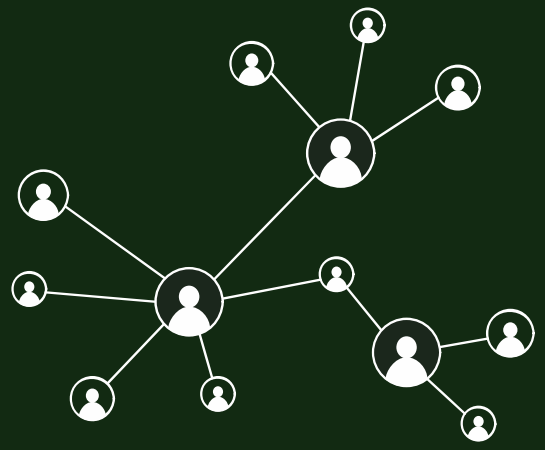
Economics and Metrics Related to Water, Resilience, and Equity

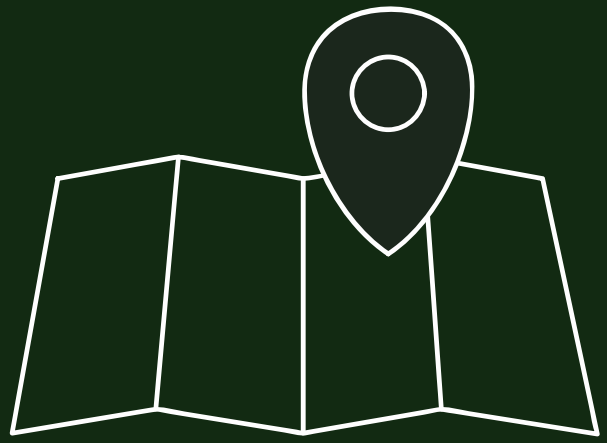
Rowan Schmidt, Program Director
rschmidt@eartheconomics.org

EARTH ECONOMICS

Our Approach

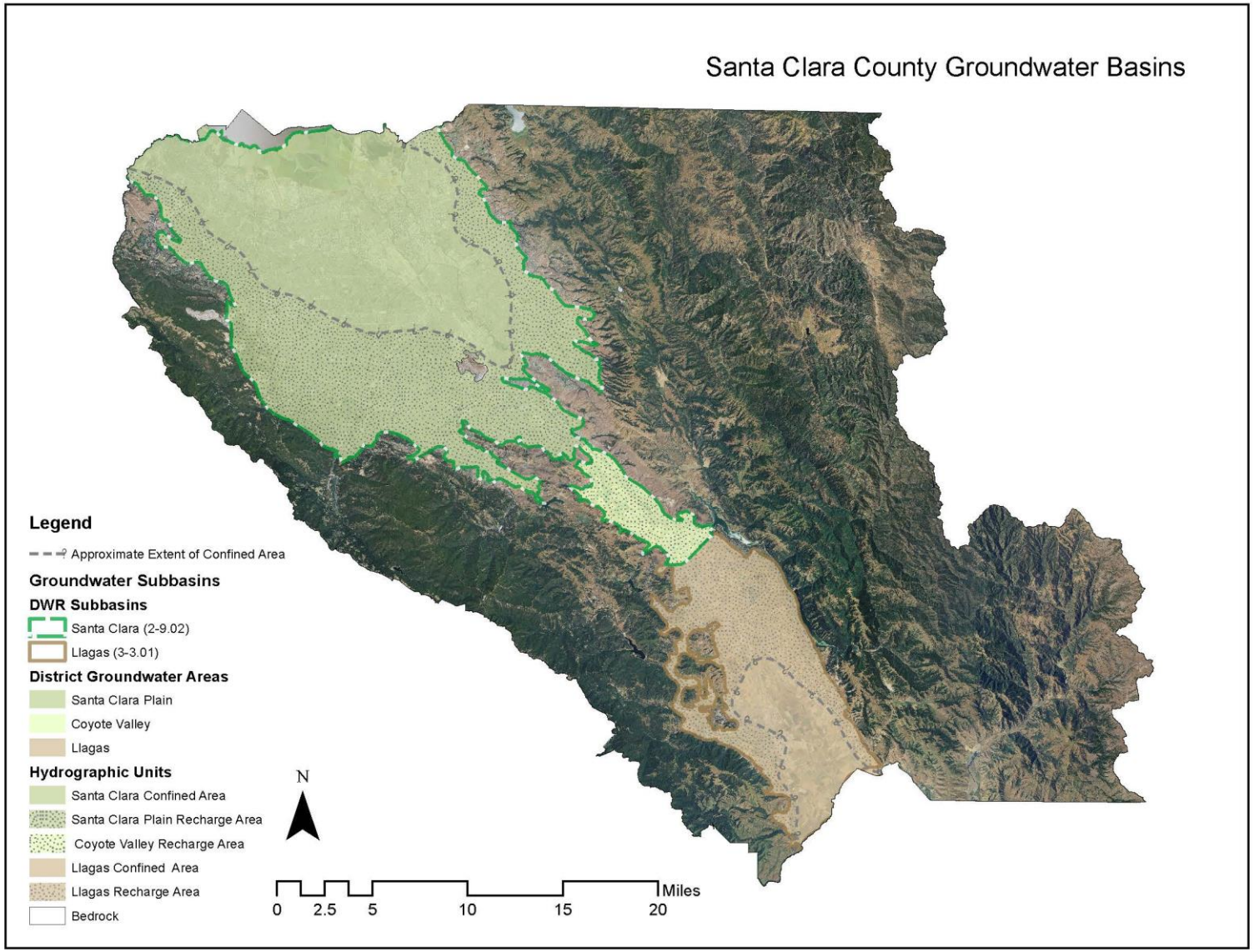


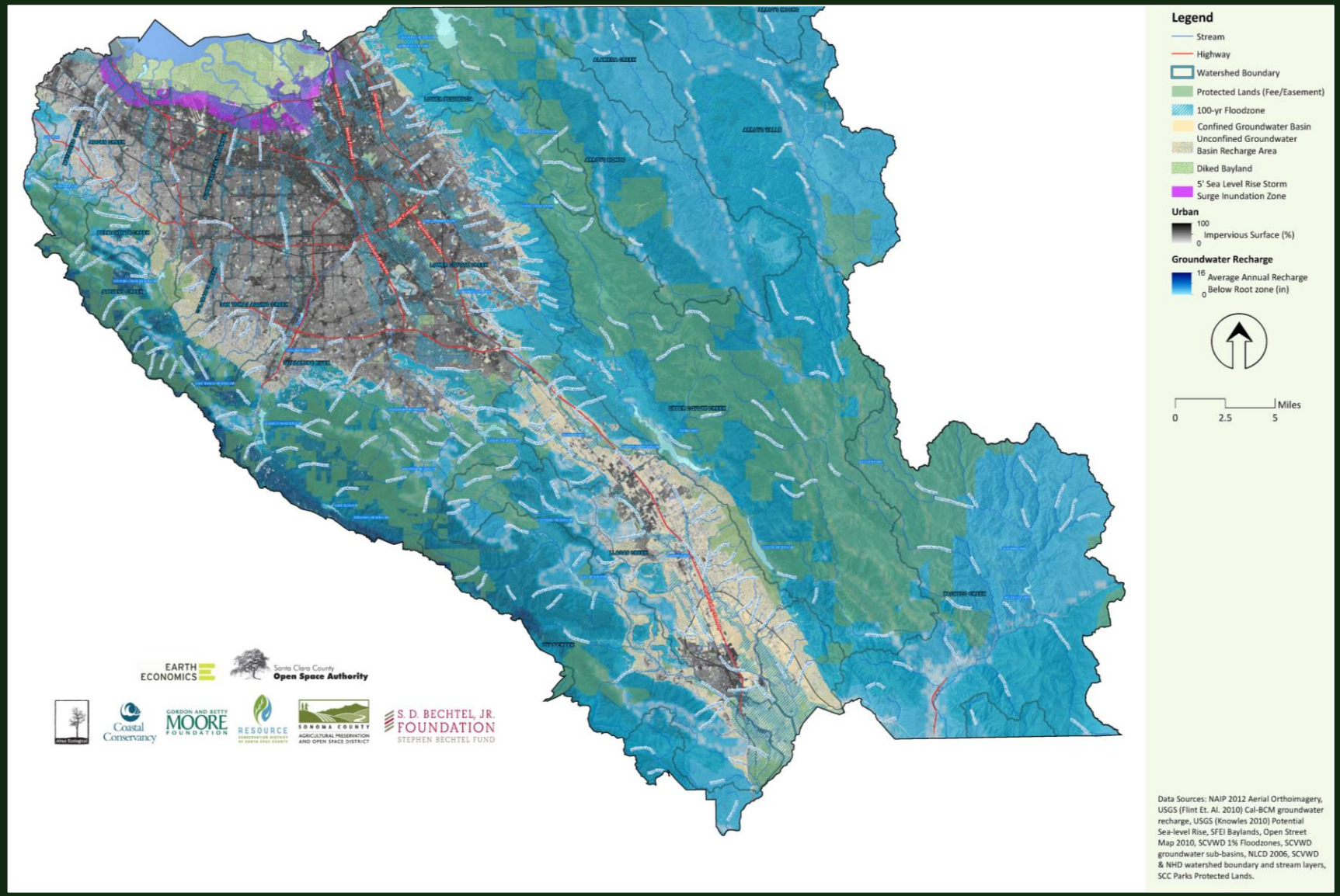
Awareness Building



Place-Based Analysis

Policy and Finance


Santa Clara County Groundwater Basins
Legend
Approximate Extent of Confined Area
Groundwater Subbasins
DWR Subbasins
Santa Clara (2-9.02)
Llagas (3-3.01)
District Groundwater Areas
Santa Clara Plain
Coyote Valley
Llagas
Hydrographic Units
Santa Clara Confined Area
Santa Clara Plain Recharge Area
Coyote Valley Recharge Area
Llagas Confined Area
Llagas Recharge Area
Bedrock
N
0 2.5 5 10 15 20
Miles


