CO_2 Sequestration in Unmineable Coal with Enhanced Coal Bed Methane Recovery (The Marshall County Project)

DE-FC26-01NT41148

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CONSOL Energy Inc.

U.S. Department of Energy

National Energy Technology Laboratory
Carbon Storage R&D Project Review Meeting
Transforming Technology through Integration and Collaboration
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Presentation Outline

- **Benefit to the program**
- **Project overview**
- **Technical status**
- **Accomplishments**
- **Summary**
- **Appendix**

Benefit to the Program

- **Program goals addressed**
  - Support industry's ability to predict CO_2 storage capacity in geologic formations to within ±30 percent.
  - Develop technologies to improve reservoir storage efficiency while ensuring containment effectiveness.
- **Project benefits statement**
  - This project will demonstrate the effectiveness and the economics of carbon sequestration in an unmineable coal seam with enhanced coal bed methane (ECBM) production.

Project Overview: Goals and Objectives

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- Demonstrate horizontal drilling in underground coal seams, ✓
- Define effective CO_2 injection methods and procedures, ✓
- Devise economical drilling strategies to maximize both CO_2 sequestration potential and CBM recovery, ✓
- Measure the impact of CO_2 injection on CBM recovery,
- Monitor the CO_2 concentrations in the water and gas phases to determine the stability of sequestered CO_2 over an extended period of time, and
- Assess the overall economics of CO_2 sequestration in coal seams, with the co-benefit of methane production.

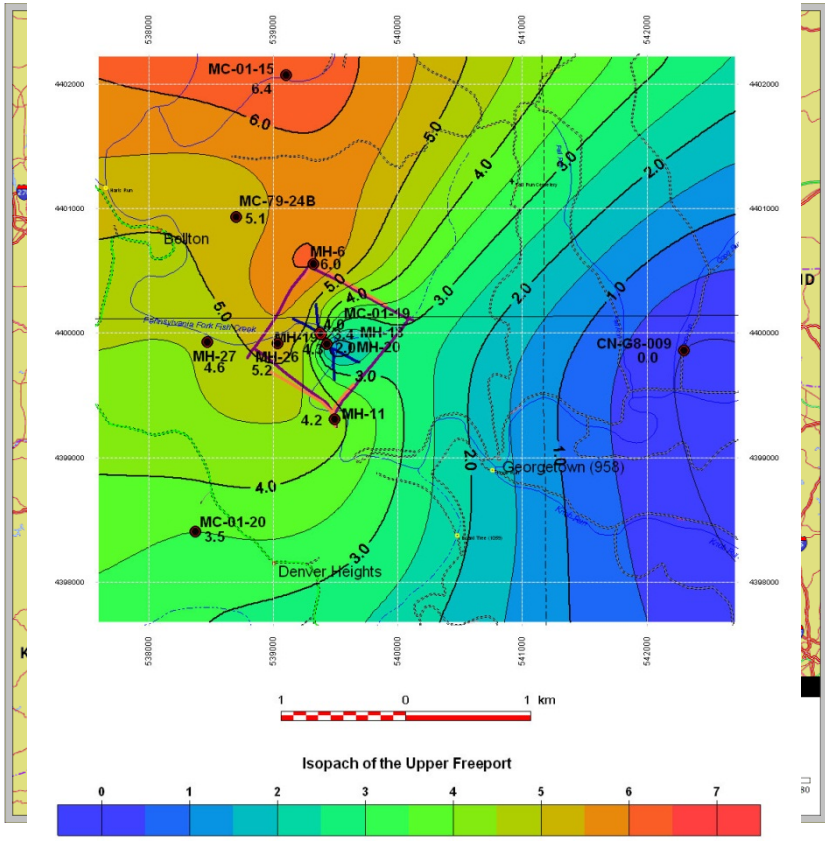
Technical Status: Background

Project Location

- Marshall County, West Virginia, USA

Target Formation

- Upper Freeport coal seam (1,200-1,800 ft deep)
  - 4-6 ft seam to the north & west
  - 1-2 ft seam to the south & east
- Pittsburgh coal seam ~600 ft above UF.
  - Vertical migration monitoring



Technical Status: Timeline

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Technical Status: Site Layout

