

# Coalbed Methane Development in the Western Canadian Sedimentary Basin:

## A Significant Emerging Resource for North America



# APF ENERGY

## Rocky Mountain Natural Gas 2004



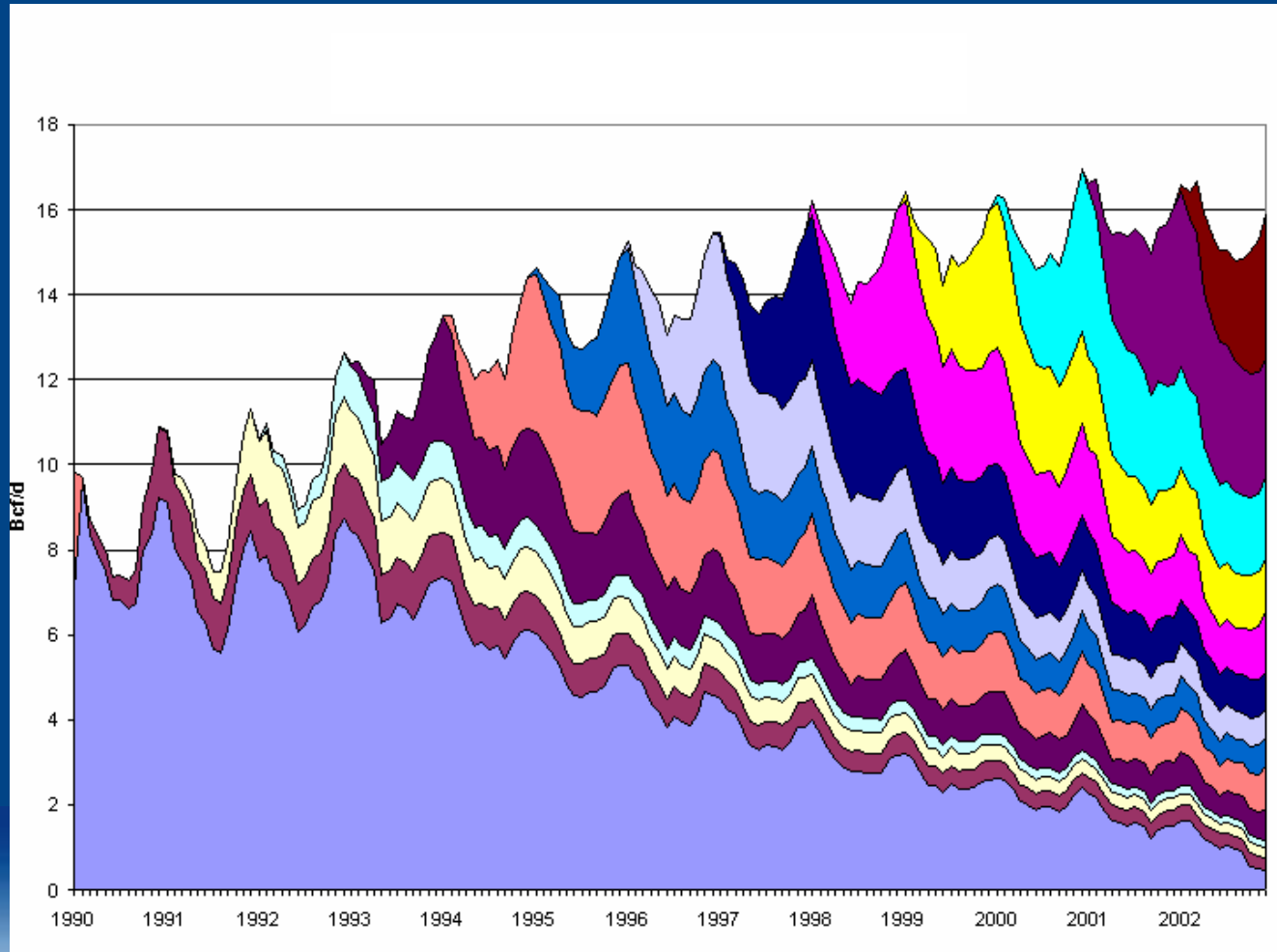
# CANADIAN CBM DEVELOPMENT



**A P F E N E R G Y**

**“FROM CONCEPT TO REALITY”**

# Western Canada Natural Gas Production Declines



Source: GMP Securities Ltd.



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# The WCSB Supply Challenge

	<u>1990</u>	<u>2000</u>	<u>2003</u>
Decline Rate (%)	8.0	18.0	20.3
WCSB Production (bcf/d)	<u>9.8</u>	<u>16.4</u>	<u>16.5</u>
Decline Volume (bcf/d)	0.8	2.9	3.4
Initial Productivity/Well (mmcf/d)	0.53	0.27	0.23
Reserve Life Index (years)	20	9	9
WCSB Supply Growth (bcf/d/yr)	0.60	0.00	(0.42)
Gas Well Connections	2,700	10,700	13,600
Cash Flow from Operations (\$billions)	7.00	31.10	39.60

Source: TransCanada Corporation April , 2004



# CBM Potential of North America



<b>Basins</b>	<b>Potential Resources (tcf)</b>	<b>Daily Production (mmcf/d)</b>	<b>Producing Wells</b>
WCSB	528	30 - 40	>700 drilled
San Juan	85	~2,000	>3,600
Powder River	39	~1,000	>11,000
Uinta	10	280	>580
Raton	10	~160	>1,100
Piceance	99	4	40-50

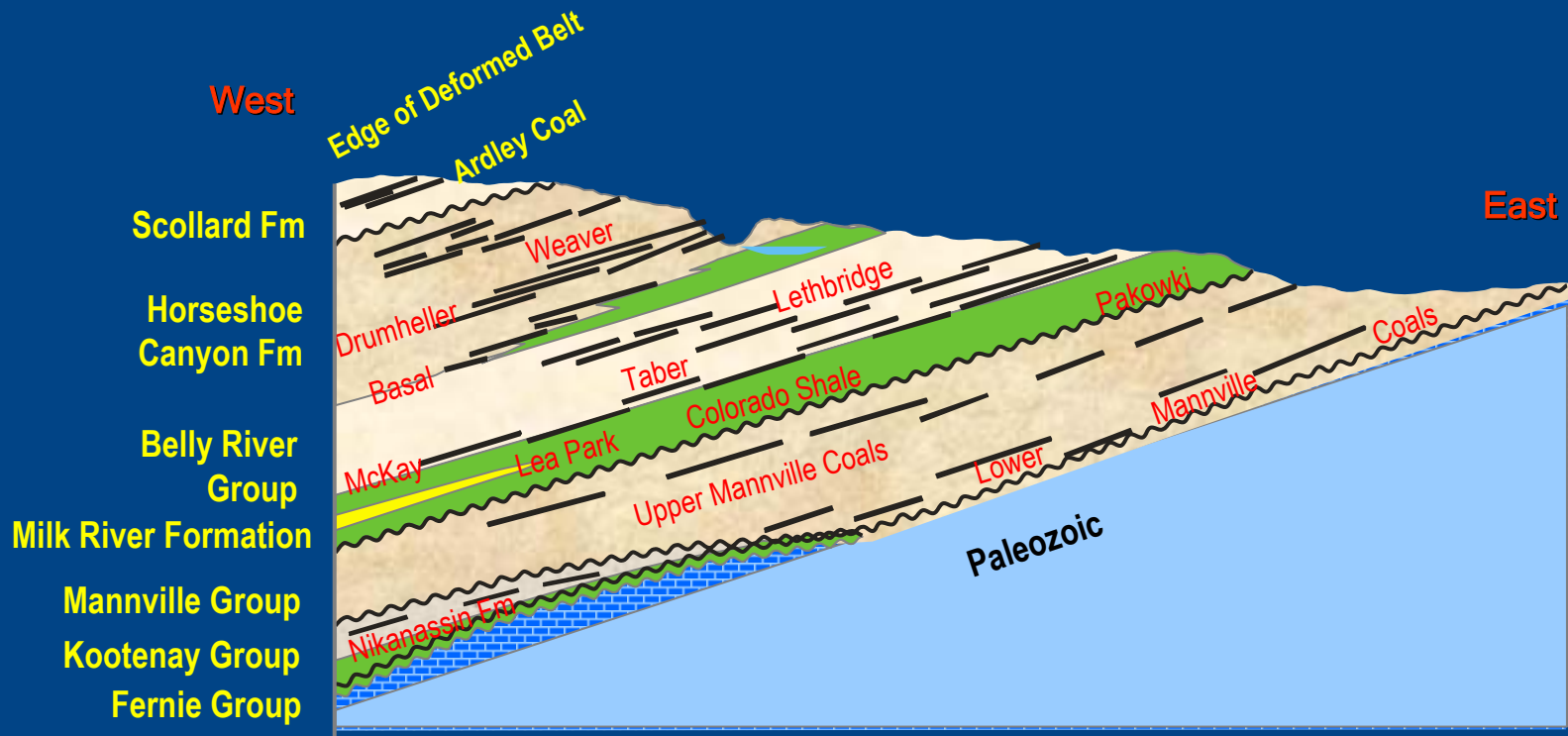
Source: Defiant Energy

# Tapping the Potential

- Total reserve potential of CBM estimated at 182-553 Tcf in western Canada
- Alberta Plains are estimated to contain 115-352 Tcf of CBM
- Current recoverable estimates for CBM are 43-130 Tcf



# Western Canadian Sedimentary Basin – Schematic Cross Section



Modified from CSUG NGC Technical Presentation, 03-2004

# North American CBM Basins - Comparison

<i>Basin</i>	<i>Coal bearing formation</i>	<i>Coal (feet)</i>	<i>gas content (scf/ton)</i>	<i>(bcf/section)</i>	<i>Avg. Perm. (md)</i>	<i>Water quality</i>
Alberta plains shallow	Horseshoe Canyon	15 – 35	25 - 75	1.5 – 3	1 - 10	Dry
	Scollard	10 – 50	50 - 120	3 – 9	1 - 10	Variable
Alberta plains deep	Upper Mannville	10 – 35	150 – 350	3 – 10	0.1 – 10	Saline
WCSB mountains and foothills	Mist Mountain & Gates	50 – 150	50 – 350	10 – 40	Variable	Variable
restricted basins – B.C.	Basin Dependent	Up to 500*	25 - 250	5 – 50	Unknown	Unknown
San Juan	Fruitland	70	225-350	15 – 20	20 – 50	Saline
Black Warrior	Pottsville	25	300 – 400	10 - 15	<10	Brackish
Uinta	Ferron	25	350 – 450	13 – 18	10 - 30	Saline
Powder	Fort Union	Up to 100	25 – 50	2 – 5	100 - 1000	Fresh
Raton	Raton	30	350	10 – 14	1 – 20	Fresh

