



# Basin Oriented Strategy for Deployment of CO<sub>2</sub> Enhanced Coalbed Methane Recovery in the Black Warrior Basin, Alabama

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# Study Objective



## Basin Oriented Strategy for Enhanced Coalbed Methane Recovery and Associated CO<sub>2</sub> Storage in the Black Warrior Basin, Alabama

Prepared for:  
U.S. Department of Energy-NETL Southeast Regional Carbon Utilization & Storage Partnership: SECARB-USA

Southern States Energy Board

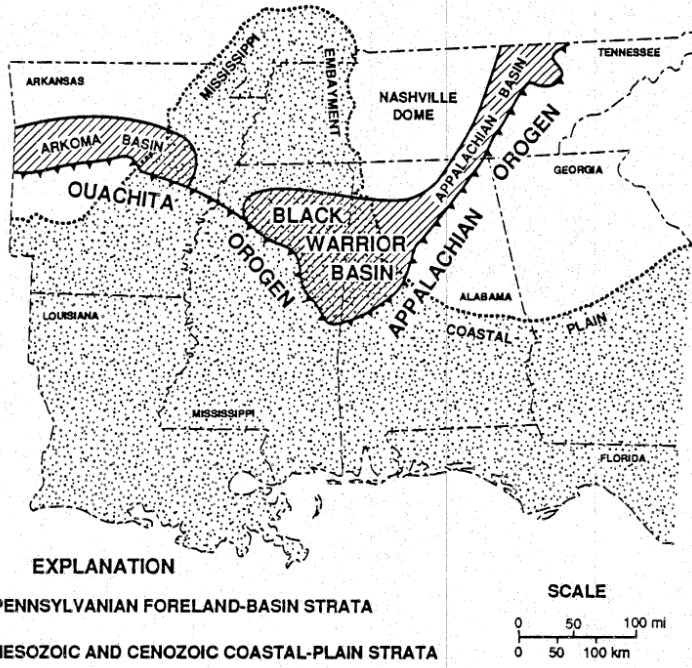
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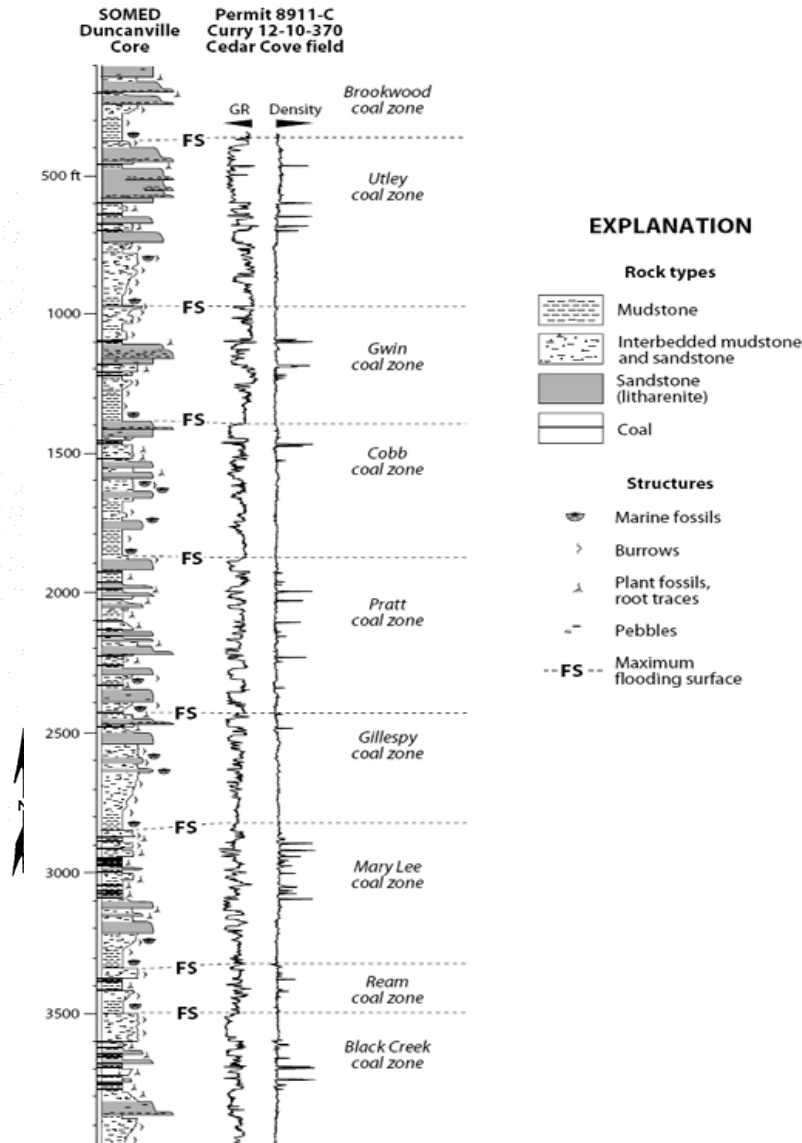