Legend
Stream
Highway
Watershed Boundary
Protected Lands (Fee/Easement)
100-yr Floodzone
Confined Groundwater Basin
Unconfined Groundwater Basin Recharge Area
Diked Bayland
5' Sea Level Rise Storm Surge Inundation Zone
Urban
100
Impervious Surface (%)
0
Groundwater Recharge
16
Average Annual Recharge Below Root zone (in)
0
Miles
0
2.5
5
EARTH ECONOMICS
Santa Clara County Open Space Authority
Coastal Conservancy
GORDON AND BETTY MOORE FOUNDATION
RESOURCE
SONOMA COUNTY AGRICULTURAL PRESERVATION AND OPEN SPACE DISTRICT
S. D. BECHTEL, JR. FOUNDATION
STEPHEN BECHTEL FUND
Data Sources: NAIP 2012 Aerial Orthoimagery, USGS (Flint Et. Al. 2010) Cal-BCM groundwater recharge, USGS (Knowles 2010) Potential Sea-level Rise, SFEI Baylands, Open Street Map 2010, SCVWD 1% Floodzones, SCVWD groundwater sub-basins, NLCD 2006, SCVWD & NHD watershed boundary and stream layers, SCC Parks Protected Lands.

Types of Capital

Built Capital

Social Capital

Human Capital

Natural Capital

Financial Capital

Conventional Framework

ENVIRONMENT

FLOOD MITIGATION

+

ECONOMY

CAPITAL INVESTMENT

OPERATIONAL COSTS

Holistic Analysis

ENVIRONMENT	+	SOCIETY	+	ECONOMY
WATER SUPPLY		RESILIENCE		CAPITAL INVESTMENT
AIR QUALITY		EQUITY		OPERATIONAL COSTS
FLOOD MITIGATION		PUBLIC HEALTH		JOBS
WILDLIFE HABITAT		RECREATION		PROPERTY VALUES
WATER QUALITY		SOCIAL COHESION		AVOIDED DAMAGES

Community-Centered Metrics

What's important?

Can it be quantified?

Can/should it be valued?

Equity

Heat Stress

Recurrent Flooding

Toxics and Pollution

Local Jobs

Community Gathering Space

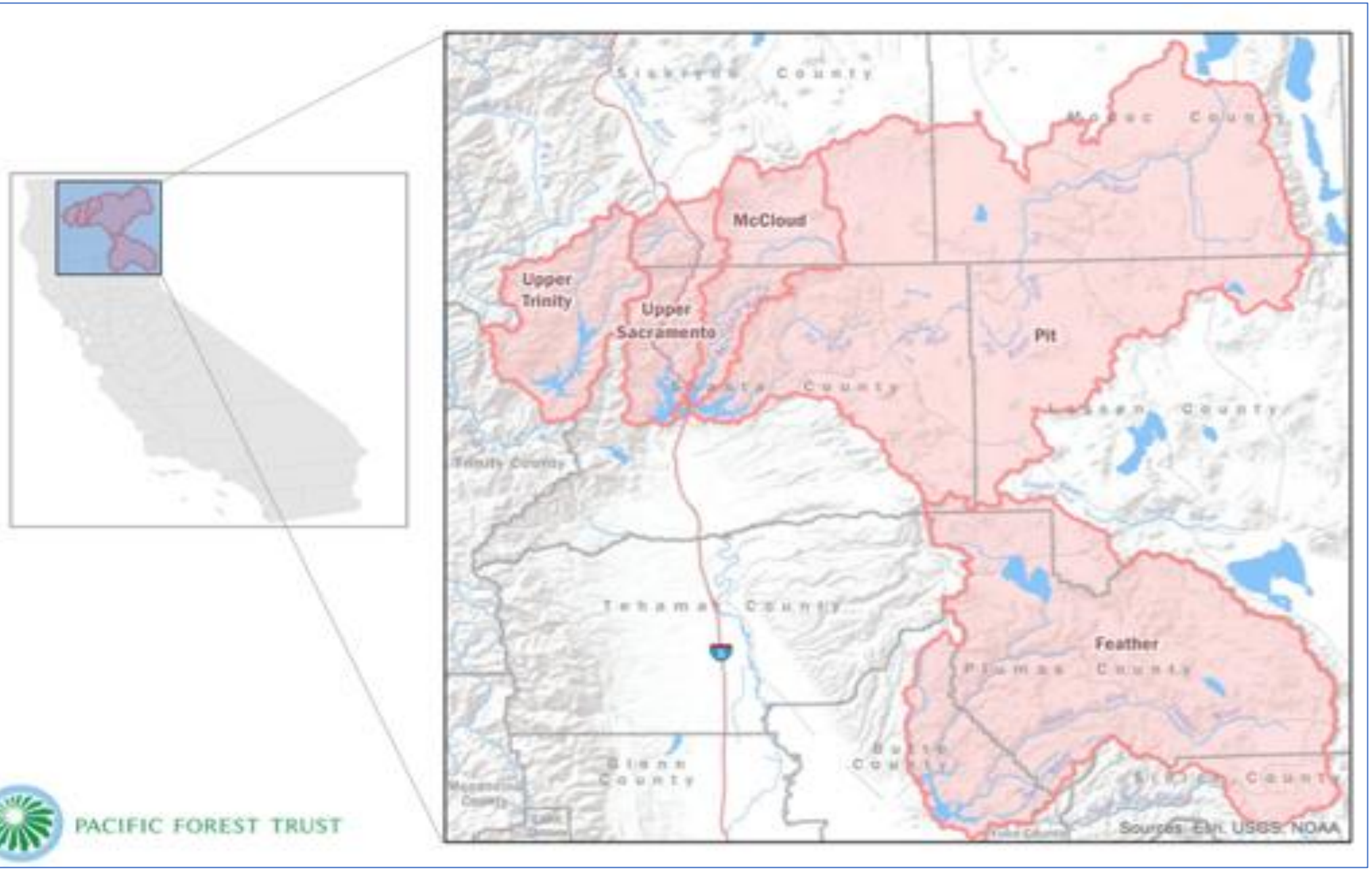
Access to Healthy Food

Accessible Transportation

Flood Protection


Flood Protection+

Case Study: Economic Assessment of Repairing and Maintaining Key Source Watershed Infrastructure



PACIFIC FOREST TRUST

	Feather	McCloud	Pit	TOTAL
Total Expenditures	$1,449,337,457	$260,943,544	$1,931,522,944	**$4,149,139,332**
Output	$2,404,887,841	$428,637,180	$3,097,129,930	**$6,771,135,507**
Earnings	$892,866,922	$149,374,536	$1,185,130,897	**$2,524,377,967**
Value Add	$1,442,168,377	$252,927,284	$1,878,398,422	**$4,070,995,292**
Employment (Job Years)	20,675	3,246	27,169	**57,685**

Program	**SIC Industry**	**Feather**	**McCloud**	**Pit**	**TOTAL**
Forest Management					
Mechanical Thinning	Commercial Logging	$587,327,471	$115,746,083	801531942.3	$1,724,573,361
Prescribed burn	Support activities for Agriculture and Forestry	$212,973,588	$43,957,885	239497551.3	$599,716,297
Forest Management Total					**$2,324,289,658**
Meadows					
Removal of Encroaching Conifer	Support activities for Agriculture and Forestry	$55,212,068	$1,454,662	$95,698,193	$156,831,333
[illegible]					
Streams					
Grazing Management	Support activities for Agriculture and Forestry	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bank stabilization	Support activities for Agriculture and Forestry	$59,613,654.39	$1,217,485.77	$72,272,006.68	[illegible]
Riffle Augmentation	Support activities for Agriculture and Forestry	$51,665,167.14	$1,055,154.33	$62,635,739.15	$118,954,882
Road Decommissioning	Highway, Street, and Bridge Construction	[illegible]	$6,780,914	[illegible]	[illegible]
Streams Total					**$634,400,530**
Roads					
Road Upgrading	Highway, Street, and Bridge Construction	[illegible]	$4,873,229	$13,937,424	[illegible]
Road Decommissioning	Highway, Street, and Bridge Construction	$1,982,500	$456,088	$650,867	$3,935,571
Roads Total					**$54,017,813**
Conservation					
Land Trust					
Stewardship	Civic, social, professional, and similar organization	$9,293,867.15	$2,485,850.91	$13,636,601.58	$29,388,000
Real Estate	Real estate	$9,293,867.15	$2,485,850.91	$13,636,601.58	$29,388,000
Commercial Logging	Commercial Logging	$291,207,837.51	$77,889,995.25	$427,280,182.83	$920,823,999
Conservation Total					**$979,599,999**
Program Total					**$4,149,139,332**

