Regional Carbon Sequestration Partnerships Review Meeting

Southeast Regional Carbon Sequestration Partnership (SECARB)

www.secarbon.org

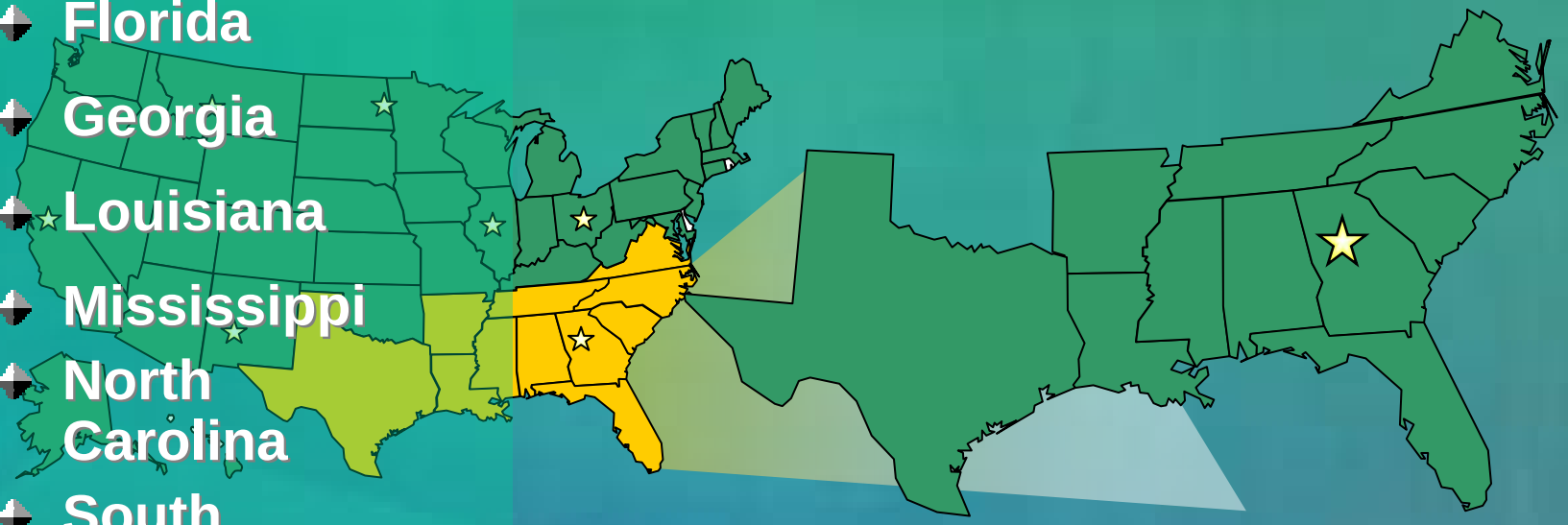
Regional Carbon Sequestration Partnerships Review Meeting

Introduction

Mr. Kenneth J. Nemeth
Southern States Energy Board

Southeast Regional Carbon Sequestration Partnership (SECARB)

- Alabama
- Arkansas
- Florida
- Georgia
- Louisiana
- Mississippi
- North Carolina
- South Carolina
- Tennessee
- Texas
- Virginia



SECARB Project Partners

EPRI Electric Power Research Institute

Geological Survey of Alabama Founded 1848

MIT

TVA

Virginia Tech VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Susan A. Rice and Associates, Inc. Consultants in Pharmacology and Toxicology

Advanced Resources International Inc.

Mississippi State University

augustasystems

AGT

Winrock International Putting Ideas to Work

Bureau of Economic Geology John A. and Katherine G. Jackson School of Geosciences

NETL

SSEB

RMS Strategies

The Phillips Group Solutions

SECARB Technology Coalition

Duke Power

SCANA Power For Living

State Energy Office Energy North Carolina Department of Administration

South Carolina Department of Agriculture

Santee Cooper

Entergy The Power of People

Southern Company Energy to Serve Your World

Dominion It all starts here.

AEP American Electric Power

CEED Center for Energy and Economic Development

Progress Energy

Old Dominion Electric Cooperative

EEI Edison Electric Institute

TECO Tampa Electric

FPL

bp

Louisiana Department of Environmental Quality LDEQ

Clean Energy Systems, Inc.

ChevronTexaco

Oak Ridge National Laboratory Managed by UT Battelle for the Department of Energy

Georgia Forestry Commission

Interstate Oil and Gas Compact Commission 1935

State of Arkansas Oil and Gas Commission

Marshall Miller & Associates

CEFA

NEI Nuclear Energy Institute

Composite Technology Corporation

AGL Resources

SECARB Objectives

- Describe CO_2 sources, sinks and transport requirements
- Develop outreach plan
- Conduct risk and environmental assessments
- Review permitting and regulatory requirements
- Establish measurement, monitoring and verification protocols
- Establish accounting frameworks (including Section 1605(b) of EPAct)
- Identify most promising capture and sequestration opportunities
- Develop Phase II field validation test plans

