



Developing Ecological Offsets for U.S. Shale Plays: Five Years of Learning(s)

Russ Krauss
Vice President, Marketing & Analysis
Resource Environmental Solutions, LLC

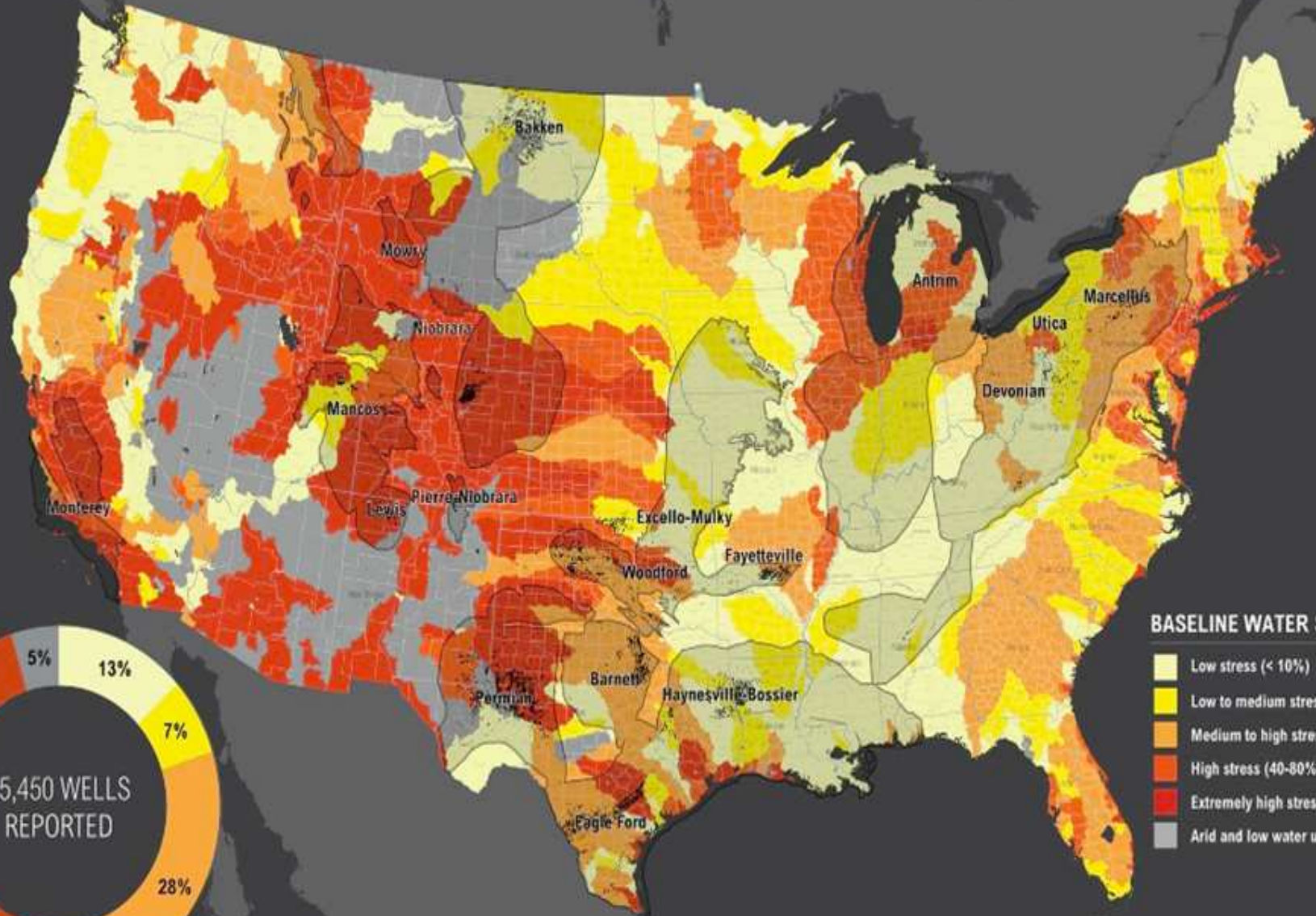


**Environmental Issues and Solutions in Exploration,
Production, Refining & Distribution of Petroleum**





Competition for Water in US Shale Energy Development



BASELINE WATER STRESS

- Low stress (< 10%)
- Low to medium stress (10-20%)
- Medium to high stress (20-40%)
- High stress (40-80%)
- Extremely high stress (> 80%)
- Arid and low water use





Permitting U.S. Onshore

Environmental Issues for U.S. Shale Gas Plays

Barnett Shale

Fayetteville
Shale

Haynesville
Shale

Marcellus
Shale

Utica
Shale

Eagle Ford
Shale

Traffic

New
Development
Areas

Urban
Development

Water Sourcing

Wildlife

Noise

Well Siting, Well Construction

Hydraulic
Fracturing

Vegetation

Air Emissions

NORM

Archeology and
Cultural
Resources

Water
Management

Wetlands and
Streams

Surface Impacts:

Well Siting, Drilling Pads, Flowlines, Laterals, Gathering Systems, Processing Plants



NEPA: National Environmental Policy Act

One Project, Many Federal Permits

Natural Gas Act Section 7 Resource Reports

Wetlands and Water Use	Water Quality	Vegetation	Wildlife	Fish	Culture	Land Use and Recreation	Air and Noise Quality
Clean Water Act and National Pollution Discharge Elimination System Program			Migratory Bird Treaty Act	Magnuson-Stevens Fishery Conservation and Management Act	National Historic Preservation Act	National Parks and Recreation Act	Clean Air Act
Coastal Zone Management Act		Endangered Species Act			Archeological and Historic Preservation Act		
Executive Order 11988 (Construction in Floodplains)		National Wilderness Act				National Wilderness Act	
Executive Order 11990 (Construction in Wetlands)							
Wild and Scenic Rivers Act						Wild and Scenic Rivers Act	

2010: Ruby Pipeline: 2.5 years permitting, \$3.8MM for 4.667 acres of Habitat; \$1.7MM Threatened Species