Case Study:
Developing a Screening Level Tool for Urban Green Infrastructure Assets

Figure 1. Gaps in Available Research (green cells indicate available research, orange cells indicate gaps)

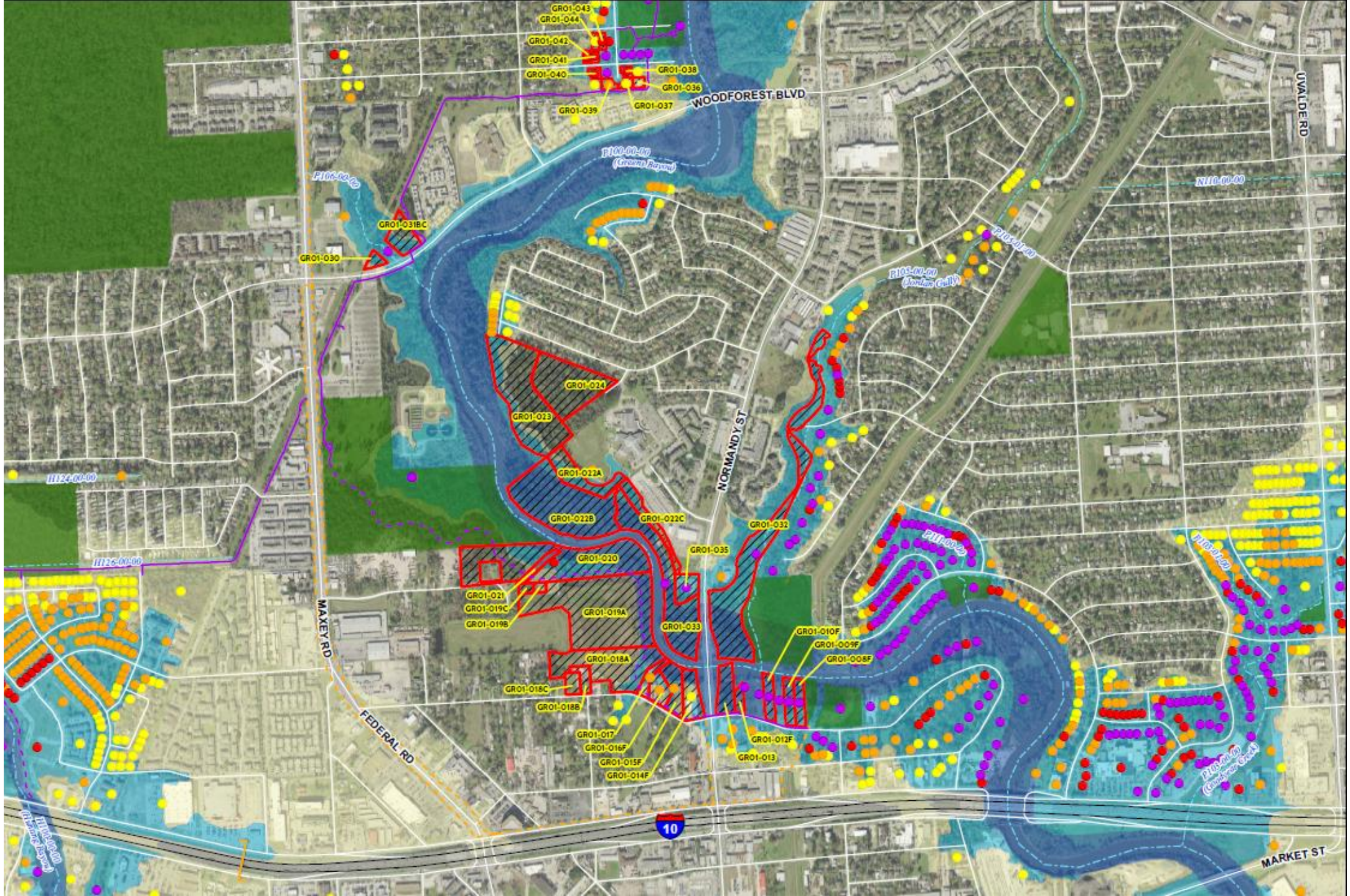
	Stormwater Flood Risk Reduction	Combined Sewer Overflow (CSO)	Stormwater Capture for Water Supply	Stormwater Quality	Urban Heat Island Effect	Environmental Education	Aesthetic Value	Air Quality	Carbon Sequestration
Raingardens and Bioswales									
Bioretention Ponds									
Pervious Pavement									
Wetlands									
Urban Forests									
Green Roofs									

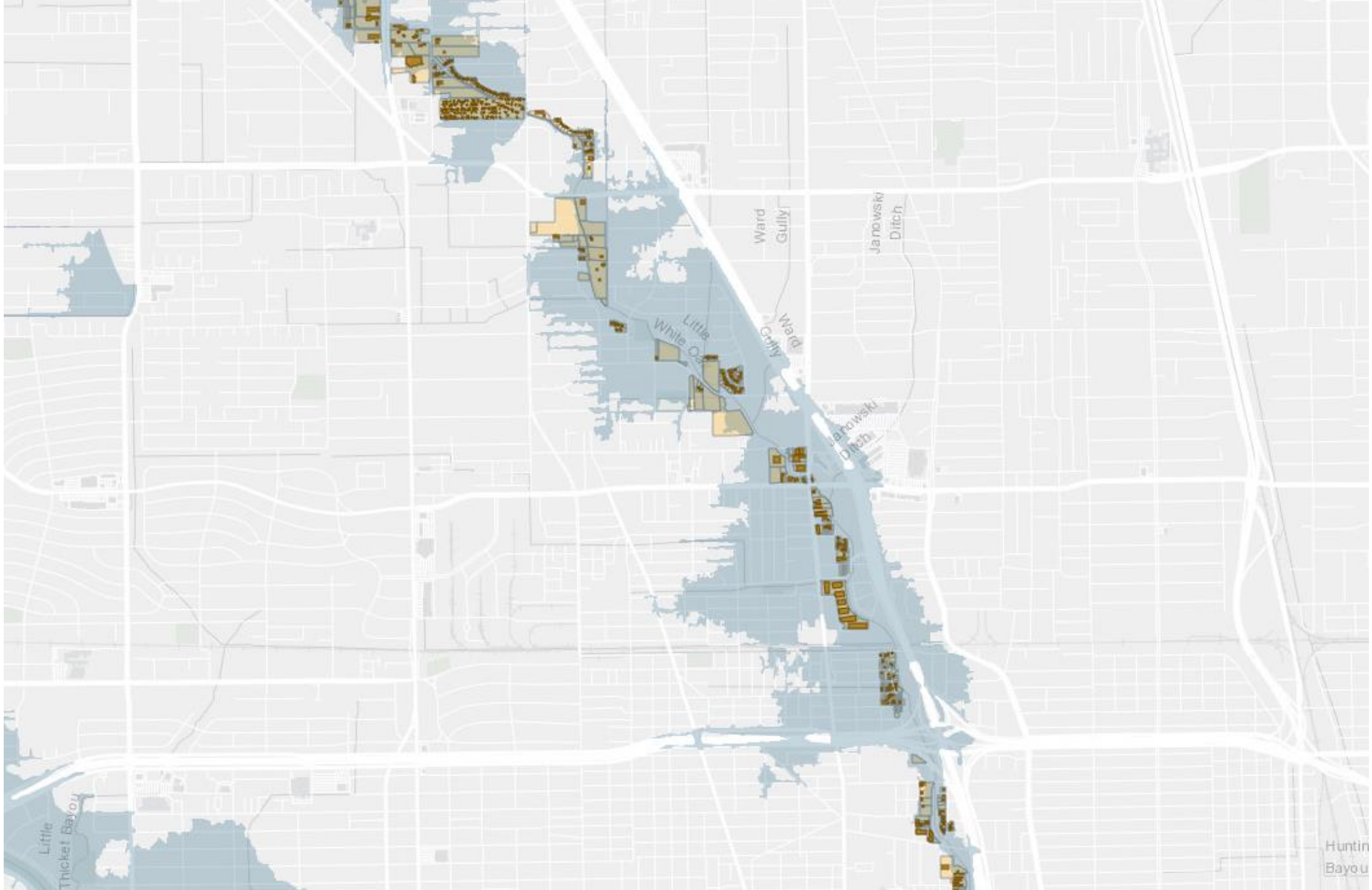
	Method	Adjustment
Stormwater Flood Reduction	Avoided disaster risk	By regional flood risk
Stormwater Combined Sewer Overflow (CSO) Reduction	Avoided cost of CSO prevention facility	Local risk of CSO (may be zero if city does not have combined sewer)
Stormwater Capture	Market value of captured water	Local value of captured water (may be zero for some cities)
Stormwater Quality	Avoided treatment cost of certain water quality components	
Urban Heat Island Effect	Energy savings due to heat reduction	By average energy cost and number of cooling days
Environmental Education	Market value of public education, per student hour	By state education costs
Aesthetic Value	Property value increase of large green infrastructure projects	By median local property value
Air Quality	Avoided health costs of various pollutants (ground level ozone, nitrogen oxide, sulfur dioxide)	
Carbon Sequestration	Social cost of greenhouse gas emissions	