- DOE/NETL Supported work through the SECARB initiative to explore opportunities for decarbonization in the southeastern US
- Coalfields of the Black Warrior Basin have been previously evaluated for CO<sub>2</sub>-ECBM potential
- This update provides the current status and technical potential of ECBM deployment in the basin through a field-by-field approach to high grade opportunities

# Black Warrior Basin CBM: Basin Overview



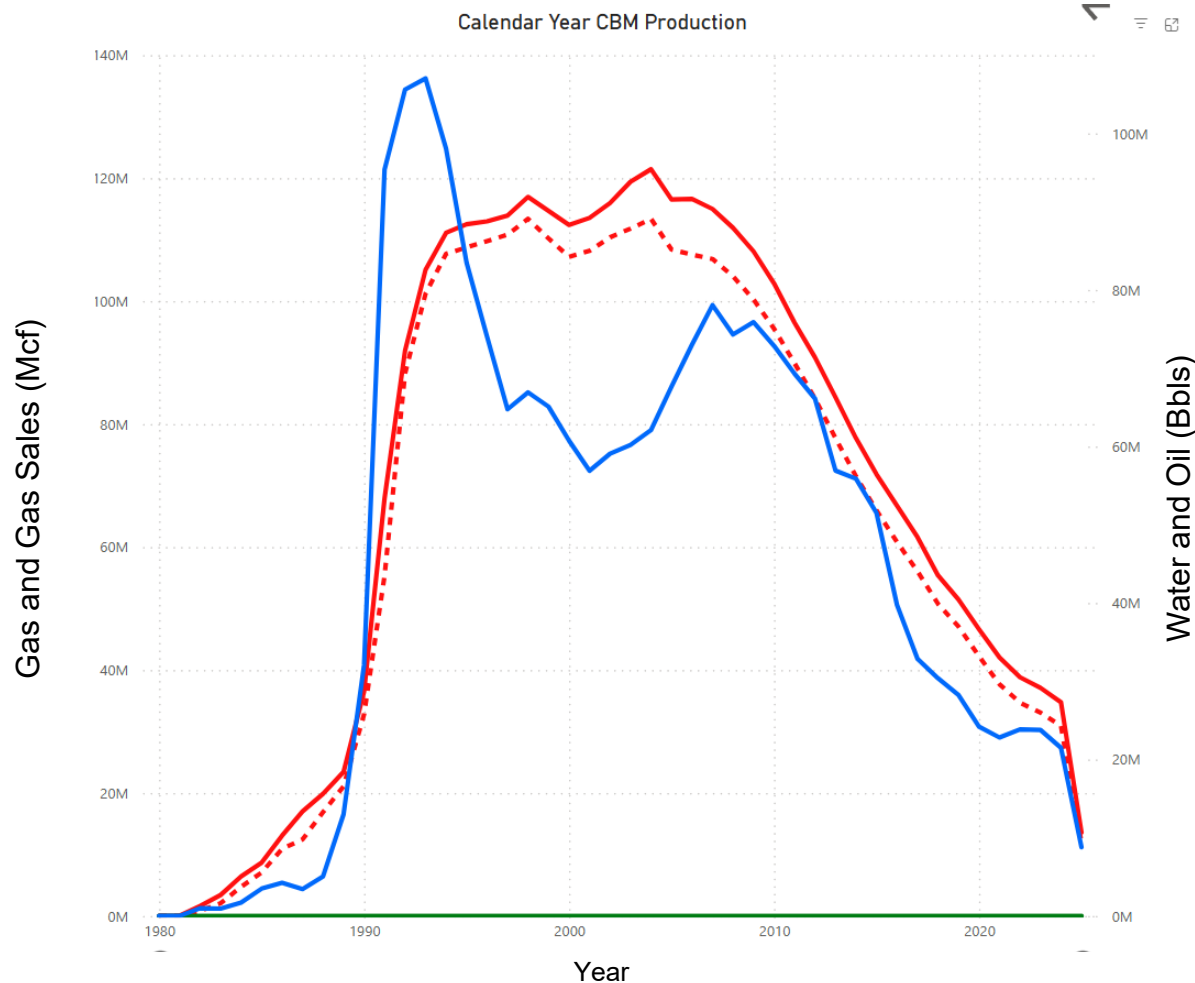
Source: Pashin et al., 2004



- Foreland basin within north-central Alabama and Mississippi
- Widely recognized as the birthplace of the modern coalbed methane industry with production beginning in the early 1980s from 19 fields
- Coalbed methane is produced primarily from 3 Pennsylvanian-aged coal seams: the Pratt, Mary Lee, and Black Creek zones

# Black Warrior Basin CBM: Current Situation

The Black Warrior Basin is one of the premier coalbed methane producing areas in the world with an estimated 10-20 TCF of original gas in place.