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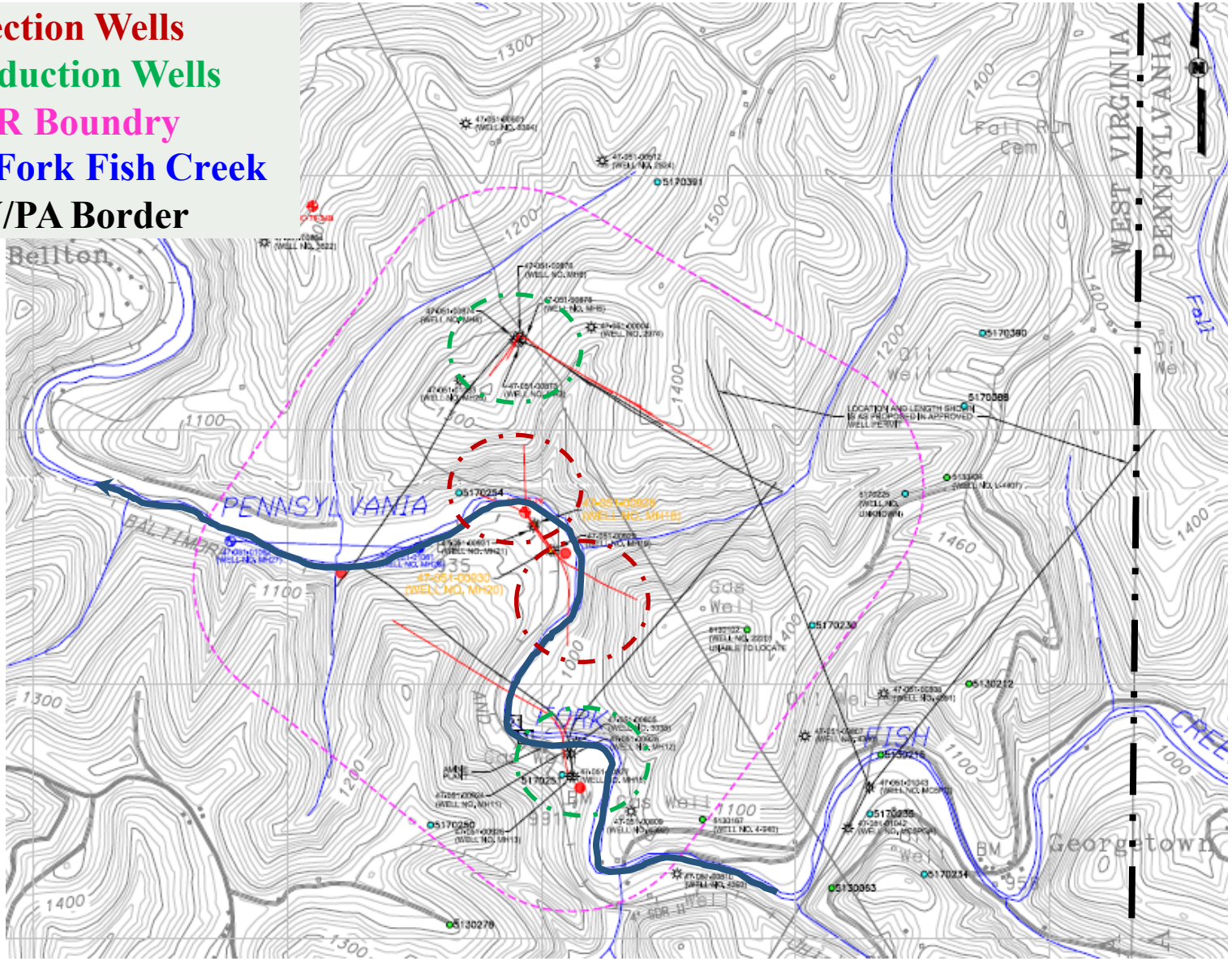
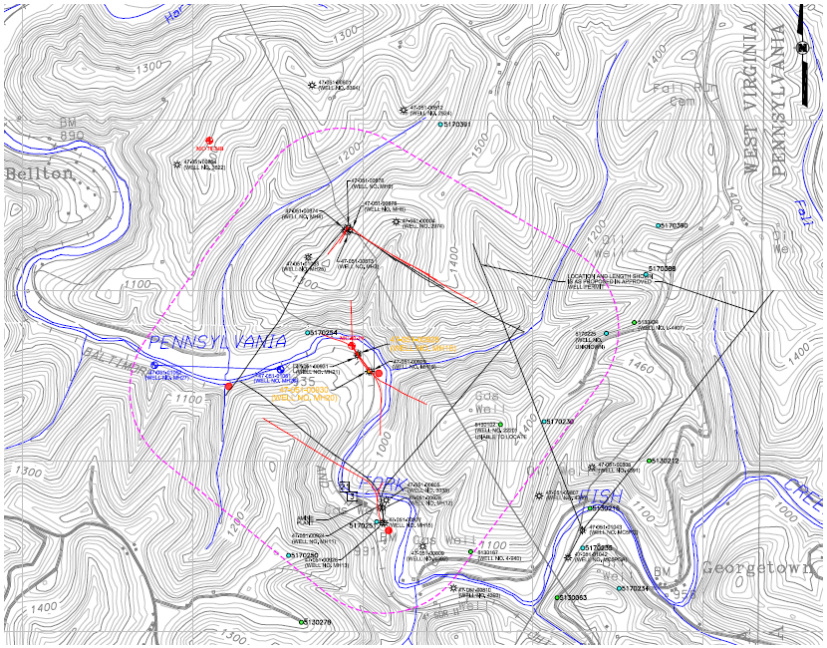
- Injection Wells
- Production Wells
- AOR Boundry
- PA Fork Fish Creek
- WV/PA Border

