

CO2 Sequestration in Coal Seams: Central Appalachian, SECARB

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SECARB Coal Group Research Team

- Southern States Energy Board
- VCCER/Virginia Tech
- Marshall Miller and Associates
- Geological Survey of Alabama
- Consol Energy
- University of Alabama
- Southern Company
- Kentucky Geological Survey
- Advanced Resources Inter
- Eastern Coal Council

SECARB Coal Group - Phase II Partners (Cost Share, Data, Wells)

- Alpha Natural Resources
- AMVEST
- Buckhorn Coal
- CDX Gas
- CNX Gas
- CONSOL Energy
- Dart Oil & Gas
- Denbury Resources
- Dominion Energy
- Eastman Chemical
- Equitable Production
- GeoMet
- McJunkin Appalachian
- Norfolk Southern
- Natural Resource Partners
- Oak Ridge National Laboratory
- Penn Virginia
- Pocahontas Land
- Praxair

SECARB Coal Group – Phase II

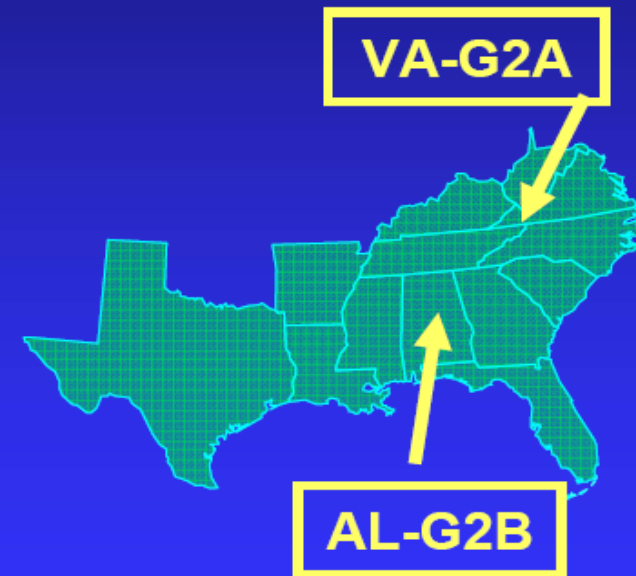
- **Phase I:** Feasibility study, completed September 2005
- **Phase II** (October 2005 – September 2009)

Sequestration and ECBM recovery:

- Over 1 billion tons of feasible CO₂ capacity in the targeted areas
- Over 2.5 Tcf ECBM potential

Target areas:

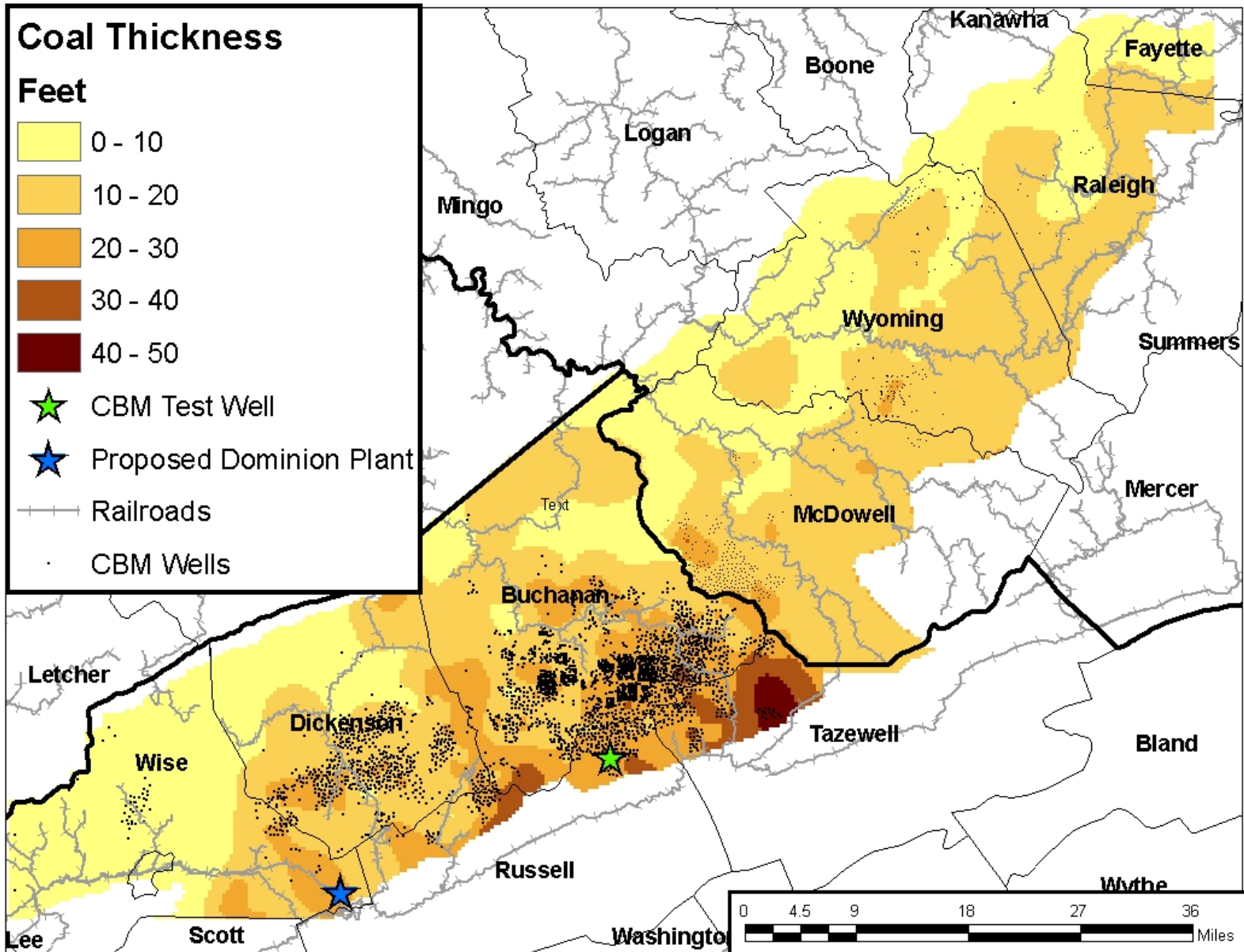
- Central Appalachian Basin, G_{2-A}
- Black Warrior Basin, G_{2-B}
- Pilot injections: 1,000 tons of CO₂