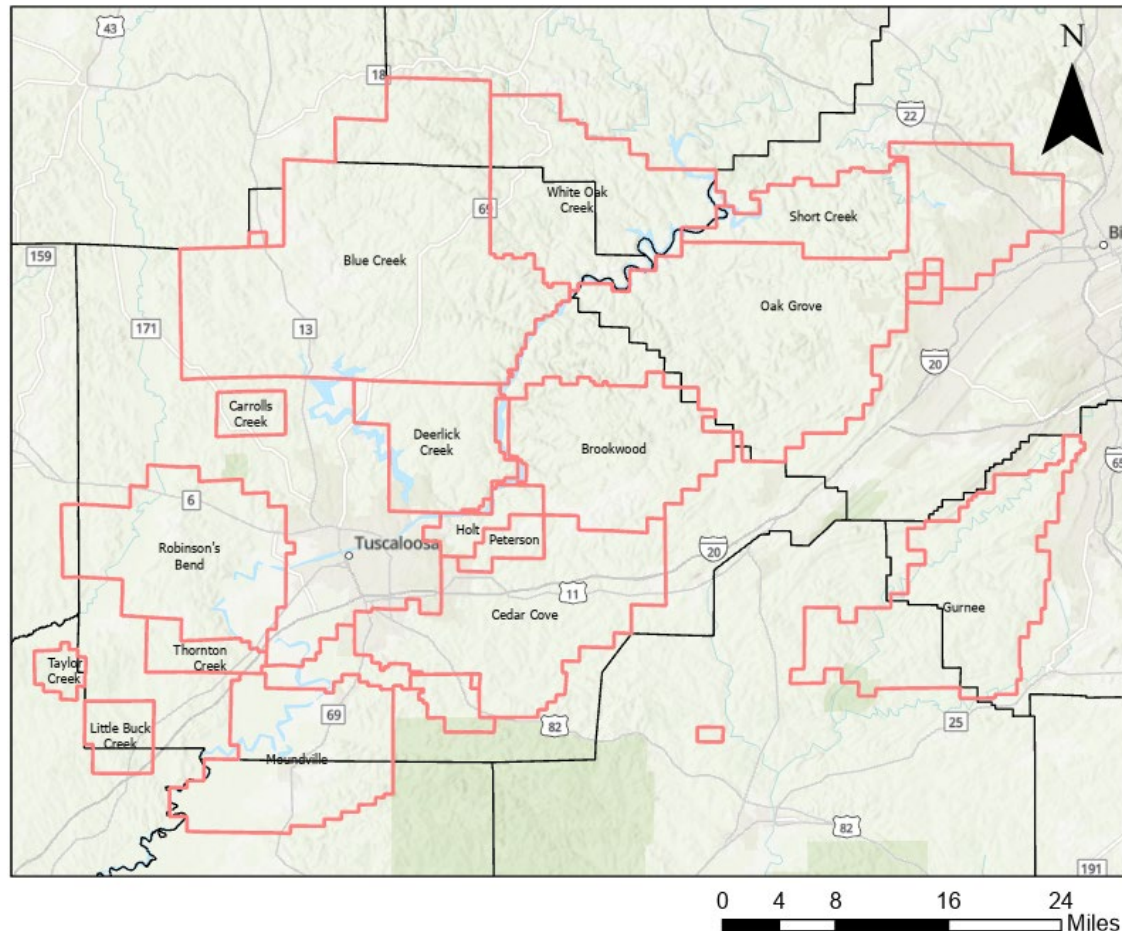


- Cumulative methane production to date of approximately 3 TCF
- Annual production has declined 72% from peak in 2004, from 120 to 34 BCF as of YE2024.
- Based on estimates of technically recoverable gas, an additional 1.4 to 3.7 TCF of recoverable gas remains to be extracted from the basin.

# Black Warrior Basin CBM: The Opportunity

Goal: conduct a field-by-field assessment of technical feasibility for deployment of CO<sub>2</sub>-Enhanced CBM recovery for the 19 CBM fields in the Black Warrior Basin.

