ridges and the lakefront in Orleans Parish and on the east bank of Jefferson Parish and between the backslope and wetlands in St. Bernard Parish. The Wood screw pump made possible the construction of postwar suburban housing on this previously uninhabitable swampland. These most recently settled areas include much of Kenner, Metairie, Lakeview, Gentilly, New Orleans East, and St. Bernard. Because of the presence of highly organic soils, some of the highest rates of subsidence in the region are found in the lowlands—areas of Kenner and New Orleans East have lost more than ten feet of elevation over fifty years.

Lowlands have some of the lowest elevations in the region and are most prone to subsidence.

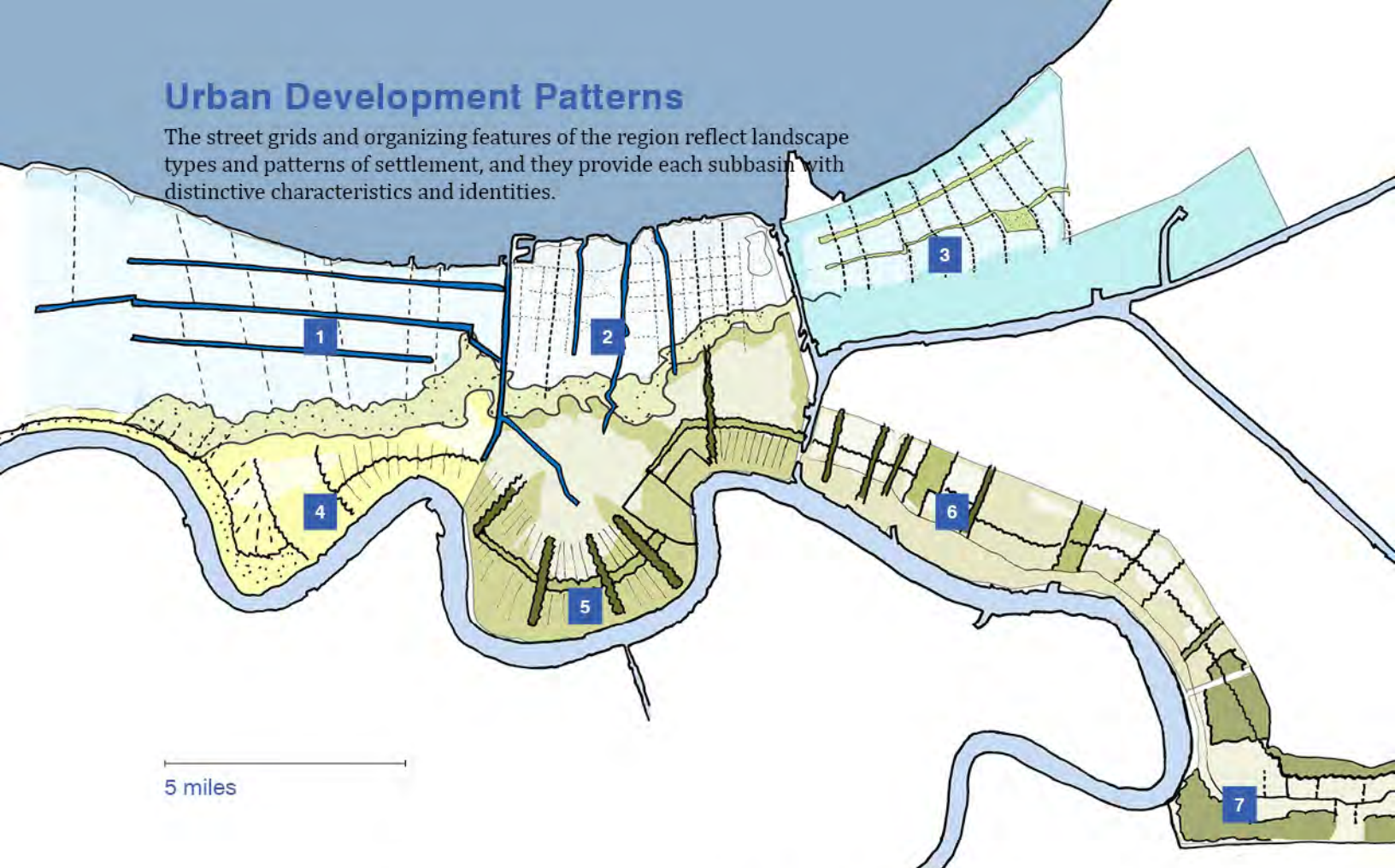
Katrina Revealed All

Geographer Richard Campanella wrote that Hurricane Katrina and the levee failures that followed provided a heartbreaking lesson in geography (Campanella 2010a). Hurricane winds and storm surge roared unhindered through coastal wetlands, already damaged after decades of sea level rise, subsidence, and erosion. The Gulf of Mexico poured through broken floodwalls anchored in weak and sinking soils. Floodwaters brought into stark relief high ground and low ground, inundating the region's bowls and lowlands, while neighborhoods higher up on levees, backslope, ridges, and artificial fill stayed more dry, if not undamaged by the winds that raked the city.

The disasters that have disrupted life in the Greater New Orleans throughout its history serve as grim reminders of the region's geography, which has been both the source of its wealth and a bane to those seeking opportunity in its fertile mix of water and soil. The area's inhabitants have always fought to overcome the limitations of the region's geography, to limit the risk of inhabiting a changing delta in order to realize the benefits of occupying an otherwise advantageous location.

Urban Development Patterns

The street grids and organizing features of the region reflect landscape types and patterns of settlement, and they provide each subbasin with distinctive characteristics and identities.



1. Jefferson Lakeside

A vast area of suburban development extending from the Metairie Ridge all the way to the lakefront, subdivided by major boulevards and canals along which commercial activities are situated, including Louis Armstrong International Airport



2. Orleans Lakeside

The suburban street grid of 20th century development stretching from the Gentilly Ridge to the artificial fill of the lakefront, with the floodwalls of the city's three primary outfall canals as barriers between neighborhoods, and City Park and Bayou St. John as major assets



3. Orleans East

Suburban residential neighborhoods and private lakes concentrated in two broad swaths, one to the north of Interstate 10 and the other to the south of Dwyer Road, and a pattern of alternating canals and major boulevards that are aligned with highway exits



4. Jefferson Riverside

The tight street grid of historic Harahan angling towards Airline Highway, Elmwood's broad expanses of treeless pavement and rooftops, and the suburban residential neighborhoods of Old Jefferson and Old Metairie, bounded by the Mississippi River and Metairie Ridge



5. Orleans Riverside

The square block structure and high-density low-rise architecture of the French Quarter at the historic core of the city, the arpent-based grid to either side that follows the curves of the river, and tree-lined boulevards that run both parallel and perpendicular to the river



6. Upper St. Bernard

The extension of the historic street grid of New Orleans across the Industrial Canal and into the Lower Ninth Ward and Old Arabi, and the suburban street pattern of Chalmette, with commerce and institutions concentrated along east-west thoroughfares and industry along the riverfront



7. Lower St. Bernard

Individual properties and historic Isleños communities arrayed along Bayou Terre aux Boeufs, now a stagnant roadside ditch on the side of Bayou Road, with large parcels of forested land and impounded wetlands flanking both sides of Bayou Road



“Water, like religion and ideology, has the power to move millions of people... People write, sing and dance about it. People fight over it. And all people, everywhere and every day, need it.”

Mikhail Gorbachev

President of Green Cross International, from *Water: The Drop of Life*



Palmetto Canal

The Palmetto Canal conveys stormwater from Central City into the 17th Street Canal. It is one of the primary outlets for stormwater flowing from the backslope and bowls of New Orleans.



3 Staying Dry, Losing Ground

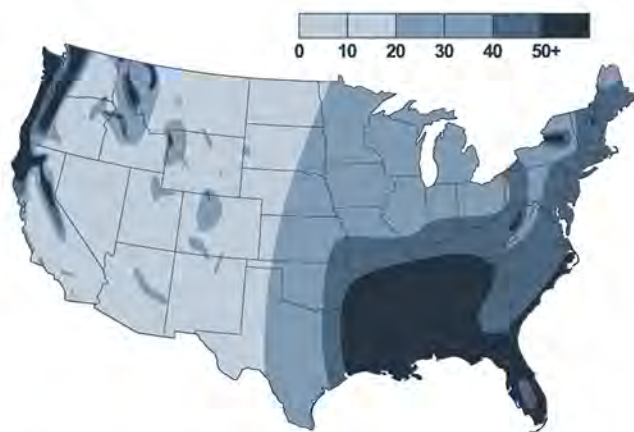
DEFINING THE CHALLENGE

When it rains, stormwater becomes floodwater when excess runoff floods streets, homes, and businesses. When it is dry, on the other hand, too little water in the ground causes the ground to sink. With the existing approach to managing stormwater, fixing the first problem compounds the second. Resolving both issues requires the management of water and ground as one.

Staying Dry, Losing Ground

DEFINING THE CHALLENGE

Greater New Orleans relies on forced drainage systems to keep dry. This single-purpose approach to stormwater management is expensive and resource-intensive, yet streets still flood regularly due to rainfall. This approach is also the primary cause of subsidence in the region, and diminishes the value of the region's waterways and water bodies as public assets.



Annual Average Precipitation

The map above shows inches of annual average precipitation. The dark blue areas are the wettest. Greater New Orleans receives over 60 inches of rain annually, one of the highest annual totals in the country.

Source: NOAA

Subtropical Climate, Intense Weather

New Orleans is one of the wettest cities in the country, averaging 62 inches of rainfall every year. Much of this water arrives in intense bursts, sometimes as much as 5 or 6 inches in a single hour. This climate poses tremendous challenges to keeping dry, and requires the operation of large banks of pumps in order to prevent the region's basins from filling up with water when the rains come.

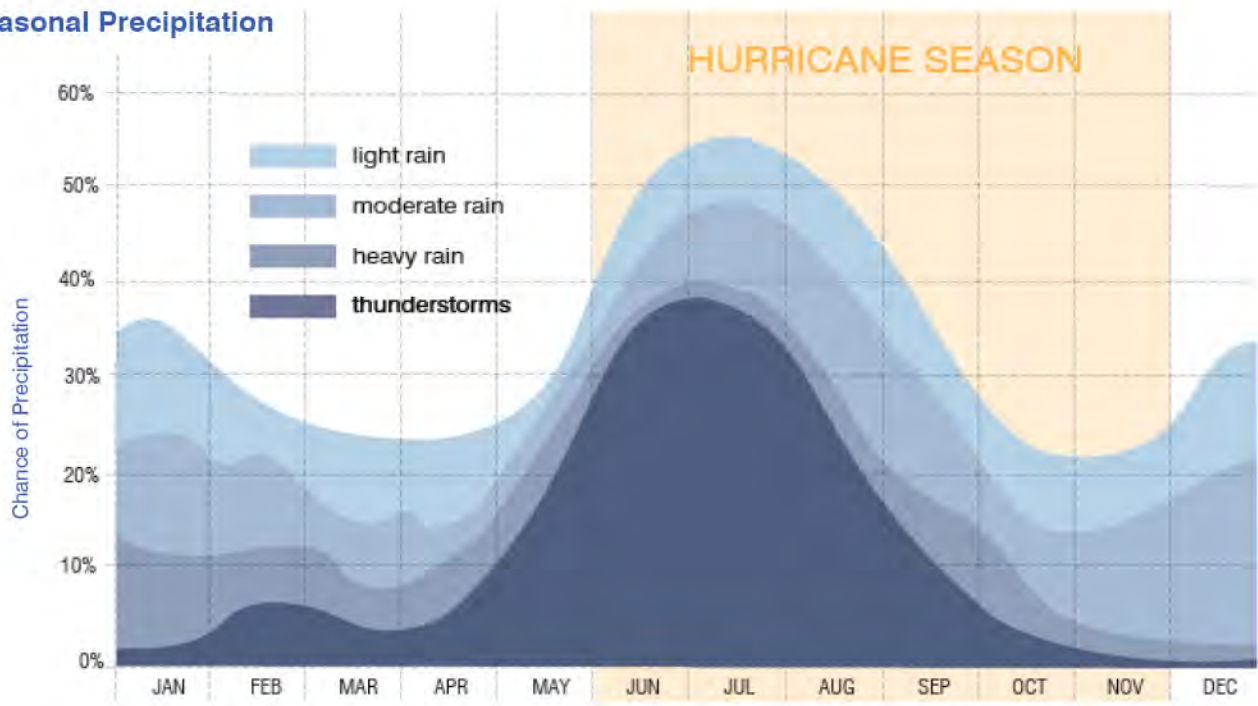
In the summer months, thunderstorms and intense rainfall are common, if sometimes unpredictable, phenomena. Isolated showers can unexpectedly inundate one area, while another area remains dry. The uneven distribution of rainfall during storms stresses drainage systems by placing heavy loads on different points in the system, so that the sizing of pipes and pumps can at any moment be rendered inadequate. It is not uncommon for one neighborhood to experience a mere drizzle while a nearby neighborhood experiences a deluge that causes flash flooding.

Hurricanes

Summer, too, overlaps hurricane season, during which the threat of catastrophically destructive weather systems spinning up out of the Gulf of Mexico is a constant presence in the minds of coastal residents. Hurricanes bring with them the added risk of high winds and storm surges. Though addressing storm surge is outside the scope of the Greater New Orleans Urban Water Plan, hurricanes bring periods of intense and sustained precipitation, and existing drainage systems are tasked with emptying the region's three basins of this stormwater while the region's floodwalls and levees are built to prevent water from entering urbanized areas from outside. The recently completed Hurricane and Storm Damage Risk Reduction System (HSDRRS) is designed to protect the city from a 100-year storm.

It is important to note if such a storm were to occur, the risk of flooding caused by the overtopping of levees would be less than the risk of flooding from rainfall (Jacobsen 2013). If the levees hold but

Seasonal Precipitation



drainage systems were to fail, New Orleans would still flood. In other words, managing stormwater within the levees is fundamental to improving regional resilience for storms both big and small.

Intense Summer Storms

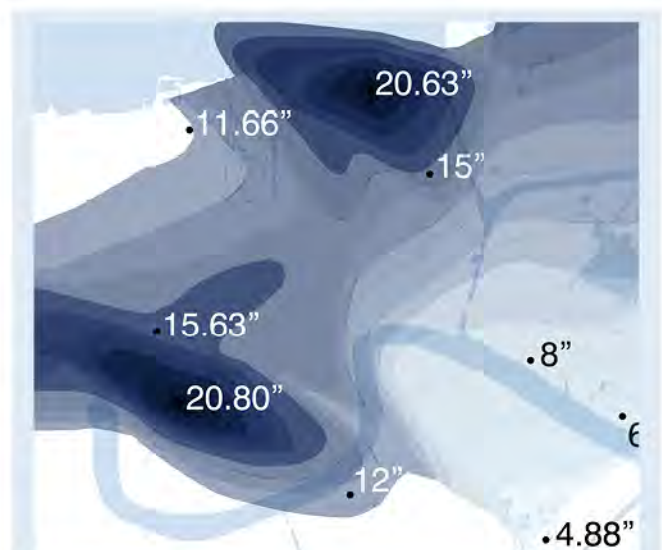
Seasonal variation in rainfall and severe weather affects water levels in the system. The highest incidence of thunderstorms and rainfall (the blue peak above) coincide with the first half of hurricane season and high summer temperatures. Drainage systems must be able to handle these varying conditions.

Single Purpose Drainage Systems

Picture emptying a bucket of water into a shallow basin. Water flows from high to low, collecting in the lowest point at the center of the dish. That water remains there until evaporation or some other action empties the dish. The physics of water flow are no different in Greater New Orleans' three basins.

Modern drainage did not exist until the beginning of the twentieth century. The first phases of modern drainage anticipated development in areas of low ground, but deliberately located major drainage canals in the bowls so that water from high ground could be captured in pipes and flow under gravity into those drainage canals, which would then be emptied into neighboring wetlands and lakes.

Human alterations to the landscape over the last three centuries have created hydrological basins that cannot be drained by gravity alone. The networks of pipes



Rainstorms are Unique Events

A thunderstorm on May 8, 1995

Rain falls at different rates in different areas. The diagram above shows rainfall for the record-breaking storm and subsequent flooding of May 8, 1995, which caused significant damage across Greater New Orleans and provided the impetus for the SELA Flood Control Project that is still in construction today. Audubon Park, Uptown, and Pontchartrain Park, at the lakefront, experienced the most intense rainfall, with totals exceeding 20" in 24 hours. This storm was stronger than a 100-year storm in these locations.



Flooding Even on High Ground

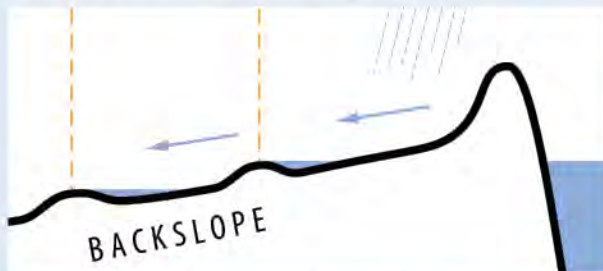
High ground in Greater New Orleans—not just areas below sea level—can also be prone to localized flooding because runoff easily overwhelms inadequate storm drains and drainage pipes. St. Charles Avenue, above, after a springtime deluge, is above sea level but still sees periodic flooding.

Photo: Nelson Engineers

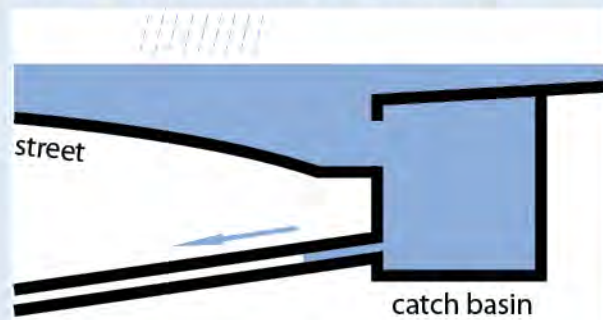
Causes of Street Flooding

Topographic conditions and point sources

Street flooding results from a combination of topographical conditions and overwhelmed drainage systems.



Ridges, created by features like streetcar lines, railways, and roadways, trap runoff that flows from areas upslope.



Water also backs up where catch basins are clogged or outflow pipes are undersized ("point sources").

Replacing pipes and drains with larger pipes and drains can solve some flooding problems, but these solutions are far more expensive than retention features and other measures to reduce runoff, and they yield few corollary benefits.

that remove water from the region's streets mimic the gravity flow of a natural watershed, directing water into larger pipes and canals downstream. Thus, water collects where the ground is low just as it would if there were no drainage systems. The difference is that with modern drainage, large pumps are necessary to mechanically extract that water from these collection points, and to dispose of it into Lake Pontchartrain and the other waters and wetlands that surround each basin.

Stormwater Becomes Floodwater

The region's low ground often fills with water faster than the rate at which drainage pumps can extract it. Insurance claims, commutes and shopping trips postponed, trips to the mechanic to repair flooded vehicles, moldy drywall, and impassable roadways make up the tally of "everyday" disasters that accompany rain events.

Because of the region's near total reliance on pipes and pumps, both high ground and low ground often flood. On any given street, too much runoff can overwhelm the system when there are too few storm drains or drainage pipes are too small. This is a common cause of localized flooding, regardless of neighborhood or topography.

With enough rainfall, large quantities of runoff entering a drainage system during a short period of time and flowing towards the same pump stations can overwhelm downstream pipes, canals, and pump stations. When downstream pipes are full and pumps are overwhelmed, runoff from upstream neighborhoods have nowhere to go, resulting in flooding that typically is worst in the lowest areas, but often reaches back upstream and onto high ground.

When heavy rains are expected, locals know to park their cars on high ground, whether that's a neutral ground or sidewalk that provides even just a few inches of extra elevation.

Quantifying Excess Water

As with any mechanical system, the region's drainage pumps have a pre-determined capacity. For example, a set of pumps draining a given catchment area may have

Excess Runoff

Localized flooding from a “10 year storm,” one defined as having a 10% chance of occurring in any year (these storms actually occur approximately four times each year). 10 year storms and 100 year storms have similar amounts of rainfall, so reducing flooding for a 10 year storm would also reduce the impact of larger storms.



an operational capacity of one thousand cubic feet per second (cfs). That is, the pumps are able to move a volume of water that would fill a room ten feet in each dimension in a single second. If the flow of water to this pump station exceeds that volume, the system backs up and flooding will occur.

Although the New Orleans Sewerage & Water Board, Jefferson Parish, and the Lake Borgne Basin Levee District drainage pumps are extremely powerful, there is not enough piping and pumping capacity to prevent flooding during a heavy rainstorm.

The excessive quantities of stormwater that arrive at the city's pump stations during intense rainfall are common because of the intensity of storms, but also because of the high ratio of paved to unpaved surfaces

Stormwater Issues

- Flooding is estimated to cause nearly **\$8 billion** in damages to structures over the next 50 years.
- The region averages over **60 inches of rain per year**. Some areas have received **20 inches in a single day**.
- **Seasonal rainfall peaks** during hurricane season worsen with climate change.
- **Hard infrastructure** and paved surfaces shed water too quickly, overwhelming the system.



Water Highways

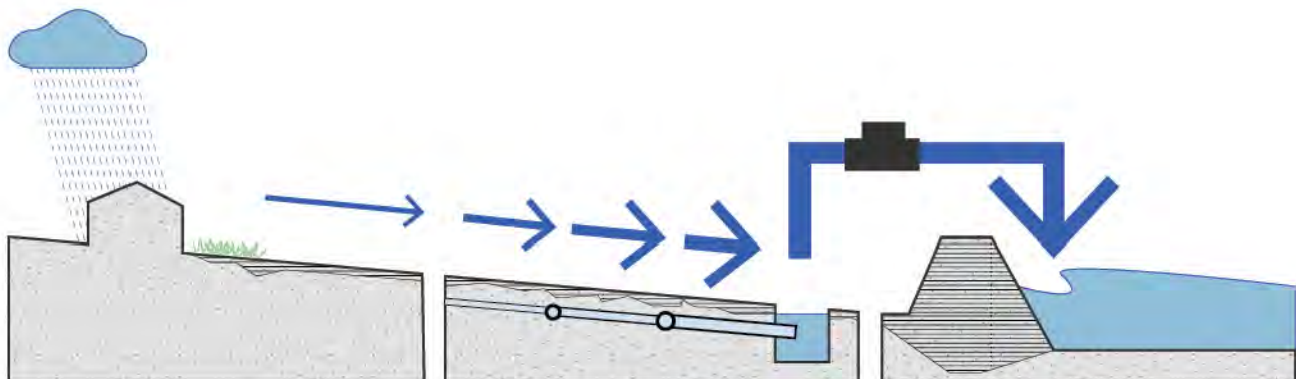
With existing drainage systems, large volumes of runoff rush off of paved surfaces, causing surges of stormwater in drainage channels such as the Palmetto Canal, shown in its day-to-day condition (top) and flush with runoff after a rainstorm (above).

Bottom photo: Times Picayune

across the region. Because buildings, asphalt, and concrete do not allow stormwater to infiltrate into the ground the way vegetated surfaces do, almost all of the stormwater in urbanized areas slides off of these hard surfaces and speeds into storm drains, which convey these waters without delay to pump stations.

The **water assignment** is the volume of stormwater runoff that the drainage system cannot handle, which appears as flooding.

Throughout this document, the term **water assignment** denotes the volume of stormwater for a given rain event (typically 10-year storm) that exceeds the total storage and pumping capacity of a catchment area. In order to reduce flooding, one of the primary objectives of the Urban Water Plan is to find efficient means for meeting the water assignment for each catchment area. While increasing pumping capacity is appropriate in some instances, reducing runoff and integrating storage features into existing drainage systems provide more cost-effective and sustainable alternatives for achieving the same objective.



Pave

Urban surfaces, including streets and parking lots, are paved with impervious materials that shed stormwater directly into storm drains and prevent that water from soaking into the ground.

Pipe

Underground pipes and culverts are often overwhelmed by stormwater, causing backed-up storm drains to overflow into streets. These pipes do not allow stormwater flowing through them to infiltrate into surrounding soils.

Pump

Fed by drainage pipes and canals, powerful pumps at the perimeter of each basin lift stormwater over the levees into Lake Pontchartrain, the Inner Harbor, and the Central Wetlands Unit.

Low Water Levels

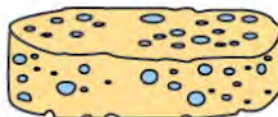
Existing drainage systems maintain surface water and groundwater levels well below where they would be otherwise in order to provide storage capacity within drainage systems in anticipation of rain events. In the drained swampland of New Orleans East, for example, water levels in area canals are maintained at approximately 15' below mean sea level. This is several feet below the surface elevation of the ground, and 16' below the average surface level of Lake Pontchartrain. In contrast, the water table of bayous, wetlands, and water bodies in the same area would have fluctuated seasonally at or near the elevation of the ground before the advent of forced drainage.

The **water table** is the surface of groundwater. This level can be observed when a hole in the ground fills with water.

Maintaining the water table well below the surface of the ground has immediate consequences. Like a sponge, the porous and highly organic soils of drained wetlands lose volume as they dry out and oxidize. Even more stable clay soils shrink and swell as they cycle between being dry and being saturated over the course of each year, disturbing utilities and breaking up streets and sidewalks.

Even though there are a number of naturally-occurring causes of subsidence in the Mississippi River Delta, the region's drainage systems increase rates of subsidence on average by a factor of over four.

Pumping stormwater out of a basin is difficult, expensive, and resource-intensive, and becomes only more so as the basin sinks deeper. While backslope neighborhoods are still capable of gravity flow into drainage canals, some lowland neighborhoods now lie below the pile-supported canals into which they once drained. Where this is the case, internal pumps are necessary just to lift stormwater into the canals, even before perimeter pump stations can lift the collected



Delta soils are like a sponge

Organic soils are only stable when they are full of water. When they dry out, they shrink.



Drainage sinks the land

Forced drainage dehydrates soils and lowers the water table. Oxidation and compaction caused by the drainage system was measured as early as 1927.

Shrink-Swell Cycle

Forced drainage heightens the differences in groundwater levels between wet and dry periods, with negative consequences for infrastructure networks.

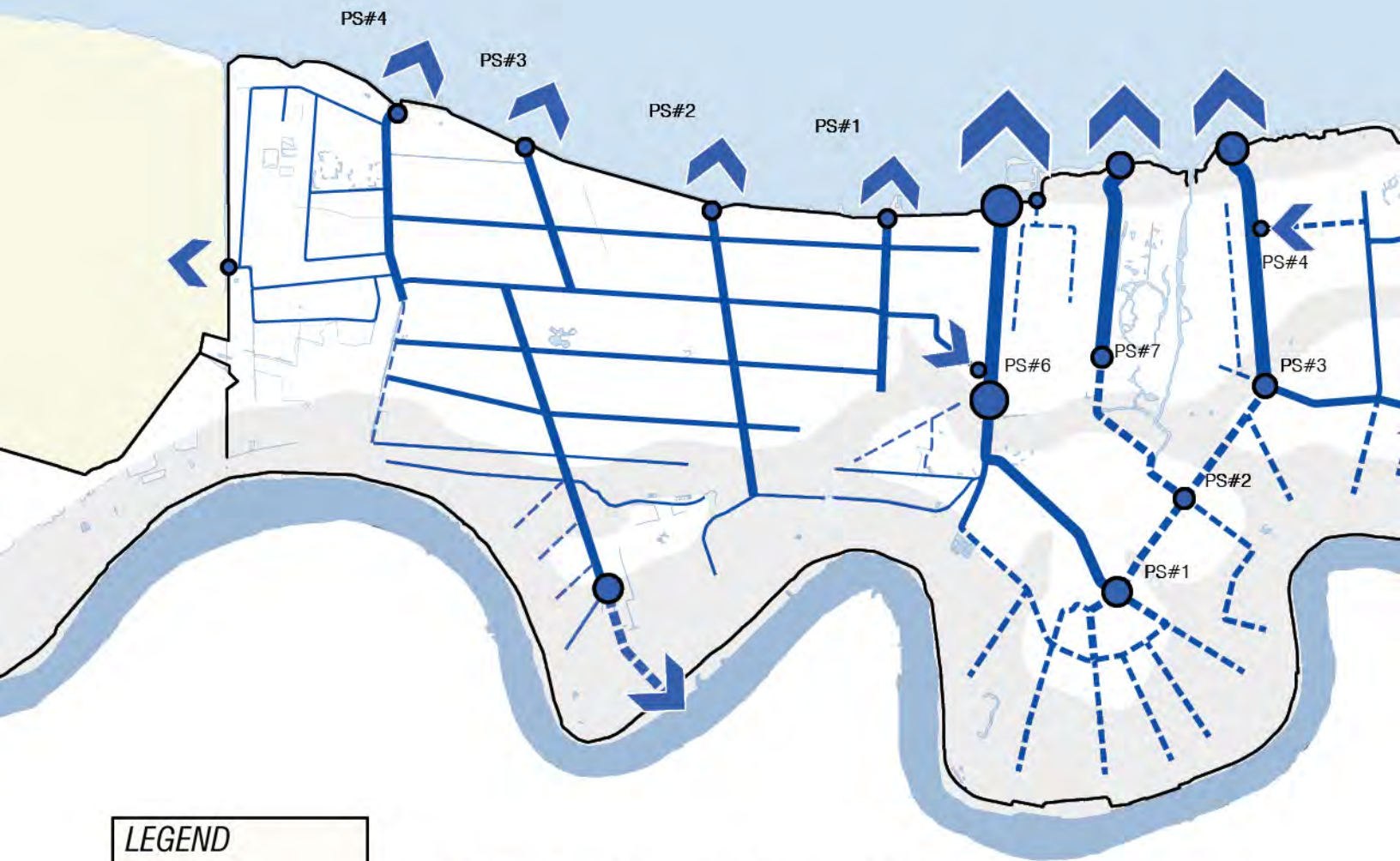
Irreversible subsidence is not the only unintended consequence of forced drainage. Because groundwater flows through soil layers just as surface waters do above ground, draining stormwater and groundwater, and maintaining low water levels in drainage canals has additional impacts on daily life across the entire city, from the backslope and ridges to the lowlands. While the lowlands are especially prone to subsidence because of their organic soils, the relatively stable clay soils that are found on high ground experience the same shrink-swell cycle to which lowland soils are susceptible.

The use of pumps to manipulate water levels in anticipation of rainfall, during rain events, and following each storm changes the height of the water table across the region. As rainfall saturates the ground and canals fill up and empty back out, the ground shrinks and swells with the moisture that fills the pores between the soil particles. While this is a naturally occurring process, forced drainage heightens the differences between wet and dry periods, which intensifies the effects that the shrink-swell cycle has on streets, utilities and foundations.

Existing Drainage System

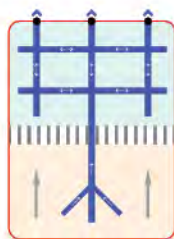
Paving, pipes, and pumps accelerate the flow of water out of each basin.

Water enters the drainage system through catch basins in the street, and is conveyed through pipes, concrete culverts, and open canals to pump stations that lift it over perimeter levees. Water in this single-purpose system flows primarily away from the river and towards the lake. Existing drainage networks are designed to drain runoff that can be expected from a 10-year storm over 24 hours. In reality, they often cannot handle peak intensity rainfall, even for smaller storms.



LEGEND

-  Open Canal
-  Covered Canal
-  Stormwater Discharge
-  Pump Station
-  Levee

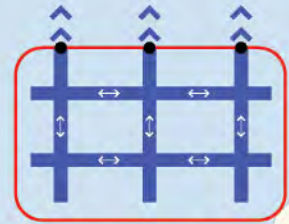


Jefferson-Orleans Basin: Open Networks

The East Bank of Jefferson Parish consists of two subbasins, one lakeside and one riverside of the Metairie Ridge. Lakeside, the drainage system is a grid of open canals. Pump stations along the lakefront draw from the same network, providing redundancy between pump stations. Riverside runoff also flows toward the lake, which compounds drainage issues in the lakeside subbasin. Projects are underway to separate some of this drainage at the ridge, and redirect backslope runoff into the Mississippi River.

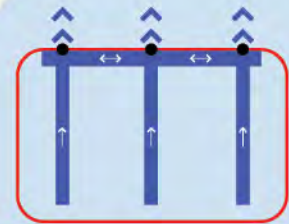


5 miles



Orleans East Basin: Networked System

Like in Jefferson, Orleans East Basin's drainage system consists of grid of open canals. Most stormwater is pumped into Lake Pontchartrain, although some is pumped into the Inner Harbor and the Gulf Intracoastal Waterway. Pump stations can provide relief to other pump stations because the canals allow the flow of water from one catchment area to another in the event of a system failure.

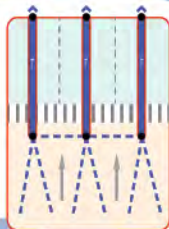


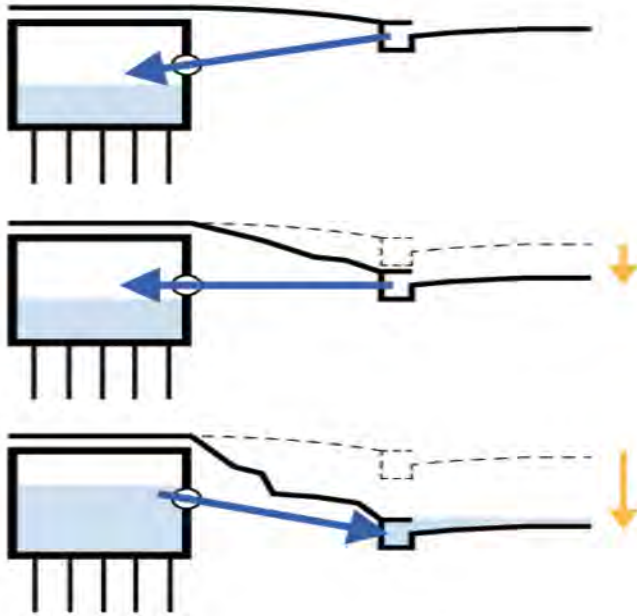
St. Bernard Basin: Backbone Canal

In St. Bernard Basin, the Forty Arpent Canal act as a backbone that collects all stormwater before it is pumped into the Central Wetlands Unit. Currently, water systems are divided at the Orleans/St. Bernard parish line and managed by two separate agencies, even though the Lower Ninth Ward and St. Bernard Parish share the same hydrological boundaries.

Jefferson-Orleans Basin: Divided Catchments

Orleans has both perimeter and internal pump stations. Stormwater flows to internal pump stations that empty into the city's primary outfall canals. Unlike other subbasins, the water level in the three main outfall canals is higher in elevation than their surroundings, confining flows to singular paths toward the lake.





Impossible to Drain

As land subsides around pile-supported culverts, drainage infrastructure becomes higher than the surrounding area it is designed to drain, preventing gravity flow of stormwater into the culvert and causing localized flooding.

Subsidence Takes a Toll

- Subsidence is estimated to cause **\$2.2 billion** in damages to structures over the next 50 years.
- Subsidence **damages infrastructure** like roads and levees, with high costs for government and taxpayers.
- Subsidence **affects thousands of individual property owners**, costing each tens of thousands of dollars in repairs.
- Continuing to **pave, pipe, and pump** will only worsen subsidence's effects.
- **No agency is responsible** for groundwater or subsidence control.

stormwater out of those canals and into surrounding waters.

The current drainage regime has developed into a destructive cycle in which pumping and low water levels cause the land to sink, which then necessitates increased pumping capacity in order to keep dry, which then leads to further subsidence.

Though responsible for many gains in everyday quality of life, drainage systems have paradoxically increased the long-term risk of inhabiting the Mississippi River Delta. The region is significantly lower relative to the Mississippi and Lake Pontchartrain than it was one hundred years ago. Neighborhoods that were once at sea level or higher now sit as low as twelve feet below sea level. As the levee failures of 2005 demonstrated, every inch of elevation makes a difference.

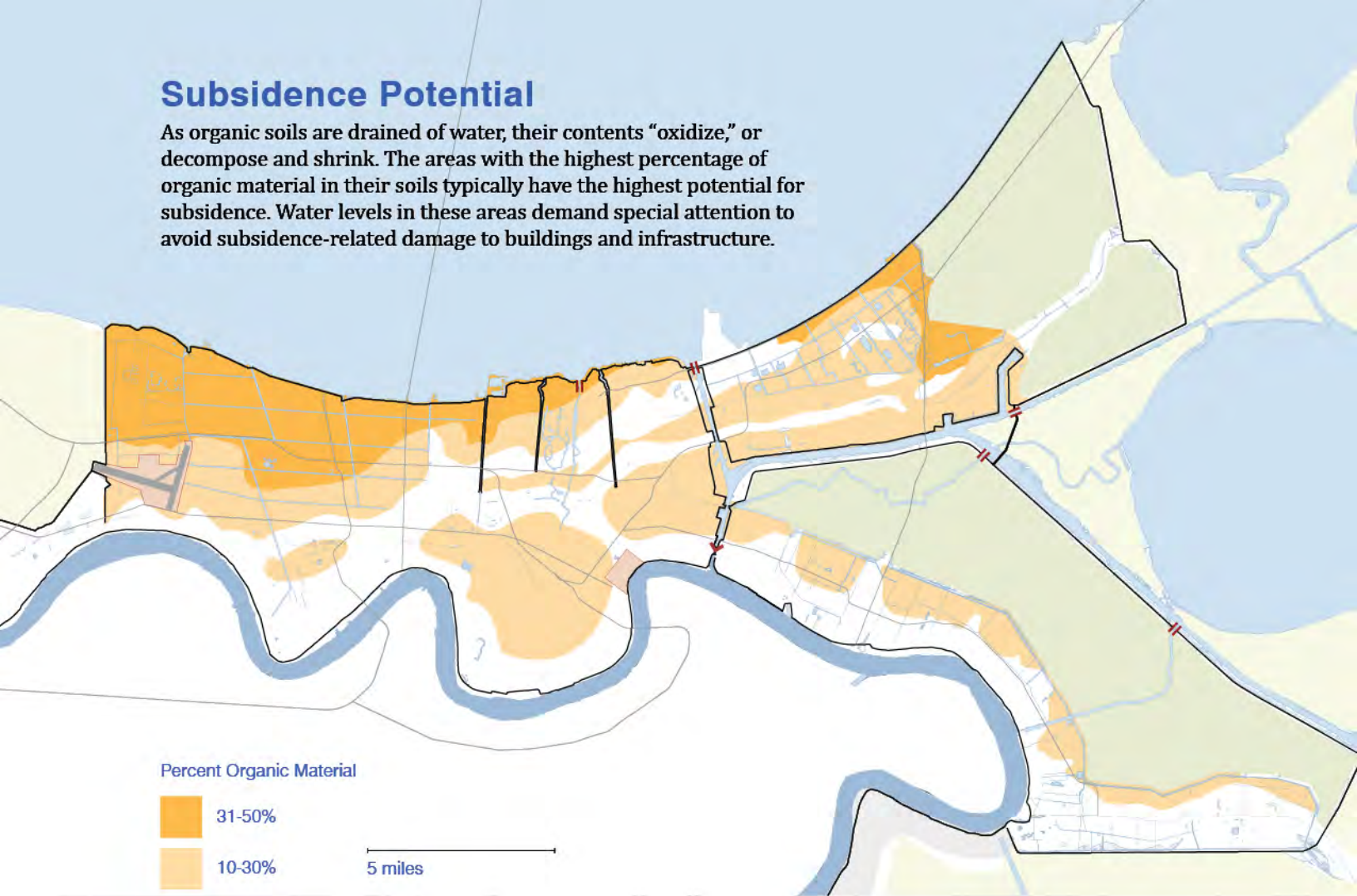
This suggests, perhaps, a choice between maintaining the current drainage regime with continued subsidence or foregoing dry feet and maintaining a high water table in order to lower rates of subsidence. There is another choice, however. Cities and villages in the Netherlands are also situated below sea level and have highly organic soils, but are able to support modern urban life even while maintaining a more sustainable balance between water and ground. Greater New Orleans, too, can find the balance between wet and dry, and between the needs of today and long-term resiliency for the future.

