Coalbed Methane Development in the Western Canadian Sedimentary Basin:
A Significant Emerging Resource for North America
CANADIAN CBM DEVELOPMENT

“FROM CONCEPT TO REALITY”
Western Canada Natural Gas Production Declines

Source: GMP Securities Ltd.
The WCSB Supply Challenge

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

Source: TransCanada Corporation April, 2004
CBM Potential of North America

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

Source: Defiant Energy
- 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

Source: GSC, BC Government
## North American CBM Basins - Comparison

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

Source: Defiant Energy
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

Source: Defiant Energy
Distribution of Major Coal-bearing Areas

Source: Defiant Energy

- Mannville Formation
- Horseshoe Canyon Formation
- Scollard Formation
- Mountains and Foothills
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

Source: Defiant Energy
Major Exploration Areas: Alberta Plains shallow - Horseshoe Canyon Fm

- **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

Source: Defiant Energy
**Major Exploration Areas:**

**Alberta Plains Deep – Upper Mannville Fm**

- **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

**Map and Diagrams**

- Alberta map showing Calgary, Edmonton, and Grande Prairie.
- Legend for net coal:
  - 0-2 m
  - 2-6 m
  - 6-10 m
  - > 10 m

**Coal Zones**

- Paskapoo
- Scollard
- Battle/Whitemud
- Bearpaw
- Oldman
- Foremost
- Lea Park
- Colorado Gp
- Luscar Gp
- Alberta Gp
- Brazeau
- Gates
- Moosebar
- Gladstone
- Cadomin
- Kootenay Gp
- Nikanassin

**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

Pilot projects

Source: Defiant Energy
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

Source: Defiant Energy
## 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)

Source: Defiant Energy
APF Alberta CBM Projects

- Corbett Creek
- Bittern
- Wood River
- Doris
- Hackett
- Edmonton
- Rowley
- Calgary

- APF CBM project areas
- Horseshoe Canyon Formation
- Bearpaw Formation
- Other CBM projects
APF Alberta Upper Mannville CBM Projects

- Corbett Creek
- Doris
- Edmonton
- Calgary
- Horseshoe Canyon Formation
- Bearpaw Formation

APF CBM project areas
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.
- Withdrawal, 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

Data As Of: 2004-05 (AB)
From: 2002-12
To: 2004-05

INDIVIDUAL PRODUCTION
981405 ET AL CORBETT 16-10-62-6
100/16-10-062-06W5/00

Status: Pumping Gas
Field: CORBETT (0257)
Pool: MANN UND (0248098)

Cumulative GAS Mcf
Calndr-Day Avg GAS Mcf
Cum WTR Bbl
Monthly Hours hrs

Prdcg-Day Avg WTR Bbl
Prdcg-Day Avg CND [No Data]
Prdcg-Day Avg GAS Mcf
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

Bearpaw
Belly River
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

Number of wells drilled and Daily production over time from 1975 to 2003, with projected data up to 2004. Source: Defiant Energy.
Predicted CBM Production in Canada

Current Canadian gas production is ~ 17 Bcf/D

Modified from CSUG NGC Technical Presentation, 03-2004
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

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