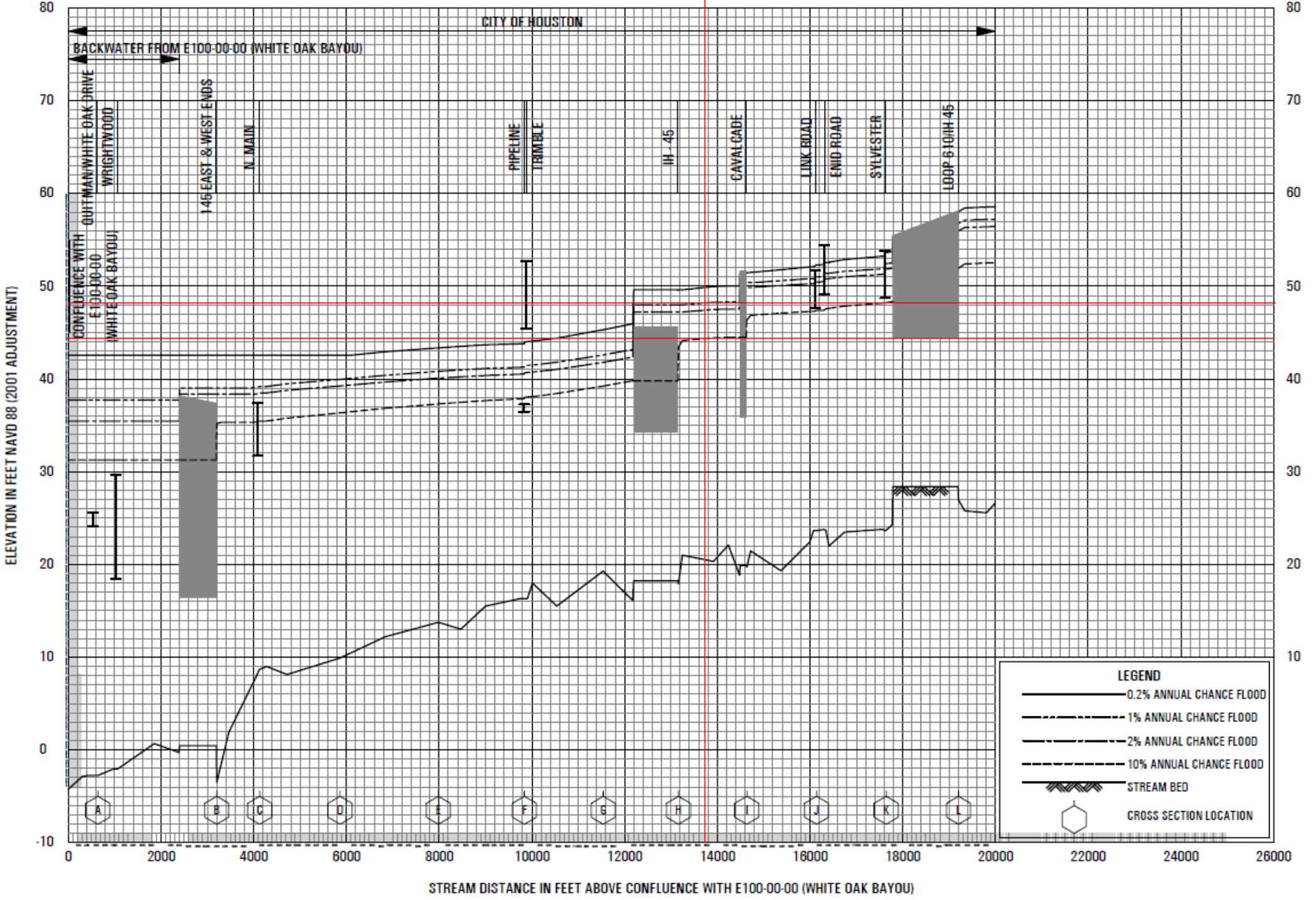
Key Inputs: CSO reduction example

- Physical
  - Precipitation days
  - # CSO events
- Economic
  - Avoided cost of CSO ($/liter)
  - Cost of BMP (capital, O&M)

Case Study:
Financing Conservation and Building Community Resilience


GR01-043
GR01-044
GR01-042
GR01-041
GR01-040
GR01-038
GR01-036
GR01-039
GR01-037
WOODFOREST BLVD
UVALDE RD
P100-00-00
(Greens Bayou)
N110-00-00
P106-00-00
GR01-031BC
GR01-030
P105-01-00
P105-00-00
(Jordan Gully)
GR01-024
GR01-023
NORMANDY ST
GR01-022A
H124-00-00
GR01-022B
GR01-022C
GR01-032
GR01-035
H126-00-00
GR01-020
P110-00-00
P110-01-00
GR01-021
GR01-019C
GR01-019B
GR01-019A
GR01-033
MAXEY RD
GR01-010F
GR01-009F
GR01-008F
GR01-018A
GR01-018C
GR01-018B
FEDERAL RD
GR01-017
GR01-016F
GR01-015F
GR01-014F
GR01-012F
GR01-013
P105-04-00
(Greens Bayou)
10
MARKET ST


Ward Gully
Janowski Ditch
Little White Oak
Ward Gully
Janowski Ditch
Little Thicket Bayou
Huntin
Bayou



FLOOD PROFILES

E101-00-00 (LITTLE WHITE OAK BAYOU)

FEDERAL EMERGENCY MANAGEMENT AGENCY

HARRIS COUNTY, TX

AND INCORPORATED AREAS

E12P

Key Inputs driving Benefit-Cost Ratio

- Benefits
  - First floor elevation
  - Flood and river elevations (10, 50, 100, 500 year events)
  - Depth damage function (0-50% damage)
  - Building replacement value ($/sq foot * sq footage)
  - Environmental benefits (after 0.75)
  - Social benefits (mental stress & anxiety, lost productivity)
- Costs
  - Acquisition, annual O&M

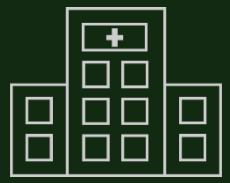
Financing Solutions at Scale

Co-benefits can Inform Financing and Partners

Co-Benefit	Partner/Financing
Disaster Risk Reduction	FEMA; HUD
Water Quality/Supply, Energy Efficiency	Municipal Bond Market
Economic Uplift	HUD
Public Health	Healthcare Systems
Carbon Sequestration	Carbon markets
Recreation/Tourism	Dept. of Economic Development

Outcomes from affordability and increased stability of housing
100 units over 10 years

