Case Studies on the Simultaneous Extraction of Coal and Gas in the U.S.

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Global Methane Initiative

Presentation Outline

- Overview
- Warrior Met Coal, Alabama
- Consol (Coronado Coal)/CNX, Virginia
- Indian Potential

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Overview

- In the U.S., a number of mines produce coal and CBM/CMM simultaneously from within the area of the mine boundary;
- The CBM/CMM is produced using a combination of vertically fractured wells, in-mine horizontal boreholes, and gob wells. The combination of these wells can drain 70 to 80% of the in-situ gas from the coal seams prior to mining, thus improving mine safety and productivity, as well as generating an additional revenue stream;
- In some cases, even conventional oil and gas is produced from within the mine boundary. This requires close coordination between the mining company and oil and gas operator.

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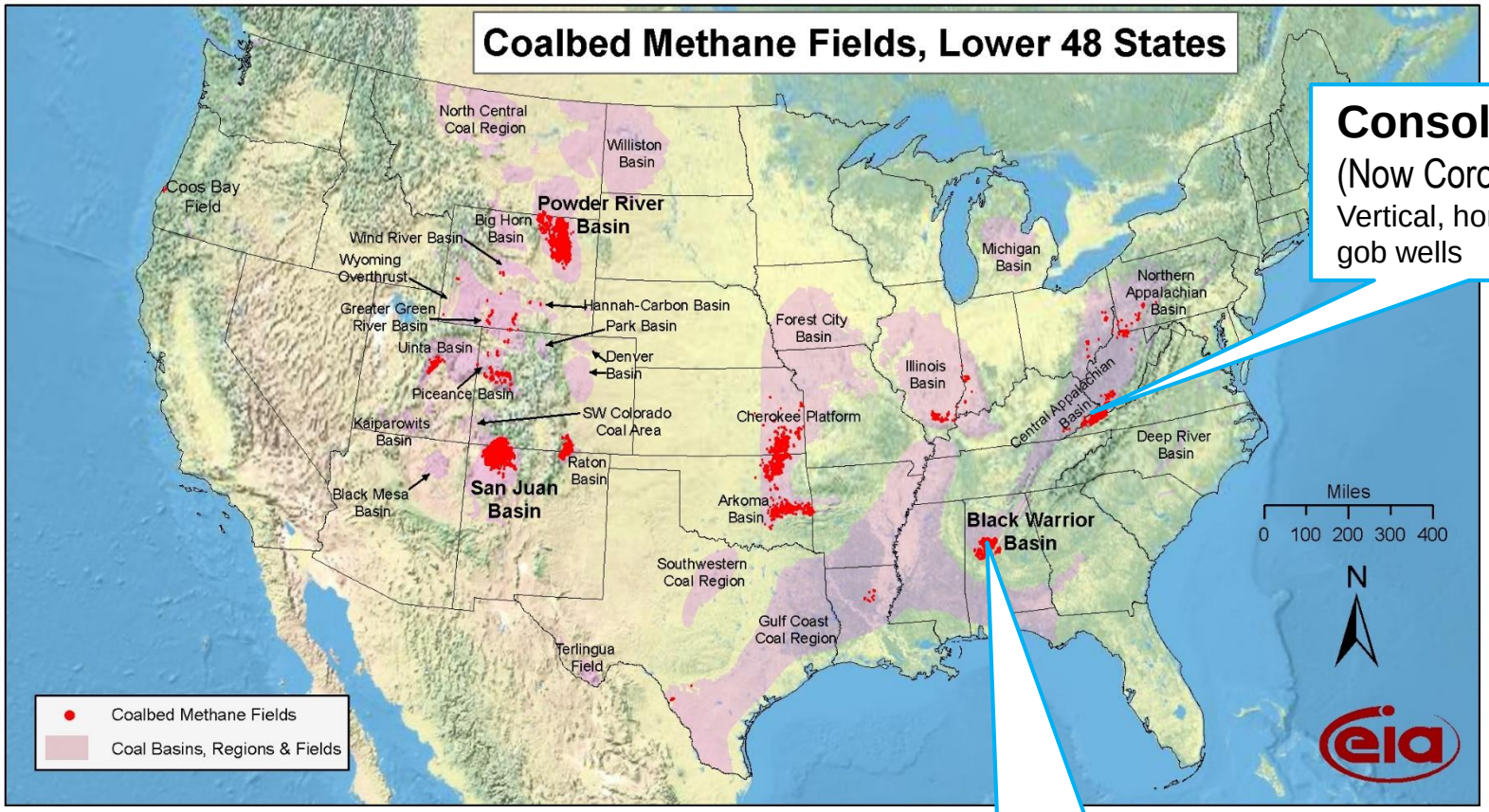
Map of U.S. Coal Basins and Project Locations