Black Warrior Basin CBM Fields



## Project Objectives:

- Identify CBM fields amenable to CO<sub>2</sub>-ECBM deployment
- Quantify the incremental gas production and associated CO<sub>2</sub> storage to be achieved from each favorable field
- Develop a methodology that can be applied in future assessments of other coal basins

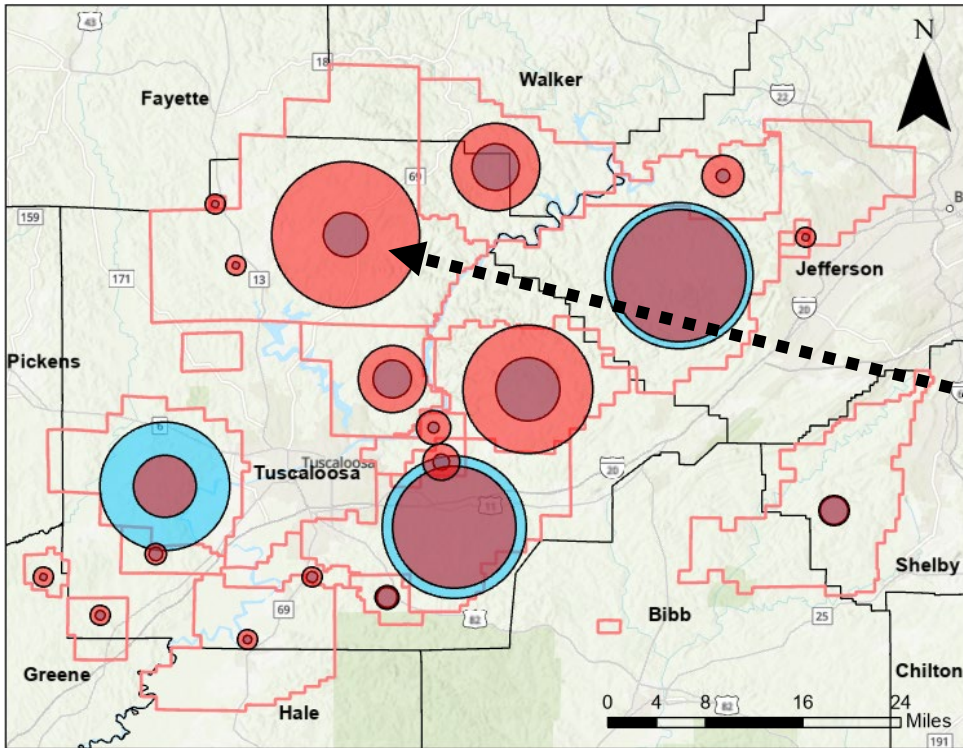
# Assessment Methodology

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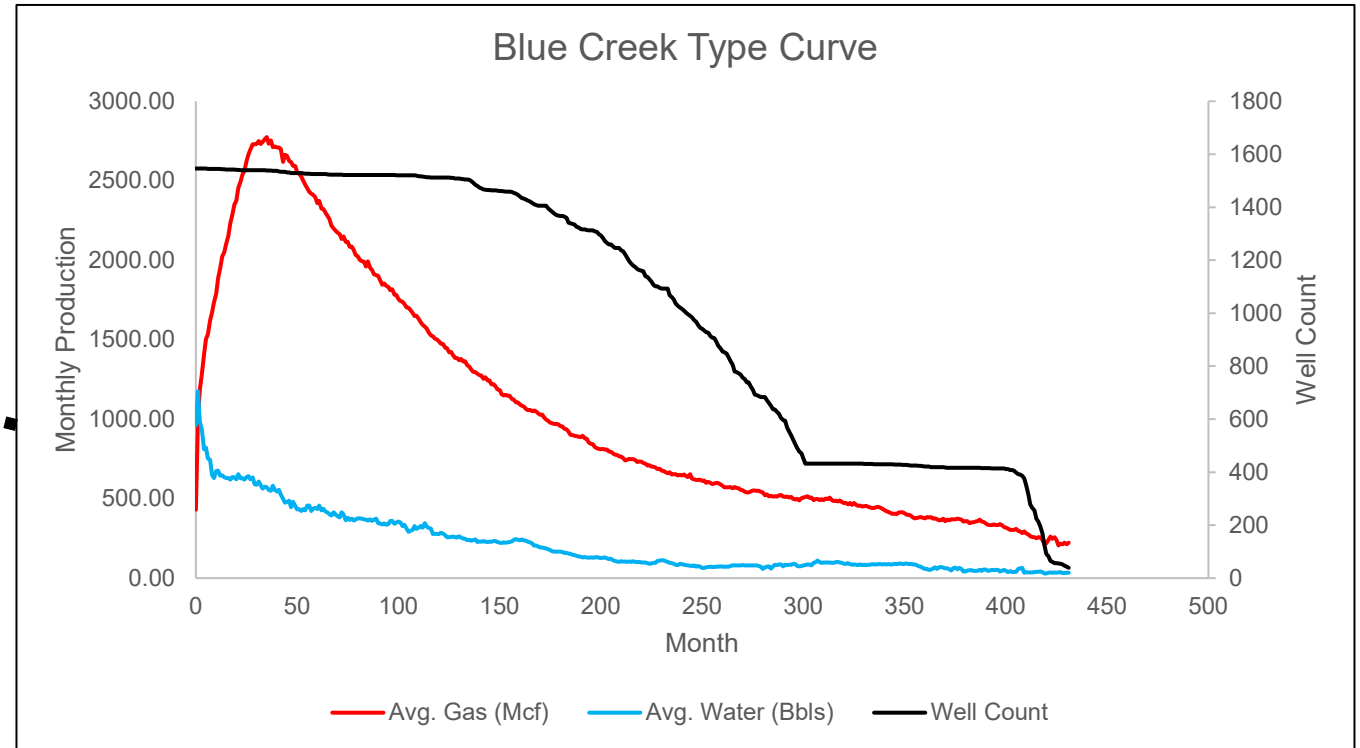
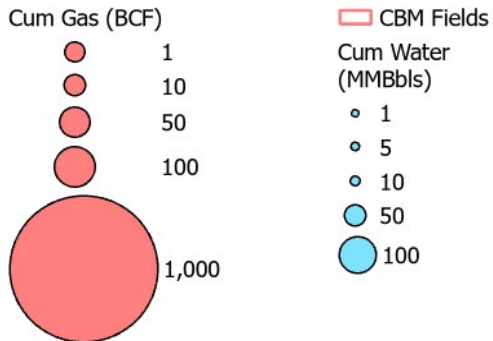
The following workflow was used to conduct the evaluation of CO<sub>2</sub>-ECBM potential in the Black Warrior Basin:

1. Establish cumulative gas and water production from each field in the basin
2. Generate time-zero type curves for each field to represent average well production within each field
3. Screen fields to determine those favorable for including in modeling workflow
4. Construct and initialize quarter 5-spot model for each field using reservoir parameters available from published data
5. History match production data
6. Run CO<sub>2</sub> injection scenarios for quarter 5-spot pattern to determine incremental gas production and CO<sub>2</sub> storage per pattern
7. Upscale pattern results to the field scale to determine incremental gas production and CO<sub>2</sub> storage potential by field.

# Production History Analysis



**Cumulative Production Bubble Map**



- Mapped cumulative gas and water production. Note higher water producing areas to south (dewatering field) and east (proximal to aquifer recharge source).
- Generate type curves for average well in each field. Example above from Blue Creek Field

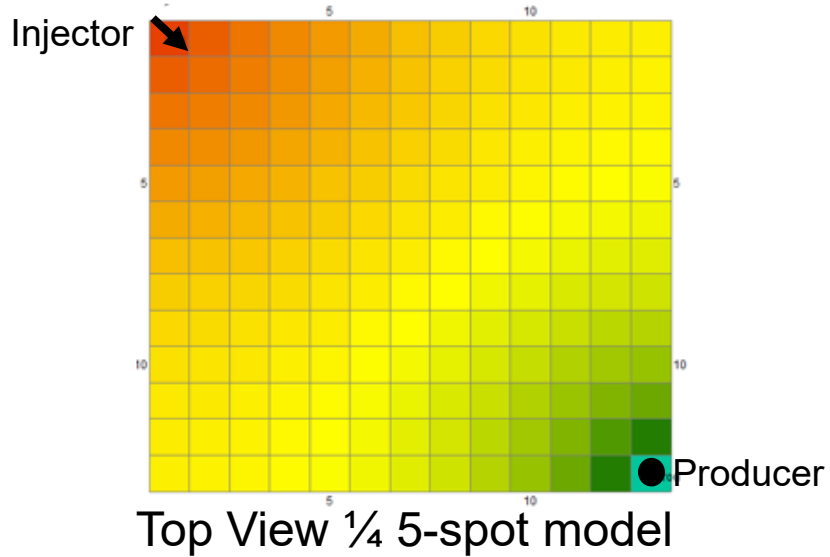
# Field Screening

Field	Productive Area (Ac.)*	Productive Wells	Cum Gas (BCF)	Cum Water (MMBbls)	Included in Assessment
Oak Grove	130,800	1,666	531.5	463.6	Yes
Blue Creek	113,000	1,546	596.0	124.6	Yes
Cedar Cove	60,790	637	482.7	454.5	Yes
Brookwood	59,660	1,286	511.7	189.2	Yes
White Oak	53,780	678	319.7	134.8	Yes
Robinsons Bend	45,980	553	201.4	407.7	No-Dewatering Field
Gurnee (Cahaba)	40,970	558	51.7	68.9	Yes
Deerlick Creek	29,950	460	224.0	105.8	Yes
Short Creek	18,770	235	105.8	22.8	Yes
Moundville	16,600	158	0.4	3.9	No-Dewatering Field
Peterson	6,830	113	79.2	32.5	Yes
Big Sandy Creek	6,190	66	17.3	46.3	No-Dewatering Field
Holt	5,160	81	68.2	15.9	Yes
Thornton Creek	3,080	33	8.2	24.9	No-Dewatering Field
Little Sandy Creek	2,820	47	1.4	13.6	No-Dewatering Field
Taylor Creek	2,790	20	0.1	3.0	No-Too Small
Little Buck Creek	2,340	14	0.3	8.6	No-Too Small
Wolf Creek	660	6	<0.1	0.2	No-Too Small
Boone Creek	330	5	<0.1	0.6	No-Too Small
Pleasant Grove	140	4	0.3	0.2	No-Too Small