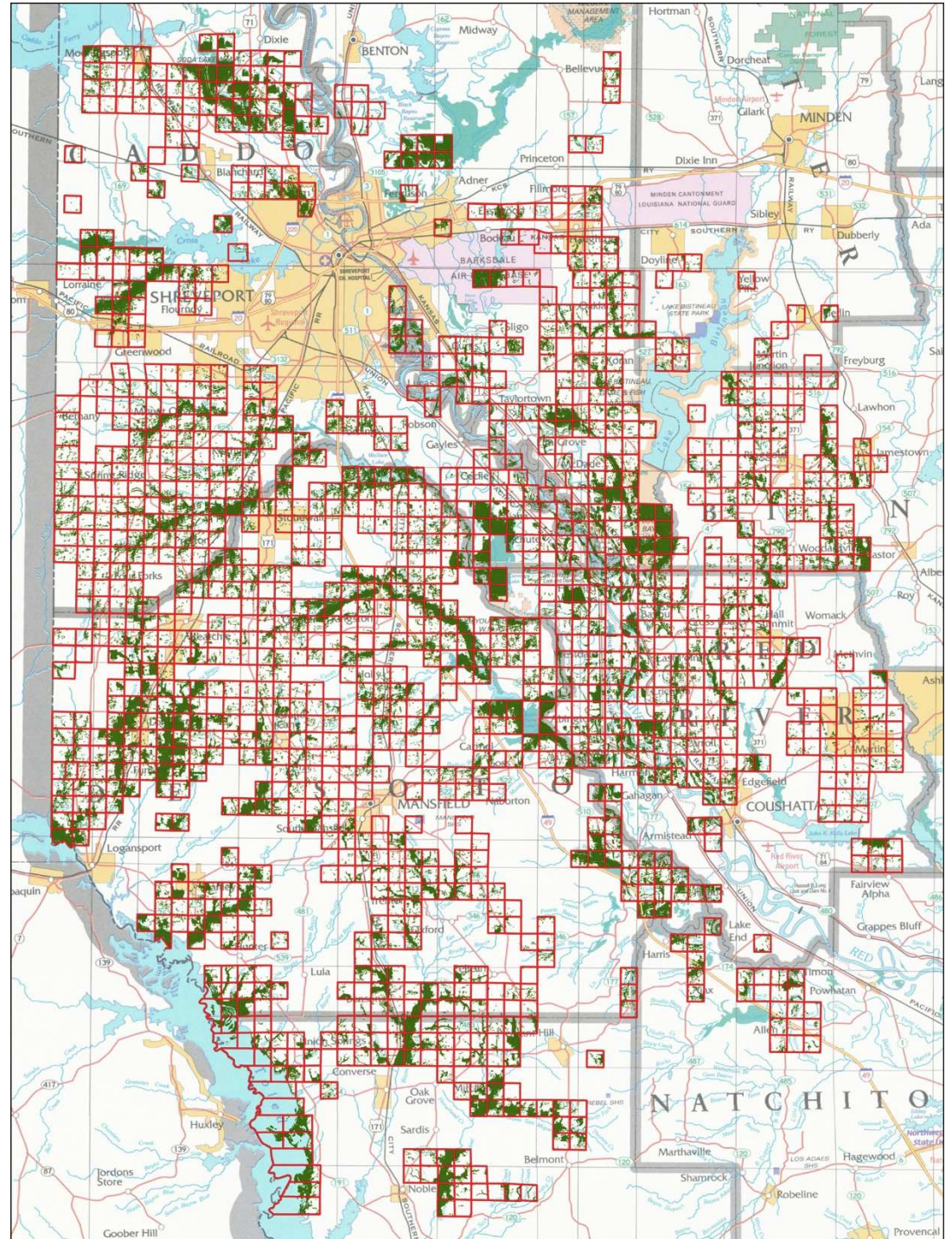
2013: Post-project Enforcement In Process

Haynesville Shale

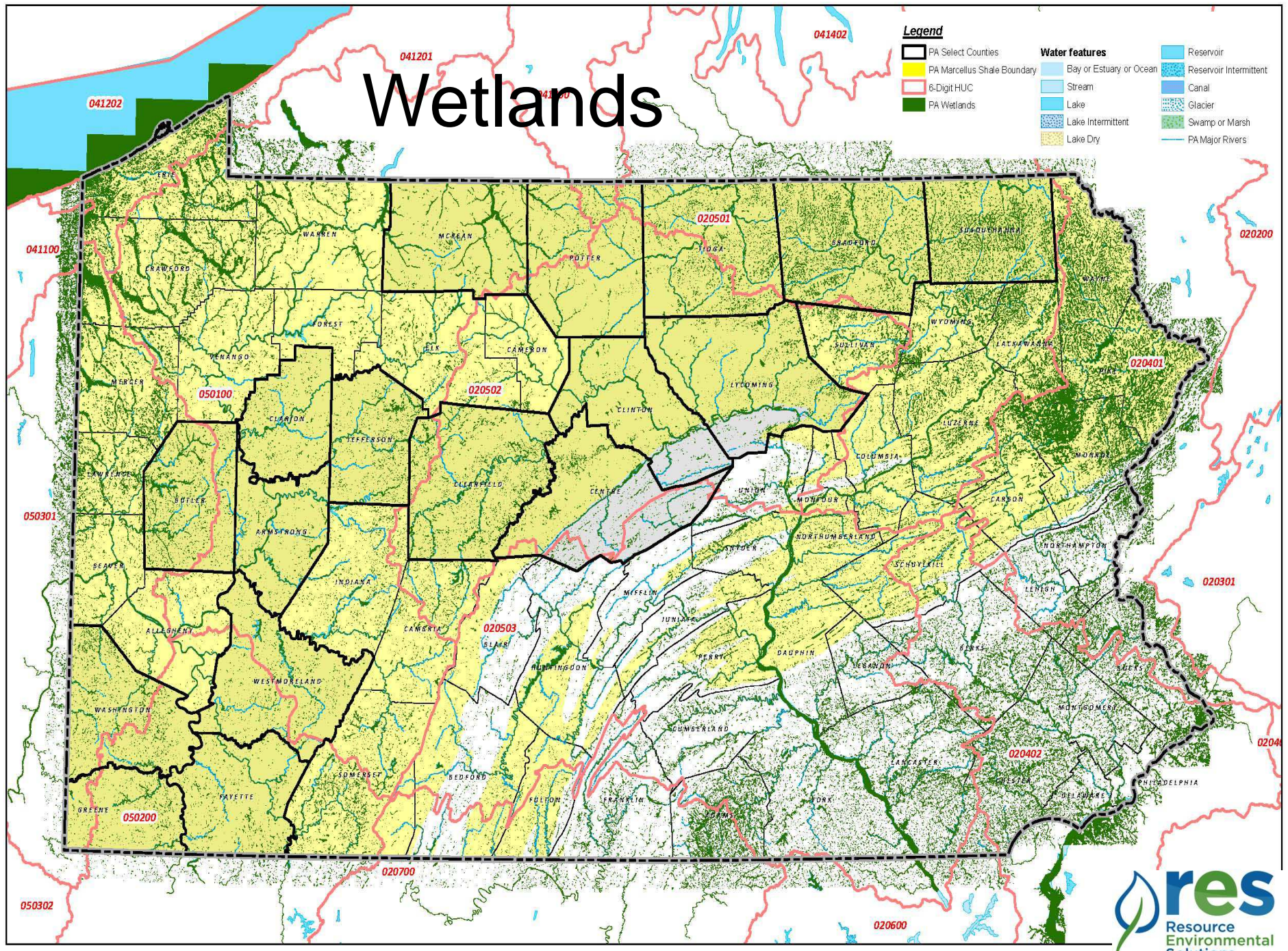
Potential
Surface Impact
to Wetlands
Every 5th Well