Regional Attributes – A Temporal Approach

Near-Term ➡ Terrestrial Sinks

- Address YR2012 Voluntary Targets

Mid-Term ➡ EOR & ECBM

Economic Drivers

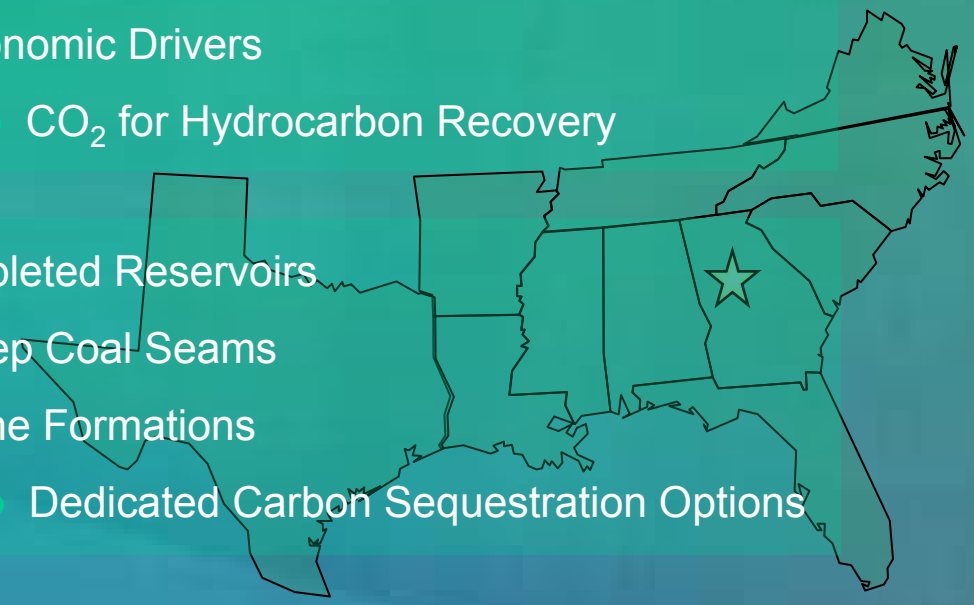
- CO_2 for Hydrocarbon Recovery

Long-Term ➡ Depleted Reservoirs

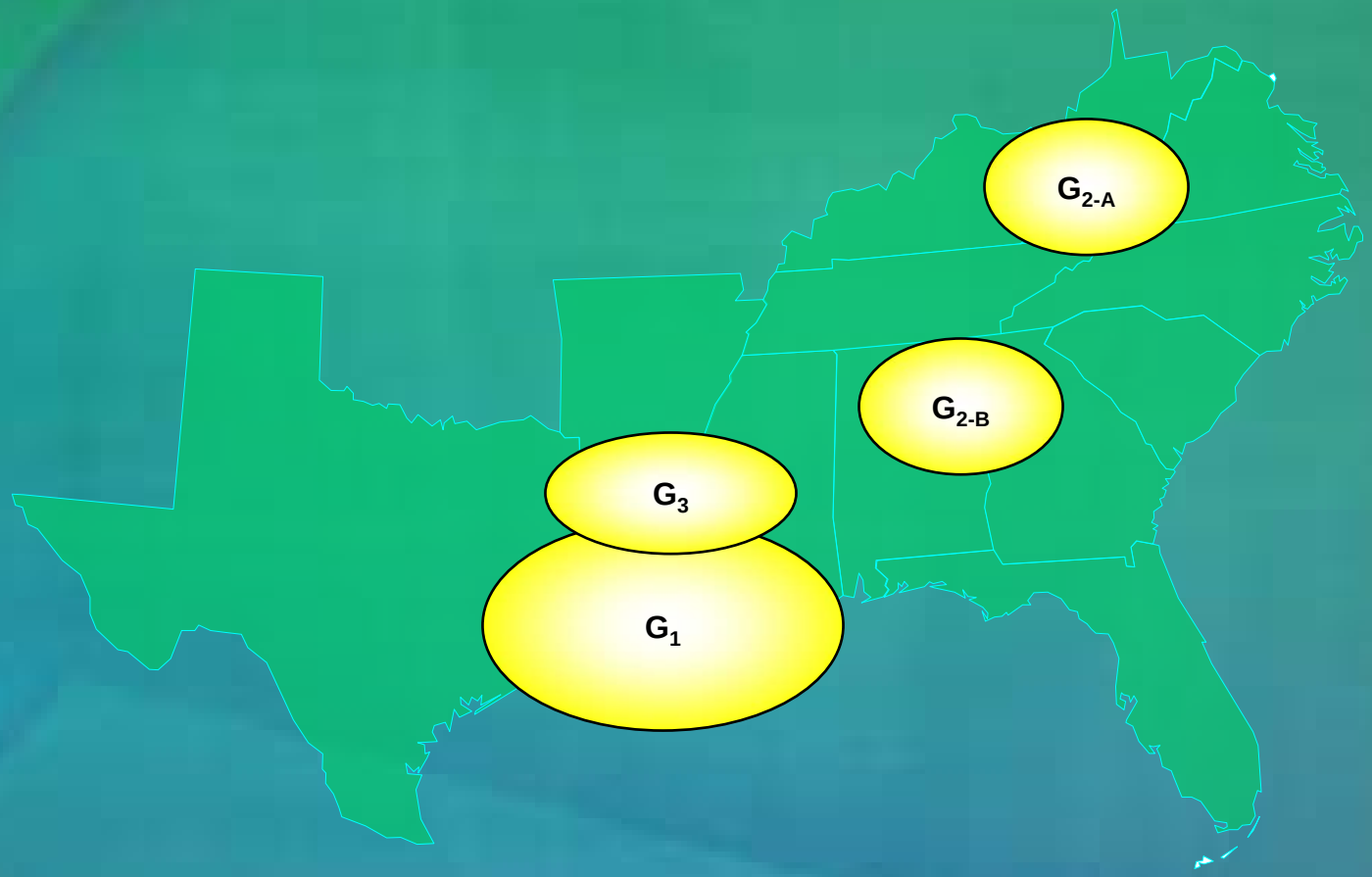
Deep Coal Seams

Brine Formations

- Dedicated Carbon Sequestration Options



SECARB Region & Field Test Site Locations



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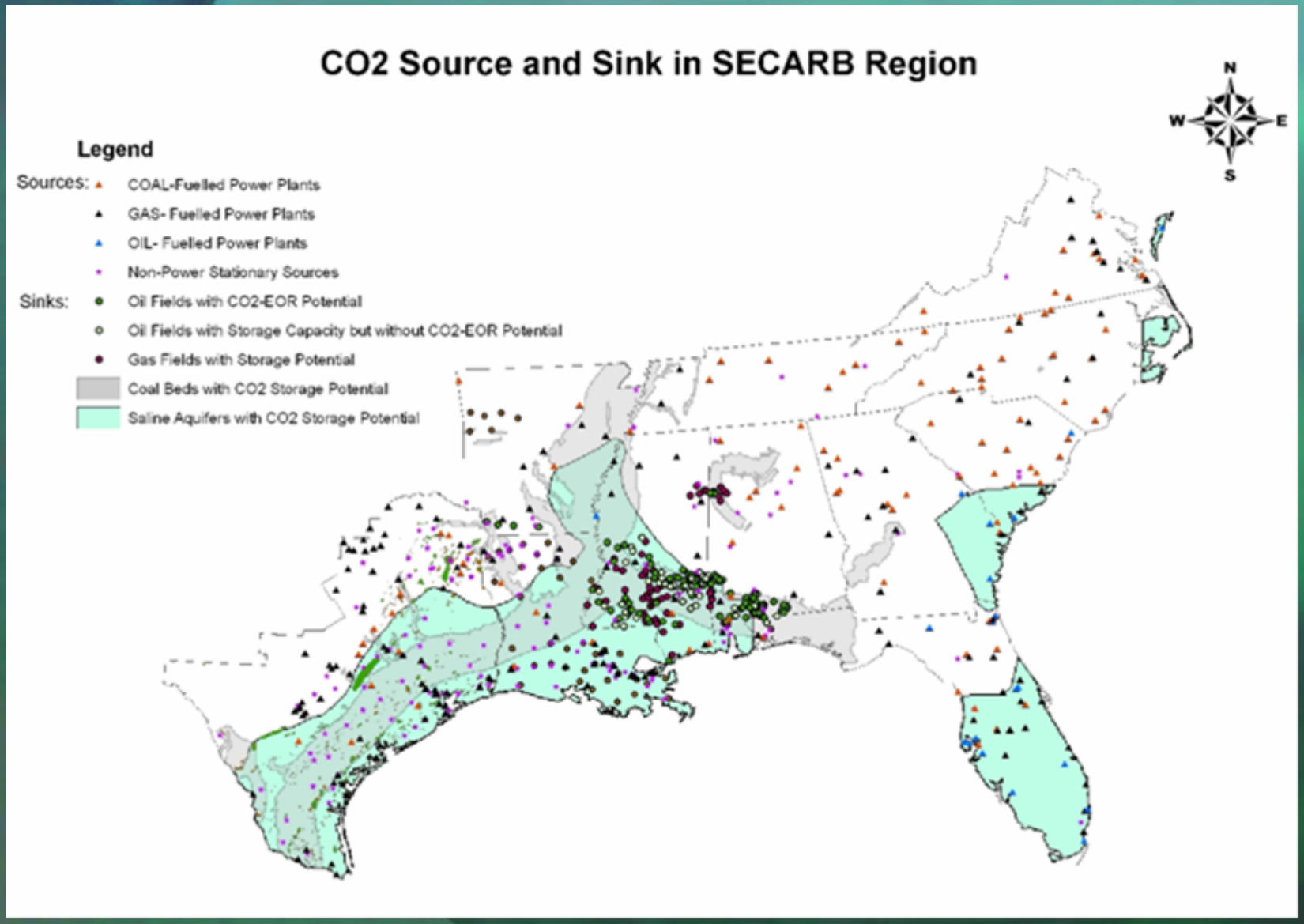
Source – Sink Matching

Richard Rhudy, EPRI
Howard Herzog, MIT
Henry Zhang, MIT
Weifeng Li, MIT

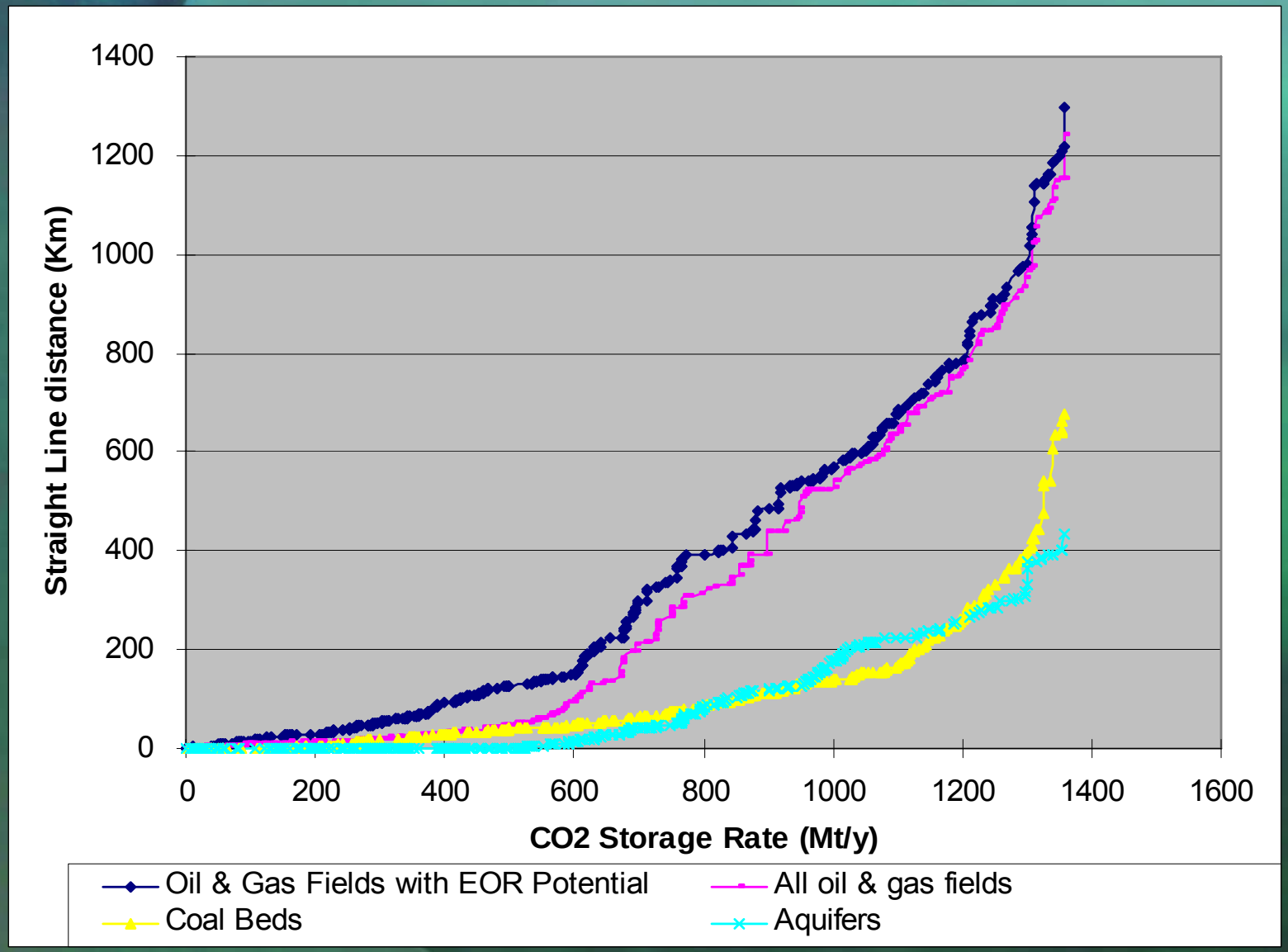
Source-Sink Matching

- **Distance-Based Source-Sink Matching**
- **Texas Study**
  - Full-Cost
  - Optimized Transportation
  - Storage Cost
    - *For EOR Uses EOR Credit*
    - *For Gas Fields and Saline Reservoir Uses DOE/EPRI/TVA Developed Costs*

Distance-Based Source-Sink Matching (2)



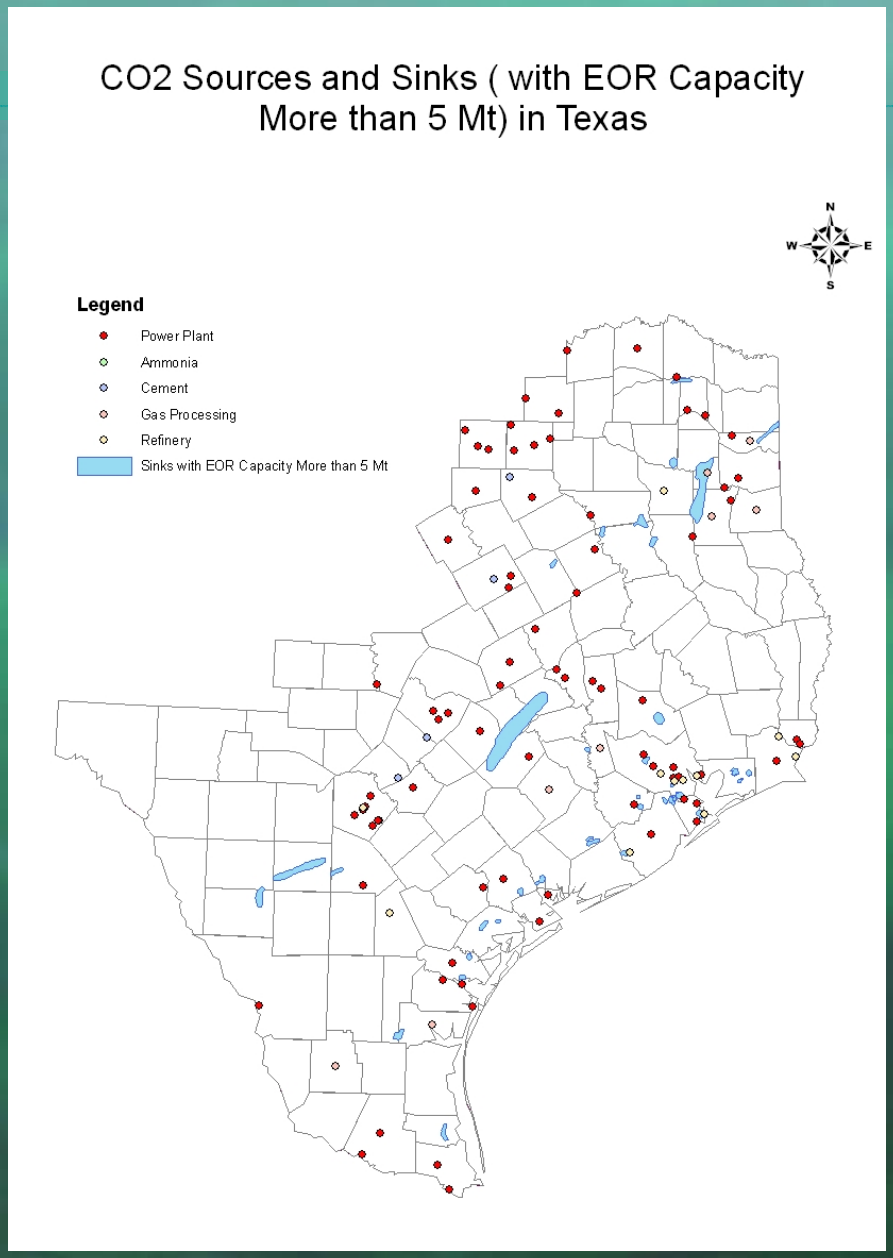
Distance-Based Source-Sink Matching (3)



Texas Study

- For sinks and sources in Texas only
- Least-cost path matching
- Sink capacity constraint is considered
- Transportation obstacle layers are applied
- A cost allocation iteration is used for source-sink matching
- Two stages:
  - CO_2 Sources to EOR Sinks Matching
  - Remaining Sources to Gas Fields and Aquifers Matching