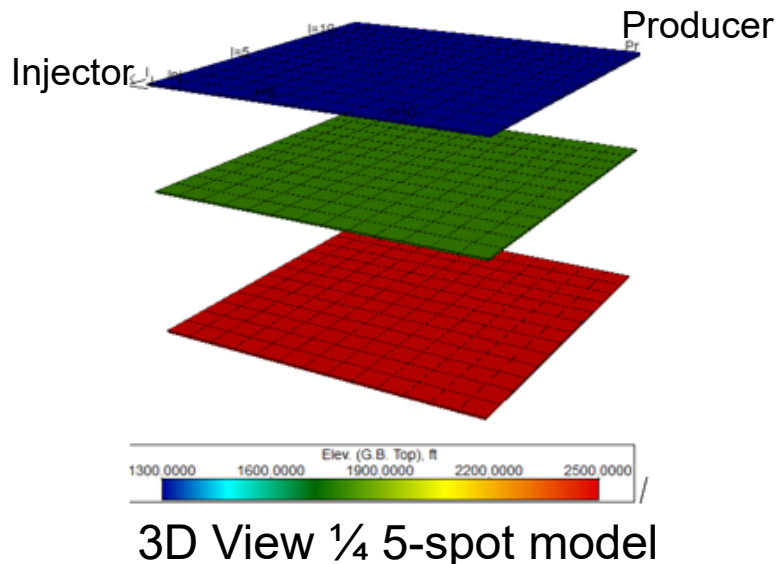
- 10 fields screened were deemed favorable to include in modeling workflow.
- The remaining nine fields were screened out due to their small size, or due to excessive water production, both scenarios which make history matching difficult.

\*Productive area refers to the developed acreage within the larger regulatory boundary of each field.

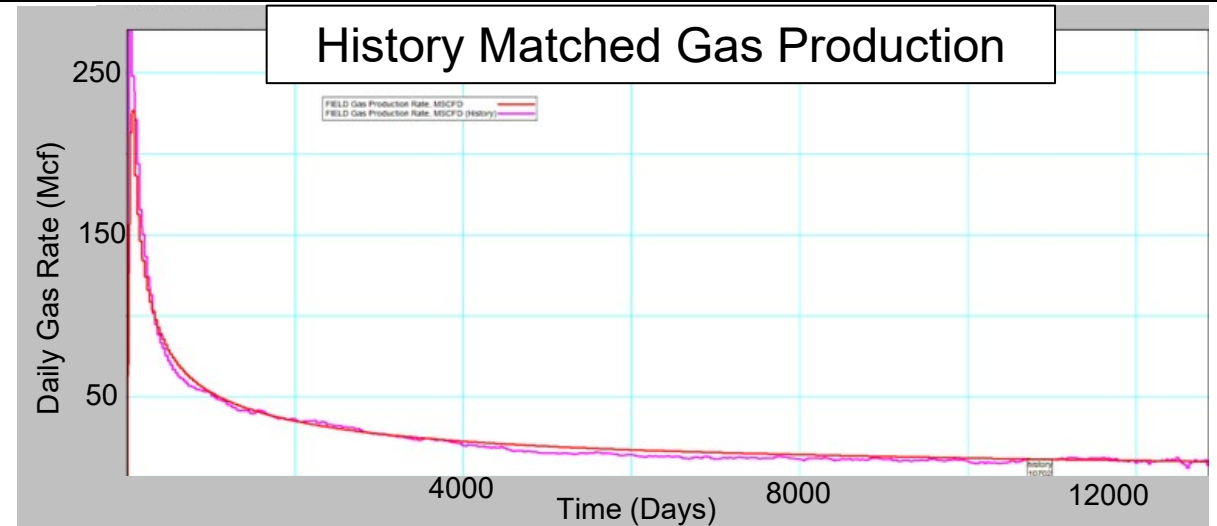
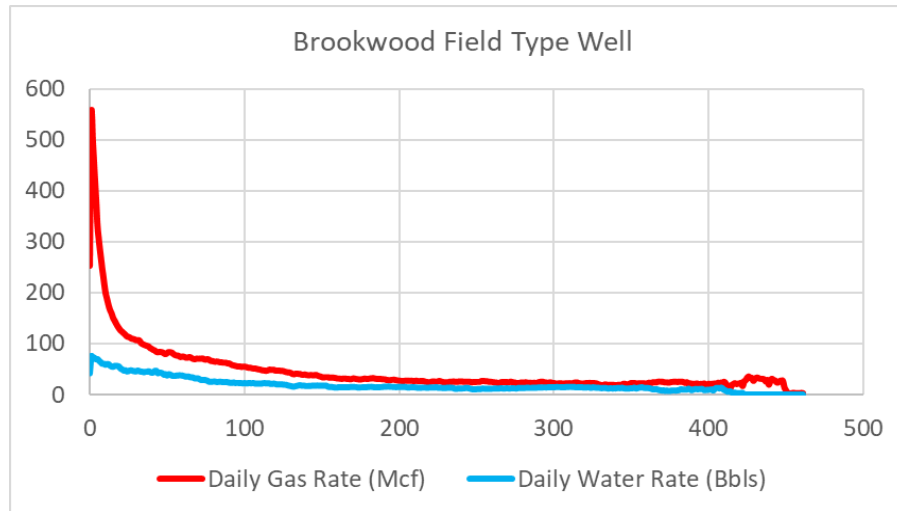
# Model Initialization