Source: Defiant Energy



# Coal Distribution and Play Definition

Four distinct CBM play styles in Western Canada each of which has unique geological and reservoir characteristics

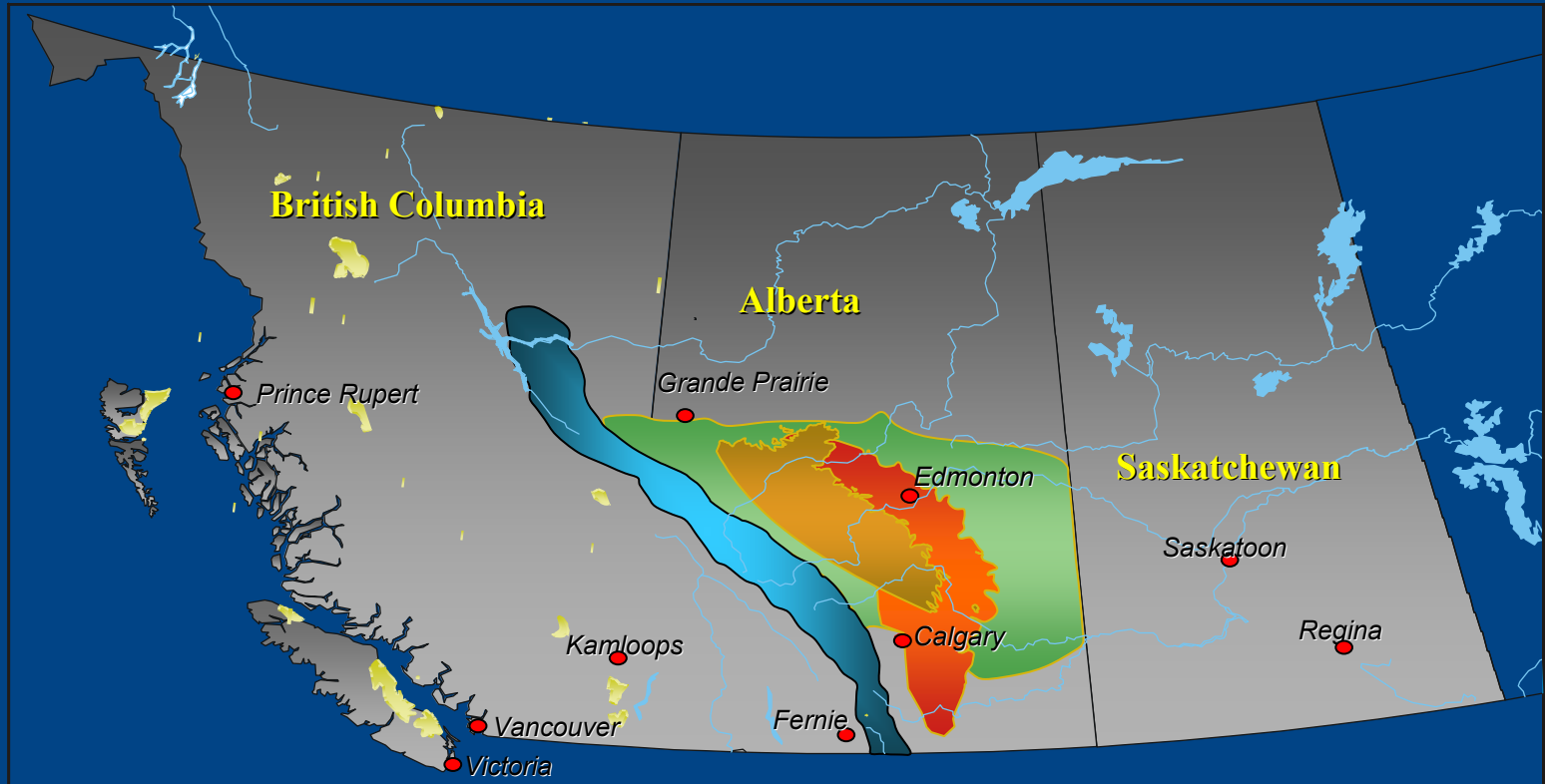
- Western Canada plains – shallow (Horseshoe Canyon/Scollard)
- Western Canada plains – deep (Upper Mannville)
- Cordilleran mountain and foothills (Gates)
- Restricted Basins - British Columbia



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Source: Defiant Energy

# Distribution of Major Coal-bearing Areas



Source: Defiant Energy



**Mannville Formation**  
**Horseshoe Canyon Formation**

**Mountains and Foothills**  
**Scollard Formation**

# Major Exploration Areas: Alberta Plains Shallow – Scollard Fm

## Scollard

Cum coal thickness (metres)	1-20
Natural gas content (scf/ton)	30-130
Depth range (metres)	0-700
Resource base (bcf/section)	2-8
Total resources - GIP (tcf)	20-40
Well costs (\$Cdn)	250,000
Time to production (months)	variable
Water quality	variable

## Pilot projects

- Enerplus
- Penn West
- Bonterra

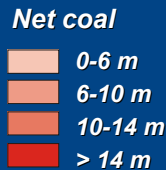


	Foothills/Mountains	Plains	Major Coal Zones	
Tertiary	Paskapoo	Paskapoo	Obed	
	Coalspur	<b>Scollard</b>	<b>Ardley</b>	
Upper Cretaceous	Saunders Gp	Entrance Cgl		
		Battle/Whitemud	Carbon/Thompson/Drumheller	
	Brazeau	Wapiti	Horseshoe Canyon	
		Belly River Gp	Bearpaw	Lethbridge
			Oldman	Taber
	Alberta Gp	Foremost	McKay	
			Lea Park	
Lower Cretaceous	Luscar Gp	Colorado Gp		
		Mannville Gp	Luscar/Mannville	
Jurassic	Kootenay Gp/Nikanassin		Kootenay	

# Major Exploration Areas: Alberta Plains shallow - Horseshoe Canyon Fm

## Horseshoe

Cum coal thickness (metres)	1-12
Natural gas content (scf/ton)	30-150
Depth range (metres)	0-800
Resource base (bcf/section)	2-3
Total resources - GIP (tcf)	15-20
Well costs (\$Cdn)	250,000
Time to production (months)	0-1
Water quality	dry



	Foothills/Mountains	Plains	Major Coal Zones		
Tertiary	Paskapoo	Paskapoo	Obed		
	Coalspur	Scollard	Ardley		
Upper Cretaceous	Entrance Cgl				
	Saunders Gp		Battle/Whitemud	Carbon/Thompson/Drumheller	
		Brazeau	Wapiti	Horseshoe Canyon	
			Belly River Gp	Bearpaw	Lethbridge
				Oldman	Taber
				Foremost	McKay
Alberta Gp	Lea Park				
Lower Cretaceous		Colorado Gp			
	Luscar Gp		Mannville Gp	Luscar Mannville	
		Gates			
		Moosebar			
		Gladstone			
Cadomin					
Jurassic	Kootenay Gp/Nikanassin		Kootenay		

Source: Defiant Energy

# Major Exploration Areas: Alberta Plains Deep – Upper Mannville Fm

## Upper Mannville

Cum coal thickness (metres)	1-12
Natural gas content (scf/ton)	175-330
Depth range (metres)	800-2000
Resource base (bcf/section)	5-12
Total resources - GIP (tcf)	150-170
Well costs (\$Cdn)	750,000
Time to production (months)	12-18
Water quality	saline

## Pilot projects

- Centrica / APF
- Trident
- Thunder
- Burlington



	Foothills/Mountains	Plains	Major Coal Zones	
Tertiary	Paskapoo	Paskapoo	Obed	
	Coalspur	Scollard	Ardley	
Upper Cretaceous	Saunders Gp	Entrance Cgl		
		Battle/Whitemud	Carbon/Thompson/Drumheller	
	Brazeau	Wapiti	Horseshoe Canyon	
			Bearpaw	Lethbridge
		Belly River Gp	Oldman	Taber
	Lower Cretaceous	Luscar Gp	Foremost	McKay
			Lea Park	
Colorado Gp				
		<b>Mannville Gp</b>	Luscar Mannville	
Jurassic	Kootenay Gp/Nikanassin		Kootenay	

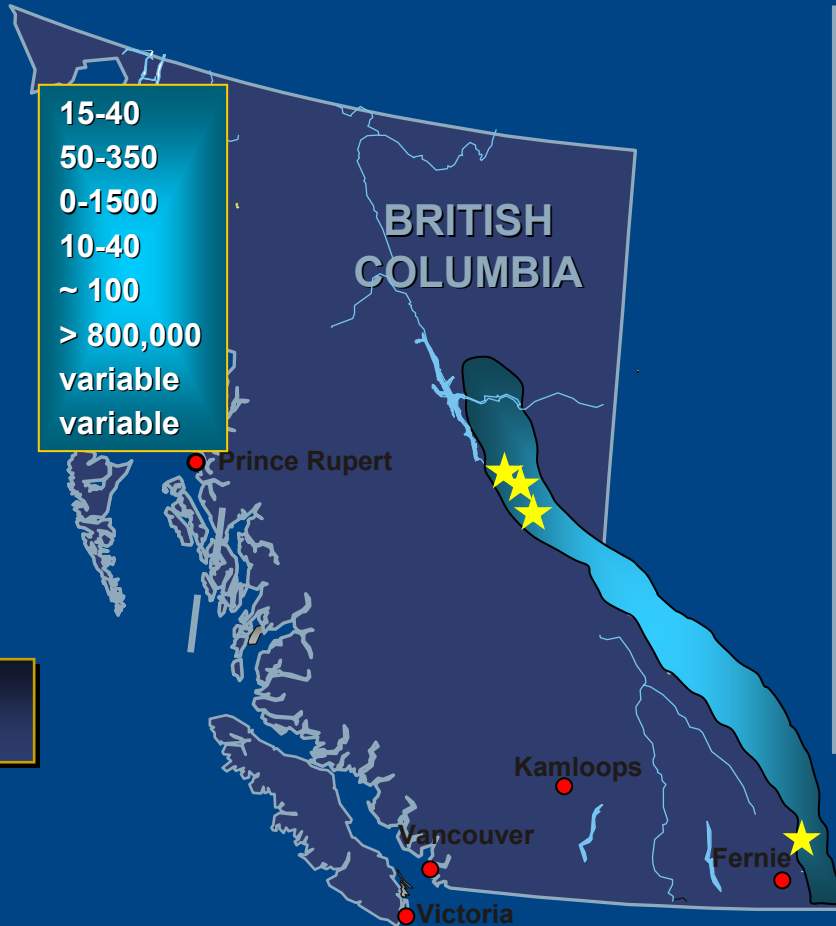
Source: Defiant Energy

# Major Exploration Areas: WCSB - Mountains and Foothills

Cum coal thickness (*metres*)  
 Natural gas content (*scf/ton*)  
 Depth range (*metres*)  
 Resource base (*bcf/section*)  
 Total resources-GIP (*tcf*)  
 Well costs (*\$cdn*)  
 Time to production (*months*)  
 Water quality

