

Fruitland Coal Infill
De Novo Hearing
HPA Geology and Engineering

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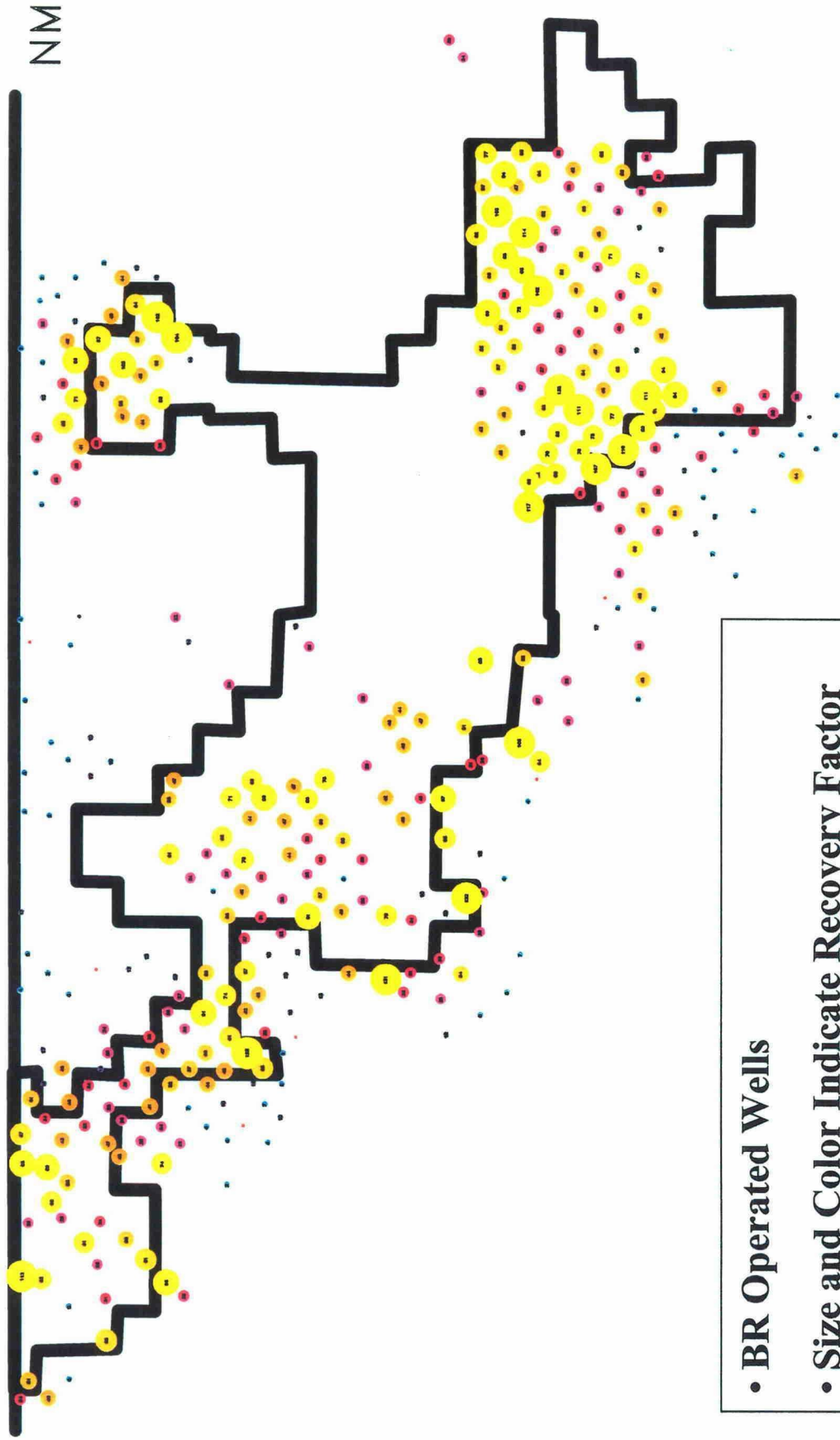
Outline – Reservoir Engineering Data

- Summary
- Recovery factor map
- Stranded gas
- Layered pressure testing
- Recovery estimates
- Conclusions

Summary – Reservoir Engineering Data

- New data is available since the July 2002 hearing
- Small amount of pressure reduction liberates large quantities of gas through infill drilling
- Reservoir and geological data indicate that significant amount of gas will be left in place in the HPA under current density
- 300 - 600 BCF of incremental gas will be recovered due to infill drilling in the HPA of the Fruitland Coal (New Mexico)