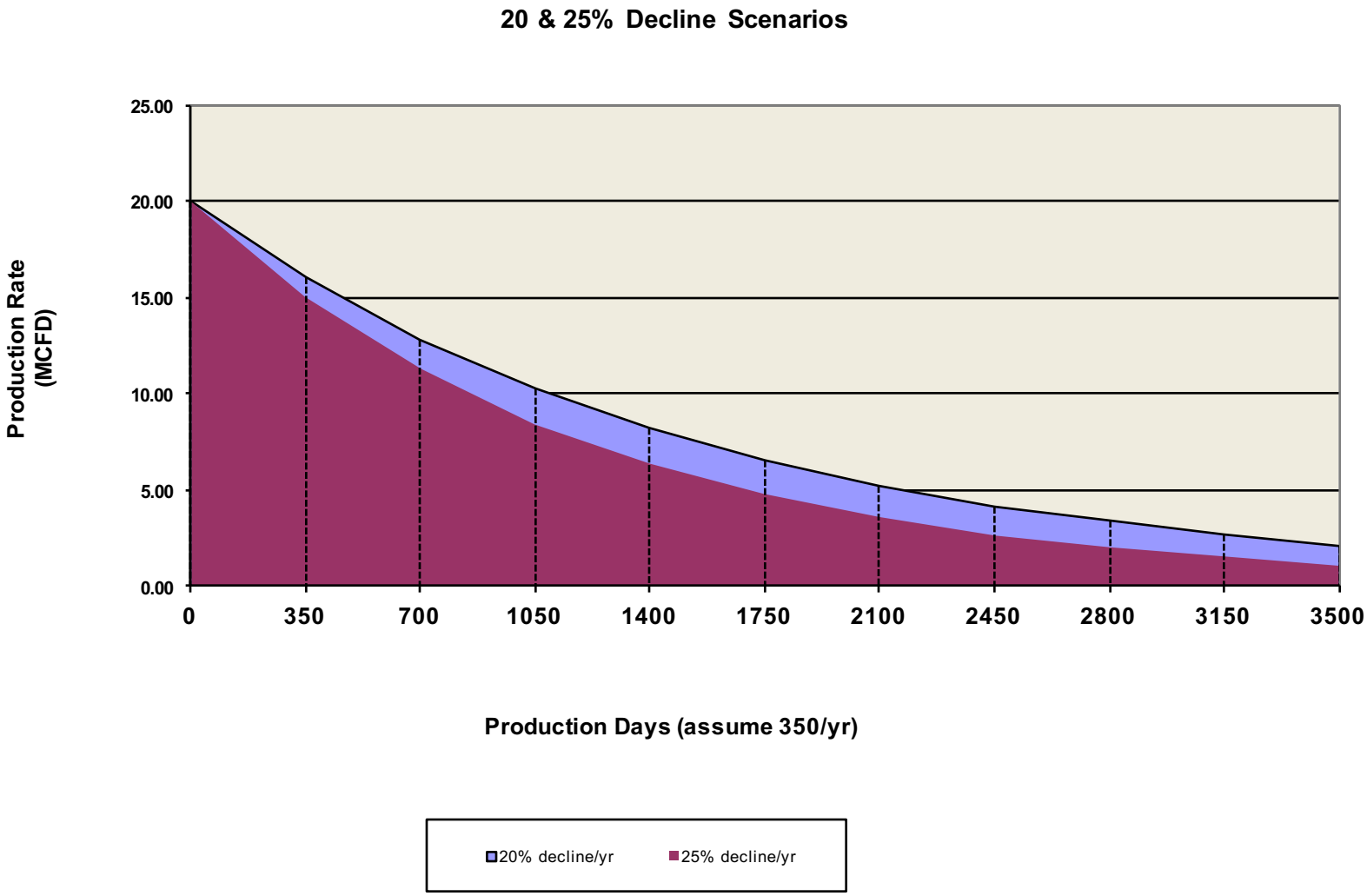


Technical Status: Injection

- MH-11 CO_2 breakthrough
  - 09/04/13: MH-11 CBM CO_2 @ 21.8%
- UIC permit expiration – Dec. 31, 2013
- 4,968 short tons CO_2 injected
- Site reclamation
  - Injection components removed
  - Injection well plugging or return to production