15-40  
 50-350  
 0-1500  
 10-40  
 ~ 100  
 > 800,000  
 variable  
 variable

**Pilot projects**

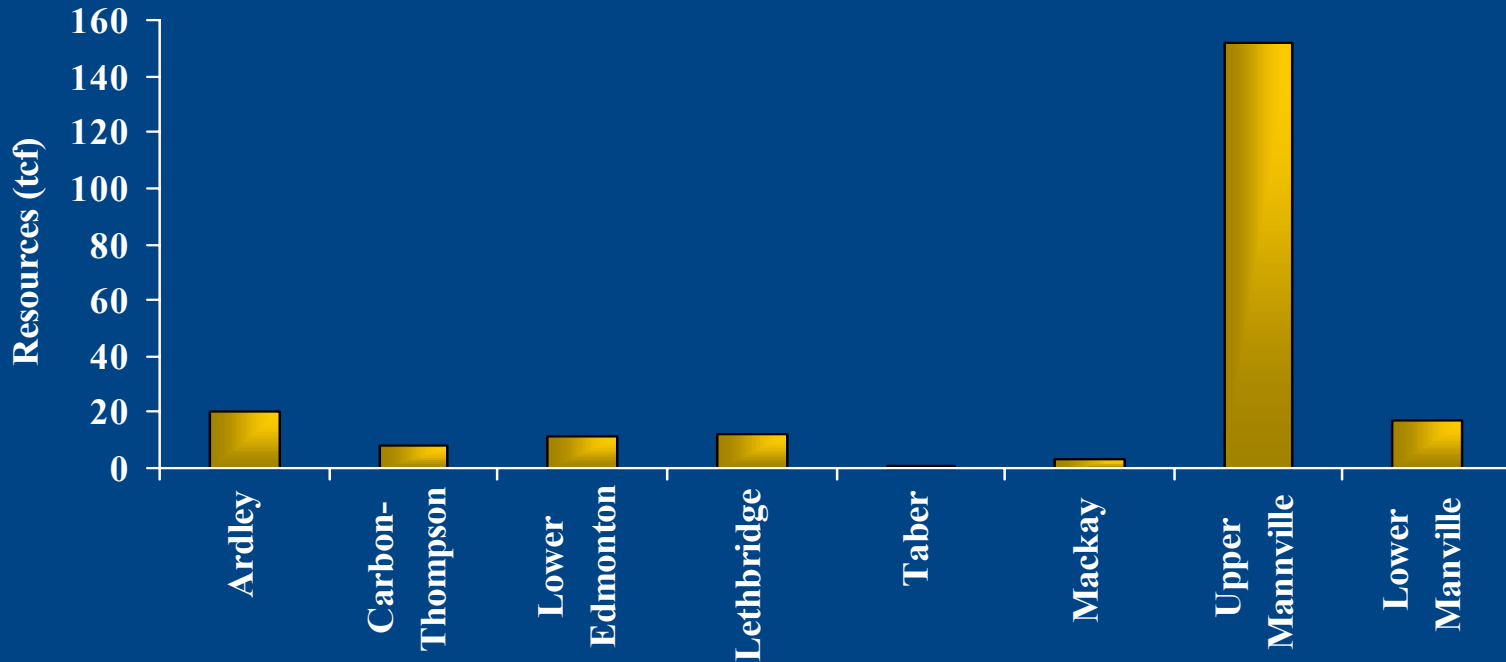


	Foothills/Mountains	Plains	Major Coal Zones	
Tertiary	Paskapoo	Paskapoo	Obed	
	Coalspur	Scollard	Ardley	
Upper Cretaceous	Saunders Gp	Entrance Cgl		
		Battle/Whitemud	Carbon/Thompson Drumheller	
	Brazeau	Wapiti	Horseshoe Canyon	
			Bearpaw	Lethbridge
	Belly River Gp	Oldman	Taber	
		Foremost	McKay	
Lower Cretaceous	Alberta Gp	Lea Park		
		Colorado Gp		
Lower Cretaceous	Luscar Gp	Gates	Luscar Mannville	
		Moosebar		
		Gladstone		
		Cadomin		
Jurassic	Kootenay Gp		Kootenay	
	Nikanassin			

Source: Defiant Energy

# Clear Opportunity

Alberta Plains In Situ Coalbed Methane Resources By Coal Zone



Source: Sproule

**Largest potential exists in the Upper Mannville coals**



# Critical success factors for Western Canadian CBM play types

## *Alberta Plains – Horseshoe Canyon Formation*

- low cost drilling and completion techniques
- well established land base and low royalty structure
- co-mingling of all coal beds in stratigraphic section
- serendipity of conventional reservoirs
- existing low pressure surface infrastructure
- strong gas prices

## *Alberta Plains – Scollard Formation*

- low cost drilling and completion techniques
- well established land base and low royalty structure
- cost effective water disposal options
- strong gas prices





# Critical success factors for Western Canadian CBM play types

## *Alberta Plains – Mannville Formation*

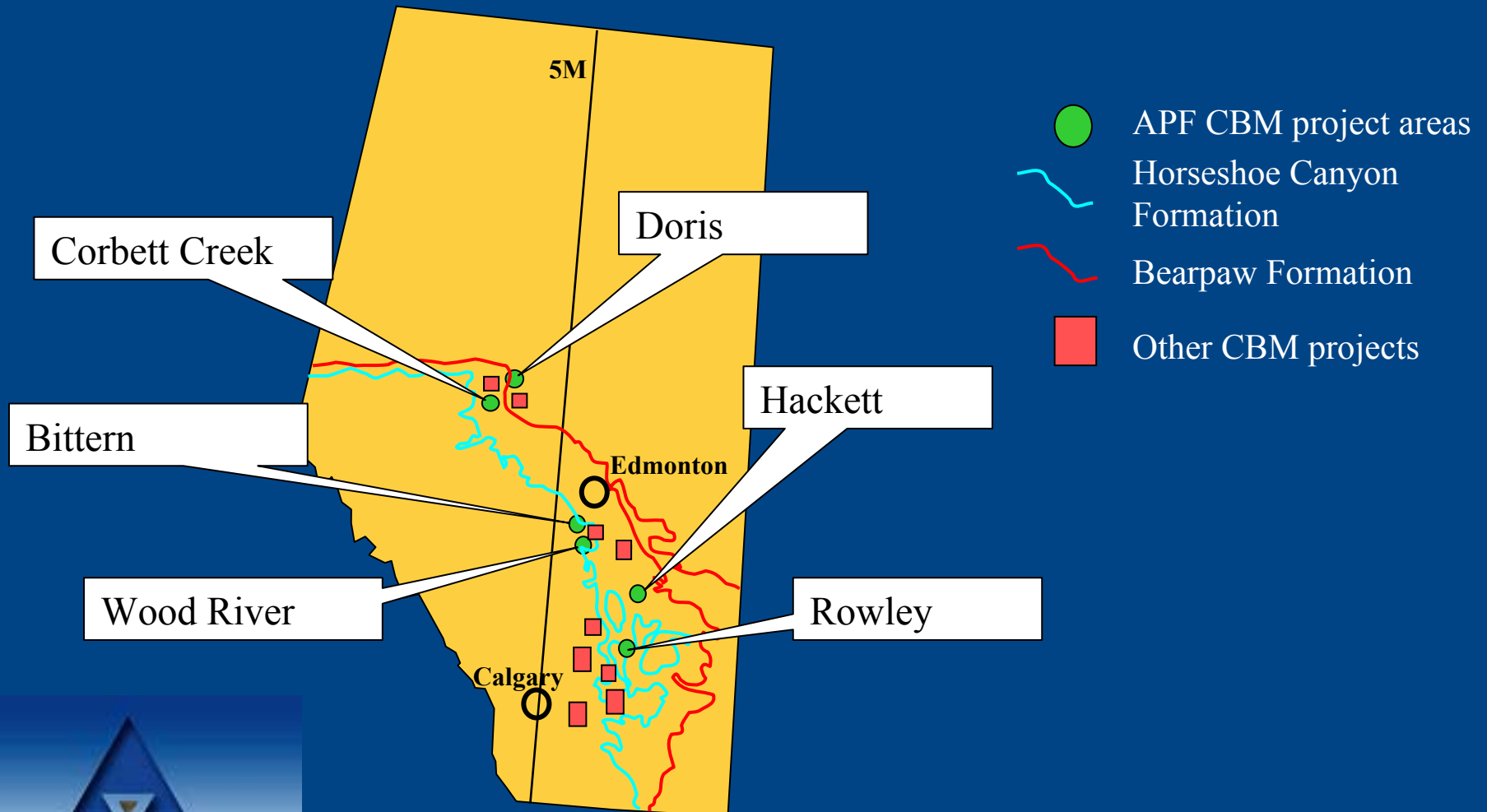
- low cost drilling and completion techniques
- well established land base and low royalty structure
- serendipity of conventional reservoirs
- effective dewatering of reservoir through critical mass of production wells
- existing low pressure surface infrastructure

## *WCSB Foothills and Mountains*

- low cost drilling and completion techniques
- well established land base and low royalty structure
- cost effective water disposal options
- application of new drilling and completion technology to overcome permeability and coal fabric barriers (sheared coals)