Water Assets Wasted

For a region built on a river and an estuary and created out of swamp, water is remarkably hard to find. Except for Bayou St. John and the beloved lakes and lagoons of Lafreniere Park, Audubon Park, City Park, Joe Brown Park, and Sidney Torres Park, most of the region's canals and other waterways provide little value as spaces for public life. The existing water infrastructure is in many places unsightly and dangerous: cheaply constructed drainage pipes poke out from canal banks, ditches are often dry or smothered with weeds, water stagnates

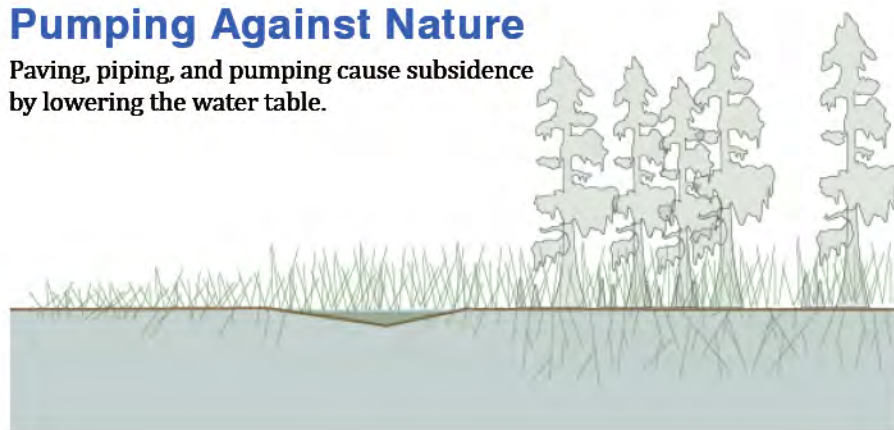
Subsidence Potential

As organic soils are drained of water, their contents “oxidize,” or decompose and shrink. The areas with the highest percentage of organic material in their soils typically have the highest potential for subsidence. Water levels in these areas demand special attention to avoid subsidence-related damage to buildings and infrastructure.



Pumping Against Nature

Paving, piping, and pumping cause subsidence by lowering the water table.



Pre-existing Condition

The water table is high in wetlands, where water permeates soil layers and creates anaerobic conditions that prevent organic materials from oxidizing.



Groundwater Imbalance

Low groundwater and fluctuating levels destabilize soils and cause the ground to settle unevenly. This causes failures in utilities and foundations, which increase the costs of maintaining infrastructure and lower quality of life.

“The opportunities are virtually unlimited; the alternatives are unthinkable.”

Keith Twitchell

Committee for a Better New Orleans

Above Ground, Below Ground

Existing infrastructure, such as drainage ditches and culverts dating from the early twentieth century continuously drain groundwater without bringing value to the communities through which they run.



in neglected waterways, and trash-strewn channels block access to neighborhoods.

A Regional Water Identity

Existing drainage canals and ditches are typically designed for one function: the speeding of water towards a pump station. They have the potential, however, to be much more: functional, beautiful assets that the region's residents use every day.

Well into the twentieth century, locals inhabited houseboats on waterways such as Bayou St. John, and lived in lakeside camps elevated along the lakefront. Residents' relationships to water have changed, however. Canals are too often ugly cuts in the landscape, built for drainage to the exclusion of all other purposes. Low water levels provide storage and conveyance capacity, but make for unsightly and unstable canal banks that limit visual access to the water. For these and other reasons, drainage canals are rarely accessible, and human interaction with basic elements of urban infrastructure is typically forbidden by systems managers.

A **culvert** is an underground drainage pipe. Some culverts in the New Orleans area are large enough to drive a bus through.

In New Orleans, where much of the drainage infrastructure has been hidden underground in the form of pipes and culverts over the course of the twentieth century, surface canals that do exist are hidden behind high concrete walls. Throughout the region, over \$1.5 billion dollars have been allocated to the Southeast Louisiana (SELA) Drainage Program, which continues the expensive process of burying infrastructure underground and out of sight.

Greater New Orleans has the ability, however, to develop a positive regional water identity with the water resources that are here today. In the lowlands of Jefferson and New Orleans East, extensive canal networks can become vital and beautiful public assets. New Orleans East possesses, too, an array of lakes, each over five acres and around which entire subdivisions are organized. The bayous,

lakes, and lagoons of the region's defining parks and the many activities that take place around these assets each day speak to the importance that water still holds for the region's residents.

Furthermore, the iconic and historic architecture of the Sewerage & Water Board's water treatment plants and pump stations that date back to the 1895 Drainage Master Plan continue to reflect the values associated with the proud civic improvement efforts of that era. In contrast, more recently constructed waterworks are too often utilitarian sheds that hide their function and detract from surrounding neighborhoods. A positive regional water identity depends not only on the character of regional waterways, but also on the attention paid to the design and construction of each of the components that make up the region's water systems.

Public Spaces Built Around Water

The region's drainage infrastructure has significantly diminished the presence of waterways, water bodies, and wetlands that are associated with delta landscapes. Furthermore, high levees and floodwalls at the perimeter block visual and physical access to the waters that surround the area.



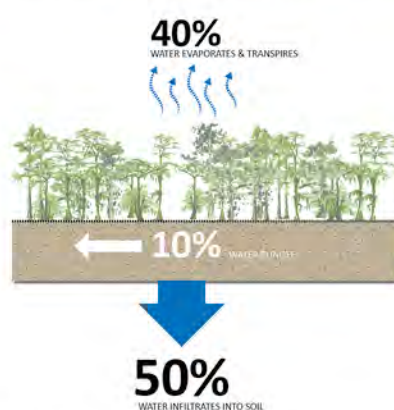
Groundwater Ownership

No one is responsible for groundwater, but all bear the costs of low water levels.

No entity in New Orleans is currently responsible for monitoring groundwater levels and maintaining groundwater levels for improved soil stability and minimizing subsidence. This means that the operating water levels in region's drainage networks are maintained with the singular purpose of preventing flooding, rather than preventing flooding and maintaining soil stability. The result is an approach to stormwater management that creates imbalances of ground and water, the costs of which are shouldered by citizens, business owners, utilities, and government as they contend with the effects of subsidence every day.

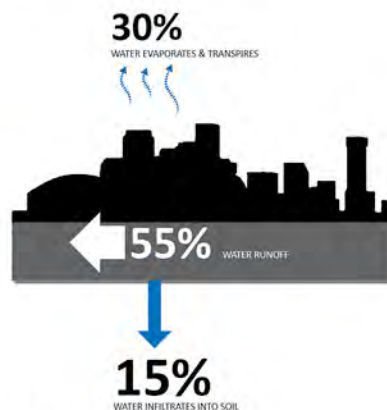
Ground as Sponge

Allowing the land to absorb runoff



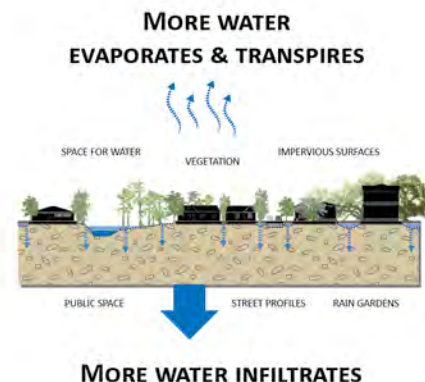
Natural Landscape

Soil and vegetation naturally absorb 90 percent of rainfall through infiltration into the ground and evapotranspiration into the air. Plants on the delta have adapted to the wet environment.



Hard Urban Surfaces

Rooftops and paved surfaces shed water. Developed areas are responsible for over 5x the runoff from non-urbanized landscapes of the same size.



Ground as a Sponge

In an integrated living water system, pervious paving, trees, plants, and other soft infrastructure can slow, filter, and absorb runoff.

International Water Cities

Many cities around the world use water to improve public spaces and urban quality.

In ancient Shaoxing, China, Da Wu tamed annual floods by digging canals, and those waterways still enrich the landscape and city culture to this day. In Dutch cities like Rotterdam and Amsterdam, beautiful waterways define the identities of entire neighborhoods, spurring development even as they function as drainage infrastructure.

In contrast, water in Greater New Orleans is out of sight and out of mind. The waterways that are visible are often stagnant and ignored, while other waterways are hidden behind floodwalls or buried underground. Building on assets like Bayou St. John and the momentum of the Reinventing the Crescent riverfront park in downtown New Orleans, waterways across the region can become places for public life, supporting reinvestment and development by bringing people and commerce to the water's edge. Complementing the river, street life, seafood, and jazz—regional trademarks—Greater New Orleans can become known as a place of great waterways and waterfronts as well.



New Orleans, Louisiana



Amsterdam, Netherlands



Rotterdam, Netherlands



Shaoxing, China



Named for Moon Landrieu, the mayor of New Orleans from 1970 to 1978, the riverside promenade now known as “the Moonwalk” was developed in the 1970s as place to bring people to the mighty Mississippi. The Moonwalk plays host to public life. Residents and visitors stroll on a path atop the levee, rest on benches to take in the sweep of the river, gaze back at the steeples of St. Louis Cathedral, and peer downriver at ships rounding Algiers Point and upriver towards the twin spans of the Crescent City Connection. Though the Moonwalk is neither iconic like the Mercedes Superdome nor famous like Bourbon Street or the Garden District, there is perhaps no other place that speaks more directly to the essence of New Orleans’ history and geography.

Just as the Moonwalk brings cultural, historic, economic, and aesthetic value to the region’s residents and visitors, each of the region’s waterways is an opportunity to build a place of beauty, community, pride, and value.

Greater New Orleans can develop more than 26 miles of waterfront as regional amenities and centers for public life with the water assets already in its possession.

Waterways such as the Industrial Canal, 17th Street Canal, Orleans Avenue Canal, and London Avenue Canal are now all protected within the HSDRRS, and are underutilized as waterfronts with the potential for high-value industrial, commercial, and residential development. The Forty Arpent Canal in St. Bernard could serve as an ecological counterpart to those urban waterfronts, as a site for environmental restoration, agricultural, and recreational programming that would benefit the whole region. The Lafitte Blueway envisions a waterway that reconnects New Orleans to its past while addressing present-day issues. These waterways can be the basis for new forms of development, public space, and multi-use corridors—each a large-scale transformation that may take decades to realize, but that will yield benefits for generations to come.

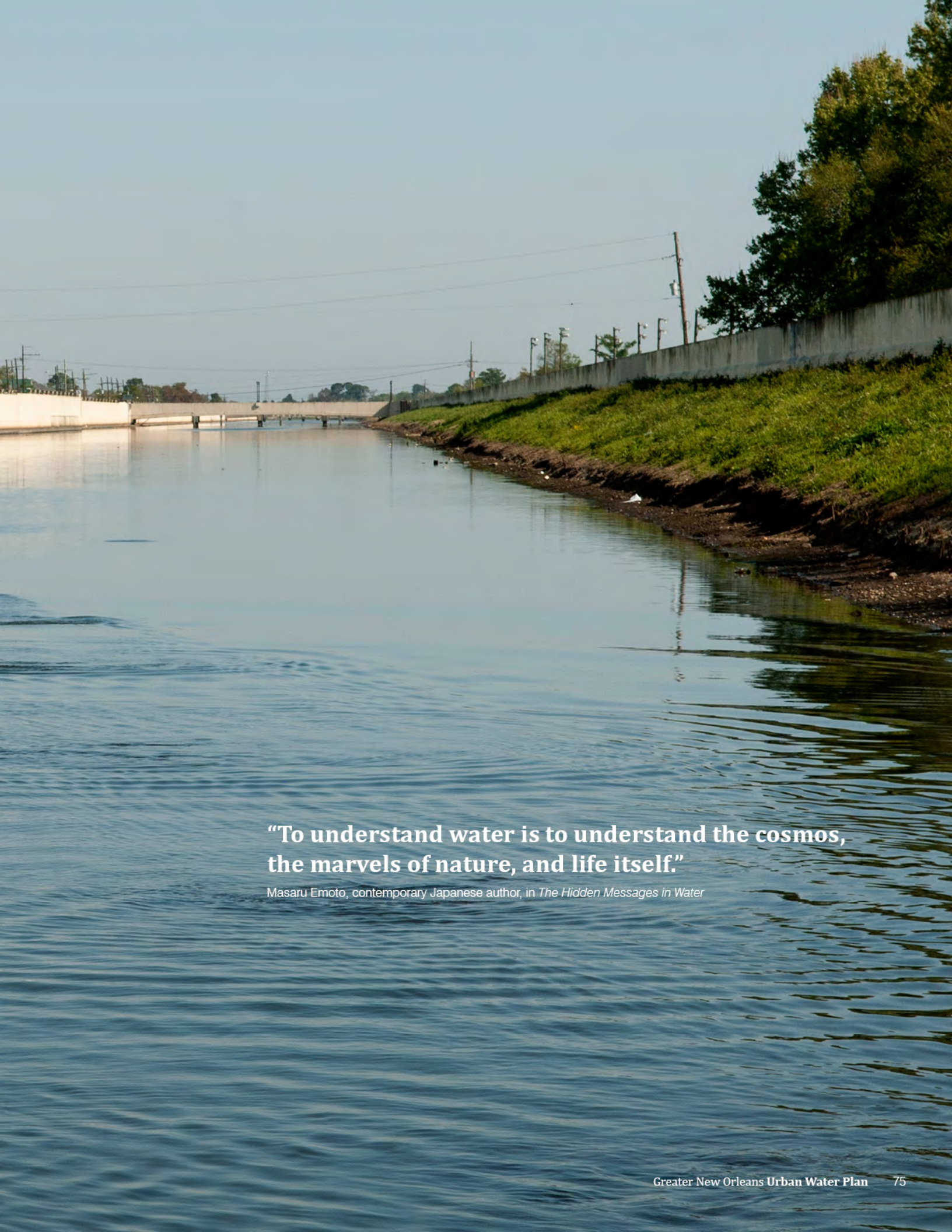
At a smaller scale, existing canal networks and water features, such as the lakes of New Orleans East, also have the potential to become sites for investment and redevelopment. Each district and neighborhood must ask: “Where’s the water? How can we make use of it to better our surroundings?” Improving public access to and investing resources in new and existing water assets are means to revitalizing commercial districts and residential neighborhoods alike. The fashioning of a regional water identity depends on these smaller-scale efforts too, each building towards a coherent, more beautiful and resilient whole.

Potential in Existing Assets

The region’s waterways, such as the Palmetto Canal (below), present opportunities for improved drainage and quality of life. A few waterways, like Bayou St. John (bottom), serve already as invaluable urban assets.







**“To understand water is to understand the cosmos,
the marvels of nature, and life itself.”**

Masaru Emoto, contemporary Japanese author, in *The Hidden Messages in Water*

Restoring the Flow

In 2012, installation of a new floodgate at the intersection of Bayou St. John and Lake Pontchartrain allowed for the removal of a dam that was constructed in 1962 to protect against storm surge. This has restored some of the natural flow of water between the lake and the bayou.



4 Adapting the Flow

A NEW APPROACH TO URBAN WATER

Addressing today's water and soil management challenges requires a new paradigm in which stormwater and groundwater are managed as valuable resources. The Urban Water Plan outlines the changes necessary to achieve a more sustainable balance between ground and water, through a long term program of retrofits to existing systems and the urban landscape. The retrofits emphasize slowing and storing stormwater rather than pumping, circulating surface water and recharging groundwater, creating vital public spaces around water, and incorporating natural elements and processes into the operation of an integrated living water system.

Adapting the Flow

A NEW APPROACH TO URBAN WATER

The current approach to managing stormwater dictates that every drop of water that falls must be pumped out, but this wastes resources and leads to imbalances between soils and water. A new approach to stormwater and groundwater management suggests instead an integrated living water system that provides measurably higher levels of safety, reduces the rates at which the land is sinking, and establishes the reputation of Greater New Orleans as a driver of innovation for climate-adaptive planning, design, and technology.

Slow, Store & Use, Drain

Caught in a rainstorm with neither umbrella nor roof to huddle beneath, one tends to search out the nearest tree, preferably one with the densest, broadest canopy in sight.

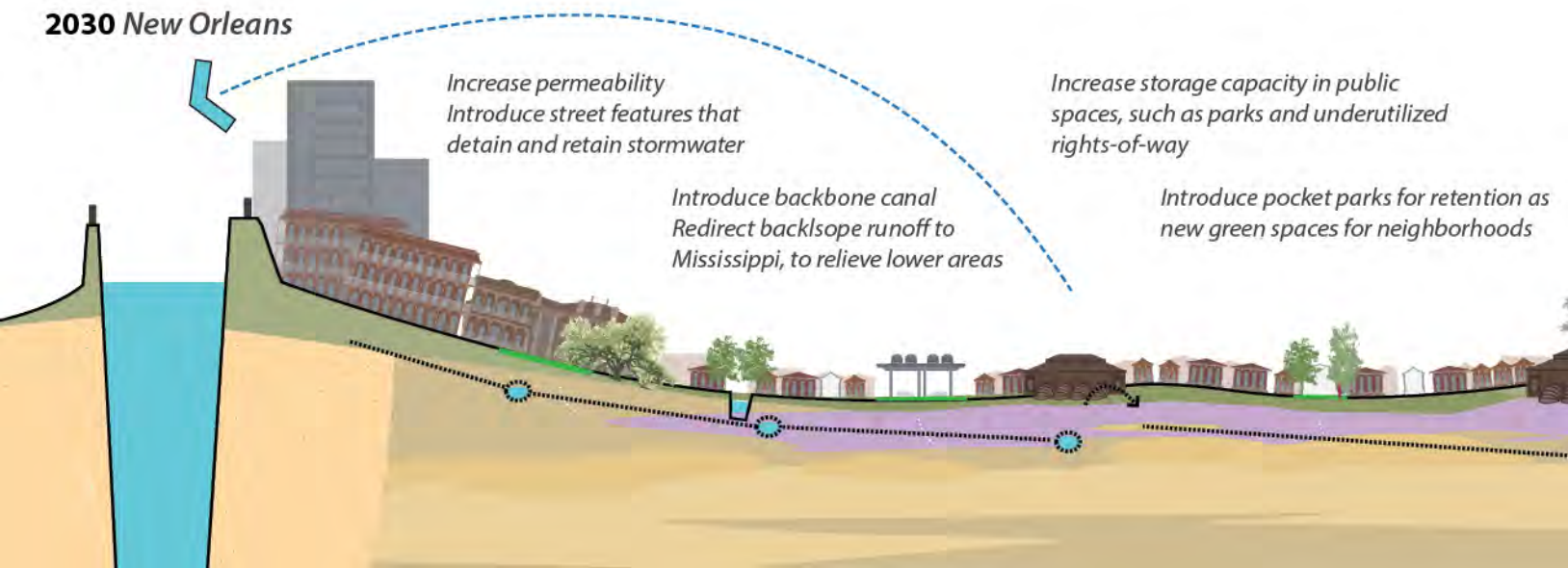
Each leaf blocks the path of raindrops plummeting to the ground, holding on to a few so that leaves glisten with moisture and slowly release their harvest after the storm has passed. The ground absorbs some of the water that falls, replenishing groundwater for tree roots to absorb and send back up into the canopy. Trees are thus good models for a sustainable approach to managing water resources. They slow the flow of water; they store large volumes of water; and they make use of the water that they absorb.

Slow

The structure of existing drainage systems resemble the branches of a tree, with gutters feeding small pipes that connect to larger pipes that empty into canals. Imagine that each tree, garden, and park is a leaf on the region's "drainage tree." Unfortunately, this tree has been stripped of its leaves. Because of how land has been developed, with houses and parking lots built where there had once been water-absorbing wetlands and forests, the branches and the trunks remain but too there are too few "leaves" to slow the flow of stormwater.

Rooftops, yards, driveways, parking lots, and streets can be redesigned and retrofitted to function as if they were the

2030 New Orleans

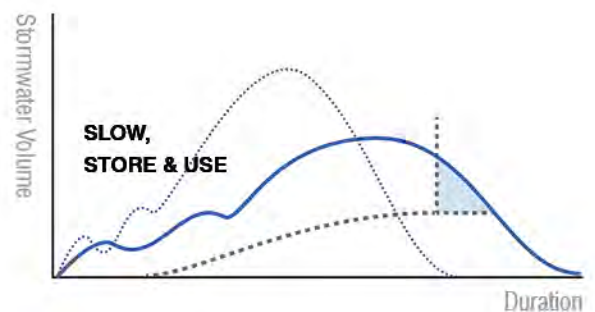
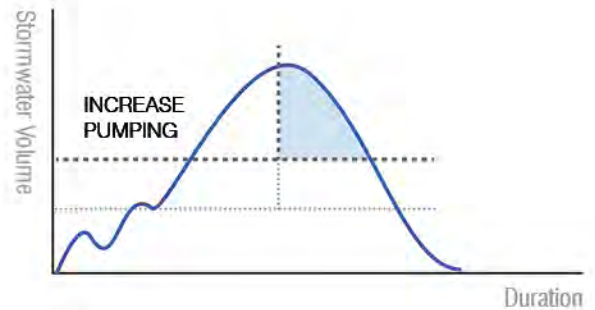
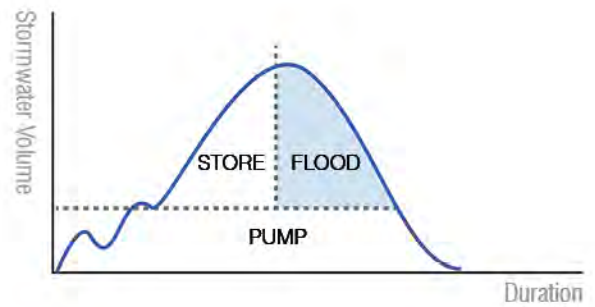


leaves of a tree. That is, hundreds and thousands of these “leaves” can be created across the region’s 155 square miles. Each slows and absorbs water where it falls, and the water that does run off is cleaner and reduced in volume. Just as a tree’s leaves provide benefits for the surrounding environment by cleaning the air, by absorbing water, by providing shade, and by providing homes for variegated flora and fauna, so too will the addition of “leaves” to today’s drainage systems provide quantifiable and long-term benefits to the people and environment of the region.

The region can take the first step from pump-first drainage systems towards an integrated living water system by replacing paved areas wherever possible with vegetated and pervious surfaces that absorb large quantities of rainfall.

Store & Use

The metaphor of the tree has further utility in thinking about the importance of storing water within a drainage network. Each tree is a reservoir within which water from the last rainstorm is stored, and from which the tree’s tissues draw the moisture that is necessary for survival and growth. Similarly, existing drainage networks benefit from the addition of storage areas that can accommodate stormwater that exceeds the capacity of existing systems. Safely stored, stormwater can be absorbed into the ground to replenish groundwater, or diverted to municipal and industrial uses ranging from irrigation to power



Conventional vs. Slow, Store & Use, Drain

These simplified hydrographs compare different strategies for improving drainage. Slow and Store retrofits are cost-effective means of altering the distribution of runoff over time, which reduces flooding without increases in pumping capacity.

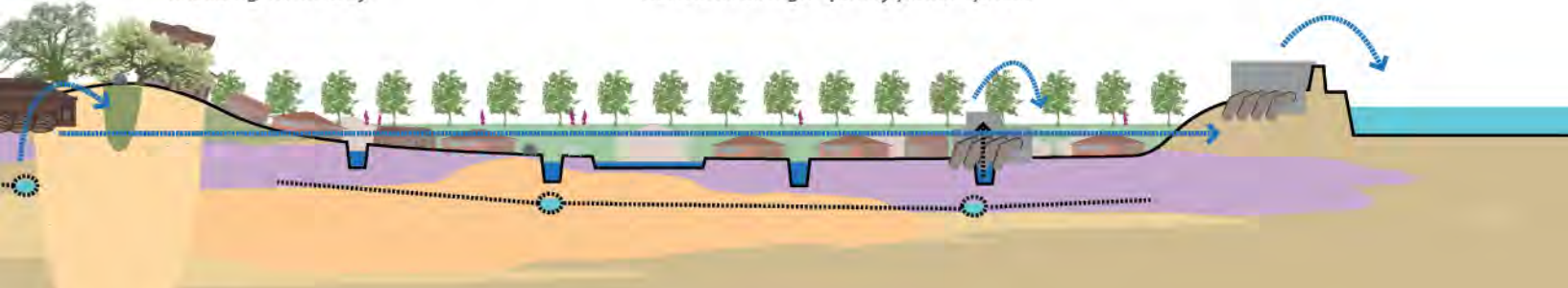
*Introduce retention features on vacant lots
Increase permeability*

*Introduce circulating canal system
Recharge groundwater and raise water table*

Increase storage capacity in public spaces, such as parks and underutilized rights-of-way

*Remove outfall canal floodwalls
Access outfall canals and water networks as high-quality public spaces*

Lakefront closure structures for outfall canals in place



generation. Freshwater is, after all, a resource in increasing demand around the world, and is as fundamental to human existence as it is to the growth of a tree.

Access to freshwater is a critical indicator of a region's sustainability and potential for growth. Finding ways to store the region's abundant rainfall will enable Greater New Orleans to make use of the region's most sustainable source of freshwater.

Drain

With enough Slow and Store features in place, the urban landscape will produce runoff at lesser rates of flow and in lower total quantities. In other words, the volume of stormwater and the speed at which that water arrives at the region's pump stations each time it rains will both be lower. A storm that once required one thousand cubic feet per second (cfs) of pumping capacity to keep a given catchment area dry may only require 600 cfs of pumping capacity, because so much of the stormwater is held upstream where it falls, and safely contained in storage basins that are integrated into the drainage system.

This means that smaller rain events that once triggered pumping may be handled entirely by Slow and Store features, while more intense storms will also place a lesser

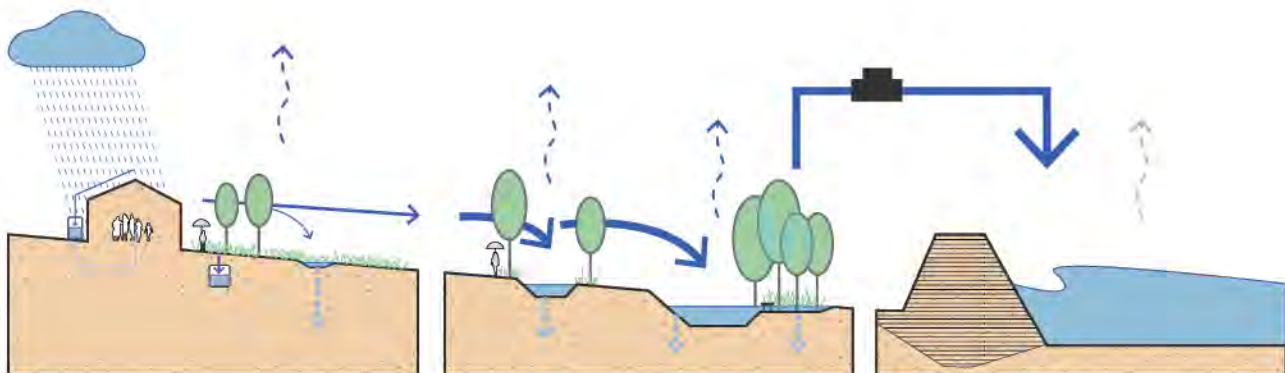
burden on pump stations, so that there are fewer incidences of system overflows and street flooding overall. Greater New Orleans will be able pump less, yet do more, with the drainage systems it has today.

This approach prioritizes investments in distributed water management features upstream over more significant investments in bigger pipes and pumps. Slow and Store retrofits are more readily implementable, provide improved long-term resiliency, and are more adaptable and appropriate to the landscapes and the needs of specific communities across the region.

This alternative to building bigger pipes and more powerful pumps is more appropriate to the urbanized delta landscape of Greater New Orleans, and one that is ultimately more sustainable because it costs less to implement and maintain than the installation of bigger pipes and bigger pumps.

Circulate and Recharge

Year-round and seasonal flows of water are necessary to maintain soil stability and the health of local ecosystems. In contrast, existing drainage systems sit dormant whenever there is no rain. Most pumps are switched off, except for the few that are used to



Slow

Rooftops, driveways, streets, and sidewalks can be redesigned to catch rain where it falls, and to allow some of that water to soak into the ground. A healthy urban tree canopy also slows the flow of water and improves environmental quality.

Store & Use

Large scale detention and retention features integrated into canal networks and public spaces provide additional storage capacity. Stored water can be used for irrigation, recreation, and other purposes.

Drain When Necessary

Pumping should not be the only solution for managing stormwater. Slow and Store features lessen loads on pumping stations, provide additional factors of safety, and enhance the capacity of drainage systems overall.

manage dry weather flow, which includes seepage from drinking water and sewer pipes as well as groundwater that makes its way into drainage pipes and canals. This dry weather flow also contains anything washed into storm drains, including runoff from the watering of lawns or the washing of cars, paint, used motor oil, and other discarded liquids. The water that remains visible in drainage canals stagnates, and the low water levels allow the oxidation and compaction of organic soils to continue.

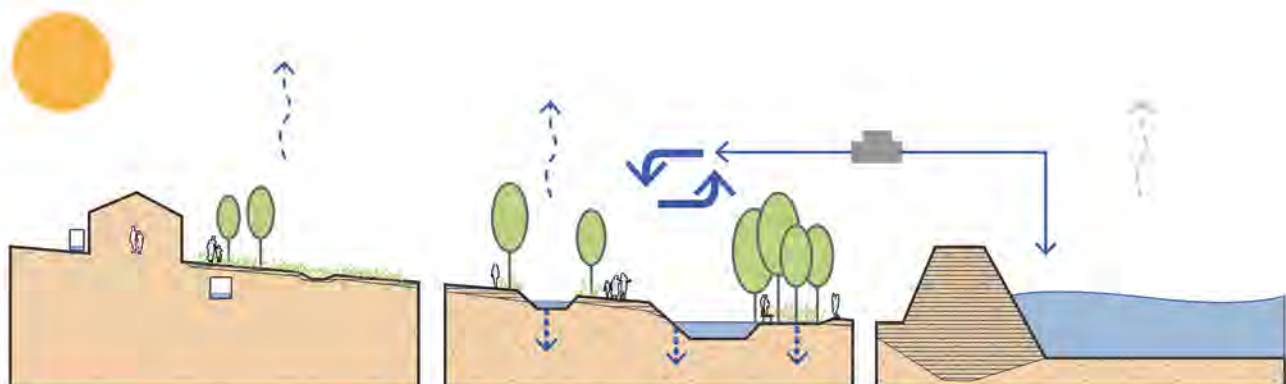
Circulate

With an integrated living water system, today's single-purpose drainage systems would be redesigned to circulate water through surface canals. By constructing siphons and adapting existing pump stations to draw water from Lake Pontchartrain and the Mississippi River, and by tapping stormwater stored during rain events, the region will be able to sustain these flows of water year-round, with some seasonal variation that reflects the climate and its patterns. With continuously flowing water, canals will no longer become clogged with debris and invasive species as they do today, and there will be fewer pockets of stagnant water where mosquitoes are likely to breed. Additionally, new connections between local waterways, lakes, and wetlands will reestablish some of the flows of water that are vital to the health of delta ecosystems.

Recharge

Operating water levels are critical to the sustainability of the region, because they determine whether areas with organic soils stay stable or continue sinking. With an integrated living water system, existing water systems are redesigned to recharge groundwater in addition to performing basic drainage functions. Maintaining higher water levels in surface canals will improve the stability of surrounding soils, but additional measures will be necessary to raise groundwater levels and improve soil stability across the broad lowland areas that are not immediately adjacent to canals. In these areas, the redesign of drainage pipes and catch basins, the construction of new waterways and of distributed groundwater distribution systems will be necessary to recharge groundwater and maintain a higher water table. These networks will rely on surface canals to be their primary water source.

Circulation and Recharge features can only function properly if surface water and groundwater monitoring networks are put in place to enable a comprehensive understanding of water and soil relationships throughout Greater New Orleans.



Circulate

Flowing water makes for improved water quality and more healthful and beautiful canal environments. Restoring connections to wetlands strengthens regional ecology.

Recharge

Maintaining higher groundwater levels improves soil stability and reduces the rate of subsidence for the region's low lying areas. This requires distribution and monitoring networks.



Strategic Parklands

System-scale storage in the form of strategic parklands that can store large volumes of stormwater complement other system strategies for improved wet weather and dry weather flow.

System Strategies

The Urban Water Plan proposes a number of major retrofits to existing systems that include redirecting stormwater flows, adding new pumps and waterways, and strengthening connections between lakes, canals, and wetlands.

Split Drainage at the Ridge

In Jefferson-Orleans Basin today, stormwater from the backslope and bowls of the basin is collected, conveyed across the width of the city, and discharged into Lake Pontchartrain. This means that all of this runoff is pumped through the Metairie-Gentilly Ridge and aggregated with runoff from the lowlands. Building upon existing proposals and projects already underway, the split-at-the-ridge retrofit will instead divert runoff from areas riverside of the ridge into the Mississippi River and the Inner Harbor (Industrial Canal) using new and expanded pump stations in Harahan, Monticello Canal, and the Upper Ninth Ward, in order to unburden lakeside pump stations of that runoff.

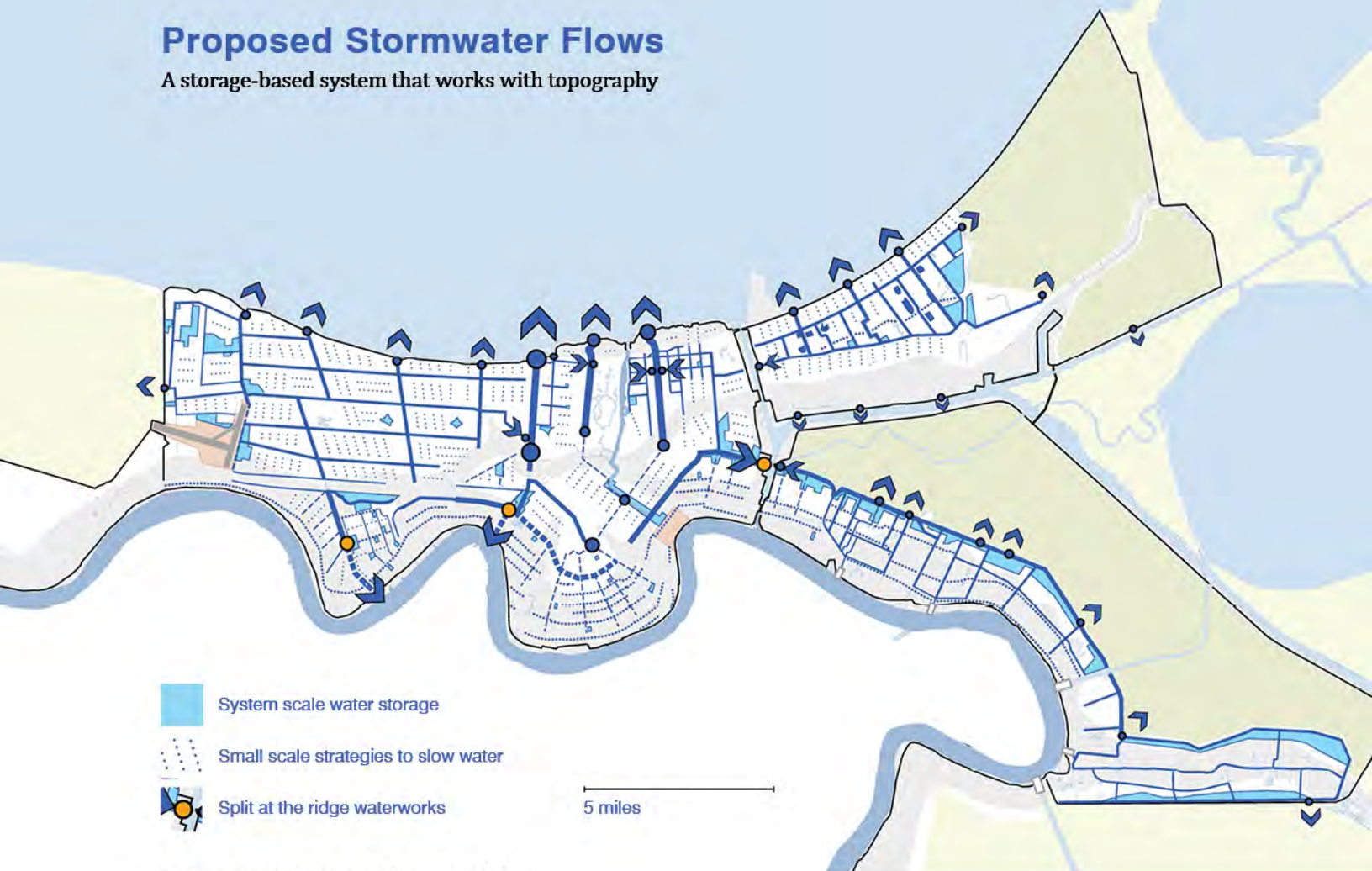
Conveying runoff from the backslope and bowls to the Mississippi and the Inner Harbor rather than towards the lakefront is the primary drainage proposal of the Urban Water Plan.