RECOVERY FACTOR



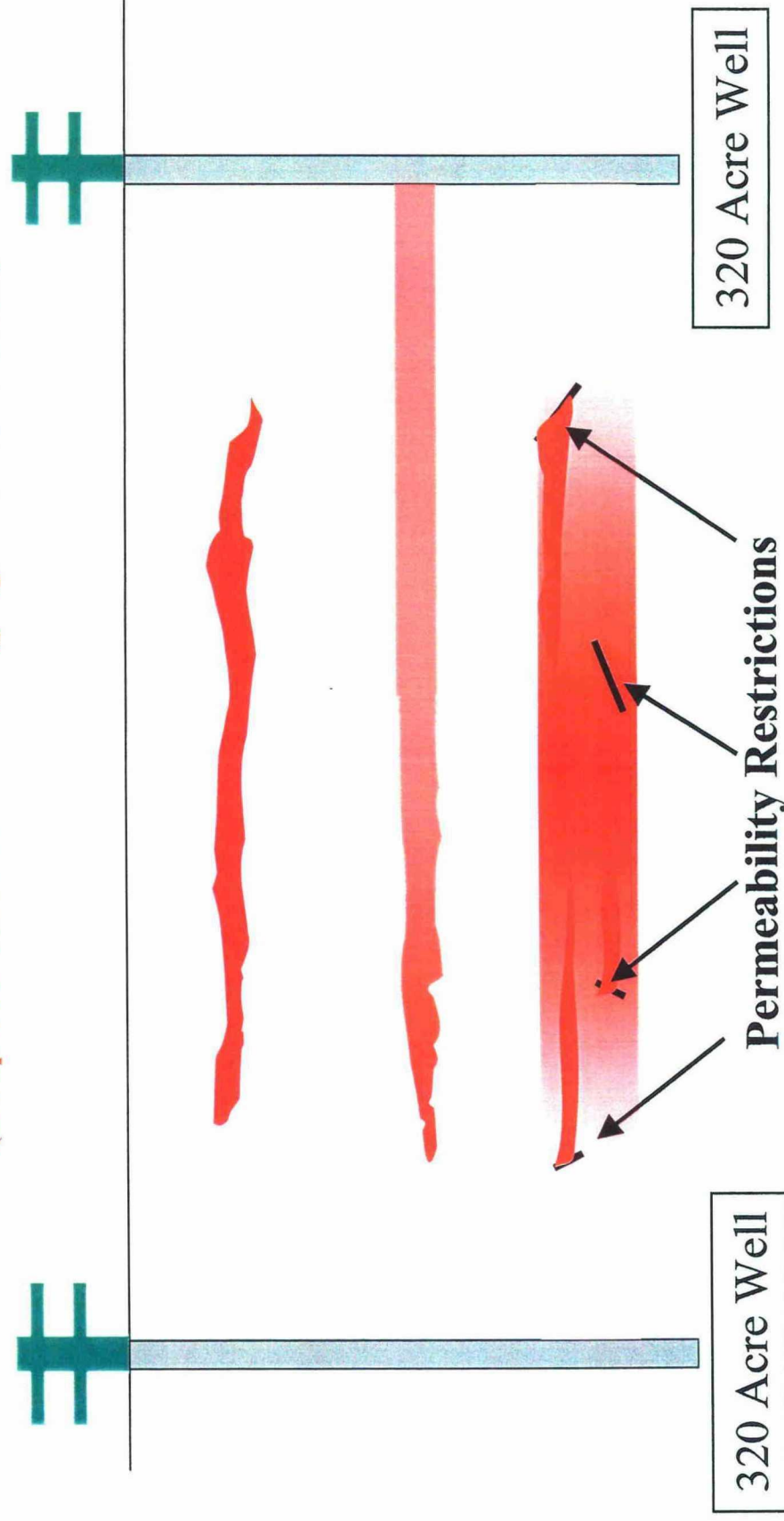
- BR Operated Wells
- Size and Color Indicate Recovery Factor
- High Degree of Variability

How is Gas Recoverable Through Infill Drilling?

- Gas is recovered by any reduction in reservoir pressure
- Even in perfectly homogeneous zones, additional gas is recovered
 - The Fruitland Coal is not homogeneous
- Gas is recovered in zones that are not effectively intersected by wells
- Gas is recovered in zones that are not intersected by existing wells

