

USDA – CSREES
National Water Conference
Reno, Nevada – February 4, 2008

Symposium D5:
Balancing Agriculture, Water Use, Human Resources
and Energy Production

Coal Bed and Conventional Natural Gas Production:
Money, Water and Other issues
Harold Bergman
Ruckelshaus Institute -- University of Wyoming

Conventional Natural Gas

Estimated Recoverable NG in WY = 54.8 TCF

The Greater Green River Basin = 26.0 TCF

Coal Bed Natural Gas (aka...Coal Bed Methane)

Estimated Recoverable CBM in WY = 31.7 TCF

Powder River Basin = 25.1 TCF

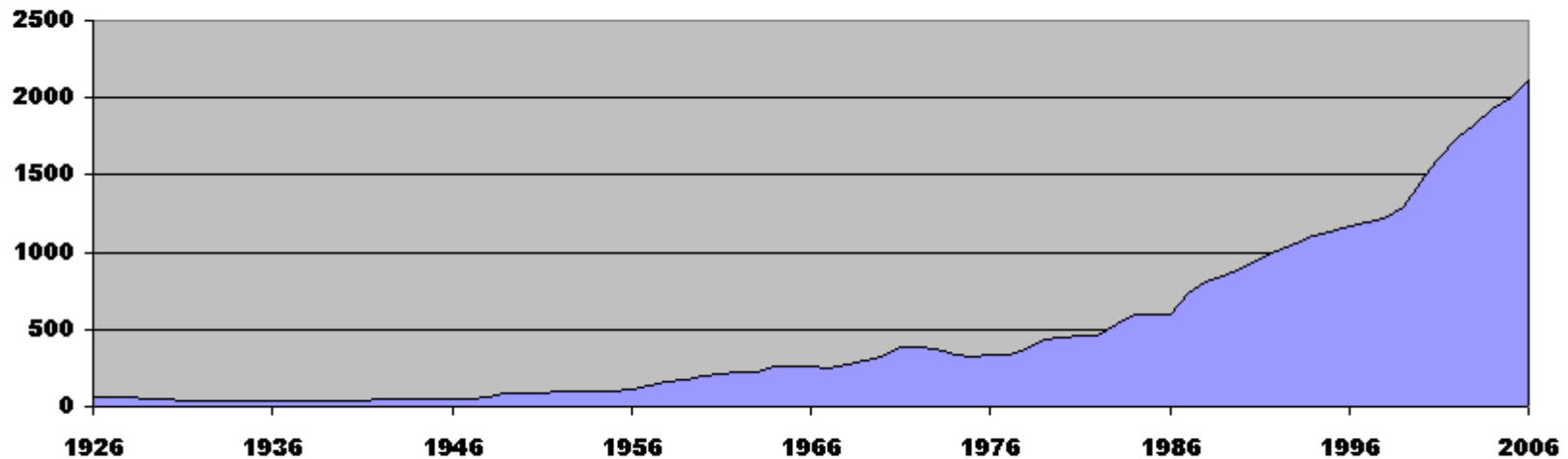
Total Gas in WY = **86.5 TCF**

The US consumed **23.0 TCF** of NG in 2002.

WY could supply US for ~ **4 years** at current demand.

Wyoming Annual Gas Production (BCF)

WYOMING OIL AND GAS CONSERVATION COMMISSION
ANNUAL GAS PRODUCTION IN BCF
1926 TO 2006



2006 GAS PRODUCTION = 2,111,868,333 MCF
(Note: 2006 includes 148,579,742 MCF CO₂)



Water Production from Coalbed Methane
Development in Wyoming:
A Summary of Quantity, Quality
and Management Options

FINAL REPORT

Prepared for

The Office of the Governor
State of Wyoming

Prepared by

The Ruckelshaus Institute of Environment
and Natural Resources

With contributions from

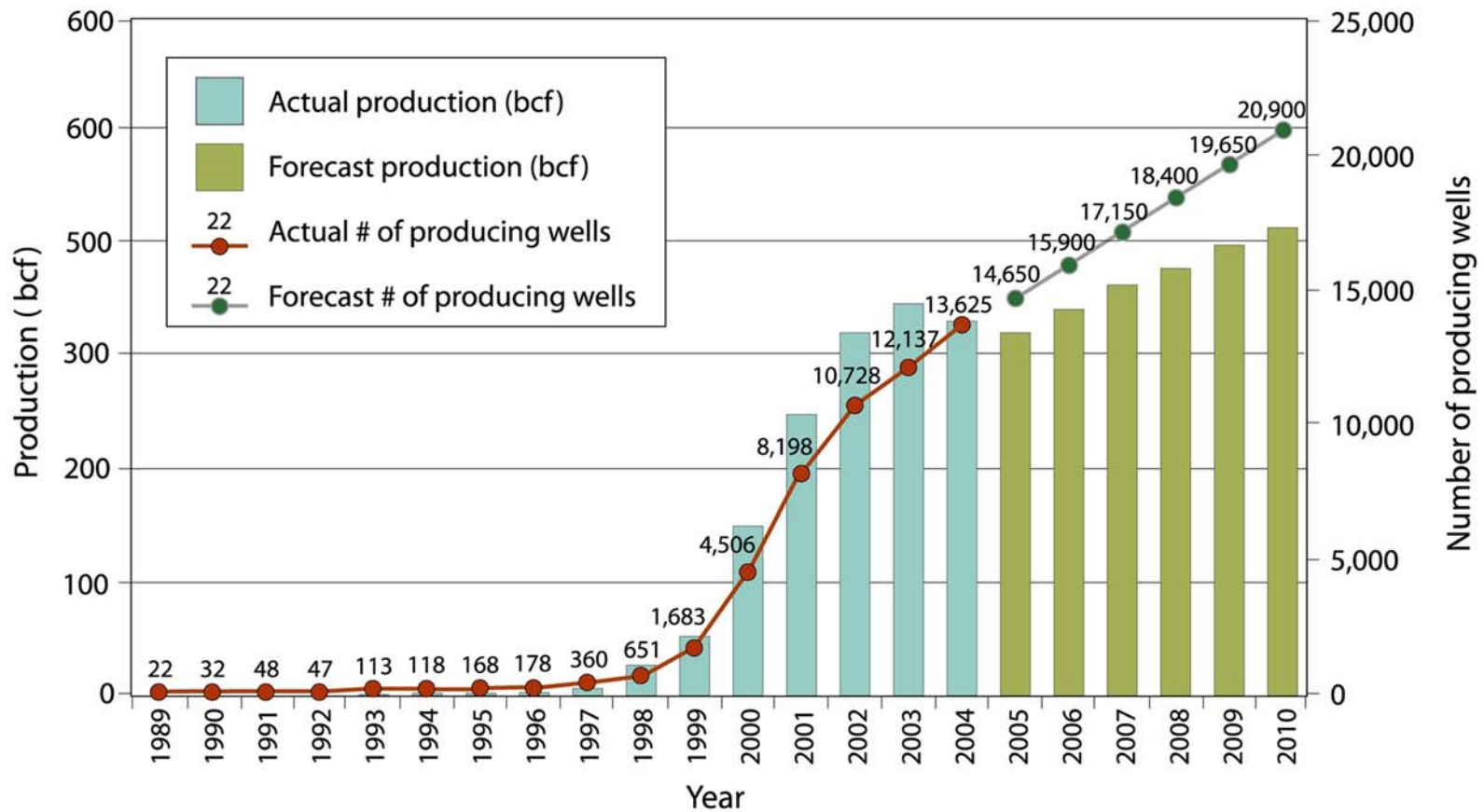
Faculty, Staff, and Students at
The University of Wyoming