Housing Intervention



	Outcome	Monetizable Benefits
Rent Alleviation	$10 Million	**$800K Expenditures in Hospitals**
Lifetime Income boost	$150K per child	**$15 Million**
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Child Education Spending	Education for 83 children	**$46,000**
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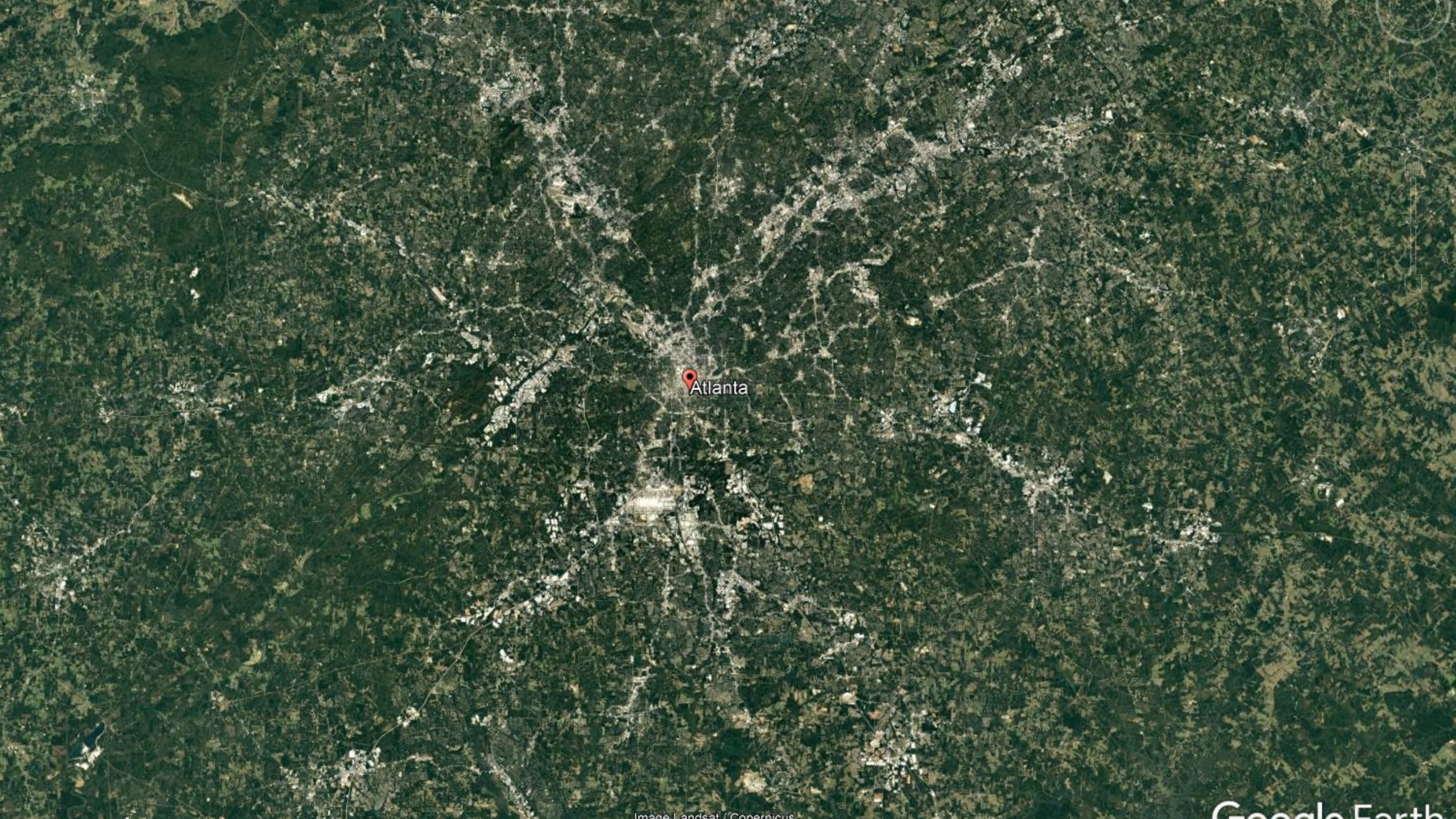
Taxes	$2.4 Million from expenditures	**$2.4 Million from total expenditures**
Medicaid ED Visits	2475 fewer visits	**$7.2 million**
Community Reputation	5% to 10% appraisal value increase	**$185 million appraisal increase**
Readmission Visits homeless	15% decrease	**Maintain reimbursement**

How can we help?

- Green infrastructure coaching, mentorship
- Case study analysis or economic storytelling
  - Green infrastructure valuation
  - Benefit-cost analysis
  - Economic impact analysis
  - Green infrastructure mapping
- Green infrastructure policy and funding options


THANK YOU
THE KRESGE FOUNDATION


Economy
Environment


Atlanta
Image Landsat / Copernicus
Google Earth

U.S. Department of Homeland Security
Washington, DC 20472

FEMA

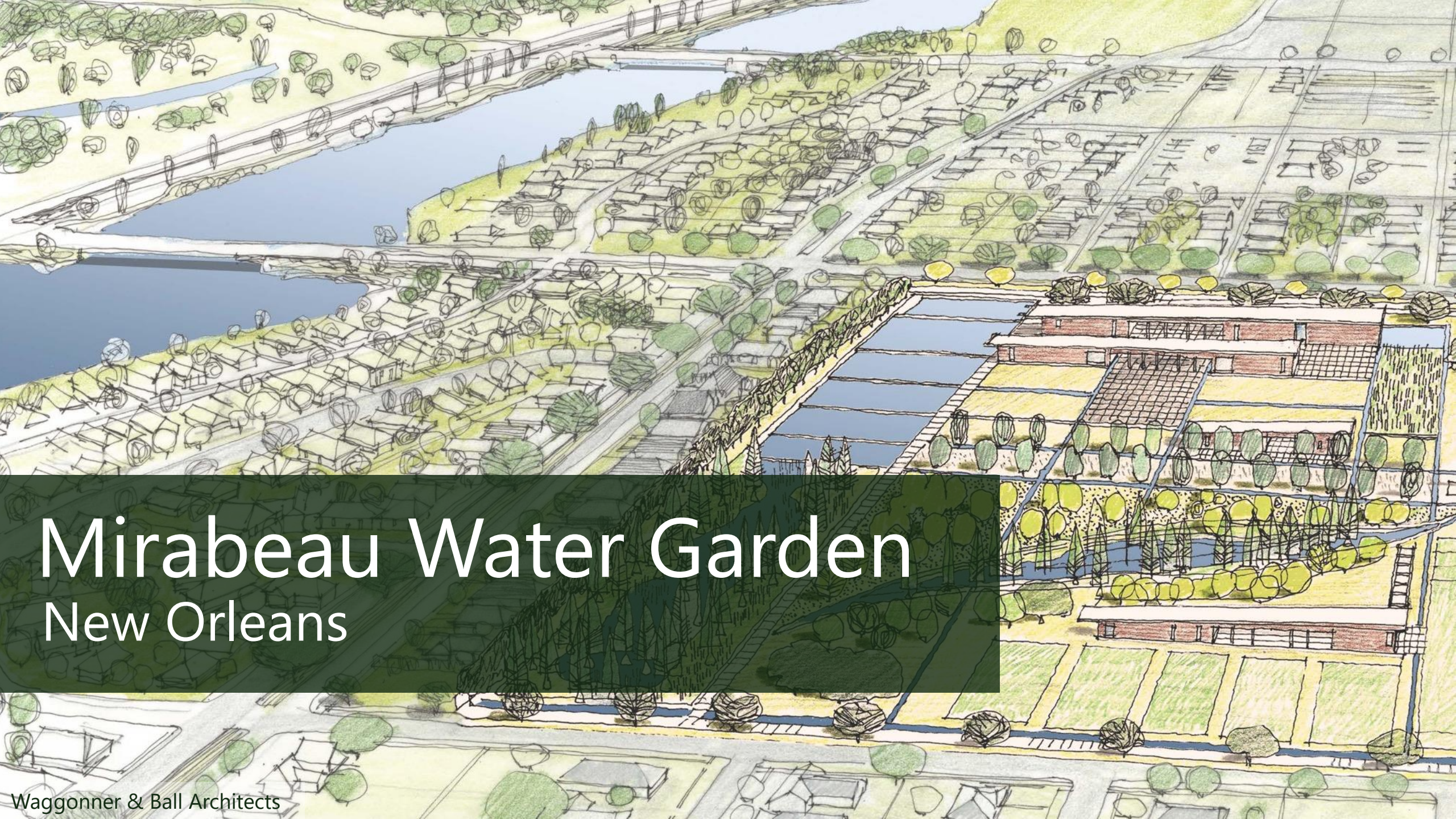
May 12, 2016

MEMORANDUM FOR: Mitigation Division Directors
FEMA Regions I-X

FROM: Michael M. Grimm
Assistant Administrator for Mitigation
Federal Insurance and Mitigation Administration

SUBJECT: Benefit Cost Analysis Tools for Drought, Ecosystem Services, and Post-Wildfire Mitigation for Hazard Mitigation Assistance

In September 2015, FEMA released three new activities eligible for the Hazard Mitigation Assistance (HMA) programs: Aquifer Storage and Recovery, Floodplain and Stream Restoration, and Flood Diversion and Storage, known as the Climate Resilient Mitigation Activities (CRMA). These activities can be used for any hazard when appropriate and leverage traditional risk reduction benefits and applicable ecosystem services. Additionally, FEMA developed pre-calculated benefits for cost effectiveness evaluation of soil stabilization, flood diversion, and reforestation projects in wildfire impacted areas to support expedient implementation of post-wildfire mitigation actions. With this memorandum, FEMA is releasing the following additions



