

Wyoming Reservoir Information Tool (WyRIT)

CO₂-EOR & CO₂ Buffer storage opportunities

Carbon Management Technical Conference (CMTC)
Houston Texas

Nick Jones – Project/Client Manager,

July 19th



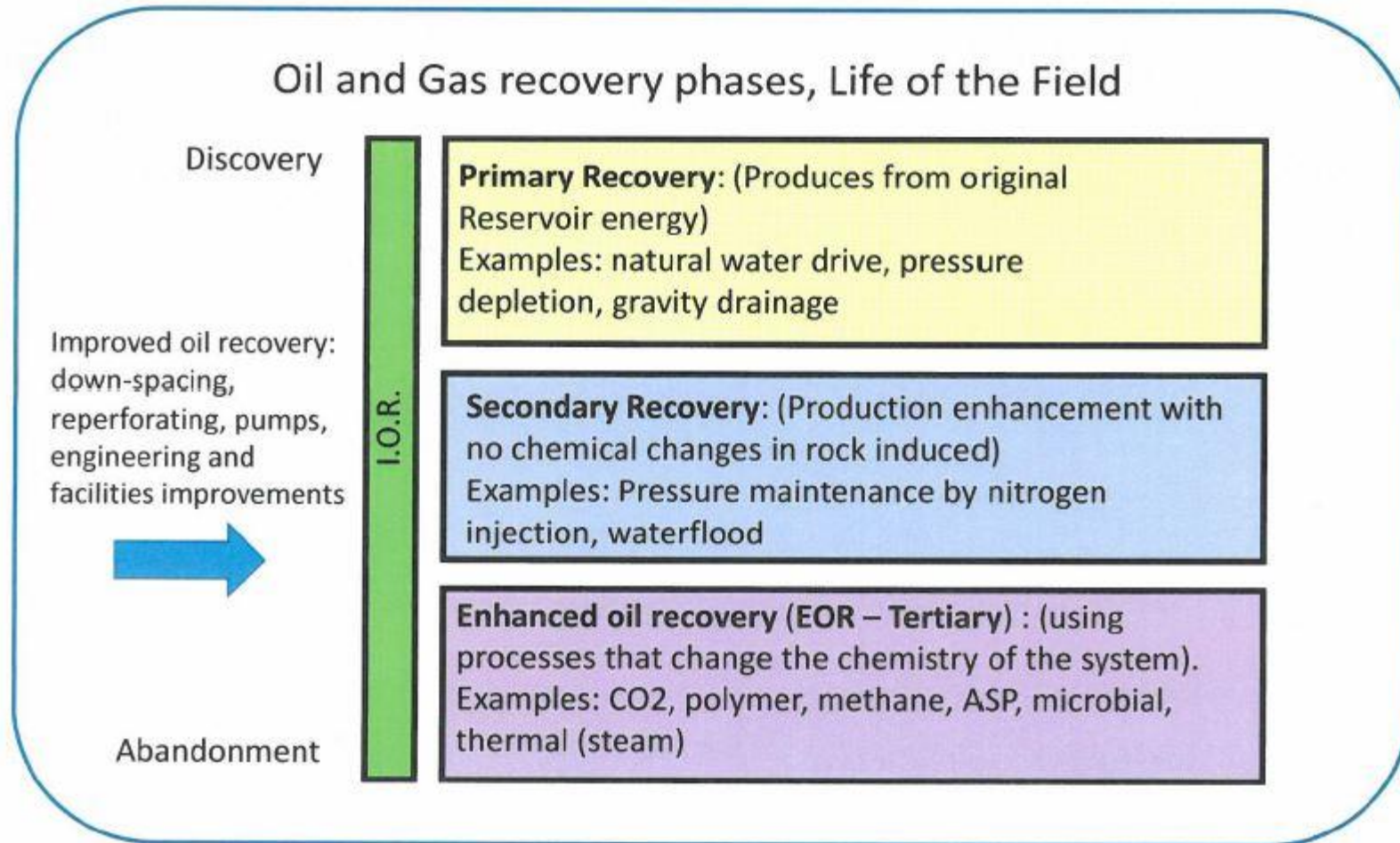
Enhanced Oil
Recovery Institute

UNIVERSITY OF WYOMING



The mission of EORI is to facilitate a meaningful and measurable increase in recoverable reserves and production of oil and natural gas in Wyoming that may otherwise not be realized. Key to this is the effective and efficient transfer of relevant technology, information and knowledge to Wyoming producers. EORI believes that its mission is being met when producers consider EORI as a vital source of relevant technology, information, expertise and knowledge for Wyoming fields.