Source: Energy Information Administration based on data from USGS and various published studies
Updated: April 8, 2009

Consol Coal
(Now Coronado Coal)
Vertical, horizontal, and gob wells

Warrior Met
Vertical, horizontal and gob wells

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Warrior Met Coal

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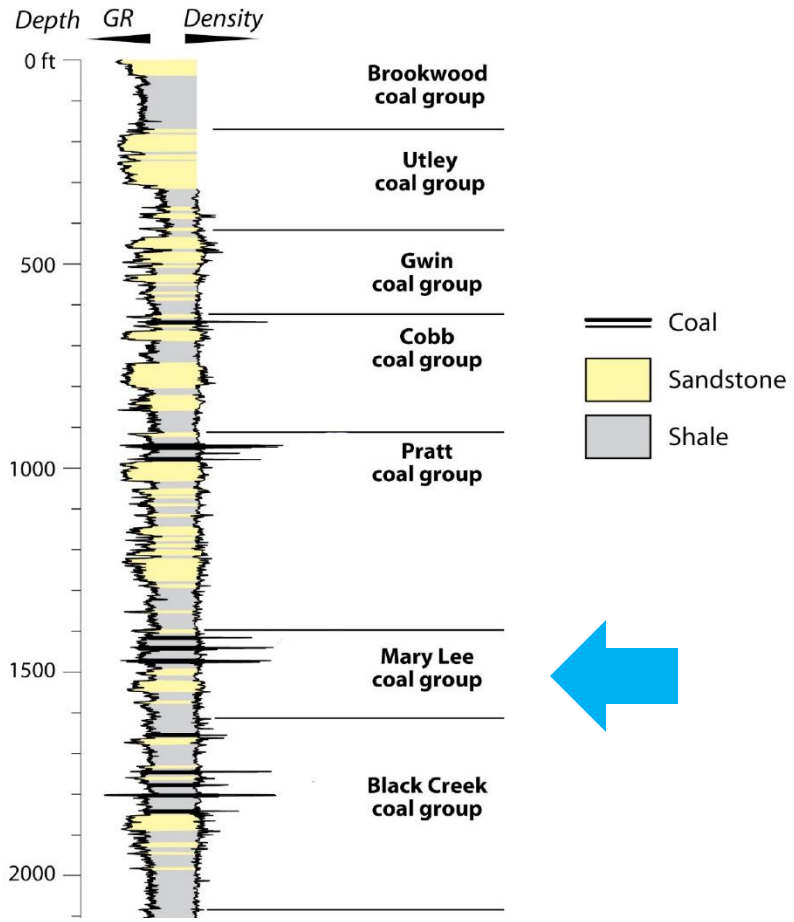
Warrior Met Coal Overview

- Warrior Met Coal produces high quality, metallurgical coal with gas contents ranging from 11 to 16 m^3/tonne (350 – 500 cf/ton);
- Two seams are mined, the Mary Lee (0.5m to 0.8m (1.6 – 2.6 ft)) and the Blue Creek (1.5m to 2.1m (5 – 7 ft)) ;
- The mine complex produces 500,000 m^3/day (17.6 MMcfd) of methane from a combination of vertical, hydraulically fractured wells, in-mine horizontal boreholes and gob wells;
- Gas production operations are managed by Black Warrior Methane (BWM), which is a joint venture between Warrior Met Coal (coal producers) and Atlas Resource Partners, who handles the production, processing and transportation of the methane.



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Vertical Hydraulically Fractured Wells

- BWM operates about 350 vertical wells that were drilled into the coal seams prior to mining;
- Production is about 343,000 m^3/day (12 MMcfd);
- In the Warrior Basin as a whole, over 5,000 vertical wells have been drilled and have produced more than 71 Bm^3 (2.5 Tcf) of gas.
- For Mine-Through: Clean out, log, plug, cement perfs through coals, mill casing out, set plug and cement

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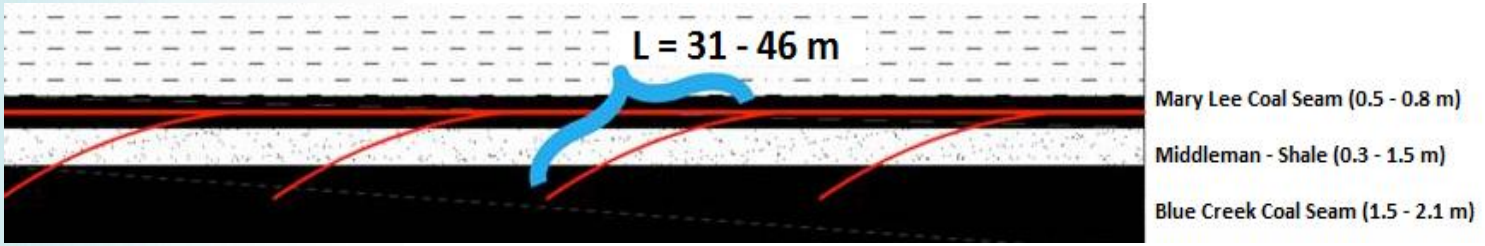
In-Mine Horizontal Boreholes