- 1/4 5-spot pattern models for each of the 10 selected fields were created in *COMET3*, a reservoir modeling software used to model gas and water production from desorption-controlled reservoirs (such as coal).
- Models were initialized using reservoir properties of each coal seam including depth, thickness, porosity, permeability, and Langmuir isotherms.
- The number of producing coal seams depends on field (3-6 productive seams); depth and thickness of seams are held constant

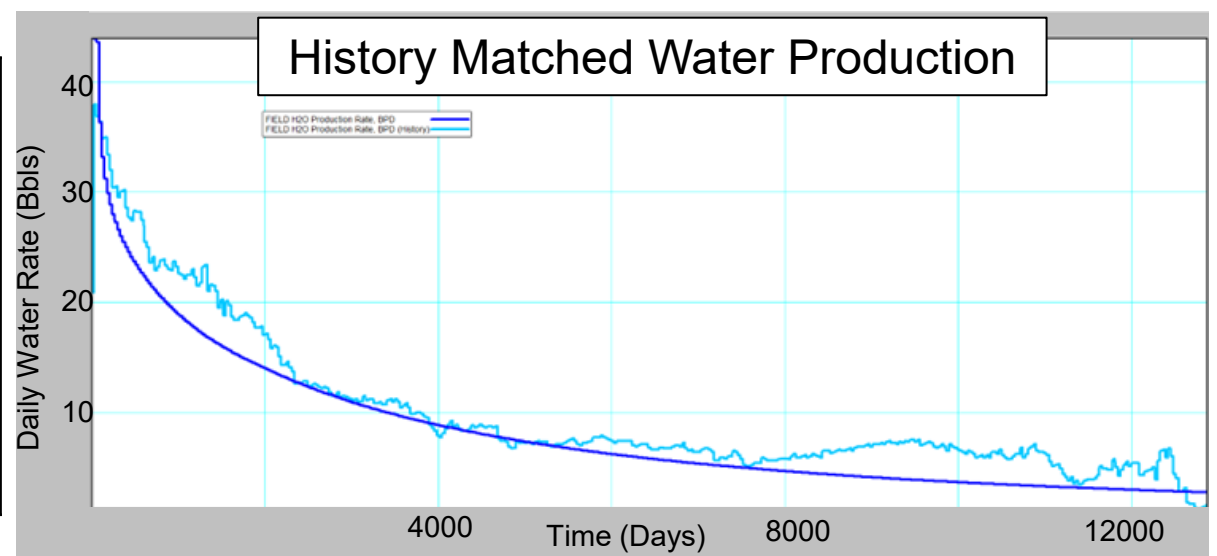


# History Matching



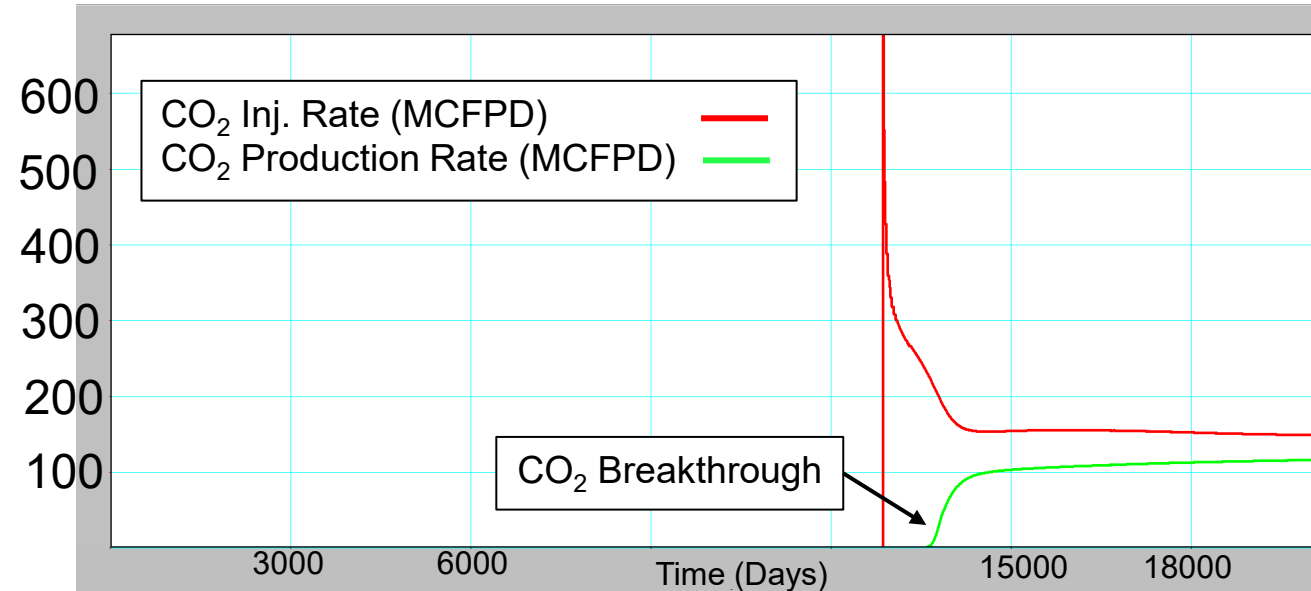
Brookwood Field History Match Inputs

Coal Seam	Depth (ft)	Thickness (ft)	Permeability (mD)	Porosity (%)
Cobb	700	5	36	5
Pratt	1,300	9	6	5
Mary Lee	1,800	8	1.3	5
Black Creek	2,000	8	0.4	3.5



History matching was conducted to refine specific reservoir properties for each coal seam to match the actual data (type curve) with the input data for the 1/4 5-spot model.

# 1/4 5-spot CO<sub>2</sub> Injection and Pattern Upscaling



Field	5-spot Pattern				
	ECBM	Injected CO <sub>2</sub>	Stored CO <sub>2</sub>	Injected CO <sub>2</sub>	Stored CO <sub>2</sub>
	MMscf	Bscf		Million Tonnes	
Blue Creek	370	4.9	3.1	0.26	0.16
Brookwood	120	4.9	2.2	0.26	0.12
Cedar Cove	190	4.1	3.1	0.22	0.16
Deerlick Creek	160	7.0	2.8	0.37	0.15
Gurnee	266	2.2	2.2	0.12	0.12
Holt	160	6.5	3.6	0.34	0.19
Oak Grove	148	2.6	2.2	0.14	0.12
Peterson	202	8.6	3.7	0.46	0.20
Short Creek	149	3.3	2.3	0.17	0.12
White Oak	60	5.4	1.9	0.29	0.10

- The models assume CO<sub>2</sub> injection could occur at max bottom hole pressure for 20 years.
- The graph to right shows the modeled CO<sub>2</sub> injection and production over the 20 years.
- For each field, the model returns the incremental gas production, as well as injected and stored CO<sub>2</sub> per pattern

# Field Upscaling

Field	Field Upscale						
	# wells	# patterns	ECBM	Injected CO2	Stored CO2	Injected CO2	Stored CO2