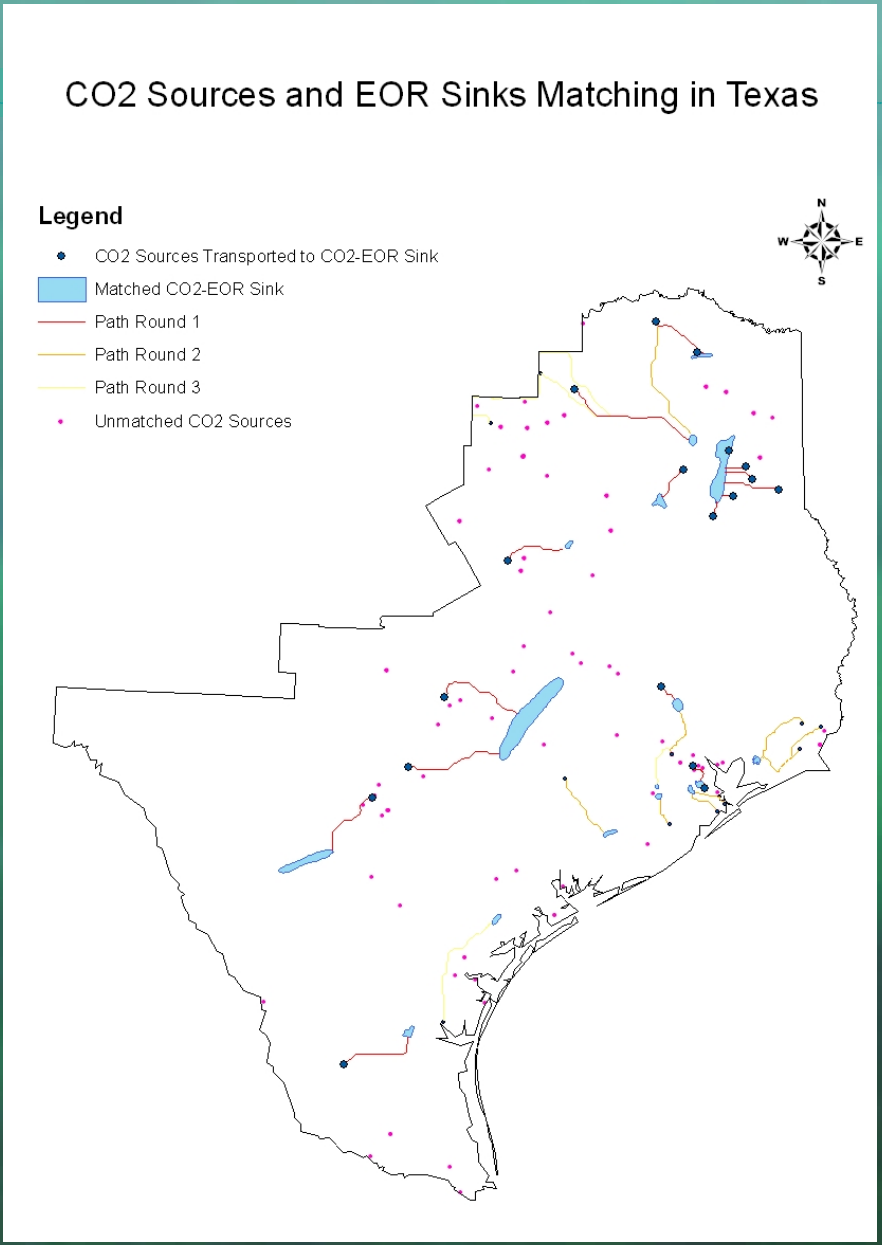
Sources & Sinks in Matching (Stage 1)



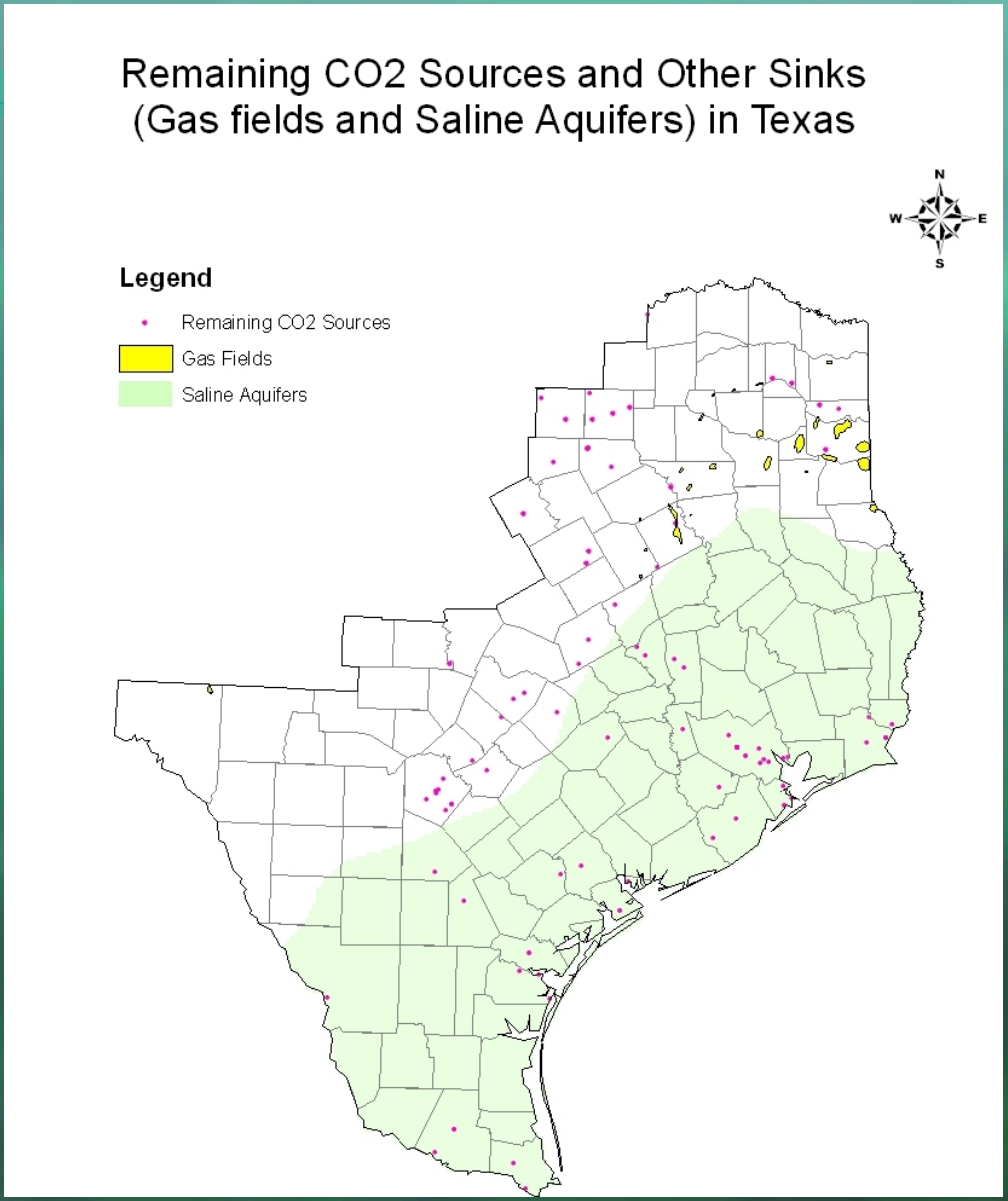
- 130 Sources (25-year emission: 8.9 Gt)
- 37 Sinks with EOR storage capacity greater than 5 million tons (Capacity: 1.5 Gt)

Application

- Stage 1 Results
  - 32 Sources Matched
  - 98 Remaining Sources

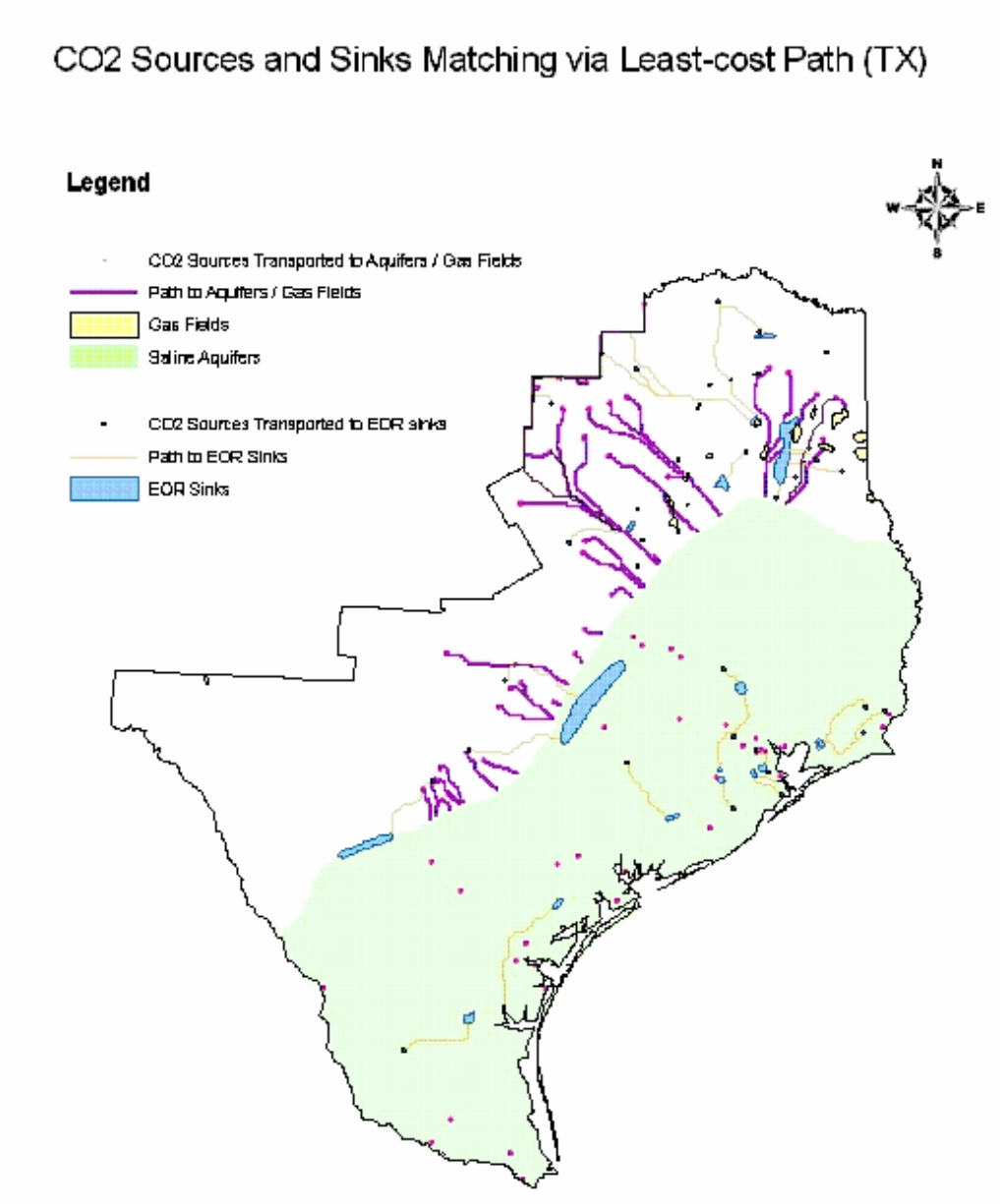


Sources & Sinks in Matching (Stage 2)

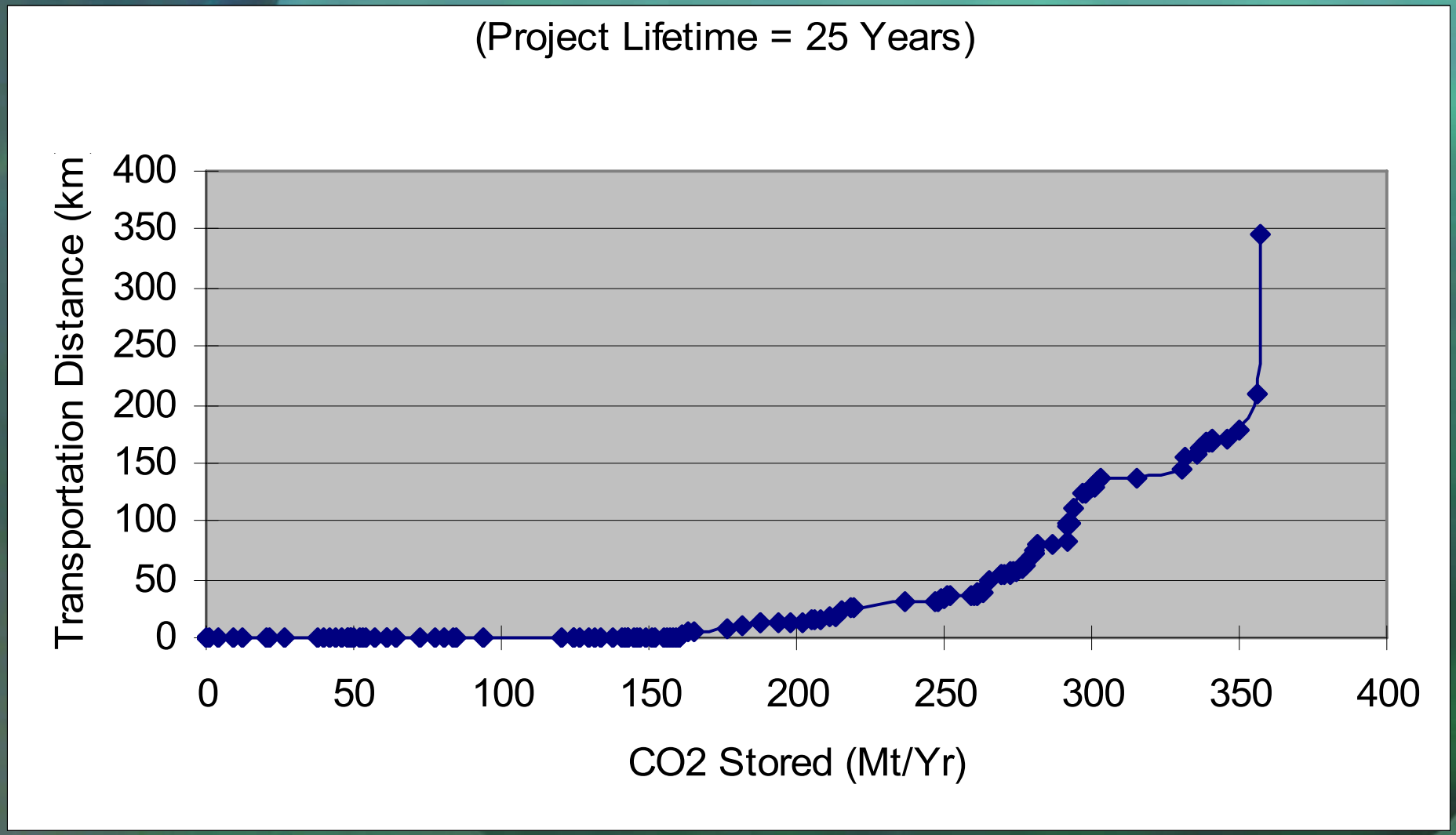


- 98 Remaining Sources
- Sinks: Gas Fields and Saline Aquifers
- Least Cost (Transportation & Injection)