Permits:
CWA §404 RGP/IP
Well Pad and Infrastructure
Access Roads and Flowlines

USACE Vicksburg District

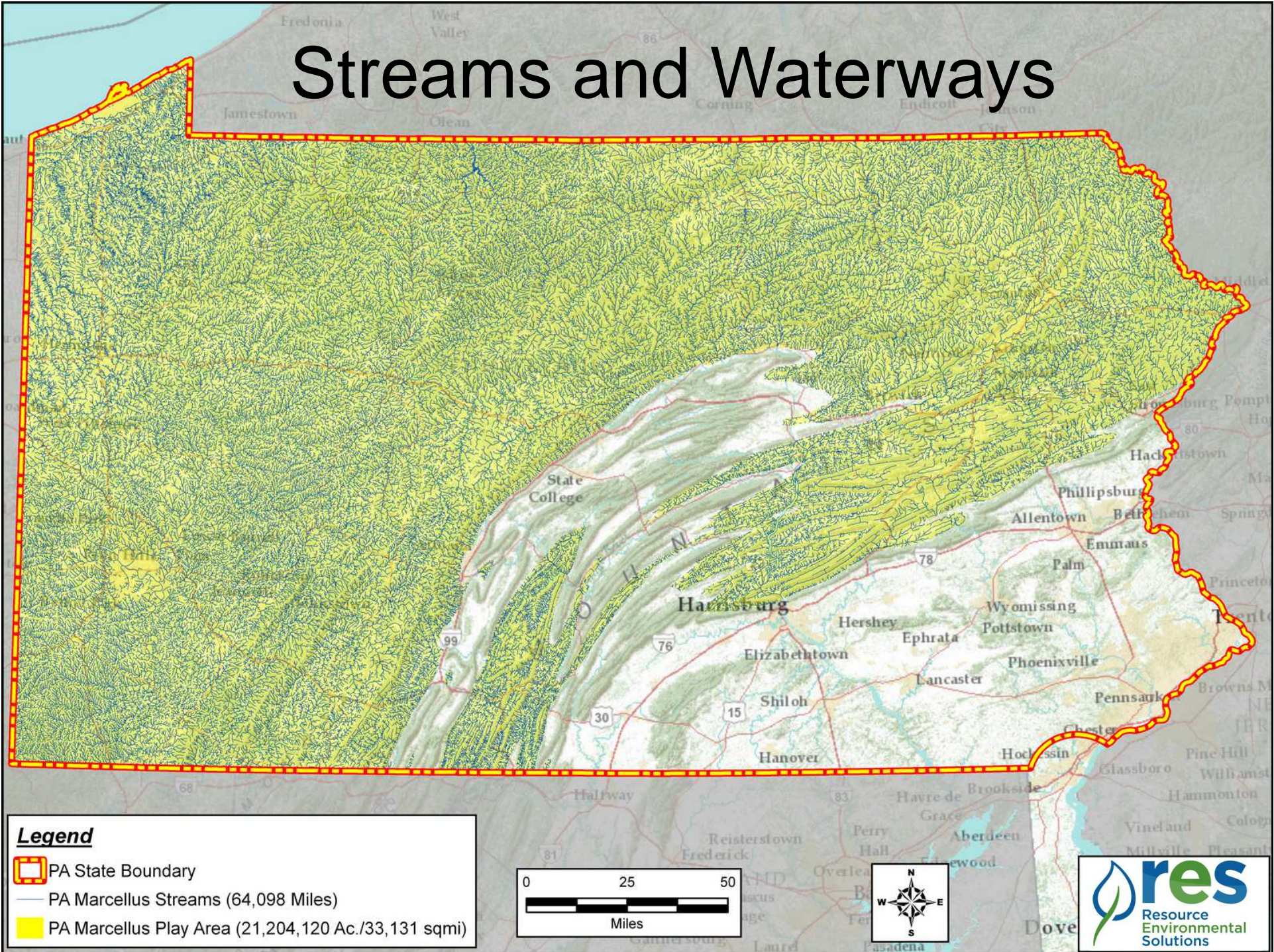


Wetlands



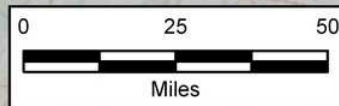


Streams and Waterways



Legend

-  PA State Boundary
-  PA Marcellus Streams (64,098 Miles)
-  PA Marcellus Play Area (21,204,120 Ac./33,131 sqmi)



Typical Regulators of Wetlands And Streams

	Haynesville/LA	Marcellus/PA	Utica/OH	Eagle Ford/TX
Federal	US Army Corps of Engineers: Vicksburg District	US Army Corps of Engineers: Pittsburgh, Baltimore Districts	US Army Corps of Engineers: Pittsburgh, Huntington Districts	US Army Corps of Engineers: Galveston, Fort Worth Districts
	US EPA Region 6	US EPA Region 3	US EPA Region 5	US EPA Region 6
	US Fish & Wildlife Service Region 4	US Fish & Wildlife Service Region 5	US Fish & Wildlife Service Region 3	US Fish & Wildlife Service Region 2
State	Louisiana Department of Environmental Quality (LA DEQ)	Pennsylvania Department of Environmental Protection (PADEP)	Ohio Environmental Protection Agency (Ohio EPA)	Texas Commission on Environmental Quality (TCEQ)
	Louisiana Department of Wildlife and Fisheries (LDWF)	Pennsylvania Game Commission	Ohio Department of Natural Resources (Ohio DNR)	Texas Parks and Wildlife Department (TPWD)
	Louisiana Department of Natural Resources (LA DNR)	Pennsylvania Fish and Boat Commission		Texas General Land Office (GLO)
		Pennsylvania Department of Conservation and Natural Resources (PA DCNR)		