December, 2005

UNIVERSITY OF WYOMING

Key CBM Facts from WSGS

- **Started in the Powder River Basin in 1987**
- **13,600 wells through 2004, with 20,900 wells predicted by 2010 (PRB only)**
- **348 bcf of gas in 2003 and 31.7 tcf predicted recoverable resource in Wyoming**
- **Economic value:**
 - **2003 for 348 bcf = \$1.5 billion, with tax & royalty to state (\$140M), counties (\$90M), and feds (\$27M)**
 - **Total for 31.7 tcf = \$140 billion, with tax & royalty to state (\$12.8B), counties (\$8.2B), and feds (\$2.5B)**



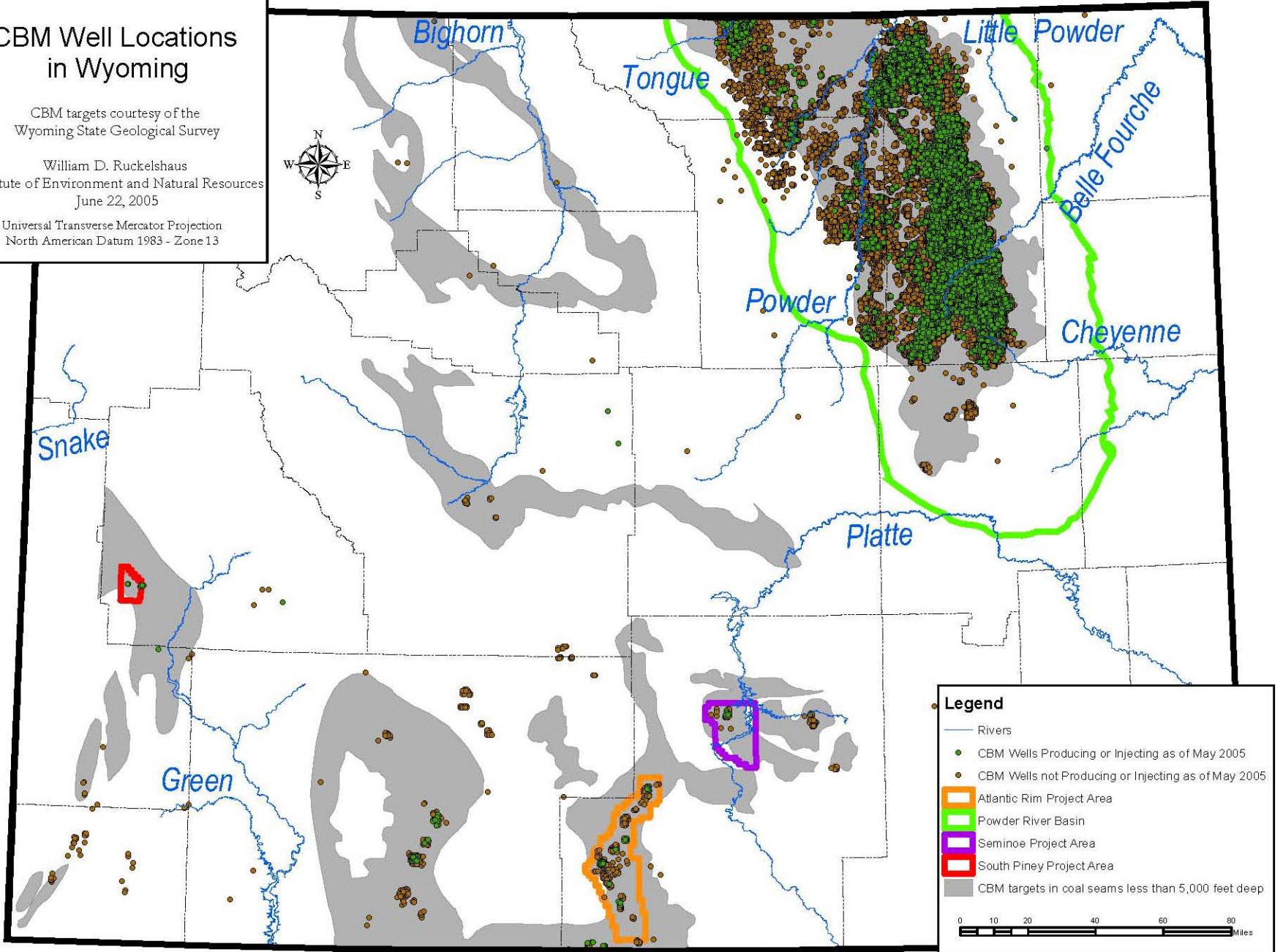
Yearly production and numbers of producing wells for CBM in the Powder River Basin of Wyoming (De Bruin, 2005)

CBM Well Locations in Wyoming

CBM targets courtesy of the Wyoming State Geological Survey

William D. Ruckelshaus
Institute of Environment and Natural Resources
June 22, 2005

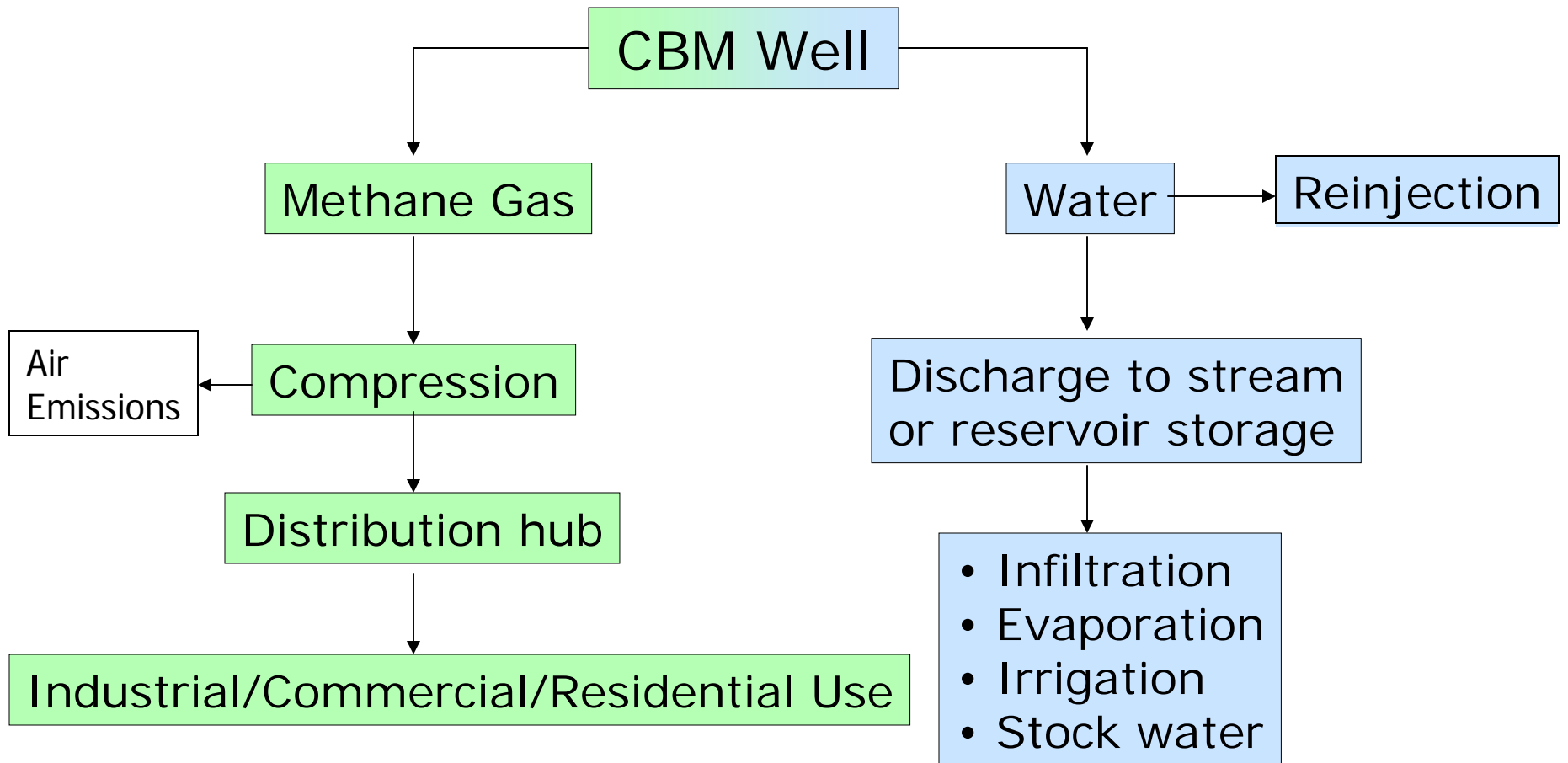
Universal Transverse Mercator Projection
North American Datum 1983 - Zone 13