Surface and subsurface conveyance channels along both Claiborne Avenue and the Airline Corridor play primary roles in redirecting this runoff, making use of box culverts recently completed along Claiborne as part of the US Army Corps of Engineer's ongoing SELA Flood Control Project. Existing connections to lakefront pump stations provide redundancy in the case of system failure.

Splitting drainage at the ridge means that there will be less interdependency between sub-catchment areas, or the potential for cascading failures when runoff from one area combines with that of another area. The proposal will also reduce the volume of stormwater flowing into the 17th Street, Orleans Avenue, and London Avenue Canals. This enhances the opportunities

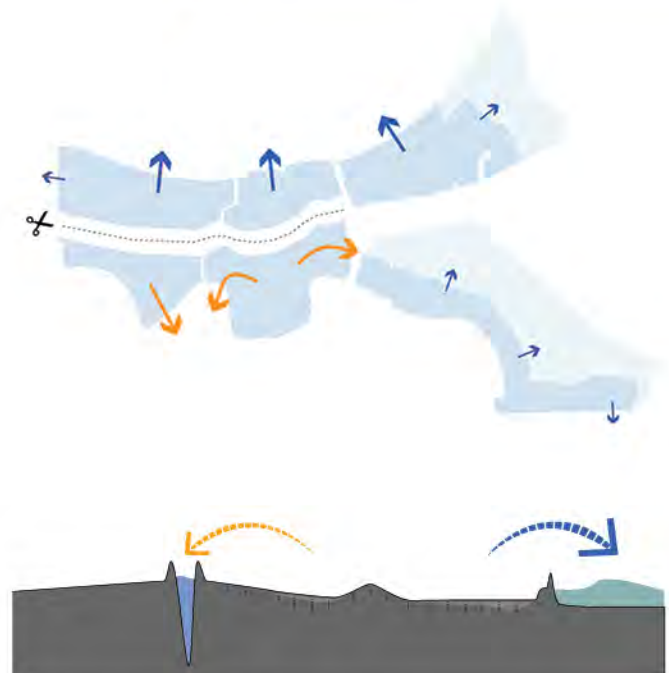
Proposed Stormwater Flows

A storage-based system that works with topography



Stormwater Retrofits

- **Pump to the River** at the Harahan/Elmwood line (project underway)
- **Pump to the River** at the Jefferson/Orleans Parish Line via Monticello Canal
- **Pump to the Inner Harbor** via Florida Canal
- **Store Stormwater** in Strategic Parklands
- **Slow Stormwater** with small scale retrofits distributed across each basin



Split Drainage at the Ridge

Redirect backslope and bowl runoff to the river and the Inner Harbor, rather than conveying it over and through the ridge to lakefront pump stations.



Preventing Mosquitoes

Flowing water, natural predators, and salinity reduce mosquito breeding.



Mosquito control is very important because mosquitoes are vectors for many diseases. Water that stands for more than a few days can become breeding grounds for mosquitoes. However, water management areas can be designed to have all water drain away within a day or two of rainfall or to have continuously flowing water that disrupts breeding. Certain species of fish (like the "mosquitofish," *Gambusia affinis*) and amphibians—cultivated as residents of a healthy, rehabilitated water system—can also be used to control mosquitoes. Finally, the proposed water management strategies control salinity levels in order to create environments inhospitable to mosquitoes.

that exist for lowering canal floodwalls, when the canals' new lakefront closure structures and water levels are operated to provide additional measures of safety.

New Connections

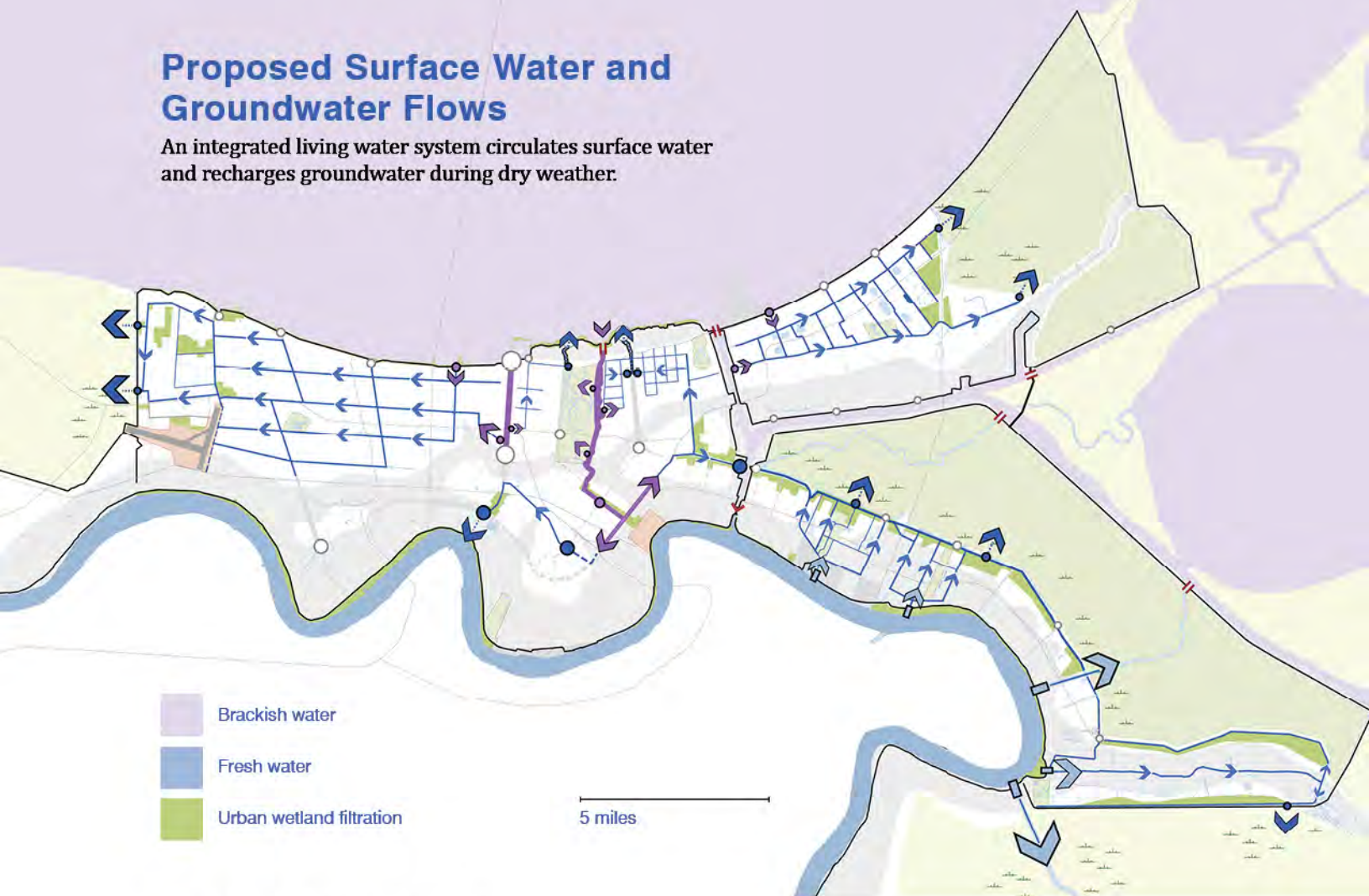
New Orleans East and St. Bernard have lower flood risks than Jefferson-Orleans Basin, because of lower population densities and a lower ratio of impervious to pervious surfaces. Additionally, their canal networks have interconnected catchment areas so that there is redundancy where one pump station can drain stormwater from another catchment area in the case of pump station failure. The Urban Water Plan proposes retrofits in these two basins to further enhance connectivity, enable healthy dry weather flow, and link canal networks to strategic parklands and existing wetlands.

In Orleans East Basin, the Urban Water Plan proposes the installation of a new pump at the eastern end of Morrison Canal to divert a portion of stormwater that is currently pumped into the lake into Bayou Sauvage National Wildlife Refuge instead. This will also serve as the primary outlet for the basin's circulating canals, and as a means of establishing a constant flow of freshwater through the canals and into the wetlands. Farther upslope, a new hydrological connection links the existing Dwyer Canal to Bayou Michoud, which will convey runoff from the Gentilly Ridge (Chef Menteur Highway) towards the basin's wetlands as well. New lateral canals in the heart of the basin connect east-west between the existing drainage canals and between those canals and existing lakes. This will provide additional storage capacity during wet weather and enhance the circulation and recharge of surface water and ground water across the basin.

In St. Bernard Basin, the Urban Water Plan proposes new siphons in Chalmette and Poydras that will bring river water into the basin's canal network and the Bayou Terre aux Boeufs, just as the Violet Canal now provides a constant, though larger, flow of river water into the Central Wetlands Unit. These new flows of water will improve the dry weather function and aesthetics of the basin's waterways, and strengthen wetland habitats situated along the Forty Arpent Canal, in the Central Wetlands Unit, and in Lower St. Bernard.

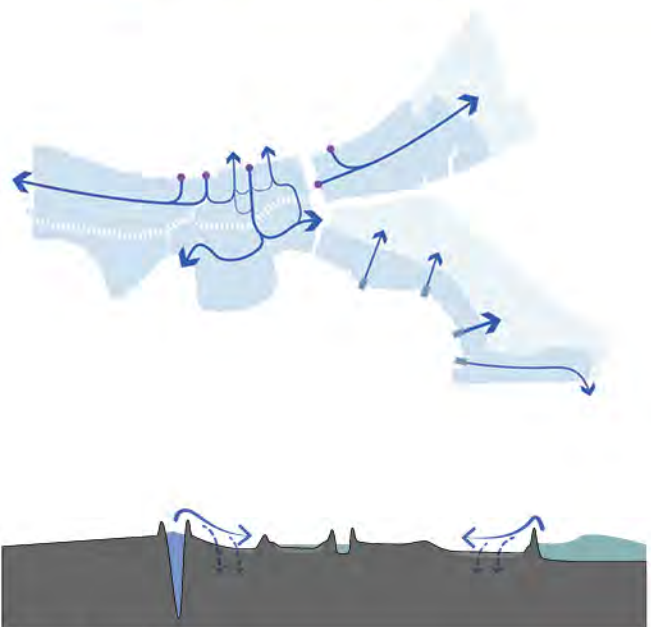
Proposed Surface Water and Groundwater Flows

An integrated living water system circulates surface water and recharges groundwater during dry weather.



Surface Water and Groundwater Retrofits

- **Circulate river water** via siphons through the St. Bernard canal network
- **Circulate lake water** via existing pump stations and Bayou St. John through lowland canal networks
- **Connect canal networks** to lakes and filtration wetlands
- **Maintain higher water levels** in surface canals, within 2' to 3' of the surface of the ground
- **Adjust water table** with distribution and monitoring networks



Circulate Water Every Day

The river and the lake provide ready sources of freshwater and brackish water with which to circulate water through the region's canal networks, which allows for groundwater recharge and improved water quality in canals.

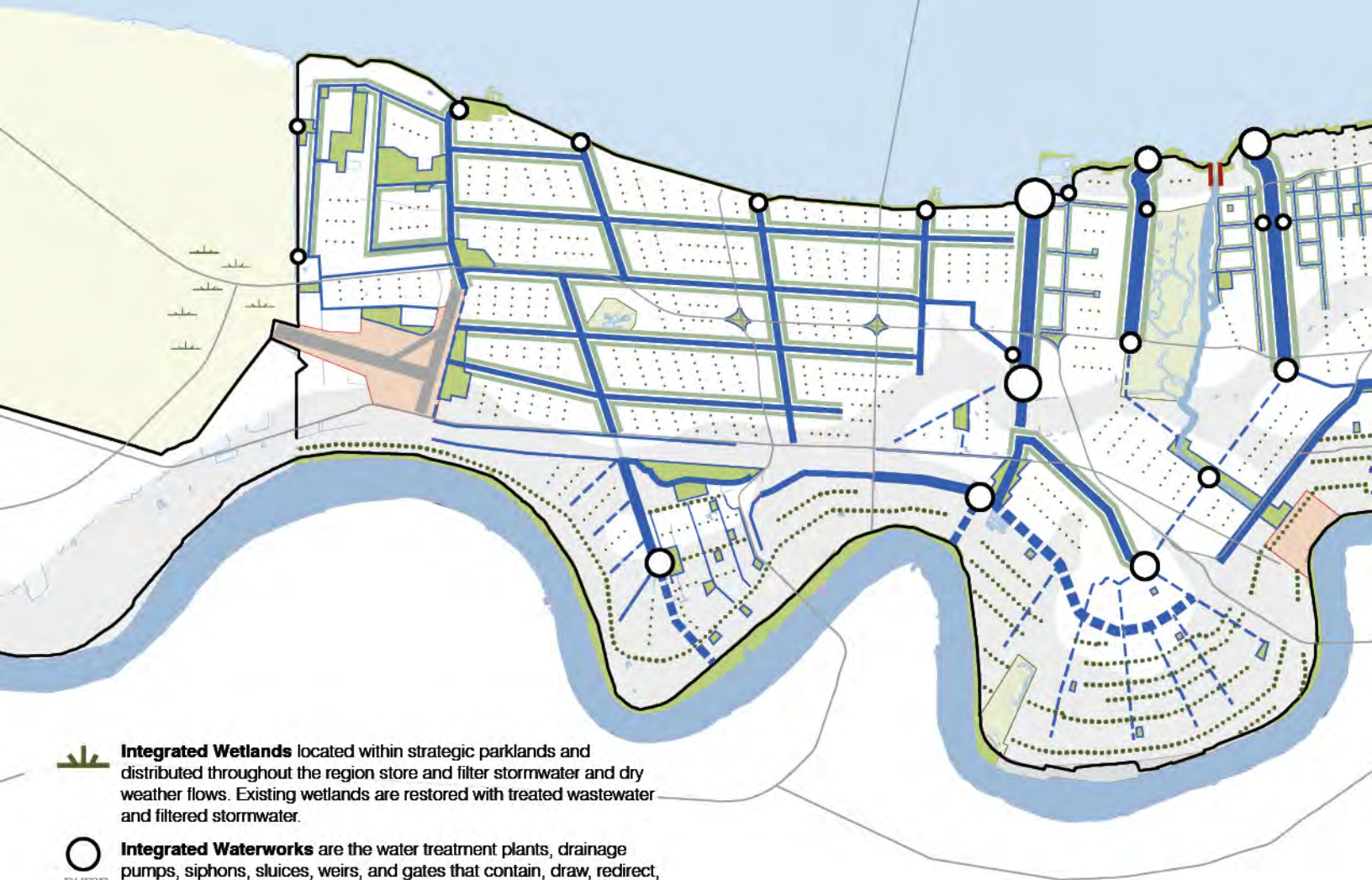
The Integrated Living Water System

The Components of the Proposed System

 **Small-scale Retrofits** in streets, on individual properties, in parks, and in squares and plazas slow and store stormwater, catching and infiltrating water where it falls. Interceptor streets on high ground are a critical subset of small-scale retrofits.

 **Circulating Canals** in the region's bowls and lowlands recharge groundwater and sustain local habitats. During wet weather, they continue to serve as drainage conduits.

 **Strategic Parklands** at key junctures of the integrated living water system contain vast quantities of stormwater during heavy rains, while providing valuable open space and recreational amenities.



 **Integrated Wetlands** located within strategic parklands and distributed throughout the region store and filter stormwater and dry weather flows. Existing wetlands are restored with treated wastewater and filtered stormwater.

 **Integrated Waterworks** are the water treatment plants, drainage pumps, siphons, sluices, weirs, and gates that contain, draw, redirect, and filter stormwater, surface water, groundwater, drinking water, sewage, and industrial wastewater. They are the components that establish the flows and rhythms of the living water system.

Regional Monitoring Networks for surface water and groundwater provide system managers with real-time data that are necessary to address immediate drainage needs and long-term trends in water levels and water quality, and to maintain higher water levels without compromising safety.

Waterfront Development Zones around key waterways and parklands anchor the development of higher-density, multi-use districts defined by urban water assets.



5 miles



System Components

Expanded definitions and examples

Small Scale Retrofits in streets, on individual properties, in parks, and in squares and plazas slow and store stormwater, catching and infiltrating water where it falls. Interceptor streets on high ground are a critical subset of small-scale retrofits.

Already, there are rain gardens along Oretha Castle Haley Boulevard and in City Park, pervious streets in the Lower Ninth Ward, curb extensions and bioswales planned for Pontilly, and pervious paving, rainwater harvesting, and similar detention and retention features on scattered properties throughout the region. Such projects provide direct environmental benefits to their implementers and users. And because large scale retrofits to existing drainage systems alone are not enough to mitigate flooding, significant reductions in runoff are necessary as well. Achieving these reductions begins with the streets and properties that make up the urban landscape.

Small Scale Retrofits: Properties

With hundreds of thousands of residential and commercial properties across Greater New Orleans, each is an opportunity to manage runoff at the source. The replacement of impervious surfaces such as asphalt and concrete with pervious paving and the introduction of water-loving vegetation will slow and filter the flow of stormwater off of a property. Bioswales, rain gardens, detention basins, and retention basins will store rainfall, giving it time to soak into the ground, while trapping sediments and absorbing pollutants. Rain barrels and other water-harvesting systems provide a ready source of water for irrigation and other uses, just as cisterns throughout the region once did.

Small Scale Retrofits: Streets

Streets are important because their gutters and curb inlets are the initial points of entry for runoff into drainage systems. Runoff from properties and streets collects debris, fertilizers, pesticides, oil, and other

common pollutants, all of which are drained into receiving waterways and water bodies. Street-side solutions for collecting and filtering first-flush runoff are necessary for overall improvements in water quality and reducing total runoff volumes.

As road surfaces near the end of their usable life spans, the gradual replacement of impervious asphalt with pervious paving will allow the ground to absorb stormwater. The introduction of water-storing subbases and subsurface storage chambers will augment the storage capacity of each street. Installing curb cuts and curb extensions to divert runoff into neutral grounds and street-side rain gardens will provide another means of improving stormwater retention along public rights-of-way.

The planting of additional street trees expands the urban forest, which provides much-needed shade and water storage capabilities. A single mature cypress can absorb over 800 gallons of water in a single day, and the evapotranspiration of trees cleans the air and cools the surrounding environment.

Small Scale Retrofits: Interceptor Streets

Interceptor streets are configurations of small scale retrofits designed for backslope neighborhoods. The insertion of pervious paving, subsurface storage, curb extensions, and rain gardens into public rights-of-way that run perpendicular to the flow of water will allow each interceptor street to function as a speed bump, absorbing and slowing water as it moves down slope. This will significantly reduce the load on pump stations and alleviate street flooding for downstream neighborhoods.

Circulating Canals in the region's bowls and lowlands recharge groundwater and sustain local habitats. During wet weather, they continue to serve as drainage conduits.

In some cases, such as the lowlands of Jefferson and New Orleans East, extensive canal networks already exist. In other cases, such as the lowlands of Orleans, the canals that do exist are hidden behind high concrete walls, and most of the surface canals that once drained the land have been buried underground as pipes and culverts.

Realizing the benefits that are possible with these waterways is possible if the canals are seen as more than mere highways for stormwater. Well into the twentieth century, canals and bayous served as sites of commerce and public life.

In initial phases, canal improvements begin as simple retrofits to canal banks and water levels that improve groundwater balance, aesthetics and public access to water. Long-term, providing canals with water sources that induce water flow during dry weather, adding new canals that connect existing canals and new strategic parklands, and the strengthening of hydrological connections to the region's lakes and wetlands will form a more resilient and adaptable multi-use network that improves drainage, soil stability, water quality, environmental quality, and access to open space and recreational amenities.

Strategic Parklands at key junctures of the integrated living water system contain vast quantities of stormwater during heavy rains, while providing valuable open space and recreational amenities.

Storm intensity and limited storage capacity are two of the reasons providing adequate drainage is so difficult. On May 30, 2013, for example, over six inches of rain fell on Kenner in two hours, resulting in street flooding, disruptions to business and transportation, and property loss. Building pipes and pump stations large enough to handle the peak rainfall of every storm is cost-prohibitive, and provides few fail safes in the case of system failures.

Thousands of acres of parklands are located at key points throughout the region where relief is often necessary, such as critical outfall areas, points where drainage channels converge, and at intersections of drainage channels with railroad embankments and other hydrological barriers. The construction of parklands at these points will provide critical release valves with over 10,000 acre feet of additional storage capacity.

When not in use as overflow basins, parklands will provide a diversity of ecological and recreational environments ranging from wetlands and meadows to athletic fields and agricultural fields. All



Street Retrofits & Waterworks

Street retrofits like Portland's bioswales (top) can be very cost effective, technologically undemanding, and pleasant. Passive systems (like the City Park waterwork at bottom) manage water and have greater benefits for the water system and environment.

Top Photo: ASLA

of these amenities can be designed to withstand periodic flooding. Wally Pontiff Park in Jefferson Parish is an example of an existing parkland, where the construction of low levees around the 35 acre site allows it to safely hold stormwater from adjoining neighborhoods.

Integrated Wetlands located within strategic parklands and distributed throughout the region store and filter stormwater and dry weather flows. Existing wetlands are restored with treated wastewater and filtered stormwater.

The restoration of regional wetlands and the development of new urban wetlands in Kenner and New Orleans East are key to the region's ability to thrive. Furnished with new sources of freshwater and brackish water, and integrated into canal networks and parklands, these wetlands will become healthier habitats with improved biodiversity, and become regional assets that draw visitors from around the world.

Providing opportunities for residents and visitors to experience wetlands within the region's boundaries will benefit the regional economy and reconnect residents to the delta. A twenty seven acre parcel of undeveloped wetland next to the London Avenue Canal and Dillard University is a hidden asset in the middle of New Orleans. St. Bernard's Central Wetlands Unit is a ten-minute drive from the French Quarter, but is neglected and hidden behind levees. The New Orleans Sewerage & Water Board and the Lake Borgne Levee District are currently collaborating on a wetlands assimilation project to restore cypress swamps in this environment using treated wastewater. Bayou Sauvage National Wildlife Refuge—located in Orleans East Basin and the largest urban national wildlife refuge in the country—is similarly disconnected from the city proper in the mental maps of most residents and visitors. Motorists leaving Jefferson-Orleans Basin on Interstate 10 traverse the LaBranche Wetlands, which gives a glimpse of the watery environment out of which the region's urbanized lowlands were created. These wetlands are the site for a wetlands assimilation proposal from the City of Kenner.

While the integrated living water system cannot replicate the seasonal overbank river flooding that nourished regional swamps and marshes in the past, a holistic approach to managing water and nutrient flows between the urban water networks and wetlands can improve the function and health of both.

Integrated Waterworks are the water treatment plants, drainage pumps, siphons, sluices, weirs, and gates that contain, draw, redirect, and filter stormwater, surface water, groundwater, drinking water, sewage, and industrial wastewater. They are the components that establish the flows and rhythms of the integrated living water system.

Together, these waterworks determine the water balance of Greater New Orleans. Meaning, these facilities regulate the total volume of water contained in pipes, canal, local waterways, soils, and aquifers in relation to rainfall, evapotranspiration, and water usage. This balance changes from day to day, during rainstorms, during droughts, and over longer periods of time as demand for water resources fluctuates.

Drainage, drinking water, sewerage, irrigation, and industrial wastewater systems are currently managed as separate systems, even though they are related in critical ways. For example, underground drinking and sewer pipes can and do break due to subsidence caused by drainage systems. These breaks allow for groundwater and sediments to be drawn into drainage pipes. That groundwater can contain water and effluent leaked from broken drinking water pipes, but also from broken sewerage pipes. By integrating the management of these systems and the waterworks that govern their function, Greater New Orleans will be equipped to manage water in times of excess as well as shortage, improve water quality, and maintain sustainable surface water and groundwater levels.

As Greater New Orleans improves both the function and aesthetics of its water networks, its waterworks will become increasingly important locations for educating the public on changes to water systems. Fully integrated into everyday

life, they will be proud structures and vital public places where residents and visitors can see the region's water systems in action.

Regional Monitoring Networks for surface water and groundwater provide system managers with real-time data that are necessary to address immediate drainage needs and long-term trends in water levels and water quality, and to maintain higher water levels without compromising safety.

Surface water monitoring gauges already exist. Sharing the collected data between water management authorities will enable a comprehensive regional approach to stormwater and surface water flows. New data collection points for water levels and water quality will allow managers to tune operations to the particular profile of each rain event and the needs of individual catchment areas. A regional groundwater monitoring network will build on the data already being collected at monitoring wells distributed throughout the region. Additional wells are necessary to study the following issues:

- Soil and water dynamics in subsidence-prone areas
- Exposure of wooden piles to aerobic conditions
- Relationship between groundwater levels and surface water levels

- Influence of the Mississippi River and Lake Pontchartrain on groundwater levels
- Capacity of local soils for absorbing and storing stormwater
- Regional saltwater intrusion

Waterfront Development Zones around key waterways anchor the development of higher-density, multi-use districts defined by urban water assets, as well as lower density residential development alongside parklands.

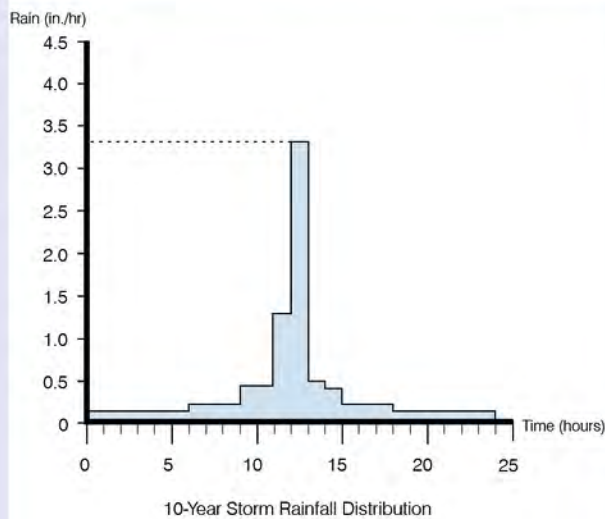
Boston's Emerald Necklace. San Antonio's Riverwalk. Houston's Buffalo Bayou. Each of these is an iconic destination that anchors the urban fabric, and they are memorable because they are of a specific place and people. Greater New Orleans, too, can develop such iconic places around the region's waterways and parklands.

Where waterways and floodwalls now form barriers between neighborhoods, retrofits and lowered floodwalls will allow new waterfront zones to prosper, as places to come together and to see the urban landscape in a new way. The floodwall failures of 2005 left indelible marks on the landscape and in the psyches of residents. Investing in improvements to the infrastructure where these failures occurred strengthens flood defenses, while allowing the public to reclaim these waterways as beautiful places for everyday use, public life, and economic growth.



Strategic Parklands

Jefferson Parish's Wally Pontiff Park is the region's foremost example of a strategic parkland. Its 35 acre site is bounded by low levees, which contain stormwater pumped from adjoining neighborhoods into the park during heavy rainstorms.



10-Year Design Storm

A so-called “ten year storm” is a theoretical rain event that has a 10% chance of occurring in any given year, developed from actual storms that have occurred in metro New Orleans. The hydrograph, above, describes the distribution of rainfall over 24 hours, during which 8.5 inches of total rainfall is expected, with a peak intensity of 3.43 inches/hour. For actual storms, the geographic distribution of rainfall and the intensity of the storm for different locations varies, as seen in the photograph of isolated rainfall, top.

Proof of Concept

Engineers on the Urban Water Plan team developed hydraulic models to determine the impact of the plan’s proposals, individually, in aggregate, and at different levels of implementation. Modeling results indicate that significant gains in safety are possible, though collaborations between stakeholders across the region and at all scales of implementation are necessary to achieve the benefits of an integrated living water system.

Modeling Inputs

A digital stormwater management model (SWMM) was developed to test the Urban Water Plan’s proposals at a proof of concept level. Contributing factors for each catchment area included surface elevations, land cover, soil infiltration rates, storage capacity, pumping capacity, and the largest elements of existing and proposed drainage networks. For Jefferson and St. Bernard Parishes, these included open canals, but not the pipes that empty into those canals. For Orleans Parish, this included canals and drainage pipes greater than 36” in diameter. This coarse level of detail was not enough to test for district-level impact, or for individual projects, but clear patterns emerged at the basin scale to guide the development of Urban Water Plan proposals.

Engineers modeled the performance of existing and proposed systems during a theoretical 10-year storm (8.5 inches of rainfall over 24 hours, with a peak intensity of 3.43 inches/hour). The design storm was developed as an average of actual 10-year storms recorded in metro New Orleans over the past fifty years, and anticipates a 5% increase in rainfall intensity by 2025 as a result of climate change. The model takes into account rainfall distribution over time, and the effect that existing groundwater levels have on storage capacity.

Three basic parameters were adjusted in order to test the living water system relative to the existing system:

- **Slow** proposals include small scale retrofits on public and private properties as well as the addition

of detention and retention features on vacant properties. These are modeled as adjustments to each catchment area's land cover and runoff characteristics.

- **Store** proposals include strategic parklands and the conversion of other open spaces such as highway interchanges into detention and retention basins. They are modeled as additional nodes or wide shallow conduits within drainage systems that expand the overall storage capacity of the catchment area in which those features are located.
- **Drain** proposals include the split-at-the-ridge retrofit for Jefferson-Orleans Basin, as well as the new connections proposed for St. Bernard and Orleans East Basins. They are modeled as new conduits and increased pumping capacity for the associated catchment areas.

Modeling Results

For each basin, the impact of Slow, Store, and Drain proposals were modeled separately and in combination. The results described here focus just on the scenarios in which the three categories of proposals were modeled together. For more detailed modeling inputs, full modeling results, and detailed explanations of each scenario modeled, please consult the Water System Analysis and Water System Design Reports, available for download at livingwithwater.com.

Modeling outputs consist of the average peak stages (high water levels) in each basin's drainage system during a 10-year storm, which can be compared for three scenarios:

- The **Existing Scenario** establishes baseline data against which to measure the impact of proposed retrofits.
- The **Basic Scenario** assumes partial implementation of Slow, Store, and Drain proposals, with retrofits selected for modeling that are more likely to be implemented given existing resources and regulatory frameworks. This scenario would lower flood risk

Basic Scenario



SLOW

- Retention on 3.33% of Vacant Lots
- 870 Acre-Ft. of Street BMPs
- 25% of Properties Store 1.25"



STORE

- 2,165 Acres of Near-Term Storage



DRAIN

- \$1.1 Billion in Drainage System Upgrades

Intensive Scenario



SLOW

- Retention on 20% of Vacant Lots
- 1,815 Acre-Ft. of Street BMPs
- 100% of Parcels store 1.25"



STORE

- All 5,622 Acres of Storage



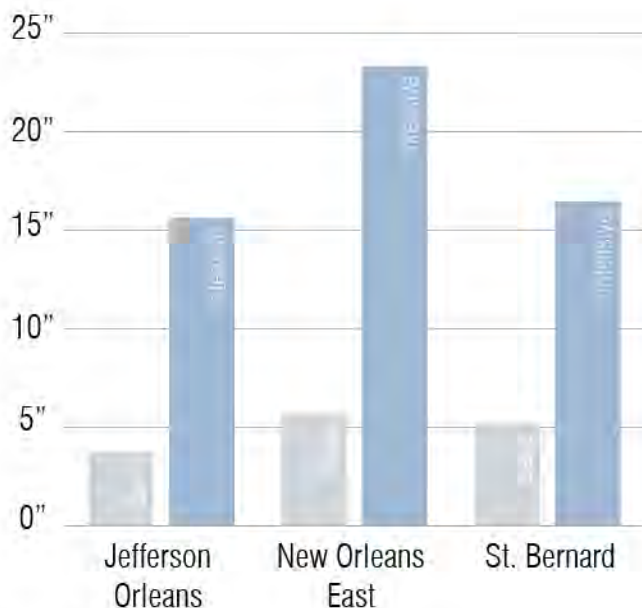
DRAIN

- \$2.2 Billion in Drainage System Upgrades

Basic and Intensive Scenarios

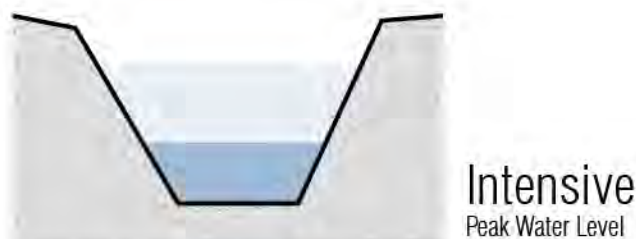
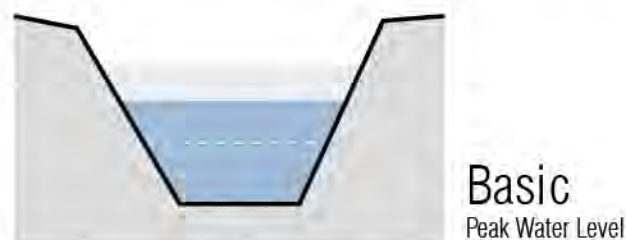
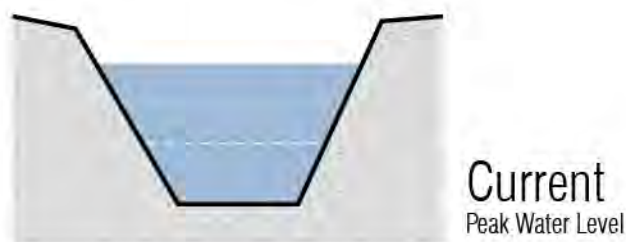
Hydraulic modeling tested the performance of the proposed drainage system at two levels of implementation in order to determine average peak stages—high water levels—for each basin in the event of a 10-year storm.

Each scenario combined Slow, Store, and Drain measures, including the use of selected vacant lots, private properties, public small scale retrofits (Street BMPs), strategic parklands (Storage), and the Split-at-the-Ridge retrofits and New Connections described in the "System Strategies" section of this chapter.



Basic & Intensive Peak Reductions

Based on modeling of Urban Water Plan proposals, peak stage water levels would be reduced across all basins. Basic and Intensive implementation scenarios are shown above for each basin.



Reducing Peak Water Levels

Hydraulic models tested for peak water levels (stages) in the basins' drainage systems. Both Basic and Intensive scenarios would lower peak stages for all basins, which would reduce canal overflows, system backups, and other causes of flooding.

throughout the region, as seen in average peak stage reductions of 3.72 inches for Jefferson-Orleans Basin, 5.64 inches for Orleans East Basin, and 5.16 inches for St. Bernard Basin.

- The **Intensive Scenario** assumes full implementation of the most ambitious Slow, Store, and Drain proposals, which would not be feasible in their entirety without broad shifts in policy, funding, and design and engineering at every scale. This scenario would dramatically lower flood risk in each basin, as seen in average peak stage reductions of 15.6 inches for Jefferson-Orleans Basin, 23.28 inches for Orleans East Basin, and 16.44 inches for St. Bernard Basin.

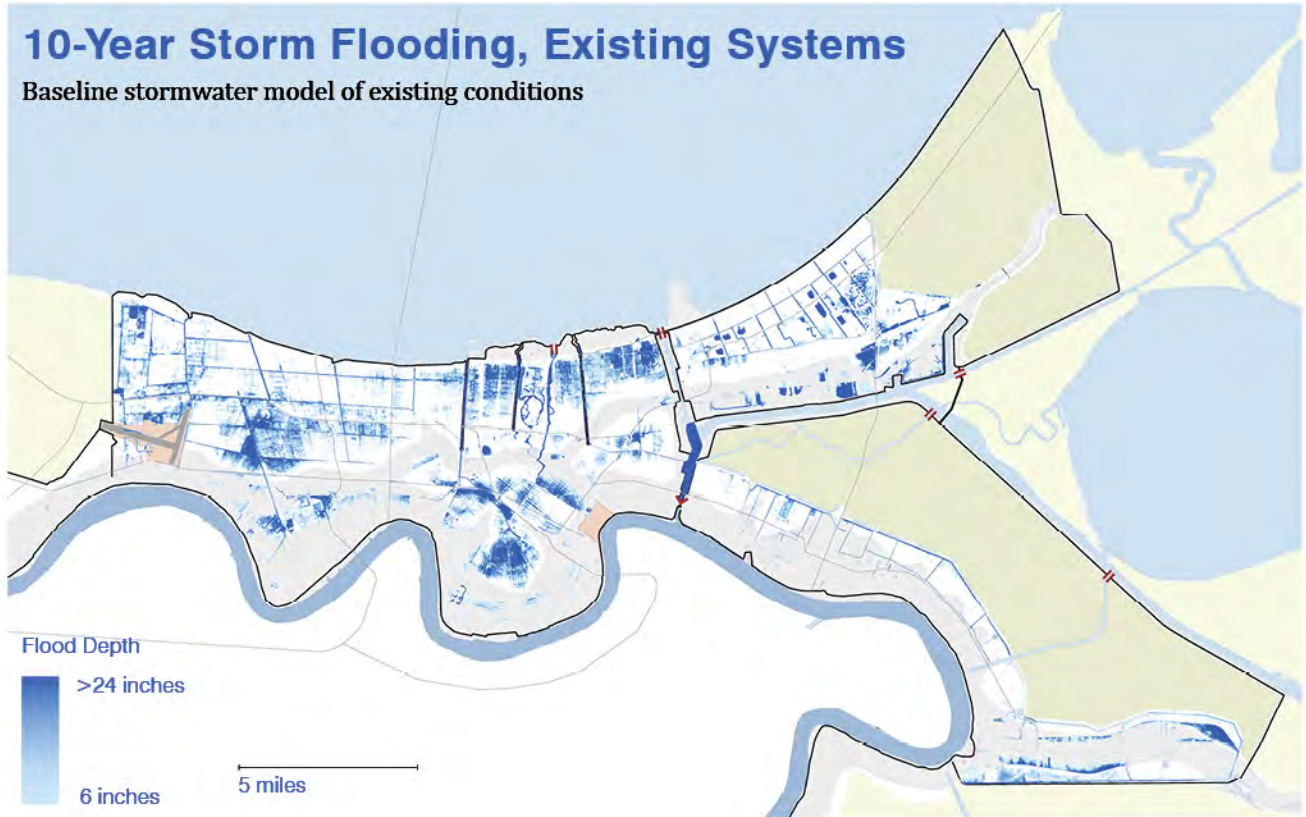
This means that at a given point in St. Bernard Basin's drainage network, for example, stormwater that currently threatens to overtop canal banks during a 10-year storm, would be lowered by an average of 16.4 inches. The actual peak stage reduction for any given point would be dependent on local hydrological conditions, but the gains in safety across the basin would be considerable overall. Peak stage reductions would likely be even greater for the majority of rain events, because most rain events in the region are, by definition, smaller than the 10-year storm used in the modeling process.