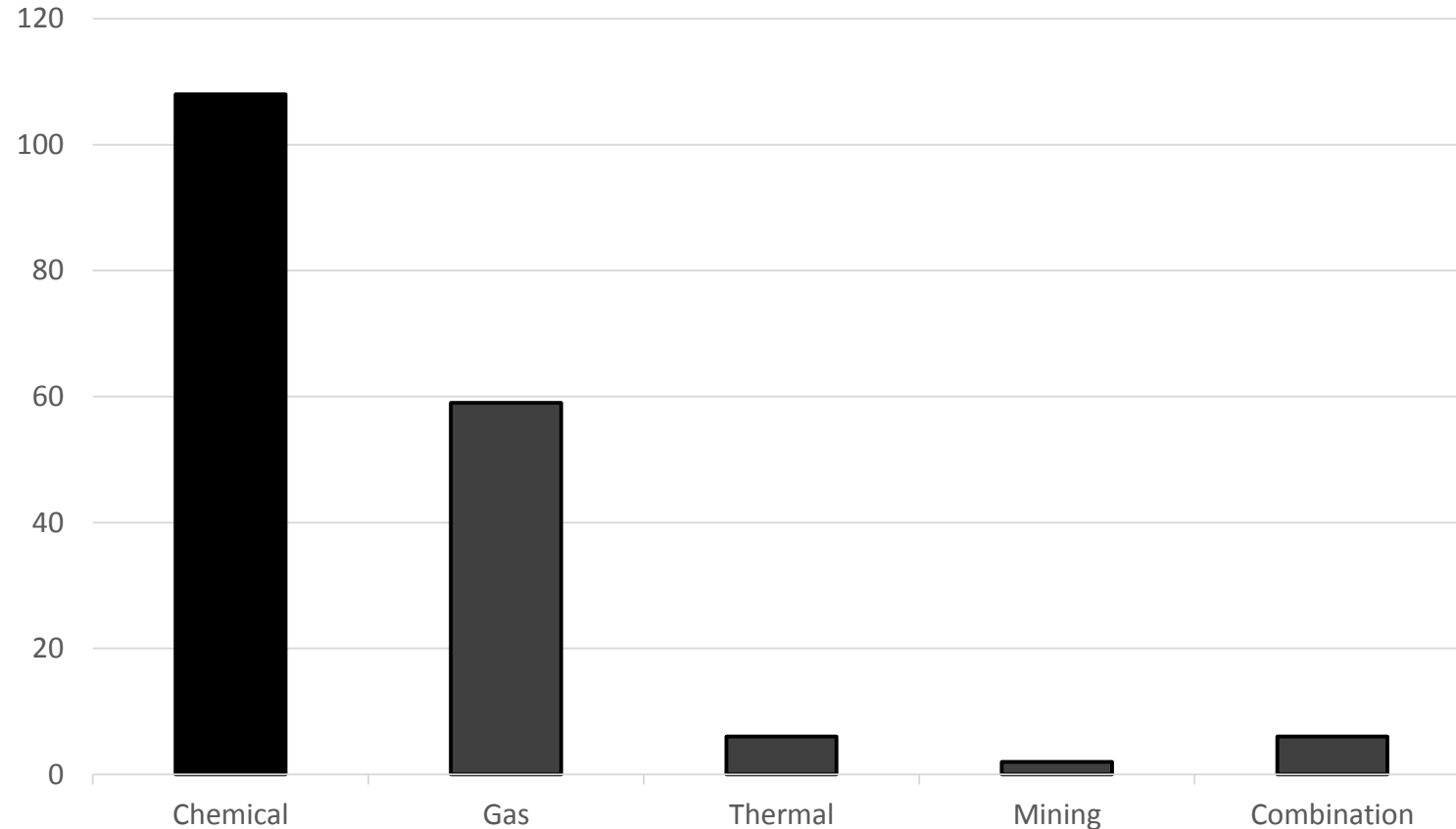
Enhanced and Improved Oil Recovery



Reported EOR Projects in Wyoming

Count of EOR projects by type

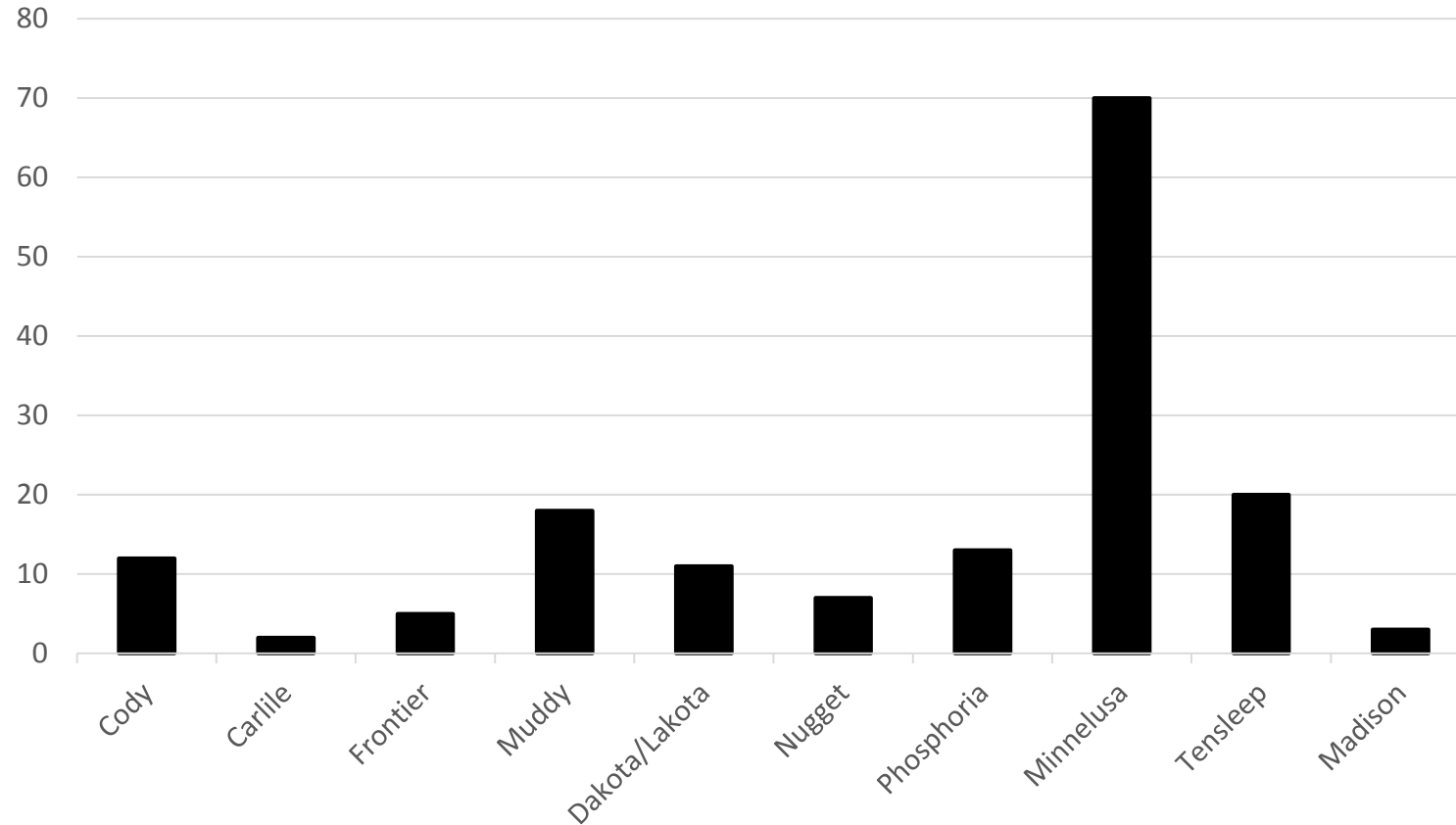
- Chemical
 - Alkaline
 - Polymer
 - Surfactant
 - Combinations
- Gas
 - Nitrogen
 - Methane
 - Carbon Dioxide
- Thermal
 - In-Situ Combustion
 - Steam
- Mining
 - Gravity Drainage
- Combination
 - Chemical/Thermal
 - Chemical/Gas
 - Gas/Thermal



EOR Projects by Reservoir

- Mesaverde
 - Teapot
 - Parkman
- Cody
 - Sussex
 - Shannon
- Carlile
 - Turner
- Frontier
 - Wall Creeks
- Muddy/Newcastle
- Lakota/Dakota
- Phosphoria
- Minnelusa
- Tensleep
- Madison