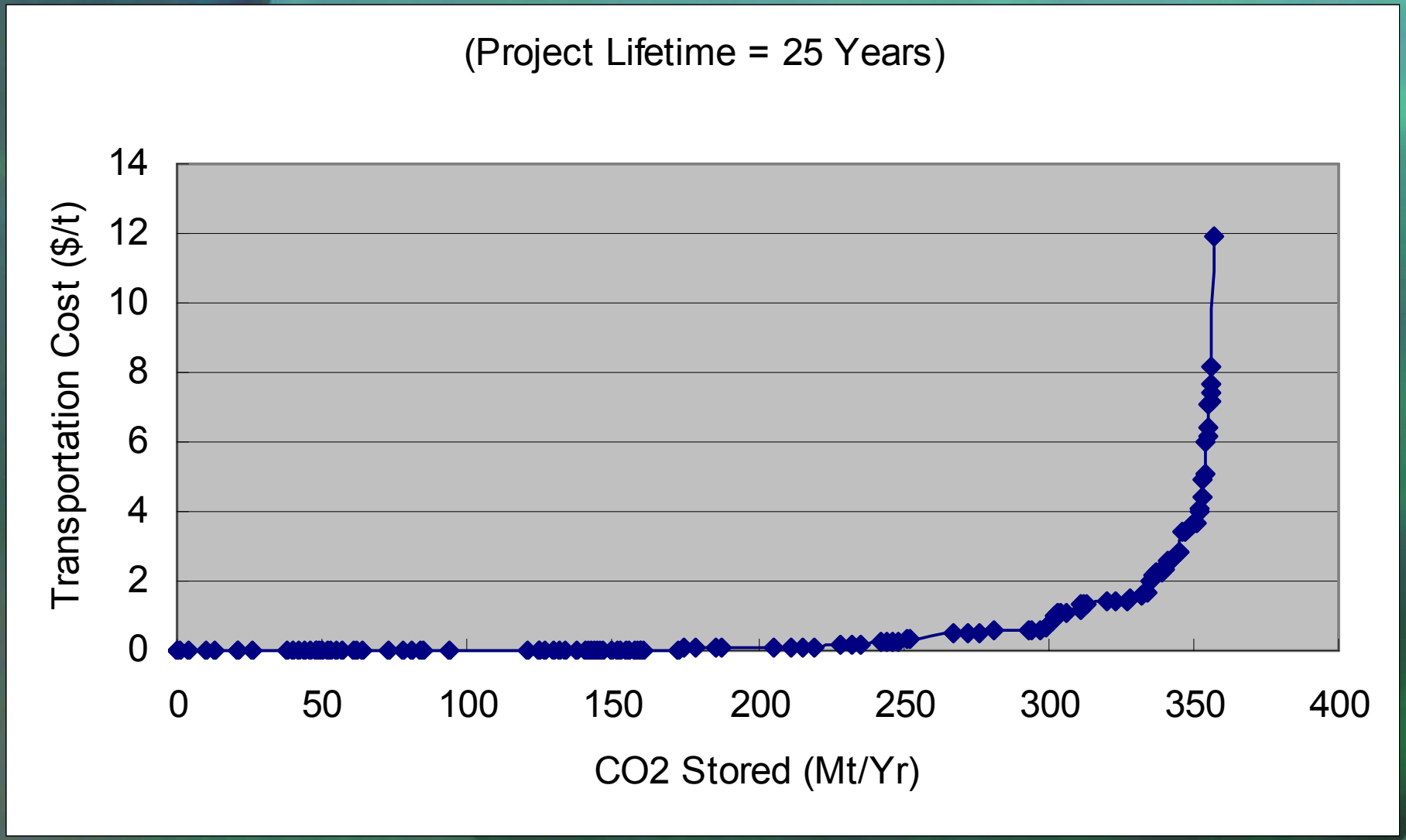
Sources & Sinks Matching
Final Results



Marginal Transportation Distance by Annual CO_2 Storage Rate In Texas, All Sinks

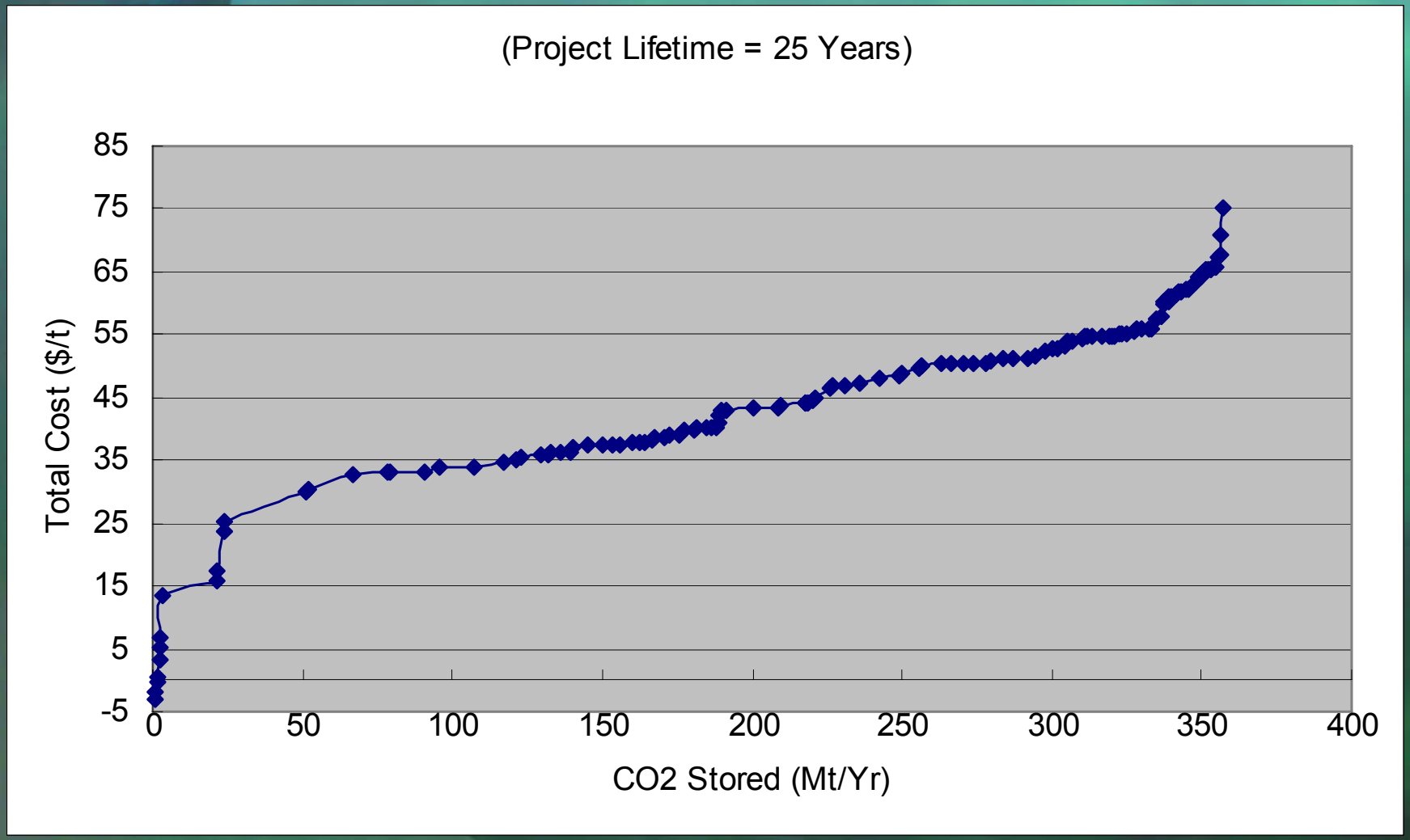


Marginal Transportation Cost by Annual CO_2 Storage Rate In Texas, All Sinks



Supply Curves for Capture and Geologic Storage Assume Present Day Conditions

Texas Marginal Cost by CO_2 Storage Rate



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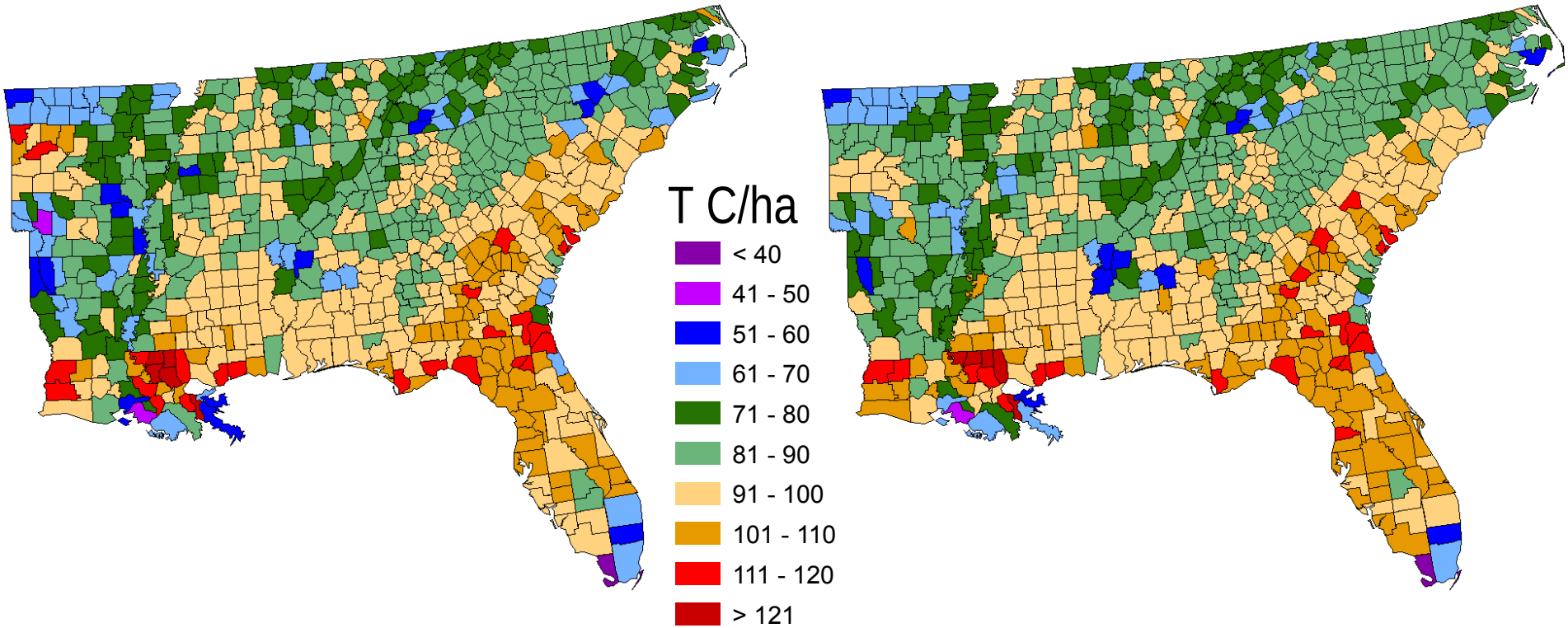
Terrestrial Opportunities