Central Appalachian Field Test – Progress Overview

- Finalized Sequestration and ECBM Assessment for Central Appalachian Basin
- Developed a suite of geologic maps for sequestration and ECBM analysis
- Selected a donated CNX Gas well for field test
- Finalized indemnification and operating agreements with CNX Gas and Buckhorn Coal Company
- Conducted required safety training from CNX Gas
- Received NEPA Categorical Exclusion from DOE
- Received EPA Class V UIC Permit
- Permitted monitor wells as production wells with VA DMME
- Drilled one monitor well and currently coring second well

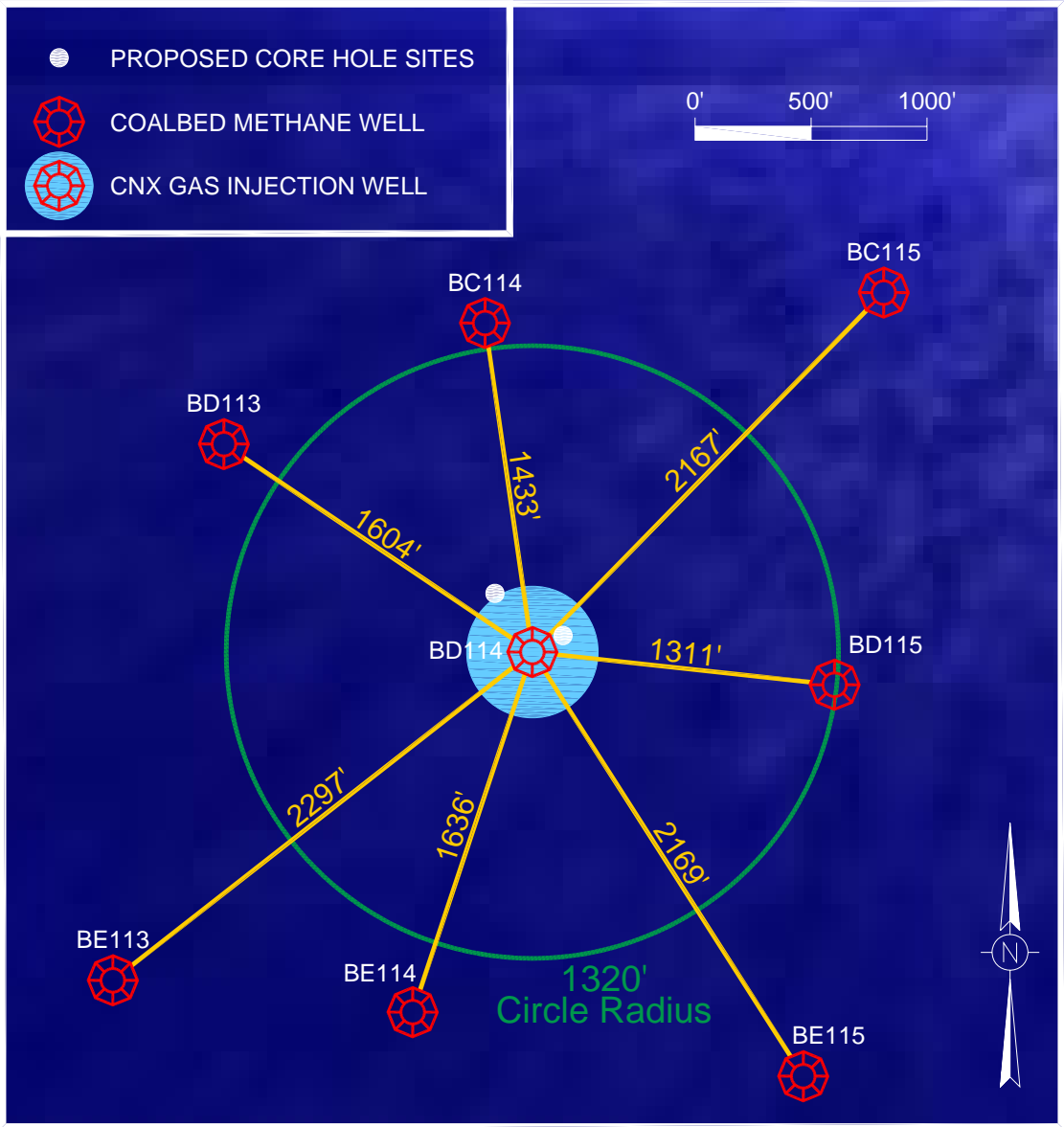
CNX Gas Field Test Location

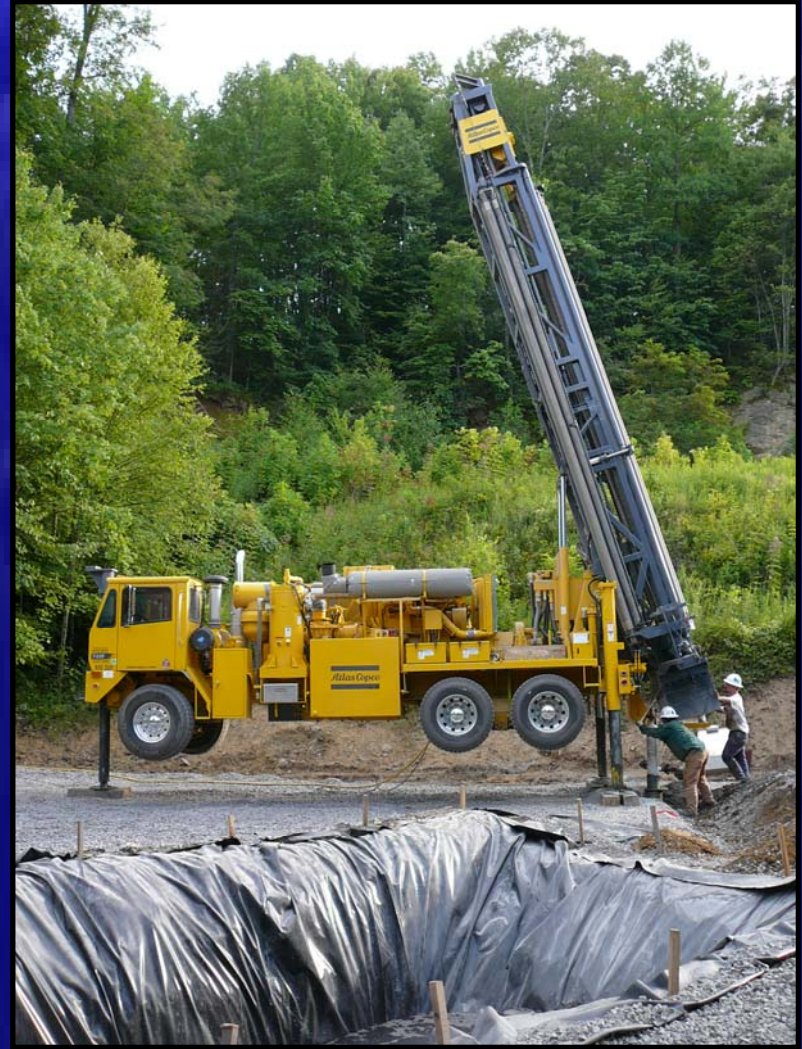


Groundbreaking Event - 08/18/2008

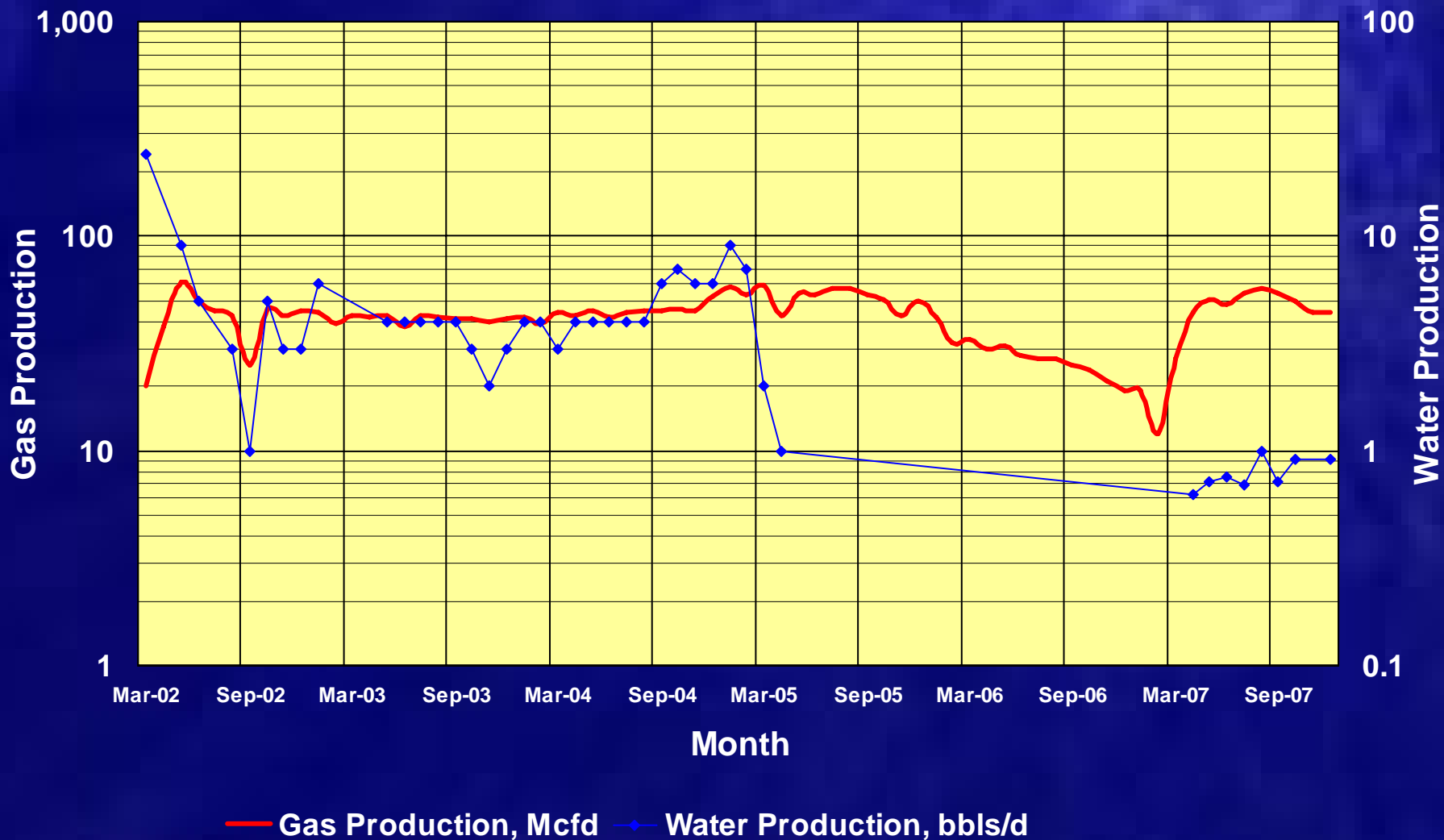


Offset CBM and Monitoring Wells