# APF Alberta CBM Projects

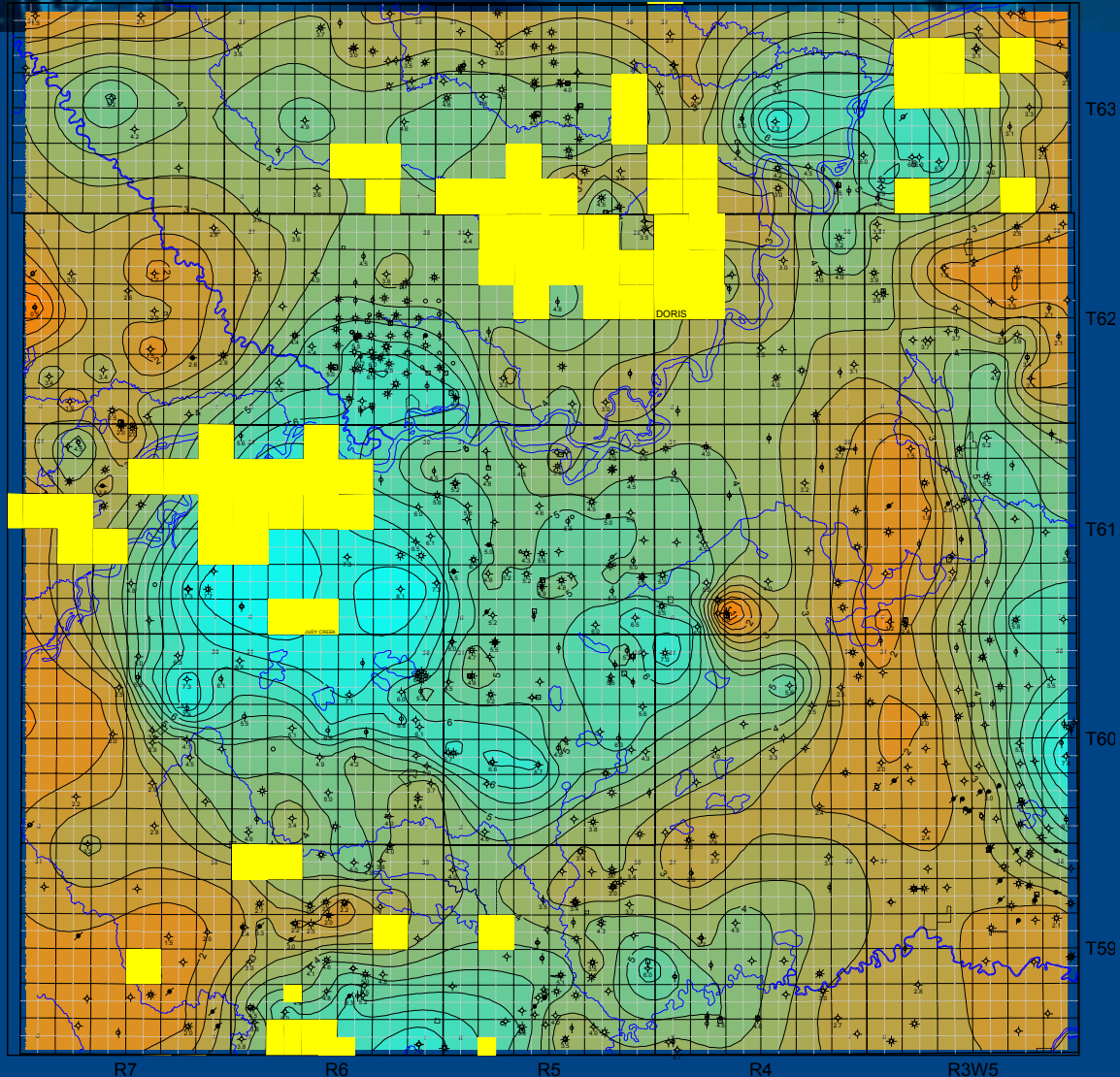


# APF Alberta Upper Mannville CBM Projects



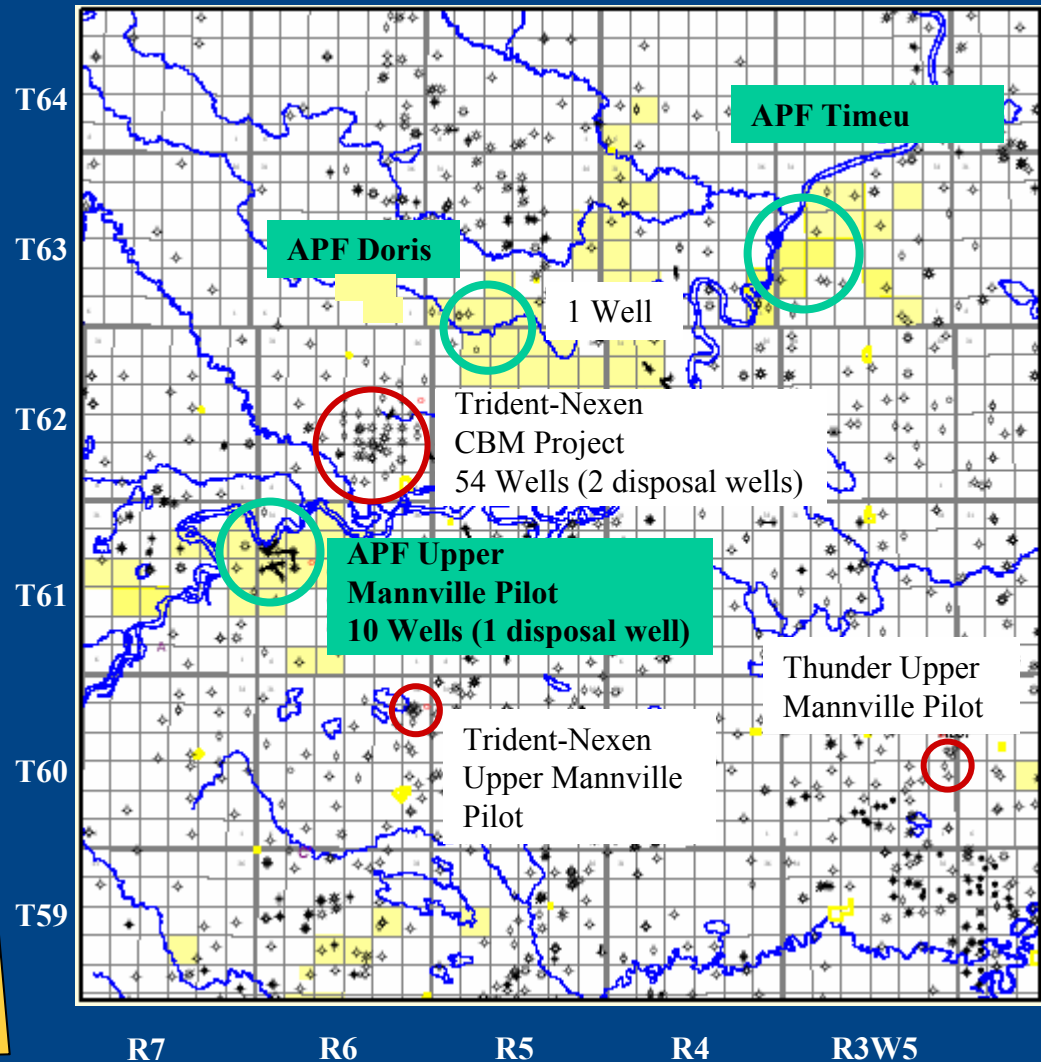
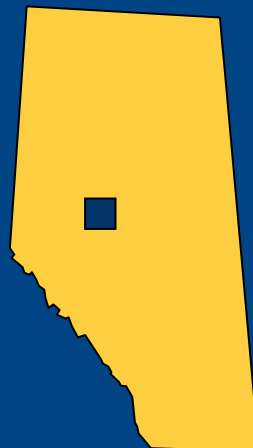
# Corbett CBM Project

- Cum thickness of Mannville coals depicted.
- Light blue is maximum total thickness of coal



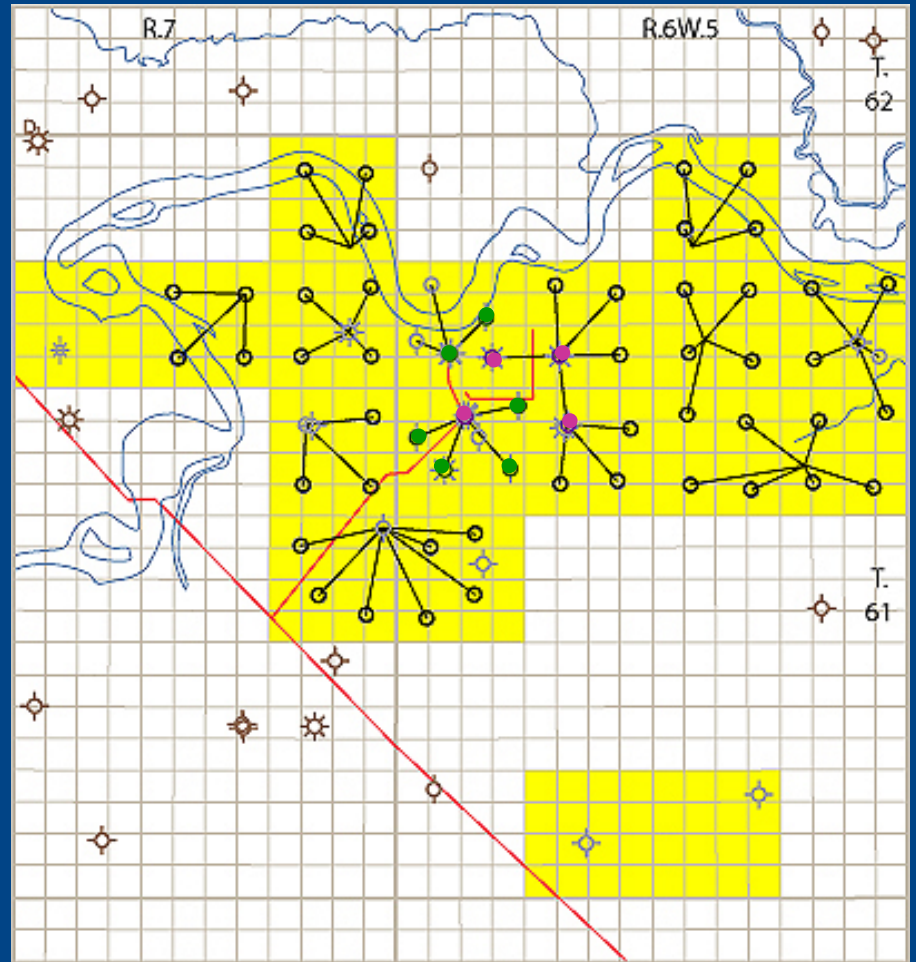
# Greater Corbett Area

- Area of thick Upper Mannville coals
- Good permeability indicated
- Several Upper Mannville pilot projects underway
- Potential 69 bcf of recoverable reserves to APF
- Active area for a number of producers



# Corbett Creek

- Phase 1: 4 wells, 1 water disposal well
- Phase 2: 6 wells
- Phase 3: 50 additional locations



# Upper Mannville Economics

- Reserves: 0.95bcf/well sales gas
- Productivity:
  - six months, 25 mcf/d
  - 6-12 months, increase to 300 mcf/d
  - 12-24 months constant
- Gas Price:
  - GLJ October, 2003 Forecast
  - \$5.80, 4.70, 4.70, 4.70, 4.75, 4.85/mcf CDN/mcf (AECO)
- Capital Cost:
  - Well: \$600,000 per well
  - Facility: \$150,000 per well
- Operating Cost:
  - \$0.50/mcf
  - \$2,500 per well-month