- In-mine horizontal boreholes are currently directionally drilled in the Mary Lee coal to lengths of about 1,000m (3,280 ft) in the longwall panels. Once the well has been drilled to its total length, a series of downward directed “touches” into the Blue Creek coal are performed. This is necessary because of poor drilling conditions in the Blue Creek coal.

Section of coal seams of methane pre-drainage



- A pattern of these boreholes from one location into a longwall panel produces approximately 420,000 m^3/day (1.5 MMcfd).
- Boreholes injected with water at collar prior to mine-through.

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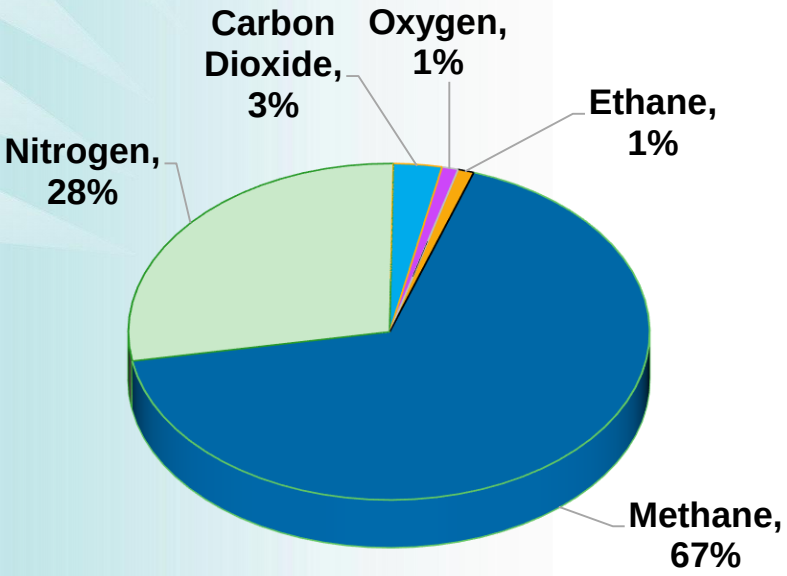
Gob Wells



View of GOB well

- Gob wells collect methane from sealed and active areas. The gas produced from these wells is about 60% methane.
- The gas is sent to a gas processing plant, where nitrogen, oxygen, and carbon dioxide are removed and the gas is upgraded to 96% quality methane.
- The gob wells produce about 107,000 m^3/day (3.8 MMcfd) which is sent to an interstate pipeline for sale.
- An added benefit to the processing of gob gas is that the rejected nitrogen is injected into the gob and old working areas as an inert gas to minimize spontaneous combustion and mine fires.