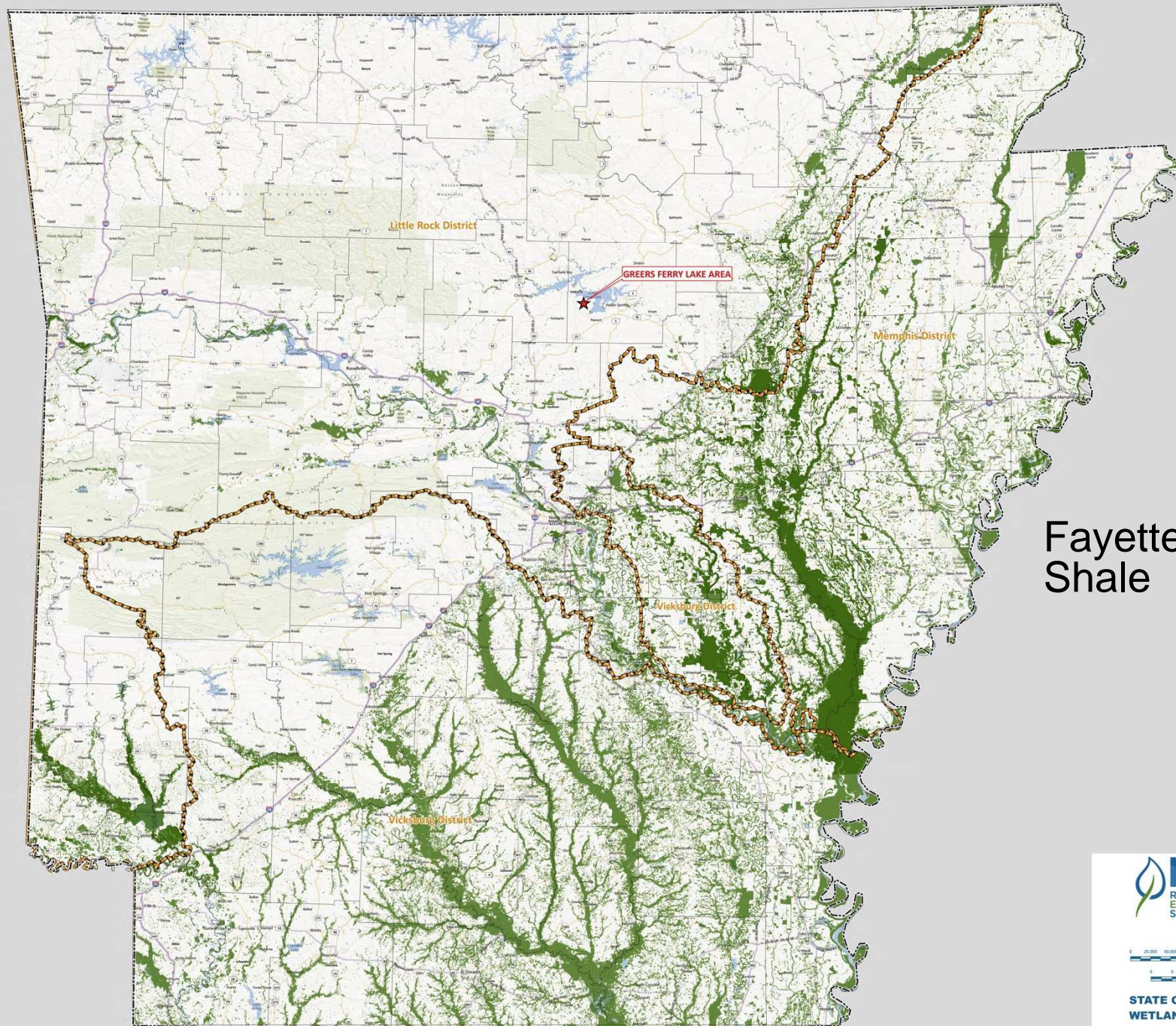


A wide-angle photograph of a lush green field with several cows grazing. In the background, there is a line of trees and a clear blue sky. A single large tree stands on the left side of the field.

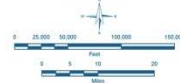
*Environmental is a small part
of our project budget.*

*Environmental issues and permitting have
the largest impacts on project timing.*



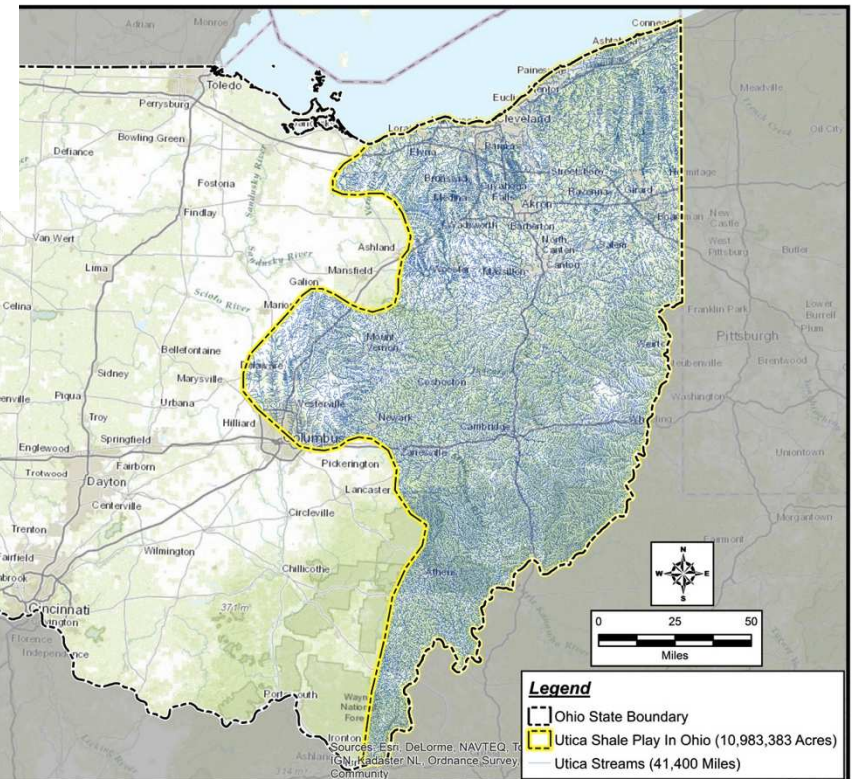
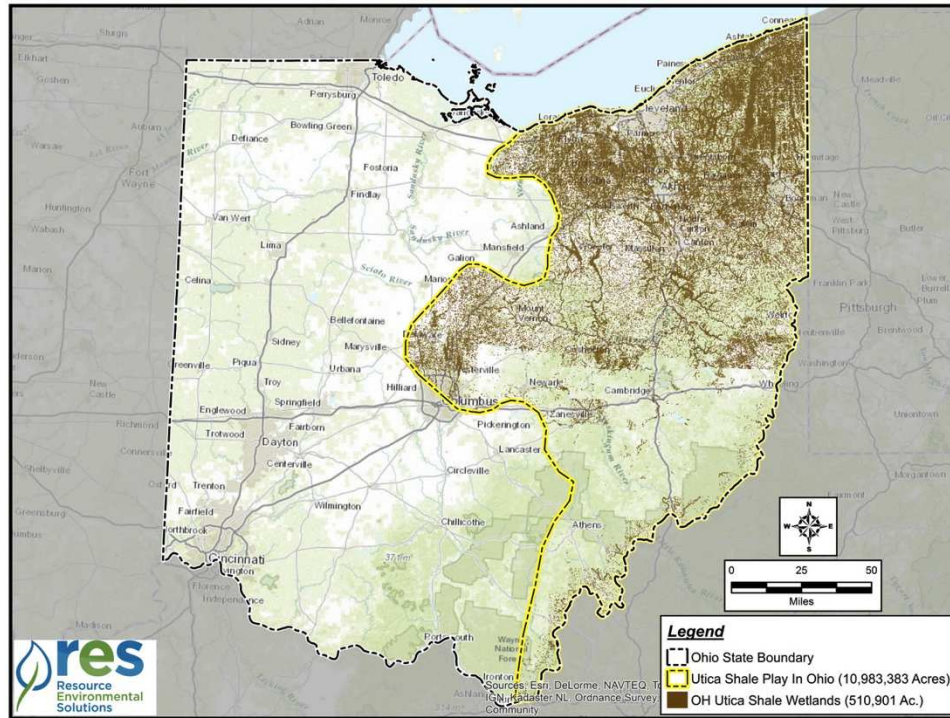