**Mannville Production Rate Over Time**



**Payout in 4.1 years**

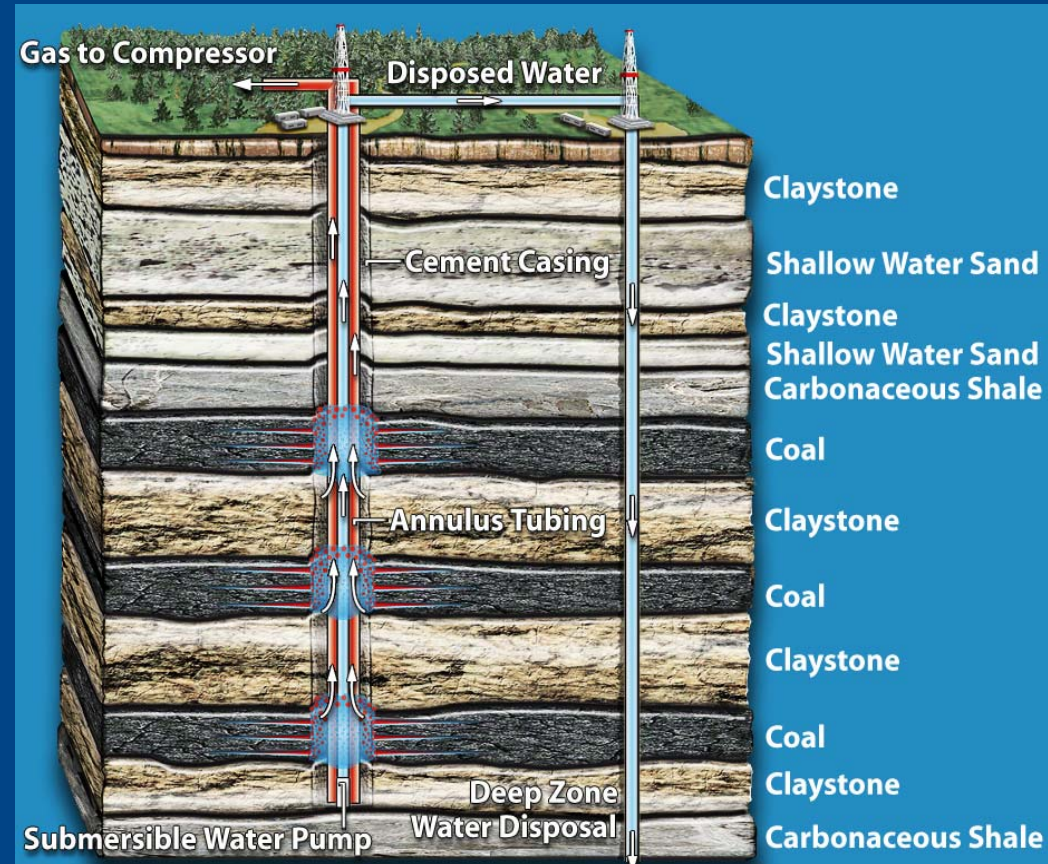
**ROR: 30%**

**F&D: \$0.80/mcf**



# CBM Completion & Water Disposal

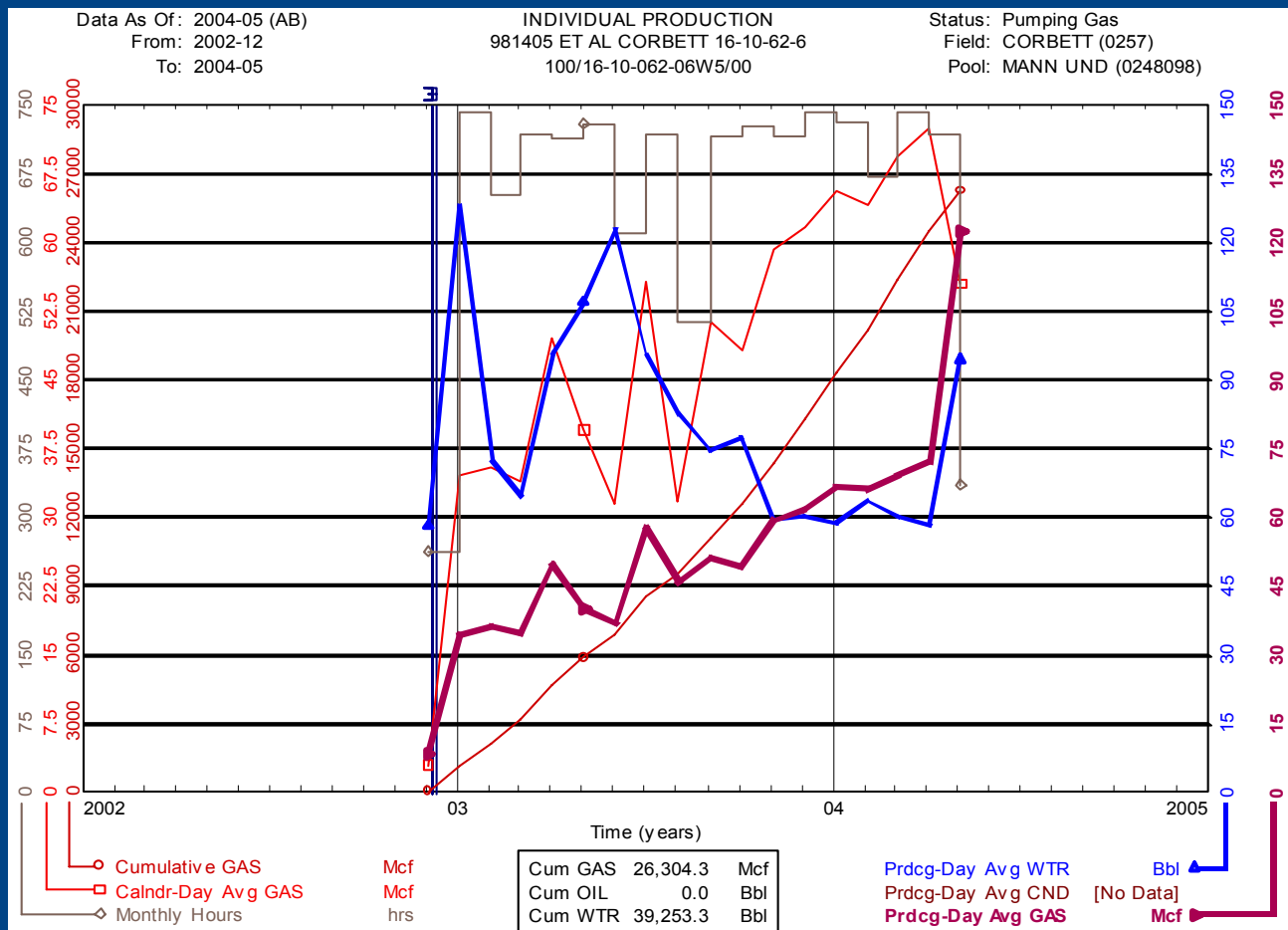
- Removal of water lowers the pressure within the coal zones allowing the gas to be produced
- Volumes that are produced during de-watering are re-injected into approved water disposal zones
- Withdrawl, use and disposal of all produced water is regulated by the Province of Alberta. To protect the ecosystem, no surface disposal of saline water is permitted
- Cost of drilling disposal wells can be allocated across the relevant producing wells