Mirabeau Water Garden

New Orleans

Waggonner & Ball Architects

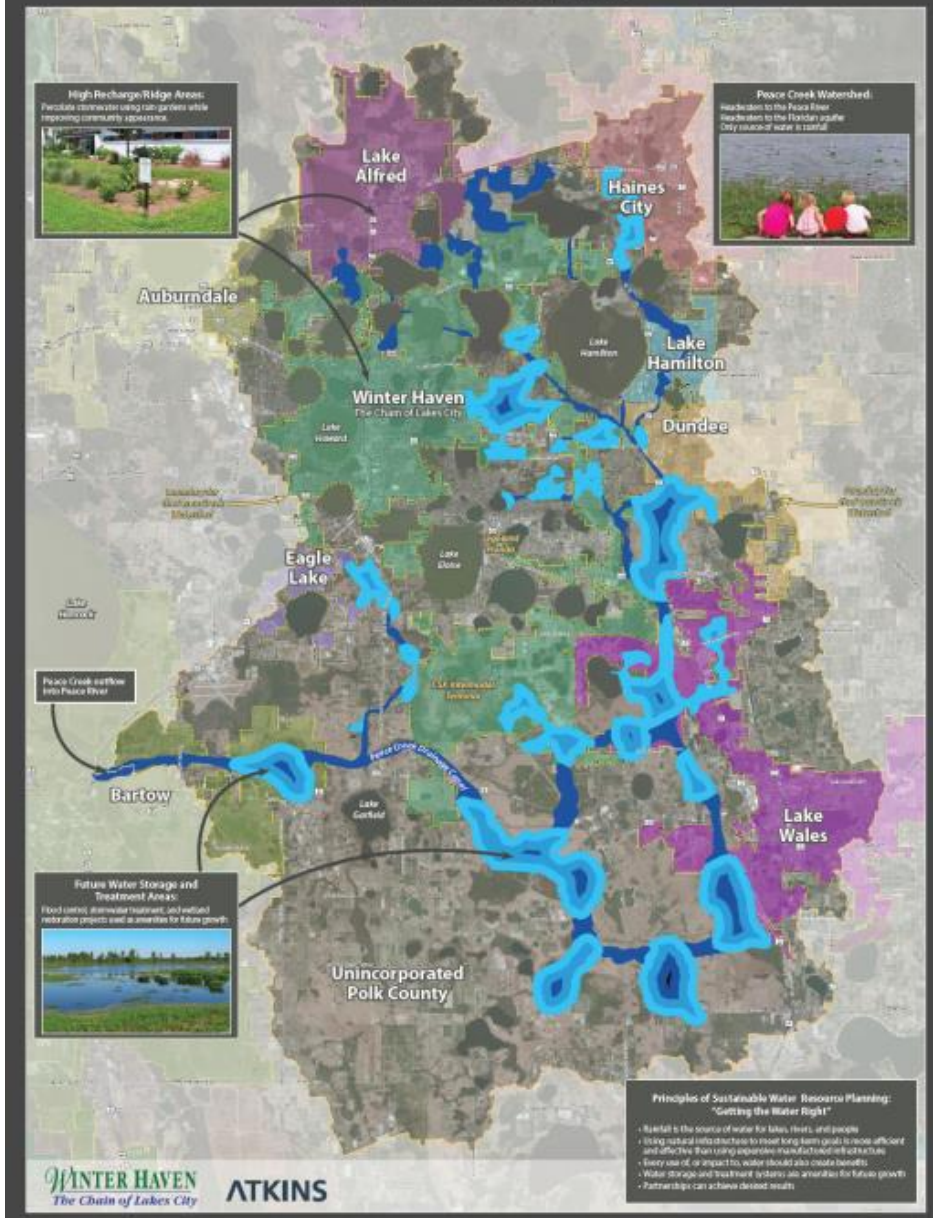
For every **$1** spent, Mirabeau contributes **$5.73** to society

$95.7MM in social benefits

Impact Type	Cost/Benefit	Median Value	95% Confidence Interval		
Financial	Capital Expenditures	**-$12,141,029**	-$12,576,950	to	-$11,739,432
Financial	Operations and Maintenance	**-$2,622,715**	-$3,290,368	to	-$2,139,443
Financial	Replacement Costs	**-$2,774,896**	-$6,437,983	to	-$1,443,802
Financial	Residual Value of Assets	**$827,631**	$147,289	to	$1,993,376
Social	Heat Island Effect	**$79,612**	$111,616	to	$30,748
Social	Recreational Value	**$1,309,576**	$1,014,965	to	$1,602,333
Social	Flood Risk	**$90,250,751**	$23,588,468	to	$278,011,070
Social	Subsidence Risk	**$232,436**	$116,722	to	$368,578
Social	Education	**$480,097**	$318,422	to	$651,232
Social	Public Health	**$742,323**	$324,566	to	$1,304,393
Social	Property Value Uplift	**$2,604,632**	$1,531,101	to	$3,998, 568
Environmental	Water Quality	**$31,599**	$31,599	to	$31,599
Environmental	Carbon Emissions from Concrete	**-$144,877**	-$257,507	to	-$63,189
Environmental	Air Pollution Reduced by Vegetation	**$90,082**	$53,622	to	$133,687
Environmental	Carbon Reduction by Vegetation	**$12,579**	$5,498	to	$21,598
COMPREHENSIVE NET PRESENT VALUE		**$79.1 M**	$4.6 M	to	$269 M