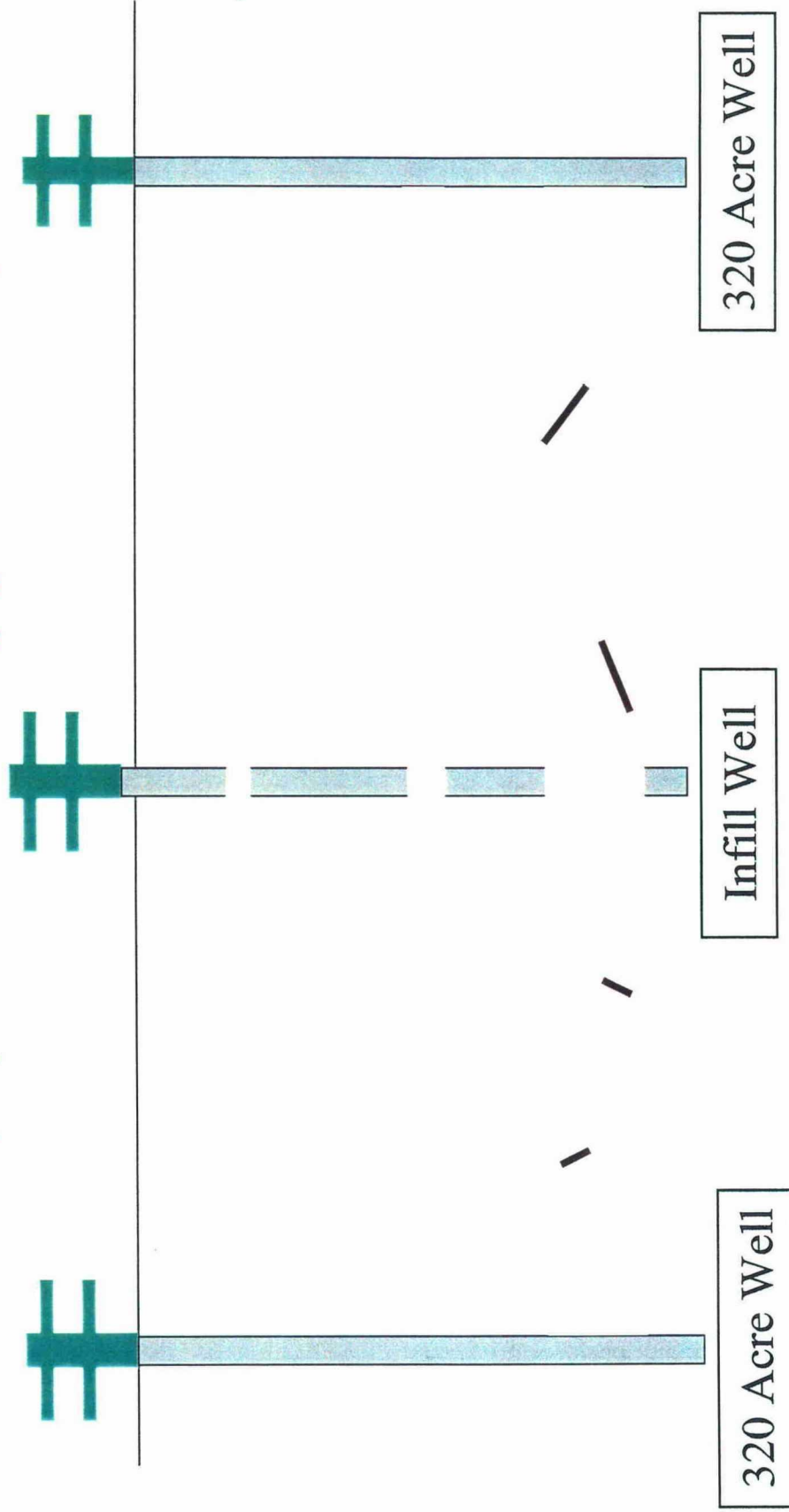
Stranded Gas – Abandonment Conditions

(Deep red color indicates high gas concentration)



Effect of Infill Well

(Deep red color indicates high gas concentration)



How Much Gas is Recoverable?

$$\text{Gas in Place} = 1359.7 Ah \bar{\rho}_c \bar{G}_c$$

$$\text{Gas Liberated} = 1359.7 Ah \bar{\rho}_c \Delta \bar{G}_c$$

Gas in Place (scf)

A = Area (Acres)

h = Thickness of Coal (ft)

ρ_c = Coal Density (g/cc)

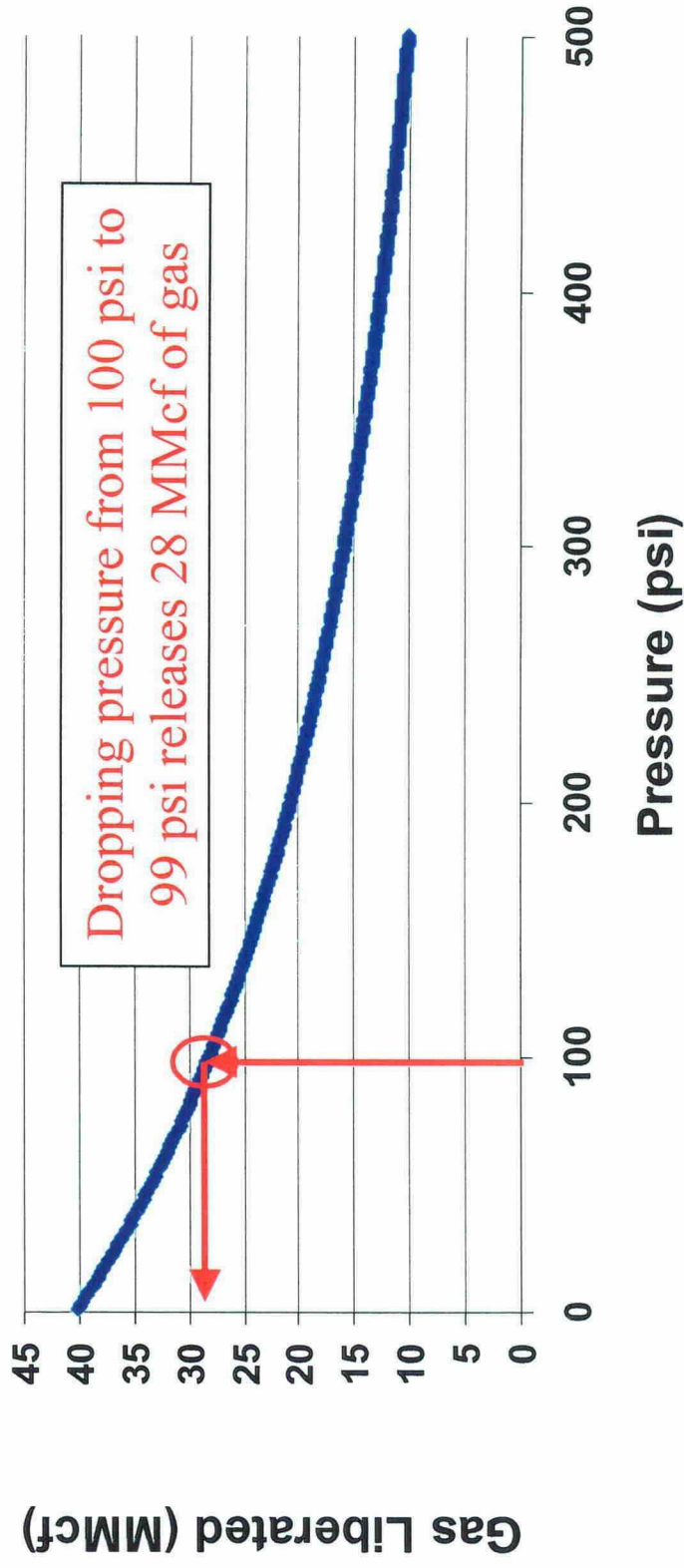
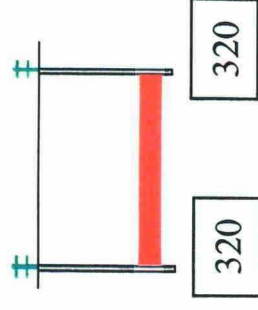
G_c = Gas Content - From Isotherm (scf/ton)