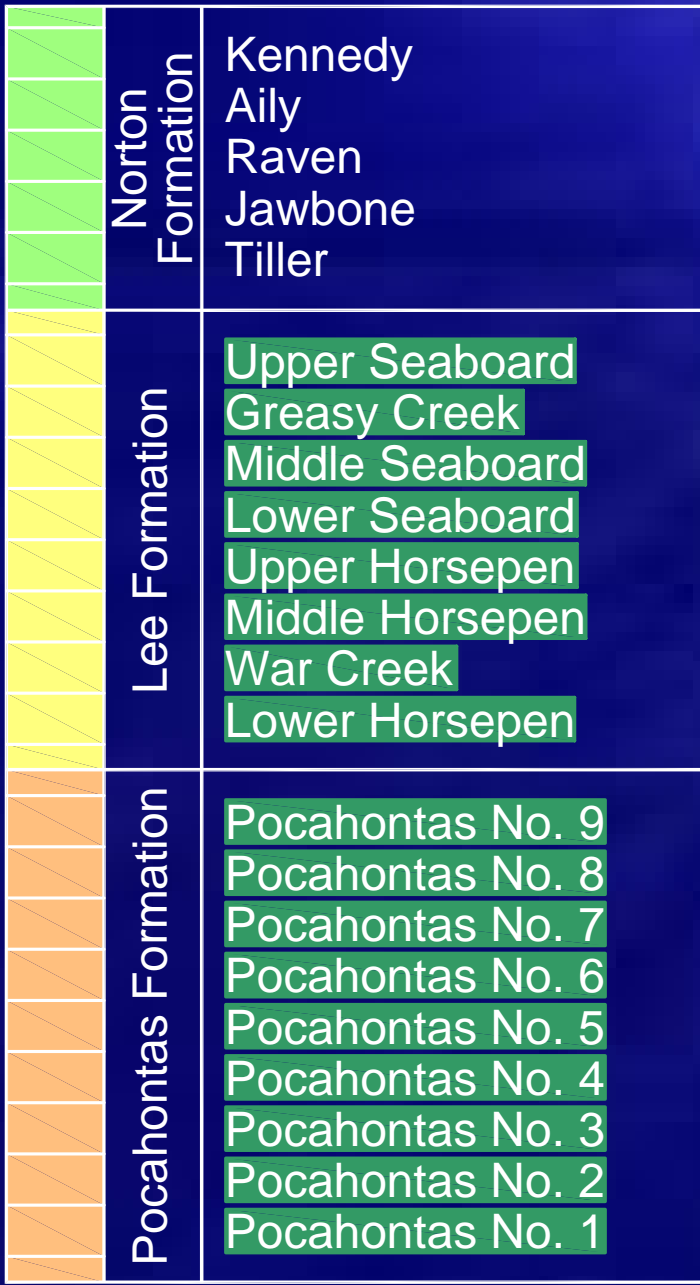


Injection Well Production History



Central Appalachian Basin

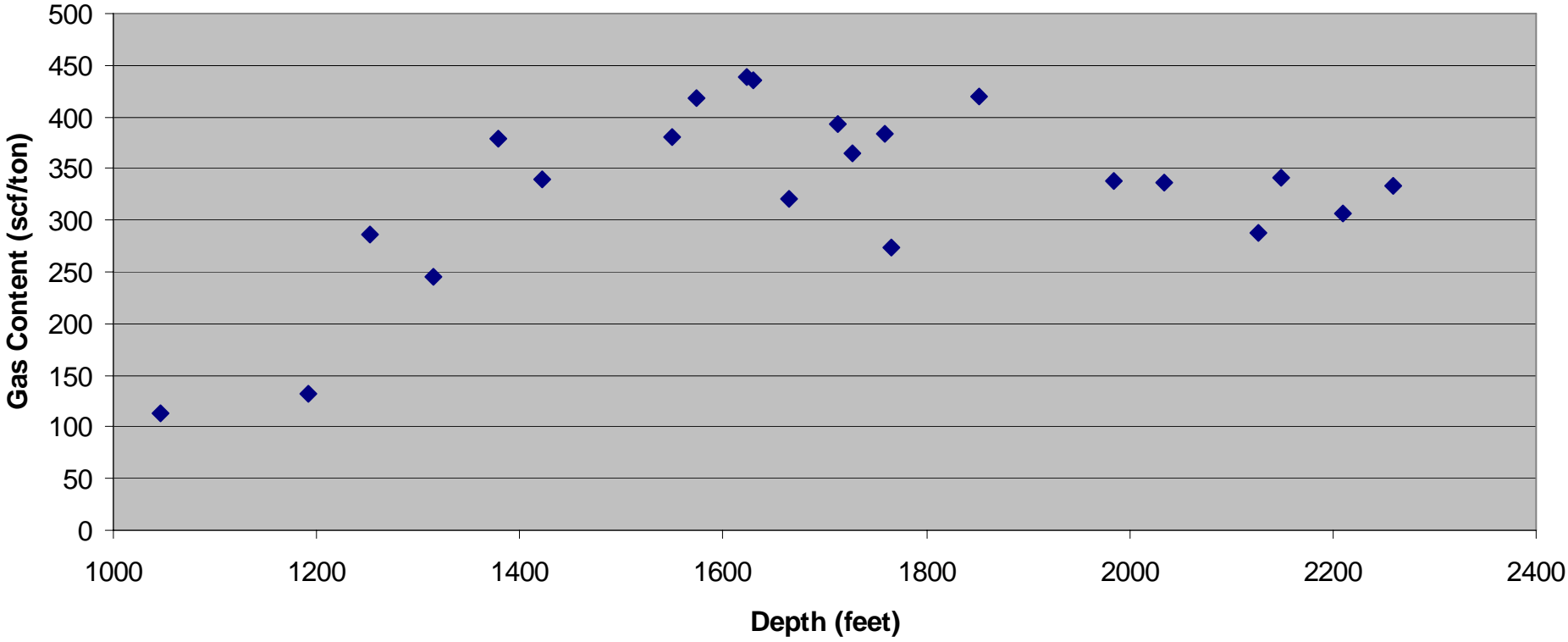
Generalized Stratigraphic Column



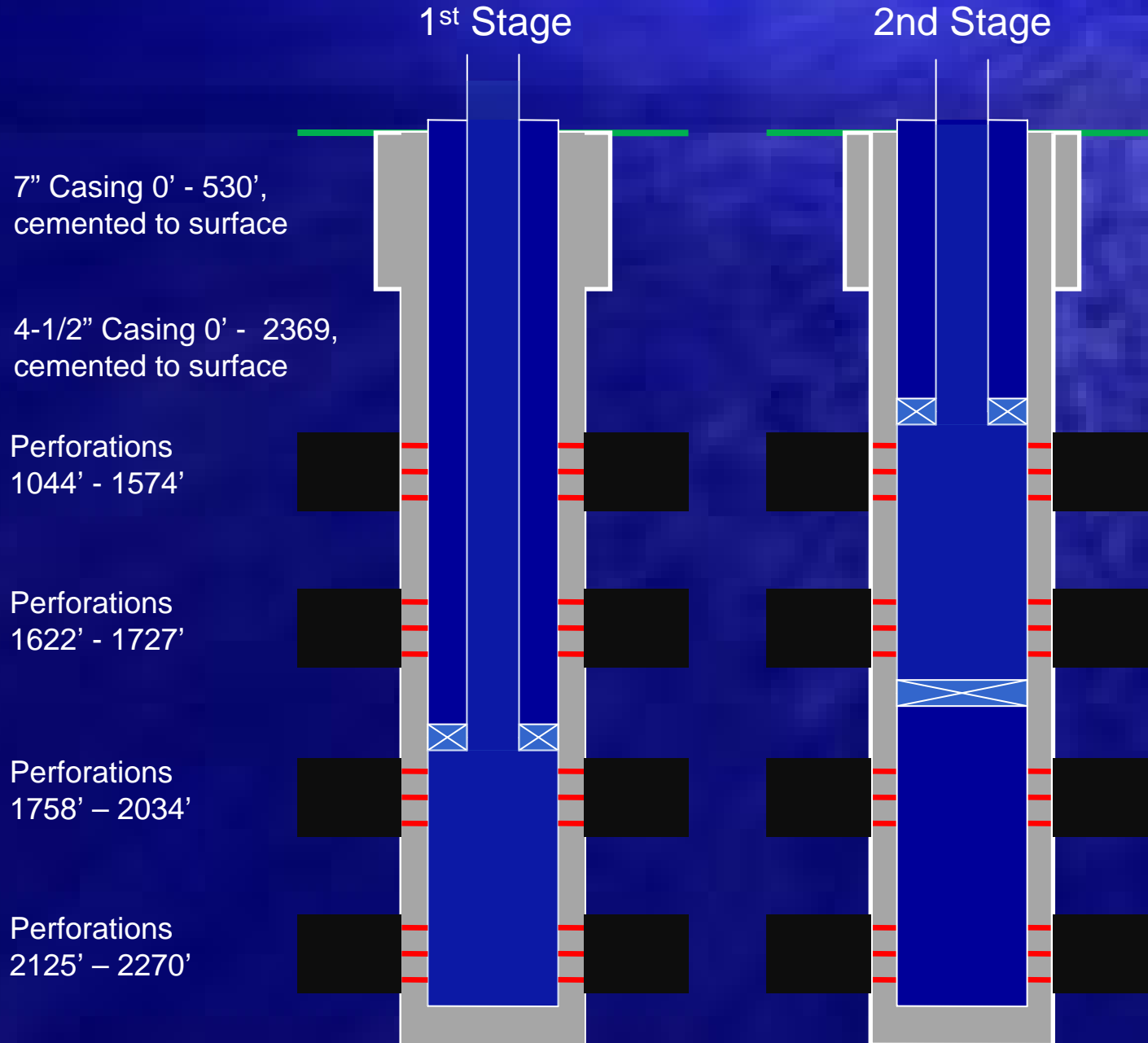
 Prospective Coalbeds For Carbon Sequestration