Richard Rhudy, EPRI
John Kadyszewski, Winrock

Potential C Supply (t C per ha) for Afforestation After 40 Yr

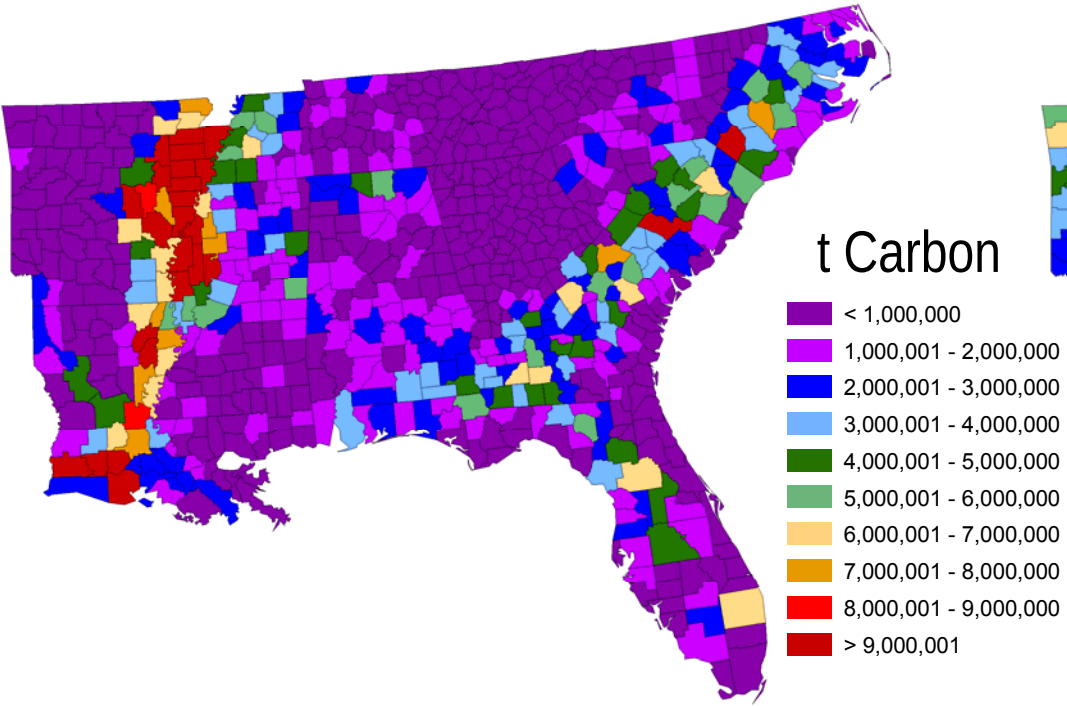
Croplands

Grazing Lands

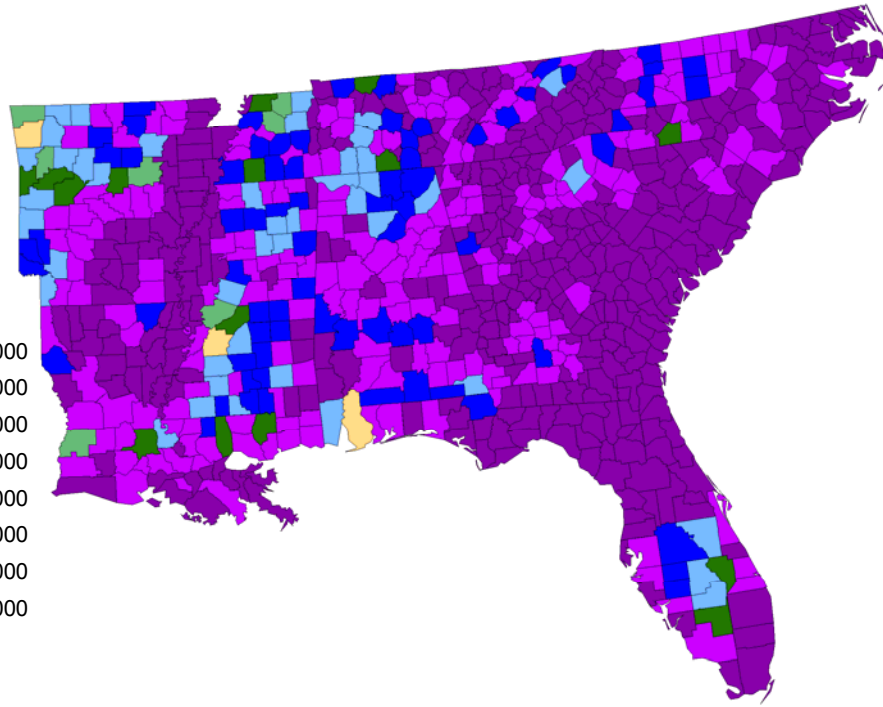


Potential C Supply (t Carbon) for Afforestation After 40 Yr by County

Croplands



Grazing Lands

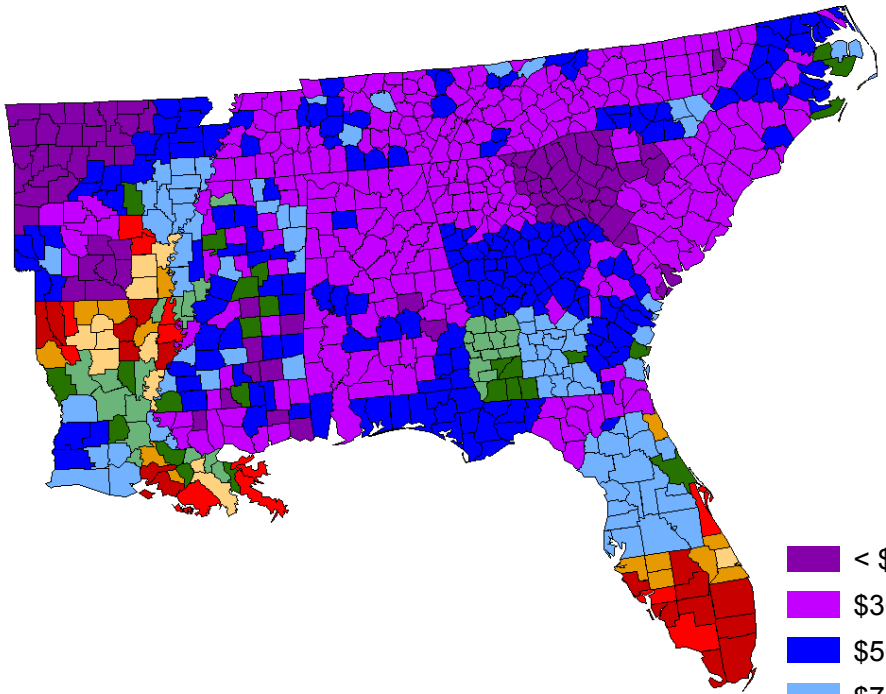


t Carbon

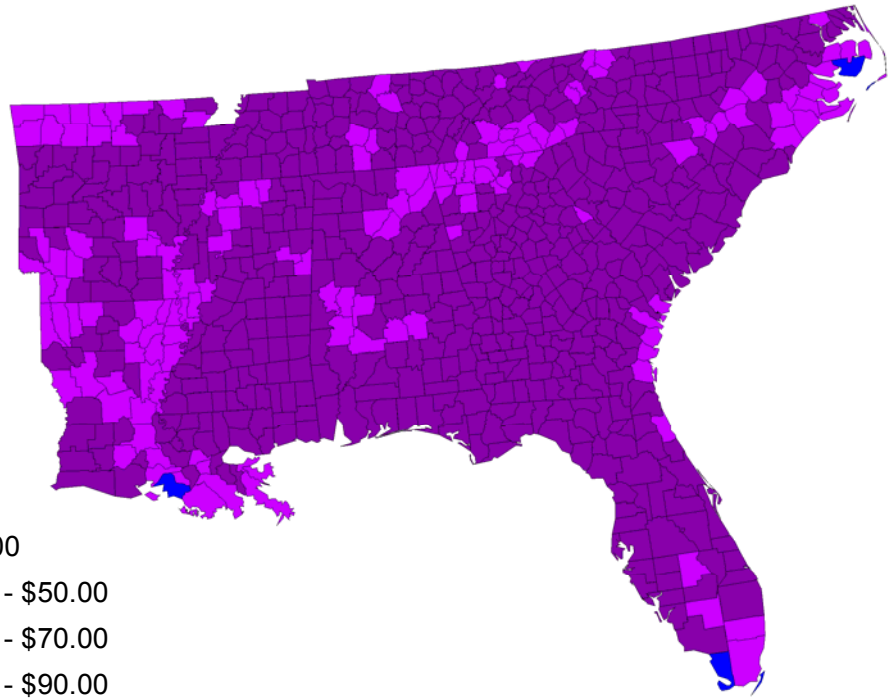
- < 1,000,000
- 1,000,001 - 2,000,000
- 2,000,001 - 3,000,000
- 3,000,001 - 4,000,000
- 4,000,001 - 5,000,000
- 5,000,001 - 6,000,000
- 6,000,001 - 7,000,000
- 7,000,001 - 8,000,000
- 8,000,001 - 9,000,000
- > 9,000,001

Potential C Supply ($/t C) for Afforestation After 40 Yr

Croplands



Grazing Lands



- < $30.00
- $30.01 - $50.00
- $50.01 - $70.00
- $70.01 - $90.00
- $90.01 - $110.00
- $110.01 - $130.00
- $130.01 - $150.00
- $150.01 - $170.00
- $170.01 - $190.00
- > $190.01

Divide $/t C by 3.67 to get $/t CO_2 equiv

Potential Terrestrial Carbon Supply Through Land Use Management

Activity	Quantity of C—million metric tons CO_2			Area available—million acres		
	20 years	40 years	80 years	20 years	40 years	80 years
Crop lands—Afforestation						
≤$2.40/metric tons CO_2	0	5	15	0	0.04	0.1
≤$10/metric tons CO_2	203	1,128	1,423	2.3	7.7	7.9
≤$20/metric tons CO_2	1,613	3,881	4,785	19.3	28.0	28.6
≤$35/metric tons CO_2	2,480	4,889	6,222	31.1	36.5	38.1
Grazing lands—Afforestation						
≤$2.40/metric tons CO_2	0	0	0	0	0	0
≤$10/metric tons CO_2	1,379	3,277	4,310	16.0	24.4	26.9
≤$20/metric tons CO_2	1,817	3,485	4,357	24.2	27.3	27.3
≤$35/metric tons CO_2	1,901	3,488	4,357	27.3	27.3	27.3

Activity	Quantity of C—million metric tons CO_2			Area available—million acres		
	5 year extension	10 year extension	20 year extension	5 year extension	10 year extension	20 year extension
Forest lands—Rotation Extension						
≤$2.40/metric tons CO_2	0	0	0	0	0	0
≤$10/metric tons CO_2	0	0	0	0	0	0
≤$20/metric tons CO_2	6.20	3.68	4.69	0.863	0.043	0.014
≤$35/metric tons CO_2	20.44	12.34	9.11	4.3	1.0	0.3