Gas Liberated (scf)

Delta G_c = Change in Gas Content - From Incremental Isotherm (scf/ton)

Simple Pressure Reduction

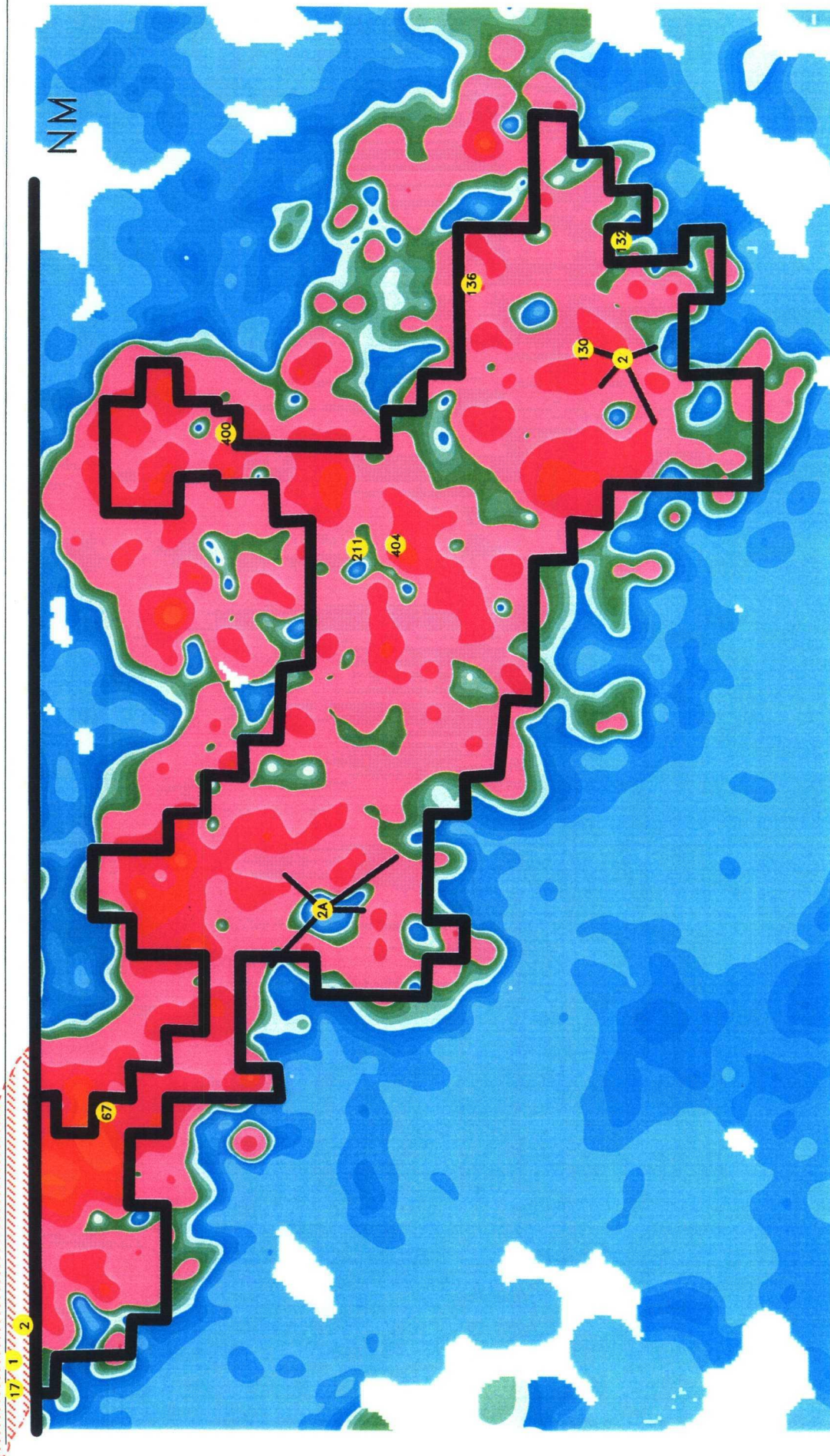
Incremental Isotherm
(Amount of gas liberated with a
1 psi drop in pressure)



Layered Pressure Tests in HPA

- Two types of wells were utilized for testing
 - Plug and abandon candidates (5)
 - Pressure observation wells (4)
- Testing consisted of isolating individual zones and taking pressure measurements
 - Temporary gauges (P&A's)
 - Permanent gauges (POW's)
- Locations of tests are widely dispersed across the HPA
- Locations of tests varied in proximity to parent wells
 - Six were in approximate infill locations ($\geq 1500'$ from parent well)
 - Nine possible infill locations including the 3 Devon wells
- Cost of BR Pressure Tests $\sim$ \$675M

POW/TEST WELL LOCATOR



Layered Pressure Testing Conclusions

- Coal is not being drained efficiently
- Coal is vertically heterogeneous (variable in quality)
- Single pressure does not fit all layers
- Differential depletion is occurring
 - Significant layers are not depleted
 - Thin layers can be productive

Testing Results HPA

<u>Well Name</u>	<u>Distance to Offset (ft)</u>	<u>Net Thickness (ft)</u>	<u>Measured Pressure (Psi)</u>	<u>Percent Recovered</u>	
Seymour #2A	2400	10	765	21%	- Heterogeneous - Differential Depletion - Coal is not being drained efficiently - Thick, higher pressure zones - Thin layers are productive
	2400	7	660	26%	
	1800	20	100	79%	
	1800	15	110	77%	
	1800	5	180	66%	
	1800	21	560	31%	
32 - 9 #67	2900	4	281	53%	
	410	2	482	36%	
	410	23	423	40%	
	410	30	550	32%	
UTE 17 POW	2650	2	1090	10%	
	2650	2	1075	11%	
	2650	2	1050	12%	
	2650	4	890	16%	
	2650	1	105	78%	
UTE POW #2	2650	1	495	35%	
	2650	2	185	65%	
	2650	45	110	77%	
UTE POW #1	2650	6	1089	10%	
	2650	45	95	80%	

Testing Results HPA (cont.)