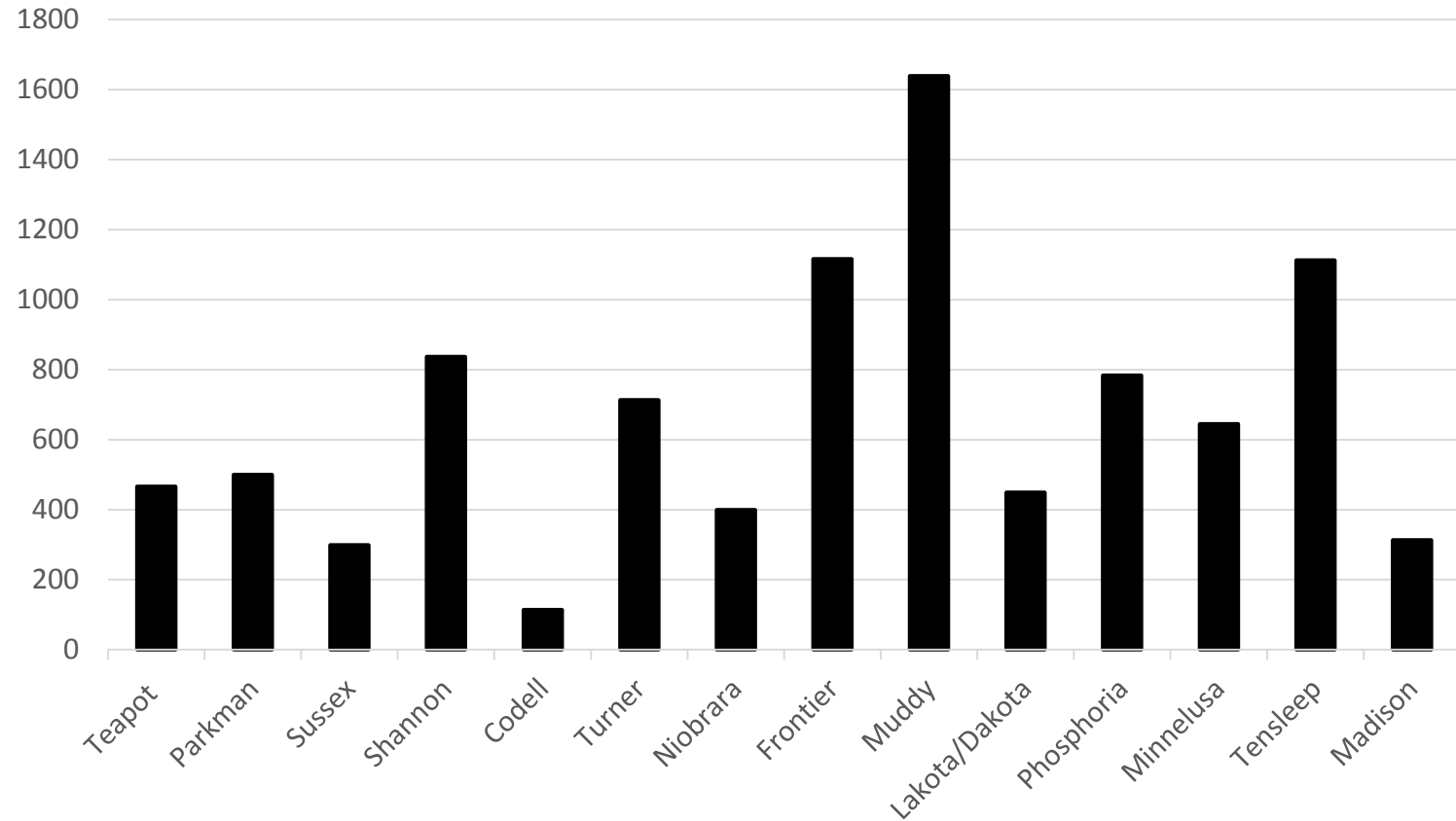
Count of EOR projects by Geologic Formation



Well count

- Mesaverde
 - Teapot
 - Parkman
- Cody
 - Sussex
 - Shannon
- Carlile
 - Codell
 - Turner
- Niobrara
- Frontier
 - Wall Creeks
- Muddy/Newcastle
- Lakota/Dakota
- Phosphoria
- Minnelusa
- Tensleep
- Madison

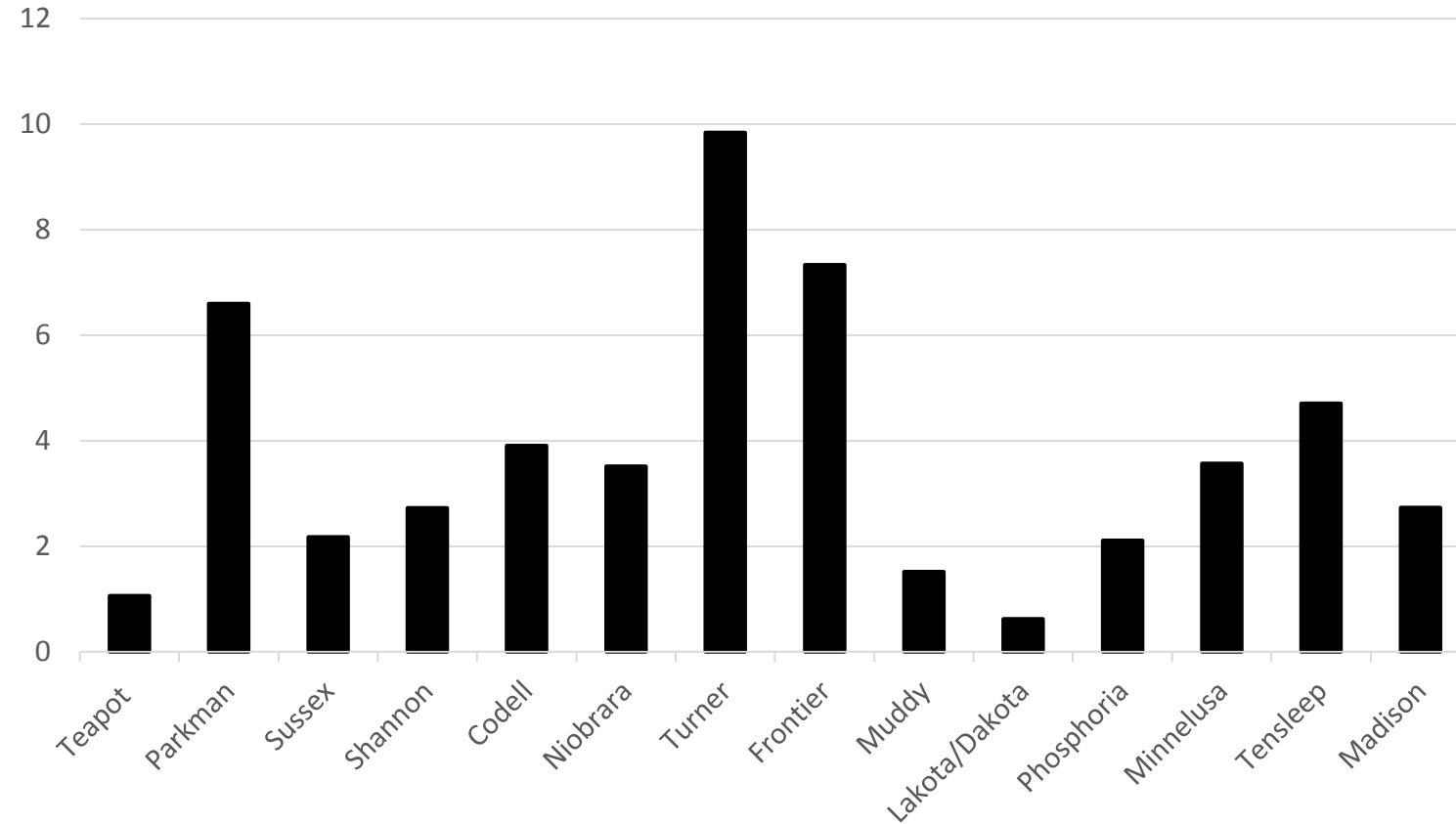
Existing development by reservoir based on producing wells