Sustainable Solutions for Water Resources

A Proactive Plan for the Peace Creek Watershed

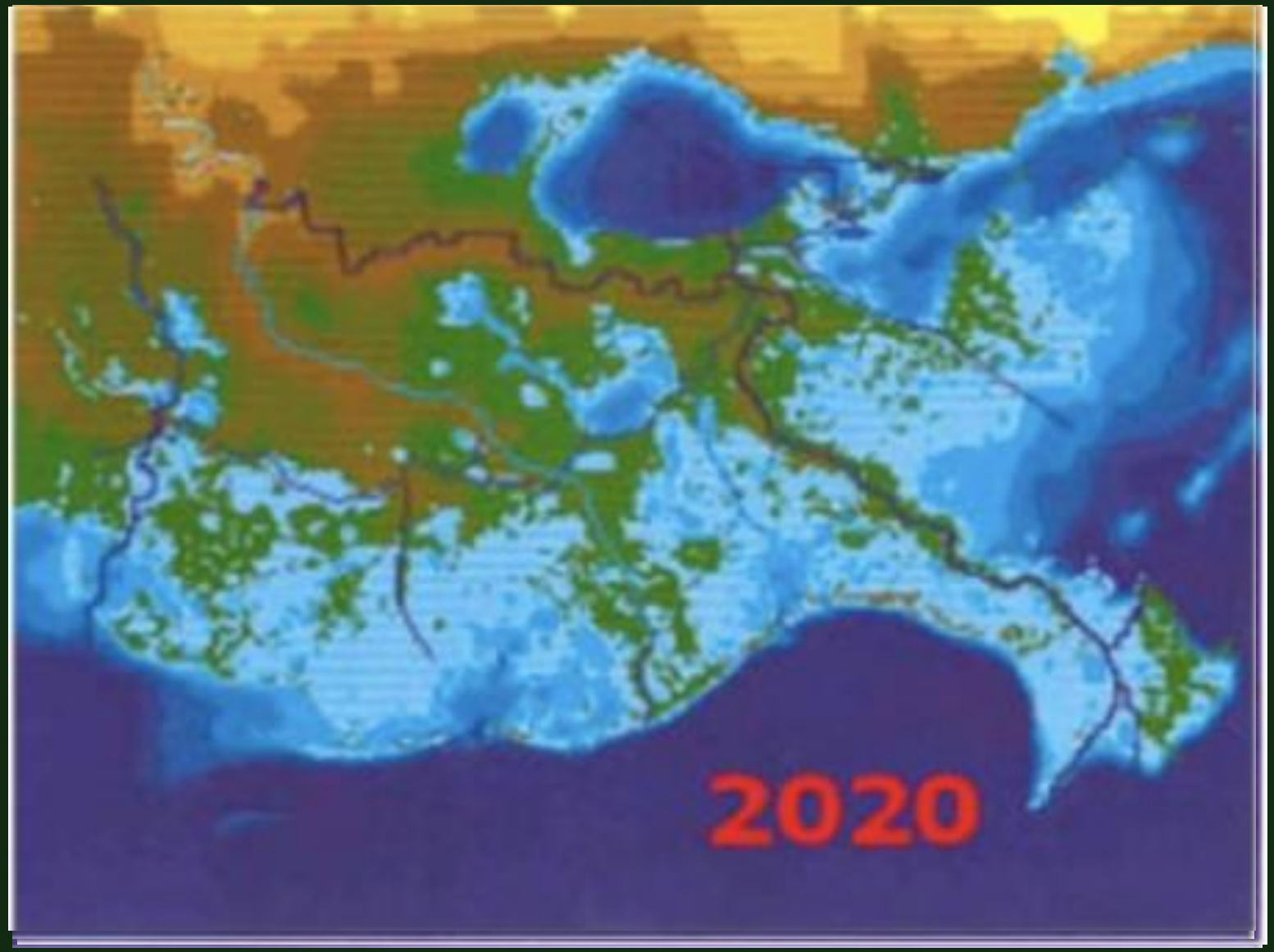


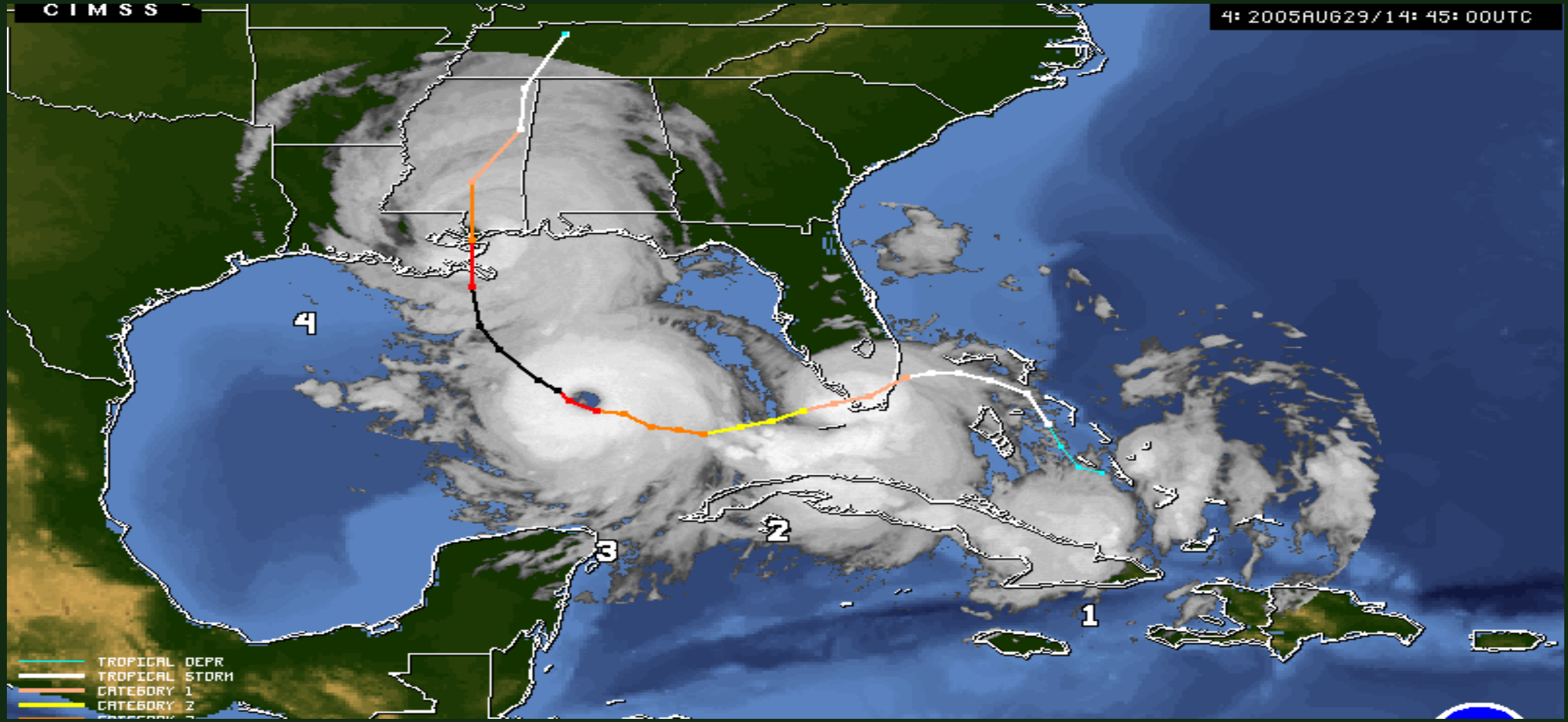
Please review the Sustainable Water Resource Management Plan at: **www.mywinterhaven.com/natural_resources.htm**