<u>Well Name</u>	<u>Distance to Offset (ft)</u>	<u>Net Thickness (ft)</u>	<u>Measured Pressure (Psi)</u>	<u>Percent Recovered</u>	
30 - 6 #136	?	2	860	17%	• Heterogeneous
	1916	2	280	53%	• Differential
	1916	5	215	61%	Depletion
	1916	5	180	66%	
	1916	4	180	66%	
	1916	40	145	71%	
30 - 6 #130	1013	7	495	35%	• Coal is not being
	1013	1	345	47%	drained efficiently
	1013	25	130	73%	
	1013	12	190	64%	
	1013	19	320	49%	
30 - 6 #132	381	3	390	43%	• Thick, higher
	381	4	190	64%	pressure zones
	381	20	165	68%	
	381	10	270	55%	
	381	3	400	42%	• Thin layers are
30-6 POW #2	2400	7	1155	9%	productive
	2400	30	125	74%	
	2400	20	147	71%	

Recovery Estimate Methods

- Data Management
- Modified Material Balance (MMB)
- Reservoir Description

Recovery Estimate

(Data Management Method)

- Nine wells are in approximate infill locations
- Eight of the nine wells (89%) have at least one zone that is less than 35% depleted
- The average well will have almost 16' of this type of non-depleted coal (total of 142' of coal)
- The thickness-weighted average recovery factor is < 23% after 15 years of production
- Matching the recovery factor to date (on 142' of coal) by infilling will produce approximately 10,600 MMcf of gas, or 1200 MMcf/well
- Across the HPA, this results in an additional recovery of approximately 480 BCF from these zones alone

Recovery Estimate

(Data Management Method continued)

- Nine wells are in approximate infill locations
- One of the nine wells (11%) has at least one zone that is not depleted
- The average well will have $1\frac{1}{3}$ ' of this type of non-depleted coal (total of 12' of coal) – assume that it is 160 acres
- A 50% recovery factor applied to this 12' coal section results in an incremental recovery of 1 BCF total, or 105 MMcf/well
- Across the HPA, this results in an additional recovery of approximately 40 BCF from these zones alone.

Summary of Data Management Method

Unique Recovery Estimate: $480 + 40 = 520$ BCF

Recovery Estimate

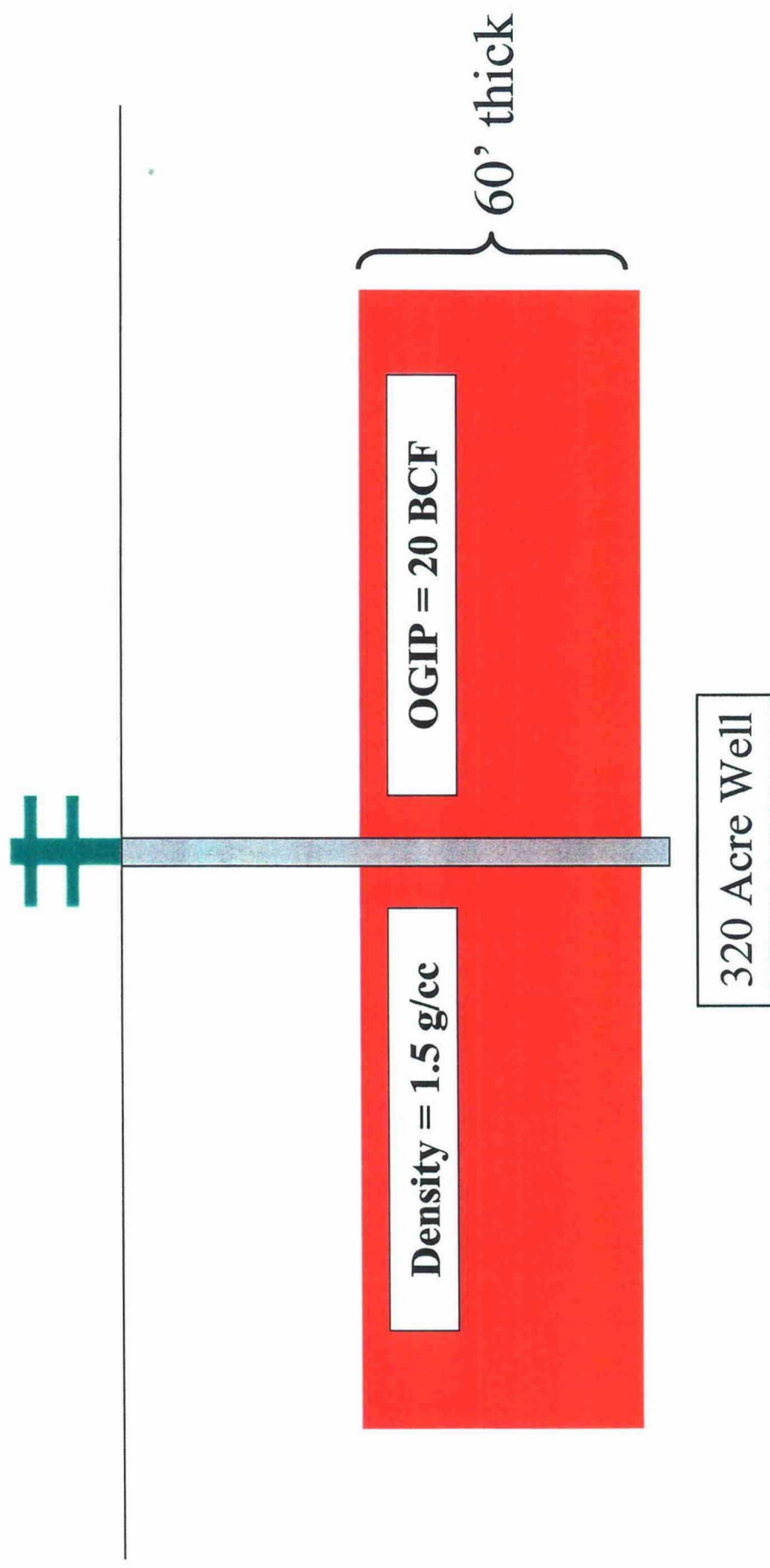
(Modified Material Balance Method)