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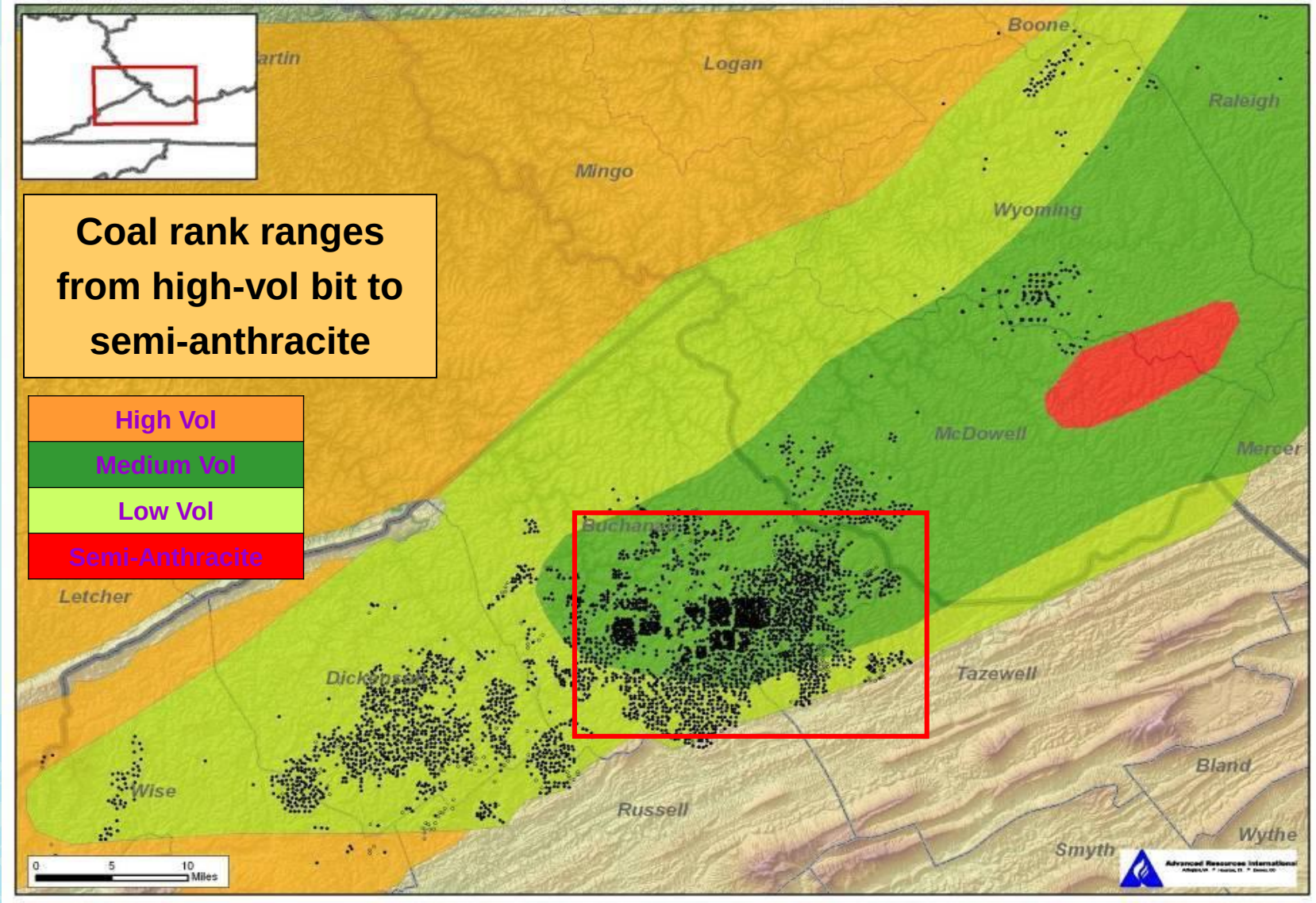
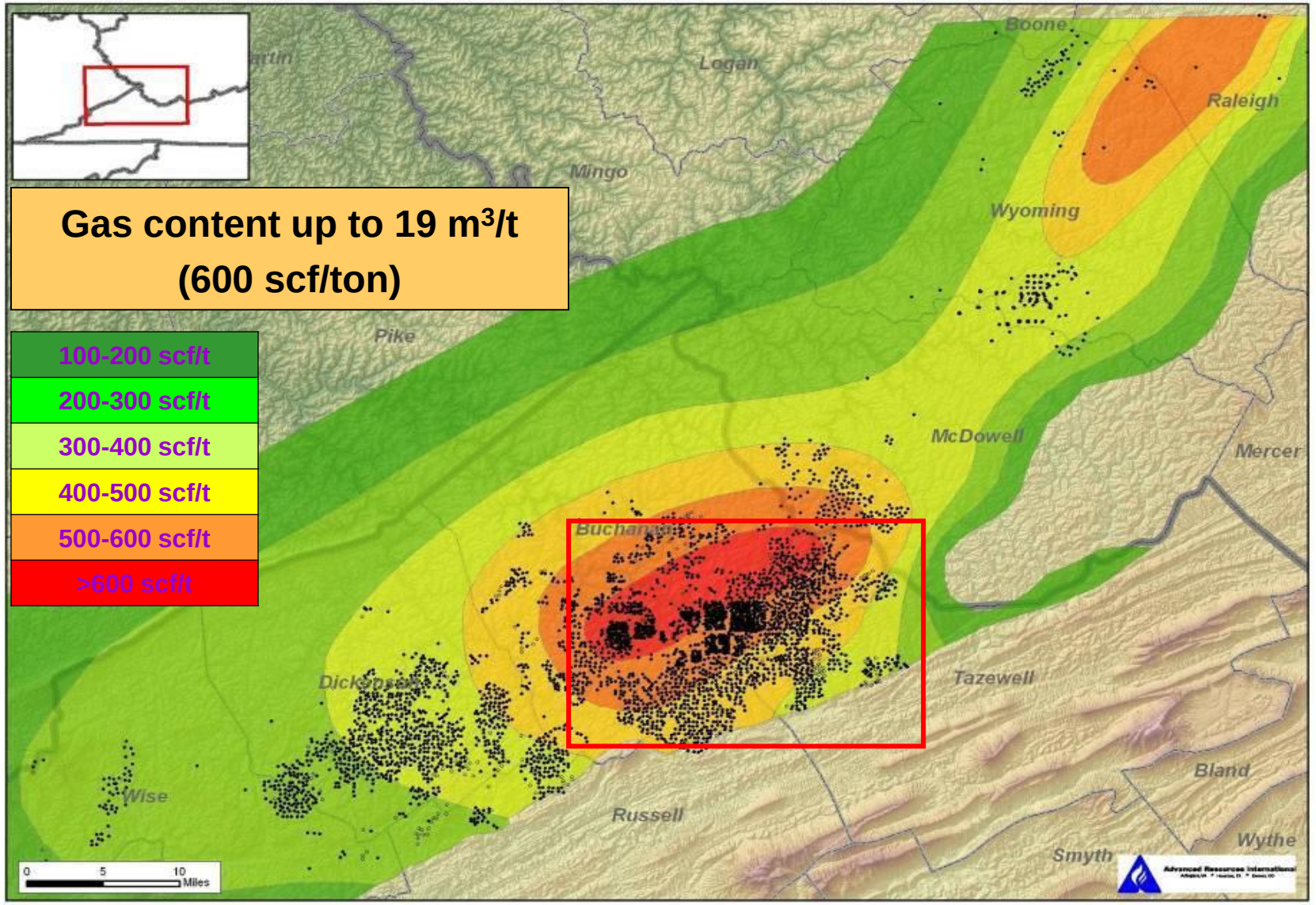
Coronado Coal/CNX, Virginia