2016 Oil Production

- Mesaverde
 - Teapot
 - Parkman
- Cody
 - Sussex
 - Shannon
- Carlile
 - Codell
 - Turner
- Niobrara
- Frontier
 - Wall Creeks
- Muddy/Newcastle
- Lakota/Dakota
- Phosphoria
- Minnelusa
- Tensleep
- Madison

2016 Oil production by reservoir (mmbo)



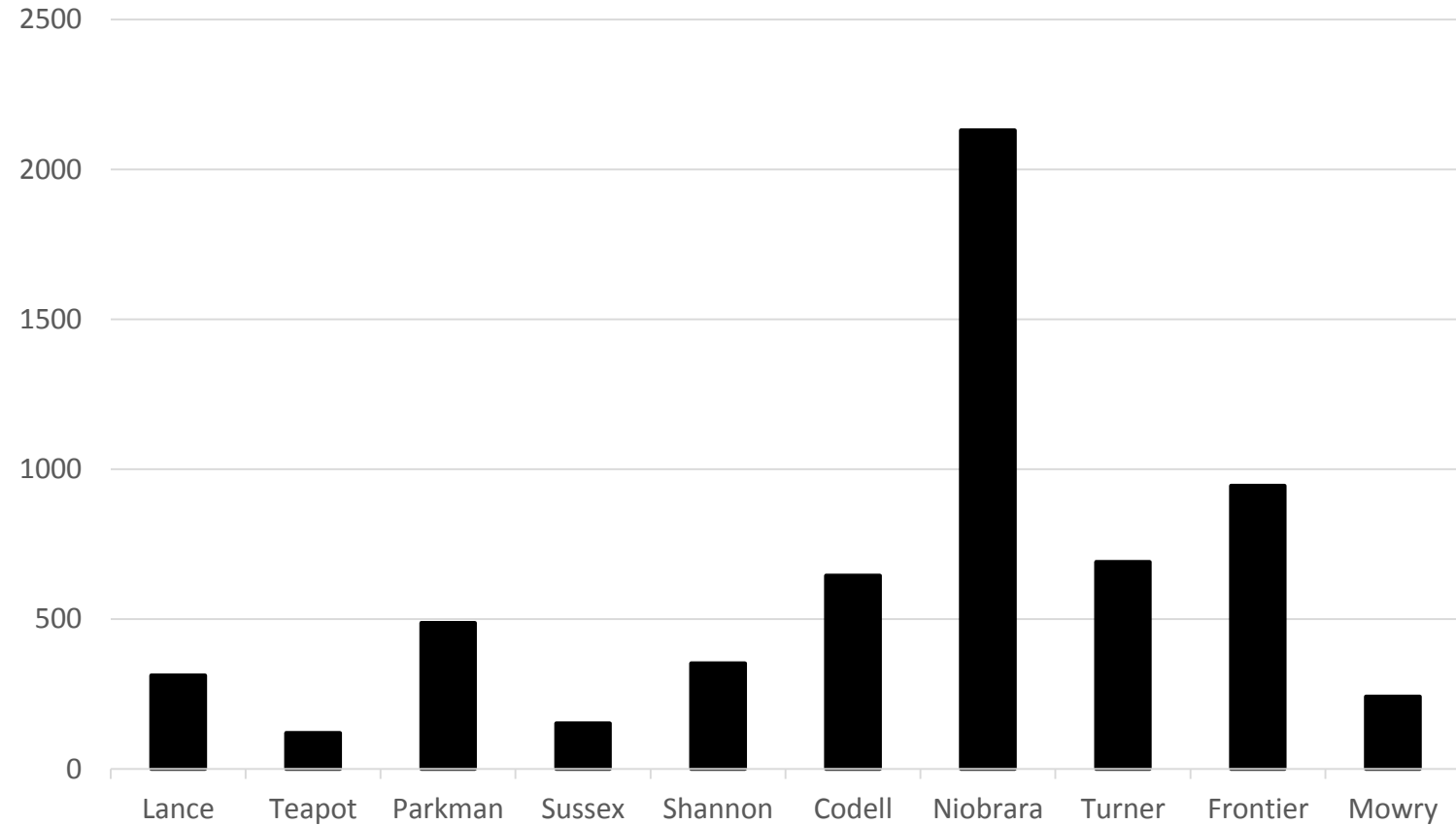
Together these Formations represent ~ 72% of total state oil production for 2016



Unconventional Targets

- Lance
- Mesaverde
 - Teapot
 - Parkman
- Cody
 - Sussex
 - Shannon
- Niobrara
- Carlile
 - Codell
 - Turner
- Frontier
 - Wall Creek
- Mowry

Future development by reservoir based on APD's





WyRIT


Information Management



Collaboration is Key


Wyoming Reservoir Information Tool (WyRit)

WyRit is a geospatial information and engineering tool focused on Wyoming Oil and Gas Reservoirs. For additional information or to provide comments regarding the WyRIT please contact EORI at uweori@uwyo.edu



DISCLAIMER

Tips: *If the popup blocker is enabled on any web browser some functionality of the Wyoming Water and Climate web application may not be available.

 ** Detailed instructions may be viewed at any time by clicking the **Help** icon on the top right of the application.

1 2 Forward

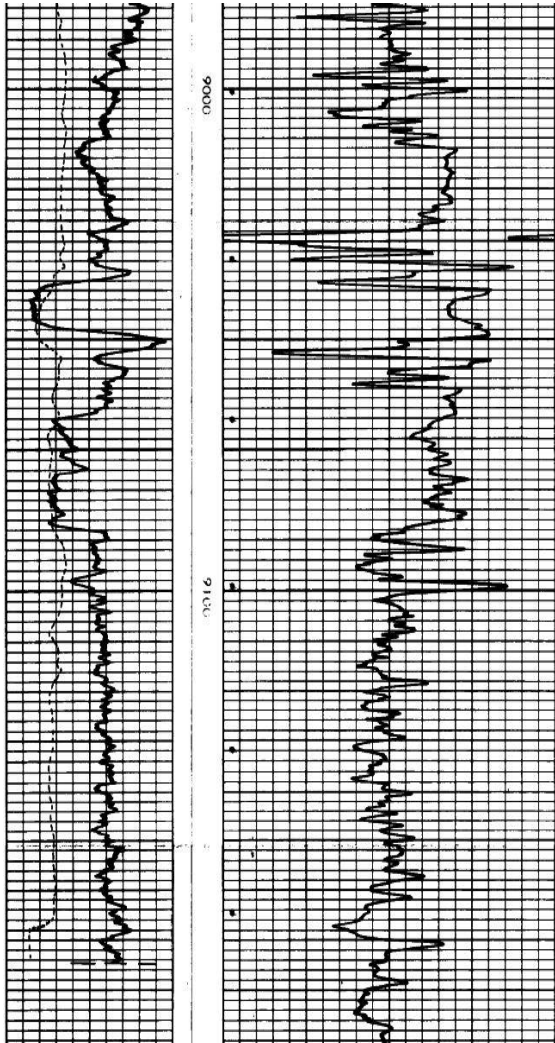
WyRit Application Developed by WyGIS

[Continue to application](#)