Technical Status: CBM Production



Technical Status: CBM Production

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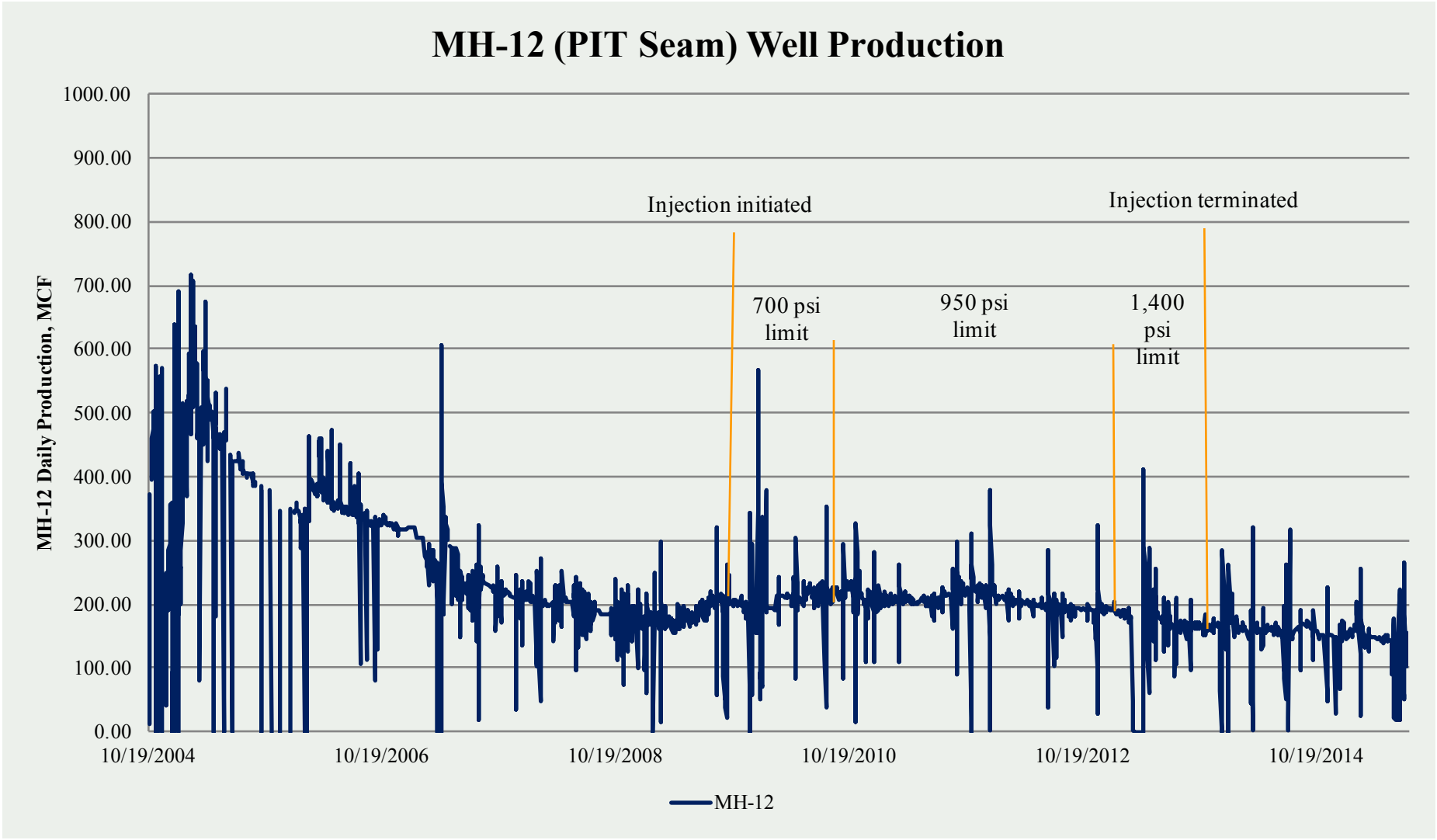