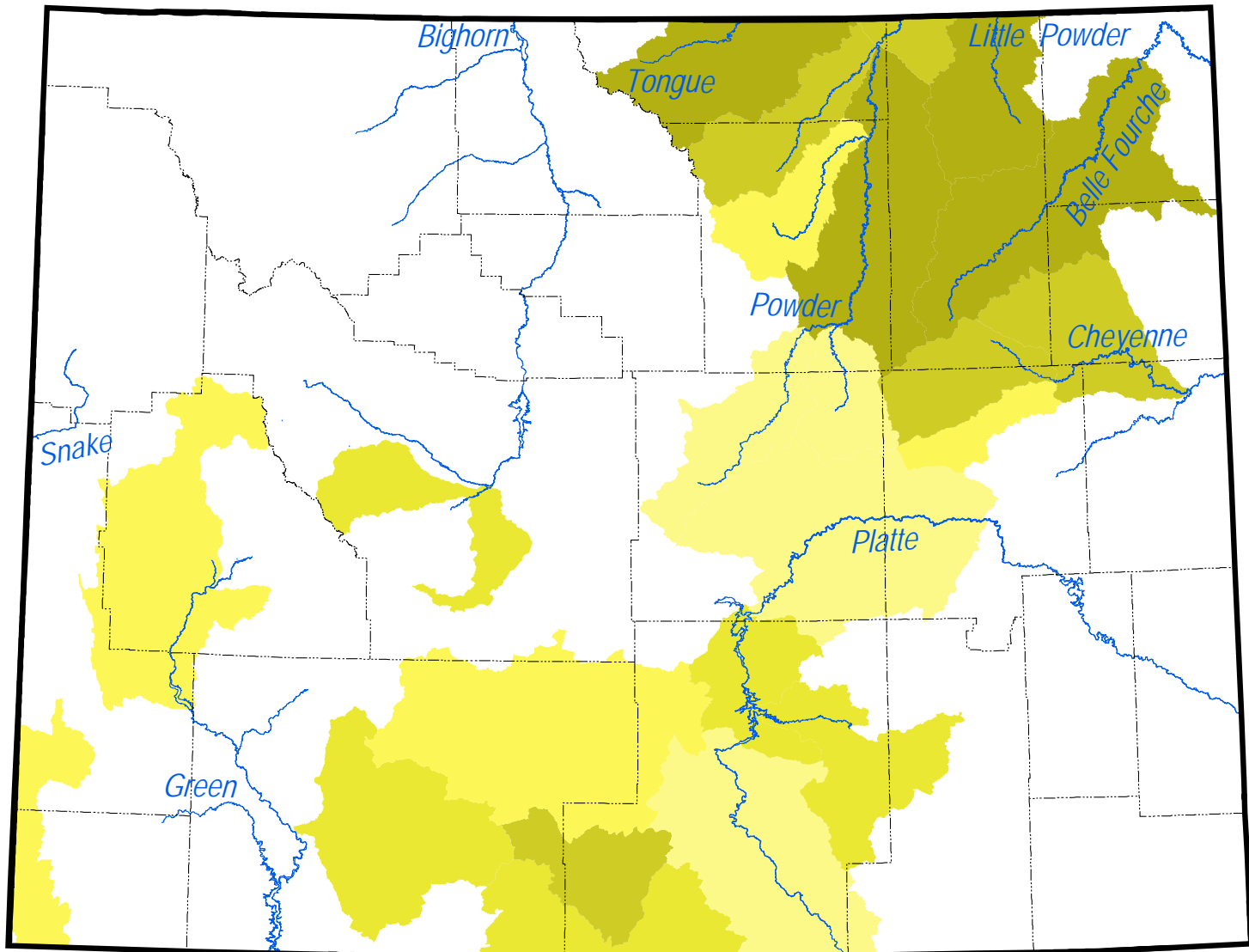


Legend

- Rivers
- CBM Wells Producing or Injecting as of May 2005
- CBM Wells not Producing or Injecting as of May 2005
- Atlantic Rim Project Area
- Powder River Basin
- Seminoe Project Area
- South Piney Project Area
- CBM targets in coal seams less than 5,000 feet deep

0 10 20 40 60 80 Miles

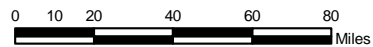




Legend

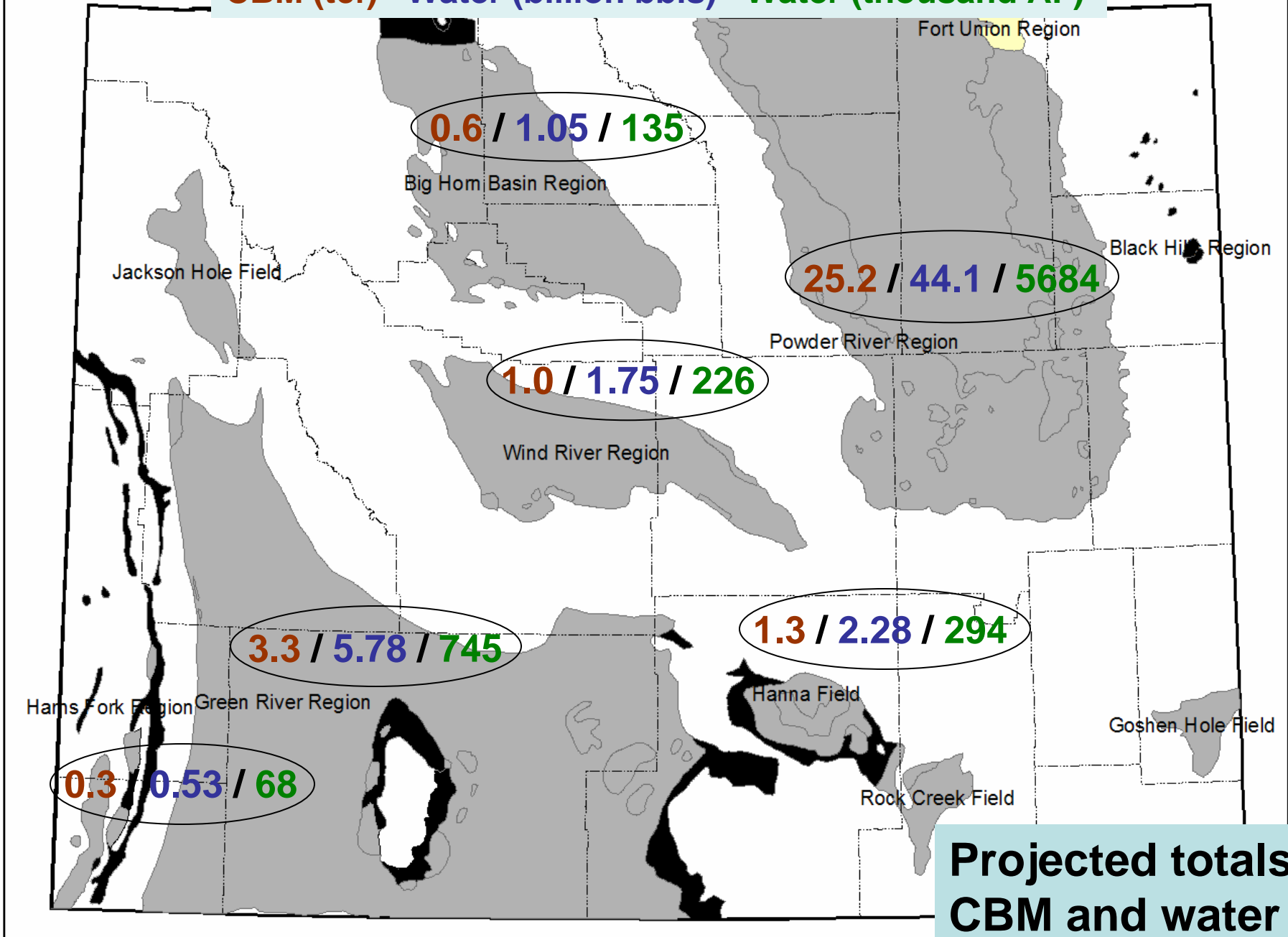
Level 4 Water in bbls (acrefeet)