Significant peak stage reductions are possible with the proposed system retrofits.

The modeling results support the underlying principles of the Urban Water Plan, in which investments in slowing and storing stormwater improve the function of existing drainage systems and provide an additional measure of safety for storms both smaller and greater than the design storm. However, visualizations of the modeling results provided on the facing page indicate that some smaller areas would still experience flooding during a 10-year storm, even within the Intensive scenario. This makes clear the importance of further system modeling, and of the design efforts that are necessary at the district and project scales in order to address localized conditions and opportunities for addressing specific challenges.

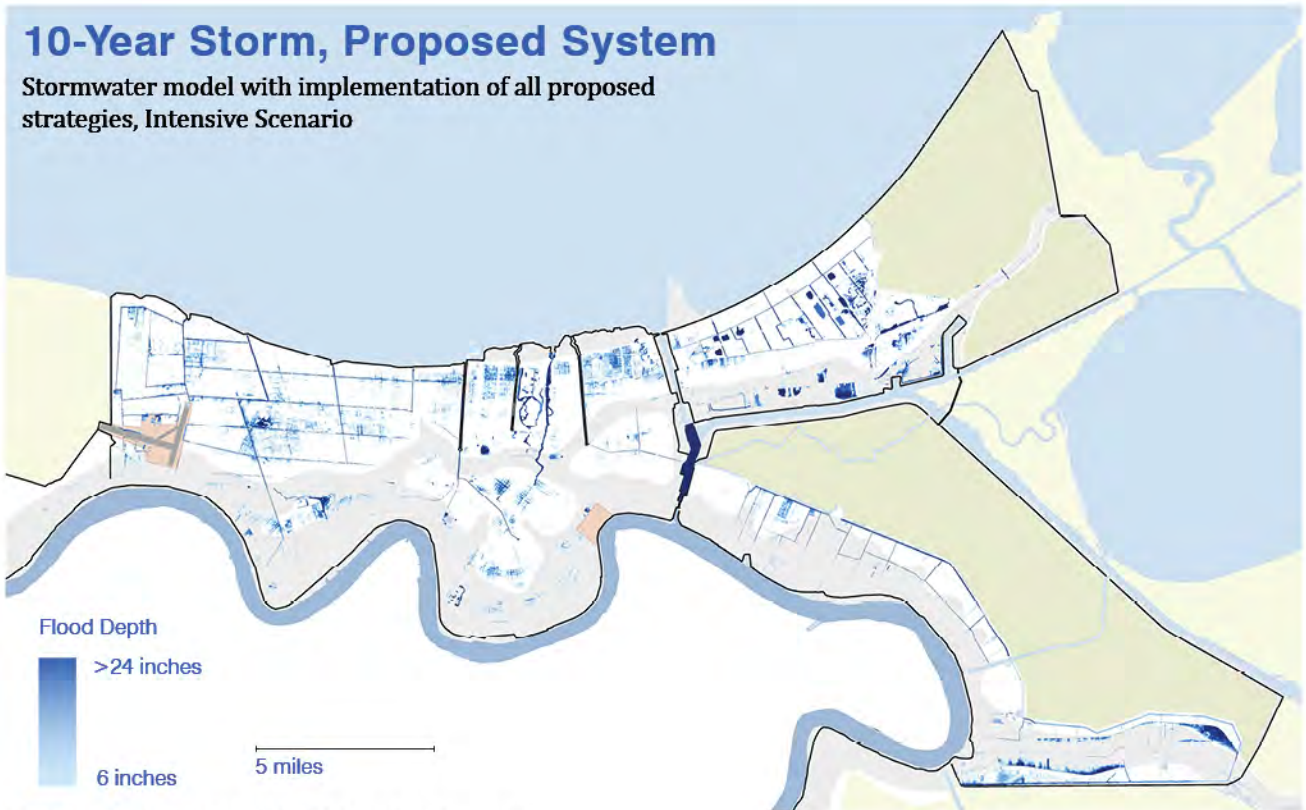
10-Year Storm Flooding, Existing Systems

Baseline stormwater model of existing conditions



10-Year Storm, Proposed System

Stormwater model with implementation of all proposed strategies, Intensive Scenario



Modeling the Impact of Urban Water Plan Proposals

The hydraulic model was developed to test concepts at the regional scale. It shows that the integrated living water system would provide widespread drainage improvements. The residual flooding that remains, however, requires more detailed modeling at the district scale, and more specific solutions developed in partnership with local stakeholders.



“The reflected world is the conquest of calm.”

Gaston Bachelard

Early 20th century French philosopher. From “Clear Waters, Springtime Waters”





5 Seeing Solutions

DESIGN PROJECTS

A renewed awareness of place is needed to develop effective planning and design solutions, and this starts with experiencing the water that flows through Greater New Orleans. Geophysical problems—and solutions—transcend political and demographic boundaries, and require water-based planning at every scale where there are shared conditions and opportunities. Visualizing solutions entails not only realizing near-term opportunities for retrofits that will make an immediate difference, but also envisioning the water-rich and resilient city that New Orleans can become.

Each solution is also an affirmation of the positive role that water can play in everyday life, as a tangible asset, an economic resource, a critical element in the city's public life, and as a source of stability in maintaining the flows and water balance crucial to the long term sustainability of the region.

Seeing Solutions

DESIGN PROJECTS

Greater New Orleans is surrounded by water and accessible primarily by bridge, boat, and air. The form and culture of the region have deep roots in its waterways and water resources. Planning and design according to the guiding principles of the Urban Water Plan at the basin, district, and demonstration project scales yield opportunities from the redesign of single streets to the revitalization of entire districts.



Bridge City

Greater New Orleans is sited amidst water and accessible primarily by bridge. Establishing connections to outside resources, people, and environments is critical to the future of the region.

Know Where You Are

What new kinds of cultural knowledge are needed to live safely below sea level? What does every resident of the Mississippi River Delta need to know? By most measures, Greater New Orleans—the urbanized area within the hardened perimeter of the HSDRRS—is an island on the delta, surrounded on all sides by water. One must travel over water in order to get into the city, no matter the mode of transportation. By plane, one descends over vast expanses of wetland, the muddy blue ribbon of the Mississippi or Lake Pontchartrain, and lands on the lily pad of hardened and drained wetland that this region has become. By car, all roads turn to bridges or causeways for the final stretch as one crosses into the city, except for River Road, which hugs the high ground of the river levee.

Within the levees and floodwalls, maintaining awareness of the life-sustaining role of water in every aspect of deltaic life becomes much more difficult. Reintegrating water back into the physical fabric, consciousness, and identity of the region is the key to ensuring its longevity on the soft land of the delta.

Physical Principles

Physics, and gravity in particular, are of utmost importance to Greater New Orleans. The famously slow-paced lifestyle of the region is not only a cultural phenomenon, but it is also the pace of the surrounding environment. The almost imperceptible slope of the landscape keeps the flow of water slow as it courses through marshes, swamps, and bayous.

The energy-intensive technologies of modern forced drainage represent current efforts to counteract the basic physics of soils and flowing water. But by countering intense rainfall with speed and power, moving massive quantities of water rapidly across flat land and lifting that water out as quickly as possible, modern drainage infrastructure slowly compromises the long-term safety of the city.

The same laws of physics, however, can be harnessed to bring the system back

into balance, with benefits for residents, communities, and habitats throughout the three basins. Physical spaces and public infrastructure should revel in the slow and steady rhythms of the delta, living with water and working with nature. Public works can benefit from incorporating natural processes and constant adaptation as the delta shifts and the climate changes, and even mechanical systems and infrastructure can be tuned to topography, ecology, and weather.

Shape of the Ground

Greater New Orleans already orients itself to the water. The growth of the city is evident in the backslope's arpent-derived street grid, which radiates from the Mississippi and substitutes "lakeside, riverside, uptown, and downtown" for the cardinal directions common to other cities. For those living in the delta, water offers a sense of direction and place.

Unfortunately, nuanced knowledge of the landscape has been erased by urban

development. Before pumps and pipes, relationships between high and low ground were common knowledge. Hurricane Katrina and its aftermath brought these distinctions back to the fore, however. Now advancing beyond disaster recovery, the region must recognize how fundamentals of the landscape and the relationship between ground and water influence the ways we live today, and point to a more secure future.

The ground shapes possibilities for interacting with water, and shapes the way the region sees itself.

New Patterns and Strong Identities

The Urban Water Plan proposes new patterns in the landscape, and in the structuring of ground, water, and infrastructure. Picture networks of circulating canals, and canopies of live oaks integrated into streets. Wetlands and cypress forests provide greater biodiversity



Island City

Greater New Orleans is an island on the delta, a patch of urbanized and hardened ground made out of the swamps, bayous, and estuaries of southeast Louisiana.



Lake City

The Lake Pontchartrain coastline is an asset shared by all three basins, a common line of flood defense, but also a place to enjoy the sun and water.

with restored habitats. Strategic parklands are located at key points of confluence. Blueways and greenways link once-isolated districts and connect parks and plazas. Overall, a richer, more beautiful region is the result, with a distinct design aesthetic built on the inexorable physical principles of the delta. For each district, there are stronger identities and more stable ground, as design and planning strategies are adjusted to the specific topography, soils, waters, culture, people, and businesses of each area. With the Urban Water Plan in hand, the people of Greater New Orleans can build towards this vision, one project, one district, and one basin at a time.

A New Kind of Knowledge

Today, a local is someone who knows which streets flood when it rains, and where to park his or her car to avoid having it flooded. The Urban Water Plan proposes a place where parking cars on neutral grounds in anticipation of rain is a quaint tradition rather than a necessity; a place where people gather around water, rather



A Safe Place to Swim

In the most advanced implementation phases of the Urban Water Plan, constructed barrier islands can provide storm surge protection at the lakefront while offering beach and wetland amenities that link together the coastline of Greater New Orleans.

than hiding from it. It is a place where people wield a new vocabulary of place and public works that reflects a deeper understanding of the lay of the land and the flow of water: backslope, ridge, and bowl; groundwater level and water assignment; catchment area and watershed.

Basins, Districts & Demonstration Projects

The Urban Water Plan will be achieved one small step at a time, street by street, canal by canal

Water Crosses Political Lines

A holistic reimagining of the physical landscape that looks beyond political and jurisdictional boundaries makes possible long-term solutions to regional challenges. The shape of the ground, both man-made and natural, creates distinct areas with shared conditions and characteristics, from the three main hydrological basins to individual districts and project sites. Water moves differently in each zone and must be planned for accordingly.

Within each basin, the Urban Water Plan provides urban design proposals for key districts to illustrate district-level water planning. Additionally, it lays out conceptual designs for seven demonstration projects to illustrate the use of new technologies and principles at the scale of individual sites. On the pages that follow, proposals at each of the scales below are grouped according to “critical connections”—eight narrative lines drawn across the region that follow the flow of water or the slope of the ground.

Hydrologic Basins

Basins are areas of low ground that contain bowls, lowlands, ridges, and other landscape types. They are protected by levees and floodwalls at the perimeter. Basins are the largest scale of water planning in the Urban Water Plan.

Basins, also known as polders, are low-lying areas surrounded by levees or floodwalls with water on the other side.

“Any landscape is a condition of the spirit.”

Henri Frederic Amiel

Philosopher & poet, 1821-1881



Waterfronts, Past, Present, Future

In the past, waterways were considered functional parts of the delta city. Today, waterfronts along internal waterways can provide public access to water and spur reinvestment inside the city.

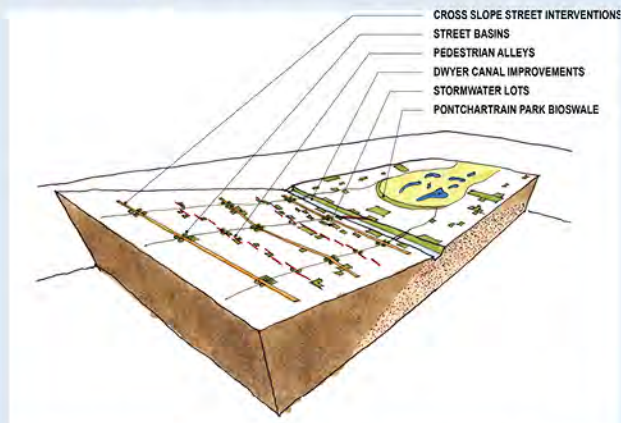
Pontilly District Plan

Sustainable Stormwater Strategies

Because of chronic flooding and flood damage throughout Pontilly's history, the Gentilly Woods and Pontchartrain Park neighborhood associations worked with the New Orleans Redevelopment Authority to advocate for sustainable stormwater strategies that would reduce runoff in the 900-acre area without additional pumping. This coalition received a \$15 million federal hazard mitigation grant to implement a holistic stormwater management system tailored to Pontilly. With a projected benefit-cost ratio of 3:1, these strategies will reduce damages by \$45 million over a period of years.



Chronic flooding in Pontilly has resulted in severe repetitive loss claims through the National Flood Insurance Program.



Small scale retrofits are arrayed along upslope areas, to catch stormwater before it overwhelms the drainage system downstream. Image: NORA, CDM Smith



Spaces for water are integrated into streets and vacant lots
Image: NORA, CDM Smith

Each basin is a man-made watershed and requires pumps to move water out. The east bank of Greater New Orleans is made up of three main basins:

Jefferson-Orleans Basin includes the east bank of Jefferson Parish and New Orleans.

Orleans East Basin includes New Orleans East and the Bayou Sauvage National Wildlife Refuge.

St. Bernard Basin includes St. Bernard Parish, the Lower Ninth Ward, Bayou Bienvenue, and the Central Wetlands Unit.

Water Districts

In the Urban Water Plan, districts are the intermediate scale between basins and demonstration projects. They are smaller sub-watersheds that make up each basin. Districts are defined as an area with consistent urban development pattern (including the street grid, land use, density, and even vegetation), landscape type, and shared drainage infrastructure. There are planning and design strategies appropriate to each district, even if all districts share general water and soil principles. Successful district planning resolves shared water and soil issues, and builds value and identity around water amenities.

Districts are groups of neighborhoods bounded together by major infrastructure and natural features that shape how water moves.

The identification of water districts is intended to initiate discussions among residents and stakeholders, in some cases across cultural, socioeconomic, and political lines, in order to address shared geophysical issues. The selection is not comprehensive; rather, representative examples of urban patterns and landscape types have been chosen for design in each basin. These examples show one way forward, but not the only way. District planning must ultimately come from within, from citizens' recognition of common issues and their collective will to act.

Demonstration Projects

The Urban Water Plan design team selected

seven demonstration projects across the three main basins and every landscape type for conceptual design development. These projects yield a greater understanding of how key principles can be realized in different parts of the region. Some projects are prototypical, thus representing solutions that can be repeated in a similar landscape or urban condition. Others are site-specific, based on the involvement of key stakeholders and properties with crucial water system functions.

Demonstration projects apply water principles at the scale of individual streets and properties.

These seven projects highlight water principles and play an educational role in the communities they serve. For each project, there are preliminary cost estimates as well as estimates of the storage capacity provided by specific strategies. Additional funding, design development, and stakeholder involvement will be necessary for the actual implementation of each project.

“Every surface inch of land or water seems to possess a voice of its own; the water-lillies speak unto one another, the shadows cry out.”

Lafcadio Hearn

*From *Inventing New Orleans: Writings of Lafcadio Hearn**



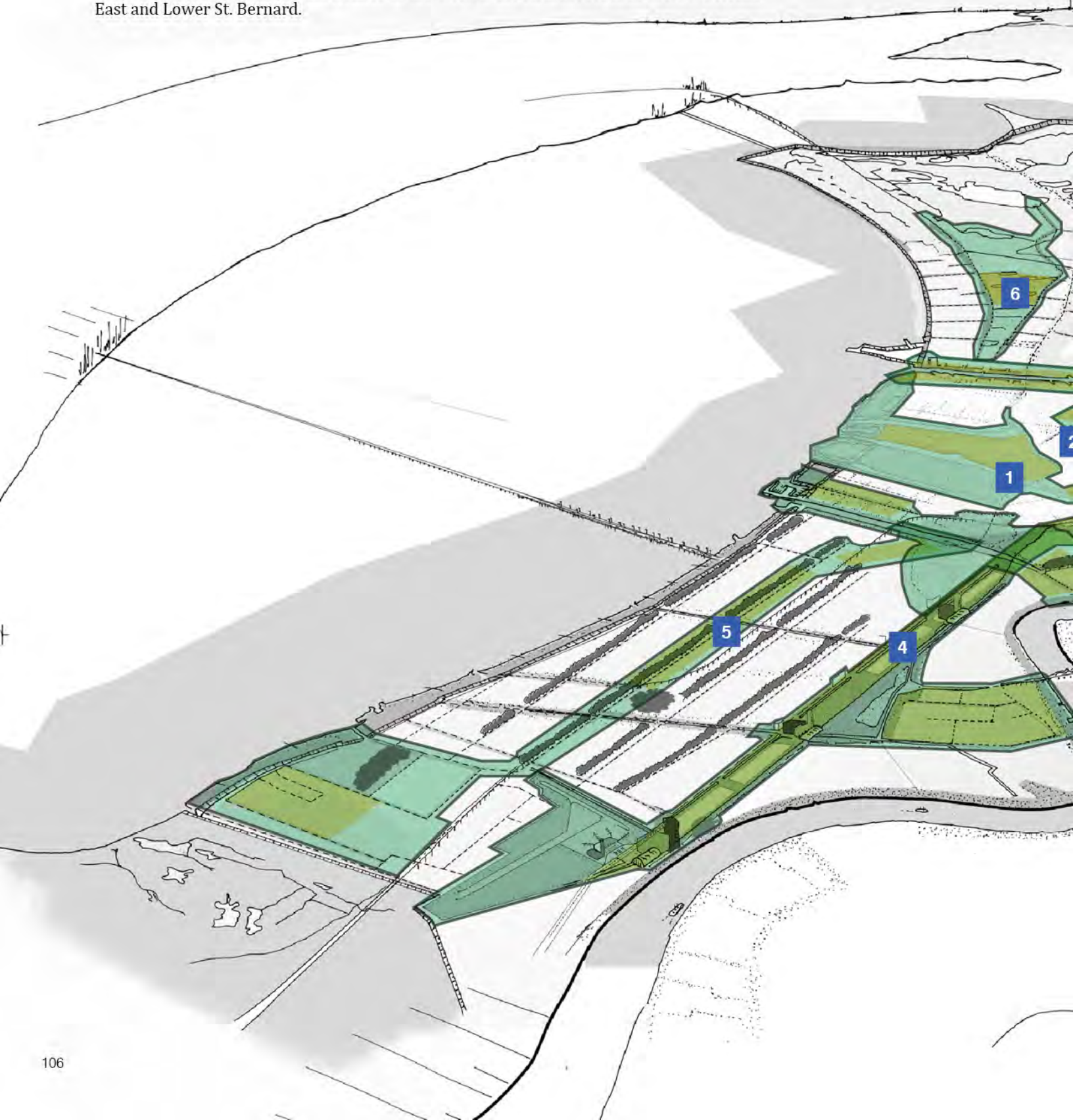
Greater New Orleans, 2030

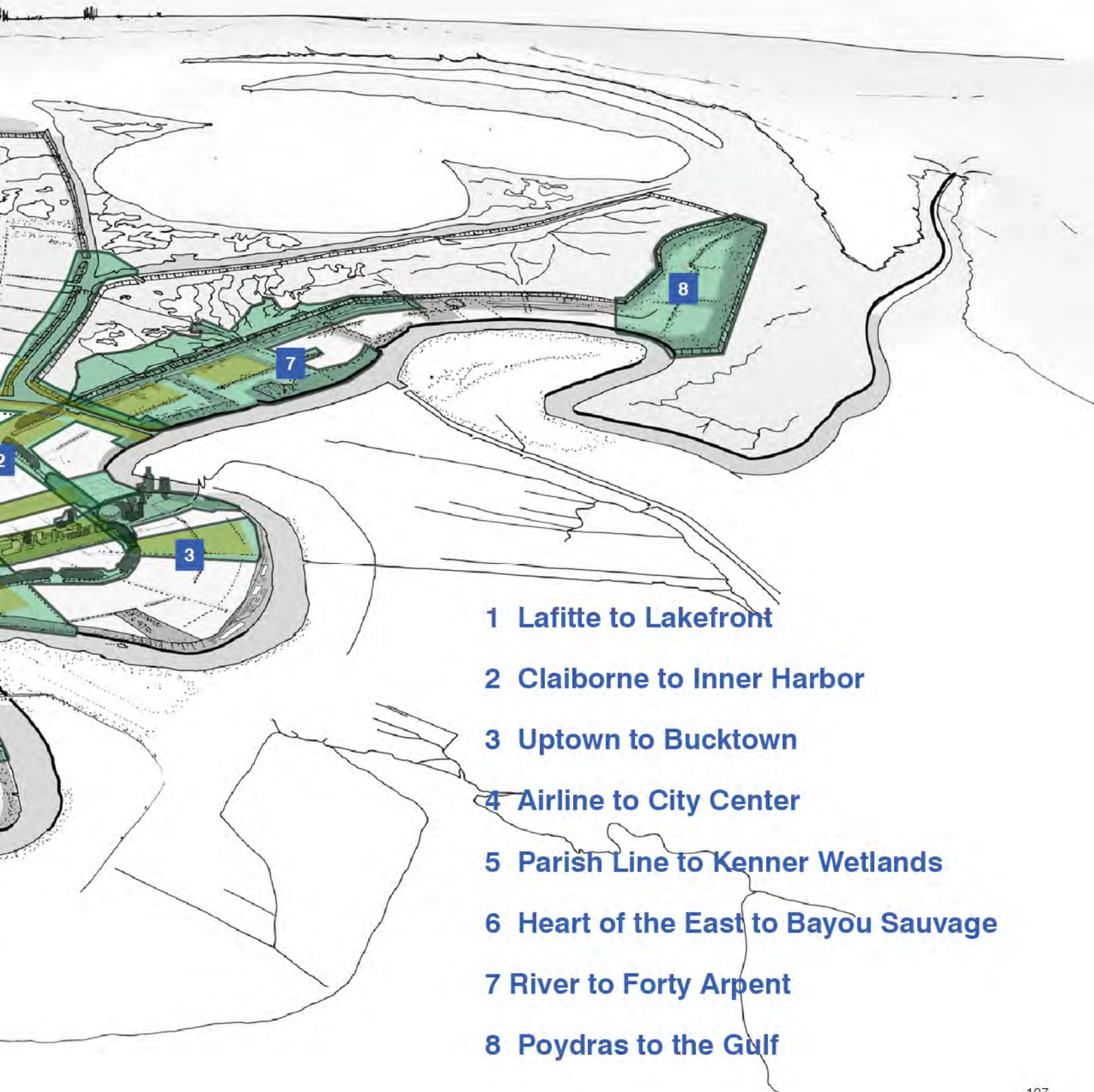
Blueways and greenways strengthen the urban fabric, building upon the region's existing boulevards, canal networks, and wetlands.

Critical Connections

Groupings of individual projects with shared strategic interests

The districts and demonstration projects are grouped along lines of strategic interest that cross parish and neighborhood boundaries, and follow either the flow of water or the slope of the ground. Each line tells a story about water in the region, the identities of each basin and that of Greater New Orleans as a whole, how neighborhoods relate to one another, and the many ways in which an integrated urban water system can improve safety, quality of life, and economic vitality, from Kenner in the west to the farthest reaches of New Orleans East and Lower St. Bernard.





Lafitte to Lakefront

Early French settlers founded New Orleans on the banks of the Mississippi, a short portage from Bayou St. John and Lake Pontchartrain. In the 19th century, the Carondelet Canal enabled the flow of goods and people between the Bayou and the Quarter. Investing in the **Lafitte Blueway** and the city's primary **outfall canals** as park zones and public spaces reestablishes that historical connection and revitalizes the entire city.

Water features, open parkland, and wetlands alongside each of these waterways provide critical storage capacity and water sources for the city's water networks. They are also amenities that serve residents from the French Quarter and Mid City to **Lakeview** and **Filmore (Gentilly)**, where the 25-acre **Mirabeau Water Garden** provides a model for lowland water management.





Demonstration Project

Lafitte Blueway

Making space for water in the historic Lafitte corridor reestablishes the historical connection between the French Quarter and Bayou St. John. Linear water features in the corridor enhance programming outlined in the Lafitte Greenway Master Plan, allowing the corridor to become a vital public park and water infrastructure component.

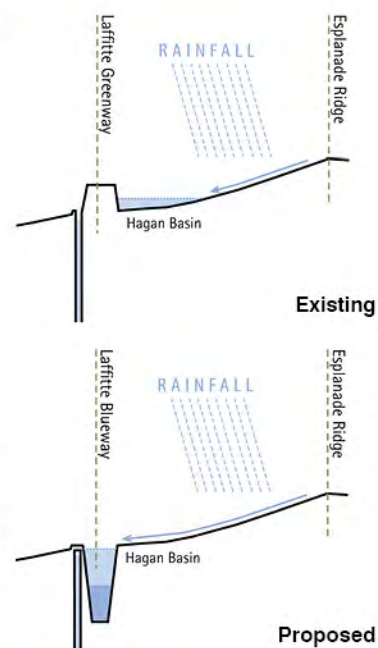
Water flowing through Bayou St. John cascades down into the Blueway, and serves as a source of water for circulating canal networks in the city's bowls. This improves local soil stability and limits subsidence. The blueway also features open parkland that doubles as overflow zones that store 35-50 acre feet of water during wet weather. This in turn alleviates the drainage needs of adjoining neighborhoods while providing new recreational amenities and redevelopment opportunities.



Linking the Quarter to the Bayou

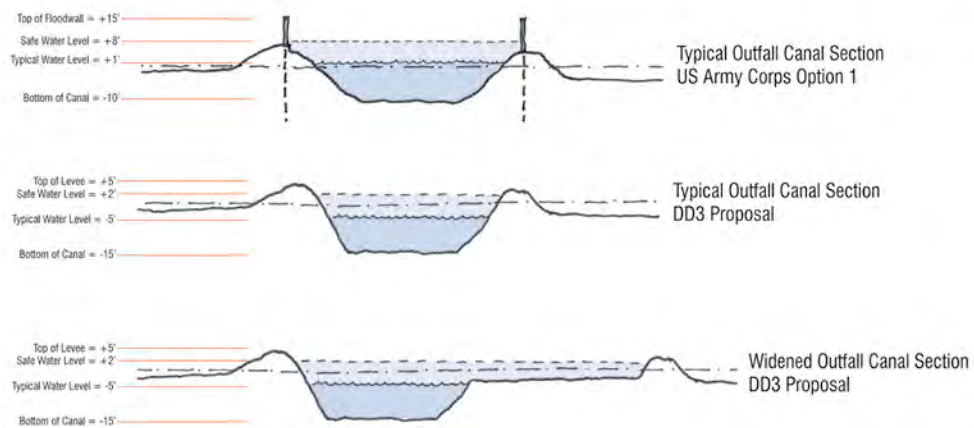
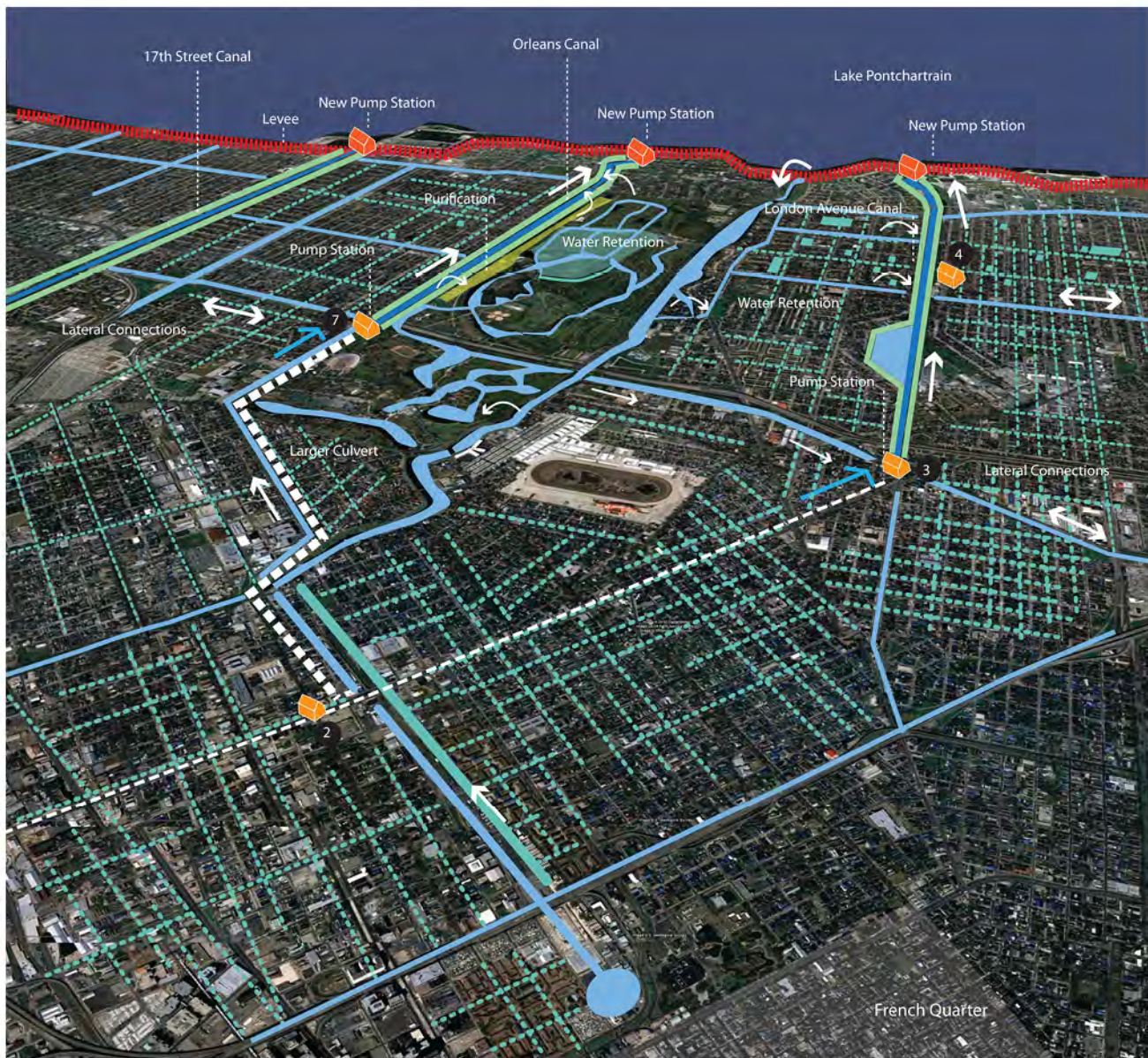
Top: View of the Lafitte Blueway, looking towards Lake Pontchartrain from North Claiborne

Above left: A restored connection from the French Quarter to Bayou St. John



Making Space for Water

Above right: Excavation of a man-made ridge reduces flood risk for adjoining neighborhoods.



A Lowland Canal Network

Above: A circulating canal network connects to the primary outfall canals, Bayou St. John, and the Lafitte Blueway, providing improved drainage during wet weather and circulating water during dry periods.

Left: Permanent closure structures at the lakefront eliminate the role of outfall canal floodwalls in protecting the city from storm surge. Lowering those floodwalls to reveal each waterway as a vital public space can be safely accomplished.



Safety First

Top: Sectional perspective of London Avenue Canal as a public waterway and linear park that links the Gentilly Ridge to the lakefront. With ready public access, each outfall canal allows residents and visitors to the city to gain a new perspective on the city, relationships between neighborhoods long divided by outfall canal walls, and the city's relationship to the lake and to water infrastructure.

Above: Sectional perspective of London Avenue Canal as it exists today, with high concrete walls on either side of the waterway blocking views and access to and across the canals.

Urban Opportunity

The Outfall Canals

The removal of functionally obsolete floodwalls and the reshaping of New Orleans' primary outfall canals brings beauty and new amenities to the city's lowlands. With closure structures at the lakefront in place, the outfall canals' levees and floodwalls no longer function as a last line of defense against storm surge, as they were asked and failed to do in 2005.

Reconceived as multi-functional waterways and with walls atop green levee banks removed, each of the three primary outfall canals is a significant public asset, with park areas, trails, docks, and waterfront development in place of the bare concrete walls and hidden canals of the outfall corridors today.

The transformation of the canals represents broader changes in the region's attitudes towards water, now as an irreplaceable resource and source of pleasure and pride rather than one of fear and destruction.



Seeing Behind the Walls

Top: Inhabiting and making use of the outfall canals enhances quality of life for the city's residents.

Above: As wide watercourses with flowering green banks, the outfall canals as they exist today are hidden treasures that neighboring residents can neither see nor access.

Urban Opportunity

The Outfall Canals

Each waterway is the backbone for myriad park spaces, trail networks, and boating facilities that serve lowland neighborhoods situated alongside a total of eight miles of newly accessible water. In areas with broader rights-of-way or where there are groupings of vacant properties adjacent to the canal, the public canal corridors widen in order to accommodate additional uses, and also to provide expanded storage capacity for the lowland canal network in anticipation of intense storms.

During dry periods, the outfall canals are hydrologically connected to the lake, so that they connect the lowland canal network with the water it needs to circulate water throughout each of the lowland districts, such as Lakeview and Filmore.



Design District

Filmore (Gentilly)

The lowlands of New Orleans need surface waterways and improved groundwater management in order to maintain soil stability. With Lake Pontchartrain to the north, London Avenue Canal to the east, and Bayou St. John to the west, Filmore has ready sources of water that can circulate throughout the district in roadside bioswales and canals inserted into the neutral grounds of the district's boulevards. These water features and a system of weirs allow for the precise control of groundwater levels, critical in areas with highly organic soils that are prone to subsidence.

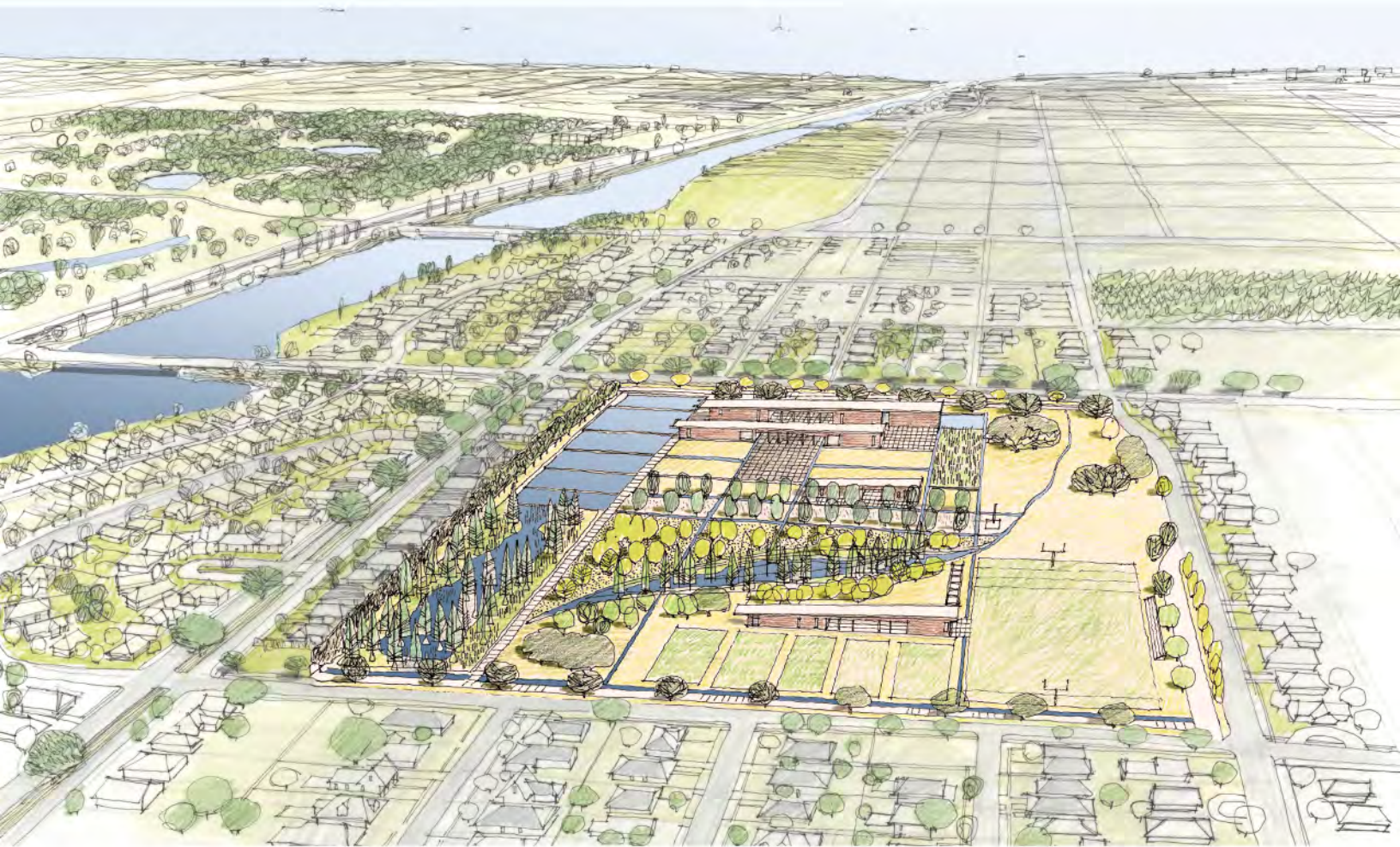
During rain events, strategically located vacant lot corridors and neighborhood parks connected to the network of bioswales and canals provide additional storage capacity with which to reduce street flooding.



Arresting Subsidence with Water

Top: Waterways become important to Filmore's identity as critical components of a network that circulates water throughout the district.