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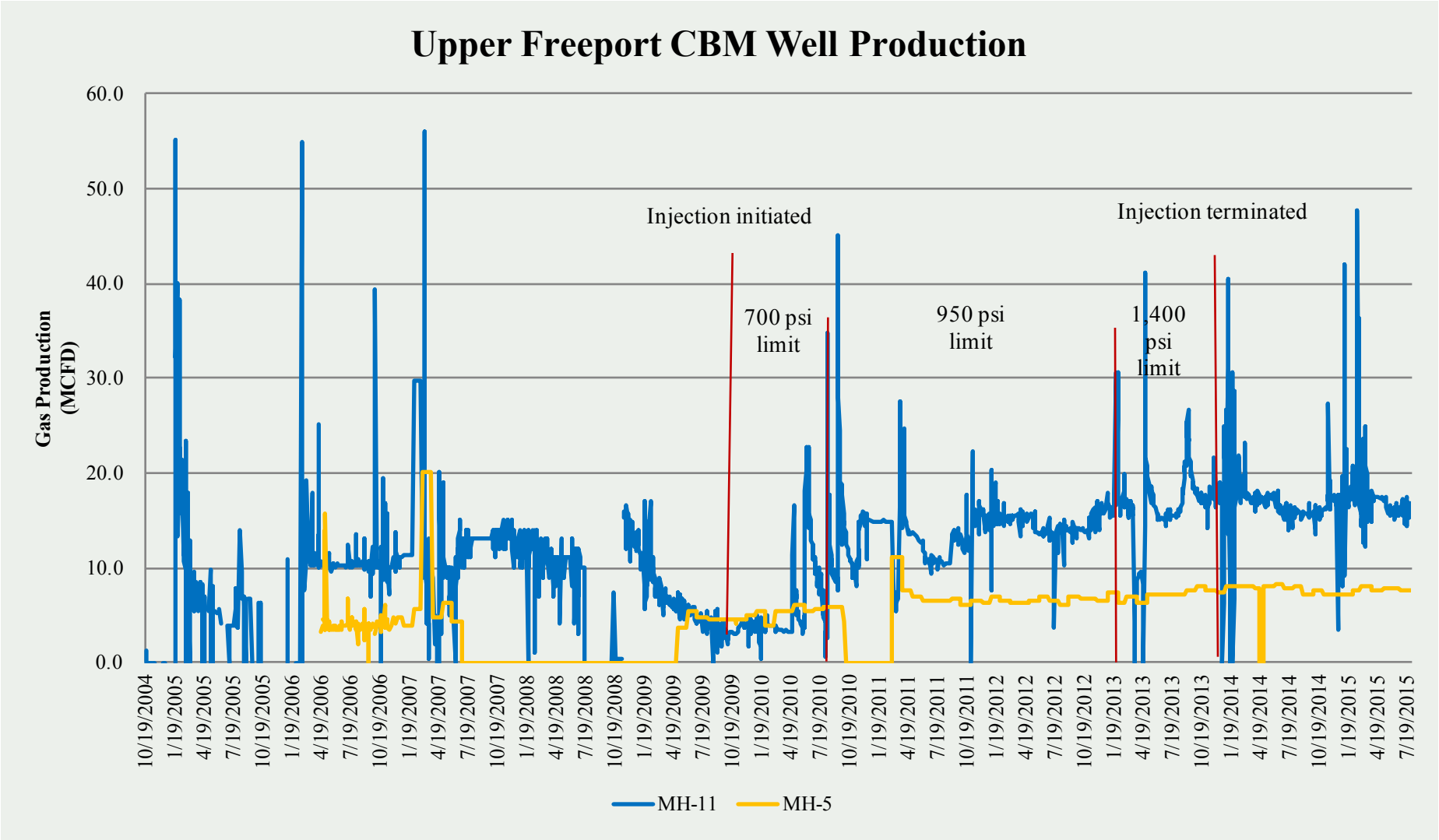
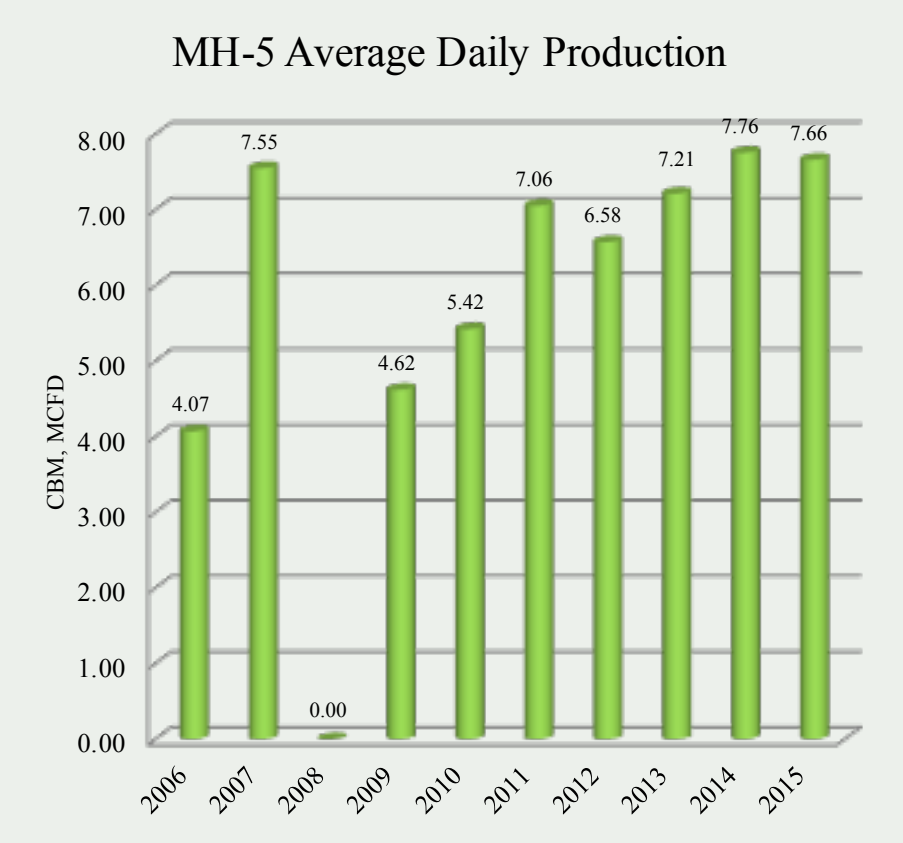
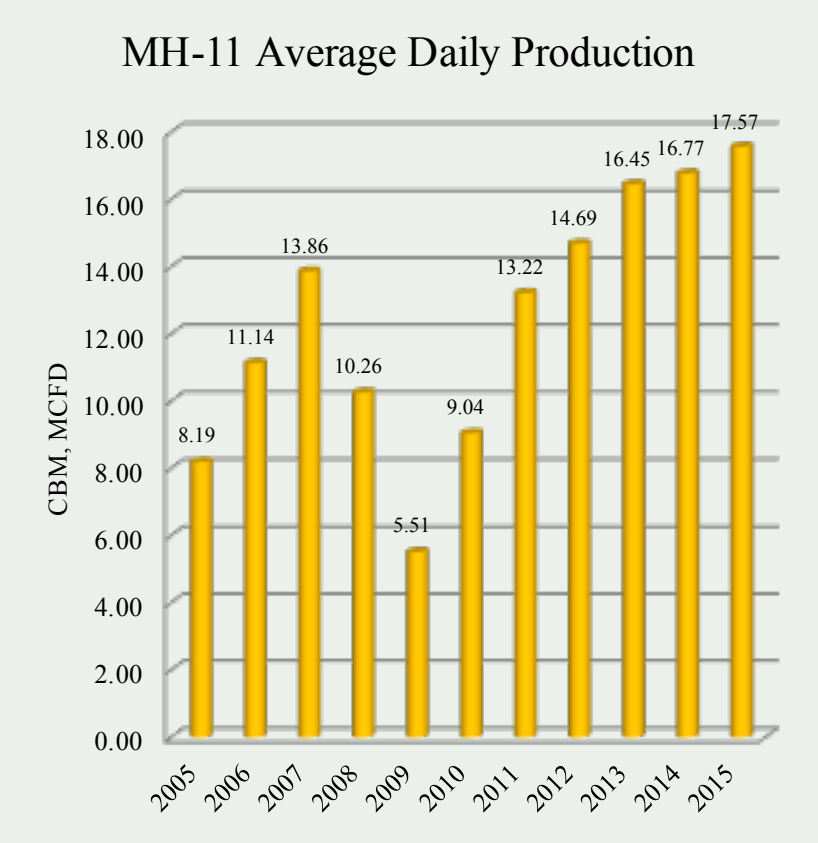