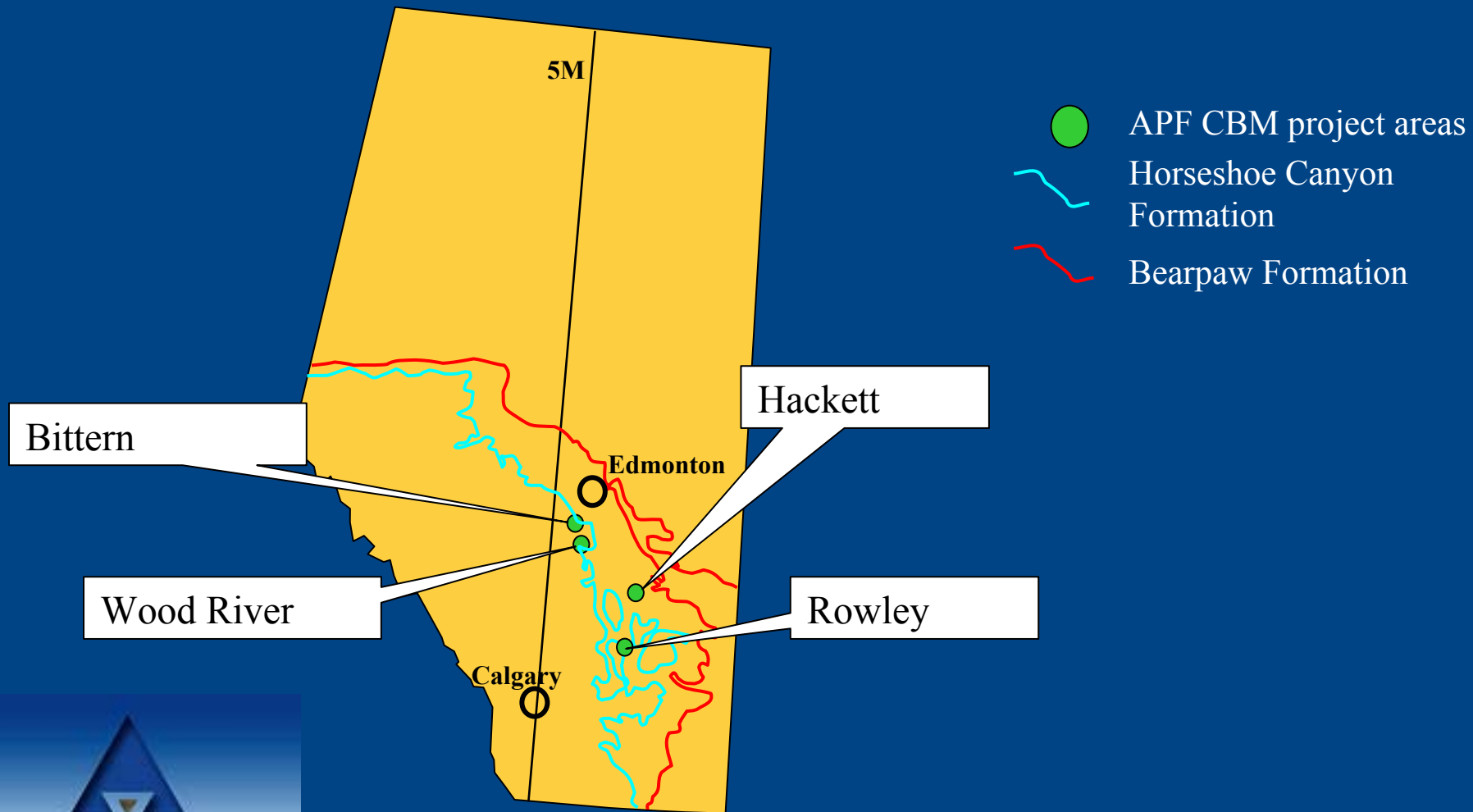


# Corbett "Inside" Well

Possible preliminary evidence of increasing gas rate as dewatering proceeds



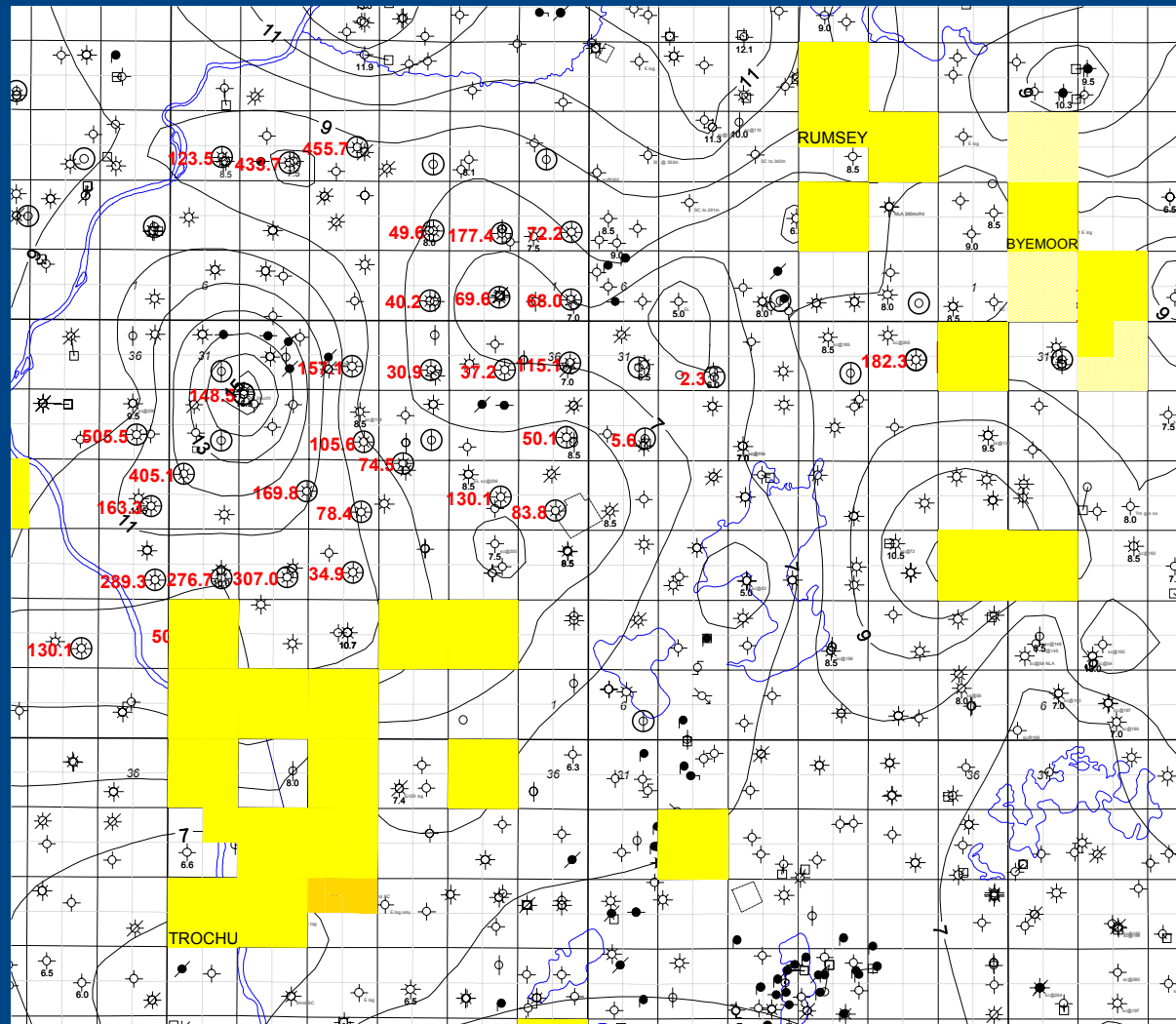
# APF Horseshoe Canyon CBM Projects



# Rowley (Trochu) Detail

- Detail of Trochu area showing
- Isopach of cumulative Horse Shoe Canyon Coals in meters.
- Wells licensed as CBM wells circled in black.
- Last month (May-04) average daily gas production in mcf/d.

□ APF CBM Wells



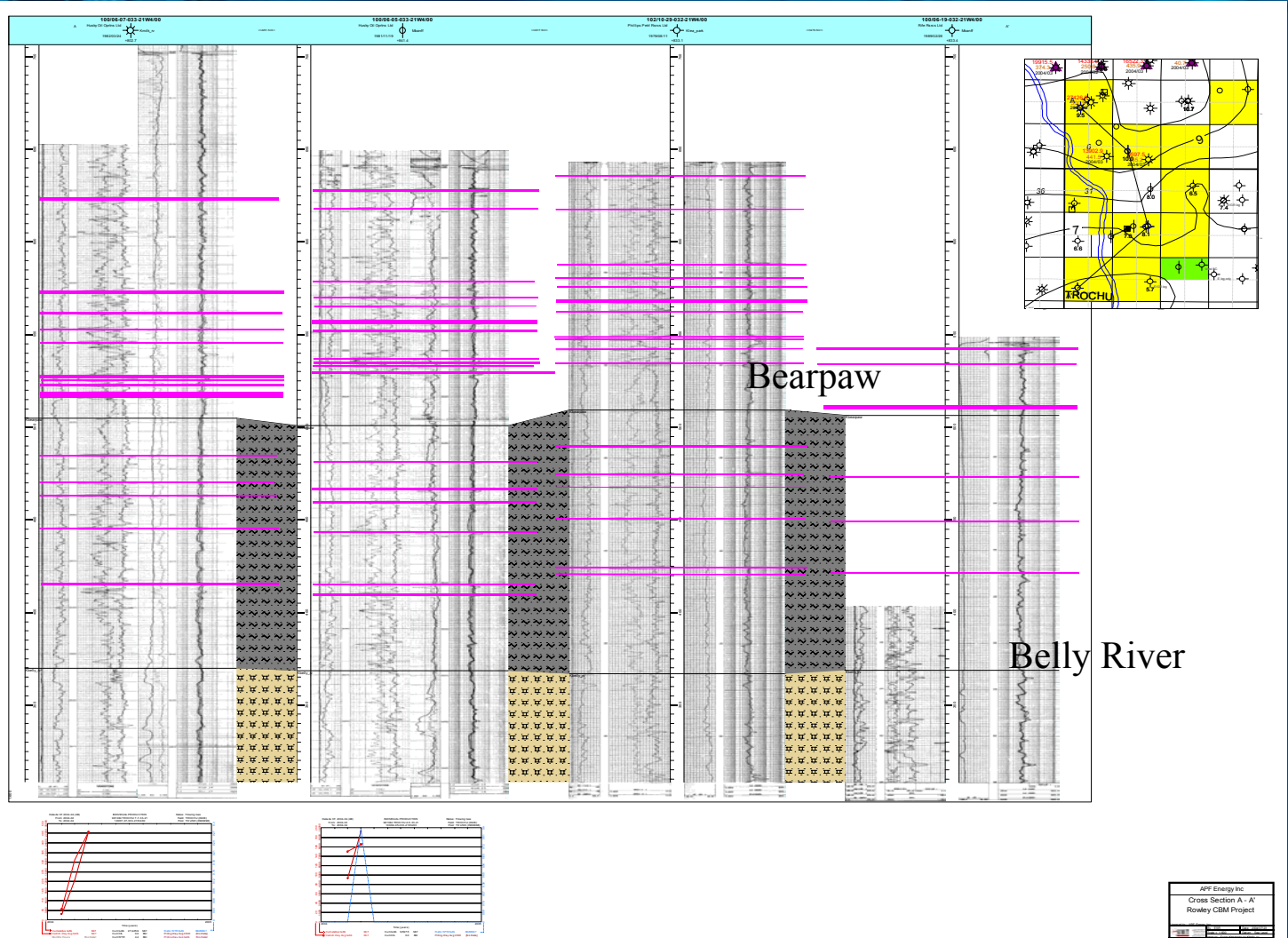
# Trochu (Detail) Cross-Section

6-7-33-21W4

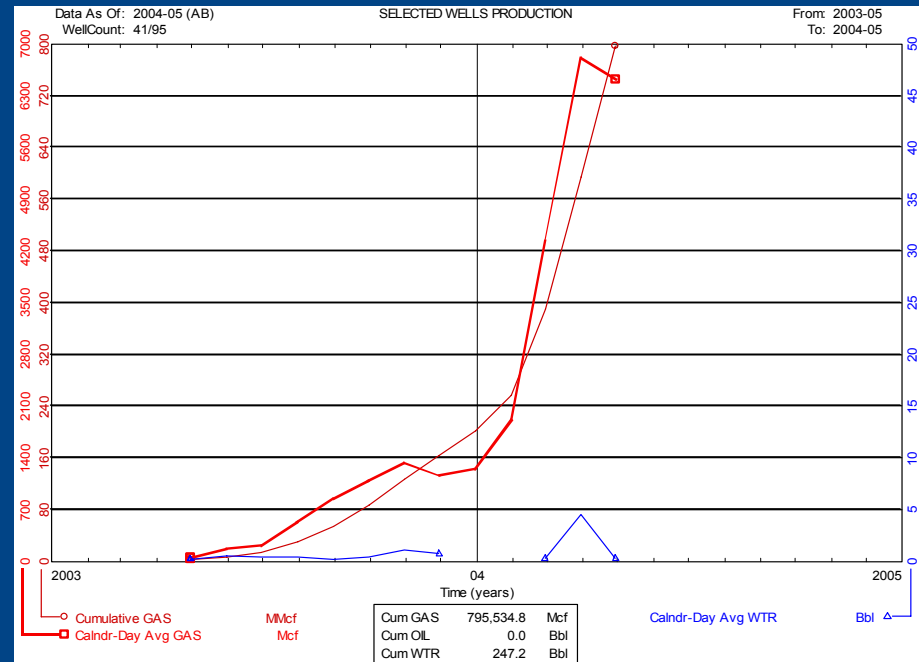
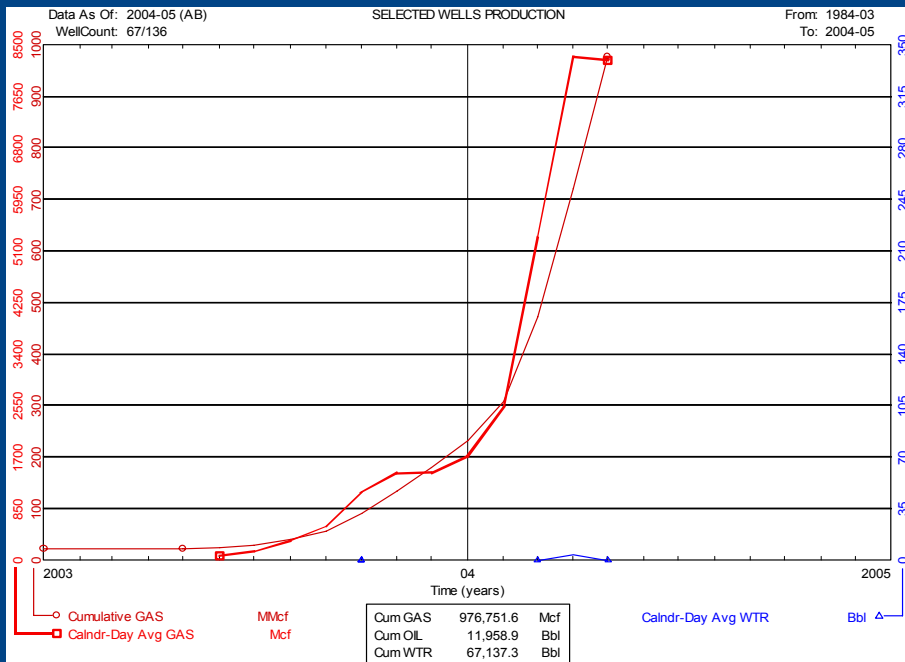
6-5-33-21W4