Stage	Coal Seam	Depth	Thickness	Gas Content
		(feet)	(feet)	(scf/ton)
1	P34	2259	1	333
	P31/P32	2210.5	2.4	306
	P42	2149.5	1.1	341
	P41	2127	1.9	287
	P51	2034	0.7	336
	****/P61	1985	0.5	338
2	***	1876	0.9	
	P72	1852	1.6	420
	**	1766	0.9	274
	*	1759	0.8	383
	P82/P71	1727	1.3	365
	P81	1712	2	393
	P91	1665.5	1.8	321
3	LH2	1629	1	436
	LH1	1624	2.1	438
	P10	1574	1	419
	P11	1549	1.9	380
	MH2	1498	0.7	
	MH1	1422.5	2.2	340
4	UH2/UH3	1378	3.7	379
	LS3	1315.5	2.2	245
	LS1/LS2	1253	2	286
	SE2	1191.5	0.5	132
	GC1	1046	1.2	113
			35.4	330

Gas Content vs. Depth



SECARB Injection Well, Virginia RU-84



WELL MONITORING

<i>Measurement Method/Parameter</i>	<i>Monitoring Phase</i>			<i>Research group</i>
	Pre-injection	Injection	Post-injection	
Geophysical logs: - Gamma Ray, - Caliper, - Density, - Induction, - Temperature,	♦			MM&A
Flow Tests	♦	♦		MM&A
Gas Pressure and Composition	♦	♦	♦	VCCER
Gas Desorption	♦		♦	MM&A
CO ₂ -CH ₄ -N ₂ Adsorption Isotherms	♦			DOE/NETL
Porosity, Permeability, Stress and Strain	♦			DOE/NETL
Proximate, Ultimate and Petrographic Analysis	♦			VCCER
Gas Composition, Gas Production and Water Production at Off-set CBM Wells	♦	♦	♦	VCCER

MMV

- This project includes a MMV program that will focus on deep well monitoring and surface and near surface monitoring.
- Monitoring will be divided into pre-injection, injection and post-injection phases.
- Appropriate MMV protocols are needed to ensure:
 - maximum storage capacity;
 - integrity of CO₂ storage;
 - safety of on-site personnel;
 - protection of groundwater, surrounding ecosystems and settlements;
 - more precise long-term predictions;
 - early detection of storage failure; and
 - lower operational costs.