Regional Carbon Sequestration Partnerships Review Meeting

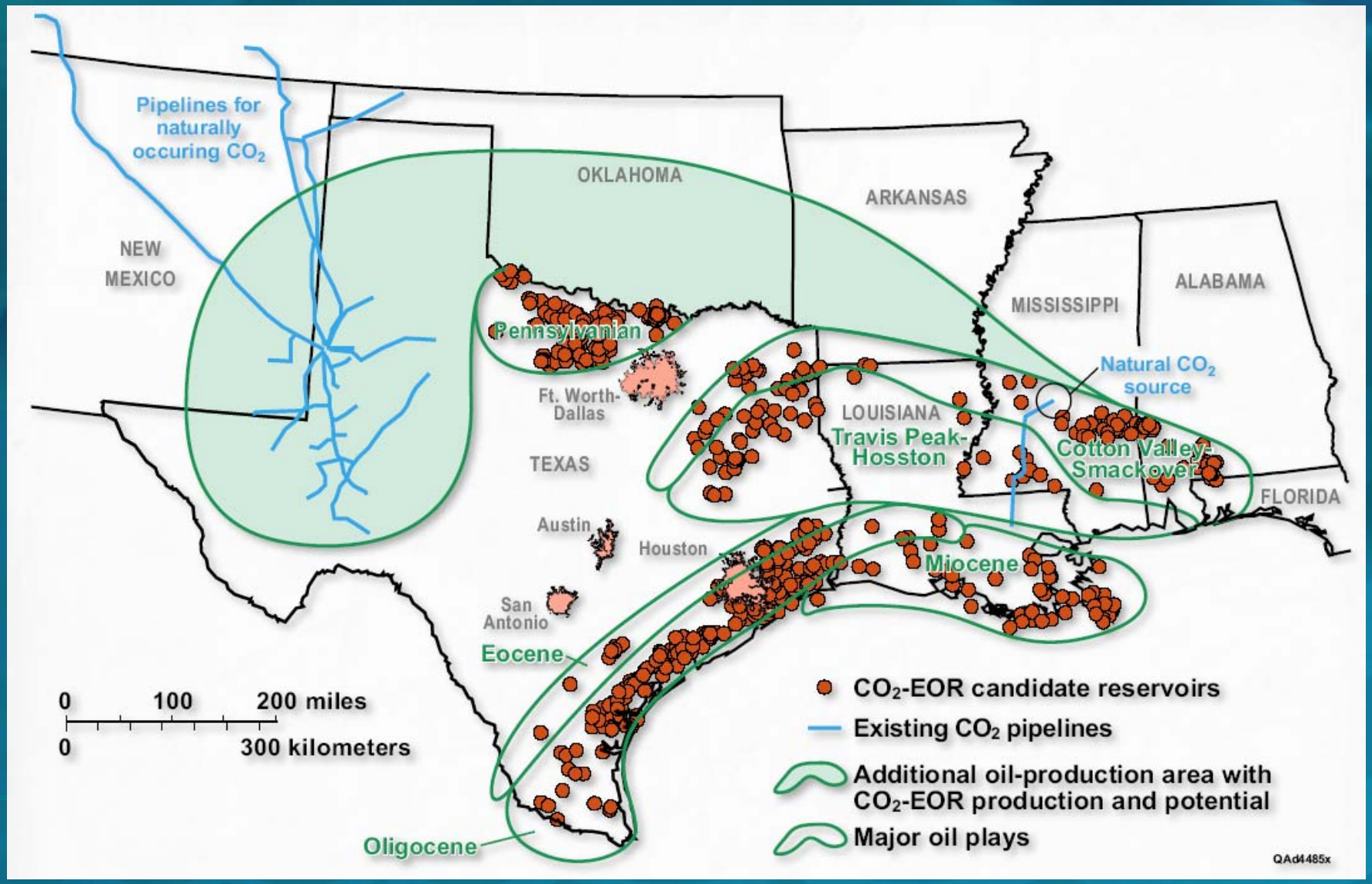
Geologic Characterization

Susan Hovorka, Gulf Coast Carbon Center, TX-BEG

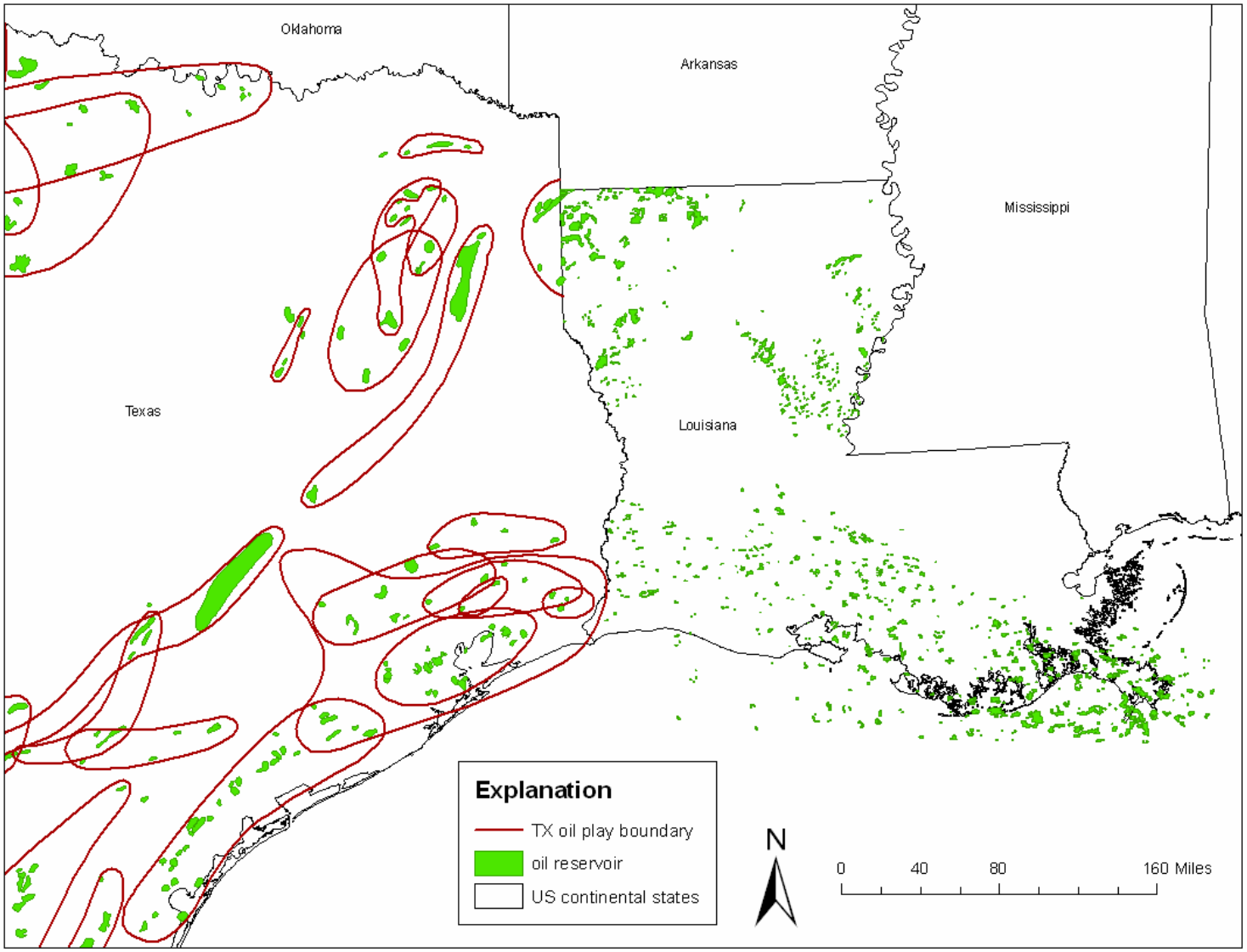
Outline

- **Reservoir Assessment**
- **Brine Formation Assessment**
  - Atlantic Coast
  - No-go Areas
  - Gulf Coast
  - Other Areas
- **Other Gulf Coast Carbon Center Activities**

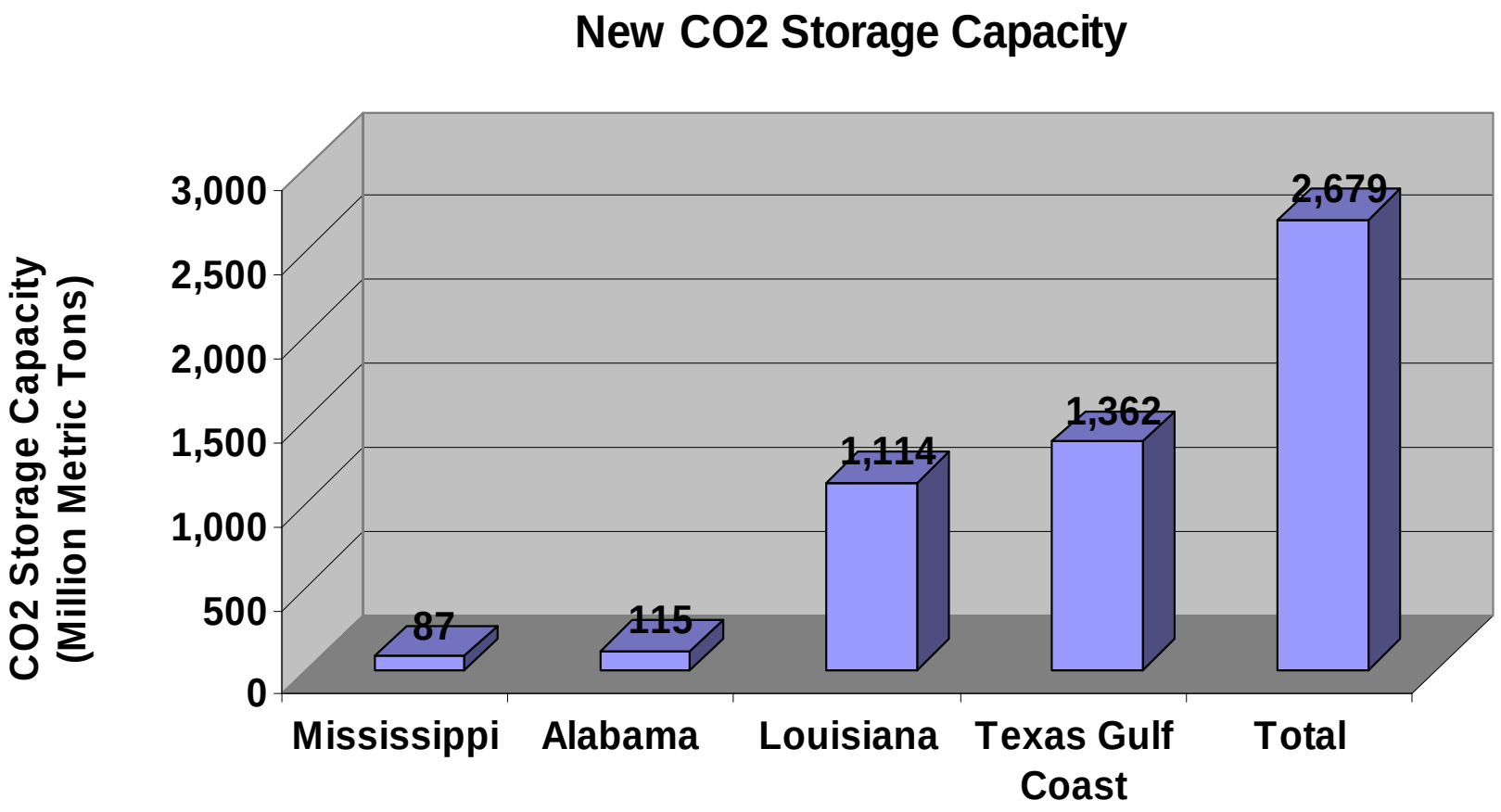
Overview of Gulf Coast Reservoirs



GIS Data Sample - Reservoirs



Storage Capacity Associated with CO_2 EOR



CO_2 Utilization

CO2 EORP = NCO2 (UCO2T – UCO2R)

where OOIP = Original oil in place (MSTB)

Np = Cumulative oil production (MSTB)

Rps = primary + secondary recovery

NCO2 = Cumulative CO2 EOR target

RCO2 = Ultimate recovery factor from CO2 EOR (% of OOIP)