- Enhanced Oil Recovery Institute
- Wyoming Geographic Information Science Center
- ***Wyoming Oil & Gas Conservation Commission
- ***Wyoming Geological Association
- ***Wyoming Pipeline Authority
- Wyoming State Geological Survey
- ***Seismic Exchange

***Key data providers

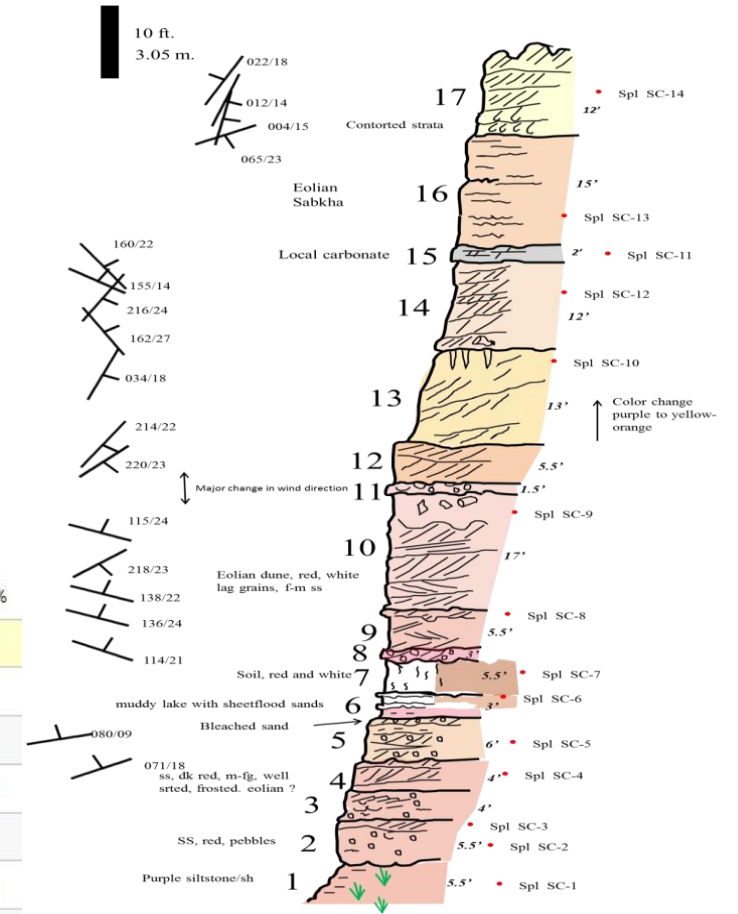
Background



- Wyoming Oil & Gas Reservoir Information
 - Database development
 - Using relational database design
 - Geospatial perspective
 - Data sharing and collaboration
- Reservoir Screening
- Data Dissemination
- Web Application
 - Wyoming Reservoir Information Tool
 - WyRIT
 - End Users

Denver	378	9.94%
Houston	119	3.13%
Dallas	111	2.92%
Cheyenne	98	2.58%
Rock Springs	78	2.05%
Casper	66	1.74%
Boulder	56	1.47%
(not set)	54	1.42%
Oklahoma City	39	1.03%

**Measured section: Tensleep (Casper) Formation
Sand Creek, Albany County Wyoming
Fryberger, Jones, Johnson
Section complete except for upper 30 feet of Tensleep**



Wyoming Reservoir Information Tool (WyRIT)