- 0
- 1 - 200,000 (0.000129 - 25.8)
- 200,000 - 2,000,000 (25.8 - 258)
- 2,000,000 - 20,000,000 (258 - 2,578)
- 20,000,000 - 200,000,000 (2,578 - 25,777)
- 200,000,000 - 1,239,000,000 (25,777 - 159,686)



Cumulative CBM water production, 1987 - 2004

CBM (tcf) **Water (billion bbls)** **Water (thousand AF)**

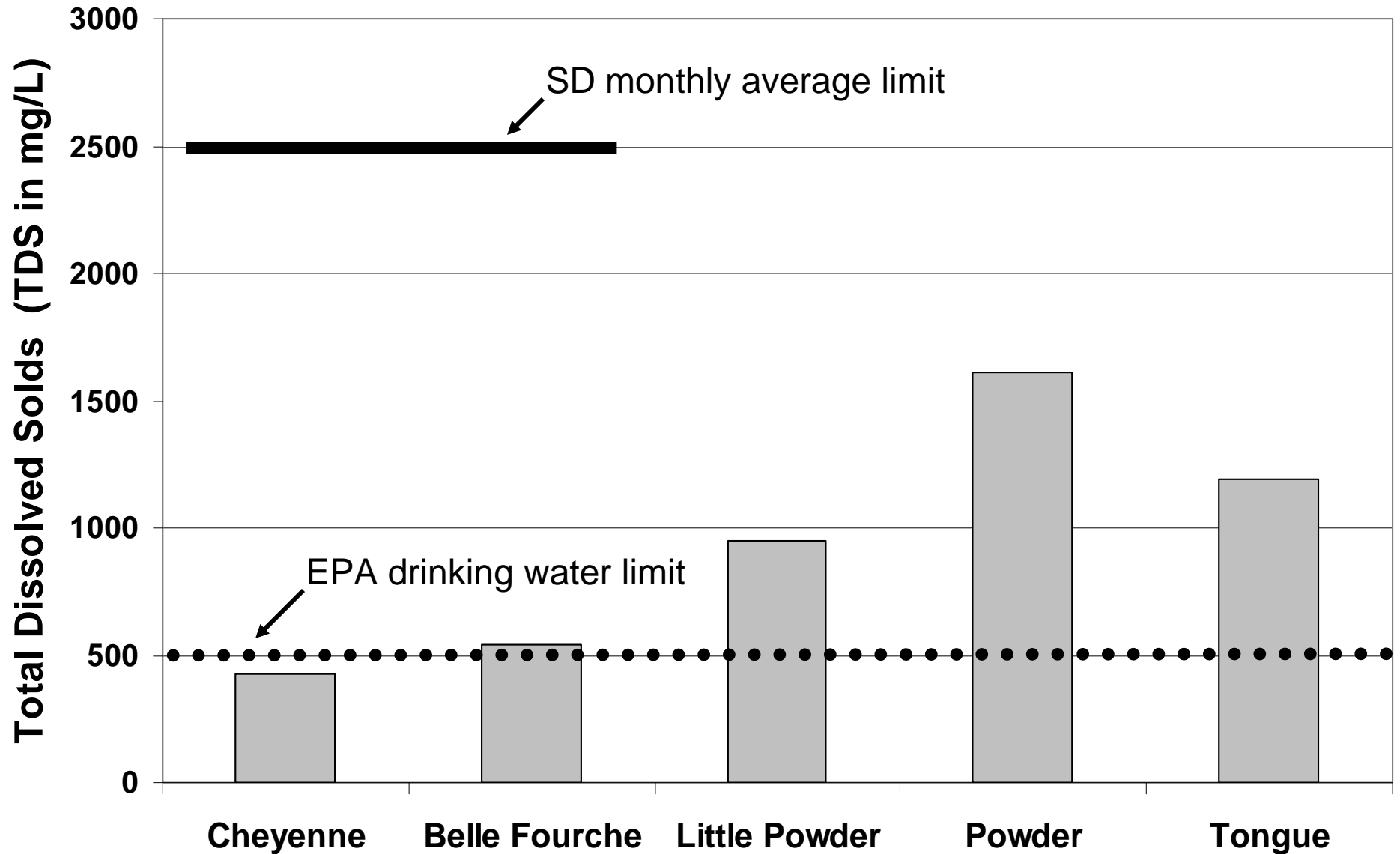


**Projected totals:
CBM and water**

WY CBM Gas & Water Production

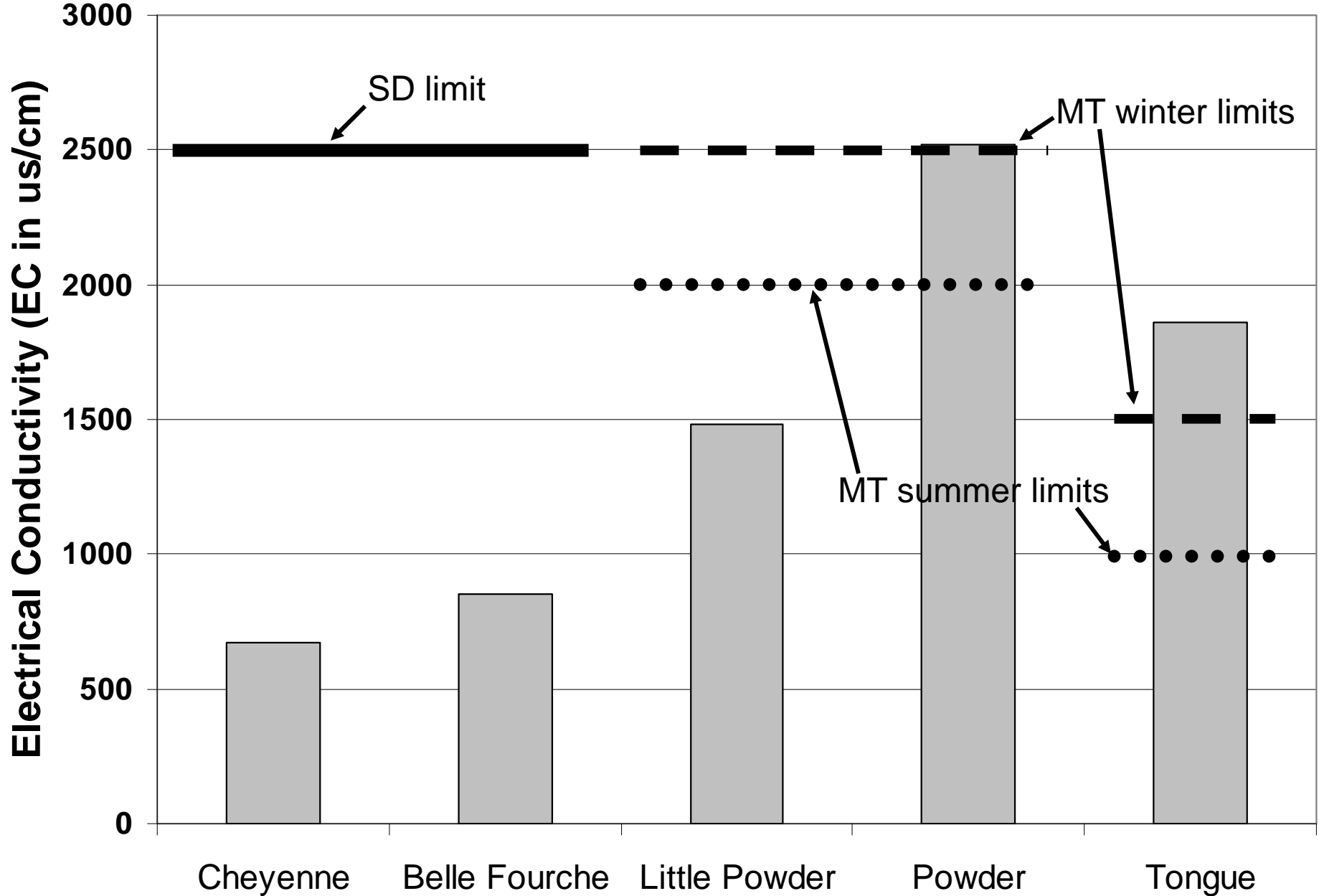
	Gas	Water
	(tcf)	(1000 AF)
Cumulative (Through 2004)	1.5	380
Projected	31.7	7,150
<u>Percent Produced</u>	<u>5%</u>	<u>5%?</u>