Above: Retrofits include canals, bioswales, vacant lot corridors, and parks that retain stormwater.



Demonstration Project

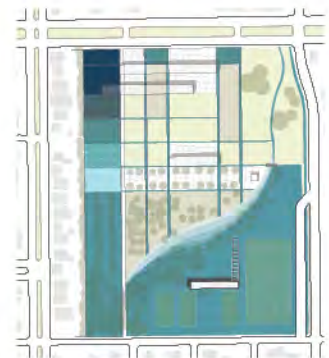
Mirabeau Water Garden

Stormwater storage and filtration, environmental education, and athletic fields support the community and an educational institution. A system of wetland terraces, rain gardens, bioswales, and a woodland wash provide diverse habitats for native flora and fauna, as well as for educational programming for local schools. The ambitious design diverts runoff from a Sewerage & Water Board pipe, infiltrating it into the sandy substrate of the Pine Island Beach Trend and filtering it for use in recreational and ecological features.



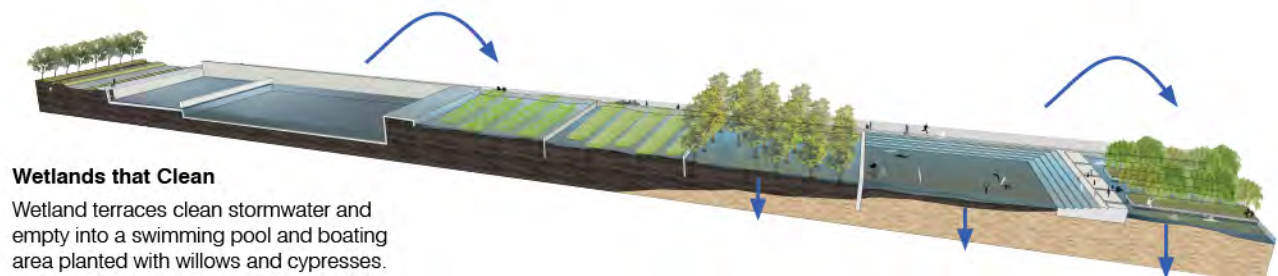
Dry

Top and above: Water features and fields for the neighborhood and local institutions



Wet

Above: Rain gardens, bioswales, and low-lying athletic fields provide storage during the heaviest rain events.



Wetlands that Clean

Wetland terraces clean stormwater and empty into a swimming pool and boating area planted with willows and cypresses.

Claiborne to Inner Harbor

Splitting drainage at the Gentilly Ridge means that runoff from the French Quarter, Treme, Seventh Ward, and Upper Ninth Ward will be diverted along the **Claiborne Corridor into the Inner Harbor**, rather than flowing toward the lake as it does now. This new flow pattern brings water into the **Desire Parklands**, a broad open area with the capacity to store and filter thousands of acre feet of runoff, and to spur reinvestment in surrounding neighborhoods.

New and existing pumps at the eastern edge of the Desire Parklands lift stormwater into the **Industrial Canal and Gulf Intracoastal Waterway**, a new center for industry, innovation, and waterfront development.





Design District

Claiborne Corridor

This major roadway becomes a critical conduit for water with the proposal to divert backslope runoff into the Industrial Canal. Already a major thoroughfare for goods and vehicles, the addition of a surface canal and associated water storage features to the public right-of-way and adjoining properties allows the corridor to accept and store runoff flowing from the backslope of the city and redirect it into the Florida Canal and Desire Parklands. This lessens the drainage burden on the lowland outfall canals and reduces flood risk for both upstream and downstream neighborhoods.

In dry periods, Claiborne's new water features draw from the Lafitte Blueway to circulate water and recharge groundwater in adjoining bowl neighborhoods and the Desire Parklands.



Thoroughfare for Water and People

Top: View of the Claiborne Corridor and potential storage areas at the I-10 and I-610 intersection, looking back towards downtown New Orleans

Above: Large underutilized spaces along lines of infrastructure are suited for conversion into large-scale water storage areas.

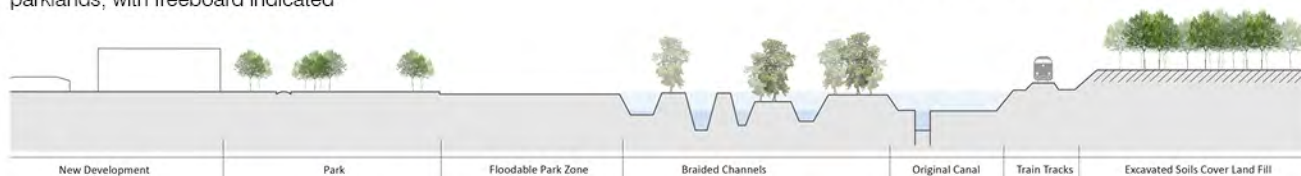


Wetlands and Detention Basins

Top: Strategic parklands as a recreational and ecological backbone

Above: Neighborhoods to the north and south benefit from expanded stormwater storage and new amenities.

Below: Sectional diagram of strategic parklands, with freeboard indicated



Design District

Desire Parklands

New water features provide opportunities for reinvestment and benefits to nearby residents. With the proposal to split drainage at the ridge, using the Claiborne Corridor to divert runoff from the backslope of New Orleans towards the Industrial Canal and away from the lake, the existing Florida Canal becomes critical to the flow of water from west to east.

New detention basins and stormwater wetlands in the Florida Canal corridor, south of the Desire neighborhood, make possible this proposal, and provide new amenities with which to spur reinvestment in a long-neglected corner of the city.



Urban Opportunity

Inner Harbor

The Industrial Canal and Gulf Intracoastal Waterway are now sites for waterfront development and industrial innovation. Existing port facilities, shipping, and industrial facilities serve as the basis for re-imagining this area as a place for housing, commerce, and innovation within minutes of downtown New Orleans. These waterways also serve as an enclosed outfall area for drainage pump stations in both Orleans East and St. Bernard Basins.

The completion of the Industrial Canal in 1923 severed the Ninth Ward, and created three distinct hydrological basins out of what had once been a single unit. Now protected from storm surge by the Seabrook Floodgate and the Lake Borgne Surge Barrier, water levels can be managed so that new forms of industry, inhabitation, and use are possible.



Building Around Key Waterways

Top: The Industrial Canal and Gulf Intracoastal Waterway as places to live, work, and experience a critical man-made waterway

Above: The Inner Harbor zone's industrial facilities and proximity to both business centers and wetland restoration zones provide opportunities for redevelopment and innovation in industry and ecology.

Uptown to Bucktown

The Garden District, Central City, Hollygrove, and Lakeview may seem to have little in common, but they are bound together by shared lines of water infrastructure. The rain that falls on **Uptown Streets** in backslope neighborhoods flows toward the bowl of New Orleans, which is drained by the **Palmetto Canal**. This critical channel fills to the brim with each heavy rain, carrying water into the 17th Street Canal. It is joined there by the water that drains from **Hollygrove** and Hoey's Basin into the **Monticello Canal**, which follows the parish line into the 17th Street Canal. In the lowlands, stormwater from **Lakeview**, too, joins the rush of water towards the lake.

While the Pump to the River proposal redirects the flow of backslope runoff towards the Mississippi in order to improve system function, retrofits and storage features that are feasible today can reduce flooding and improve groundwater balance immediately.





Slope Matters

Top: Slowing and storing water on the backslope keep runoff from overwhelming systems downstream.

Above: Interceptor streets feature multiple small-scale retrofits that slow the flow of water as it moves downhill.

Design District

Uptown Streets

Small scale retrofits in public rights-of-way catch rain where it falls. They reduce the volume of stormwater that leaves the backslope and flows down into the bowl of the city, where pumps push that water out towards the lake via the Palmetto and 17th Street Canals. This eases the load on drainage systems and reduces flood risk and drainage-driven subsidence for neighborhoods downstream.

Pervious paving, subsurface storage, rain gardens, and water-loving plants distributed throughout Uptown street corridors reduce localized street flooding by providing pockets of space to which stormwater can flow, and where this water is filtered, infiltrates the ground, and is absorbed by plants. These retrofits are particularly effective on streets that run parallel to the River because they intercept the flow of stormwater as it moves down the backslope.



Palmetto Canal

The canal is the major drainage collector for all of Uptown New Orleans and backbone of the BioDistrict plan. Water must be held upslope and diverted elsewhere before retrofits can be made to the canal.

Urban Opportunity

Palmetto Canal

The Palmetto Canal is one of the most visible pieces of water infrastructure in New Orleans, but serves more as a barrier than as a place for public life. What is now a wide barren cut through the city can become a public asset on par with Bayou St. John, an amenity for Broadmoor, Gert Town, Hollygrove, and Xavier University.

This opportunity reflects the interconnected nature of watersheds and water systems. Keeping runoff on the backslope in Uptown New Orleans, which is higher up in the watershed than the Palmetto Canal drains, is one of the necessary improvements elsewhere that makes possible the transformation of the Palmetto Canal from concrete ditch to beautiful waterway.

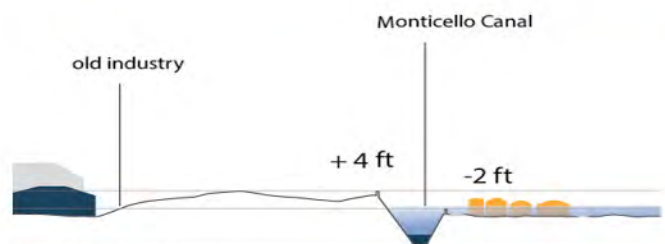


Design District

Hollygrove & the Monticello Canal

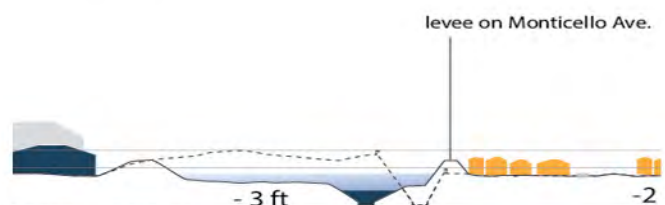
Strategic parklands at the parish line benefits neighborhoods and businesses on both sides. Widening the Monticello Canal, relieving a critical bottleneck at Airline Highway, and building levees around recreational and agricultural spaces that store stormwater during intense rain events improves stormwater management at a critical juncture where key roadways cross over an important hydrological seam in Jefferson Orleans Basin. This also reduces flood risk for the Hollygrove neighborhood of New Orleans.

In addition, the Pump to the River retrofit splits drainage at the Metairie Ridge, which means that runoff from Hoey's Basin and Uptown New Orleans is directed toward the river instead of toward the lake via the 17th Street Canal.



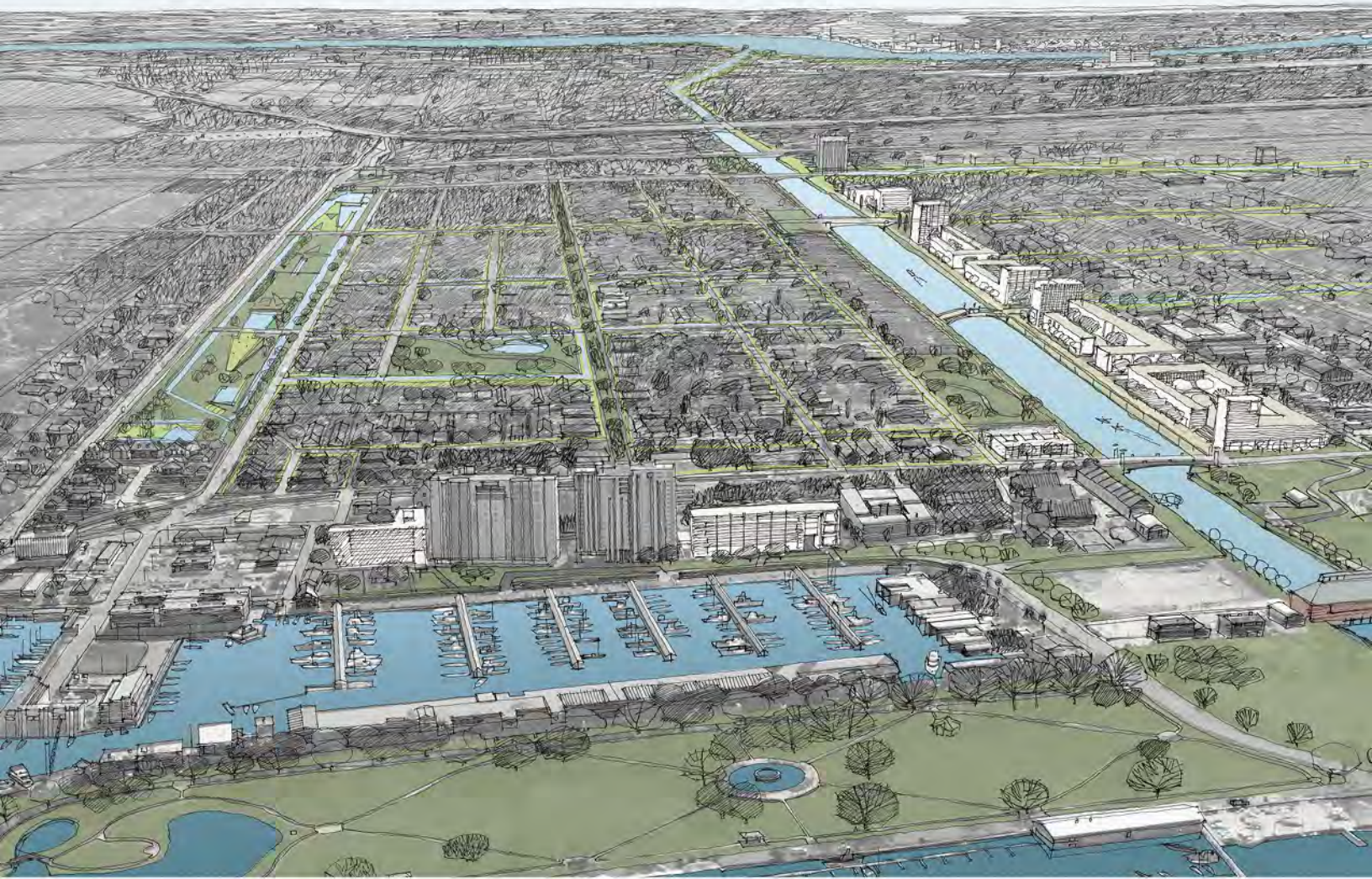
Existing Section

Above: A narrow canal cross section provides limited storage capacity.



Proposed Section

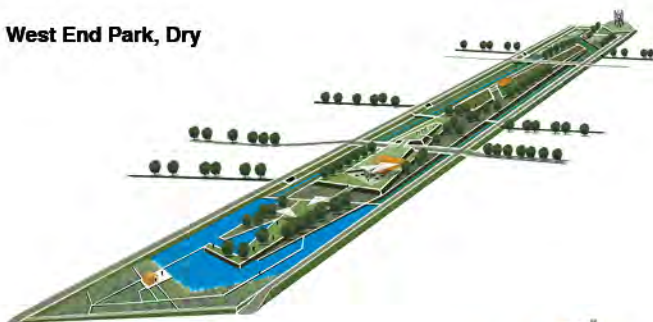
Top and above: Levee realignment and excavation creates space where water can safely overflow canal banks during heavy rainfall, and be used for recreation and agriculture during dry periods.



Lowland Landscapes Need Water

Above: Water features integrated into streets, properties, and public parks replenish groundwater and store stormwater when it rains. The view above is from the lake looking towards the river, with the Seventeenth St. Canal to the right, and West End Boulevard to the left.

West End Park, Dry



West End Park, Wet



Design District

Lakeview

Higher groundwater levels provide improved stability for roads and homes. Sources of water that can replenish the groundwater supply during dry periods are key to maintaining proper groundwater balance with the highly organic soils of Lakeview. Nearby Lake Pontchartrain and stormwater collected during each rain event serve as these sources, supplying water to perforated pipes that then exfiltrate it into surrounding soils when groundwater levels drop below target levels.

During rain events, a combination of reconstructed floating streets (see demonstration project), detention basins on vacant lots, and larger detention and retention basins in neighborhood parks and the West End neutral ground provide ample storage capacity with which to minimize street flooding and the need to pump stormwater into Lake Pontchartrain.

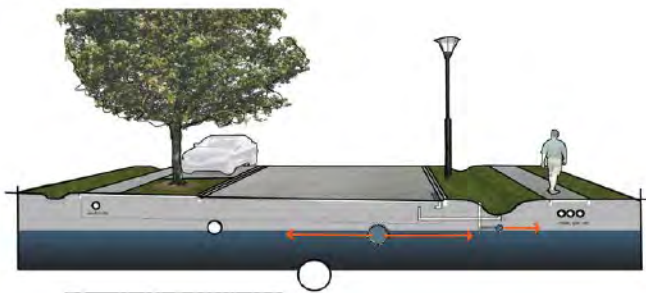


Lowland Landscapes Need Water

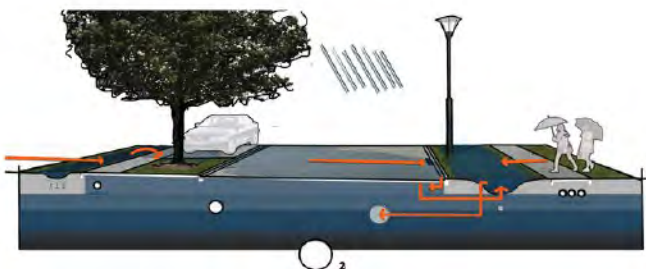
Above: Streets with built in spaces for water to minimize street flooding and improve stormwater retention

Below: Perforated pipes running beneath each floating street maintain higher groundwater levels during dry periods, and drain excess stormwater when it rains.

Dry



Wet



Demonstration Project

Floating Streets

Lowland streets need higher groundwater levels to stay aloft. Conventional streets are crowned: they are high in the middle, and drain stormwater to gutters on either side. Floating streets are high on one side, and slope towards a parking lane and bioswale that provide considerably more storage capacity for stormwater. In combination with tree plantings, pervious paving, and a deeper water-storing subbase, Lakeview's redesigned streets provide a model for infrastructure that serves many purposes, from transportation to filtering and storing stormwater to balancing groundwater during both dry and wet periods.

Because the lowlands are characterized by highly organic soils, the ability to infiltrate stormwater and maintain higher groundwater levels is fundamental to reducing rates of subsidence and to the sustainability of public infrastructure investments.

Airline to City Center

For residents and visitors alike, the common entry point to southeast Louisiana and the Mississippi River Delta is **Louis Armstrong International Airport**. From there, the historic **Airline Corridor** brings travelers from Kenner through Jefferson Parish to **downtown New Orleans and beyond**. New water features and improved urban design provide opportunities for strengthening the visual identity and adding to the attractiveness of the region as a destination for business and pleasure.

Adjacent to Airline Corridor is the **Elmwood District**, an important contributor to the region's commercial base, where smart retrofits and district-scale water management will reduce flood risk and provide favorable conditions for the long-term prospects of the district's businesses and institutions.





First Impressions

Top: New water features and wetland habitats bring life and beauty to the region's primary airport and underscore the region's new approach to water management.

Above: Louis Armstrong International Airport possesses underutilized spaces that can be safely converted into stormwater retention features.

Urban Opportunity

City Arrival: Airport

With an \$800 million dollar redevelopment planned, Louis Armstrong International Airport represents an opportunity to remake the first impression that Greater New Orleans has on visitors. Detention and retention basins and attractive constructed wetlands change with the seasons, filling with stormwater each time it rains, filtering runoff, and reducing the volume of runoff that leaves the airport.

These water features manifest the core principles of the Urban Water Plan in ways that directly enhance the experience of travelers coming to and from the region.

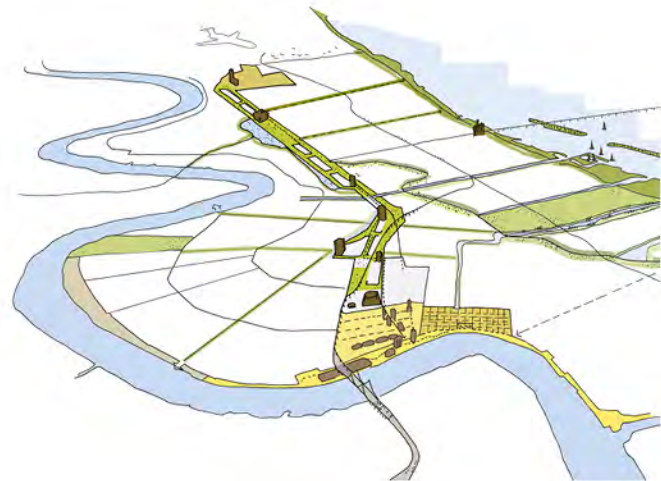


Urban Opportunity

City Arrival: Airline Corridor

Airline Highway, local rail lines, and the Metairie Ridge divide Jefferson Orleans Basin into two subbasins and form a critical water axis. These linear features and regionally significant assets, which include Zephyr Field and the training facilities for the New Orleans Saints and Pelicans, also comprise an important regional corridor that connects Louis Armstrong International Airport directly to downtown New Orleans, the French Quarter, and the new medical district.

Large-scale detention and retention basins located within this corridor support water networks in Elmwood and the Jefferson lowlands with increased storage capacity, and strengthen the identity and character of the region as a place of innovative urban stormwater management for those arriving in New Orleans.



From the Airport to French Quarter

Top: Airline Highway once served as the main entry to the city for those arriving at Louis Armstrong International Airport, and can serve that purpose once again. Strategic parklands and new light rail enhance the infrastructural role of the corridor, and serve as the basis for redevelopment.

Above: The Airline Highway to downtown New Orleans arrival corridor



Arriving in New Orleans

Top: The Airline Corridor crosses watersheds and brings commuters and visitors to the historic center of the region. Urban water plazas, parkways, and new developments provide form and structure to this important point of arrival.

Above: The existing Airline Corridor entry to downtown New Orleans

Urban Opportunity

City Arrival: Downtown New Orleans

The Airline Corridor begins in Kenner but extends across distinct watersheds and into the downtown core of New Orleans. Airline Highway becomes Tulane Avenue as one approaches the Superdome.

In this prominent but overlooked area, what is now a tangle of highways, rail lines, disconnected local streets, vacant lots, and industrial areas becomes a proud point of arrival, a place for public gatherings and the festivities that manifest New Orleans culture, and a key corridor for private reinvestment.

New urban water plazas serve projects in progress, such as the 1,500 acre New Orleans BioDistrict, as well as new mixed-use and institutional development.



Existing, facing south from Citrus Boulevard



Dry



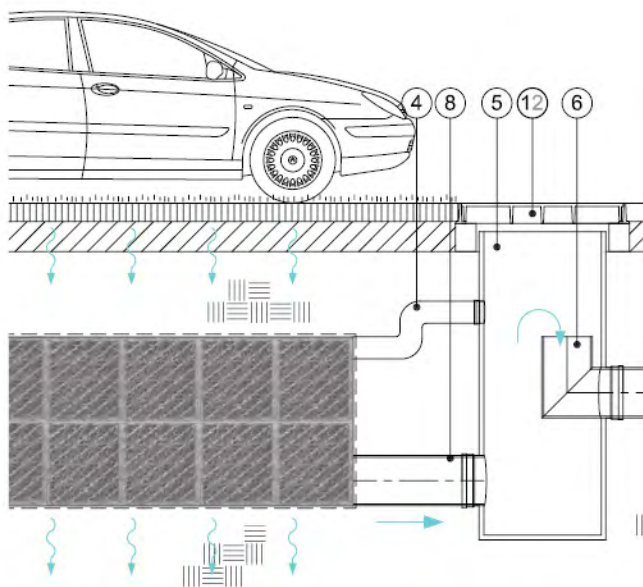
Wet

Design District

Elmwood Fields and Water Lanes

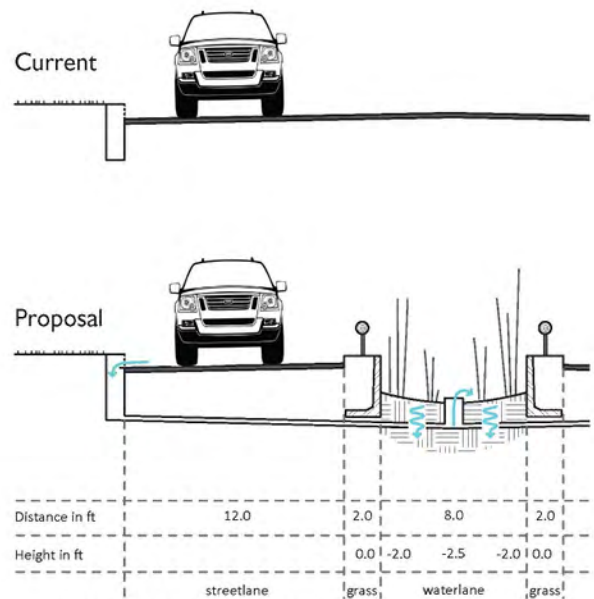
Space for water is good for business. Elmwood can be a model for the many largely paved commercial districts throughout the region. Elmwood's vast expanses of rooftops and parking lots contribute to high levels of runoff and street flooding, and have a negative impact on the drainage of neighborhoods downstream.

With phased retrofits, Elmwood's streets and underutilized spaces are the basis for a district-scale network that collects and filters stormwater. "Water Lanes" bring runoff to detention basins located throughout the business park, and parking lot retrofits provide additional storage capacity. Water-loving vegetation supplies shade, improves air quality, and enhances the district's ambiance.



Parking Lots That Store Water

Above: A combination of pervious paving and subsurface storage chambers allow even heavily used parking areas to collect, store, and infiltrate stormwater.



Water Lanes for Managing Runoff

Top: Peeling back asphalt and concrete makes space for bioswales that convey water to storage areas.

Above: Water lanes can fit into many of Elmwood's roadways.

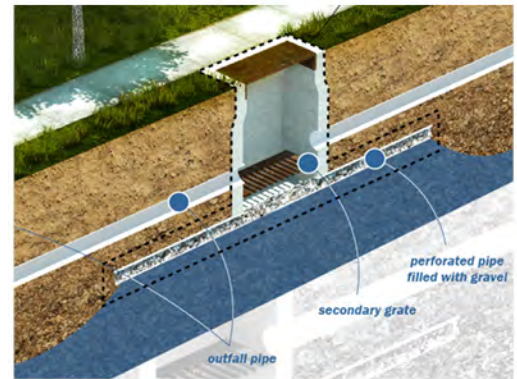
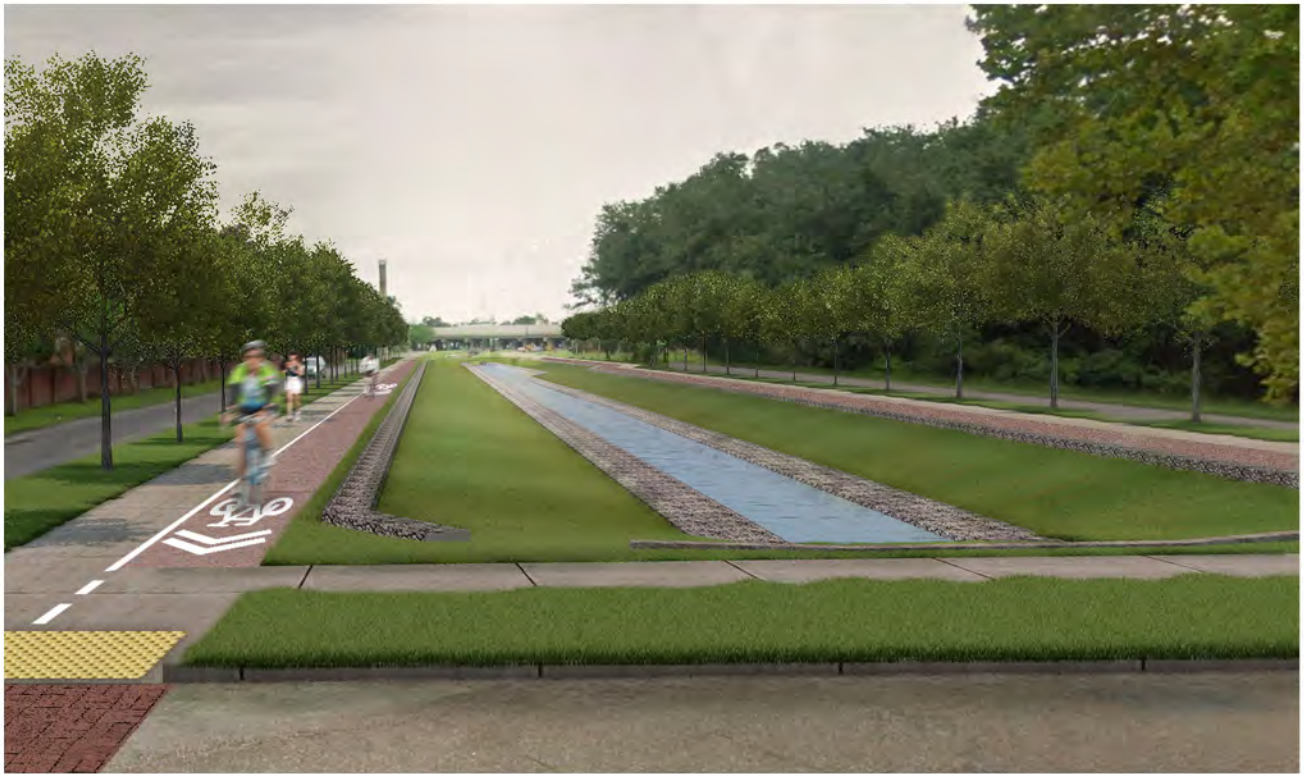
Parish Line to Kenner Parklands

JEFFERSON ORLEANS BASIN

Water drawn from the 17th St. Canal can enter Jefferson's lowland canal network through the **Canal Street Canal**. This is an ideal site, at the boundary between Jefferson and Orleans Parishes, for demonstrating improved canal edges and water level management. During dry periods, water flows from here into the **Veterans Canal**, which from east to west towards the Kenner Parklands.

In the **Kenner Parklands**, constructed wetlands will filter the outflow of the basin's lowland canal network before it empties out into the LaBranche Wetlands on the western side of the federal levees and floodwall that protect Jefferson Orleans Basin.





Stormwater Exfiltration Catch Basin

Demonstration Project

Canal Street Canal

This waterway is a place to pilot improved water level management, innovative stormwater exfiltration basins, and new flows of water through the basin's lowland canals. Currently a stagnant ditch with low water levels and unsightly outfall pipes, testing in 2012 by the Jefferson Parish Public Works Department of higher water levels showed the potential of the canal to become an asset to the neighborhood. During testing, water from the canal exfiltrated into the surrounding soils, improving the groundwater balance and soil stability of the neighborhood.



A Place for Testing

Top: Retrofits to the Canal Street Canal improve both function and aesthetics

Above: Photographs show effects of raising water levels in the canal



Canals That Bring Beauty

Top: Higher water levels reduce area subsidence while allowing visual connections to the water for drivers and pedestrians.



Existing



Proposed

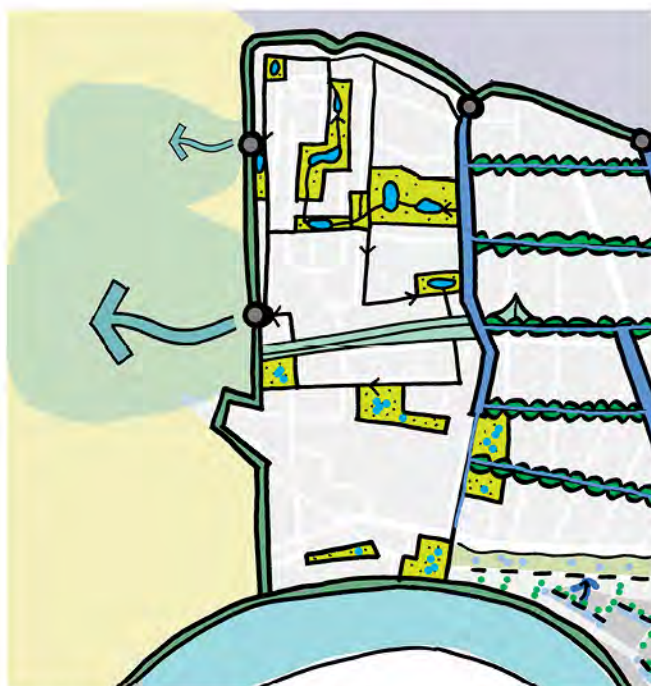
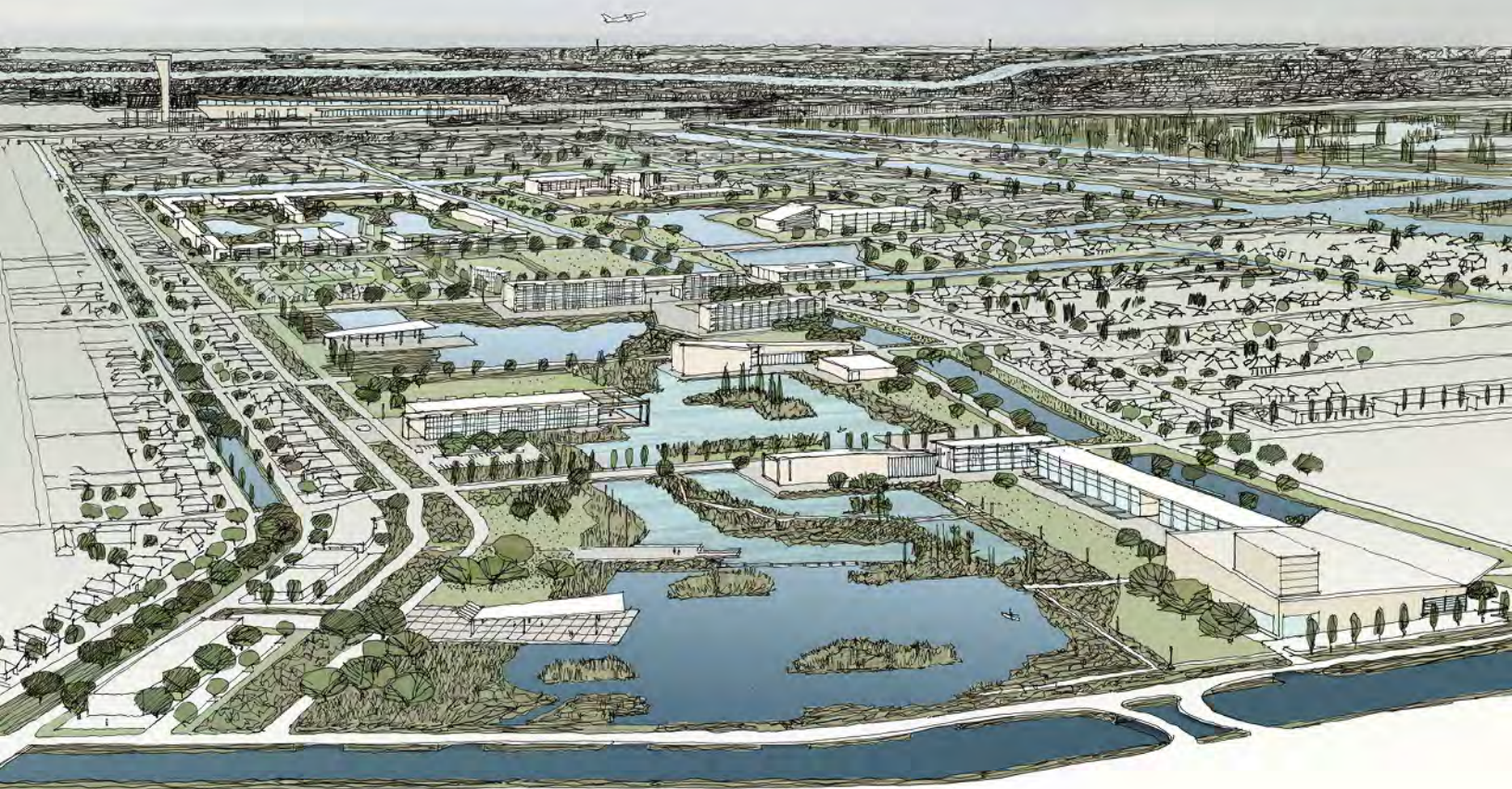
Design District

Veterans Canal

Higher water levels stabilize the ground and improve the visual environment. Running east-west through the Jefferson lowlands, Veterans Canal is flanked on either side by three lanes of traffic and commercial establishments. Steep canal edges and low water levels compromise bank stability and keep the water out of sight.

Landscaped canal banks, tree plantings, and improved water level management enhance the view for motorists and pedestrians, and elevate the identity of Jefferson Parish by making one of the most important commercial corridors in the region a beautiful place to work and shop.

Similar retrofits would benefit other corridors throughout Jefferson's lowlands, each with an underutilized drainage canal caught between lanes of traffic.



Development Around Water Features

Top: In the northern half of Kenner, new water features critical to the function of Jefferson's circulating canals double as sites for waterfront development.

Above: Water flows through Kenner's wetlands and then in to the LaBranche wetlands to the west.

Design District

Kenner Parklands

Higher water levels in Jefferson's lowland circulating canals are possible only if storage capacity is added elsewhere. Kenner, a city in the western half of Jefferson Parish, possesses swaths of vacant land that can provide this storage in the form of wetlands, waterways, and detention and retention basins.

This allows for improved water level management throughout the Jefferson lowlands and alleviates the flooding problems that exist in Kenner today. Properties located adjacent to these water features become sites for waterfront civic, institutional, mixed-use, and residential developments.

In dry periods, Jefferson's lowland canals empty into filtration wetlands, which cleans the water that flows through the parish and keeps the subsidence-prone soils of Kenner stable.

Heart of the East to Bayou Sauvage

JEFFERSON ORLEANS BASIN

New Orleans East's residential **neighborhoods** are arrayed along the Chef Menteur Ridge as well as the lakefront. In between is the Heart of the East, an area rich with civic assets and commercial real estate.

The **Citrus Redevelopment Zone** and **Eastern Water Walk** anchor commercial redevelopment in the Heart of the East. Integrated lakes and wetlands strengthen the basin's canal network, which provides connections from the Heart out to the wetland habitats of Bayou Sauvage.