Production graphs

Field information

Reservoir data

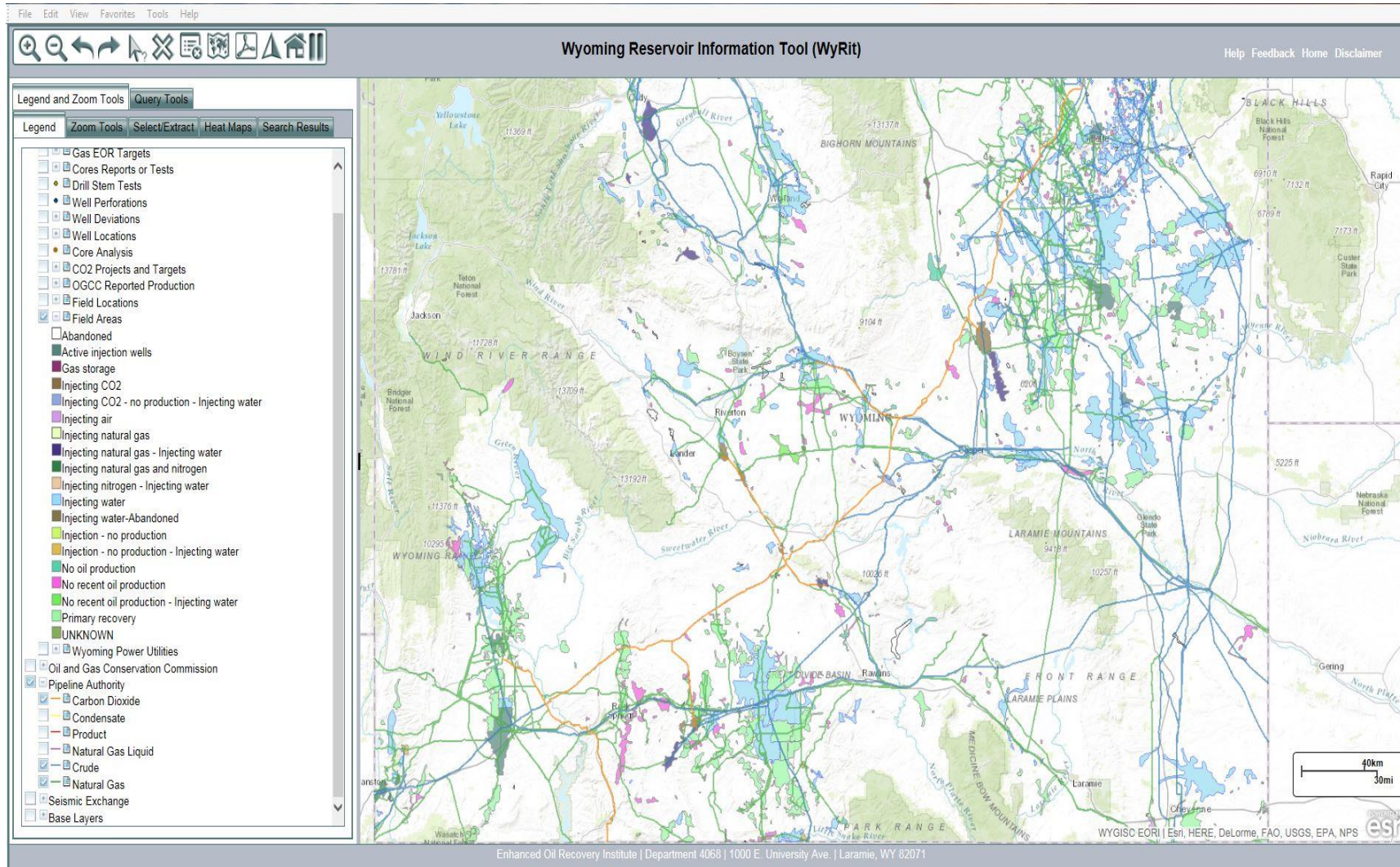
Well information

<http://eori.wygisc.org>

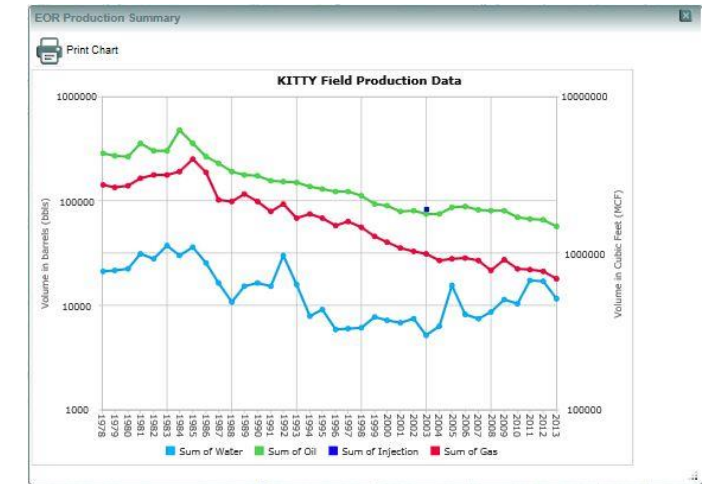
Enhanced Oil Recovery Institute | Department 4068 | 1000 E. University Ave. | Laramie, WY 82071



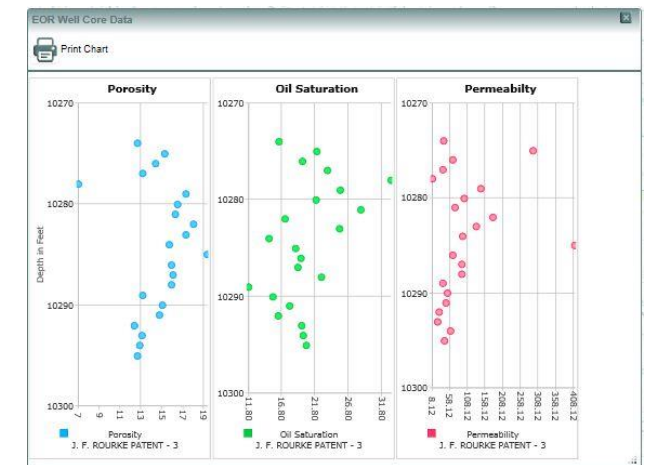
Available layers and outputs



Statewide coverage



Annual Production graphs



Core analysis charts (in press)



Available links to external data sources



Seismic attributes and links to SEI



Well attributes and links to WOGCC

SEI SEISMIC EXCHANGE | contact | careers | **OLD SPANISH TRAIL**

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Apd File	Casing	Completions	Cores/Pressures/Reports
Change of Operator	Display All Records	Geological Markers	Perforations
Production	Producing Intervals	Sales	Sundries
Tax Incentives	Treatments	Logs	Down Load Production
Download All Records	Down Load Sales	No Analysis-Check Sundries	Well Site

Back to Top Map On/Off | M A P | Off

Google Earth | AllTopo | Disclaimer | Codes | Images | About WOGCC | Topo Map

Well Number	Well Name	Operator	Section	Township/Range	Latitude	Longitude
49-025-05422	GRIEVE UNIT 7	DENBURY ONSHORE LLC	22	32 NORTH 85 WEST	42.73111	-107.013139
2131 FNL AND 495 FWL (SW NW)						

Lease No.	Permit Approved	Completion	Sand
	07/26/2006	07/09/1955	06/03/1955

Target Formation	Total Depth	Plug Back Depth	Elevation	Elevation KB
LAKOTA	6816	6731	7118	7133 KB

Form 2 Formation	Form 2 Formation
MUDDY	FRONTIER

Well Class	Last Reported Status	Status Date	Production Status	Production Status Date	Bond Release Date
G	TA	03/2012	TA	02/2016	

Country	Basin
NATRONA	WIND RIVER

Prod Oil Bbls	Prod Gas Mcf	Prod Water Bbls	Last Time Produced	Prod Produced	Last Form 2
3,782	2,910,294	3,687	02/1987	07/1955	02/2016