Technical Status: CBM Production





Notes:
Injection starts 9/1/09
Injection ends 11/1/13
Periods of shut-in omitted

Technical Status: Monitoring

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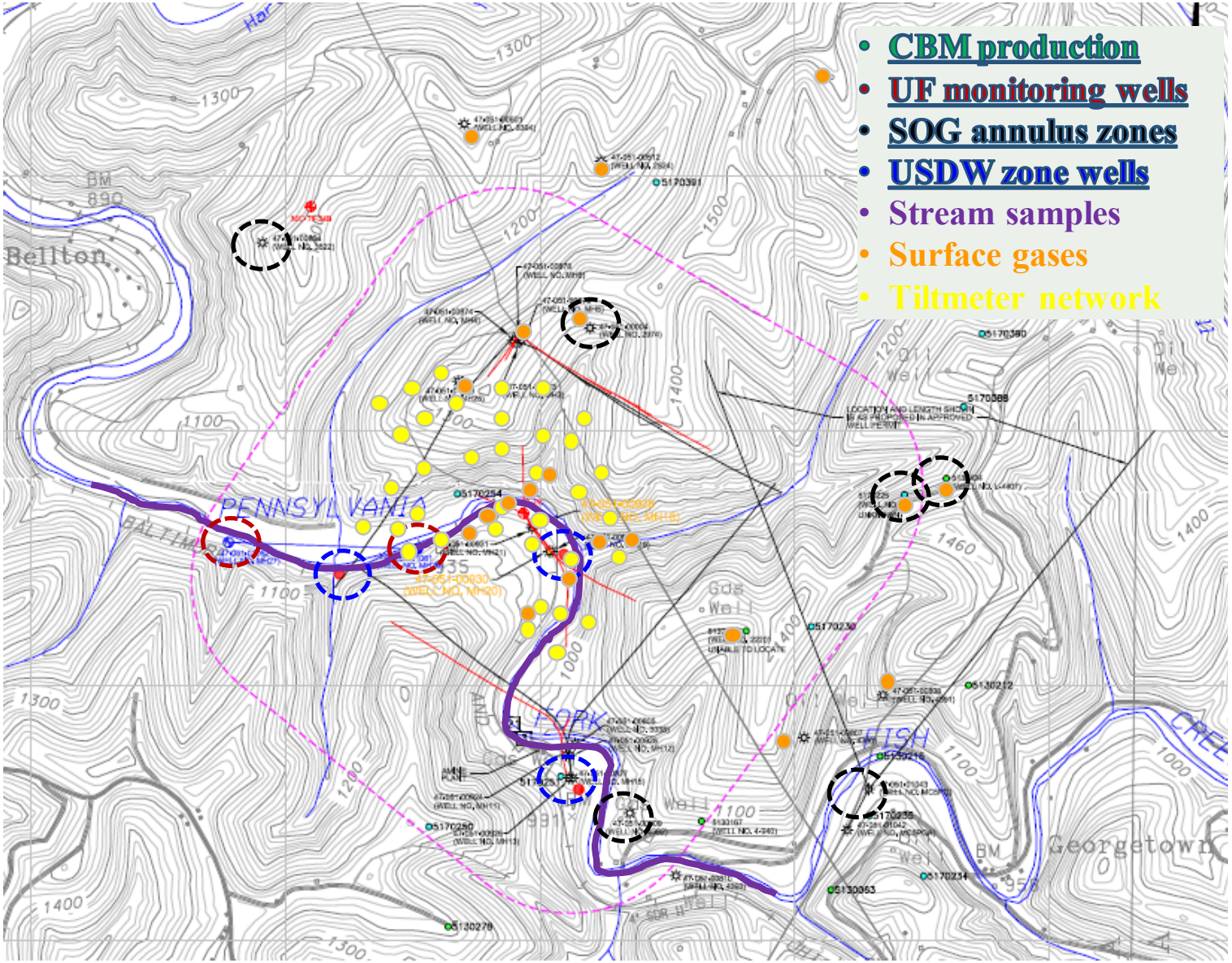