Urban Opportunity

Orleans East Neighborhoods

The strength of New Orleans East lies in its neighborhoods and the families that have made their homes in the basin's subdivisions for generations. With the lakes, parks, and open spaces that already exist in the basin, Orleans East has the potential to become the first basin in the city to store safely all the excess water from a ten-year storm, without the addition of any new pumping capacity. Small scale retrofits to the streets of neighborhood streets would help achieve this goal. Bioswales, rain gardens, and water-loving trees will reduce the volume of runoff from each neighborhood, filter that runoff, and provide shade and better air quality for residents.

Small Scale Street Retrofits

Top: Bioswales and tree plantings in neighborhood streets reduce and filter runoff.

Below: The lower density of development in Orleans East means that there is less traffic and more opportunities for implementing small scale street retrofits in each neighborhood.



Spaces for Water and Commerce

Top: A redeveloped Lake Forest Boulevard brings water to the fore, with rain gardens, trees, and bioswales enhancing stormwater retention and establishing a strong identity for the Citrus Redevelopment Zone.

Above: Lake Forest Boulevard as it exists today

Design District

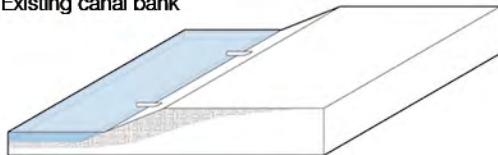
Citrus Redevelopment

Developers and businesses play an important role in shaping the city. In the Heart of the East, large vacant areas that were once regional shopping destinations are sites for redevelopment. Water features on each property connect to reconstructed streets where visible flows of water link each development to the canals that drain the basin.

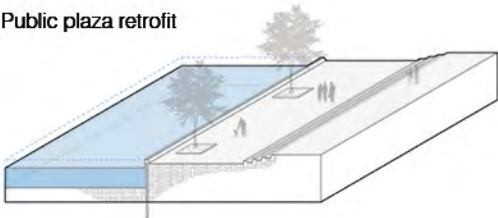
Incorporating stormwater detention and retention features onto each property reduces runoff and improves water quality in the basin's canals. Rain gardens, tree plantings, and new lateral canals in public rights-of-way improve stormwater retention and infiltration, which is critical because of the subsidence-prone soils of Orleans East. They also provide a model for development that accommodates and celebrates water.



Existing canal bank



Public plaza retrofit



Basic access retrofit



Canals as Public Spaces

Top: A commercial district built around the Citrus Canal

Above: Retrofits to the existing canal banks for public access and use

Demonstration Project

Eastern Water Walk

The canal network of Orleans East is an undervalued asset. Retrofits of canal banks, improved water level management, and re-orienting buildings and public spaces towards these waterways allows Orleans East to realize its potential as a place for living and doing business on waterfront property.

Each of the basin's canals serve as primary organizing element in the landscape, alternating with major boulevards as one travels through the basin from west to east. As with the Riverwalk in San Antonio or Buffalo Bayou in Houston, businesses and residences will draw value from their proximity to redeveloped canal frontage. Walking paths, parks, and plazas serve as spaces where public life can flourish, allowing the Heart of the East to become the urban center that this part of the city needs.



Living Around Lakes

Top: Wetland basins that provide relief to the Dwyer Canal during wet weather

Above: Two Orleans East neighborhoods, each built around a lake

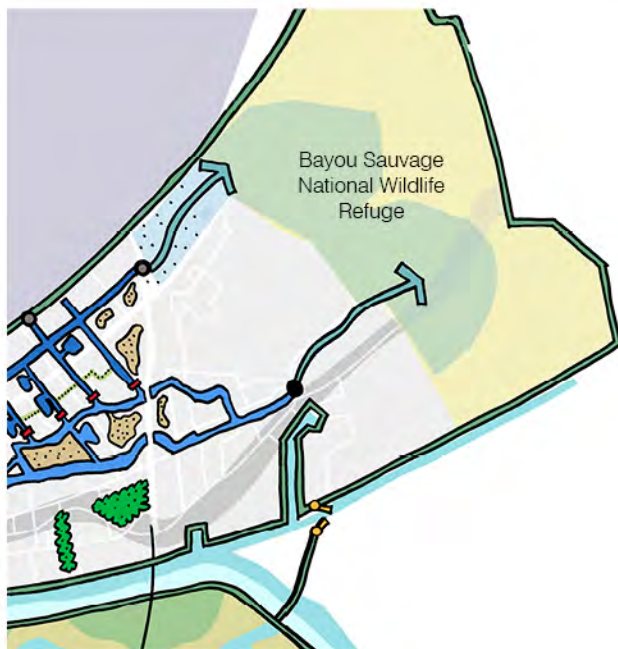
Urban Opportunity

Lakes and Wetlands

The lakes of Orleans East are central to the identity of the basin. Many of the finest neighborhoods in Orleans East are built around these privately-owned bodies of water, which collect runoff from adjacent properties and overflow into the basin's canal network.

Connecting these lakes to the canal network so that they can be operated as retention basins increases the storage capacity of the canal network. This reduces flood risk and the need for pumping.

Vacant areas throughout the basin provide additional opportunities for increasing the storage capacity of the basin's canal network. Designed as wetland basins, these areas store and filter stormwater while serving as habitats and recreational amenities that anchor new commercial and residential development areas.



Nurturing an Ecological Asset

Top: Located within New Orleans city limits, Bayou Sauvage is home to over 340 species of birds.

Above: Bayou Sauvage is protected by federal levees and floodwalls, and is accessible via Orleans East.

Urban Opportunity

Bayou Sauvage Wildlife Refuge

This urban wildlife refuge, the largest in the United States, should be integrated into the identity of New Orleans East. This remarkable asset features habitats ranging from hardwood forests to natural bayous, and fresh and brackish marshes.

Bayou Sauvage is a popular destination for birds, birders, hunters, and fishers, and its water levels are operated on a seasonal basis to support the health and diversity of its flora and fauna.

The Orleans East lowland canal network draws water from the Industrial Canal, circulates that water west to east across the basin, and empties into the wildlife refuge through extensions of the Morrison and Dwyer Canals. These restored flows strengthen the hydrology and ecology of the entire basin.

River to Forty Arpent

ST. BERNARD BASIN

The **Lower Ninth Ward** and **Chalmette** belong to the same basin. Both districts slope from the river down to the **Forty Arpent Zone**, where a backbone canal and wetland basins provide stormwater storage during heavy rainfall.

The Forty Arpent Zone is also the region's entry point to the **Central Wetlands Unit**, a levee-protected urban wetland a mere ten-minute drive from the French Quarter.





Patterns of Development

Top: Lower Ninth Ward strategic parklands

Above: Stormwater features that are specific to the topography and soils of each part of the district organize resilient patterns of development, while strengthening the identity of the Ninth Ward and its cultural and natural assets.

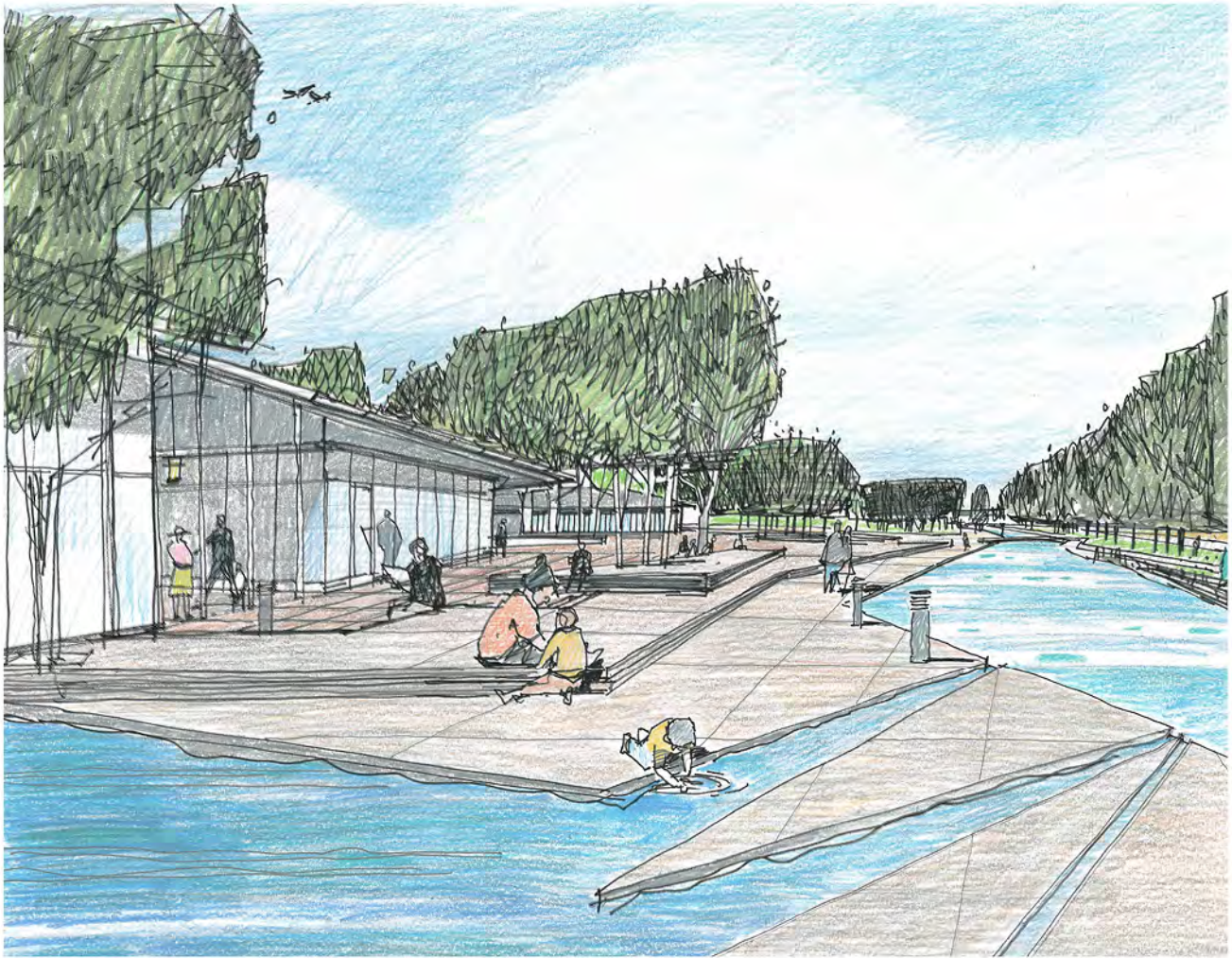
Design District

Lower Ninth Ward

Clear patterns of development and stormwater features are established as the ground slopes away from the river. The riverfront is already widely used as a promenade, a place to enjoy the river, and a vantage point to look back at the skyline of the city. On the backslope, rain gardens and improved stormwater detention reduce runoff.

Past the commercial corridors of St. Claude and Claiborne, stormwater corridors made out of vacant lots intercept runoff moving downslope, and provide recreational amenities to serve Ninth Ward residents.

A new canal, overflow basins, and wetlands at the northern edge of the district connect the Ninth Ward ecologically to Bayou Bienvenue and the Central Wetlands Unit, St. Bernard downriver, and the Industrial Canal and Desire Parklands upriver.



Design District

Chalmette Blueway

The Chalmette Battlefield at the riverfront connects to the Forty Arpent Zone and the Central Wetlands Unit. At the very core of St. Bernard, a new waterway flowing from the river to the wetlands links the Chalmette Battlefield to the new parish hospital, key commercial centers along St. Bernard Highway and Judge Perez Drive (a continuation of Claiborne Avenue), the parish's government center, and the water features and habitats of the Forty Arpent Zone and the Central Wetlands Unit.

This flow of fresh water across the basin provides the basis for new commercial and residential development opportunities, stormwater storage features, and improved groundwater management in the low-lying areas of the basin where the soils are most susceptible to subsidence.



Water from the River

Above: Connecting the Chalmette Battlefield and the Central Wetlands Unit with a two mile blueway affirms Chalmette's identity as a regional center for history, recreation, and commerce.



Reconnecting the System

Top: Strategic parklands with wetland basins and floodable recreational areas

Above: The Forty Arpent Zone in Chalmette

Below: Sectional diagram of wetland basins and floodable areas



Demonstration Project

Forty Arpent Zone

Strategic parklands are established around the basin's most important canal. Situated in the lowest lying area of the basin, where the soils are weakest, the Forty Arpent Zone is the line to which the basin drains, and the interface between urbanized areas and the Central Wetlands Unit.

Increasing the stormwater storage capacity of the Forty Arpent Zone in the form of floodable areas and wetlands basins, reduces the pumping that is necessary with each rainstorm and improves both stormwater and groundwater management for St. Bernard Parish and Lower Ninth Ward residents.



Stumps in the Water

Top: The introduction of saltwater into the Central Wetlands Unit reduced rich wetland environments into expanses of open water and cypress stumps.

Above: Crabbing in the Central Wetlands Unit

Above right: Site of pilot projects for diverting treated sewage into the wetlands to restore cypress forests



Regrowing a Cypress Swamp

Top: Cypress swamps are found throughout the Mississippi River Delta and southeastern Louisiana.

Bottom: The New Orleans Sewerage Treatment Plant in the Lower Ninth Ward is one of the sources of water and nutrients to be used in restoring cypress forests in the Central Wetlands Unit.

Urban Opportunity

Central Wetlands Unit

Forty seven square miles of wetland are restored as a regional asset. Bounded to the south by St. Bernard and the Lower Ninth Ward and to the north by the Gulf Intracoastal Waterway, the Central Wetlands Unit is critical to the safety of the entire region as a wetland buffer; as the outfall area for St. Bernard's drainage networks, and as a potential relief area for the Industrial Canal during the heaviest rain events.

The Sewerage & Water Board of New Orleans and the Lake Borgne Basin Levee District are collaborating on a wetlands assimilation project in which treated sewage is rerouted into these degraded wetlands as a source of freshwater and nutrients. As a cypress swamp once again, the Central Wetlands Unit will be a one-of-a-kind urban habitat and a stopping point for locals, tourists, and winged travelers alike.

Poydras to the Gulf

ST. BERNARD BASIN

Restoring the **Bayou Terre aux Boeufs** brings beauty, ecological vitality, and a healthy flow of water back to the historic communities of Lower St. Bernard, where unique traditions and a rural way of life can continue to thrive within the protection afforded by the farthest reaches of the region's federal levees and floodwalls.

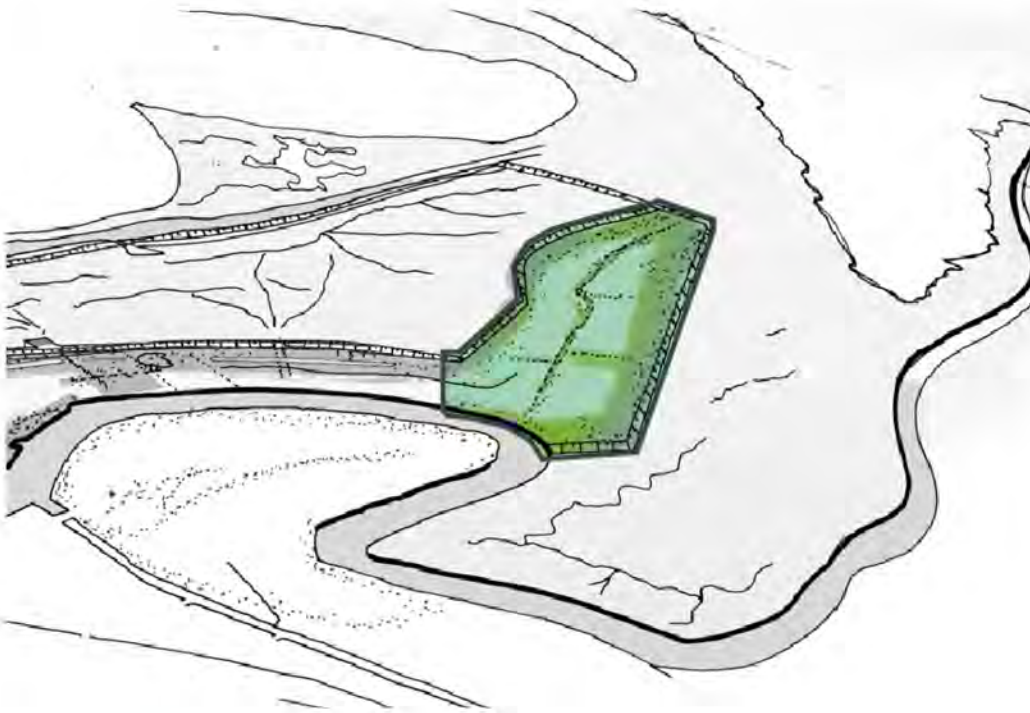
Bringing Water to the Bayou

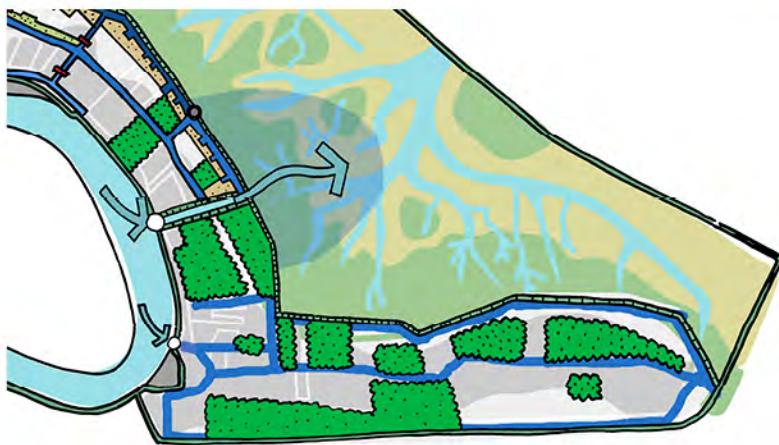
The villages of lower St. Bernard are situated along the Bayou Terre aux Boeufs. In the 18th century, Isleños (immigrants from the Canary Islands) first settled the banks of this bayou, formerly a channel of the Mississippi, and from there supplied New Orleans with produce and poultry through the 1700s and 1800s.

As a primary ridge, the high ground of the bayou still serves as an important connector between the urbanized communities of St. Bernard further upriver and the rural fishing villages outside of the federal levee protection system.

However, the bayou no longer has a steady source of water and exists largely as a stagnant weed-filled ditch that parallels Bayou Road as it runs from Poydras to the far eastern floodwalls of the HSDRRS. In the one place where the bayou exists as an amenity, (see facing page), it is a place of astounding beauty.

Restoring the flow in the bayou with water from the Mississippi improves the ecology of Lower St. Bernard. Flowing water flushes the channel of debris, improves groundwater levels, and provides the freshwater necessary to maintain healthy swamps and oak hammocks alongside the bayou. This investment restores the bayou as a defining feature and critical asset for all of Lower St. Bernard's communities.





A Restored Bayou Terre aux Boeufs

Top: Properties alongside the Bayou Terre aux Boeufs, in the town of Poydras

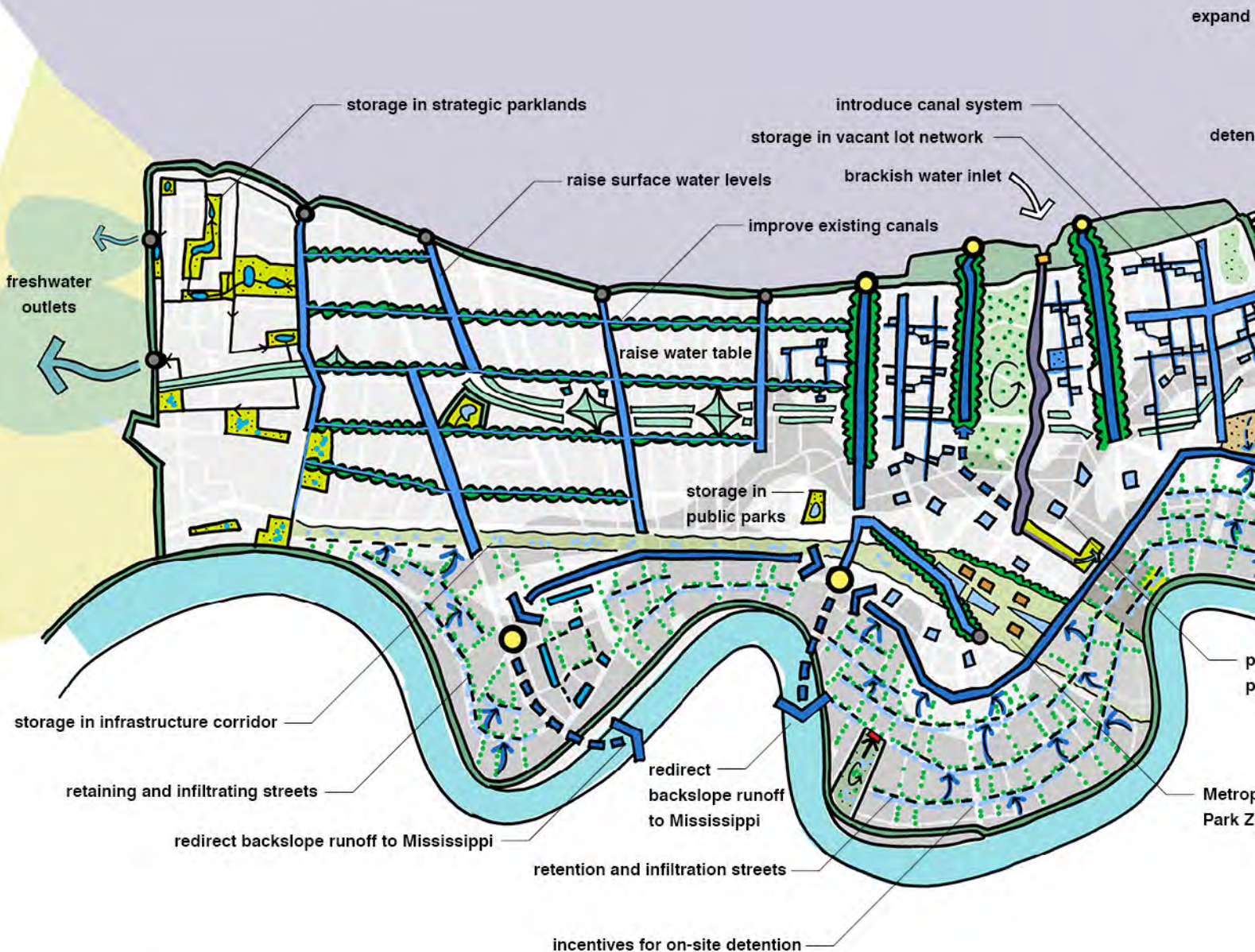
Above right: The bayou as a stagnant ditch alongside Bayou Road

Above: The Mississippi River as freshwater source to restore flow through the bayou

Urban Identities

Humans and Nature in Balance

One of the region's strengths is the distinctive identities of its neighborhoods. Historical development patterns, architecture, and demographics all contribute to these identities, as do restaurants, festivals, parade routes, tree cover, and proximity to waterways and waterfronts. The design of each proposed retrofit draws from these layers, and enriches them in turn, because the implementation of proposed water strategies strengthens the relationship of that neighborhood and its public spaces to the soil layers and water assets particular to that area.



5 miles





One Step at a Time

Stepping stones in a traditional Japanese garden. In these gardens, water is prioritized and carefully managed to harmonize with nature and attract good fortune.

6 Moving Forward

TOWARDS THE DELTA CITY

A new and improved relationship with water will result in a stronger and more diverse regional environment with healthier habitats and increased biodiversity, a more robust regional economy that capitalizes on the region's water assets and drives long-term growth through water-related technologies and processes, and a more attractive and comfortable place for people to live and work.

Moving Forward

TOWARDS THE DELTA CITY

The Urban Water Plan provides a shared vision for transforming the region through integrated water management. Grounded in science, testing, modeling, and a comprehensive planning and design process, this plan positions water as an economic and ecological resource for New Orleans and Jefferson and St. Bernard Parishes.

Water as an Asset

A preliminary cost estimate for the implementation of the Urban Water Plan suggests costs ranging from \$2.9 to \$6.2 billion. These costs would be incurred over the next 30 to 50 years as the three parishes work together to undertake a series of retrofits necessary to achieve the proposals outlined, including demonstration projects at every scale: from small road retrofits to the construction of hundreds of acres of strategic parklands.

Retrofits of this nature provide a range of benefits that can be grouped into three categories:

- **Improved Safety:** reduced flood risk, more stable ground, and long-term insurability for homes and businesses
- **Quality of Life:** improved tree cover and streetscapes, lower ambient air temperatures, improved water and air quality, robust park and wetland ecosystems, and waterways as multi-functional open space and recreational networks
- **Economic Opportunity:** stronger regional identity and competitiveness, construction jobs, reinvestment in disadvantaged neighborhoods, revitalization of commercial areas, and a global leadership role in water industries, research, development, planning, and design for resiliency

Simply improving urban water management is only part of the work to be done to ensure future prosperity for the region. It is important to bolster more than just the flood protection systems—the levees and floodwalls—and to also strengthen the health of regional wetlands, which are natural buffer zones that reduce the velocity and height of hurricane-driven storm surge and winds. The region is inextricably linked to the land around it and the strength of both is dependent on systems working in unison to adapt to a changing climate, withstand fluctuations in local and global economies, and weather severe storms and hurricanes.

Stakeholders

Stakeholders from within the city and farther afield will play critical roles in realizing the Urban Water Plan's potential.

These participants will have to collaborate on a wide array of implementation processes that require:

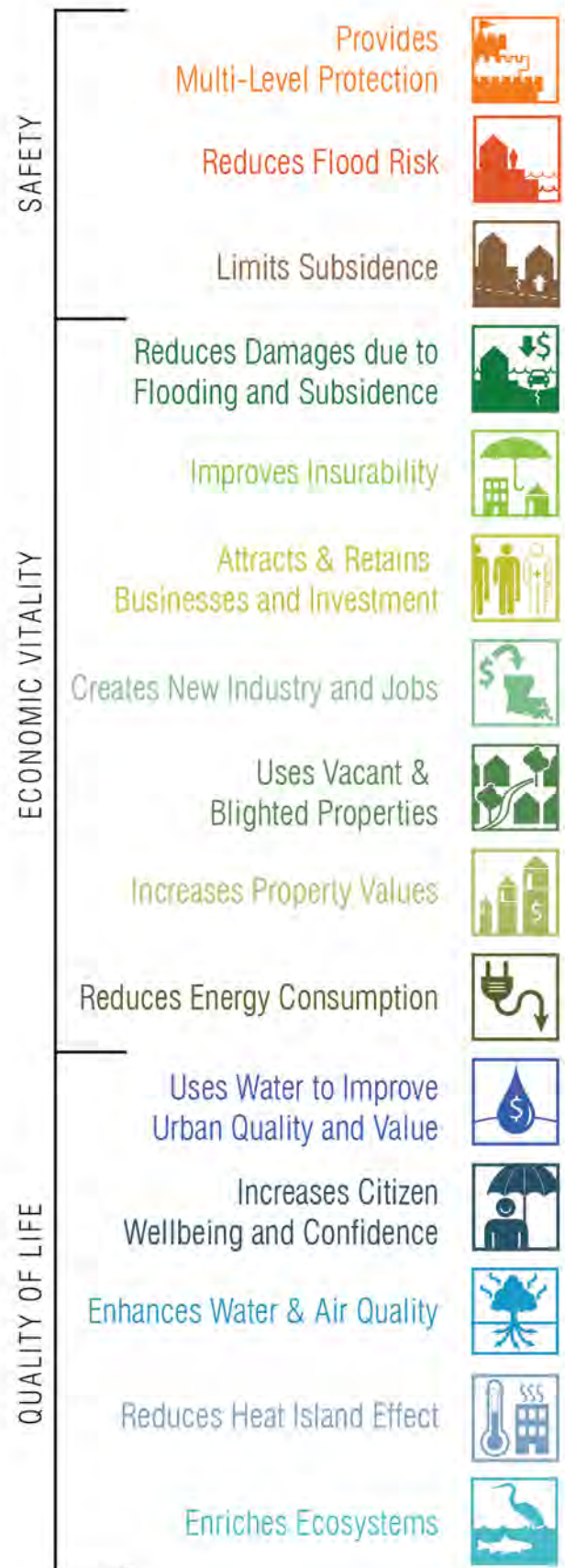
- enduring political will and consensus built on a shared understanding of challenges and opportunities
- public awareness and education efforts to build regional “water literacy”
- extensive testing and monitoring
- an iterative design and planning process
- a variety of strategies and solutions tailored to the unique scale and geography of each proposed project
- an industry and workforce with the capacity and skills to do the work

Individuals comprise a critical stakeholder group. They are the consumers of the city’s water resources, and they are property owners, citizens, and voters that provide guidance and feedback to the city as advocates for improved systems, build knowledge and consensus as neighborhood educators, and catalyze projects as fundraisers.

Homeowners can make measurable improvements to the urban landscape by planting trees, creating rain gardens, installing rainwater harvesting systems with which to water their lawn, and replacing driveways and patios with pervious paving. Such small steps bring benefits to the homeowner by reducing the risk of localized flooding. At the same time, each step also benefits the greater good, by incrementally reducing loads on drainage infrastructure.

Business and commercial property owners can improve the hydrology of entire districts as owners and operators of buildings, parking lots, and other facilities. By embracing higher standards for landscaping and site design, business owners can make an immediate impact on the urban landscape. Because business owners depend on functioning infrastructure and an environment that does not exact excessively high costs, they will play an important role in shaping discourse around public investments.

Stakeholders at the district scale include **neighborhood groups, improvement districts, and business associations.**



The Urban Water Plan's Benefits

The Plan has numerous benefits that touch safety, economic vitality, and quality of life.



Urban Water Plan Stakeholders

Key stakeholder groups include individuals, homeowners, business and commercial property owners, neighborhood groups, improvement districts, business associations, government entities, non-profit and civic organizations, economic development organizations, business councils, and chambers of commerce.

Top image courtesy of The Tulanian

These organizations come together to resolve shared problems through dialogue and collaboration, and tackle issues ranging from improving neighborhood security to incentivizing business development. They galvanize grassroots efforts, bring attention to specific issues through the media, enlist governmental and non-governmental partners, and provide a collective voice for projects that benefit their respective constituencies.

Federal, state, regional, and municipal entities determine the regulatory context within which the implementation of major public works projects takes place. That regulatory context will also be the basis upon which systems managers can enact incentives and penalties that catalyze retrofits on private and institutional properties.

Public entities can also provide the technical support and educational programs that will be necessary for widespread change. These include systems managers tasked with finding means and methods for system-scale retrofits. Retrofits on public properties will become examples for the region, while demonstrating each parish's willingness to invest in new ideas and technologies.

Nonprofit and civic organizations are essential to shaping civic life. They work at the scale of the individual, the district, the city, and the region, and they hold governments accountable and rally stakeholders around specific issues such as water quality or education. Where implementation of the Urban Water Plan is concerned, they can sponsor and disseminate information regarding research and development efforts; support neighborhood groups and community activism by building capacity and providing technical support; provide resources for pilot programs and projects; and assist districts and systems managers with financing, implementation, and maintenance strategies.

Economic development organizations, business councils, and chambers of commerce set agendas for job creation, nurturing business growth, supporting industry, marketing the region, and driving policy. A critical role that these entities will play in the 21st century will be to spur new thinking and foster innovation.

Challenges and Opportunities for Implementation

There are five key conditions that contribute to the problems associated with water management today. They include:

- fragmented and incomplete management of water resources and usage
- outdated water management systems
- underfunded agencies responsible for critical water services
- ineffective regulations regarding water objectives
- outdated paradigm that treats water as a nuisance rather than as an asset

Each serves as a starting point for identifying the key steps to redefining urban water in Greater New Orleans.

Integrating Water Resource Management

In New Orleans, for example, the Department of Public Works is responsible for stormwater once it flows into a gutter and enters a storm drain. The water becomes the responsibility of the Sewerage & Water Board (S&WB) when it enters pipes with diameters 36" or greater, and from there into one of the parish's drainage canals. In all three parishes, drainage pump stations are critical control points in the regional flood defenses, and so the U.S. Army Corps of Engineers also plays a role in determining the flow of water in the region.

In contrast, the management of groundwater does not fall within the jurisdiction of any particular agency. There is no governing organization tasked with monitoring groundwater levels, tracking effects of drainage on subsidence, or calculating the total volume used for industry, power generation, irrigation, and recreation. The importance of this gap in oversight and coordination cannot be overstated, because of the importance of groundwater to maintaining soil stability across the region.

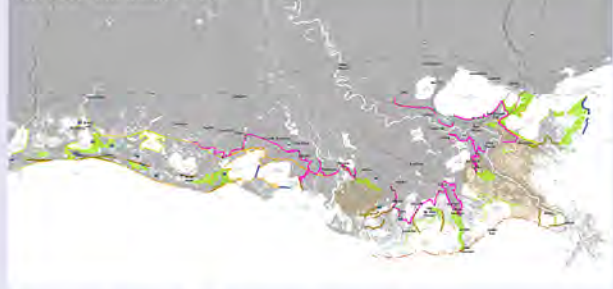
A new approach to managing groundwater should be built on a regional basis and

"The old exploration described that which is, while the new exploration projects that which can be."

Benton MacKaye

From The New Exploration, 1928

2012 Coastal Master Plan



Related Planning Processes

Federal, State, Regional & Local Planning

A number of policies, plans, and planning efforts that are underway actively shape public and private investments. Whether this is the Louisiana Coastal Master Plan, New Orleans' newly adopted City Master Plan, or St. Bernard's ongoing land use planning process, each signifies an effort by a community to define shared concerns and interests, and oftentimes a vision of how that community will function in the future.

The relationship of the Urban Water Plan to these policies and planning efforts is fundamental in two ways:

- This report describes water and water management as unifying themes that ask stakeholders to bridge various planning efforts. Living on the Mississippi River Delta requires a comprehensive approach to resiliency and public investment, so that transportation planning, land use planning, resiliency planning, coastal restoration planning, and all such efforts embody shared values and principles of water and soil management. For the region to survive and to thrive in the 21st century, coordination and collaboration must happen at every level.
- Basic principles and approaches to water and soils that are covered in this report are directly relevant to other planning processes.

“The real voyage of discovery consists not in seeking new landscapes, but in having new eyes.”

Marcel Proust

Novelist, 1871-1922

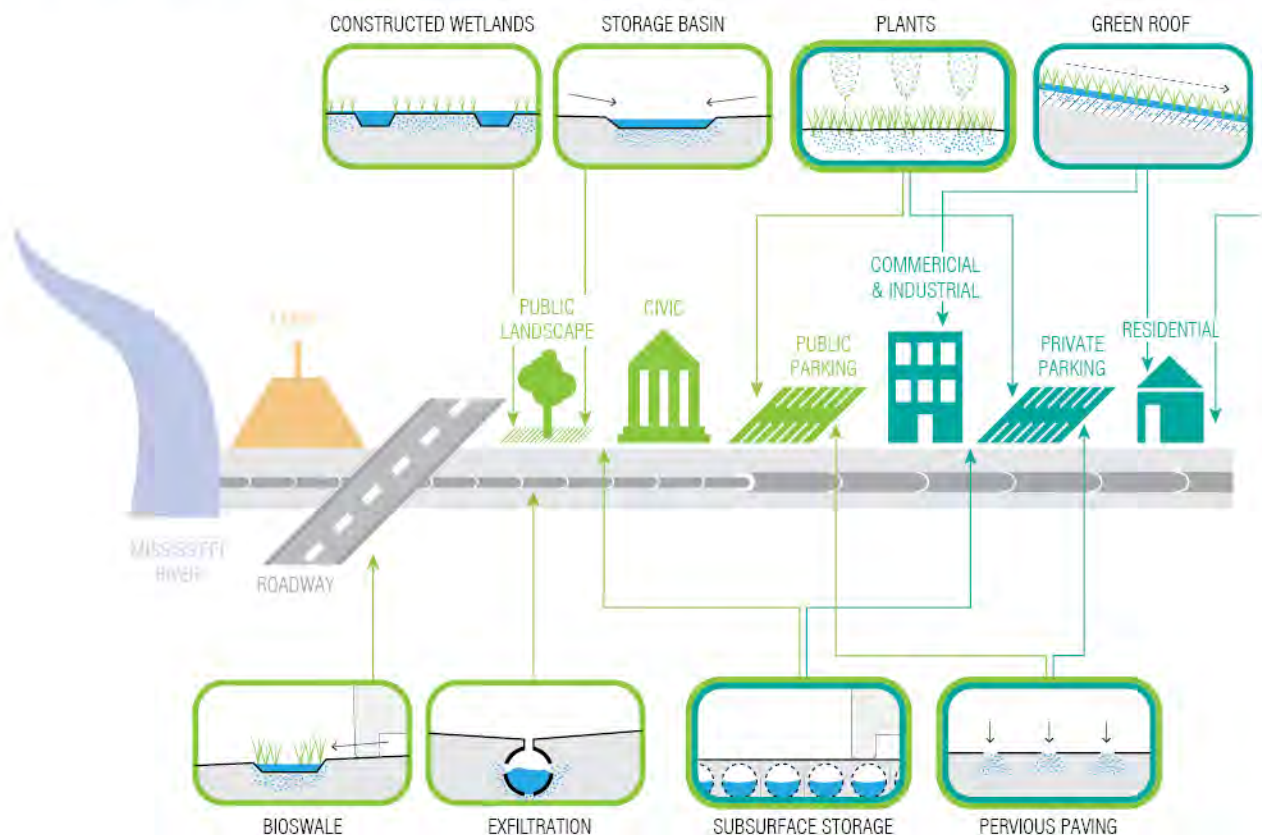
according to hydrologic and geologic jurisdictions, such as watersheds and soil layers, rather than long-standing political boundaries that have little bearing on the distribution of rainfall or the location of an aquifer.

The best way to realize the Urban Water Plan is to convene a **regional water management authority** with adequate resources to guide implementation in the coming years. This authority can coordinate water-related initiatives at system and district scales, conduct research on regional issues, and represent the region’s interests and capabilities in a national and international context.

The authority will also need to work with municipalities and local agencies to coordinate groundwater management, provide technical support and regional data, initiate a stormwater retention credits trading system, wetlands mitigation bank, or other market-based funding strategy, and establish ongoing regional monitoring and hydraulic modeling efforts.