Total Dissolved Solids Concentrations in PRB CBM Well Waters



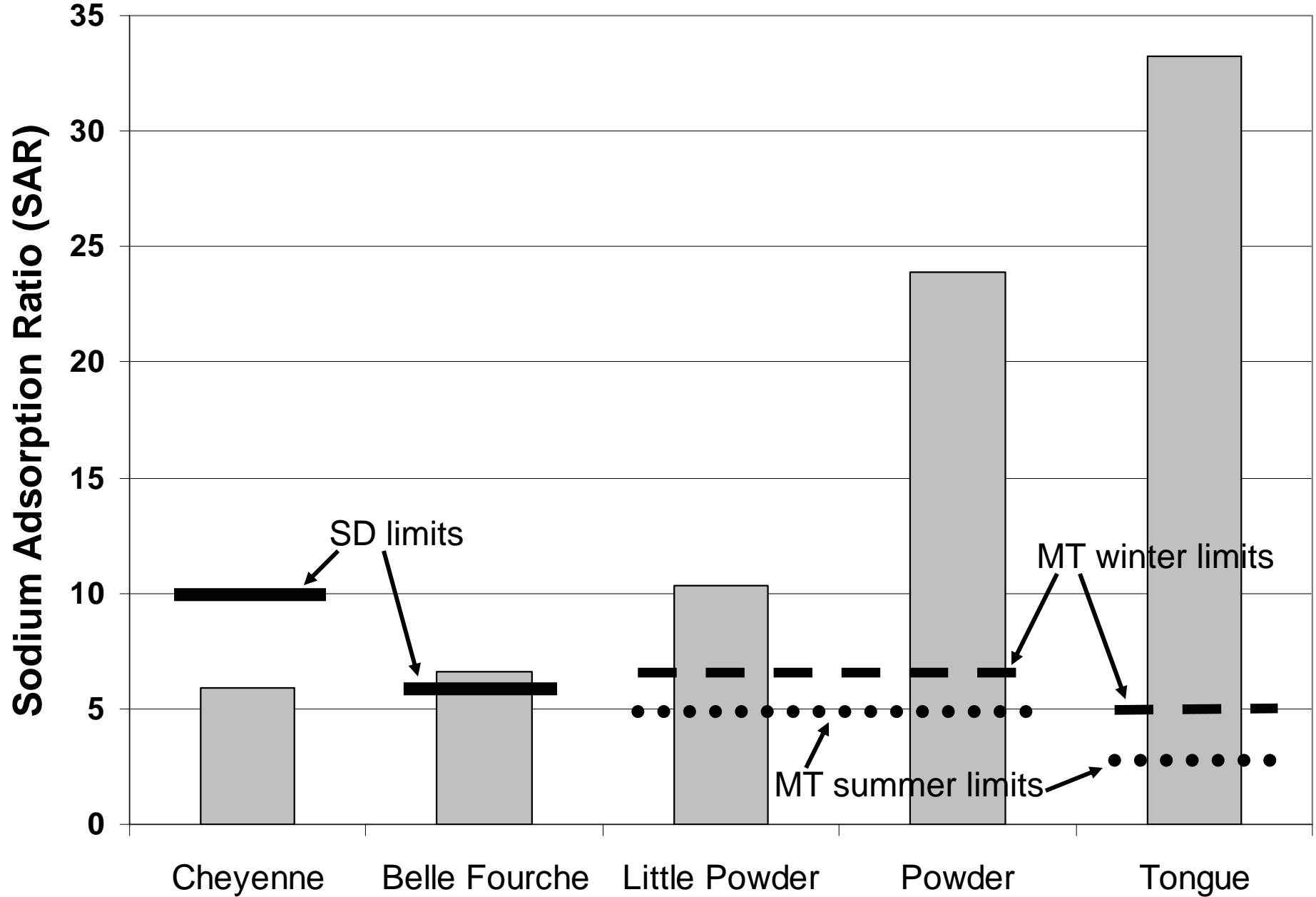
Modified from Reddy, 2004

Electrical Conductivity in PRB CBM Well Waters



Modified from Reddy, 2004

Sodium Adsorption Ratios (SAR) in PRB CBM Well Waters



Modified from Reddy, 2004

Current Water Management Methods

- **Surface discharge**
- **Off- and on-channel impoundments**
- **Injection**
- **Atomization**
- **Treatment**
 - **Reverse osmosis**
 - **Ion exchange**
 - **Deionization**