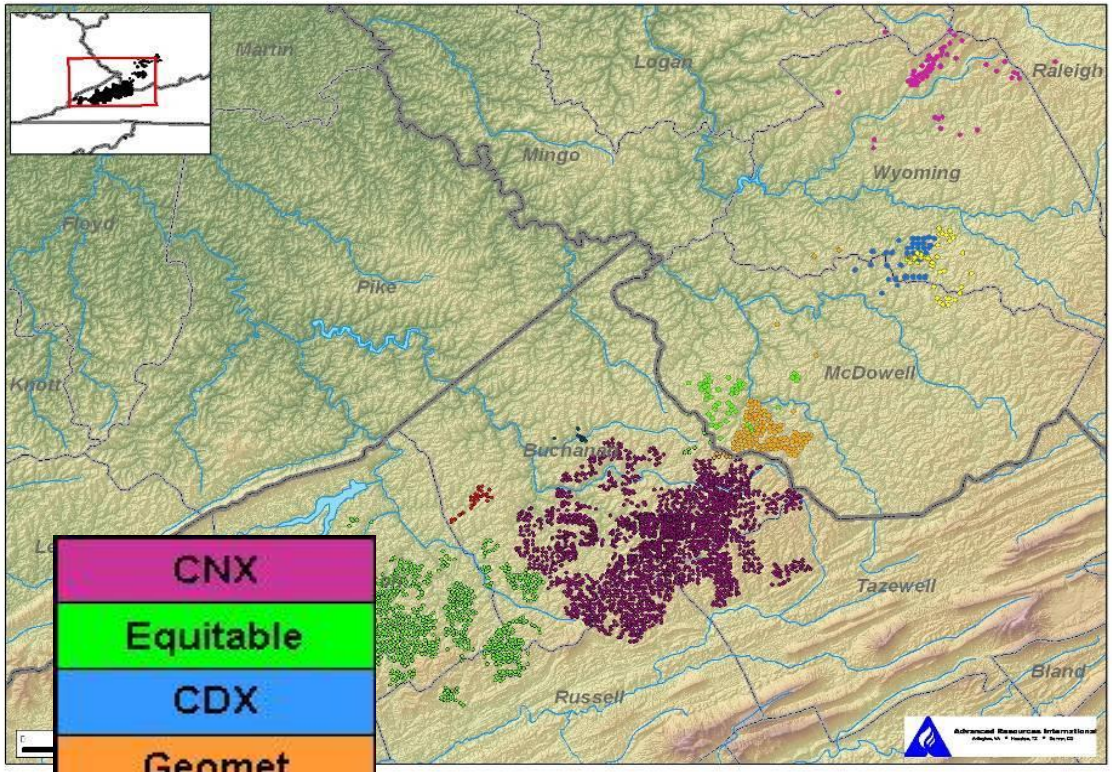
Central Appalachian Basin Coal Rank



Central Appalachian Basin Gas Content



Central Appalachian Basin
Virginia & W. Virginia CBM Development



Operator	Gross Gas (MMcf/D)	Producing Wells	Avg Per-Well (Mcfd/w)	Cum Gas (Bcf)
CNX Gas/Consol Energy	97.1	1109	88	285.1
Equitable	44.6	855	52	124.7
Penn Virginia	16.4	49	335	8.7
Geomet	11.3	146	77	7.0
CDX Gas	5.0	32	155	22.4
Other	2.2	20	111	7.2
Cabot	2.1	30	70	3.8
Pine Mountain	0.4	9	41	0.1
Total/Avg	**179.1**	**2250**	**80**	**459**

- Current production 5.1 Mm^3/d (179 MMcfd) from about 2250 wells, 2,290 $m^3/d/well$ (80 Mcfd/w).
- 13 Bm^3 (0.46 Tcf) produced to date, with estimated 57 B m^3 (2 Tcf) proved reserves.
- CNX Gas and Equitable Resources/Range Resources dominate.