Operations & Maintenance of the Proposed System

roles for traditional water managers and other public entities



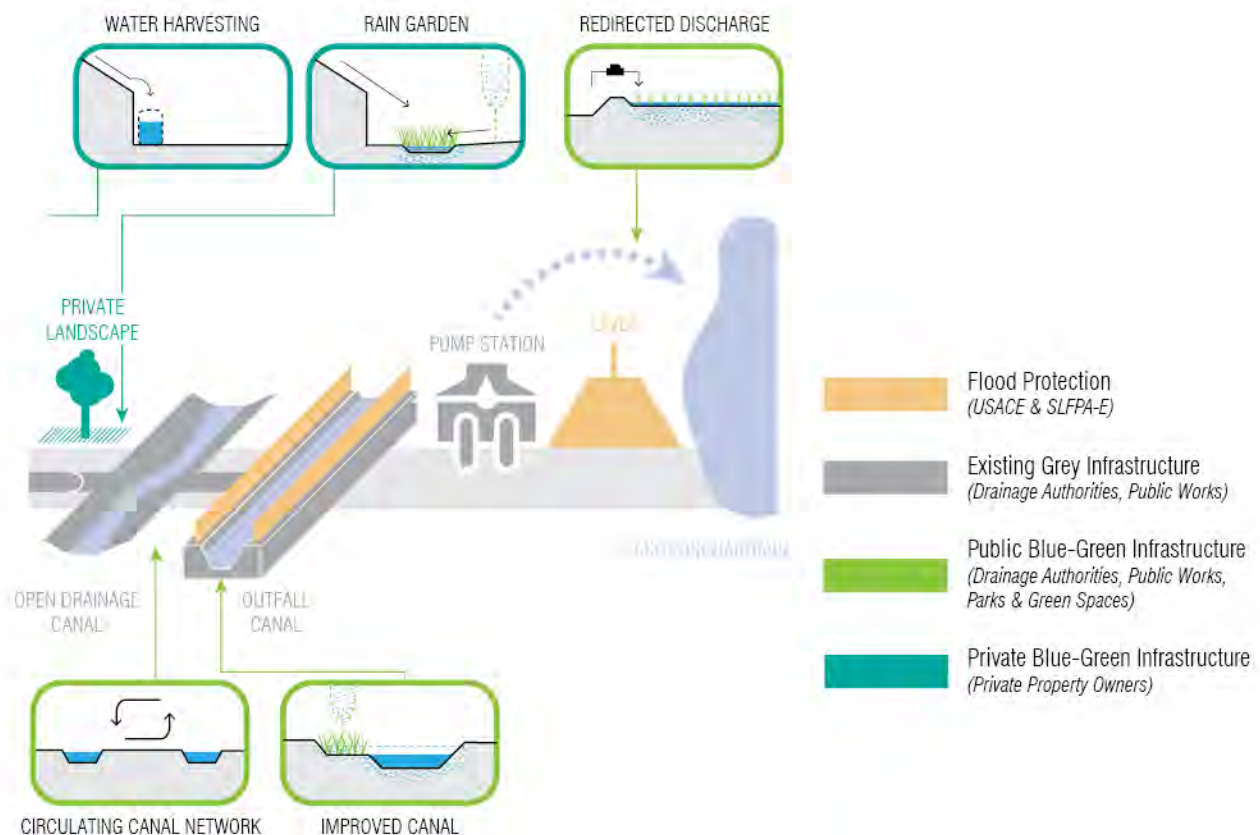
Upgrading Water Infrastructure

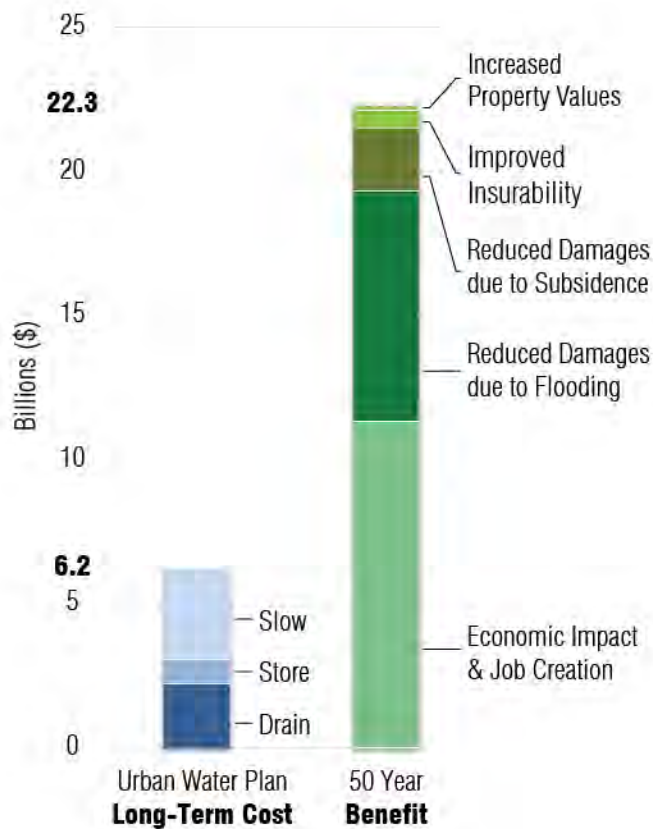
Shifting ground, urban expansion, and rising costs are all factors impacting the vast networks of pipes, canals, and pumps that make up the current water system. Current water managers are saddled with antiquated systems that performed admirably during the first part of the 20th century, but have struggled under the increased demands of the late 20th and early 21st centuries. Changes in building practices and transportation have also fundamentally altered the urban landscape, producing rates of runoff that far exceed those from early last century.

With climate change and rising sea levels altering weather patterns and the region's coastal context, the task of managing the region's water becomes even more challenging. Fortunately, the technologies and design solutions that the region needs to respond to these challenges exist already and have been successfully employed by cities with comparable soil and water conditions. Greater New Orleans can look to great water cities such

Implementation Opportunities

- **Integrate and expand management** of water resources
- **Update antiquated systems** to meet modern demands
- **Secure funding** for the agencies that provide critical water services
- **Revise regulations** to achieve desired water objectives
- **Conduct public outreach** to foster regional water literacy and build a new water paradigm





\$22.3 Billion in Benefits over 50 Years

- **\$11.3 Billion:** Economic Impact and Job Creation
- **\$7.99 Billion:** Reduced Flooding Cost
- **\$2.19 Billion:** Reduced Subsidence Cost
- **\$609 Million:** Lower Flood Insurance Premiums
- **\$183 Million:** Increased Property Values

as Rotterdam, Amsterdam, and Shaoxing, as well as U.S. cities like Portland, Seattle, San Francisco, Chicago, Houston, and Philadelphia for advances in sustainable water infrastructure. Each city provides precedents for the implementation of technologies and solutions ranging from vegetated swales and green roofs to treatment wetlands and stormwater detention and retention basins. The principles that underpin each of the Urban Water Plan's proposed strategies and projects have been tested in other contexts and proven to work.

The region has the capacity to innovate and make many of the necessary retrofits. There are strong research facilities and dedicated professionals at the Water Institute of the Gulf, the University of New Orleans, and Louisiana State, Xavier, Dillard, Southern, Loyola, and Tulane Universities who are already deeply engaged in studying the hydrology and geology of the region. Entities such as the U.S. Army Corps of Engineers and partnering contractors have successfully undertaken massive infrastructure projects such as the HSDRRS and the Lake Borgne Basin Surge Barrier. There is considerable manufacturing and engineering expertise in the region's industrial facilities, and ready access to critical commodities and markets for exporting new technologies and products through its ports and trading partners.

Additionally, there is already a robust network for sharing knowledge and exchanging ideas with water experts from around the world, as exemplified by the Dutch Dialogues workshops, the participation of New Orleans in the global "Connecting Delta Cities" coalition, and the collaboration that has been instrumental to the development of the Urban Water Plan. This network will prove to be a valuable support system as an increasing number of coastal and delta regions begin to face challenges similar to the ones that Greater New Orleans is now seeking to overcome.

Funding Critical Water Services

Funding is important in two ways. First, systems managers require significant resources to operate and maintain existing systems. Even a budget of between \$70 million and \$80 million per year has been insufficient to keep up with the necessary repairs to aging water systems. Second,

systems managers need additional sources of funding to make systemic, large-scale retrofits. In a time of budget cuts for municipalities and agencies across the country, both types of funding are difficult.

Because of the age of today's water systems, much of each agency's budget is dedicated to fixing what is broken, but many agencies are already years behind on making necessary repairs. The S&WB of New Orleans, for example, has been working towards a significant drinking water and sewerage rate increase, citing decades of deferred maintenance as one of the primary causes of present-day systems failures.

Cities around the country face similar challenges with aging infrastructure, and have had to adopt new funding strategies in order to pay for repairs and improve systems to meet changing needs. Philadelphia, for example, began charging property owners for drainage services—a so-called “impact-based drainage fee”—in order to pay for the retrofits the city needs to reduce combined sewer and stormwater overflows into the Delaware and Schuylkill rivers.

None of the three parishes' stormwater management entities charge an impact-based drainage fee. Instead, water managers pay for drainage infrastructure and operations with allocations from general budgets and revenues from property taxes and fees for other services. This means that those responsible for the most runoff, the property owners that place the greatest strain on drainage systems, are no more accountable for rising infrastructure costs than property owners that have a lesser impact. With no additional penalties for placing a disproportionate burden on the drainage system, property owners have little reason to reduce runoff. Current fee structures do not reflect the fundamental role that customers have in shaping drainage needs through the site design and landscaping of their properties.

Moving forward, collaboration across different financial sectors and government agencies will be critical. The Urban Water Plan's proposals total over \$6 billion dollars in retrofits and new construction for the next five decades, and their implementation will require innovations in funding and



St. Louis Citygarden

Public/Private Partnerships

The 2.9 acre Citygarden in St. Louis, MO, was developed under a public-private partnership between the City of St. Louis and the non-profit Gateway Foundation. The foundation funded the design, construction and soft costs associated with development, as well as ongoing operations and maintenance costs. The improvements and real estate remain under municipal ownership.

Citygarden has been cited as a catalyst for both increased development in the downtown area and expansion of programmed park space along the Gateway Mall. In addition to leveraging public private partnership structures, the project leverages partnerships with local institutions, including Washington University in St. Louis, the St. Louis Art Museum and the Contemporary Art Museum St. Louis. (Photos courtesy of Flickr, Fast Company, and W. Haun)



Houston's Buffalo Bayou

District-scale Economic Transformations

Houston's Buffalo Bayou Master Plan was published in response to a 1986 mayoral initiative. It called for a solution that integrated recreation, environmental quality, urban development and economic benefit. That same year the non-profit Buffalo Bayou Partnership was established to oversee and raise funds for the implementation of the plan. The updated *Buffalo Bayou and Beyond Master Plan* was released in 2002. The plan is expected to cost \$5.6 billion over the next twenty years, with at least \$800 million in publicly-funded hard costs.

The significant scale of the Buffalo Bayou initiatives necessitates the phasing of component projects. Notable among these projects is the Buffalo Bayou Promenade, a 1.4 mile long development connecting the Central Business and Arts Districts, which opened as a public space in 2006 and includes trails, kayaking, sculpture, and special event spaces that are designed to accommodate floodwaters when the bayou overflows its banks. Other plans call for a new canal along the right-of-way occupied by Allen Street, an ecological park at Turkey Bend and an improved sewage treatment plant near the shipping channel. Buffalo Bayou connects two regionally important areas while showcasing waterways and rights-of-way in a fashion which reconnects neighborhoods and people at the intersection of urban and natural environments.

(Photos courtesy of American Society of Landscape Architects)

strategies that yield short-term benefits and long-term growth.

In addition to impact-based drainage fees, a number of other funding sources and mechanisms hold significant potential for the implementation of Urban Water Plan proposals. These include:

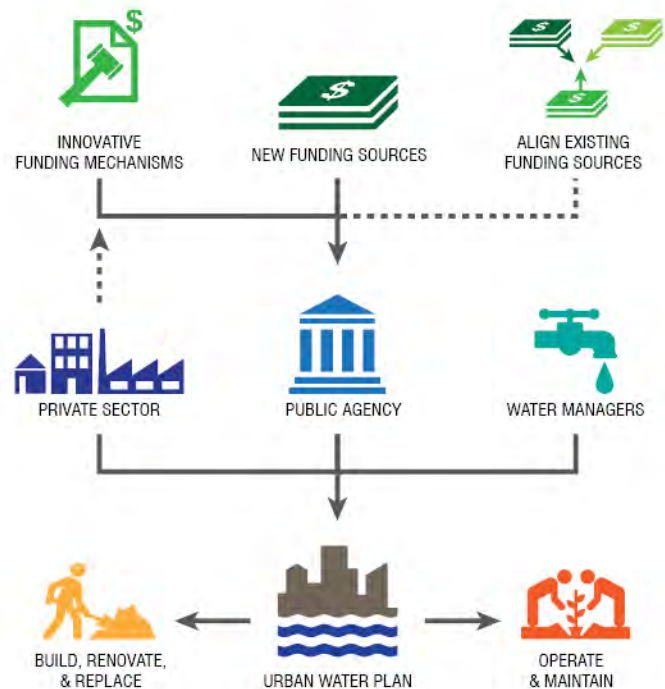
- remaining federal hazard mitigation funds meant to reduce long-term risk and property loss
- RESTORE Act funds
- special assessment districts that are created to provide specific services and infrastructure beyond what is possible through existing regulations and funding streams
- developer incentives such as rebates, fee reductions, or density bonuses
- stormwater retention credits
- pay-for-performance strategies that allow governments to outsource critical projects to third parties with no up-front cost

It will be important to find combinations of these funding opportunities that maximize potential yield. The simplest funding strategies look to create dedicated funding streams within a managing entity's annual budgeting, rather than relying on non-renewable funding sources. For example, in Washington D.C., green infrastructure funding is partly derived from a bag tax that raises \$2 million annually. Similarly, Amsterdam uses parking fees within the city center to fund the operations and maintenance of the city's iconic waterworks and canals. In both cases, measures taken to improve the quality of both daily life and the environment generate funds for critical water infrastructure.

Given much of the public's current opposition to new taxes and the reluctance of most politicians to impose them, any funding strategies that are eventually put into place will require complementary efforts to both raise awareness of the issues that need to be resolved and to inform the policy makers and voters of the importance and value of sustainable water infrastructure. Without political determination and a broad support base, making the investments that are necessary to bring water systems into the 21st century will pose an insurmountable

challenge. But with a shared vision and collaborative efforts, there are significant sources of funding available for innovative infrastructure and sustainable water management. Through the RE.invest Initiative, New Orleans will receive over \$2 million in funding as well as access to experts from the fields of engineering, finance, and law in order to develop implementation strategies for system upgrades included in the Urban Water Plan. Additionally, that funding will help support the creation of new public-private partnerships for resilient infrastructure, including additional systems that can be bundled with new water infrastructure.

Every dollar spent must also be seen as an opportunity for economic development, through the creation of long-term employment opportunities, growth of new economic sectors, and regeneration of neighborhoods across the three parishes. The justification for the projects proposed in the Urban Water Plan lies in their ability to yield multifold benefits on the dollar. One of the key criteria applied in prioritizing and designing each of the proposed projects is the economic growth that becomes possible with each investment. The stakeholders involved must be able to derive quantifiable benefits and economic value out of shared investments. The Urban Water Plan is founded on the belief



Funding Integrated Water Management

Implementation will require a mix of strategies, including the adaptation of funding streams, identifying new funding sources, and the utilization of both incentives and penalties to make possible public works projects and critical investments by the private sector in implementing water strategies.

Research and Innovation Campus

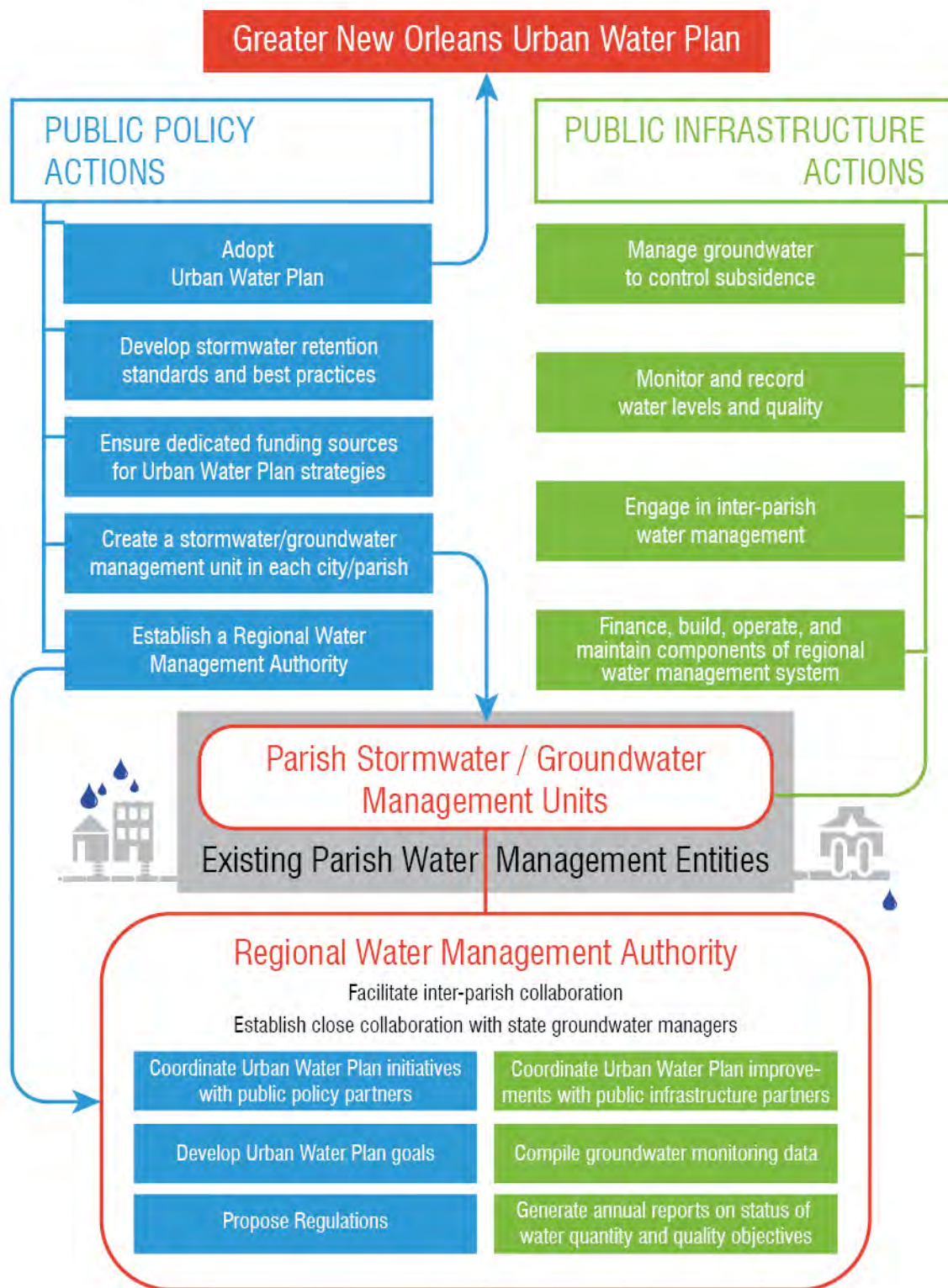
Establishing a water-focused research and innovation campus will foster local research while forming the basis for New Orleans to become a global leader in water management, technologies, and planning and design. The campus will need to be a collaborative effort between local institutions, economic development agencies, and public agencies that fosters both academic and economic growth.

The research and innovation campus will build regional capabilities for the following:

- flood protection and risk assessment
- urban green infrastructure
- coastal restoration
- subsidence control
- water-based planning and design
- living water systems operations
- integrated systems modeling



A water-based research and innovation campus will allow local industries and institutions to leverage expertise gained through implementing the Urban Water Plan into critical global leadership positions in the 21st century. There are few cities better suited to take advantage of these opportunities.



Policy Recommendations

Changes to the policies and missions of the agencies that manage water resources are necessary for these agencies to take the necessary steps towards full implementation of the Urban Water Plan.

that smart investments in infrastructure and public spaces are fundamental to the economic and ecological wellbeing of every region.

Regulating for Water Objectives

Planning officials and systems managers currently have few incentives available to encourage property owners to reduce runoff from their properties. This is because zoning regulations follow the idea that drainage is a basic right rather than a service provided. Unfortunately, this idea does not allow for the fact that runoff from any given property can impact other properties. This is something that many other cities regulate, in the same ways they regulate noise and light pollution, building heights, and land use. The configuration of drainage systems in the region connects neighborhoods in ways that are not immediately apparent. Large volumes of runoff from one area rushing towards a pump station can cause flooding in “downstream” neighborhoods. Conversely, a drainage system that is already at capacity in a downstream area may not be able to accept water from “upstream,” which may cause flooding in neighborhoods higher up. In asking each property owner to take responsibility for their own stormwater, regulating runoff becomes an opportunity to reduce risk and improve the quality of life for every resident.

In Greater New Orleans, the presence of floodwaters can be considered a public health issue, because its cause is rooted in land use regulations and road networks, and its impacts are borne disproportionately by the residents of certain areas. While flooding can and does occur even on high ground, certain neighborhoods, system choke points, and low areas see a disproportionate share of flooding and property loss. As the entity tasked with helping to shape the city, each planning agency can take an active role in establishing accountability, reducing risk, and enhancing overall well-being through advances in water management. The demanding physical environment and sub-tropical climate of the Mississippi River Delta requires such efforts, because no public entity can solve all of the issues the region faces without the cooperation of property owners, businesses, and institutions.

Water Literacy & Education

Learning water principles is critical to building a great delta city.

Significant changes in policy, finance, and operations are necessary to upgrade the region’s infrastructure, but these changes will require a shared attitude towards water and risk. High levels of “water literacy” are fundamental to making the decisions and investments that are necessary to achieve the benefits of the Urban Water Plan. The region already has a strong tradition of activism, community-based design, and large-scale infrastructure planning. But without a populace that is conversant in soils, water, and infrastructure, Greater New Orleans will not be able to, as a society, make informed decisions about why and how to invest in the coming decades.

Water can enrich curriculum at every level and in every subject, while grounding educational objectives with a deeper relationship to place. Understanding hydrology requires basic math and science skills. The soils and ecological function of living water systems build on the study of geology, biology, and ecology. The geography of water and infrastructure is critical to history and social sciences. Implementation of green infrastructure has relevance to economics and political science.

In the Netherlands, kids learn about water at an early age, through songs, through play, through literature, and through science education. In those same ways, a water education speaks to who we are as citizens of Louisiana and residents of the delta. Furthermore, water education suggests a diversity of career paths, ranging from water management and engineering to design, planning, and green infrastructure.

It is these careers that will be the basis for the growth of new industries in New Orleans, as these areas of expertise are important not just to this region, but to the world at large as climate change and water scarcity increasingly dictate the geography of public and private investment, geopolitics, and the risks and opportunities that individuals and communities face moving into the middle of the 21st century.

Children will be able to take active roles in this environment as they grow older, if learn to read the lay of the land, the flow of water, and the shape of infrastructure at an early age.



Students at KIPP Central City Primary learn about water, topography, and the drainage system of New Orleans.



1895 New Orleans Drainage Master Plan

"An influence for good in all directions"

"No project ever brought to a successful issue in the history of New Orleans had so deep and wide an influence for good in all directions as that which ensued from this achievement," opined Martin Behrman, Mayor of New Orleans, before the convention of the League of American Municipalities in 1914.

The plan was developed because previously constructed drainage systems were largely ineffective, holding the city back from continued growth and prosperity. Improving drainage infrastructure was seen as part and parcel of broader civic improvement initiatives, which included projects to better streets, railway service, lighting, and sewerage.

The 1895 plan led to the creation of the Sewerage & Water Board, inspired the invention of the Wood screw pump, and sparked a transformation of the city, reducing flooding, disease, and enabling the city to expand into former swampland. The tax for the bond measure passed almost unanimously, and the project was funded through \$20 million in bonds, with an education campaign in 1899 playing a notable role in swaying public opinion in favor of the initiative.

Though the city now pays for the consequences of the approach to drainage that has been inherited from 1895, the plan serves as a powerful example of the solidarity and single-mindedness of purpose that the region is capable of and again needs.



Top: Draining the swamp in the early 20th century

Above, left: Early Sewerage & Water Board purification plant

Above, right: The Wood Screw Pump was patented in 1920 in New Orleans and used around the world.

Within the project area, the cities of Kenner and New Orleans and St. Bernard Parish are all developing or have recently passed new master plans that will yield new zoning maps and regulations. Each of these is the starting point for creating a regulatory and land use context that asks property owners to take responsibility for the runoff from their properties, and gives systems managers and municipalities the tools that are necessary to regulate runoff. The New Orleans Master Plan states, "If risk is properly managed, water can become a great asset to neighborhoods and their quality of life." It also "calls for transforming canals and other water-management infrastructure into attractive elements of the urban landscape in a New Orleans where safety and resilience set the stage for long-term prosperity in harmony with water." As city planning officials begin to finalize the new comprehensive zoning ordinance, such statements of principles must become more than words. They must be coded into the ordinances that regulate the land-use and zoning decisions that are made each day.

A New Paradigm for Urban Water

The Urban Water Plan outlines a shift from a "pump first" paradigm to one in which water is embraced as an asset and critical resource. The fear that is associated with water today comes from a long history of working to overcome the challenges of inhabiting a wet and often volatile environment. The advent of modern drainage at the beginning of the 20th century and the drainage projects that followed are part of a long-term effort to control the flow of water and remove it from the urban landscape.

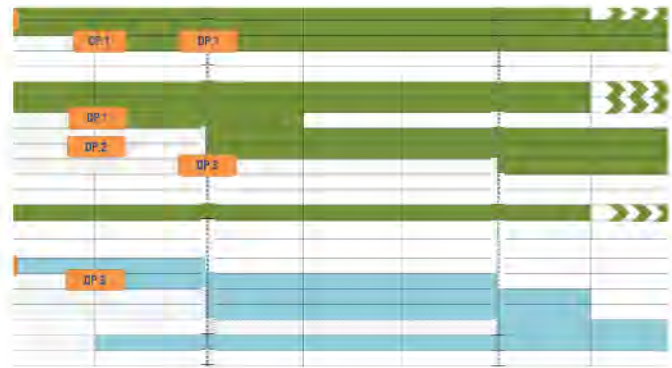
While flooding remains a significant concern and requires constant vigilance, the effects that the existing approach has had on the region and the risks that it poses for the future are undeniable. Sinking land and periodic flooding make clear the costs of the pump-first paradigm, and the importance of finding ways to live with water that are consistent with the culture and aspirations of the region.

In fighting water, the region's residents have lost touch with the elements that make the region unique: its alluvial soils and abundant water resources. The region's residents encounter water in the form of

disruptive floods, rather than as a life-sustaining element, one half of the soil-water mix that makes up every delta.

Another effect of the current approach to stormwater is that is that the region's once multifunctional waterways and bayous have been replaced by single-purpose pipes, drainage ditches, and canals. The results are unattractive drainage networks that sever neighborhoods and provide more value as dumping grounds than they do as public amenities that foster recreation, create urban habitats, beautify and inspire. With opportunities to engage water in positive ways every day, the region's residents will come to understand that water is vital to the health of any delta landscape, even ones as urbanized as New Orleans or Jefferson Parish. With that understanding, the region's stakeholders will be able to commit the resources and make the investments that are necessary to implement the Urban Water Plan.

A region that truly lives with water is only possible with a populace that is "water literate." That is, a place where citizens are conversant in water issues, and understand the lay of the land, the history and function of the region's water networks, and the relationship between flooding and subsidence. They need also to understand the topography and the geology of the delta and that the risk of flooding from rainfall are as severe as the risk posed by the overtopping of levees. They will also come to appreciate the value and opportunities inherent to a resource as important as water, and the importance of addressing these issues today.

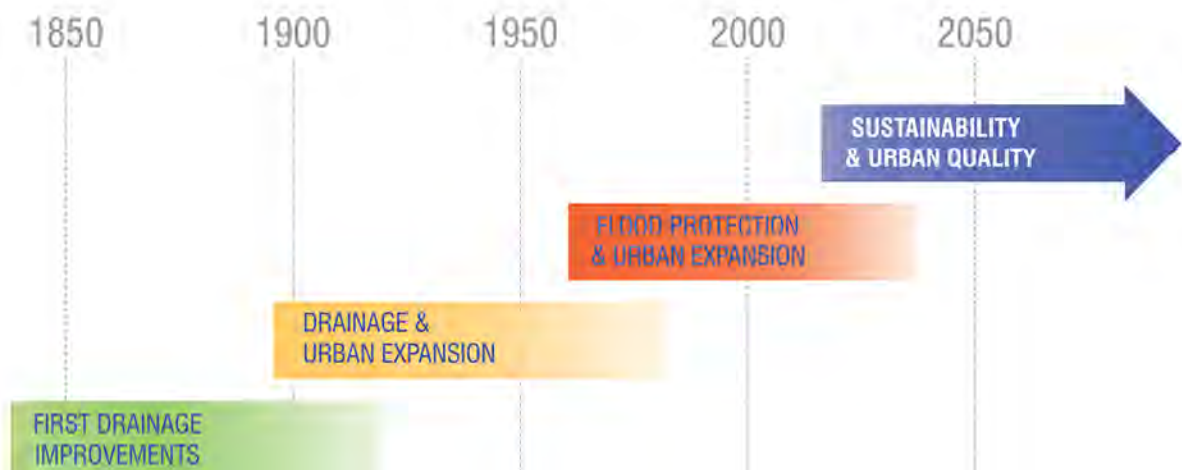


Implementation Phasing

A detailed, comprehensive Urban Water Plan phasing chart and map can be found in the System Design report.

Water Management Eras

The Urban Water Plan ushers in a new era with sustainability and urban quality as the driving forces behind region's water infrastructure.



Implementation Phasing

Full implementation of the Greater New Orleans Urban Water Plan will require the contributions of many stakeholder groups over the coming decades. The phasing diagrams on the following pages and in the SYSTEM DESIGN report anticipate three phases over fifty years, each of which will pose distinct challenges and opportunities for implementation as regulatory frameworks, public discourse, political priorities, and educational systems shift in relation to each other and to a changing environment. The distribution of projects is based on a comparison of costs and project feasibility, regional experiences with public works projects, and an evaluation of the existing political and cultural context.

Describing the boundaries between the phases and the locating of proposed projects across these phases is imprecise, at best. Many projects will span two or more phases, and convincing arguments for shifting certain projects earlier or later in the sequence can be made. That said, attempting a rough chronology for implementing the proposed projects yields useful information, such as how the role of particular stakeholder groups might shift over time as the mode of implementation and the types of projects pursued changes. Furthermore, such a chronology enables systems managers and other implementers to anticipate and budget for specific types of retrofits as they become more or less feasible over time.

The Urban Water Plan is a living document, to be revised and improved over time as conditions change and stakeholders sign on to make pieces of it their own. As with all of the drawings in this document, phasing and implementation strategies will require revisions in the coming years. Each step taken will clarify the next step, and regional understanding of sequencing and interdependencies will continue to evolve.

Near Term (2013-2020)

Priorities in this first phase include high-visibility projects that clearly communicate proposed principles and strategies along

with the costs and benefits associated with implementation processes, technologies, types of construction, and maintenance regimes that are not yet common to the region. Each of the seven demonstration projects in the Urban Water Plan provides such an opportunity, and was chosen according to six criteria:

1. Distribution of projects by geography, type, and scale
2. Visibility and accessibility for the general public
3. Feasibility (presence of committed stakeholders and resources)
4. Innovation (advances in science, engineering, design, and construction)
5. Replicability (relevance of project to other stakeholders)
6. Water Identity (contributions to surrounding community)

Each project proposes something out of the norm, something that requires advocates to push for an outcome different from conventional results, and to partner with other stakeholders to define water objectives in new ways.

These projects will be exceptions to the rule due to low levels of water literacy, the absence of a regional regulatory framework and authority, and the absence of dedicated funding sources for innovative green infrastructure. Projects may require variances where regulatory frameworks do not yet permit innovative practices, for example, and funding may well depend on non-renewable sources like hazard mitigation funding. Identifying additional sources of funding for testing, monitoring, and outreach will be critical, so that systems managers, contractors, institutions, nearby residents, and students can visit and learn from the successes and challenges of implementing the project.

A network of public officials, systems managers, economic development organizations, institutions, professionals, businesses and entrepreneurs, property owners, and activists that are committed to sustainable water infrastructure already exists. There is growing momentum behind their efforts, as evidenced by the participation of diverse stakeholders at Urban Water Plan outreach meetings, and the high level of engagement in other



Near Term

2013-2020: Smart Retrofits

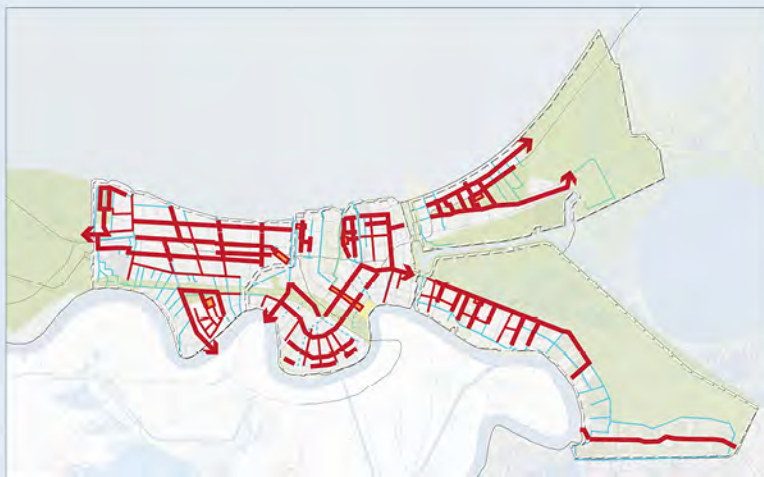
Water management strategies are incorporated into projects already planned and underway, with a priority on demonstration projects that either build on current efforts or have committed stakeholders to help move it forward. Community outreach, educational initiatives, and advocacy for recommended policies and funding mechanisms build support for Urban Water Plan initiatives.



Mid Term

2020-2030: Improved Flows and Connectivity

As demonstration projects are assessed and planning principles refined, implementation expands to establish improved water flows and connectivity and to test new standards and best practices for both public works and private properties. Pilot programs for funding, policy, and education are positioning the region as a water management industry leader.



Long Term

2030-2065: New Policies and Broad Buy-in

As new policies are adopted, regulations are put in place, broad water literacy and understanding are achieved, and public and private commitment is established, the Plan's strategies will continue to be implemented and adapted over the long term to achieve greater resiliency throughout the region.

programming dedicated to water and infrastructure issues organized by the Horizon Initiative's Water Management Committee and the Greater New Orleans Foundation. In the economic realm, Greater New Orleans, Inc., and Louisiana Economic Development have both identified water as key elements for regional economic growth, while the Idea Village's Water Challenge provides support to and inspires innovation in water technologies each year.

Mid Term (2020-2030)

As awareness of Urban Water Plan principles grows through advocacy and education efforts, advances in water management, regulations, and dedicated funding sources will likely require years to catch up, and implementation of Urban Water Plan proposals at larger scales may not be possible before then.

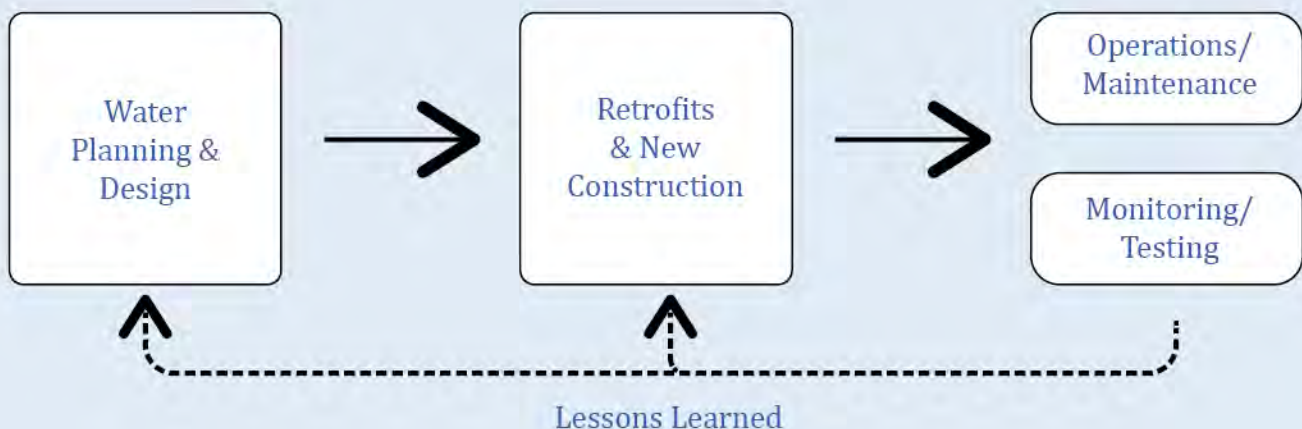
Projects in this phase will likely continue to be opportunistic, as in the Near Term phase. They may still rely on non-renewable sources of funding, but will nonetheless be instrumental in setting the stage for renewable funding sources and the broader adoption of Urban Water Plan principles and strategies by systems managers.

Priorities include lower-cost and high-benefit opportunities with fewer property ownership issues, such as creating strategic parklands on large vacant parcels in critical areas in the Airline Corridor, along Monticello Canal and Florida Canal, and along the Dwyer Canal in New Orleans East. High-benefit projects are ones that alleviate

flooding and other immediate problems, and provide much-needed amenities for surrounding neighborhoods, especially those in need of economic stimulus and revitalization.

This will also be a period of monitoring, collecting data from earlier projects, and using lessons learned to update the Urban Water Plan, and to adjust advocacy, education, and research efforts to overcome the challenges of implementing additional projects. Fostering widespread water literacy will remain critical, as a basic means of building consensus and public support for the long-term vision of the Urban Water Plan, and also for larger numbers of stakeholders to be able to help define priorities and shape implementation processes.

Feasibility studies associated with regional water management, groundwater monitoring and management, impact-based drainage fees, district-scale financing, stormwater credit markets, and other advances in oversight, collaboration, and financing will bear fruit in this phase, as Urban Water Plan principles become regulations and standard operating procedure, and non-renewable funding sources are replaced with dedicated funding sources and market-based mechanisms. The full implementation of the Urban Water Plan will be possible only when such underlying regulatory and financing structures—that inform land use decisions, budgeting, and investment models—reflect public consensus around a new approach to urban water management.