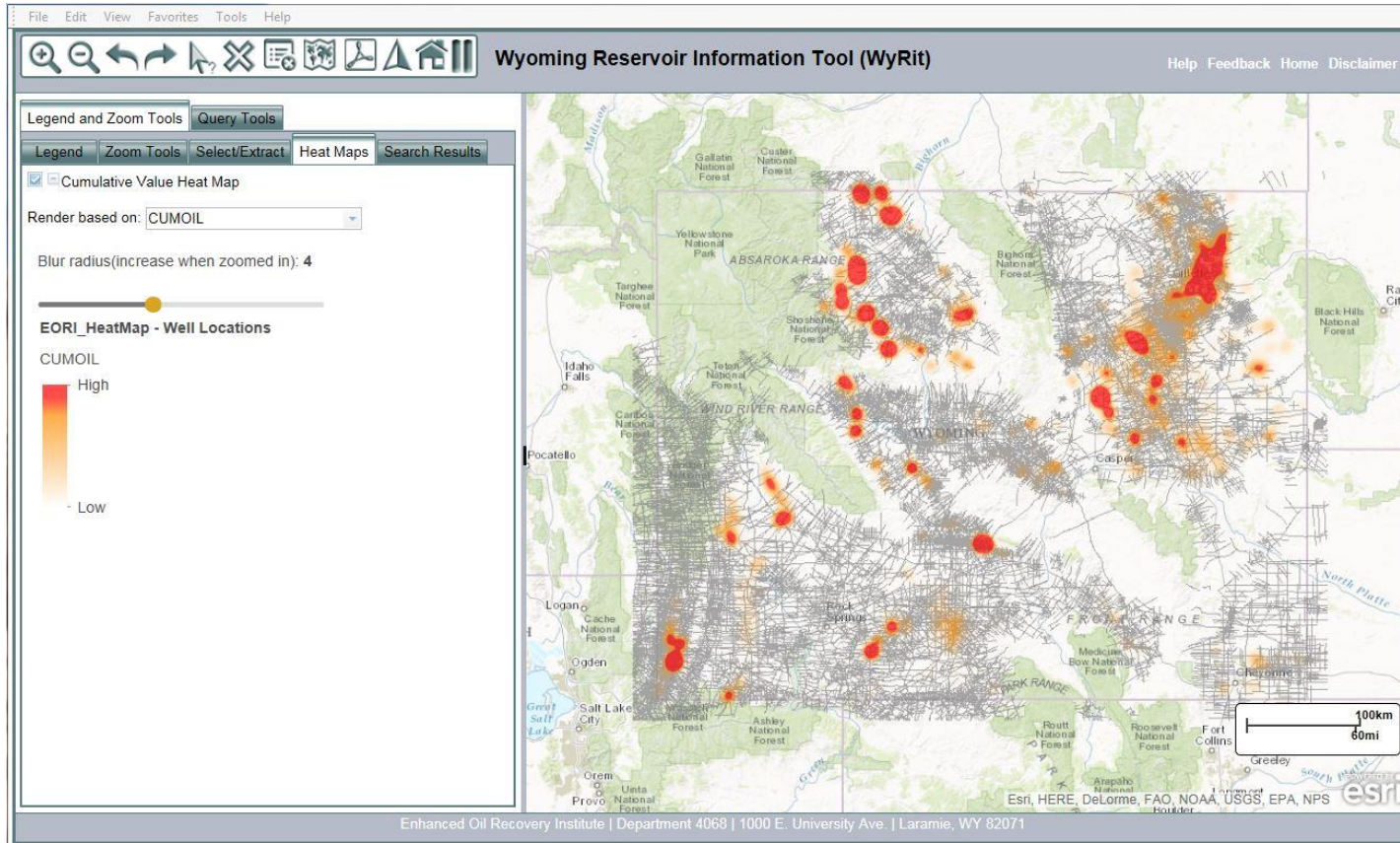
- Approvals/Notice
- Mitigation Plan
- Historical Card File
- Company Wells Status
- Commission Orders
- Offset
- Drilling Activity
- Group Number
- In Cooperation With BLM
- GRIEVE UNIT EXPLORATORY WY 109538X

04/05/2016
In SageGrouse Core Area Aliquot- ALL

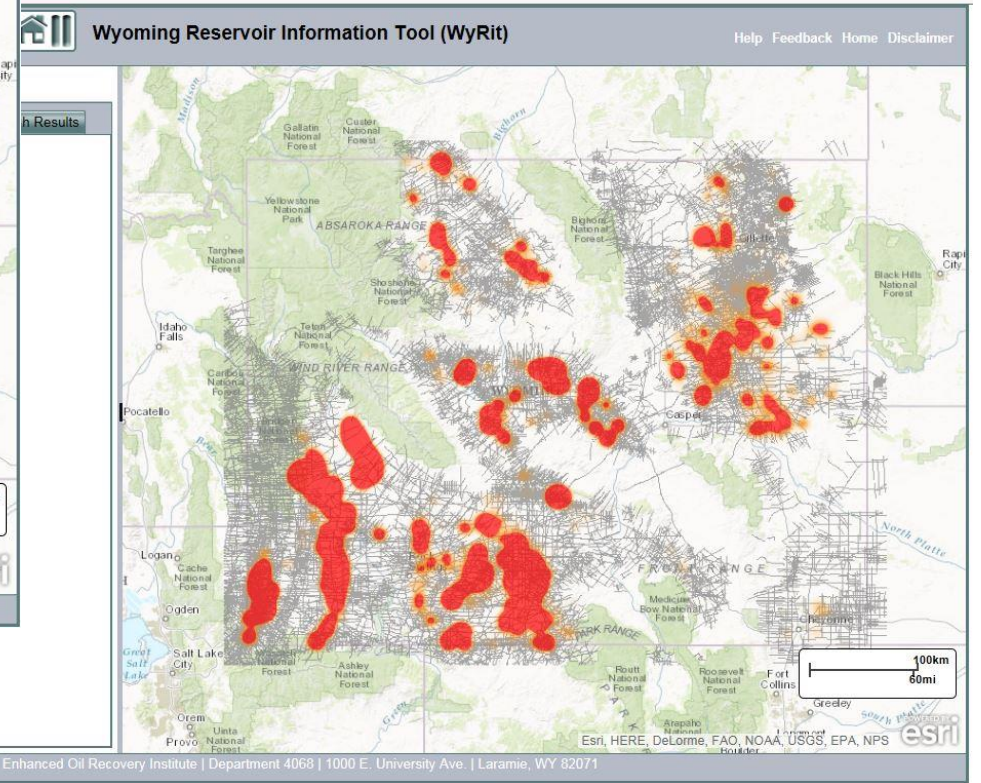


Production maps

Oil



Gas





CO₂-EOR & Buffer Storage

Incidental CO₂ sequestration

How much CO₂ is incidentally sequestered?

- Reported CO₂ injection volumes - Check
- Reported natural gas production volumes – Check
- *Little to no available public information on composition of produced natural gas*
- CO₂ loss to the reservoir is estimated to be between 15 and 30% during the project.
- It is Estimated that 90 to 95% of injected CO₂ is permanently stored at the end of a CO₂-EOR project (Melzer et al)

- This is a common theme at CO₂ conferences

Summary CO₂ Injection in Wyoming

Year	Project	Incremental bo	Cumulative CO2 (mcf)	Cumulative CO2 (tons)	
1986	Wertz	24,150,949	203,167,188	11,620,842	
1989	Lost Soldier	45,834,473	675,416,216	38,632,741	
2008	Beaver Creek	8,825,908	168,613,153	9,644,406	
2013	Big Sand Draw	916,792	39,838,773	2,278,715	
2012	Grieve		36,258,949	2,073,955	
2003	Patrick Draw	17,079,074	334,713,367	19,145,076	
2003	Salt Creek	25,762,143	2,838,584,423	162,362,548	
		122,567,280	Incremental barrels of oil	245,758,283	tons of CO2 in buffer storage
				<i>2.01 tons of CO2 per barrel of oil</i>	
Assumed Oil Price		Assumed cost			
\$50.00		\$735,403,682	state revenue	2%	\$184,318,713
		\$5,392,960,336	industry	of the price of oil	cost of CO2 for EOR



CO₂ Demand Potential

- Bighorn Basin – Potential of 1 Billion barrels in CO₂ EOR (Yin et al)
- **Potential CO₂ demand ~3 to 4.5 Tcf**
 - Phosphoria
 - Tensleep
 - Madison
- Green River Basin
- **Potential CO₂ demand ~0.8 to 1.3 Tcf**
 - Almond
- Powder River Basin – Potential of 885 Million barrels in CO₂ EOR (Branting and Whitman)
- **Potential CO₂ demand ~4.7 to 7.1 Tcf**
 - Frontier
 - Muddy
 - Minnelusa
- Sand Wash Basin
- **Potential CO₂ demand ~0.08 to 0.1 Tcf**
 - Tensleep
 - Madison
- Wind River Basin
- **Potential CO₂ demand ~1.1 to 1.7 Tcf**
 - Tensleep
 - Madison

Operator willingness to implement

- Based on CO₂ availability
- Pipelines
- Field infrastructure costs
- It's a natural progression from secondary recovery
- This is a common theme at CO₂ conferences

The top 180 CO₂-EOR Targets in Wyoming would require approximately 700 mmtons CO₂. An additional 150 mmtons would need to do the rest.