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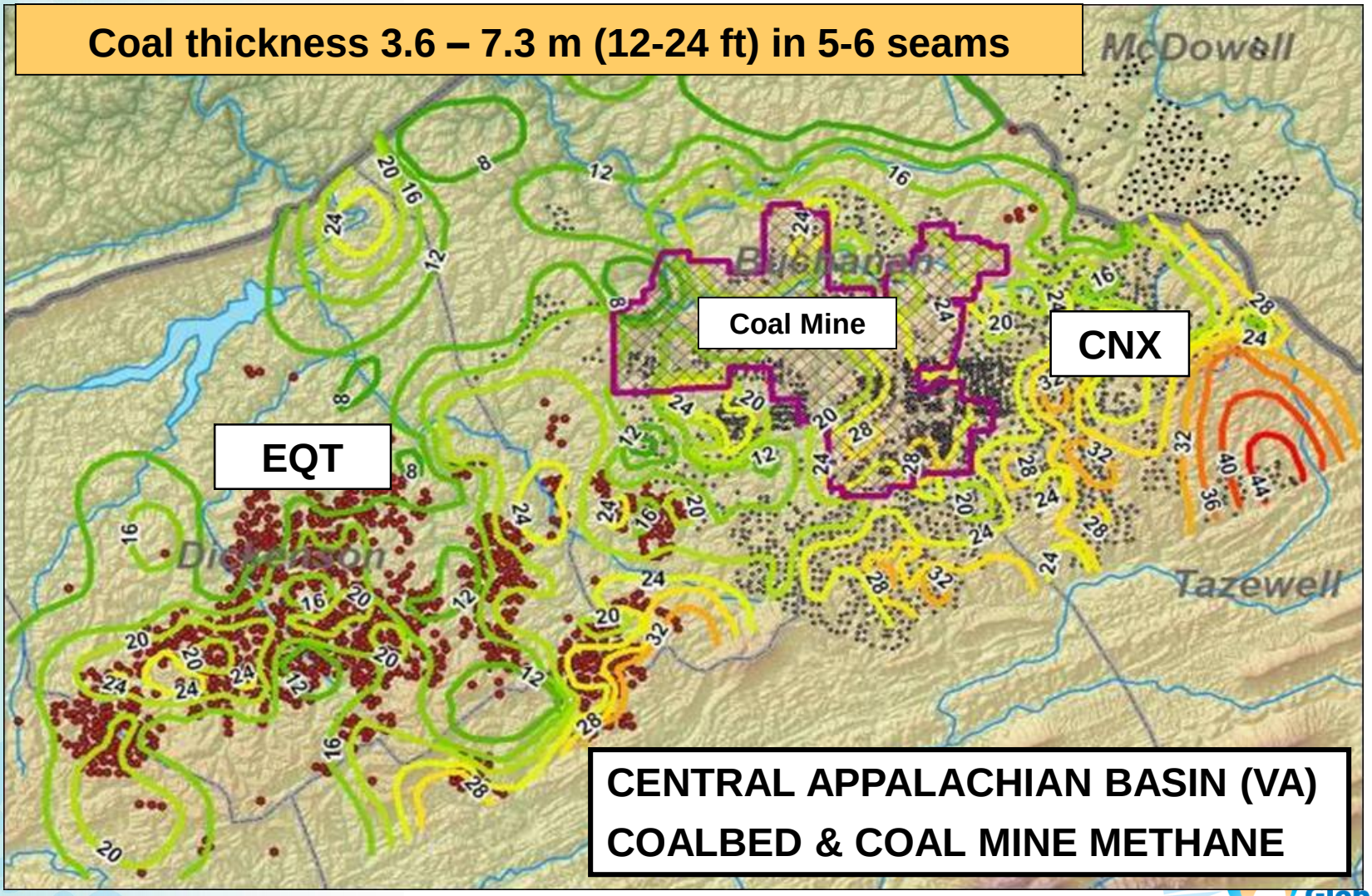
Enlarged Area of Buchanan County