	-	-	Bscf			Million Tons	
Blue Creek	1,546	745	275	3,651	2,310	193	122
Brookwood	1,286	617	74	3,023	1,357	160	72
Cedar Cove	422 (adjusted)	196	37	804	608	43	32
Deerlick Creek	460	214	34	1,498	599	79	32
Gurnee	227 (adjusted)	102	27	224	224	12	12
Holt	81	34	5	221	122	12	6
Oak Grove	1,666	804	119	2,090	1,769	111	94
Peterson	113	49	10	421	181	22	10
Short Creek	235	106	16	350	244	19	13
White Oak	678	320	19	1,728	608	91	32
<b>TOTAL</b>			<b>617</b>	<b>14,010</b>	<b>8,022</b>	<b>741</b>	<b>424</b>

- The pattern results were upscaled based on number of patterns that fit within the productive (currently developed) acreage within each field.
- Based on the upscaled results, the 10 modeled fields could produce an additional **620 BCF** of gas and **store 424 million metric tons of CO<sub>2</sub>** with the deployment of CO<sub>2</sub>-ECBM

# Conclusions

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- Significant opportunity to reverse the declining gas production within the Black Warrior Basin, with a subset of 10 fields capable of producing an **additional 620 BCF of gas** while **storing over 420 million metric tons of CO<sub>2</sub>**.
- These results represent a conservative estimate of the potential within the Black Warrior Basin. Fields that were not modeled due to high water production likely have potential for ECBM deployment with proper water management.
- Only the currently developed acreage was included in field upscaling. Additional undeveloped acreage within current field boundaries could offer expansion opportunities to further increase the ECBM resource potential.
- The assessment demonstrates a workflow for high-grading basin-scale potential for technical ECBM feasibility, which can be applied in screening studies for additional coal basins such as the Piceance, Raton, and Appalachian.



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