Material balance is a proven, pressure and production based method for predicting future conditions

- MMB line was constructed to represent OGIP using data from the layered pressure tests
 - Thickness, density, Langmuir parameters
- Wells offset to the pressure tests were analyzed (46)
 - Estimated ultimate recovery = 11.5 BCF
- Offset well EUR imposed on MMB line for abandonment pressure calculation

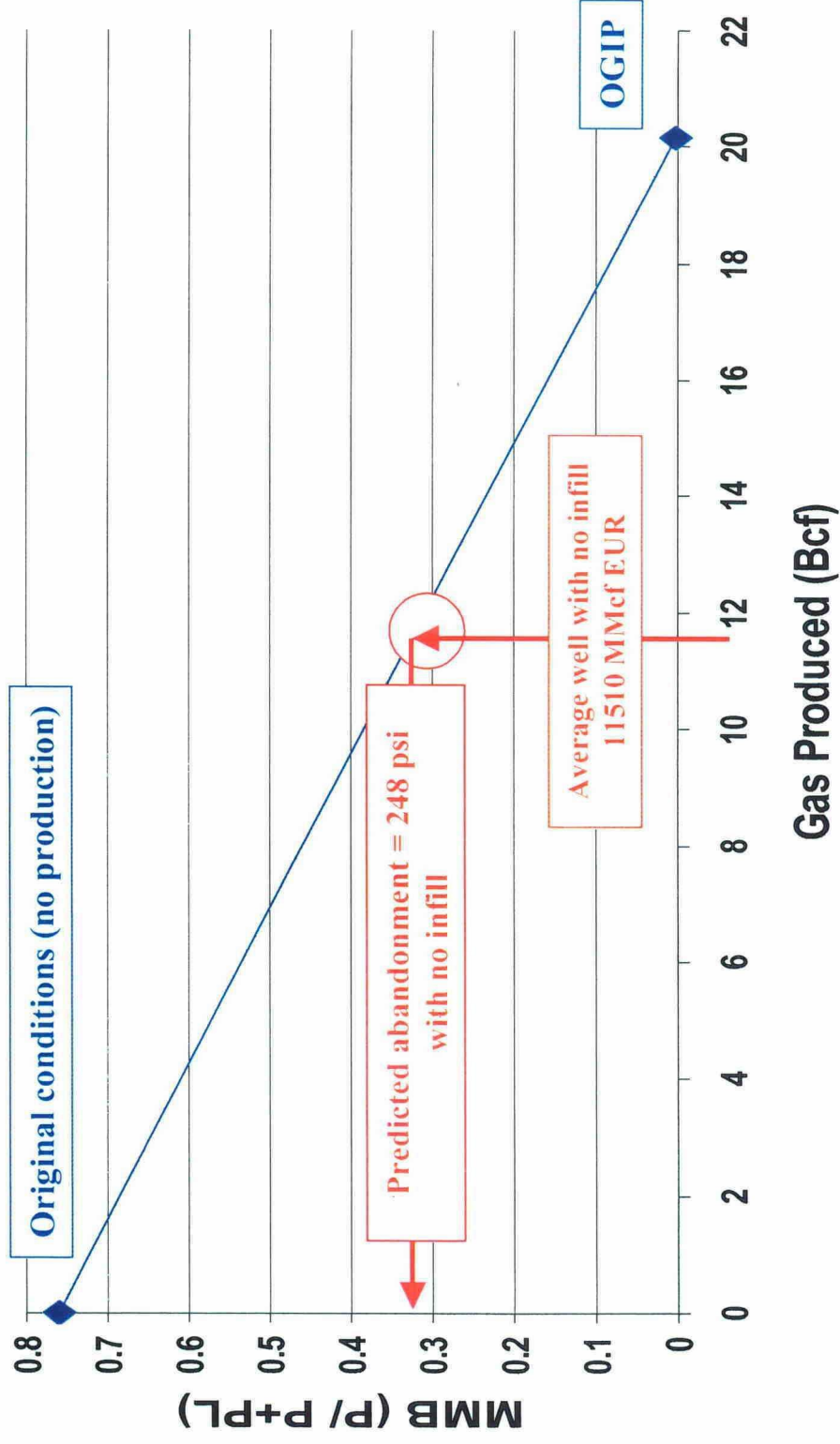
Well Schematic

(Properties calculated from layered pressure tests)