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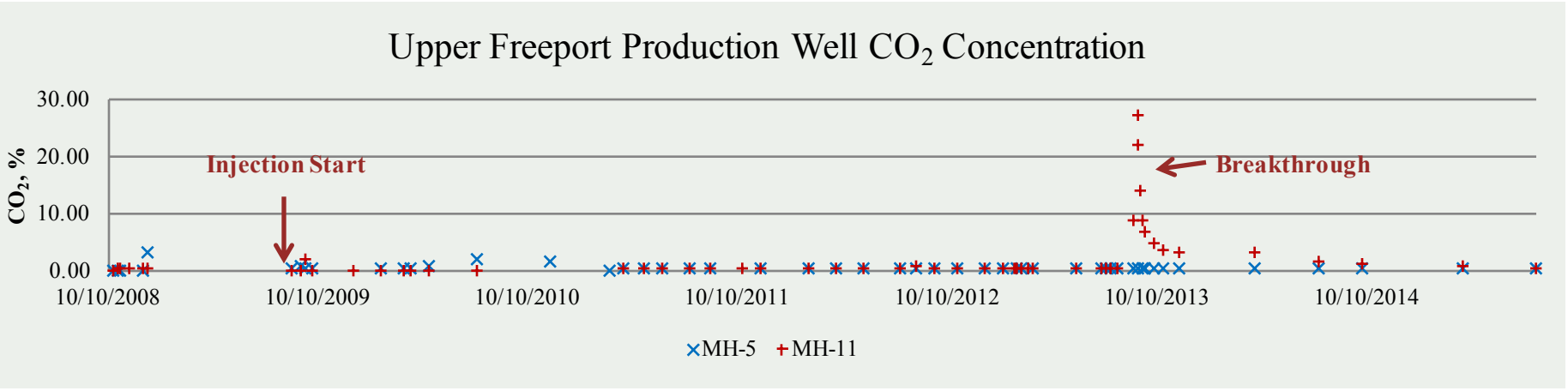

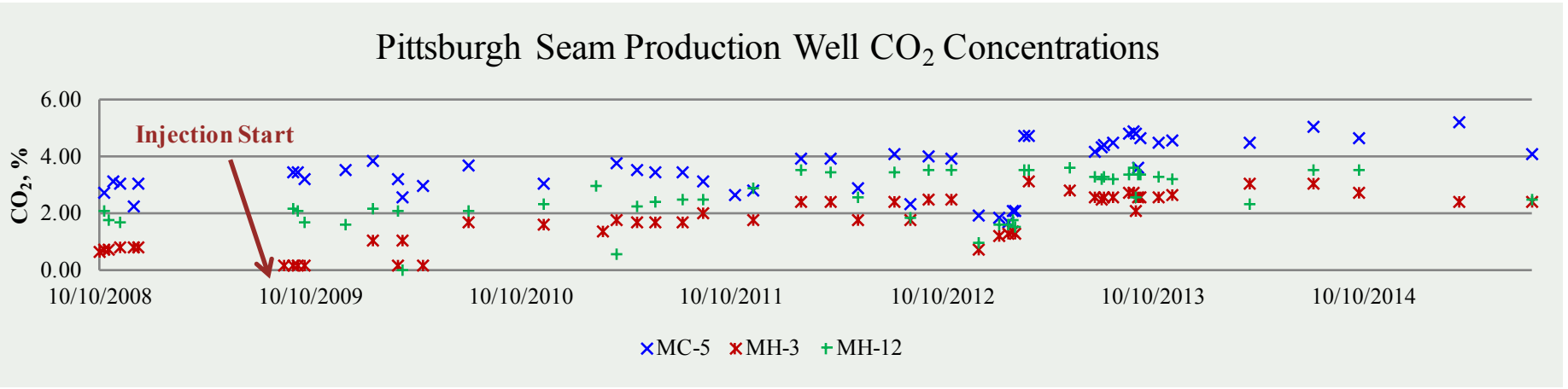

Technical Status: Monitoring

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AOR Gas Monitoring Results:

AOR Gas Wells

Well No.	% CO_2	SD
1588		
Baseline Average	0.31	0.04
Post injection average	0.38	0.14
Most recent value	0.14	
2974		
Baseline Average	0.70	0.05
Post injection average	1.33	0.53
Most recent value	1.13	
4407		
Baseline Average	0.79	0.05
Post injection average	0.51	0.25
Most recent value	0.29	
MC-5		
Baseline Average	2.82	0.38
Post injection average	3.66	0.94
Most recent value	4.11	

Aquifer-Zone Wells

Well No.	% CO_2	SD
WVU #1		
Baseline Average	0.05	0.02
Post injection average	0.10	0.07
Most recent value	0.17	
WVU #2		
Baseline Average	0.06	0.03
Post injection average	0.07	0.04
Most recent value	0.09	
WVU #3		
Baseline Average	0.05	0.01
Post injection average	0.23	0.21
Most recent value	0.53	

Upper Freeport Monitoring Wells

Well No.	% CO_2	SD
MH-26		
Baseline Average	0.20	0.27
Post injection average	0.05	0.06
Most recent value	0.02	
MH-27		
Baseline Average	0.53	0.72
Post injection average	0.09	0.04
Most recent value	0.06	

Accomplishments

- **4,968 tons CO_2 injected**
- **Achieved 1,286 psig injection**
- **Completed injection YE2013**
- **Strong evidence of ECBM**
- **Established/maintained an extensive monitoring network**
- **Provided a platform for Master's and Ph.D. research**

Summary

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Key findings

- Clear breakthrough episode
- No evidence of CO_2 migration beyond AOR
- No evidence of vertical migration
  - PIT CBM wells
  - Stream samples
  - USDW zone samples
- Enhanced CBM production linked to CO_2 injection
- Down-dip drilling not suitable for CBM wells

Future plans

- Project ends 12/31/15
- Continue post-injection monitoring through YE
- Economics
- Final report
- Site reclamation
- Well closure

Acknowledgements

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NETL

Soil and tracer gas sampling and analysis.

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Questions?

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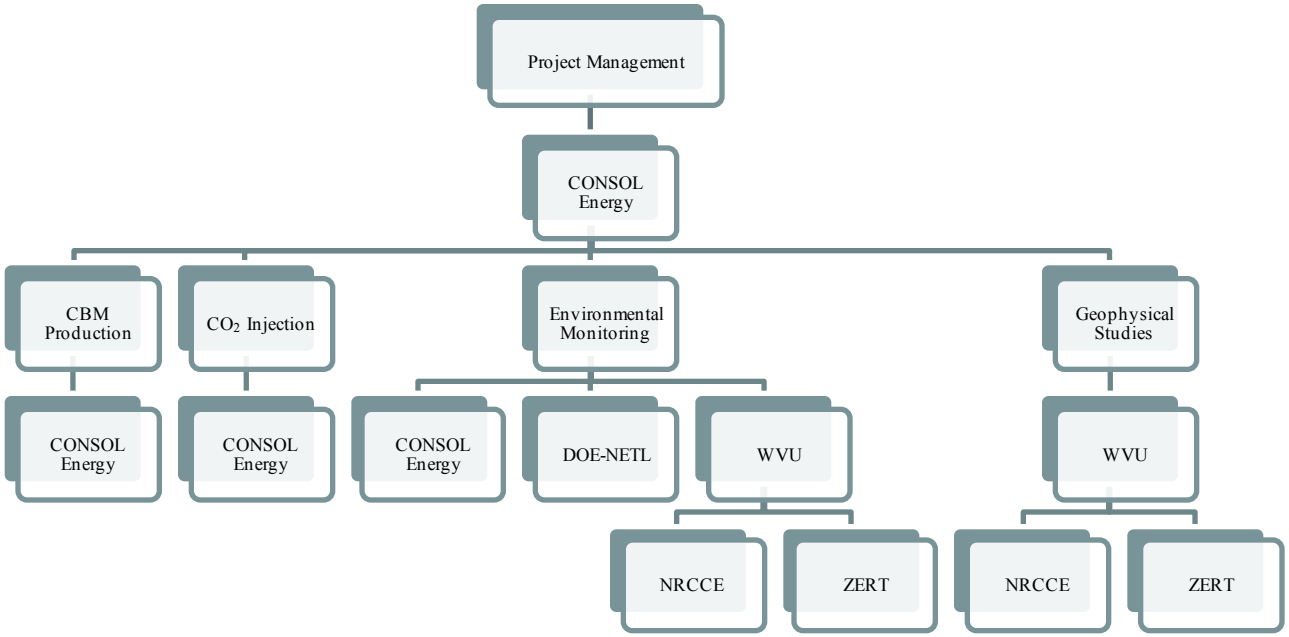
Appendix

Organization Chart



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Wilson, T. H.; Tallman, J.; Rauch, H.; Wells, A.; Smith, D.; 2003, Reconnaissance Studies of a Pilot Carbon Sequestration Site in the Central Appalachians of West Virginia, Northeastern Geology & Environmental Sciences, v. 25, no. 4, p. 330-345.