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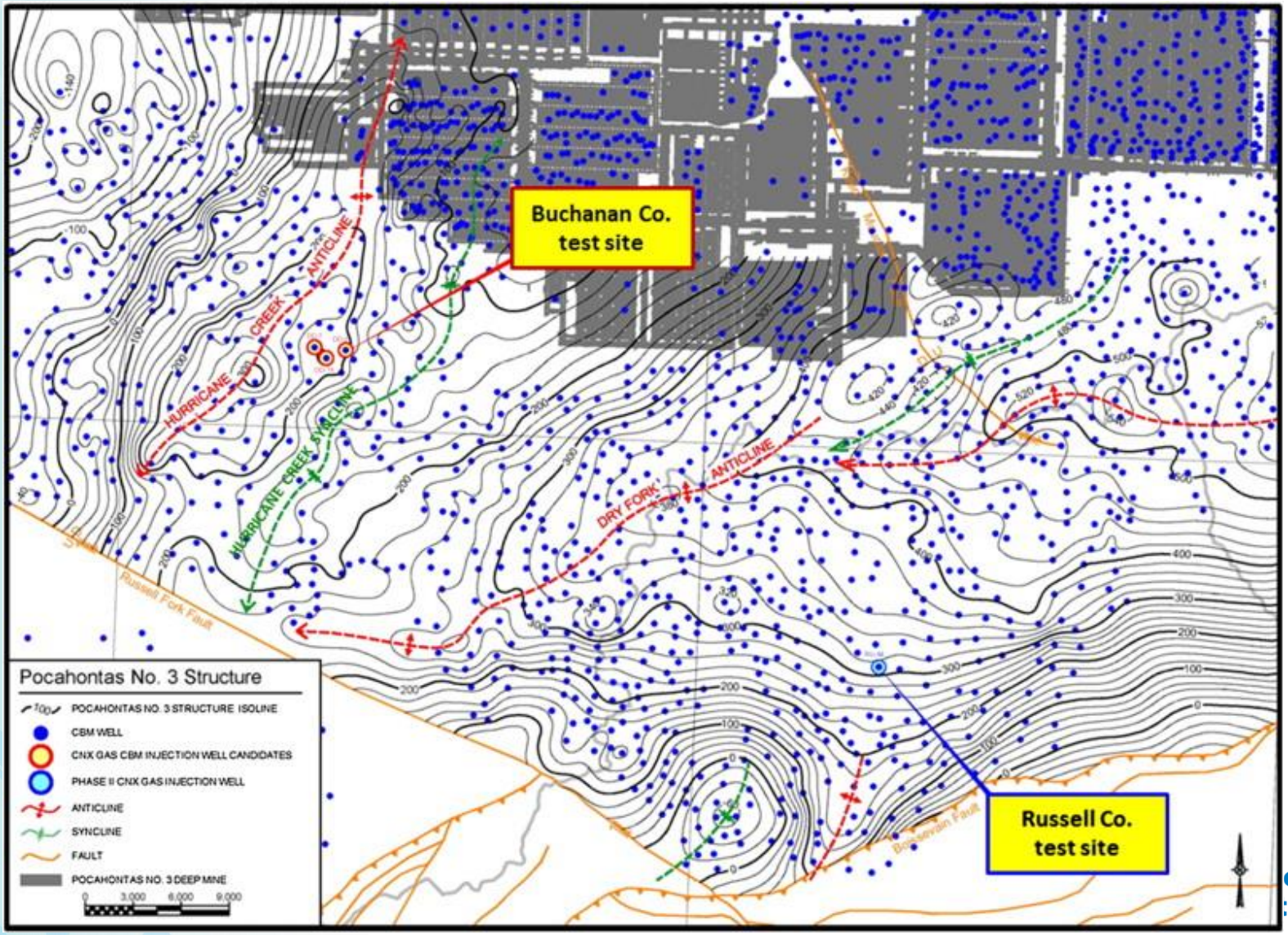
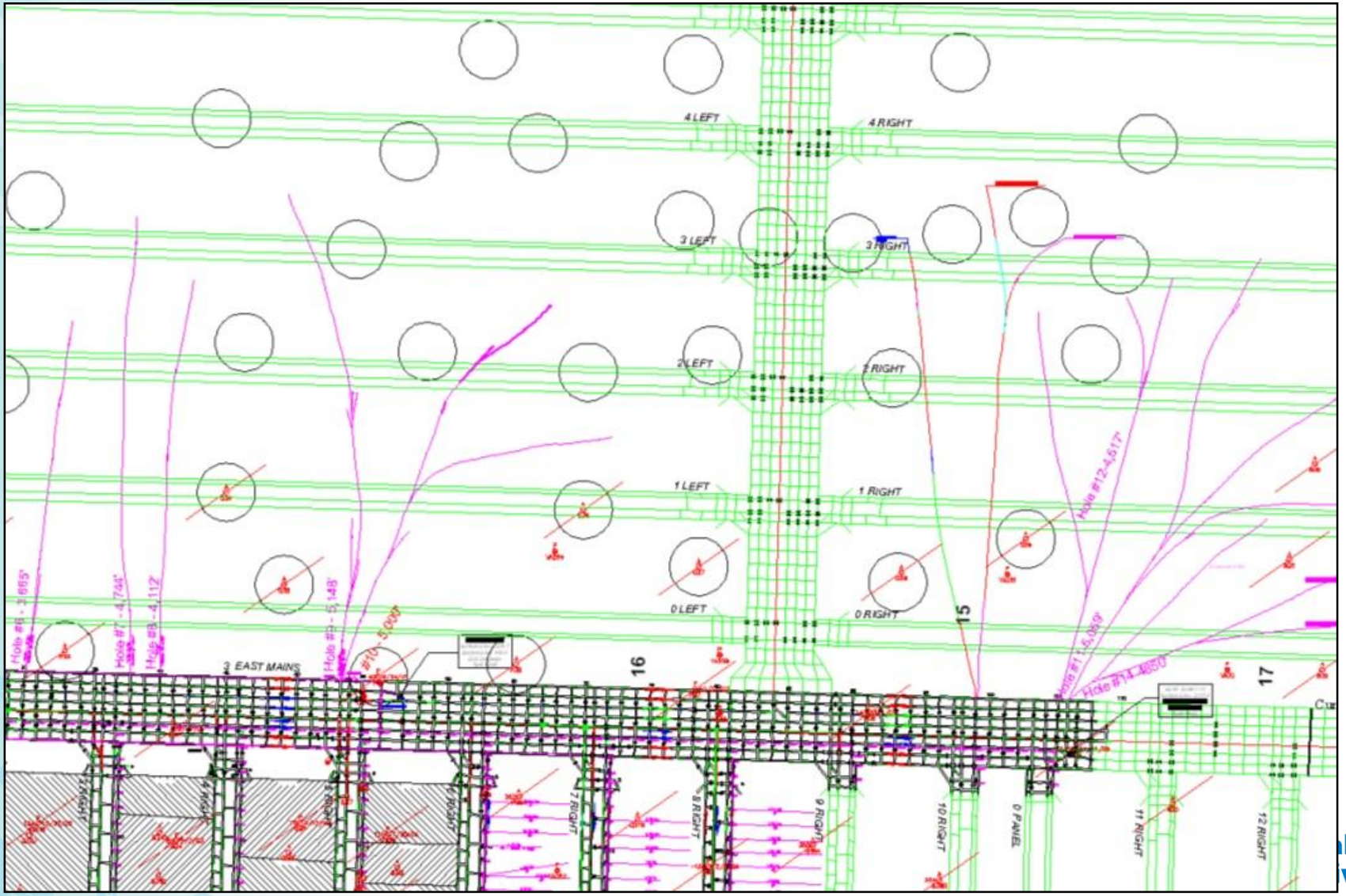
CBM Wells in Mining Area