Recovery Estimate

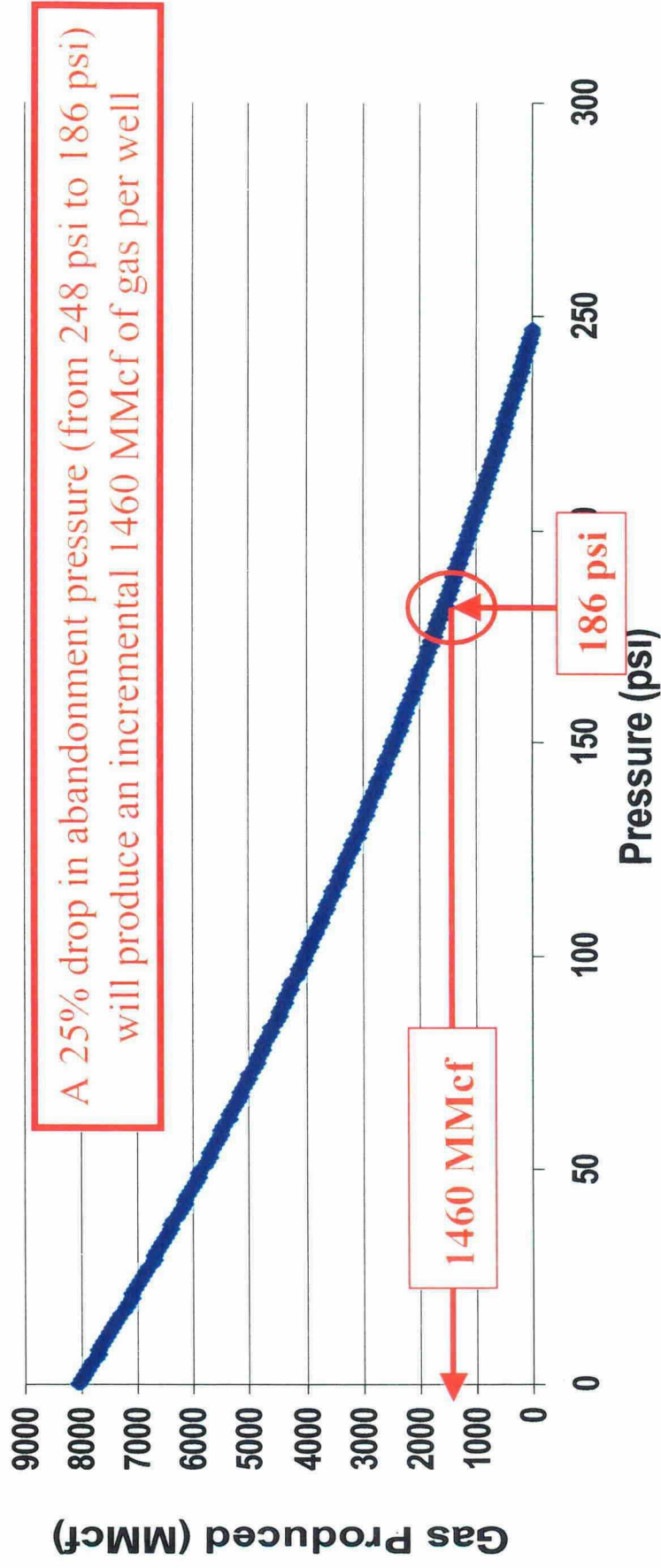
(Modified Material Balance Method)



Recovery Estimate

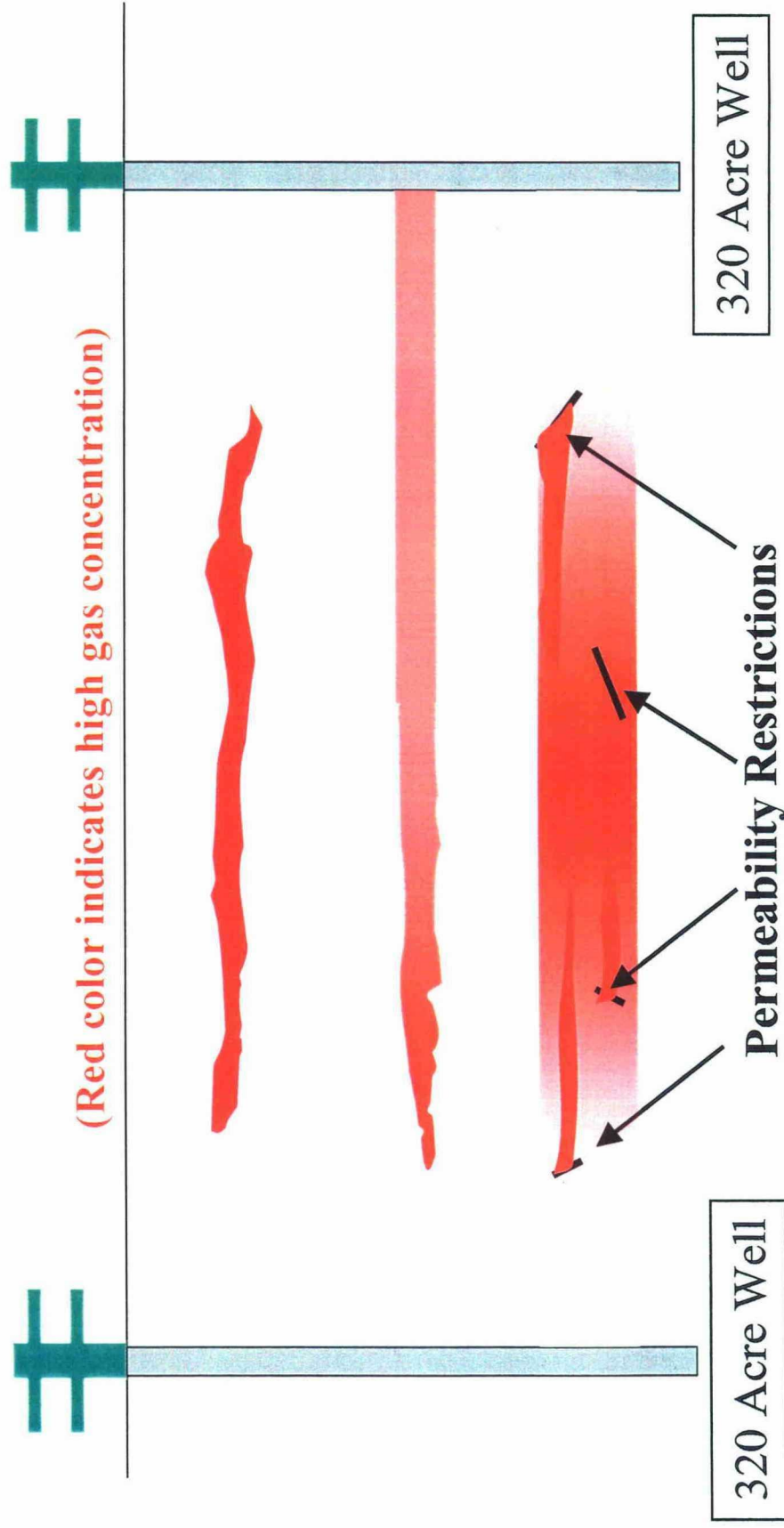
(Modified Material Balance Method)