Fayetteville Shale

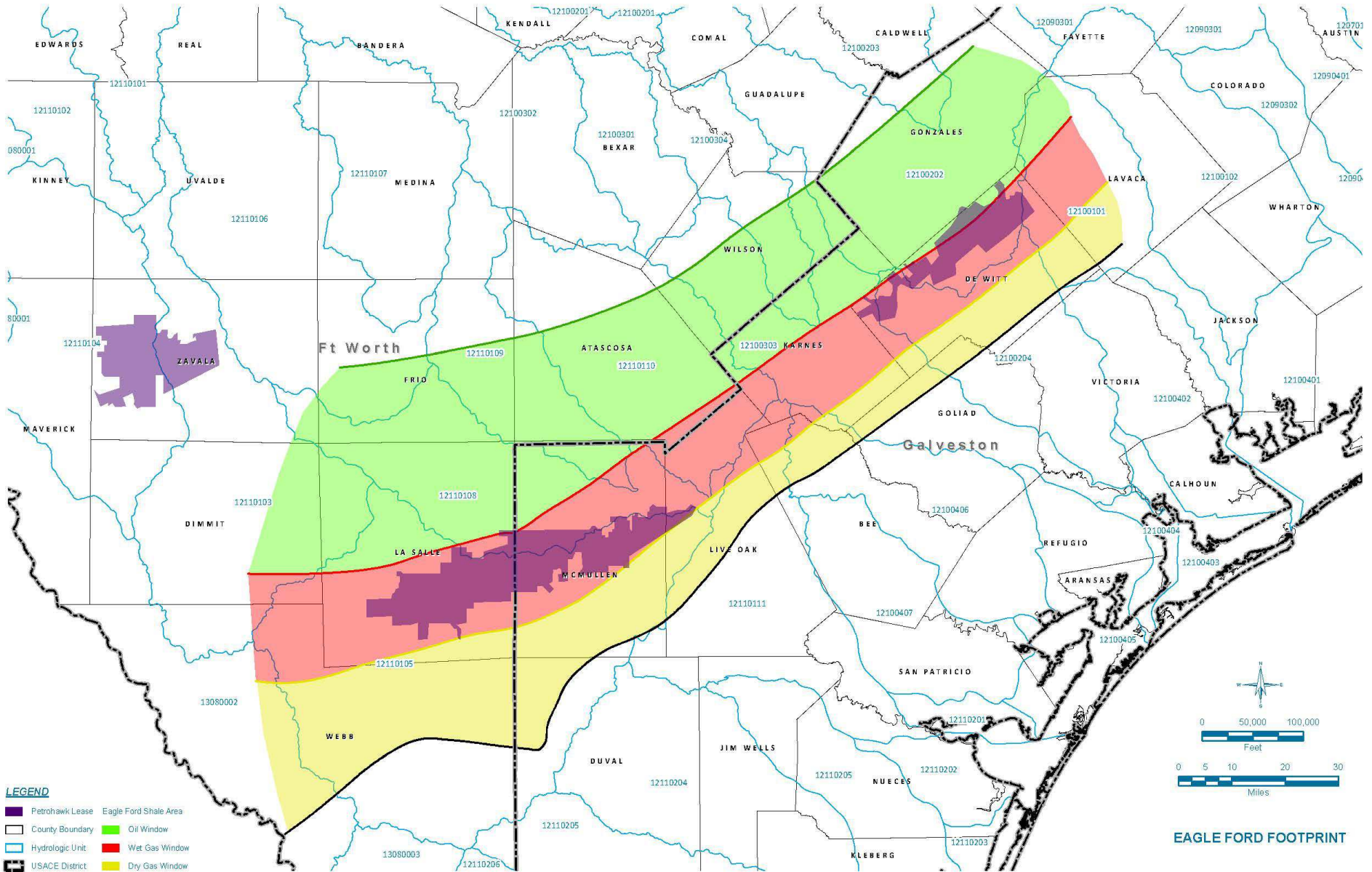


STATE OF ARKANSAS
WETLAND AREA MAP

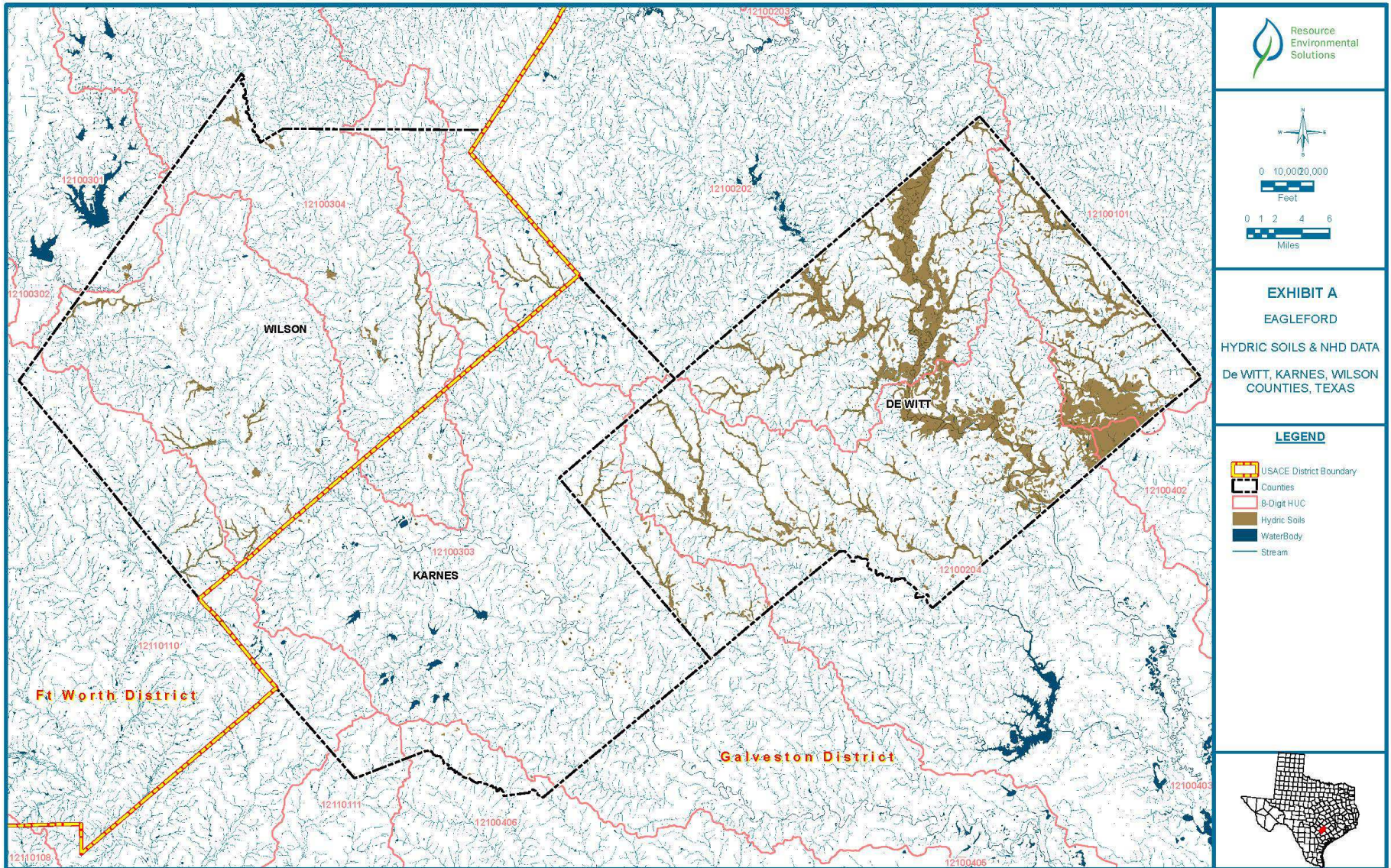
Utica Shale



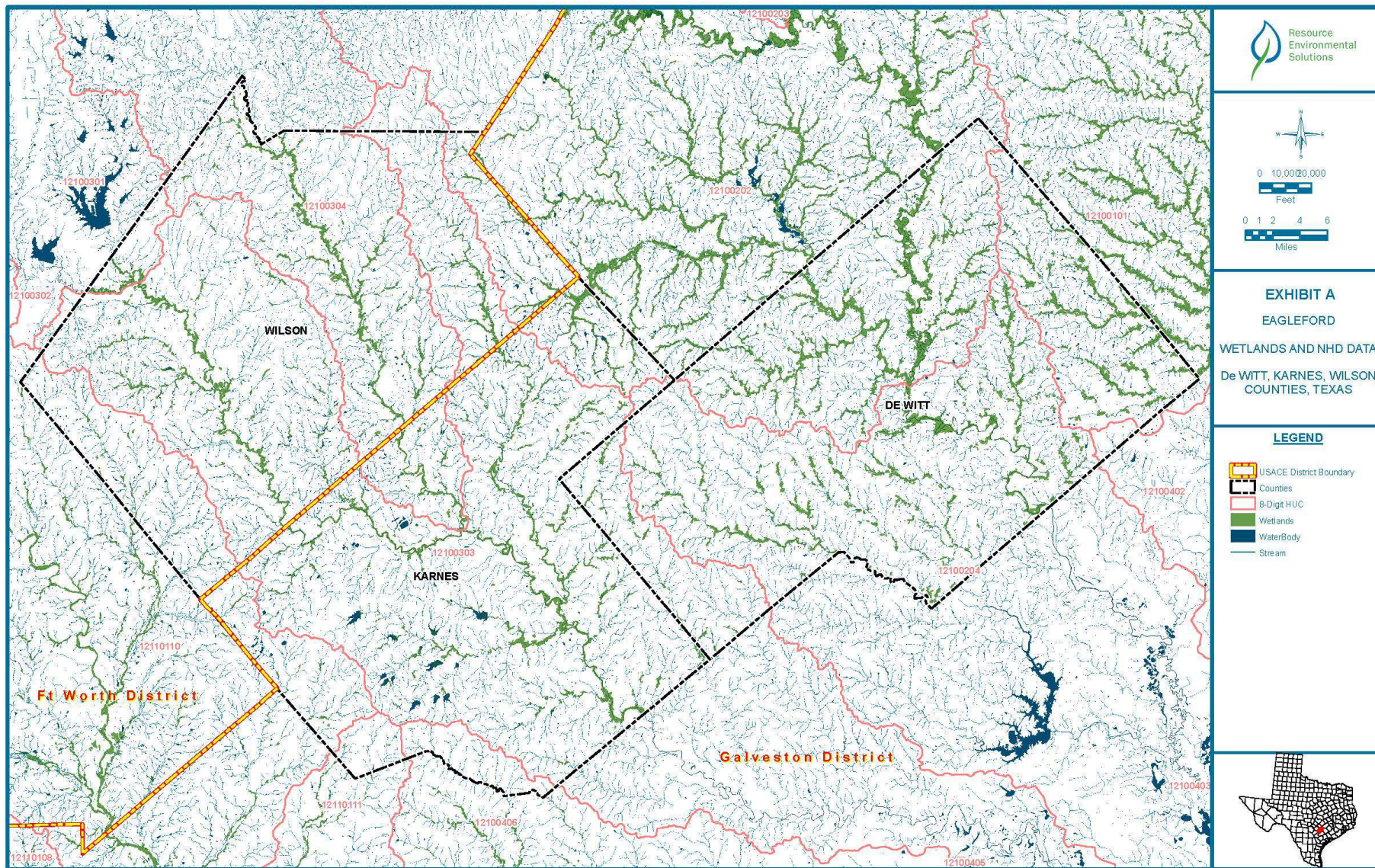
Eagle Ford Shale

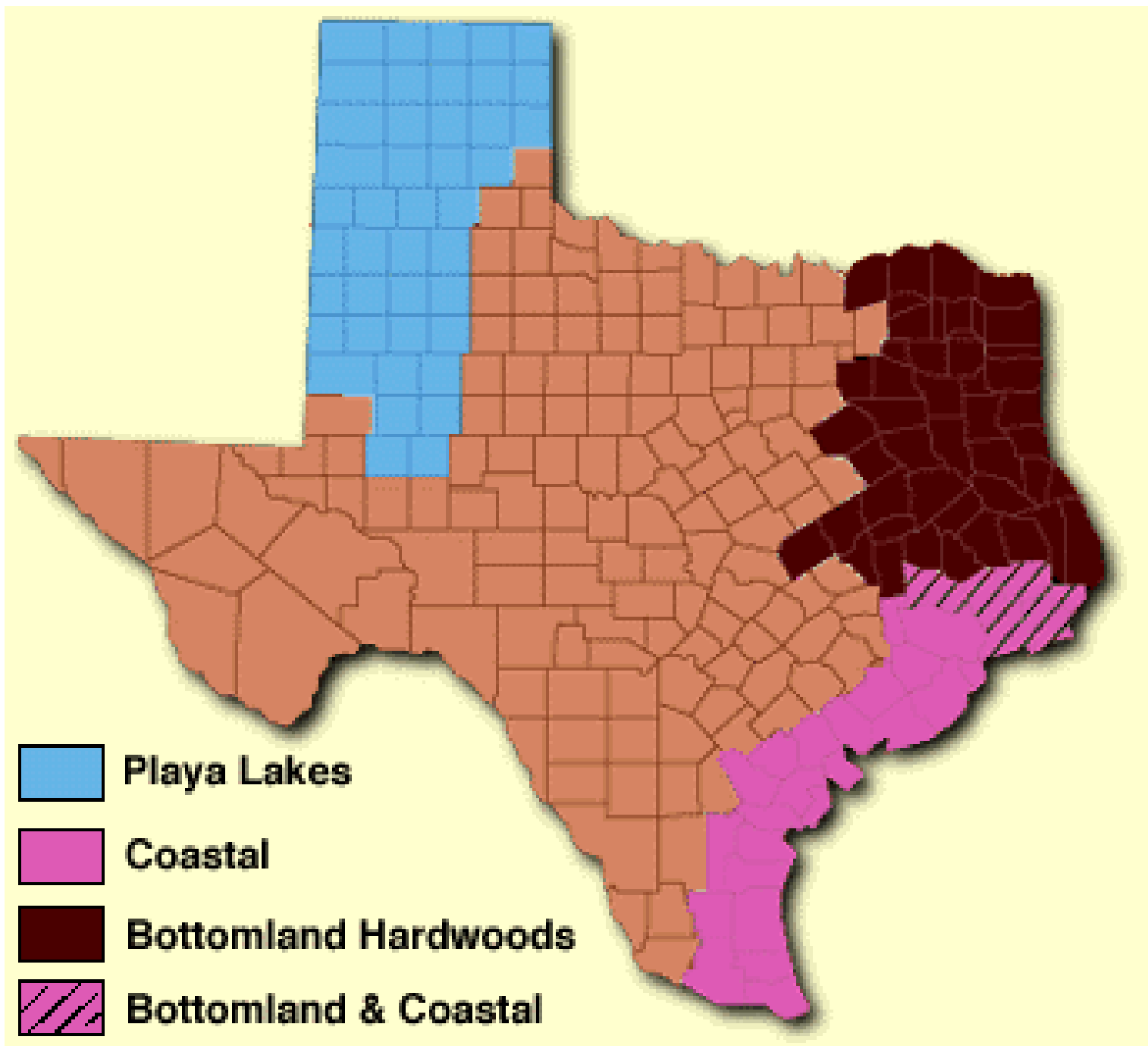


Eagle Ford Shale



Eagle Ford Shale

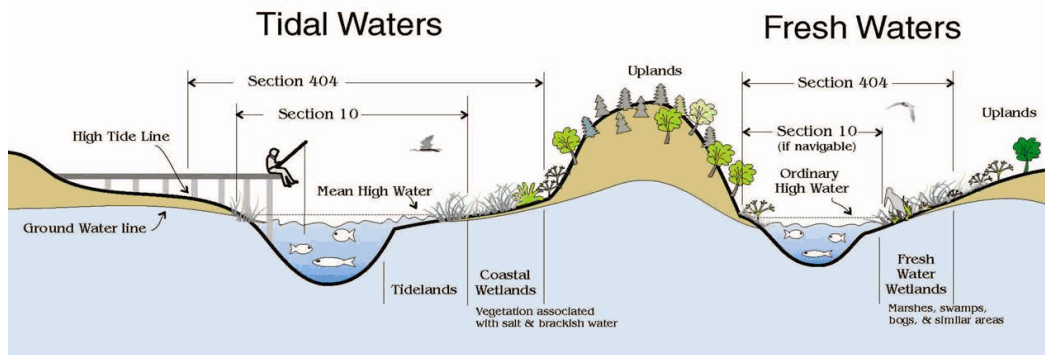






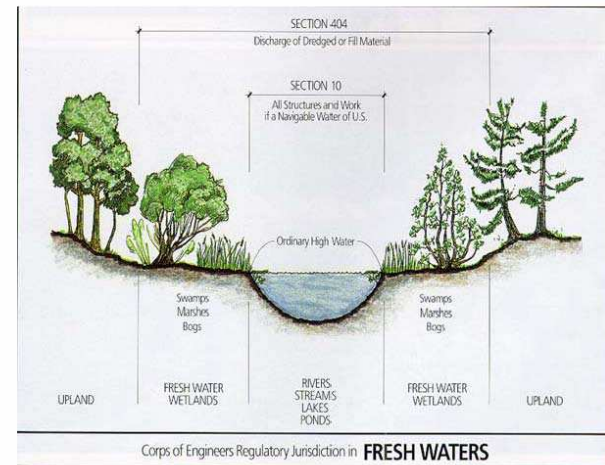


CORPS OF ENGINEERS REGULATORY JURISDICTION

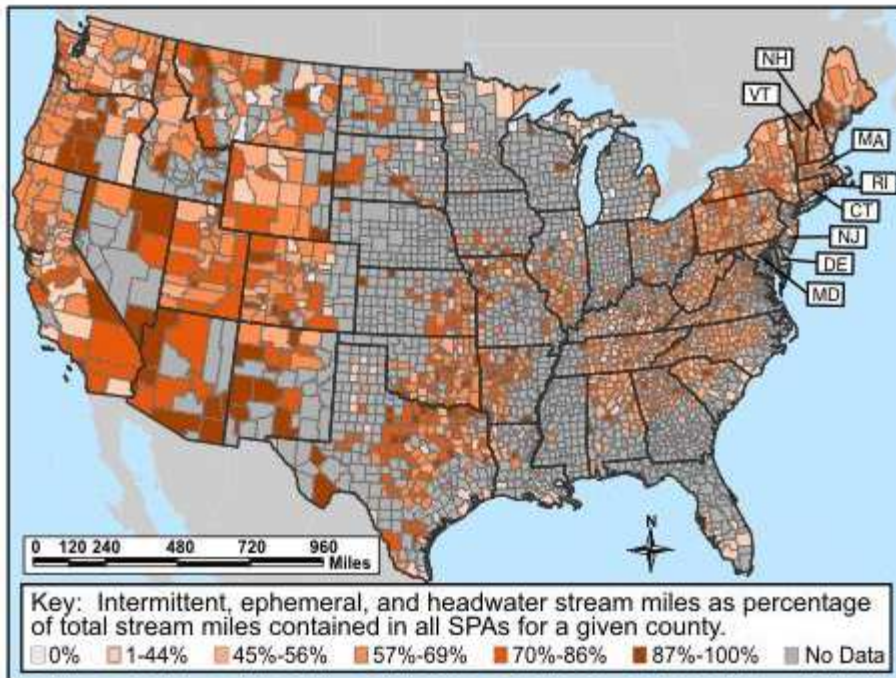


- Section 103**
Ocean Disposal of Dredged Material
Typical examples of regulated activities
Ocean discharges of dredged material
- Section 404**
Discharge of Dredged or Fill Material (all waters of the U.S.)