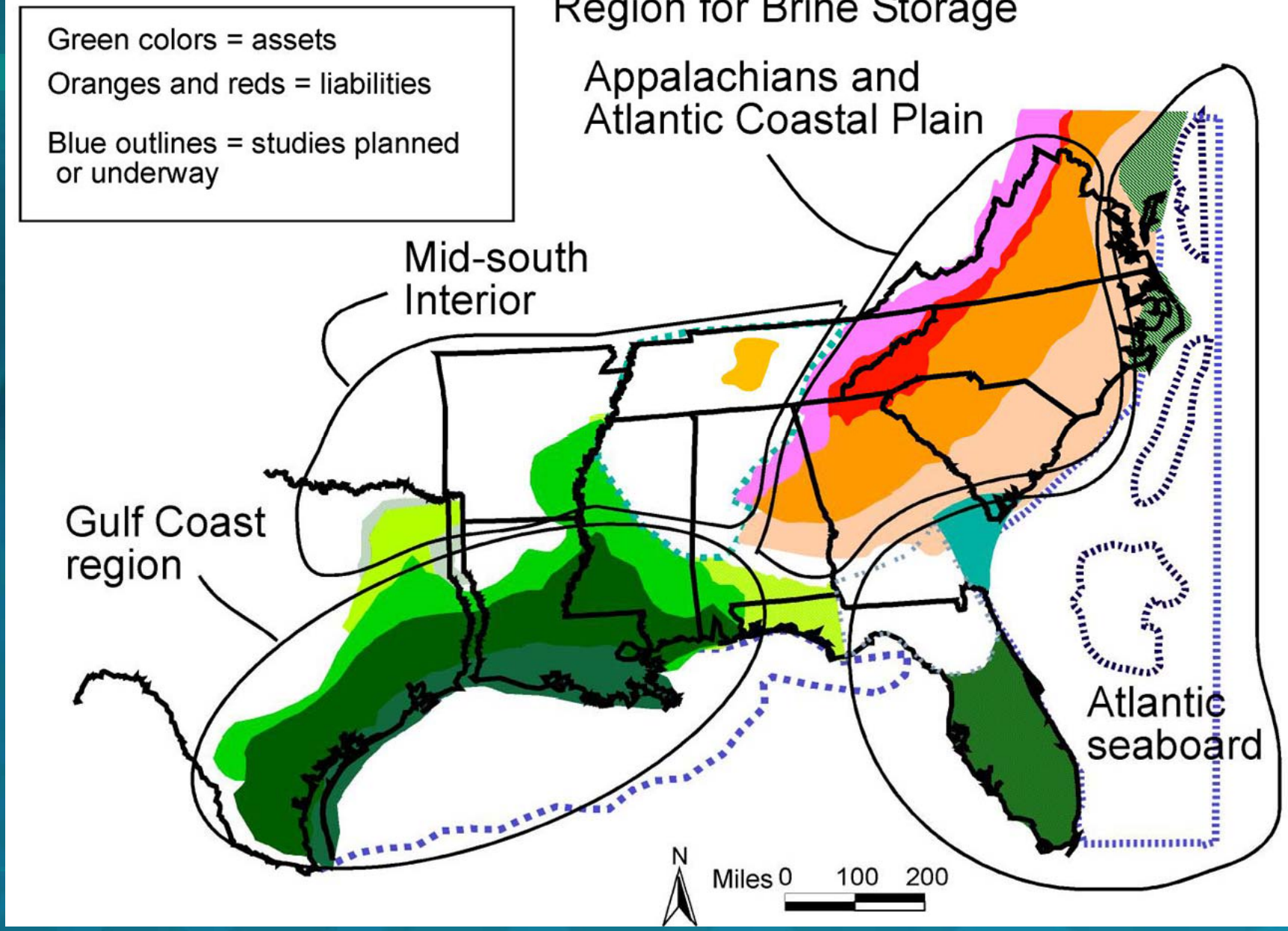
UCO2T = Total CO2 utilization (MSCF/STB)

UCO2R = CO2 utilization recycled (MSCF/STB)

CO2 EORP = Net CO2 used in EOR project

For Gulf Coast high-permeability sandstone reservoirs, the gross utilization rate was set at 4.5 MSCF/STB and the recycle rate at 2 MSCF/STB

Status of Assessment of the SeCarb Region for Brine Storage



Explanation

Cretaceous brine storage target areas

- Palauxy Formation
- Woodbine Formation
- Tuscaloosa Formation
- Cape Fear Formation
- lower Potomac Formation

Cretaceous targets ar inland and below Tertialy aquifers They have good permability, good seals, and moderatecapacity. Paluxy, Woodbine, Tuscaloosa oil producers. Cretaceous units on the eastern seaboard become sufficantly deep and saline to have potential to serve as storage units

Tertiary Gulf Coast sandstone targets

- Frio Formation, Miocene, younger units
- Middle Tertiary
- Lower Tertiary

Excellent capacity via many stacked high porosity, high permeability sandstones. In detail the units are straigraphically and structural complex. Numerous shale seals. Abundant hydrocarbon reservoirs

Storage offshore Gulf of Mexico - to be assessed

Paleozoic units

- Pottsville Formation

modest capacity
shale and limestone seals

- Lower Paleozoic units to be assessed

Cretaceous carbonates, anhydrite seal

- Ceder Keys Formation
- Upper Paleozoic-Lower Cretacous targest to be assessed

Poor quality/high risk areas

- Blue Ridge
- Piedmont

Metamorphic and intrusive terraines: no capacity below fresh water aquifers; no seal

- Atlantic Coastal Plain:

Little or no capacity below fresh water aquifers, inadiquate depth to basement

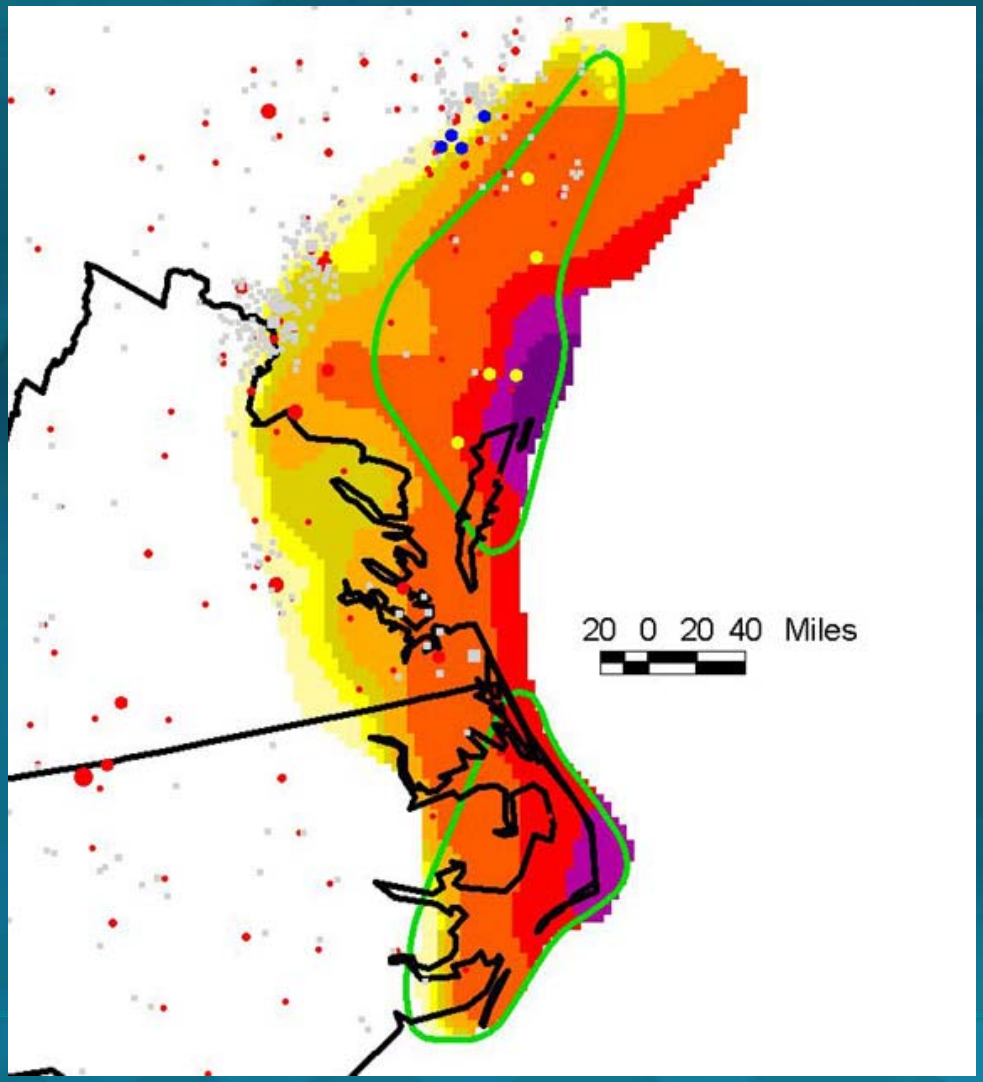
Limited capacity

- Valley and Ridge province - structurally complex, may have capacity; local area-site-specific information needed
- Nashville Dome: thin sedimentary cover, minimal capacity

Targets for East Coast sources?

Offshore Atlantic Basins, capacity for storage to be assessed

Detail Study Eastern Seaboard Options: Lower Potomac Formation Thickness and Salinity



These trends encourage us to explore for geologic storage options on the continental shelf of the eastern US.

Formation thickness (m)

- 1000-750
- 750-500
- 500-200
- 200-100
- 100-50
- 50-10
- <10

Estimated, May be imprecise

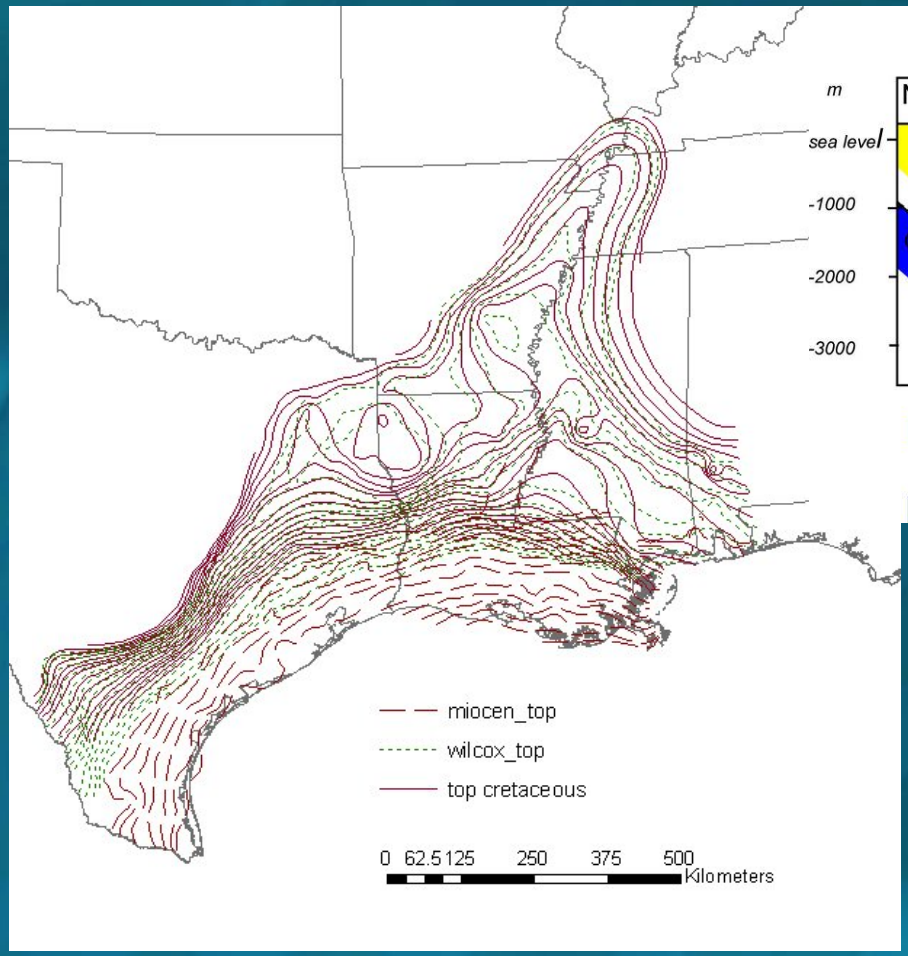
Power plant

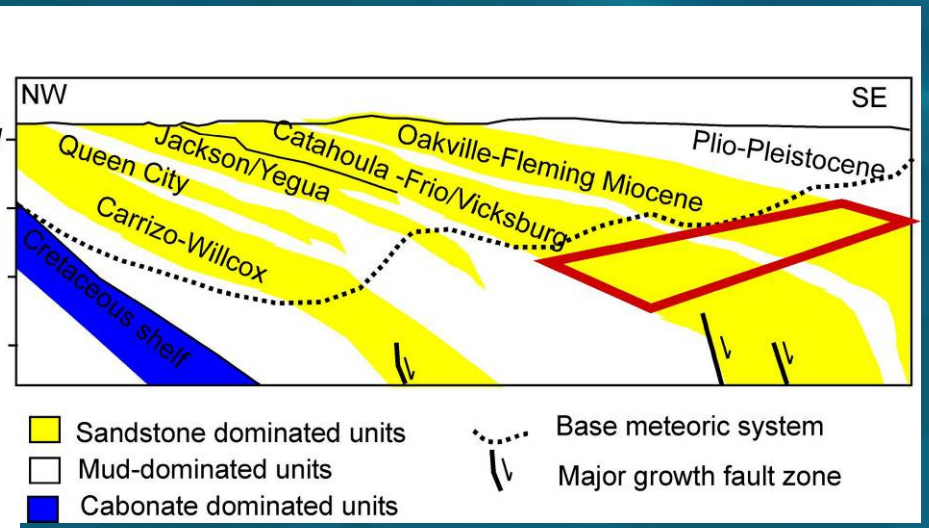
Adequate depth

Fresh

Saline

Gulf Coast Wedge





Very large capacity in numerous high injectivity sandstones, clay seals, fault bounded compartments, exceptionally well known