Branting, J.K. and Whitman, L.D., 1992. The Feasibility of Using CO₂-EOR Techniques in the Powder River Basin. Society of Petroleum Engineers – SPE-24337 – MS.

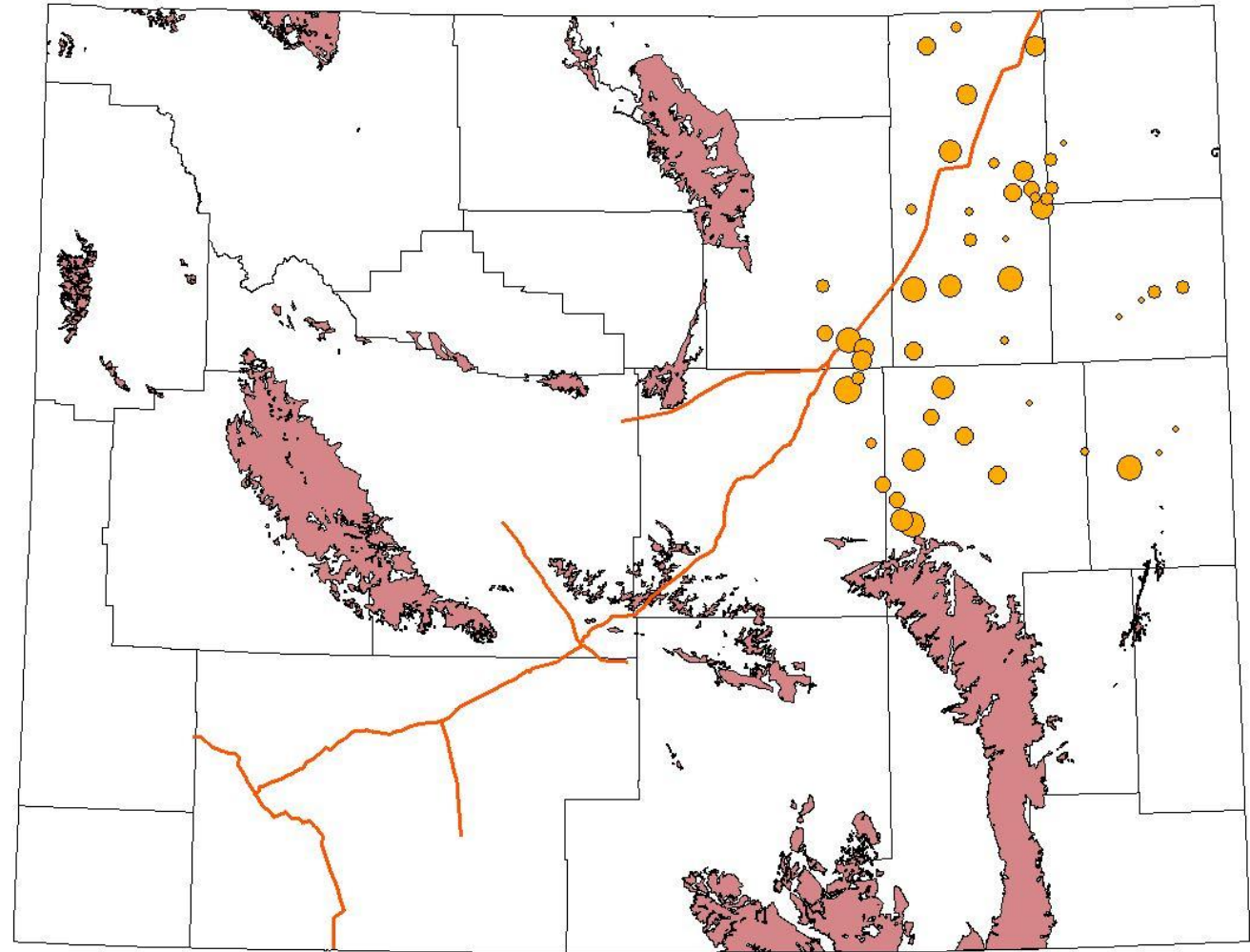
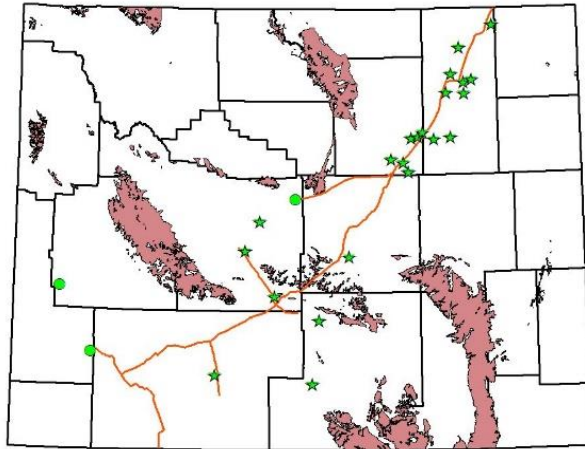
Wo, S., Whitman, L.D., and Steidtmann. 2009. Estimates of Potential CO₂ demand for CO₂-EOR in Wyoming Basins. Society of Petroleum Engineers – SPE-122921 – MS.



Candidate PRB Reservoirs suitable for CO₂-EOR



Enhanced Oil
Recovery Institute



Criteria used to identify these reservoirs include:

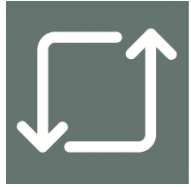
- Depth between 2,200 and 12,000 feet
- Api oil gravity between 22 and 45
- Cumulative oil production greater than 1 mmbo

*Note – CO₂ needed was derived from estimated recovery factors, cumulative production, 2 bo per ton CO₂,

Tons CO₂ required = Estimated incremental production/2



Enhanced and Improved Oil Recovery



Acknowledgements and Credits

- Enhanced Oil Recovery Commission
- Wyoming Geographic Information Science Center
- Wyoming Oil & Gas Conservation Commission
- Wyoming Geological Association
- Melzer Consulting
- Wyoming State Geological Survey
- University of Wyoming School of Energy Resources



School of
Energy Resources



Thank You!

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