All filling activities, utility lines, outfall structures, road crossings, beach nourishment, riprap, jetties, some excavation activities, etc.
- Section 10**
All Structures and Work (navigable waters)
Dredging, marinas, piers, wharves, floats, intake / outtake pipes, pilings, bulkheads, ramps, fills, overhead transmission lines, etc.

“Waters of the United States”



Percentage of Surface Drinking Water from Intermittent, Ephemeral, and Headwater Streams



Enforcement

National Enforcement Initiatives

EPA protects people's health and safeguards communities by assuring compliance with the nation's environmental laws and by taking enforcement action when laws are violated. Every three years, EPA sets national enforcement initiatives to focus civil and criminal enforcement resources and expertise on serious pollution problems affecting communities. The 2011–2013 initiatives were chosen with state and public input and support EPA's seven priorities.

Our National Enforcement Initiatives for Fiscal Years 2014 – 2016

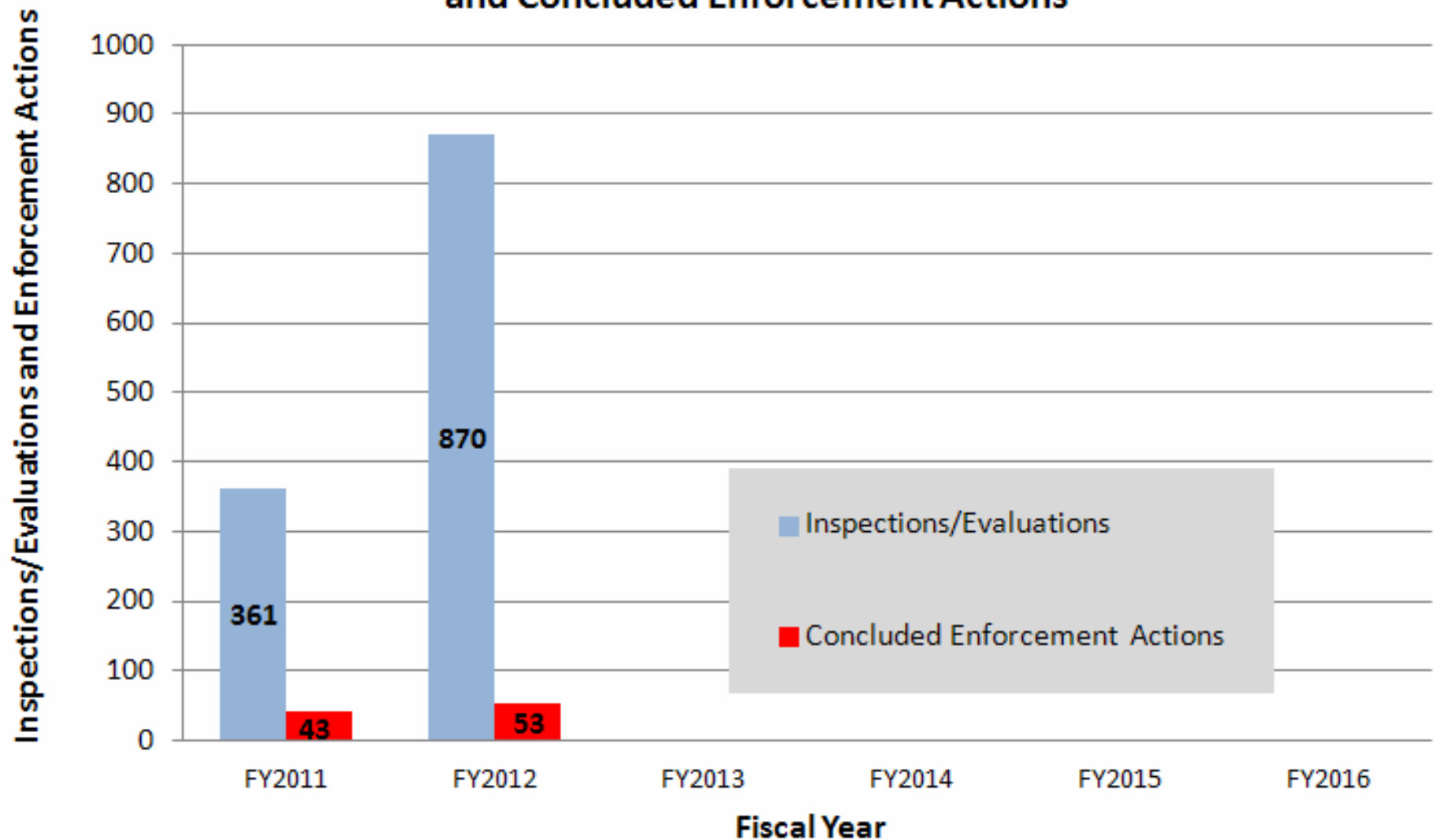
EPA will continue our current National Enforcement Initiatives for the 2014–2016 fiscal years. [Read the announcement.](#)
(PDF) (4 p 84 kb, [About PDF](#))

Assuring Energy Extraction Sector Compliance with Environmental Laws

“...EPA will develop an initiative to assure that energy extraction activities are complying with federal requirements to prevent pollution of our air, water and land.”