10-29-32-21W4

6-19-32-21W4



# Rowley CBM Well Production



Trochu - All licensed CBM wells.  
67 wells averaging 120 mcf/d

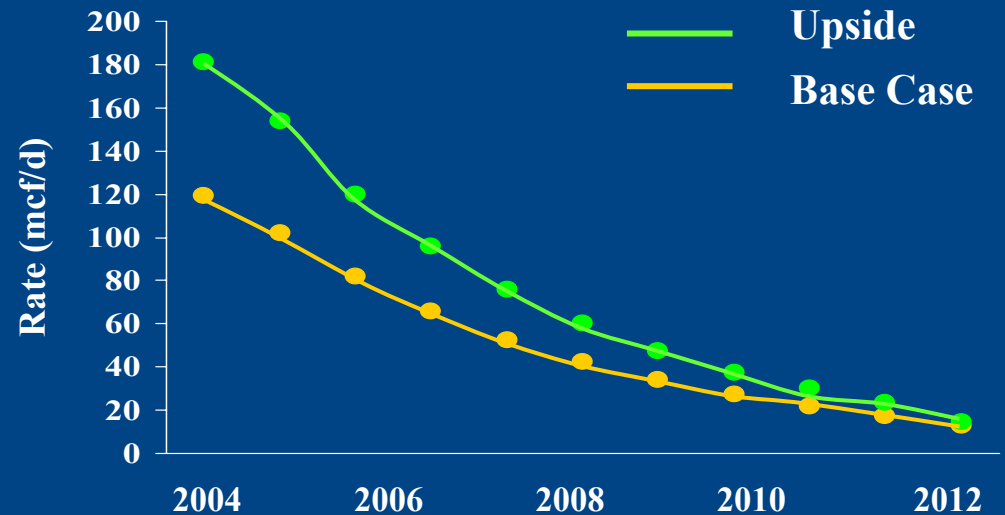
Trochu – All Trident wells 41 wells averaging  
160mcf/d. Press release (7-29-04) reports  
6MMCF/D from 32 wells = 188 mcf/d/well.



# Horseshoe Canyon Economics

- Reserves (bcf/well sales gas):
  - Base 0.180 & Upside 0.265
- Productivity (raw):
  - Base case 125 mcf/d
  - Upside 190 mcf/d
  - Decline exponentially
- Gas Price:
  - GLJ July, 2004 Forecast
- Capital Cost per well:
  - Well: Cdn.\$292,000
  - Field: Cdn.\$82,500
- Operating Cost:
  - Cdn.\$0.60/mcf
  - Cdn.\$1,200 per well-month

Horseshoe Canyon Production Rate Over Time



**Payout in 2.6 to 1.5 years**

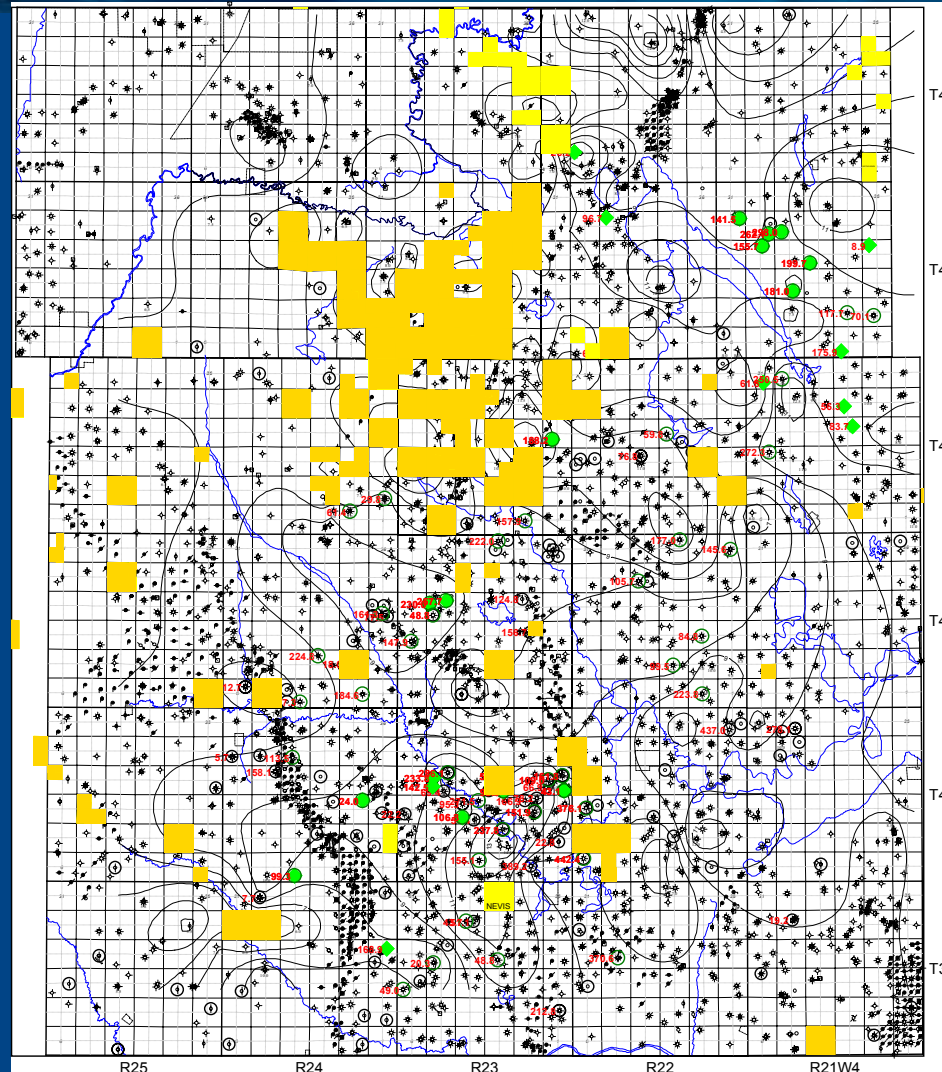
**ROR: 27% to 71%**

**F&D: Cdn. \$12.47 to \$8.47/boe**

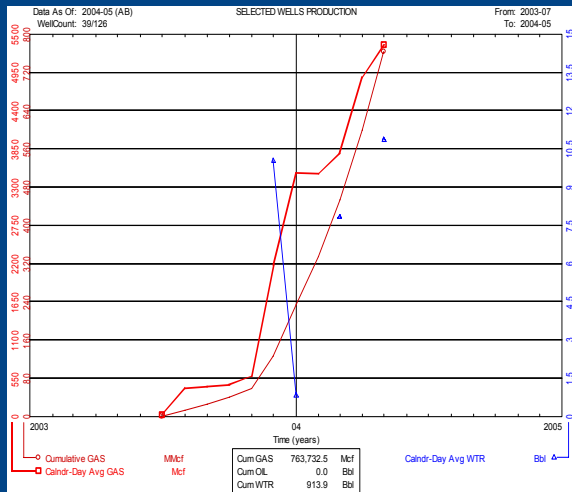


# Wood River CBM Project

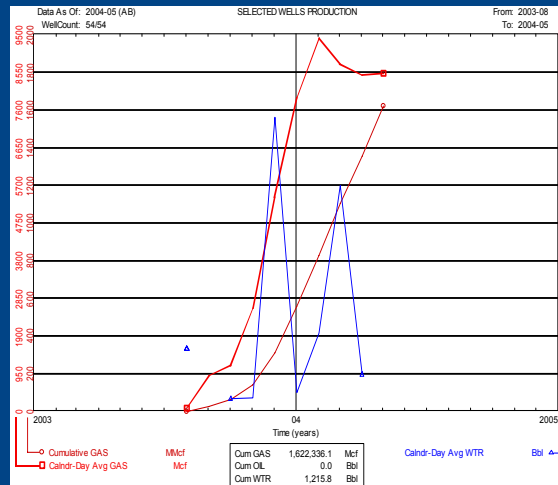
- Lic CBM wells in black.
- Pool Code is Edm Coal in open green circles.
- Perf'd in Edm/Bpw in solid green diamonds.
- Av. Daily production for last month in mcf/d in red.



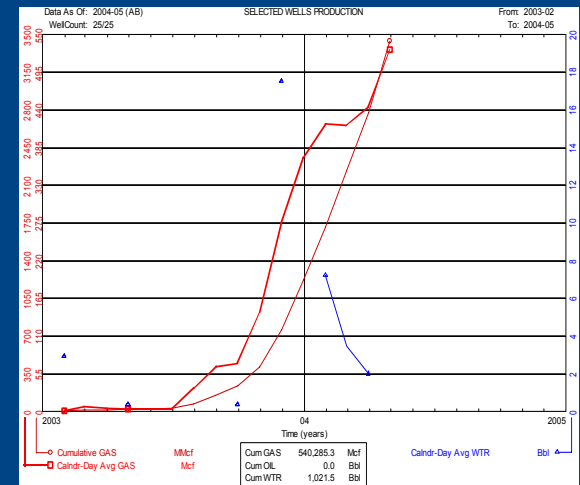
# Wood River Coal Completions



39 producing wells licensed as CBM wells. May 2004 total 5360 mcf/d. Average rate per well 137 mcf/d.