CBM Discharge Outfall into Drainage



CBM Discharge Infiltration Ponds



Powder River Basin, CBM Development, 2002

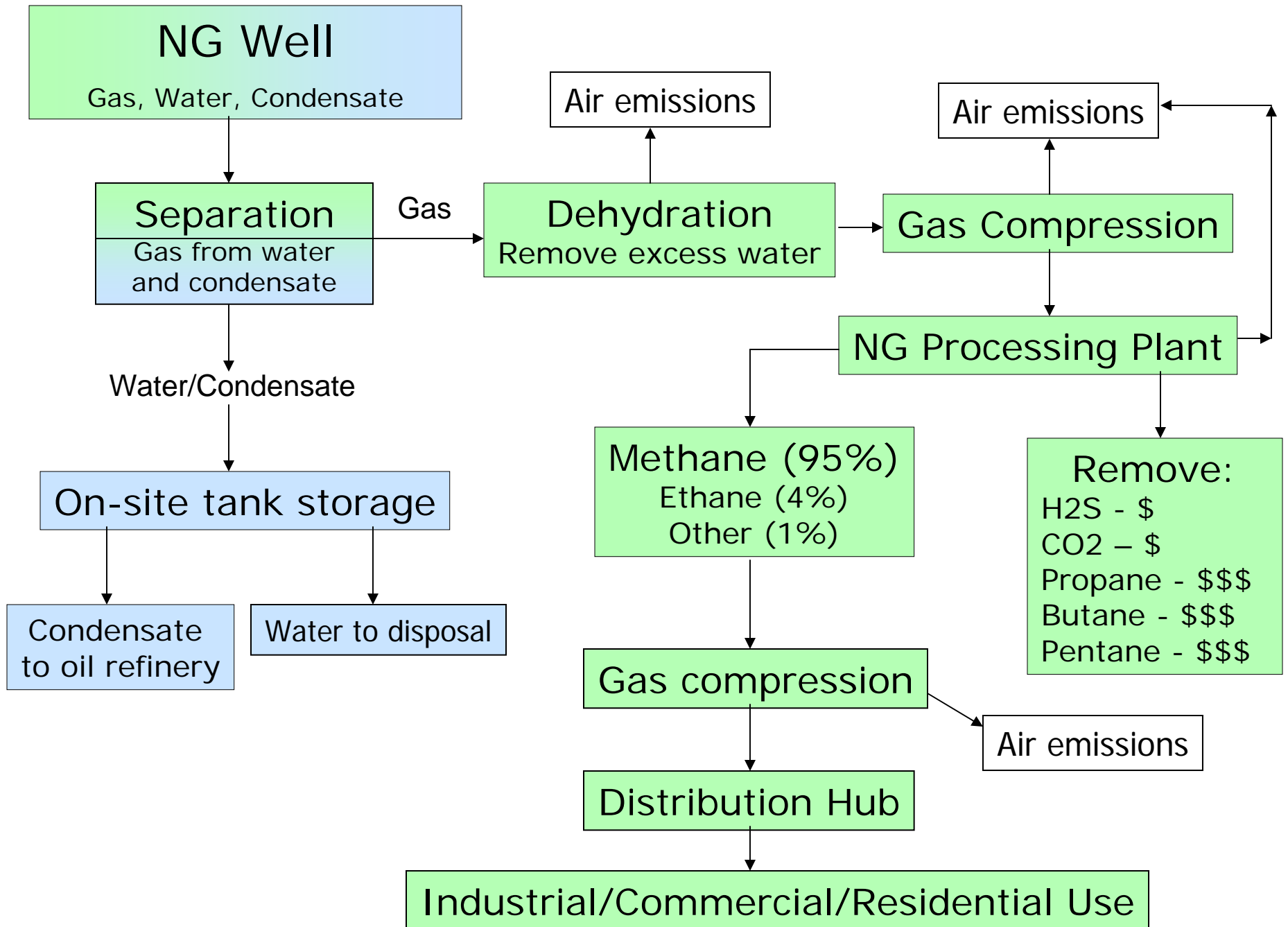


Alternative Technical, Regulatory and Statutory Strategies

- **Minimize water production.**
- **Best management practices.**
- **Injection of CBM water for storage or disposal.**
- **Additional beneficial uses of CBM water.**
- **Technology-based limits.**
- **Watershed-based management – gathering, treatment, storage and use.**
- **Watershed-based discharge permitting.**
- **Coordinated management and regulation.**

Ideas to Consider for New CBM Developments

- **Learn from the experience so far in the Powder River Basin**
- **Systematic development plan (spatially explicit plan for leasing, drilling, infrastructure, etc.)**
- **Staged development with adaptive/collaborative management**
- **Integrated management across agency responsibilities, possibly using a CBM “czar” or central management agency (oil & gas leasing and permitting, water quantity, water quality)**
- **Explicitly regulate quantity of discharge, best management practices, treatment technology, etc.**



Jonah Field, 2001



Other Western **Energy Development Issues**

Current Issues

- **Water quantity and quality**
- **Wildlife habitat**
- **Community impacts**

Future Issues

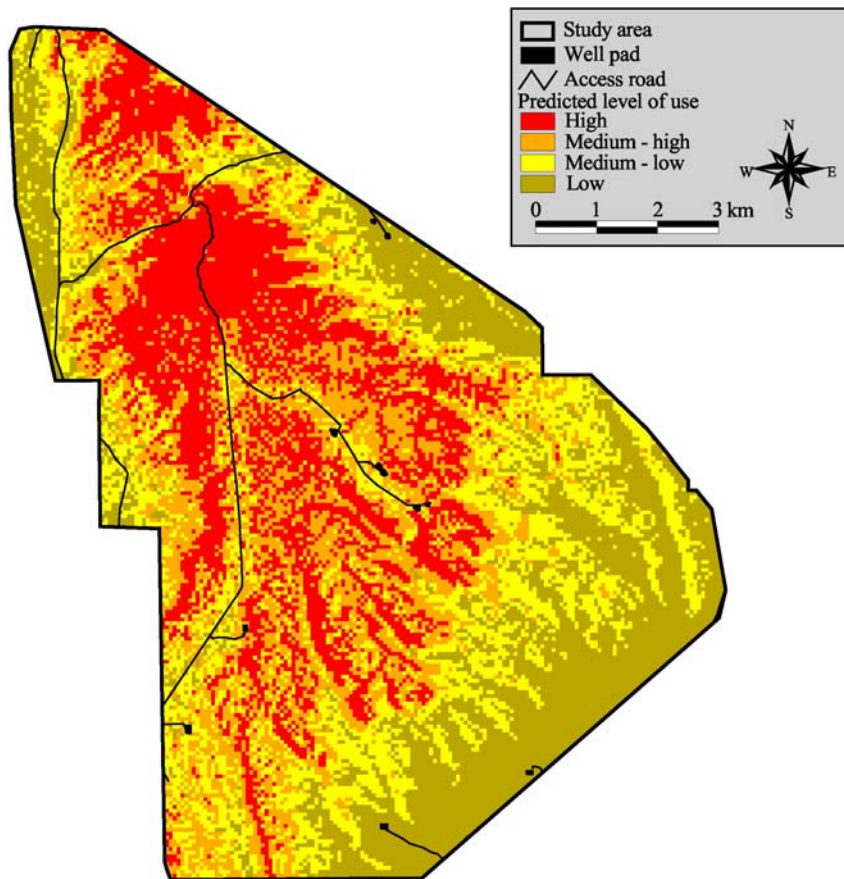
- **Increasing water demand & conflicts**
- **Climate change**

Availability of UW CBM Report

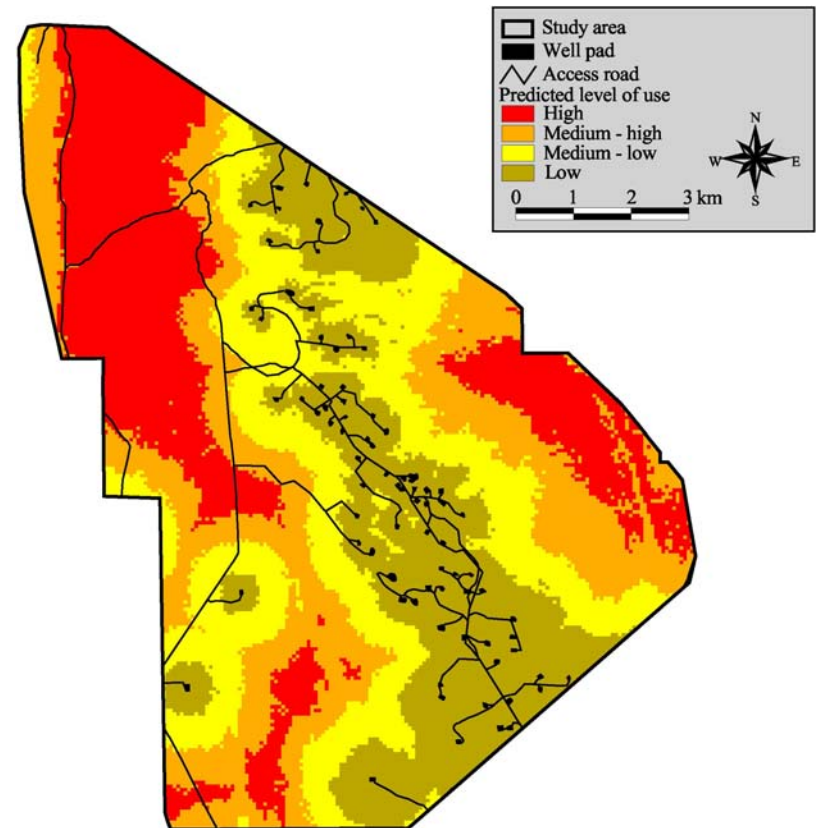
- On Ruckelshaus Institute WEB site:
 - <http://www.uwyo.edu/enr/ienr/cbm.asp>and <http://www.cbmclearinghouse.info/>
- Request by email or phone:
 - ienr@uwyo.edu
 - 307-766-5080