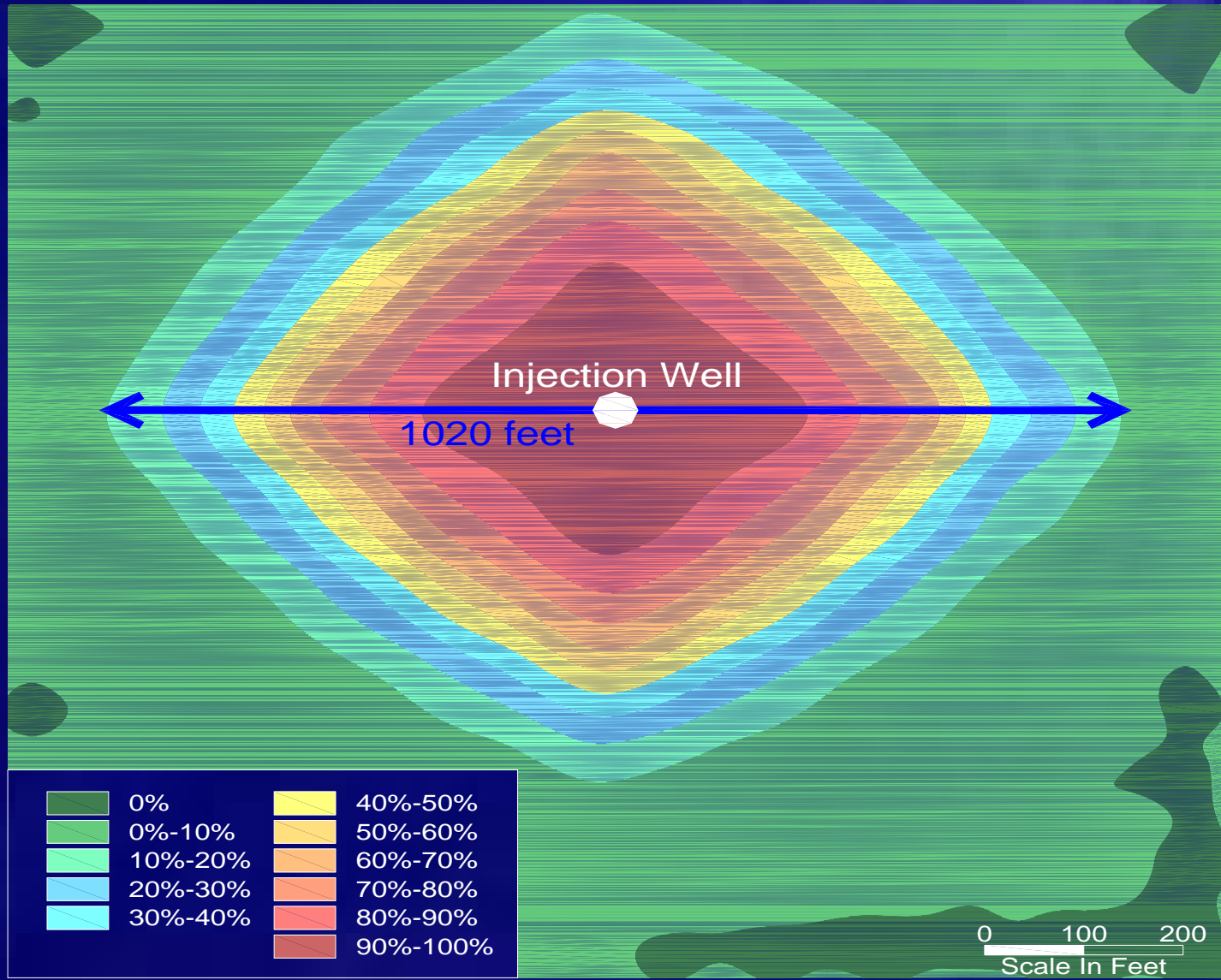
SURFACE AND NEAR SURFACE MONITORING

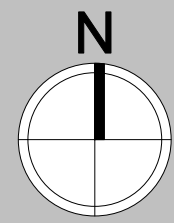
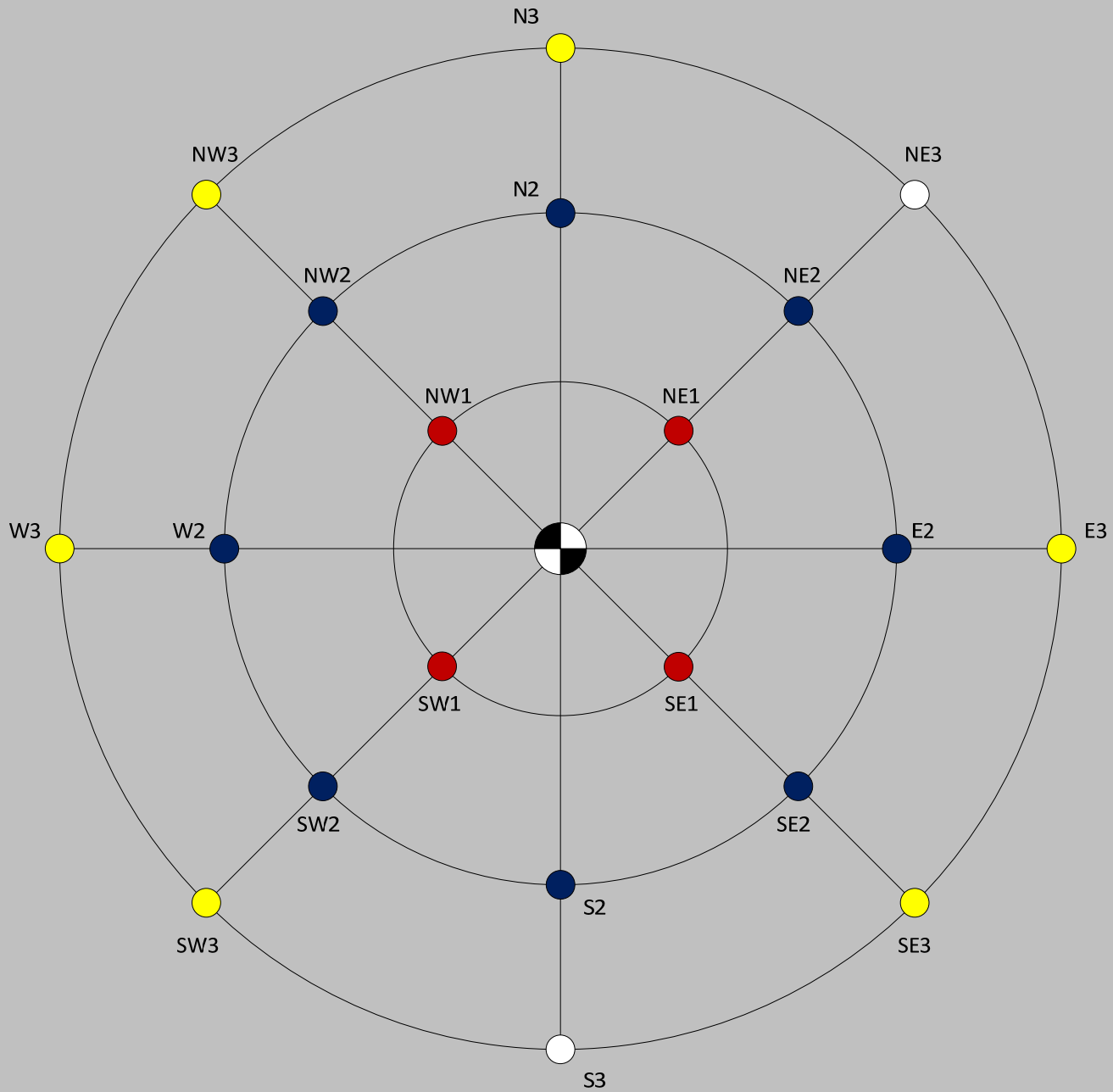
<i>Measurement Method/Parameter</i>	<i>Monitoring Phase</i>			<i>Research group</i>
	Pre-injection	Injection	Post-injection	
Soil Gas Composition	♦	♦	♦	DOE/NETL
Soil CO ₂ Flux	♦	♦	♦	VCCER
Soil CH ₄ Flux	♦	♦	♦	VCCER
Soil Moisture And Temperature	♦	♦	♦	VCCER
Geo-Microbiology	♦			VCCER
Ambient CO ₂ Concentrations	♦	♦	♦	VCCER
Ambient CH ₄ Concentrations	♦	♦	♦	VCCER
Meteorological Data	♦	♦	♦	VCCER
Water Quality	♦	♦	♦	VCCER
Introduced Tracers		♦	♦	DOE/NETL
Carbon Isotopes	♦		♦	DOE/NETL
Vegetative Stress	♦		♦	VCCER