54 wells designated as producing from Edmonton Coal undesignated Pool. May 2004 production 8618 mcf/d. 160 mcf/d per well average prod.

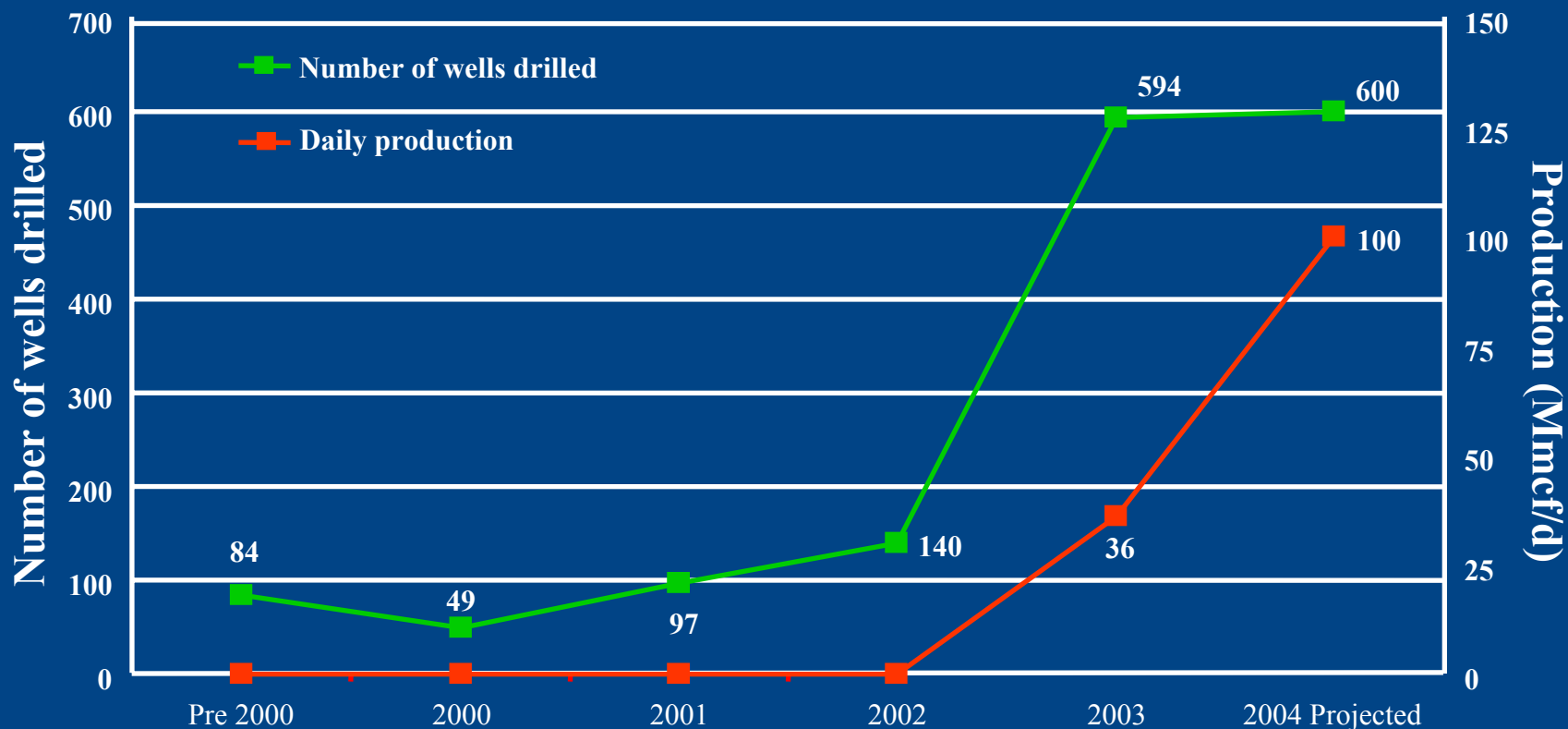


25 wells producing from perfed interval Edm Coal to Base Bearpaw. May 2004 production 3343 mcf/d. 133 mcf/d average per well.



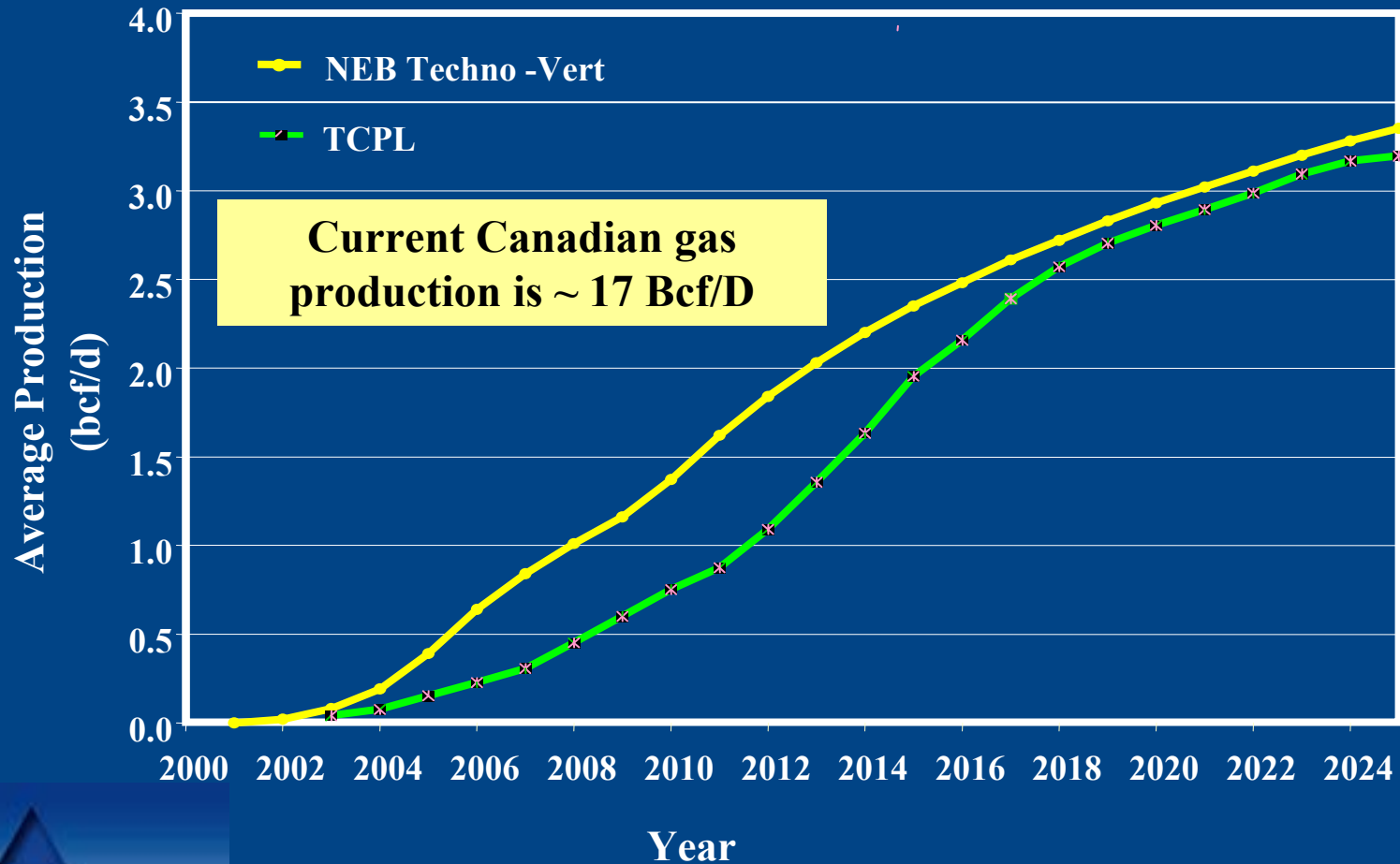


# Western Canada CBM Drilling Activity: 1975 - Present



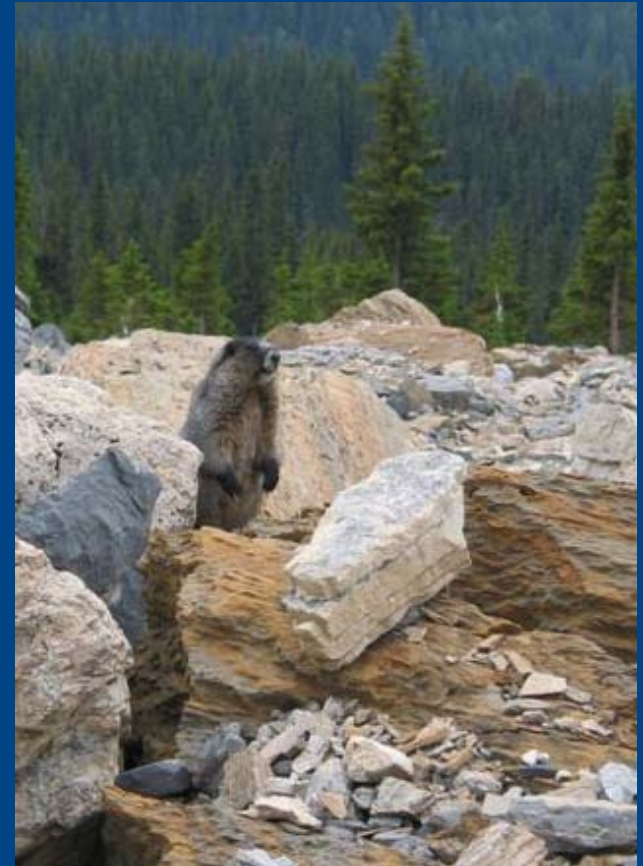
Source: Defiant Energy

# Predicted CBM Production in Canada



# Environmental Responsibility

- CBM production can utilize existing infrastructure for both drilling and development purposes
- CBM producers must adhere to the same responsible drilling, production and operations regulations as all other producers
- APF consults with local stakeholders to address concerns surrounding the perceived impacts of CBM drilling and production
- Wells are cased with steel and then cemented to protect all underground water sources during production



# Contact Information

## APF Energy Trust

2100, 144 – 4th Avenue S.W.

Calgary, Alberta T2P 3N4

Internet: [www.apfenergy.com](http://www.apfenergy.com)

E-mail: [invest@apfenergy.com](mailto:invest@apfenergy.com)

Telephone: (403) 294-1000

Toll Free: (800) 838-9206

Fax: (403) 294-1074

## Corporate Contacts

Martin Hislop, C.E.O.

Steve Cloutier, President

Alan MacDonald, Vice President, Finance

Dan Allan, Vice President, Coalbed Methane

Christine Ezinga, Corporate Planning Analyst

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