Annual Number of EPA Energy Extraction Inspections/Evaluations and Concluded Enforcement Actions



*Numbers include federal inspections/evaluations and concluded enforcement actions.

What to do?

Be Proactive

Early Understanding of Scope and Magnitude

Seek Alternatives and Solutions

“You have no impacts, no need to permit”

“We’ll skip the 404 permit process -- our impacts are too small”

“We only drill one well a quarter, why plan ahead?”

Risk Management → Liability Transfer

Do Not Avoid Compliance, The Costs are Too High

Ecosystem Services

Ecosystem services are societal benefits derived from ecosystems

- **Provisioning Services**
 - Fisheries
 - Fresh water
 - Wood products
 - Natural pharmaceuticals
- **Regulating Services**
 - Air quality
 - Local climate
 - Water quality/quantity
 - Waste assimilation
 - Soil quality
- **Cultural Services**
 - Navigation
 - Recreational angling
 - Scuba diving
 - Education/Research
- **Supporting Services**
 - Cycling of carbon, phosphorus, silicon, etc.
 - Photosynthesis
 - Chemosynthesis

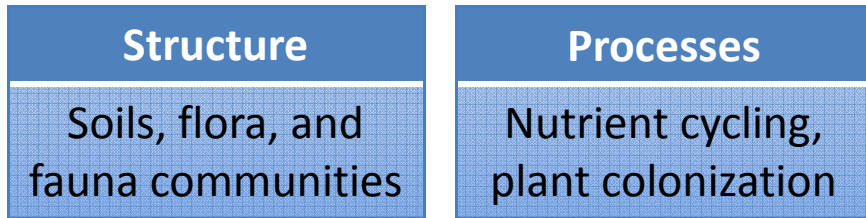


Ecology		Economics
Organization	→	Operation
Stock		Flows
Structure		Functions
Infrastructure		Services
Pattern		Processes
		Outcome
		Services
		Goods
		Benefits
		Income

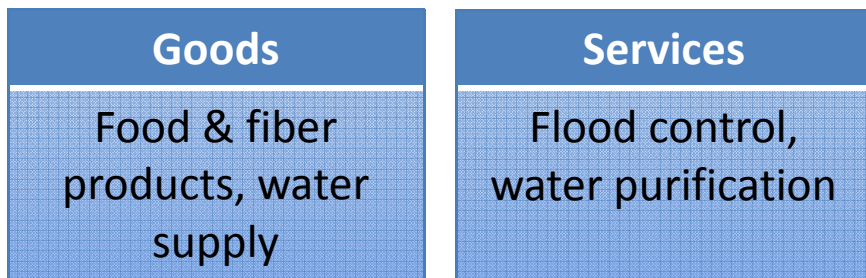


(After Fisher, Turner and Morling, 2009)

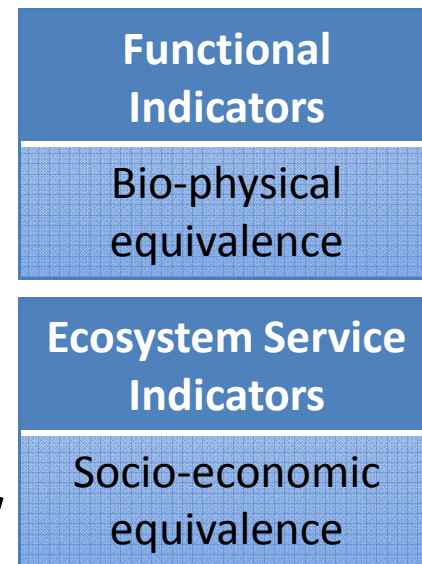
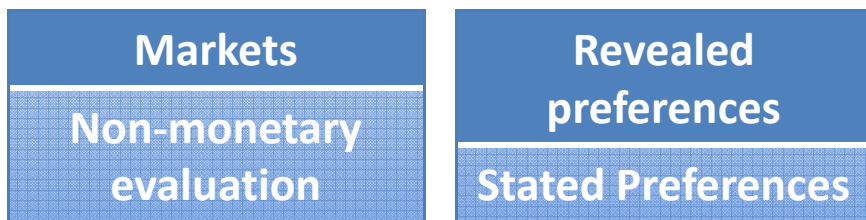
Ecology of Wetlands



Societal Benefits of Wetlands



Methods for Valuing Wetland Services



Credit for Wetland Mitigation



(Adapted from Hein et al 2006 and Turner and Daily 2008)

Functional Assessment Methods Applied to Quantify Impacts to Waters of the United States

Play	State	Wetlands	Streams
Haynesville	Louisiana	Vicksburg District: Charleston Method	Little Rock District Stream Assessment Method
Marcellus	Pennsylvania	Ratio and Level 2 Wetland Rapid Assessment Protocol	Ratio and Level 1, Level 2 Riverine Rapid Assessment Protocol
Utica	Ohio	Ohio EPA: ORAM and Ratio	Ratio and Huntington/Pittsburgh Approaches
Eagle Ford	Texas	Fort Worth District: TXRAM, Galveston District: HGMI	Fort Worth: Ratios, TXRAM Galveston: Interim Stream Assessment SOP

Comparison of Assessment Methods on Single Wetland Fill Project

District	Assessment Method	Ratio: Offsets to Impacts*	Cost per Impact Acre**
Vicksburg	Charleston Method	3.6:1	\$72,000
New Orleans	Modified Charleston Method	2.4:1	\$48,000
Galveston	HGMi	0.7:1	\$15,000
Fort Worth	TXRAM	0.6:1	\$12,000

*Based on results of typical bottomland hardwood wetland impact/mitigation scenario comparison conducted by Society of Wetland Scientists Functional Assessment Workshop, National Wetlands Research Center, Lafayette, Louisiana.

**Assumes \$20,000 per mitigation acre.

Mitigation

Typical Mitigation Sequence for Environmental Impacts:

- ✓ Avoid
- ✓ Minimize
- ✓ Compensate

Compensatory Mitigation In Order of Preference:

- Mitigation Banks
- In Lieu Fee Programs
- Permittee Responsible Mitigation





BEFORE



AFTER



Post Drilling Restored Well Site





Degraded Stream Before Restoration

Restored Stream Post Construction





Post Construction Stream and Riparian Buffer





Resource Environmental Solutions, LLC

www.res.us

Houston Baton Rouge Lafayette New Orleans Pittsburgh

Russ Krauss

russ@res.us

713-986-9222