Mule Deer Migration Impacts before and after the development of the Pinedale Anticline gas field

Before



After



CBM Drill Rigs Truck Mounted



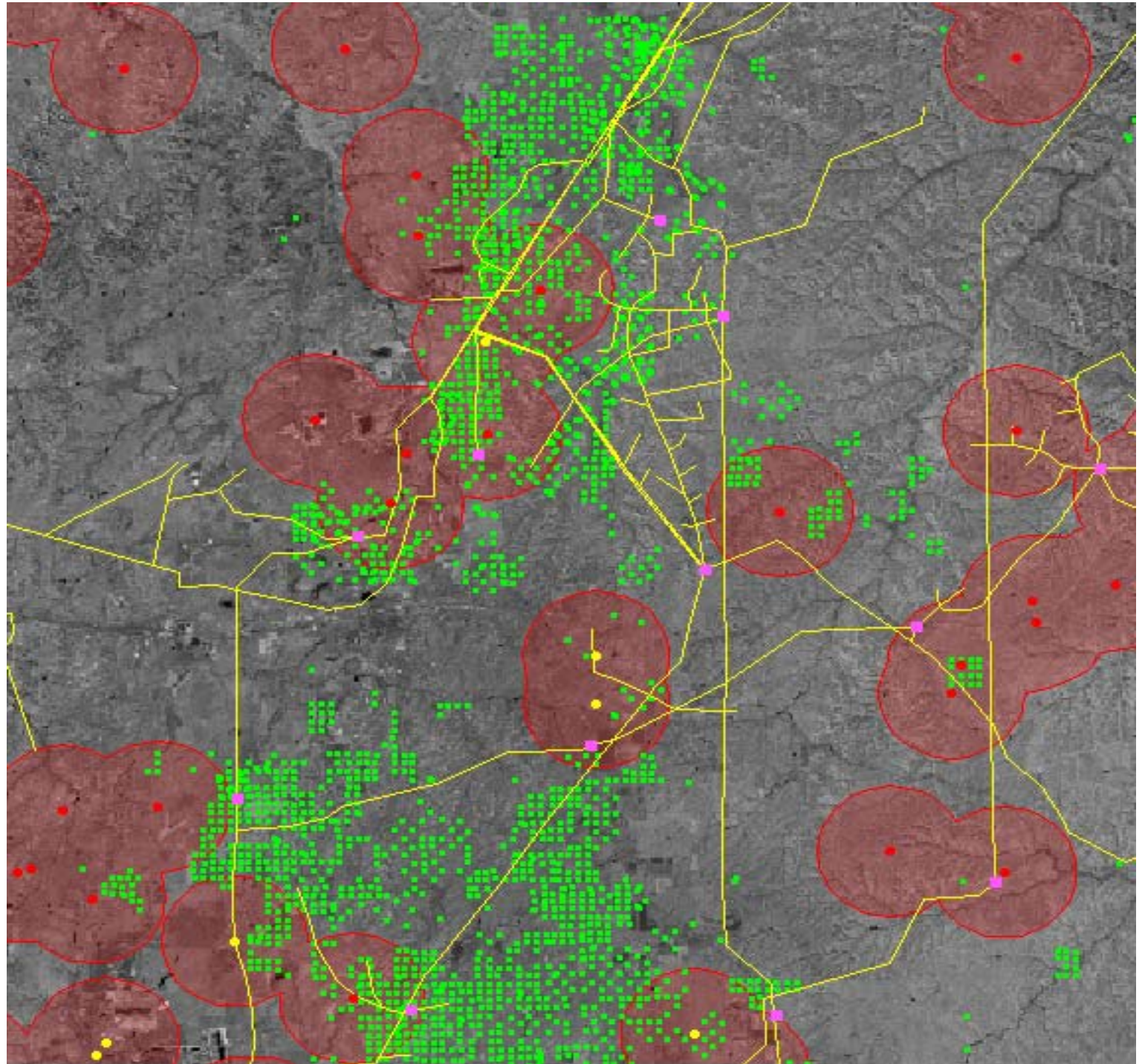
Natural Gas Drill Pad Site – Pinedale Anticline



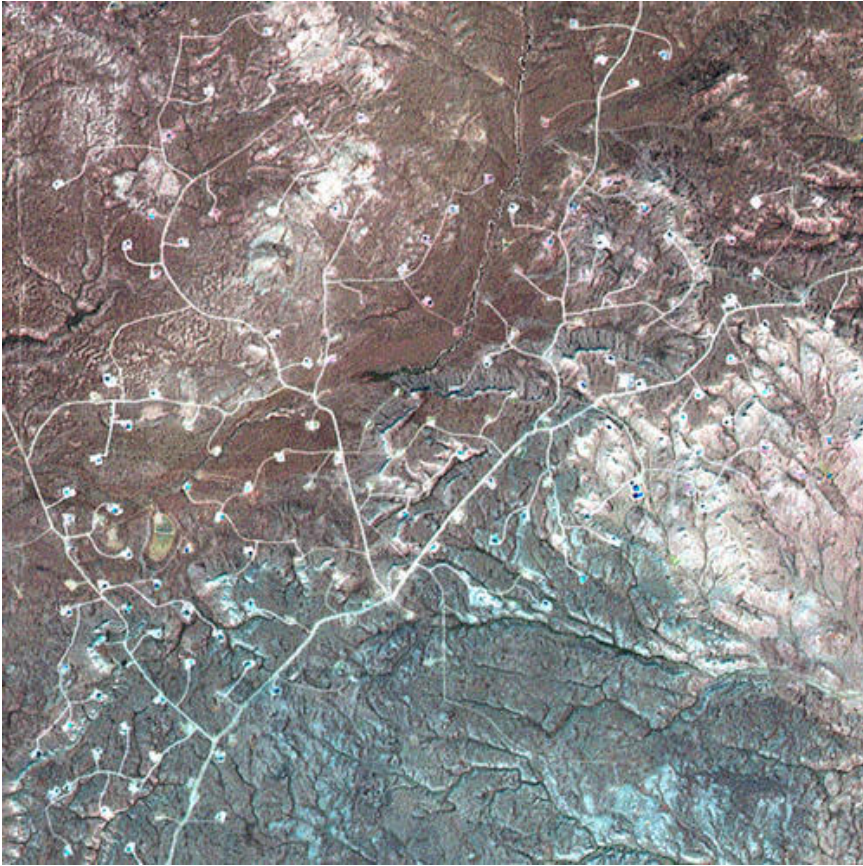
Natural Gas Wellhead
(Xmas Tree)