The change in mindset will be from a project-by-project approach to a systems approach.

While a systems approach will provide greater benefits than implementing individual projects, there will also be higher costs associated with the projects slated for this phase. Extensive street retrofits, lowering outfall canal walls, putting in new pumps, constructing new siphons and circulating systems, and other such changes will result in costs in the billions-of-dollars range rather than the millions. An emphasis on corresponding economic development is thus of particular importance in this phase, so that tax revenues and private investments can cover construction and maintenance costs and be reinvested in further improvements. Put another way, each project will need to be more than just an investment in infrastructure, and must serve instead as a long-term development opportunity that creates value for all stakeholders from each proposed retrofit.

Long Term (2030-2065)

Large scale infrastructure projects can and do take decades to complete. Proposals for drainage improvements in New Orleans (known locally as the SELA projects) that were set in motion by intense rainfall and flooding in 1995, for example, are still in construction today. Likewise, New Orleans' 1895 Drainage Master Plan yielded the patent for the Wood screw pump in 1920, and primary construction phases continued into the second and third decades of the 20th century. The scope and ambition

of the Urban Water Plan's proposals will require decades for all of the necessary resources to be brought to bear upon the full implementation of the proposed retrofits. The advantages of a longer time frame are that each phase will benefit from lessons learned previously, and costs will be distributed across generations rather than shouldered solely by the stakeholders of today.

Inhabitation of coastal Louisiana will require constant vigilance and innovation, as environmental, economic, and political conditions continue to change. Because the Urban Water Plan complements mechanical systems with natural systems, the proposed integrated living water system has the potential to evolve and yield greater benefits over time, in contrast to purely mechanical systems where costs typically rise even as function declines over time. Projects and adjustments that introduce additional layers of protection and growth, such as barrier islands along the lakefront, can be put in place after the critical systems components have been realized. Long-term monitoring, research, and innovation will allow for the continued refinement of water systems and related infrastructure. Urban Water Plan principles will be fully integrated into governance and systems operations, and also everyday life and culture. Adaptation will be second nature, as the region, the place which President Jefferson referred to as the "Island of New Orleans," becomes a true delta city.

An Iterative Process

An iterative process of 1) planning and design, 2) implementation, 3) monitoring, and data collection will advance Urban Water Plan strategies in the coming decades, as lessons learned from each project inform the next project.





**“If there is magic on this planet,
it is contained in water.”**

Loran Eisely, 20th century American anthropologist, in *The Immense Journey*

Soil and Water Balance

Maintaining groundwater levels to reduce the rate of subsidence requires an understanding of the region's soil types and their characteristics.



Talking About Water

ILLUSTRATED TOOLBOX & WATER GLOSSARY

Discussions about water and the landscape require a new vocabulary. Some terms, like runoff, describe well-known problems. Others, like subsidence, are terms that all citizens should learn in order to better understand issues facing the region and to advocate for effective solutions.

An illustrated toolbox of stormwater solutions includes strategies that can be applied across the region in streets and parking lots, on public and private properties, and within the water system. The glossary that follows includes technical terms for water-related problems and water-based solutions, including the names of important natural and man-made features that affect the flow of water.

Talking About Water

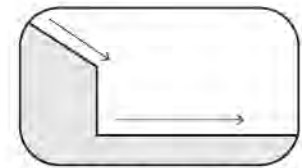
AN ILLUSTRATED TOOLBOX

Chapter 4 (Adapting the Flow) outlines a new approach to water management that embraces water as an asset. Existing drainage systems proffer piping and pumping as the only solutions to heavy rainfall. The proposed water system employs a broader array of proven techniques and strategies to manage rainfall and related water resources in ways that are attuned to landscape types, soil types, local culture, and the potential to derive environmental and economic benefits from new water assets. Integrated into individual properties, streets, parks, and existing canal networks, the proposed techniques and strategies also make for an urban landscape with increased tree cover, greener street edges, more park space, and new habitats.

Existing drainage systems are entirely dependent on public funding, whereas the techniques and strategies proposed in the Urban Water Plan are implementable by a wide range of public and private stakeholders, and can be adjusted to fit the specific needs of a property owner, neighborhood, or commercial district. Strategies that are applicable at the basin scale will require consensus and collaboration between citizens, businesses, institutions, and public agencies. This means that achieving the integrated living water system is a shared endeavor, with every stakeholder in the region playing an important role.

Each of the elements listed on this spread are defined in the Illustrated Toolbox and Water Glossary on the pages that follow.

PAVE



ROOF AND SITE RUNOFF

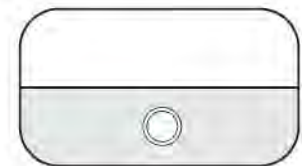


STREET RUNOFF

PIPE

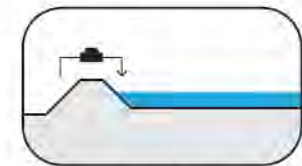


CANALS and DITCHES



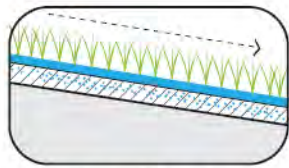
PIPES

PUMP

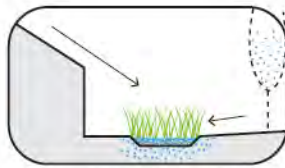


PUMPS

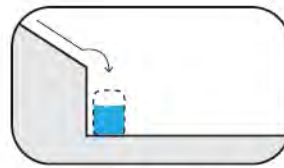
SLOW



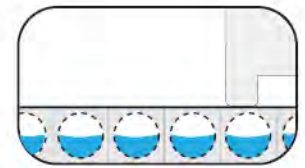
GREEN ROOF



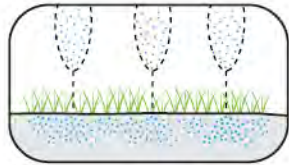
RAIN GARDEN



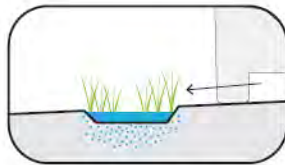
HARVESTING



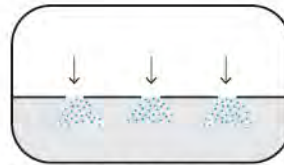
SUBSURFACE STORAGE



PLANTS



BIOSWALE

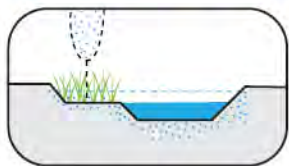


PERVIOUS PAVING

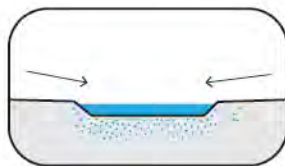


EXFILTRATION

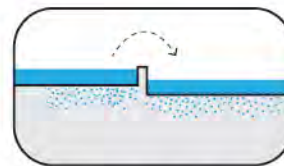
STORE & USE



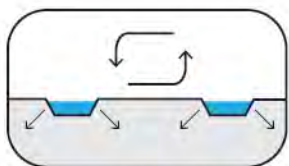
IMPROVED CANAL



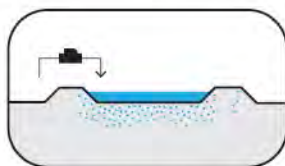
EXCAVATED BASIN



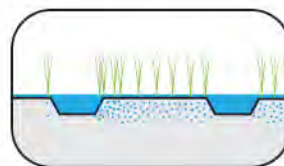
STORAGE BEHIND WEIR



CIRCULATING CANALS

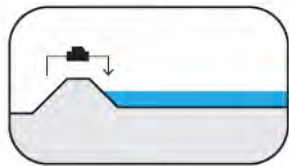


LEVEED BASIN

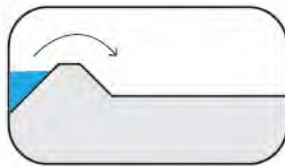


INTERNAL WETLANDS

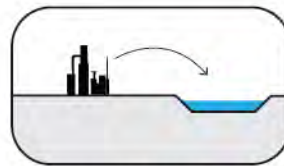
CIRCULATE & RECHARGE



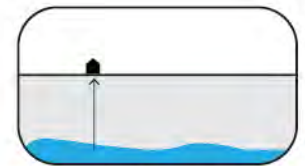
PUMPS



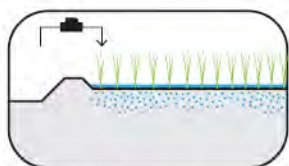
SIPHON (river or lake)



INDUSTRIAL WASTEWATER



GROUNDWATER PUMP



EXTERNAL WETLANDS



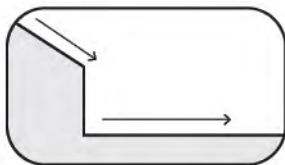
TREATED WASTEWATER

Existing Drainage System Features



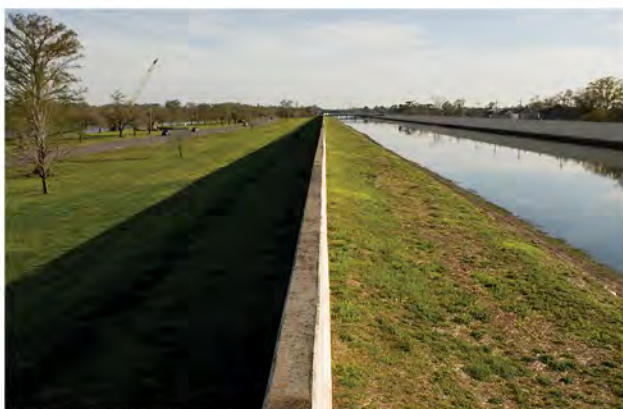
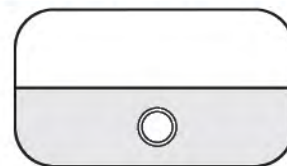
Surface Runoff

Stormwater flowing from rooftops, streets, driveways, and other surfaces that neither infiltrates into the ground nor evaporates, but collects instead and must be drained away in order to prevent flooding.



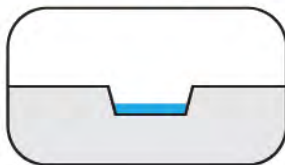
Pipes

Subsurface conduits for conveying stormwater, drinking water, and sewage.



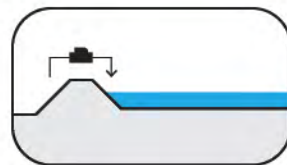
Canals & Ditches

A manmade channel for water, often built as connections to larger bodies of water. Throughout Greater New Orleans, canals and ditches both convey and store stormwater.



Pumps

In the existing system, pumps lift stormwater from the region's drainage networks out into surrounding waters, including Lake Pontchartrain, the Inner Harbor Navigation Canal, and the Central Wetlands Unit.

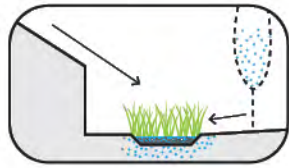


Integrated Living Water System Features



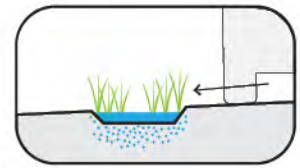
Rain Garden

A shallow excavated basin that collects and cleans storm water runoff on a small scale. Soil layers and plantings are designed for infiltration and the removal of pollutants.



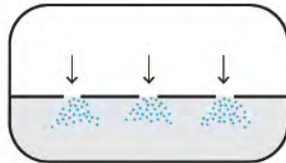
Bioswale

A linear depression in the landscape constructed to slow and filter stormwater with vegetation and soil media. Bioswales can remove silts, pollutants, and pathogens, and reduce the quantity of runoff from a site.



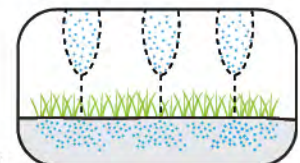
Pervious/Permeable Paving

A material for walkways, roadways, and parking lots that allows stormwater to be absorbed by the ground where it falls, reducing runoff into the drainage system.



Plants

Trees and other vegetation slow and filter the flow of stormwater across a landscape, their root systems improve groundwater balance, and their canopies cool and clean the air.

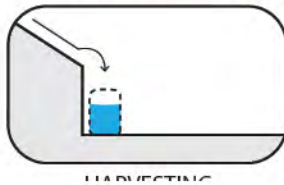


Integrated Living Water System Features



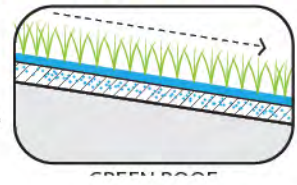
Harvesting

Collecting stormwater in rain barrels and cisterns prevents it from entering the drainage system and makes it available for irrigation and other uses.



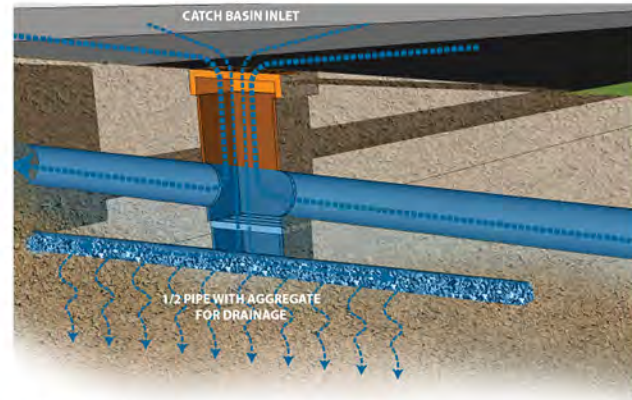
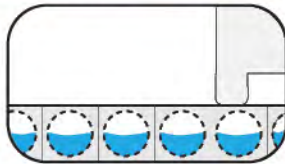
Green Roof

A roof system of soil media and vegetation that helps to absorb and store stormwater that falls on the roof. Green roofs lessen roof runoff, improve water quality, and reduce heat gain through evapotranspiration.



Subsurface Storage

Pipes, crates, and other chambers placed beneath parking lots, roadways, and other surfaces provide additional storage capacity for drainage systems.



Exfiltration

Catch basins, pipes, and other infrastructure designed to extrude water are used to raise groundwater levels in areas with organic soils.

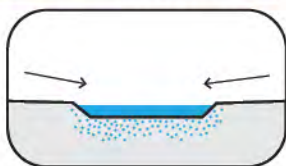


Integrated Living Water System Features



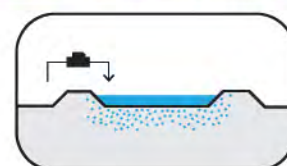
Excavated Basin

A detention or retention feature where large volumes of soil are removed in order to create a basin that can fill with stormwater in the event of heavy rainfall.



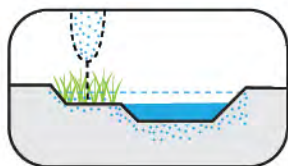
Leveed Basin

A detention or retention feature where the addition of a levee around a park or other open area allows that space to safely hold stormwater in the event of heavy rainfall.



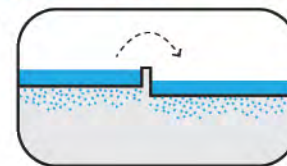
Improved Canal

Canals with functionality beyond water conveyance and storage. Landscaped banks, higher water levels, and public access improve aesthetics and allow water infrastructure to become urban amenities vital to the region.



Storage Behind Weir

Barriers that alter the flow of waterways to prevent flooding, to store water, or for navigation purposes, while allowing the steady flow of water over the top of the structure.



Integrated Living Water System Features



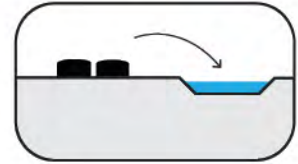
Industrial Wastewater

Water used in industrial processes is treated so that it can be reused for other purposes, for example, as a water source for circulating canal networks.



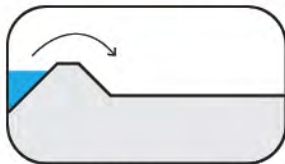
Treated Wastewater

Wetlands assimilation projects divert treated sewage into regional wetlands in order to strengthen wetland habitats with fresh water and nutrients.



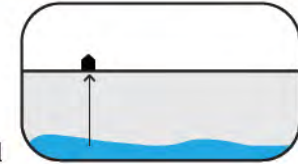
Siphon

A conduit for drawing water from a water source at a higher level into a water body or waterway at a lower level. Siphons can be used to pull water into circulating canal systems from outlying sources, such as the Mississippi River or Lake Pontchartrain.



Groundwater Pump

Water suspended in below-ground aquifers is withdrawn for industrial, agricultural, and recreational uses.

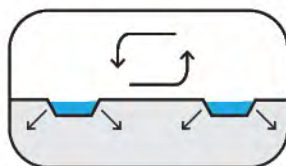


Integrated Living Water System Features



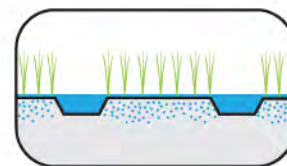
Circulating Canal Network

Water flowing through canals year-round improves water quality, provides a water source for groundwater recharge features, and connects existing water networks to internal and external wetlands.



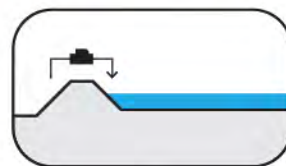
Internal Wetlands

Constructed wetlands integrated into the urban landscape absorb and filter stormwater, as well as the flow of water from circulating canals during dry weather.



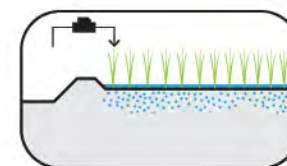
Pumps

Forced drainage is a necessity for survival in this low-lying region, but sustainable stormwater management features lessen the region's dependence on pumping. Existing pumps can also be used to regulate surface water and groundwater flows.



External Wetlands

Restoring the region's wetland habitats, which clean water and serve as natural storm buffers, improves regional ecology, provides recreational and economic opportunities, and strengthens the region's hurricane defenses.



Talking About Water

A WATER GLOSSARY

10-year storm

an event that has a 10% chance of occurring or being exceeded any given year. In New Orleans, a 10-year storm has an average total rainfall of 8.5 inches, with a peak hour total of 3.43 inches. Also known as a **T10 storm**, where the "T10" refers to the return period.

100-year storm

an event that has a 1% chance of occurring or being exceeded any given year. The US Army Corps of Engineers levees and floodwalls are meant to protect against this level of storm. Hurricane Katrina was a 75-year storm, meaning it was less intense than a 100-year storm. Also known as a **T100 storm**, where the "T100" refers to the return period.

acre foot

the volume of water needed to cover one acre to a depth of one foot, equal to 325,851 gallons or 43,560 cubic feet of water.

adaptation

adjustments to a changing climatic characteristics such as rising sea levels. These may include structural changes such as the lifting of levees or the raising of homes, as well as changes in policy and management practices that reduce vulnerability and risk to communities. See also **climate change**.

aquifer

an underground layer of permeable rock or soil layer that holds water that can be extracted for human use. The Gonzales-New Orleans Aquifer is a 100-300 feet thick sand layer underlying southeastern Louisiana that serves as the primary source of fresh groundwater for Jefferson Parish and Orleans Parish.

bald cypress (taxodium distichum)

the dominant tree species in Louisiana's native swamps as well as Louisiana's official state tree. Cypress swamps play an important as natural buffers to storm surges. Logging, development, subsidence, and saltwater intrusion have damaged cypress swamps throughout Greater New Orleans.

base flood

a flood with a 1% chance of being equaled or exceeded in any given year. This regulatory standard is used by the National Flood Insurance Program (NFIP) and other federal agencies for determining flood insurance rates and regulating new development.

base flood elevation (BFE)

an elevation set by the Federal Emergency Management Agency (FEMA) that measures the elevation to which floodwater is anticipated to rise during a base flood. To receive FEMA funds in the case of storm damage, FEMA requires the lowest floor of the building to be at or above BFE.

bayou

a slow-moving creek or swampy body of water; which may be brackish (mixed fresh- and saltwater) and home to a rich diversity of wildlife. Bayous are often associated with the southeastern part of the United States and can be found throughout coastal Louisiana and Greater New Orleans.

berm

a raised barrier dividing space, which may be used to prevent flooding or erosion. Berms can be incorporated into landscape designs to create detention and retention basins.

best management practice (BMP)

a method or technique that consistently yields outcomes superior to those achieved by other means and generally agreed upon by a community of experts to be the most effective means of delivering a particular outcome.

bioswale

A linear depression in the landscape constructed to slow and filter stormwater with vegetation and soil media. Bioswales can remove silts, pollutants, and pathogens, and reduce the quantity of runoff from a site.

blight

the impact of a slowed or depressed economy on the built environment, where the abandonment of properties, lack of maintenance, and other destructive forces lead to dilapidated buildings and overgrown lots, along with other health and safety challenges.

blueway

a waterway, typically with landscaped banks, and used as a recreational and aesthetic amenity that can benefit the communities and stakeholders that use and access it.

bottomland hardwood forest

a wetland ecosystem found throughout the Gulf Coast states, typically in floodplains alongside rivers and streams that periodically flood. Gum, oak, and bald cypresses are common tree species, along with other plants that can survive periodic flooding or standing water for much of the year.

brackish water

a mix of freshwater and seawater found in places like estuaries and deltas. Sources of brackish water in Greater New Orleans include Lake Pontchartrain and Bayou St. John.

canal

a man-made channel for water, often built as connections to larger bodies of water. Throughout Greater New Orleans, canals both convey and store stormwater.

catch basin

also known as a **storm drain** or **curb inlet**, is a receptacle that captures solids and large sediment, typically at the point where water passes from a gutter into a piped drainage system.

catchment area

an area where all runoff is conveyed to the same outlet, with boundaries typically defined by ridges or other topography. In Greater New Orleans, catchment area refers to an area drained by a pump station. See also **watershed**.

circulating canals

a system that maintains the flow of water through drainage canals even during dry weather; in order to improve water quality, recharge groundwater, and allow canals to serve as recreational and aesthetic assets.

climate change

changes in temperatures, precipitation patterns, and the frequency of extreme weather events commonly linked to human activity. In New Orleans, climate change has resulted in some of the highest rates of sea level rise in the world, and is likely to increase the intensity of storms as well as instances of drought.

culvert

a closed drain, pipe or channel used to carry water, for example, from beneath a roadway from one side to another. In New Orleans, concrete box culverts store and convey massive quantities of stormwater to drainage pump stations.

detention

the holding of stormwater temporarily in a swale, **detention basin**, or other features. Detention reduces peak discharge by allowing the slower and more controlled release of runoff, and does not allow for the permanent pooling of water.

1895 Drainage Master Plan (New Orleans)

In response drainage crises that escalated in the 1880s, the newly created Drainage Advisory Board of 1895 recommended a modern drainage system featuring improved collection, conveyance, and discharge, using street gutters, storm drains, underground pipes, canals, and large new pump stations. This plan led to the creation of the New Orleans Sewerage & Water Board, the invention of the Wood screw pump, and enabled the draining and settling of wetland areas.

evapotranspiration

the transfer of water from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants. Solar radiation, atmospheric vapor pressure, temperature, wind, and soil moisture are some of the factors that affect the rate of evapotranspiration.

delta

the flat low-lying plain that sometimes forms at the mouth of a river emptying water and sediment into another body of water, such as an ocean or lake. Greater New Orleans is situated on the Mississippi River Delta.

drainage canal

an artificial channel built to drain an area with no natural outlet for runoff. In Greater New Orleans, aboveground and underground drainage canals move runoff to and from drainage pump stations.

drought

below-average precipitation over an extended period of time that results in a water shortage, most commonly measured by a season or longer.

Dutch Dialogues

a series of workshops between 2006 and 2009 that focused on sustainable water management and regional planning in Greater New Orleans. The workshops were initiated by Waggonner & Ball Architects with the American Planning Association and the Royal Netherlands Embassy in Washington D.C., and brought together US and Dutch experts trained in engineering, urban design, architecture, landscape architecture, city planning, and geohydrology. The workshop results were the basis for the Greater New Orleans Urban Water Plan.

ecological services, ecosystem services

the beneficial products and processes provided to humanity by the natural systems of the biosphere. These services include, but are not limited to the production of clean water, crop pollination, waste decomposition, climate regulation, and recreational benefits. In stormwater management, for example, wetlands and urban forests provide these services in the form of pollutant bioremediation, evapotranspiration, and groundwater recharge.

elevation

the altitude of a place above or below sea level.

estuary

a partially-enclosed body of water where freshwater from rivers and streams flows into the ocean, mixing with seawater and forming brackish water. Estuaries such as Lake Pontchartrain are rich habitats influenced by tides but protected from the direct impact of ocean waves and winds by surrounding land, wetlands, and barriers islands.

first flush

initial runoff from a rain event. This typically has higher concentrations of pollutants such as organic debris, sediments, oil, and other surface pollutants that accumulate on rooftops and roadways in the period before the storm.

flood

the temporary condition of inundation of what is usually dry land. It can be caused by an overflow of inland or tidal waters, or the rapid accumulation of runoff in drainage ditches or inland waterways. **Flash floods** are floods that subside in fewer than six hours.

floodplain

an area of typically flat land that is susceptible to inundation by water from any source. Floodplains are typically fertile agricultural areas as a result of nutrient-rich sediments deposited by floodwaters.

floodwall

A vertical barrier, usually made of concrete, constructed to contain floodwaters from a river, lake, or sea to prevent flooding in urbanized areas. They are used in densely developed areas where building levees is not feasible, or atop levees in order to increase the level of safety provided by the levee.

floodgate

a structure that can be opened or closed in order to adjust the flow of water through a sluice or canal, or to prevent the flow of water as part of a levee and floodwall system. **Sector gates, lift gates, and barge gates** are forms of floodgates integrated into Greater New Orleans' perimeter levees and floodwalls that allow waterborne navigation through those hurricane defenses when the region is not under threat from a tropical depression or hurricane.

fluvial

of or relating to rivers and streams, and the flooding, erosion, and soil deposition associated with these waterways.

freeboard

the distance between operating and maximum water levels, such as in a drainage canal or a retention basin. The freeboard is used to calculate the capacity of a given water feature.

geohydrology, hydrogeology

the study of groundwater, including its flow and its physical and chemical interactions with soils and surface water.

gray infrastructure

traditional mechanisms for storm water management and wastewater treatment, such as pipes and sewers.

graywater

wastewater generated from domestic activities such as dishwashing, laundry, and bathing. Properly treated, it can be recycled for other uses like irrigation.

green infrastructure

an approach to stormwater management that utilizes natural processes, soils, and vegetation to filter and reduce runoff. In contrast to gray infrastructure, green infrastructure can provide additional benefits such as improved air quality and streetscapes.

green roof

a roof system of soil media and vegetation that helps to absorb and store stormwater that falls on the roof. Green roofs lessen roof runoff, improve water quality, and reduce heat gain through evapotranspiration.

groundwater

water held in underground permeable rock or soil layers. When these layers hold enough water to be usefully extracted for human use, it is called an aquifer.

groundwater monitoring network

a system of wells, gauges, and data collection for tracking groundwater levels and quality. Such a network allows for a more comprehensive understanding existing groundwater issues such as subsidence and saltwater intrusion, and the management of soils and groundwater.

harden

to make structures and utilities resistant to storms and natural hazards.

hazard mitigation

sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects, such as the building of levees, elevating of structures, or the relocation of assets. Improving urban water management is a form of hazard mitigation.

Hurricane & Storm Damage Risk Reduction System (HSDRRS)

the strengthened system of levees, floodwalls, gates, and pump stations constructed by the U.S. Army Corps of Engineers after Hurricane Katrina and Rita in 2005, designed to protect Greater New Orleans from the storm surge of a 100-year storm. The system includes 350 miles of levees and floodwalls, including interior levees and floodwalls.

hydraulics

an applied science that studies the properties of water and other fluids, especially in relation to the application of mechanical forces. Hydraulics are fundamental to the operation of forced drainage systems in Greater New Orleans. The term **hydraulic** indicates a system or activity involving fluid under pressure.

hydrograph

a chart that graphically describes the rate of flow—of water, for example—relative to a specific point over a period of time. A hydrograph can help in describing the contours of a rain event, and in the planning and design of waterways and water control structures.

hydrology

the study of the distribution, flow, and quality of water. This includes the water cycle, water resources, and watershed sustainability. The term **hydrologic** refers to the movement of water between land areas, waterways, water bodies, and the atmosphere.

impervious surface

a material or area that cannot be penetrated by water. This includes most rooftops and structures like roads, sidewalks, and parking lots that are paved with concrete, asphalt, or stone. Impervious surfaces prevent rainfall from infiltrating into the ground and recharging groundwater, and accelerate runoff.

infiltration

the passage of water into below-ground soil layers. The velocity at which this occurs is called the infiltration rate, which is dependent on the composition of surface soil layers. Infiltration replenishes groundwater and raises the water table.

infrastructure

foundational systems and installations necessary to maintain and enhance basic social, economic, governmental, economic, and military functions. These include drinking water systems, drainage systems, sewers, hurricane defenses, schools, transportation networks, electrical grids, and telecommunications networks.

inundation

flooding, the overwhelming of an area by floodwaters.

levee

a linear earthen ridge that divides areas hydrologically, and can be used to protect inhabited areas from flooding. Greater New Orleans has both naturally occurring levees and manmade levees. Many natural levees have been reinforced with additional soil, rock, concrete, and/or grass. Levees are also known as **dikes**.

LIDAR

stands for Light Detection and Ranging and is a remote sensing method that uses a pulsed laser to measure variable distances to the Earth. LIDAR systems help scientists and mapping professionals examine both natural and manmade environments with greater accuracy. In Louisiana, LIDAR is one of many tools used to create more accurate shoreline maps and digital elevation models.

Louisiana Coastal Master Plan

a framework created by the state's Coastal Protection and Restoration Authority (CPRA) focused on protecting and restoring the state's deteriorating coastline. Threats to many of Louisiana's coastal assets led to the passing of Louisiana Legislature Act 8 in 2006, which created the CPRA and required it to develop a coastal master plan every five years. The latest edition was adopted by the state legislature in 2012.

marshes

wetlands that are frequently inundated with water and characterized by soft-stemmed vegetation adapted to saturated soil conditions. Nutrients are typically abundant, allowing plant and animal life to thrive in these areas. Marshes help reduce flood damage by slowing and storing flood water. As water moves slowly through a marsh, sediments and other pollutants settle to the marsh floor. Municipalities are now building urban wetlands to harness these natural processes in cleaning stormwater and wastewater.

Mississippi River Gulf Outlet (MRGO)

built by the Army Corps of Engineers in the 1960s, this route provided a shorter shipping passage from the Gulf of Mexico to the Inner Harbor Navigation Canal and also an emergency outlet from the Mississippi River. Its construction allowed saltwater intrusion that damaged to local wetlands, and channeled Hurricane Katrina's storm surge into New Orleans. The channel was closed by a rock barrier in 2009.

Multiple Lines of Defense

a core concept of both the Louisiana Coastal Master Plan and the Best Practices Manual for Development in Coastal Louisiana, developed by the Lake Pontchartrain Basin Foundation. MLOD describes the importance of naturally-occurring and manmade features in protecting inhabited areas from the direct impact of hurricanes in southeast Louisiana. Manmade features include levees, flood gates, pump stations, elevated structures, highways that serve as ridges, and hurricane evacuation routes. Natural features external to perimeter levees include offshore shelves, barrier islands, sounds, marsh land bridges, and natural ridges. The Greater New Orleans Urban Water Plan introduces urban water management to the MLOD concept as a means of addressing risks

associated with rainfall in order to achieve a higher factor of safety overall.

network

a group of interrelated elements connected by lines, conduits, or channels, and where the function of one network component is dependent on the function of other components. Networks are common within infrastructural systems, such as road networks, telecommunications networks, sewer networks, or canal networks.

outfall

the pipe, channel or opening through which water is emptied into another body of water, or the location where such discharge occurs.

oxidation

the decomposition and compaction of organic matter that occurs in the presence of oxygen. Oxidation is a primary cause of subsidence in Greater New Orleans, in areas where highly organic soils with lowered water tables are exposed to oxygen.

peak rainfall

the duration or point in a rain event when rain is falling at its highest intensity.

peak stage

the highest level reached by water flowing through a channel, relative to a datum such as mean sea level. Improved stormwater management can lower a canal's peak stage.

pervious paving

a material for walkways, roadways, and parking lots that allows stormwater to be absorbed by the ground where it falls, reducing runoff into the drainage system.

pluvial

of or relating to rainfall.

polder

a Dutch term for land that is surrounded by embankments that is dependent on mechanical drainage systems for inhabitation. Polders are created when low-lying areas are enclosed by levees, groundwater is drained and removed from within the polder, and the enclosed land subsides, eventually sinking below the surrounding level of water. They are commonly found in river deltas. The hydrological basins of New Orleans are examples of polders.

pump, pumping

the mechanical removal of water from an area. This is how stormwater has been traditionally managed in Greater New Orleans, but is also the primary cause of subsidence in the region.

pumping capacity

the volume of water that a pump station can move over a given period of time, typically measured in cubic feet per second (cfs). Some of the pump stations in Greater

New Orleans have a capacity of over 10,000 cubic feet per second.

rain garden

a shallow excavated basin that collects and cleans storm water runoff on a small scale. Soil layers and plantings are designed for infiltration and the removal of pollutants.

resilience

the capacity to anticipate potential threats, reduce a community's vulnerability to hazard events, respond to and recover from specific hazard events when they occur, and adapt to changing risks and hazards. In Greater New Orleans, resilience refers to the region's ability to withstand and recover from major flooding and hurricanes. With the loss of coastal wetlands and climate change, the long-term future of Greater New Orleans depends on the region's ability to enhance its resiliency.

retention

the holding of stormwater permanently in basins, ponds, and cisterns. **Retention basins** allow stormwater to infiltrate the ground, and for the collected stormwater to be repurposed for other uses such as irrigation.

retrofit

a measure taken to adapt existing infrastructure to operate more efficiently and effectively, without having to completely rebuild existing systems.

risk

a predictive measure of harm or loss due to the likelihood of a hazard occurring, and the consequences of such an event.

runoff (surface runoff)

Stormwater flowing from rooftops, streets, and other surfaces that neither infiltrates into the ground nor evaporates, but collects instead and must be drained away in order to prevent flooding.

sea level rise

most simply defined as an increase in the mean sea level, caused by changes in air temperatures that are linked to global climate change. Sea level rise poses a growing risk to low-lying coastal communities. With land subsiding at high rates as well, coastal Louisiana is experiencing some of the highest rates of sea level rise in the world.

sinkhole

a cavity in the ground which is caused by the weight and movement of water. In Greater New Orleans, sinkholes can be caused by broken pipes and/or subsidence.

siphon

a conduit for drawing water from a water source at a higher level into a water body or waterway at a lower level. Siphons can be used to pull water into circulating

canal systems from outlying sources, such as the Mississippi River or Lake Pontchartrain.

slow, store, drain

a new approach to stormwater management fundamental to the Greater New Orleans Urban Water Plan: slow water as it hits the ground, create spaces in the city to store water and use it as a resource, and drain using pumps only as a last resort to prevent flooding.

sluice

a water-conveyance channel where the flow of water is controlled by a gate or other device at the head.

soil organic content, soil organic matter

component of a soil layer comprised of plant and animal residues at different stages of decomposition, cells and tissues of microorganisms, and living organisms along with the organic residues that they produce. Soil organic content is a critical measure of a soil's ecological function, quality, and stability.

stormwater management

techniques, methods, or policies that control planning, maintenance, and regulation of stormwater (rainfall). Stormwater management is critical in precipitation-rich Greater New Orleans in order to prevent flooding and reduce subsidence.

subsidence

the sinking of land relative to sea level. In Greater New Orleans, the primary cause of subsidence is the excessive pumping of groundwater. As groundwater is removed, the soil from which it is drawn compresses and highly organic soil layers are able to oxidize. Subsidence damages buildings, streets, and other infrastructure, and its effects are irreversible.

swamp

a shallow body of water and wetland habitat, typically dominated by woody vegetation such as cypresses. Swamps have highly organic soils that provide a nutrient-rich environment for the growth of a rich variety of water-tolerant species of flora and fauna.

topography

the position and elevation of natural and artificial features in an area, and also the study of the surface shape and features of an area. Topographic maps and models provide graphic representations of features that appear on the Earth's surface, including infrastructure and development, waterways and water bodies, relief (mountains, valleys, slopes, depressions) and vegetation.

water assignment

the volume of stormwater for a given rain event that exceeds the total storage and pumping capacity of a catchment area. The water assignment provides a rough measure of flooding that may occur if such an event were to occur, without taking into account finer

variations in rainfall intensity and distribution that determine the actual impact of each rain event.

water balance

the calculation of the various inputs and outputs of water in an area, including rainfall, groundwater withdrawals, drinking water withdrawals, and both stormwater and sewage discharges.

water literacy

an understanding of how water impacts and functions in a given landscape—where water is coming from, how it is used, how it is stored, and risks and opportunities associated with water. Water literacy is an important aspect of a sustainable water future for New Orleans.

water quality

a measure of how suitable water is for a particular type of use (such as drinking and bathing) based on physical, chemical, and biological characteristics such as temperature, turbidity, mineral content, and the presence of bacteria.

water table

the boundary between water-saturated soils and unsaturated soils. Typically, deeper soil layers are saturated with water while those closer to the surface are drier. In wet areas like Greater New Orleans, the water table is high and often reaches the surface of the ground.

watershed

a land area, and distinct hydrological entity, where all water drains to the same point. See also **catchment area**.

weir

barriers that alter the flow of waterways to prevent flooding, to store water, or for navigation purposes, while allowing the steady flow of water over the top of the structure.

wetlands

ecosystems that are saturated with water, including bottomland hardwood forests, swamps, marshes, and bayous. The presence of water drives the nature of soil development, as well as characteristic plant and animal communities living in and above the soil. Wetlands are natural storm buffers that store and filter runoff. They are also habitats that support hundreds of thousands of species of plants and animals, as well as myriad fishing, hunting, agriculture, and recreational uses. Much of Greater New Orleans' natural ecosystems are comprised of wetlands.



"In rivers, the water that you touch is the last of what has passed and the first of that which comes; so with present time."

Leonardo da Vinci





References & Project Team

SOURCES AND SPECIAL THANKS

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"There is on the globe one single spot... It is New Orleans, through which the produce of three-eighths of our territory must pass to market."

Thomas Jefferson

From an 1802 letter to the U.S. Minister to France

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**“We cannot complete the work,
nor are we free to desist from it.”**

Rabbi Tarfon
First century Mishnah sage