Natural Capital

Adds Real Economic Value




CIMSS
4: 2005AUG29/14: 45: 00UTC
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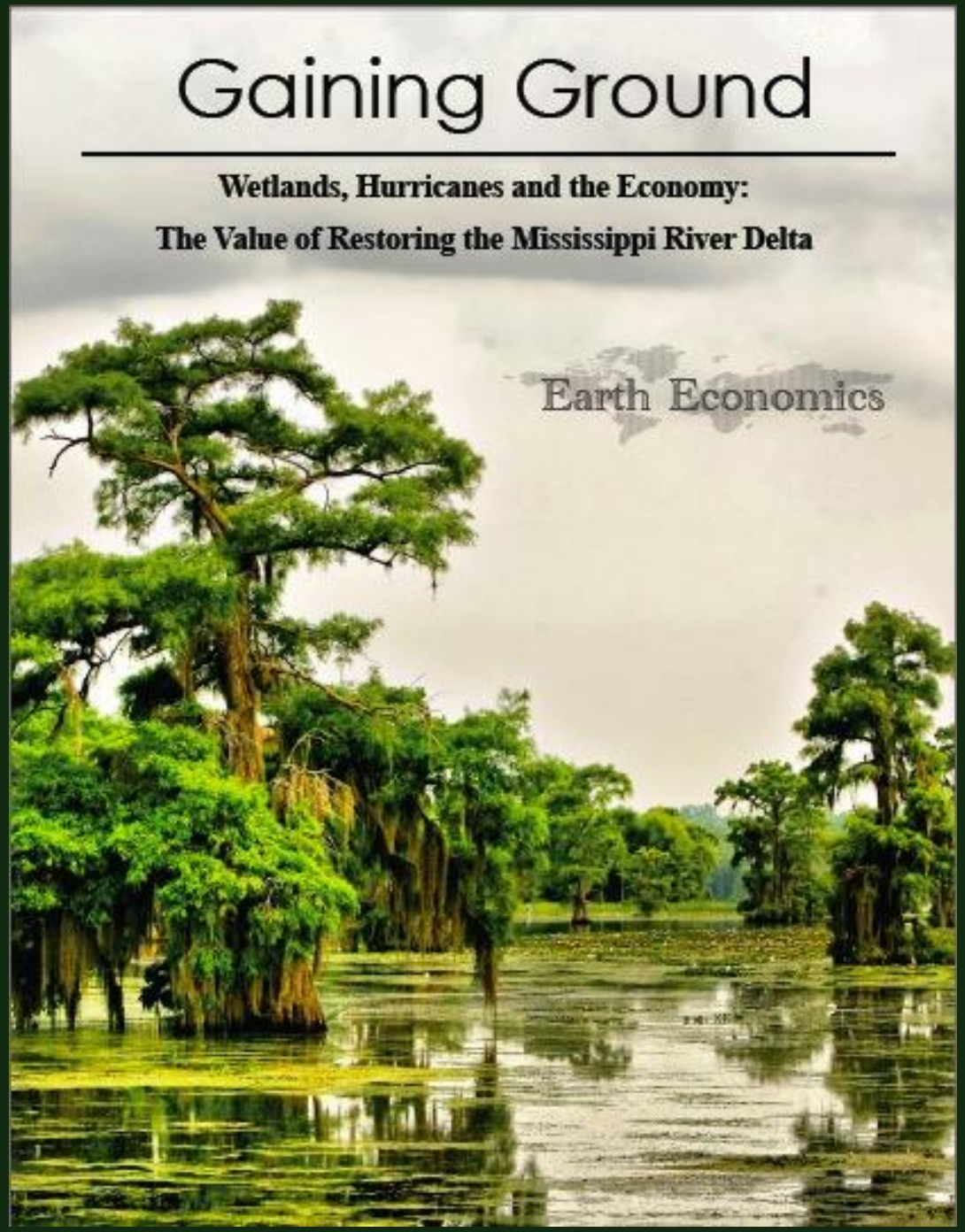
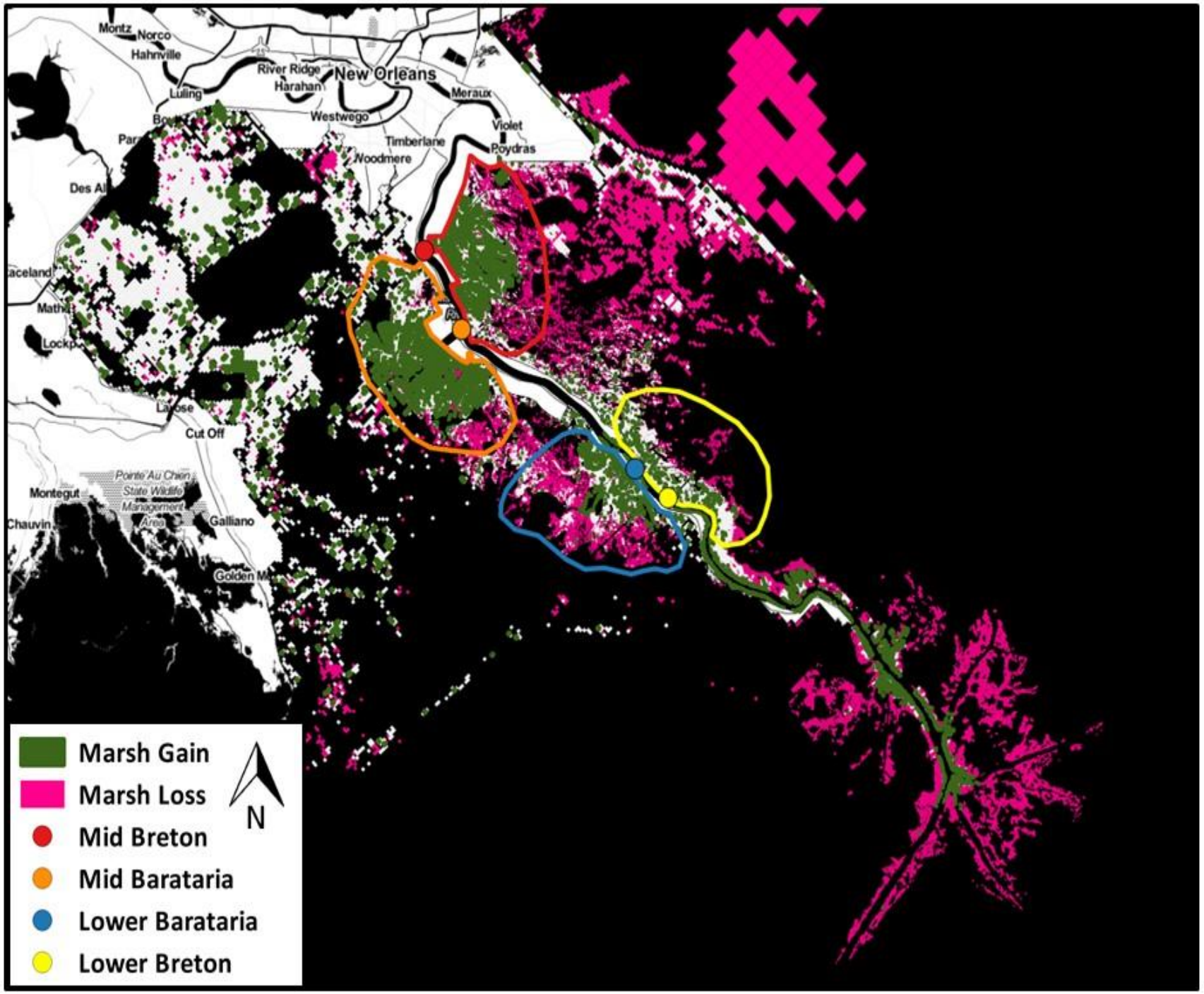
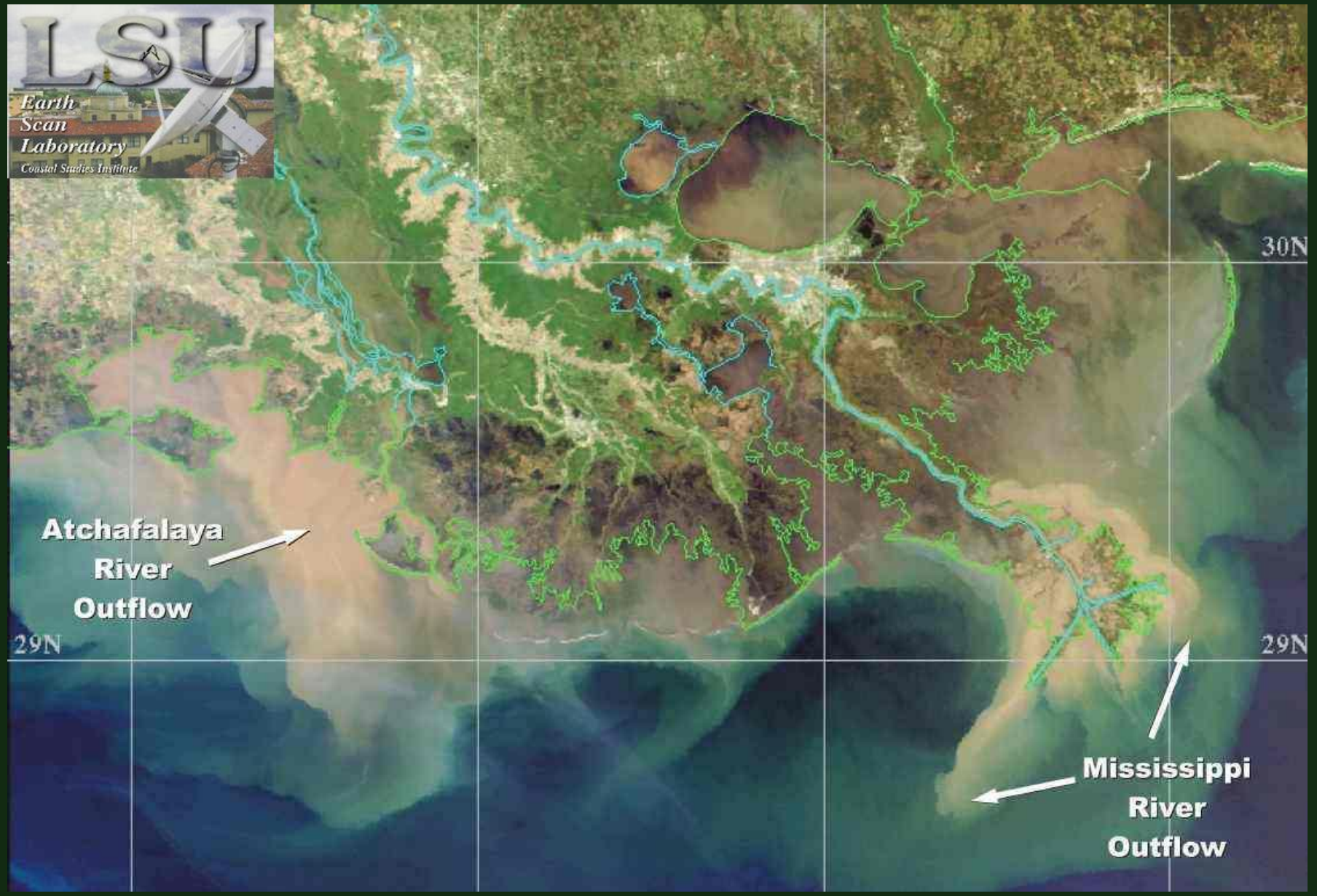
3
2
1
TROPICAL DEPR
TROPICAL STORM
CATEGORY 1
CATEGORY 2

Source: NOAA


Gaining Ground
Wetlands, Hurricanes and the Economy:
The Value of Restoring the Mississippi River Delta
Earth Economics


Montz
Norco
Hahnville
River Ridge
New Orleans
Harahan
Luling
Meraux
Westwego
Violet
Timberlane
Poydras
Woodmere
Des Al
Lockp
Cut Off
Pointe Au Chien
State Wildlife
Management
Area
Montegut
Chauvin
Galliano
Golden M
Marsh Gain
Marsh Loss
Mid Breton
Mid Barataria
Lower Barataria
Lower Breton
N

Louisiana's $50 Billion Plan



What do you want to do?

- Conserve water and use it more effectively.
- Avoid stormwater flooding.
- Prepare for sea level rise and droughts.
- Preserve local open space and streams.
- Keep water clean, safe, and healthy.

Green and Distributed Infrastructure

- Not a luxury
- Provides many co-benefits
- Practical and cost-effective solution
- Supports resilience, equity, and service capacity

Co-benefits can Inform Financing and Partners

Co-Benefit	Partner/Financing
Disaster Risk Reduction	FEMA; HUD
Water Quality/Supply, Energy Efficiency	Municipal Bond Market
Economic Uplift	HUD
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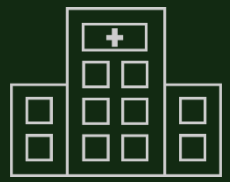
Outcomes for asthma; 100 units over 10 years

Housing Intervention

	Outcome	Monetizable Benefits
Medical Visits	1000 fewer visits	**$95,000 in out-of-pocket**
Missed Work Wages	1040 fewer days	**$270,000 earned**
Disutility	18,000 fewer days with symptoms	**$1.3M WTP**

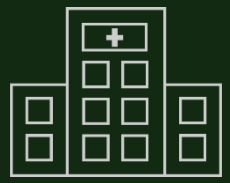
Medicaid ED Visits	670 fewer ED visits	**$290,000 savings**
Employment Productivity	1040 productive days	**$165,000 in production**
School District Cost	1020 fewer days missed	**$27,000 school funds**



Medicaid ED Visits	670 fewer visits	**$195,000 avoided loss**
Child Hospitalizations	45 fewer visits	**$203,000 avoided cost**
Length of Stay	54 fewer days hospitalized	**$65,000 cost savings**

Outcomes from affordability and increased stability of housing
100 units over 10 years

Housing Intervention



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Permeable Pavement

Stormwater treatment
Water supply
Less severe heat waves
Quieter neighborhoods
Educational opportunities

Green Roofs

Stormwater treatment
Lower utility bills
Cooler cities
Cleaner air
Neighborhood beautification

Brooklyn Grange

Urban Trees

Stormwater management
Lower asthma rates
Cooler cities
Better quality of life
Walkable cities

OLIN

Urban Waterways

Flood protection
Property values
Fish habitat
Recreation
Sense of place

Including ecosystem services and other co-benefits nearly doubled the total benefit amount.