CBM Wells in Buchanan Mine



Consol (now Coronado Coal)/CNX Buchanan and VP mines, SW Virginia

- Consol began an extensive pre-mine degasification program in the early 1990s that employed vertical frac wells, horizontal pre-mine boreholes, and vertical gob wells at their Buchanan and VP mines;
- The pre-mine vertical frac wells and in-mine horizontal boreholes produce 1.6 million cubic meters per day (58.5 MMcfd) of high quality (95%+ methane). The mine complex produces an additional 200,000 m^3 (7 MMcfd) from gob wells.
- There are multiple uses for the gas including:
  - Injection into the interstate pipeline system via 3, 500 mm diameter (20-inch) lines
  - Power generation for an 88 MW power plant owned jointly by Consol and Allegheny Energy
  - On-site usage for thermal coal drying

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Indian Potential

Indian Potential

- The highly successful Warrior Met and Consol projects demonstrate that coal and gas can be simultaneously produced both safely and profitably;
- The high grade metallurgical coal deposits of the Jharia Coalfields are similar to what is mined at the Warrior Met and Consol Mine: multiple, high rank coal seams with gas contents of up to 15 to 16 m^3/t (480 – 520 cf/ton);
- The recent policy change allowing CIL to extract CBM/CMM from within their mine blocks should help facilitate development;
- BCCL's planned Moonidih degasification project will introduce state-of-the-art in-mine directional drilling technology to the Indian mining industry;
- The completion of the GAIL pipeline through the Damodar Valley coalfield area will provide a ready market for the gas. The lifting of price controls on CBM will help improve project economics.

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Thank You!

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