

STATE OF NORTH DAKOTA PROBABLE (P2) OIL RESERVES PROJECT

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In September 2006 the Oil and Gas Division (OGD) of the Department of Mineral Resources (DMR) published the second part of the North Dakota Oil Reserves Project. The project began in August of 2005.

Probable (P2) oil reserves are defined as technically and economically recoverable oil volumes with a probability of recovery greater than fifty percent (50%). Typically P2 reserves require significant capital investment for re-completions, stimulations, drilling, or enhanced oil recovery (EOR) operations such as water-flood improvements, carbon dioxide (CO₂) flooding, or other tertiary recovery methods.

The total P2 reserves estimated within North Dakota are over 660 million barrels. These reserve estimates are useful for economic forecasting, infrastructure planning, as well as estimating North Dakota's possible (P6) reserves.

The process of estimating P2 reserves began as each pool was evaluated for Estimated Ultimate Recovery (EUR) and P1 reserves. If a pool has a known analog pool that has benefited from infill drilling, horizontal drilling, and/or EOR processes were cataloged for evaluation in this phase of the study.

P2 reserve potential from re-completions, stimulations, in-fill drilling, or water-flood improvement was estimated by grouping the pools by county and pool for statistical comparison of recovery factors. Field-pool combinations with recovery factors below the mean value were checked for re-completion, stimulation, in-fill drilling, or water-flood improvement potential. When potential was confirmed, the difference between mean recovery factor for that pool type in that county and the recovery factor of the specific pool was

multiplied by the original oil in place (OOIP) to estimate probable reserves.

P2 reserve potential for EOR was limited to pools with these characteristics:

- Madison pools with five or more active wells, water saturation less than 45%, and primary EUR of more than one million barrels.
- Devonian pools with three or more active wells, water saturation less than 45%, and primary EUR of more than one million barrels.
- Red River pools with two or more active wells, water saturation less than 50%, and primary EUR of more than one million barrels.

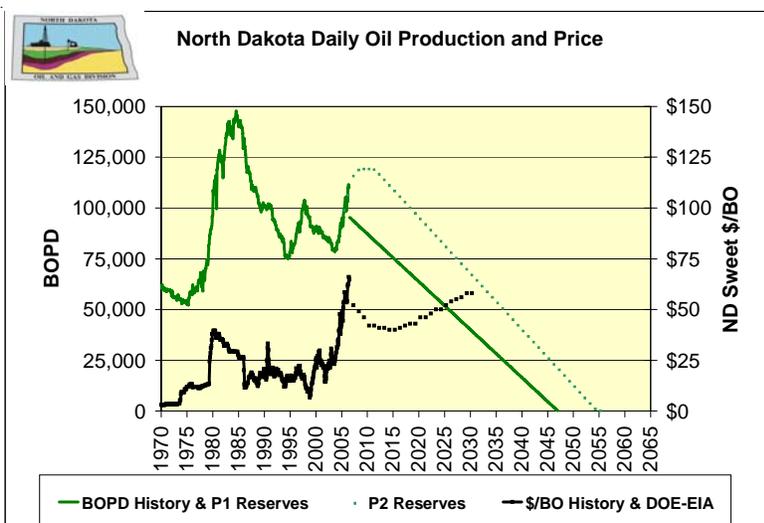
In order to compare recovery factors the OOIP had to be calculated and divided into the estimated ultimate primary oil recovery. Reservoir parameters required to calculate OOIP were taken from temporary and proper spacing exhibits, entered into spreadsheets, compared statistically, and evaluated based on experience by the authors of this paper.

Missing and/or unreasonable parameters were revised or estimated utilizing correlations, reservoir studies on file at the OGD, fractional flow curves, and well log analysis. The area parameter for each pool was estimated by multiplying the primary spacing set for the pool times the maximum number of producing wells during the pools producing history.

CO₂ – EOR reserves were taken from previous estimates published by the Energy & Environmental Research Center (EERC) as a part of the Plains Carbon Dioxide Reduction Partnership (PCORP) Phase I project. The unitized pools in the PCORP list were evaluated based on experience. CO₂ – EOR reserves in unitized pools, where water-flooding has been effective and reservoir pressure maintained above bubble point, are considered P2 reserves.