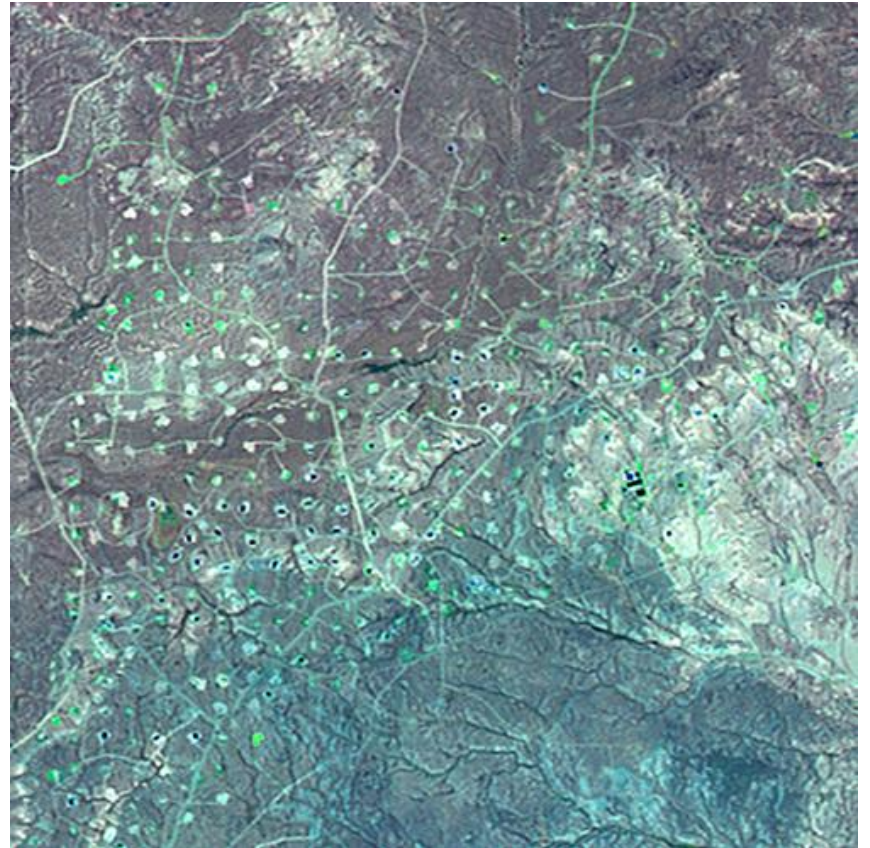
CBM Wells
and
Sage
Grouse
Leks

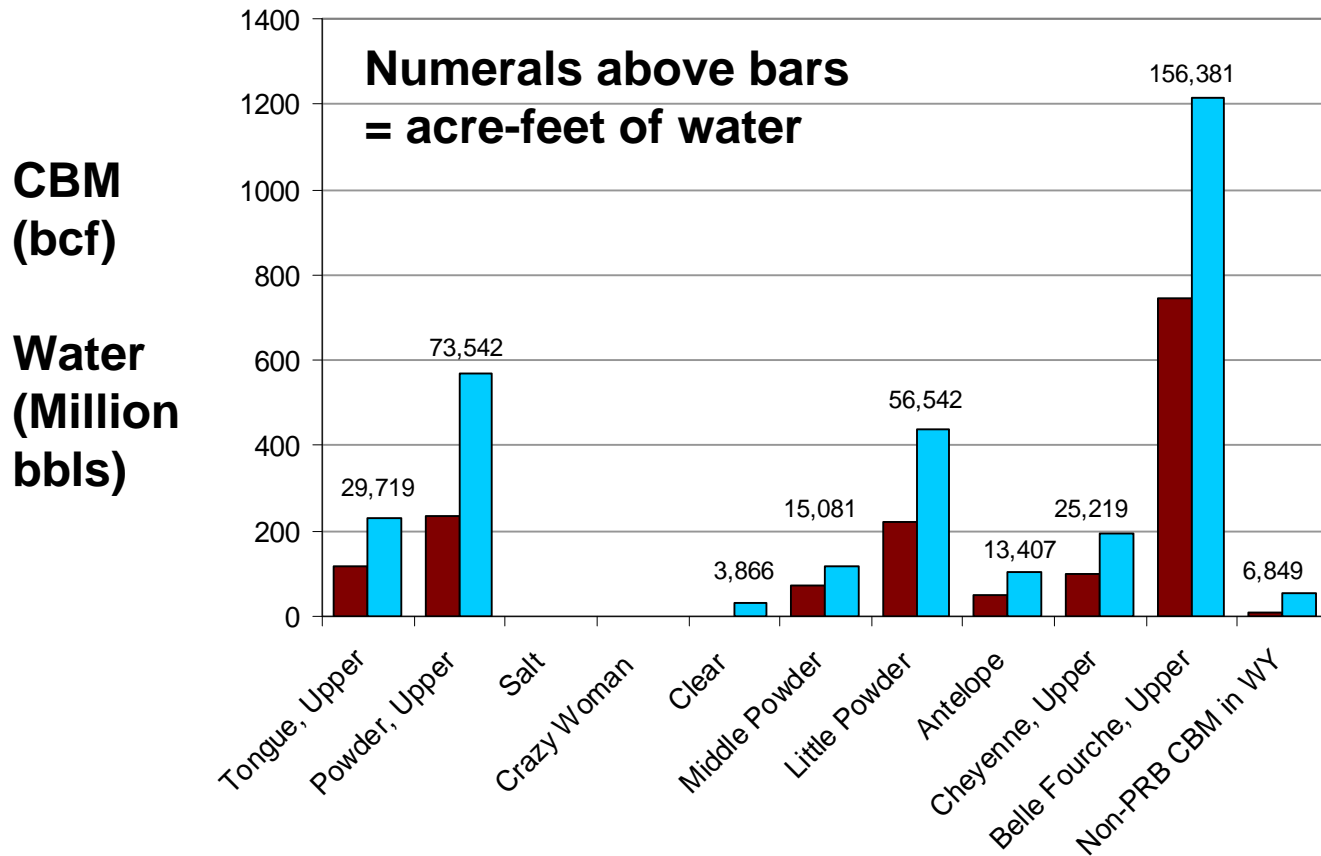


Jonah Field, 1999



Jonah Field, 2005





Cumulative (87- 04) CBM water (blue) and gas (brown) production by watershed

Ideas for Possible Next Steps

- **Workshops or studies.**
- **Incremental adjustment in management.**
 - **Speed up watershed based permitting**
 - **Comprehensive data sharing**
 - **ID and fix regulatory gaps and overlaps**
 - **Adopt stakeholder generated BMPs as regulations**
- **Comprehensive review and revision of CBM management and regulation.**
 - **State CBM coordinator**
 - **State CBM “umbrella” statute**

Overview of Comments Received

- **Some strong positive and some strong negative comments on report, overall.**
- **“Recommendations” too weak and not ranked.**
- **CBM & conventional O&G NOT different.**
- **Errors in water quality values for Big George.**
- **Add background water quality data.**
- **Strong differences (+/-) in use of water for irrigation.**
- **Narrative vs. numeric water quality standards.**
- **Doesn't emphasize enough important need for U.S. gas production and economic value to WY.**

Questions from the Governor's Office

Overriding question: “What are the options for dealing with water produced through CBM development”

- **How much CBM water – by basin and statewide?**
- **What will be the water quality?**
- **What are the options for dealing with this water?**
- **What other options are we missing?**
- **What are the consequences of each option?**

Questions and Requests Added **after the First Draft**

- **What are some alternative strategies for addressing CBM water issues, including pros and cons of each?**
- **What are the regulatory and legal issues that the state faces?**
- **Suggest some possible next steps.**
- **List but do not prioritize ideas and suggestions.**

Additional Guidance

- **Provide a broad overview report on CBM water in layman's terms.**
- **Compile and use available data from federal and state agencies and university researchers.**
- **List but do not prioritize ideas and suggestions.**

WY CBM Gas & Water Production

	Gas	Water
	(tcf)	(1000 AF)
Annual (2006)	0.377	88
Projected	31.7	7,150
Percent Prod/year	~1%	~1%?