Pilot Area Gas Composition

Well No.	Methane (%)	Nitrogen (%)	CO ₂ (%)	Oxygen (%)	Ethane (%)	Propane (%)	Btu Content
BC114	97.01	.54	1.87	.01	.557	.015	994
BC115	97.11	.57	2.08	.01	.216	.010	989
BD113	96.58	.50	2.49	.03	.392	.002	987
BD114	96.62	.68	2.33	.02	.351	.002	986
BE114	95.67	1.02	1.80	.02	1.418	.059	998
BE113	95.24	1.02	1.91	.01	1.744	.067	999
BD115	97.01	.83	1.35	.02	.740	.033	998
BE115	96.59	.65	1.89	.00	.822	.019	995
Average	96.48	.73	1.97	.02	.780	.026	993

CO₂ Plume – Pocahontas No. 3 Percent CO₂ Saturation

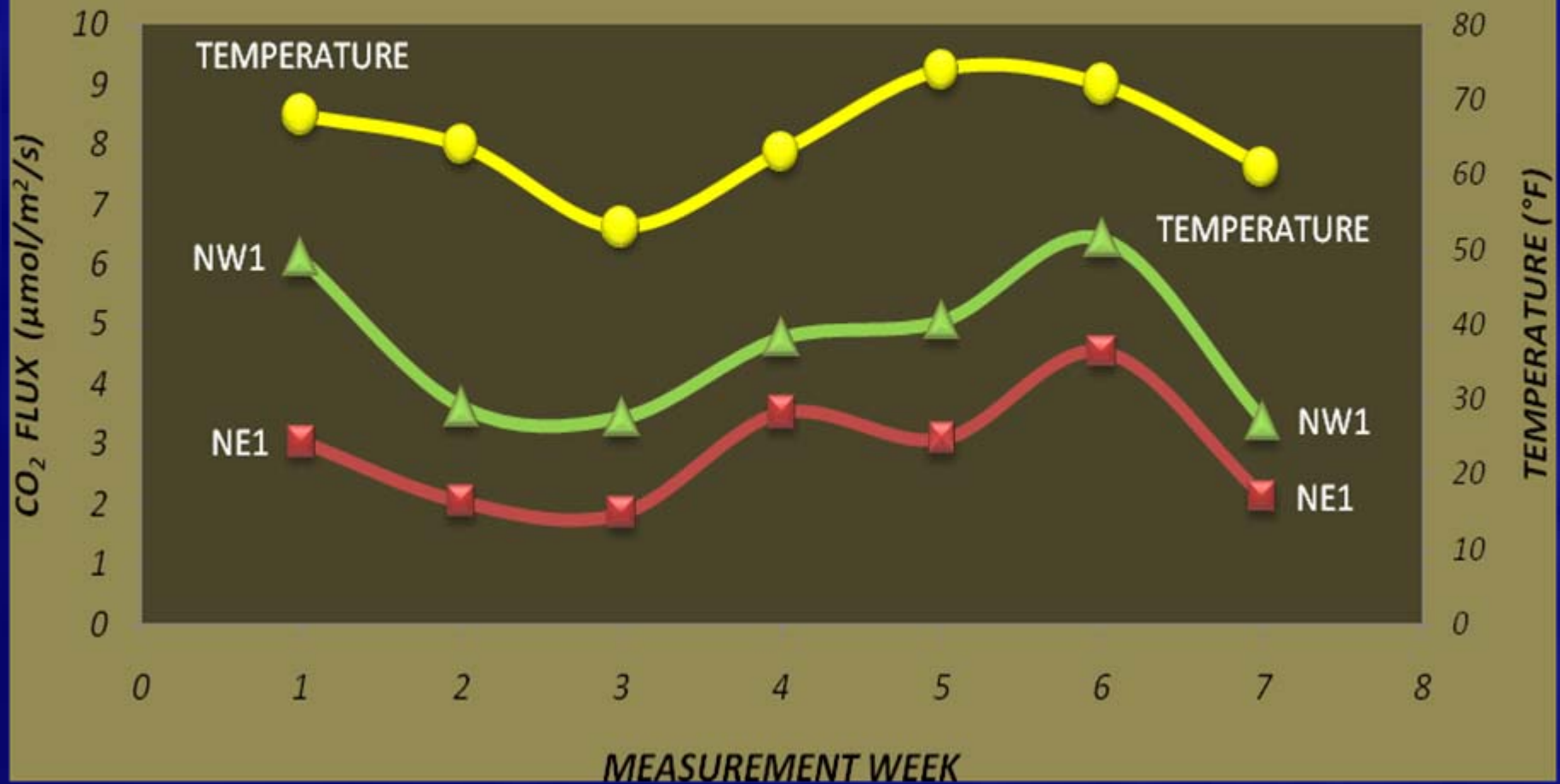




-  Injection Well
-  1st Ring Monitoring Points
-  2nd Ring Monitoring Points
-  3rd Ring Monitoring Points

AVERAGE SOIL CO₂ FLUX AND AVERAGE AIR TEMPERATURES (04/25/2008 - 06/18/2008)

■ NE1 ▲ NW1 ● TEMPERATURE



Test Schedule

- Site selection (Complete): 04/07 – 12/07
- Approvals and Permitting: 02/08 – 09/08
- Monitoring: 03/08 – 09/09
- Coring: 08/08 – 10/08
- Formation testing: 09/08 – 10/08
- Install injection equipment: 10/08 – 11/08
- Injection testing: 11/08 – 01/09
- Site closure: 05/09 – 09/09