Frio Test – CO_2 Storage in Brine

- CO_2 introduced into well-characterized relatively homogenous high permeability sandstone system
- Vigorous public/industry outreach favorable response
- Saturation and transport properties measured horizontally, vertically, and through time using multiple tools
- Improved model conceptual and numerical inputs
- Make results available to field projects planned by regional sequestration partnerships and to Carbon Sequestration Leadership Forum projects

Invitation to participate in Frio 2

Gulf Coast Carbon Center

Mission: ***A global leadership position in economic implementation of large scale greenhouse gas sequestration.***

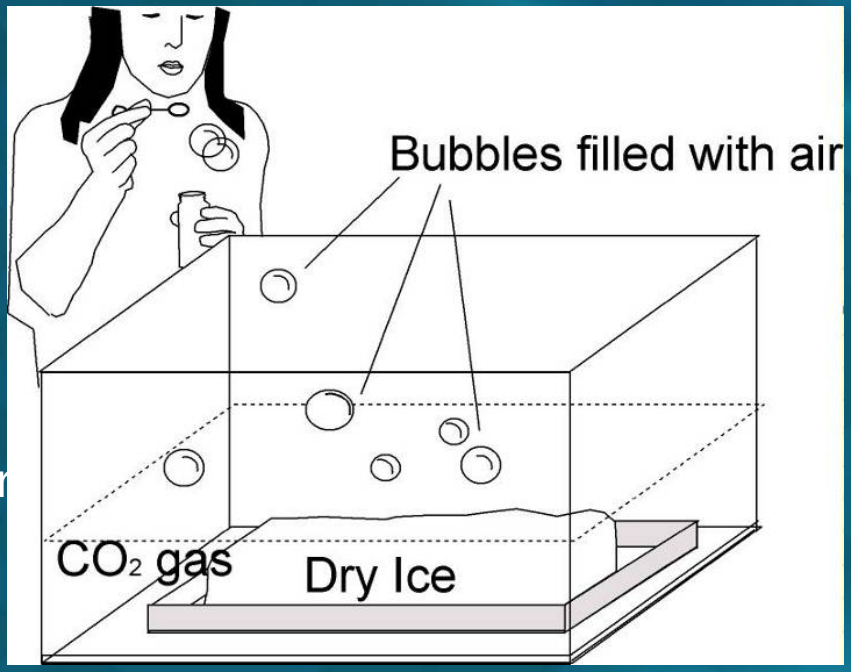
GCCC Team

Ian Duncan, Bill Ambrose, Susan Hovorka, Mark H. Holtz, Shinchi Sakurai, Joseph Yeh, Khaled Foaud, Jeff Paine, Becky Smyth, Cari Breton
Mike Moore, Falcon Environmental; Michelle Foss, Center for Energy Economics

Sponsors

Outreach Activities

- **Publications: 12 papers, 23 abstracts, web resources: www.gulfcoastcarbon.org**
- **Press: interviews and articles in newspapers, radio and TV**
- **Public and K-12 education: web resource, workshops and dem**
- **Texas FutureGen support**
- **Workshops**
  - Opportunities and Issues in carbon markets (5/05)
  - GHG Breakthrough Briefing (10/04)
  - Site visits



Regional Carbon Sequestration Partnerships Review Meeting

Public Involvement, Education and Acceptance

Patrick R. Esposito, Sr.

Augusta Systems, Inc.

SECARB

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NETL

SSEB

Stakeholder Prioritization

- **Determined relevant stakeholders to be:**
  - Elected Officials
  - Environmental NGOs
  - General Public
  - Industry Leaders
  - News Media
  - Regulators/Gov. Reps.

Message Development

- **Opinion research yielded stakeholder concerns:**
  - Clarity regarding coordination
  - Credibility of those delivering message
  - Sufficient communication of benefits of carbon sequestration
  - Carbon sequestration as a competitor to other climate change mitigation technologies or approaches
  - Involvement of environmental NGOs in the decision making process
  - Communication of sequestration technical aspects
  - Scientific and regulatory uncertainty
  - Cost of sequestration implementation

Outreach Infrastructure

Table 8 – Applicability of Outreach Methods to Stakeholders

	Elected Officials	Environmental NGOs	Industry Leaders	Regulators	General Public	Media	Custom
Advertising					X		
Briefing papers	X	X	X	X	X	X	X
Brochures					X		
Conference	X	X	X	X	X	X	
Correspondence	X	X	X	X	X	X	X
Fact Sheets	X	X	X	X	X	X	X
Forums	X	X	X	X	X	X	
Maps	X	X	X	X	X	X	
Media Releases						X	
Newsletters	X	X	X	X	X	X	
Presentations	X	X	X	X	X	X	X
Progress Reports	X	X	X	X			
Web logs (Blogs)	X	X	X	X	X	X	
Web sites	X	X	X	X	X	X	

Outreach Infrastructure (cont.)

- **Specific needs to be met through outreach methods:**
  - Educate environmental NGOs on technical matters in general and on field site-specific technical details through, possibly, briefings and conferences
  - Educate industry on opportunities for utilization of carbon sequestration technologies.
    - *CO-OP, as a platform for collaborative carbon sequestration project development already embraced by SECARB, would be a useful tool for engaging industry on this front*

Regulatory, Permitting and Accounting Frameworks

Phase I

- **Completed initial assessment of regulatory, safety, and permitting frameworks applicable for SECARB region focused on:**
  - Geologic sequestration options
  - Terrestrial sequestration options
- **Finalized initial monitoring of state, local, national and multinational working groups focused on accounting frameworks**
  - 1605(b) Program
  - GHG Protocol
  - State and other programs

Action Plan

- **Completed planning and outlining of regulatory, permitting, safety, and accounting framework action plans based upon findings of:**
  - SECARB Regulatory, Permitting and Safety Frameworks Assessment
  - SECARB Accounting Frameworks Assessment

Action Plan Highlights

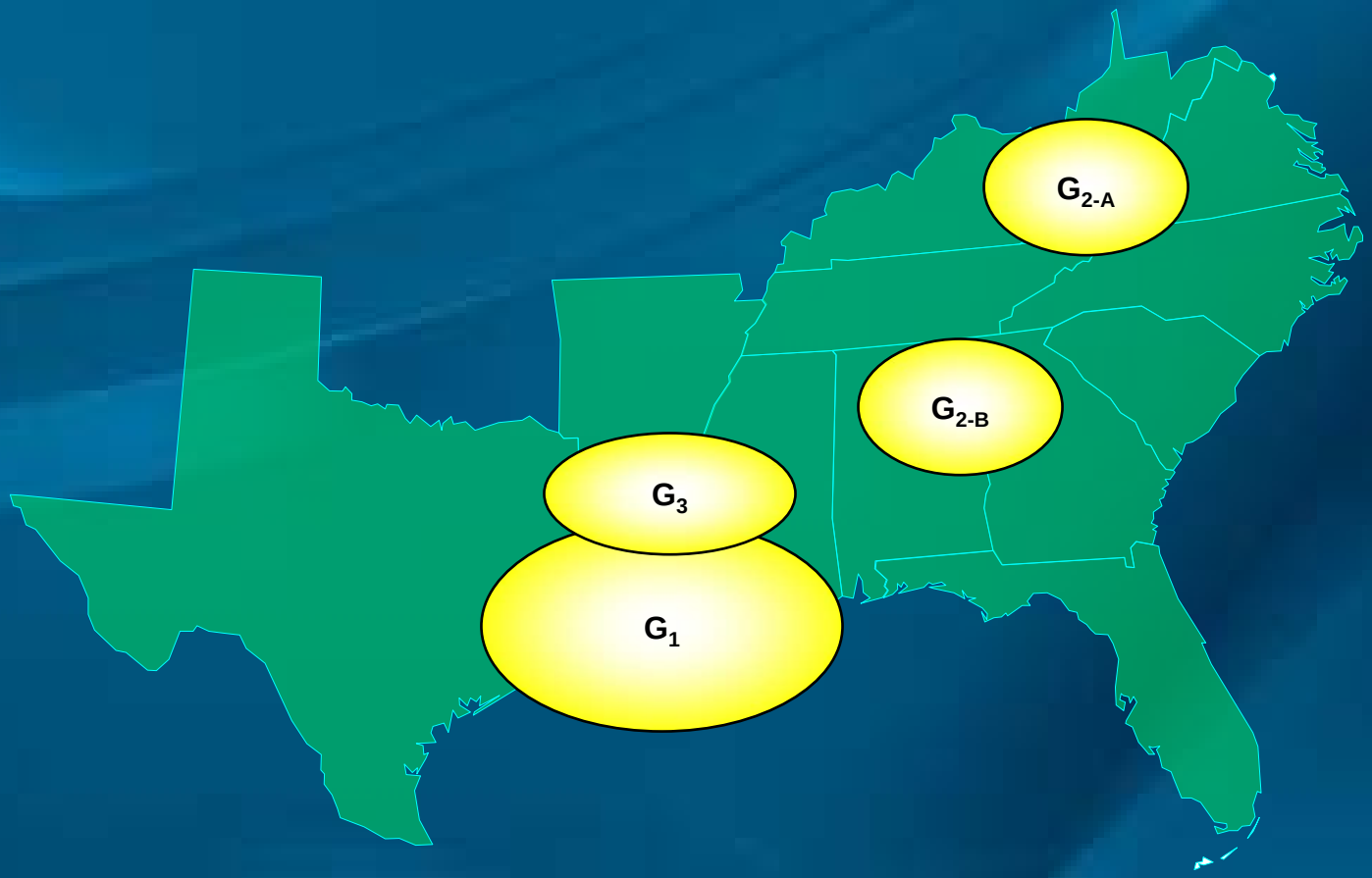
- Form SECARB Regulatory, Safety, Permitting and Accounting Frameworks Working Group (to build consensus on 11 key issues)
- Continue Assessment of Changing Landscape on Regulatory, Safety, Permitting and Accounting Matters

Action Plan Highlights

- Assist the SECARB Field Project Teams with NEPA, EIS, and other Filings
- Facilitate Outreach on the Findings of the Regulatory, Safety, Permitting, and Accounting Frameworks Working Group and SECARB Field Projects
- Publish the SECARB Model Guidance for Sequestration Regulatory, Safety, Permitting, and Accounting Frameworks

Phase II Field Tests

SECARB Region & Field Test Site Locations



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VHFDUE#Skdvh#L

Field Test G-1

- **Gulf Coast Project**
  - Management: Gulf Coast Carbon Center
  - Focus: Oil and gas reservoirs, brine formations
  - Demo: advanced methods of CO_2 injection and monitoring for enhanced oil recovery and long-term geologic storage

VHFDUE#Skdvh#L

Field Test G-2A & G-2B

- **Coal Seam Project**
  - Management: Center for Coal and Energy Research of Virginia Tech
  - Focus: Coal seams with high methane content and unminable coal seam
  - Demo: CO_2 injection for enhanced coal bed methane recovery

VHFDUE#Skdvh#L

Field Test G-3

- **Test Center Project**
  - Management: Electric Power Research Institute (EPRI)
  - Focus: locating suitable geologic sequestration sinks in proximity to large coal-fired power plants
  - Demo: investigate the geologic formations in proximity to EPRI's proposed Test Centers

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