Five tables, in the study publication, list the Madison, Bakken, Devonian, Red River, and the Midale-Nesson, Ratcliffe, Birdbear, Silurian, Stonewall, Tyler and Winnipegosis pools in North Dakota with P2 reserves for each pool. Table I shows the Devonian pools in North Dakota as an example.

Graph of North Dakota's historical oil production and price, DOE-EIA oil price projections, and P1 and P2 reserves production projections.



Field Name	Pool	County	County	Active Oil Wells	Inj	Cumulative Oil	Remaining Oil	Estimated Ultimate Oil Recovery	OOIP	Estimated Ultimate Recovery Factor	Future P2 Reserves	Basis
* ANTELOPE	DEVONIAN	MCKENZIE		3	3	6,025,328	846,583	6,871,911	16,300,000	0.42	2,540,081	Waterflood Improvement & CO ₂
* BEAVER LODGE	DEVONIAN	WILLIAMS		38	24	67,565,933	27,251,542	94,817,475	172,000,000	0.55	17,000,000	CO ₂
* BEAR CREEK	DUPEROW	DUNN		6	6	5,125,388	196,513	5,321,901	13,600,000	0.39	2,862,338	Waterflood Improvement & CO ₂
LITTLE KNIFE	DUPEROW	BILLINGS	MCKENZIE	4		832,146	477,755	1,309,901	2,592,175	0.51	**	
ROOSEVELT	DUPEROW	BILLINGS		1		942,737	36,951	979,688	13,079,171	0.07	2,350,249	***
TREE TOP	DUPEROW	BILLINGS		1		695,522	181,145	876,667	4,775,861	0.18	339,260	***
AMBROSE	DUPEROW	DIVIDE		6		1,386,465	47,153	1,433,618	4,005,197	0.36	**	
GOOSENECK	DUPEROW	DIVIDE		4		1,138,141	20,318	1,158,459	3,096,292	0.37	**	
WEST AMBROSE	DUPEROW	DIVIDE		2		134,583	128,317	262,900	1,583,082	0.17	211,049	***
JIM CREEK	DUPEROW	DUNN		1		1,946,197	91,974	2,038,171	10,175,738	0.20	**	
LAKE ILO	DUPEROW	DUNN		1		512,766	131,420	644,186	4,290,434	0.15	107,588	***
BLUE BUTTES	DUPEROW	MCKENZIE		2		908,081	244,530	1,152,611	5,291,773	0.22	160,666	***
BOXCAR BUTTE	DUPEROW	MCKENZIE		4		761,414	406,945	1,168,359	16,437,160	0.07	2,910,906	***
BULL MOOSE	DUPEROW	MCKENZIE		3		1,080,755	162,576	1,243,331	2,051,091	0.61	**	
CHERRY CREEK	DUPEROW	MCKENZIE	WILLIAMS	1		876,904	89,756	966,660	7,443,986	0.13	880,739	***
INDIAN HILL	DUPEROW	MCKENZIE		7		2,226,848	95,502	2,322,350	18,448,179	0.13	6,066,469	Waterflood
NORTH BRANCH	DUPEROW	MCKENZIE		5		1,411,711	288,719	1,700,430	4,623,520	0.37	401,993	Waterflood
PIERRE CREEK	DUPEROW	MCKENZIE		3		822,633	33,220	855,853	2,452,769	0.35	**	
ROUGH RIDER	DUPEROW	MCKENZIE		4		2,096,260	345,558	2,441,818	14,685,922	0.17	4,236,215	Waterflood
SOUX	DUPEROW	MCKENZIE		2		230,843	261,662	492,505	2,465,439	0.20	119,351	***
HARDSCRABBLE	DUPEROW	WILLIAMS	MCKENZIE	3		1,402,949	3,826	1,406,775	5,406,464	0.26	**	
NORTHWEST	DUPEROW	WILLIAMS		1		1,072,452	347	1,072,799	6,627,598	0.16	197,395	***
MCGREGOR												
TEMPLE	DUPEROW	WILLIAMS		3		624,071	162,212	786,283	25,279,554	0.03	4,058,599	***
TRENTON	DUPEROW	WILLIAMS		3		928,681	267,514	1,196,195	3,816,412	0.31	**	

* Unitized prior to 1/1/06.

** No probable reserves indicated at this time.

*** No specific mechanism identified. Candidate for recompletions, stimulations, or infill drilling.

Devonian Pools in North Dakota. One of five tables in the P2 report.