Incremental Gas Produced with Lowering of Abandonment Pressure from Infill Drilling



Recovery Estimate

(Reservoir Description Method)

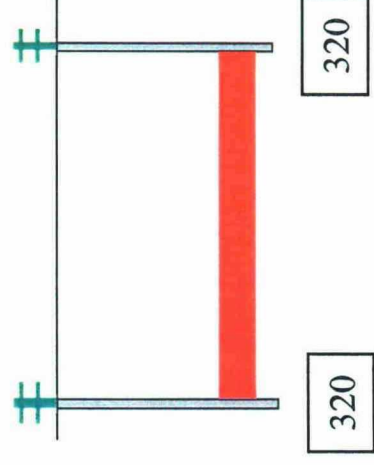


Recovery Estimate

(Reservoir Description Method)

- Simple Pressure Reduction -

- A ten psi drop in average reservoir pressure is achievable in prolific zones
- Results in a liberation of 260 MMcf/well.

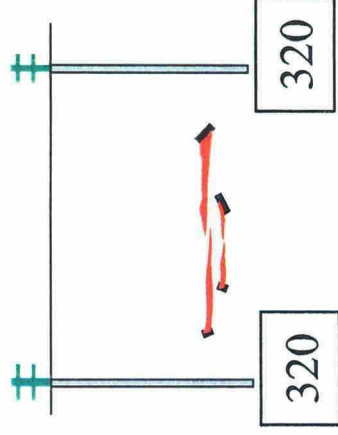


Recovery Estimate

(Reservoir Description Method)

- Permeability Restrictions -

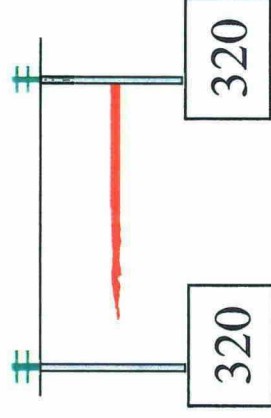
- An estimate of 10% of net pay is restricted over an extent of 160 acres
- Stranded gas OGIP is approximately 800 MMcf
- At an average recovery factor of 50%, an additional 400 MMcf of gas is recoverable



Recovery Estimate (Reservoir Description Method)

- In-effective Spacing -

- 50% of HPA wells have a zone that intersects only one 320 acre well
- The average thickness is 6' and the average pressure at abandonment is 248 psi.
- An infill well will reduce the average pressure to 186 psi.
- Results in average additional recovery of 55 MMcf/well

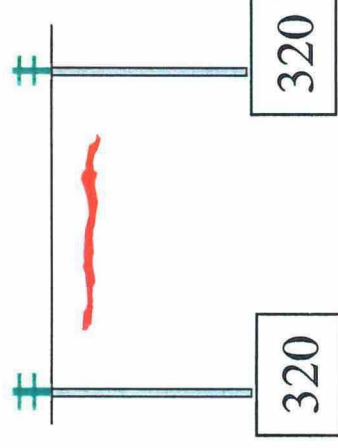


Recovery Estimate

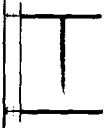
(Reservoir Description Method)

- Isolated Zones -

- 11% of HPA wells tested (1 of 9) have an isolated zone
 - Likely much higher
- The average thickness is 1.3 feet/well (12' in one well)
- At an average recovery factor of 50% an additional 105 MMcf/well is recoverable



Reservoir Description Method - Summary

Simple Pressure Reduction	260 MMcf	
Permeability Restrictions	400 MMcf	
In-efficient Spacing	55 MMcf	
Isolated Zones	<u>105 MMcf</u>	
Total	820 MMcf / Well	

Recovery Estimates – Summary

Method	Per Well (Bcf)	HPA (Bcf)
MMB	1.46	580
Data Management	1.30	520
Reservoir Description	0.82	330

Summary and Conclusions

Reservoir Engineering Data

- New studies have been performed since the July 2002 hearing
- The data is transferable across the HPA
- Three methodologies utilized to predict additional recovery
- Current 320 acre development does not adequately drain reserves in the HPA of the Fruitland Coal
- 300 – 600 BCF of incremental gas will be recovered due to infill drilling in the HPA of the Fruitland Coal