

NORTH DAKOTA GEOLOGICAL SURVEY  
Wilson M. Laird, State Geologist

NORTH DAKOTA CRUDE OIL INVENTORY AS OF JANUARY 1, 1966

by  
Clarence B. Folsom, Jr. P. E.

Miscellaneous Series #27

Grand Forks, North Dakota, 1966

NORTH DAKOTA CRUDE OIL INVENTORY AS OF 1 JANUARY 1966

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Abstract

North Dakota's reserves of crude oil recoverable with present technical knowledge, existing equipment, and current producing practices, were 630,779,166 barrels on 1 January 1966. This figure was less than the 644,726,457 barrels of stock tank oil reported for 1 January 1965.

The reduction in inventory reflected the slow-down in exploratory drilling during 1965. New discoveries, and extensions of existing pools failed to offset the years production of 26,353,333 barrels (preliminary total).

258,313,000 barrels, or 41% of the total reserves will be recovered by energy supplementation. There were 13 energy supplementation projects under way in 1965. Several other projects are in the process of formation.

There were 231 wells completed in North Dakota, during 1965, of which 74, or 32%, were wildcats. Bottineau County led in completions with 66, followed by Renville County with 62, Burke County with 25, and Billings County with 23.

Estimates of recoverable crude oil reserves in the State of North Dakota, on 1 January 1966, indicate that 630,779,166 barrels of stock tank oil remain to be recovered. This represents 73.4% of the reserves originally present (859.5 million barrels STO).

These reserves are deemed to be recoverable with present technical knowledge, current operating methods, and available equipment.

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<sup>1/</sup>Chief Petroleum Engineer, North Dakota Geological Survey

During 1965 the production of 26,358,388 barrels exceeded the amount of reserves added by new discoveries, extensions, and revisions of previous estimates. No new energy supplementation projects were initiated during the year.

258,313,000 barrels of the remaining reserves will be recovered as the result of energy supplementation. This represents 41% of the total. There were 13 energy supplementation projects under way on 1 January 1966.

Wildcats accounted for ~~69~~<sup>74</sup> of the 231 wells completed in 1965 in North Dakota. Only one wildcat was completed as a discovery, opening the Scotia Field in Bottineau County. Two new pools were found in existing fields. Flat Lake East Field, in Divide County, was not considered a discovery since it was contiguous to an existing field in Montana.

Revisions of former estimates and extensions to established fields added 10 million barrels with new pools in old fields accounting for 2,000,000 barrels. These increases were not sufficient to offset the withdrawal of 26,358,388 barrels in 1965 resulting in a net decrease in recoverable reserves.

The demand for North Dakota crude oil reached \$1,000 barrels per day in December 1965. Thus the reserve/demand ratio was 7,787 to 1. The reserves have been tabulated by Marketing Districts, County, and geologic interval in the tables at the end of the report.

#### Explanation of methods used in this study

Throughout this inventory the standard volumetric method of estimating reserves has been used, according to the following formula:

$$R = 7750 A h p (1-s) r / B \text{ where}$$

R	Recoverable reserves by presently known techniques
A	Proven acreage
h	Net average productive thickness in feet
p	Percent porosity

s     Percent water saturation  
r     Recovery factor-percent  
B     Reservoir volume factor - Barrels per barrel

The recovery factor<sup>2/</sup> used here does not take into account the economics of production. Since the study is intended to serve the same purpose as the annual inventories conducted by private business concerns, the economic situation was considered to be beyond the scope of the work.

This should not constitute a valid criticism of the method since it is anticipated that future research and experience will increase, rather than decrease, the total ultimate recovery from our oil reservoirs.

For the purpose of this inventory a 40-acre tract was considered proven acreage if it contained a producing well or if it offset a producing well. Credit given to offsetting 40-acre tracts was reduced if they contained dry holes or were offset in turn by dry holes.

The net average productive thickness was determined by Sidney B. Anderson, Chief Subsurface Geologist for the North Dakota Geological Survey, from mechanical logs on file in his office. Drill stem tests, core analyses and other information were considered. Additional development, particularly in relatively new pools, tended to reduce the average thicknesses used in earlier estimates.

Porosities and saturations were taken from core analyses, where available, or from log calculations. When such data was not available, values were assigned by analogy to other nearby pools producing from the same geologic intervals under similar conditions.

The formation volume factors were obtained from reservoir fluid analyses, when available, or by analogy.

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<sup>2/</sup>It was necessary to increase the recovery factor for the Sherwood field indicating that the recovery factors used may be too conservative, particularly in District IIb.

The final result of the calculation was rounded off to the nearest thousand barrels, if the total was over 1 million, or to the nearest 500 barrels. The cumulative production to 1 January 1966 was then deducted to arrive at the final figure. Since the production is known to the exact barrel, this results in the final figure being shown to the single barrel.

Reserves due to supplementation of reservoir energy were added only in those cases where fluid injection was actually in progress.

#### Developments during 1965

On 18 November 1965 the Industrial Commission removed production restrictions in District I. The action was taken when it appeared that supply and demand were in close balance. The Commission hopes to establish the deliverability of the fields and pools in District I as well as the ability of the market to absorb production.

Projected increases in refinery capacities may cause demand to exceed supply in which case additional exploratory drilling will be necessary.

Bottineau and Renville Counties continued to attract more than half of the drilling activity in the state with 116 out of 220 permits being issued for wells in this area. However the Medora Field, in Billings County, drew considerable attention with 17 strings of tubing added during the year.

For the first time lands within Federal Wildlife Refuges were leased for oil development in North Dakota with some stipulations. The restrictions imposed did not seem to materially hamper operations as seven wells were drilled in the first year.

Although no new energy supplementation projects got under way in 1965, there were five projects under active study at the end of the period.

The 1965 Legislature amended the Oil and Gas Conservation Law by adding provisions for statutory unitization. The new provisions became effective

on 1 July and may be invoked when 80% of the working interest and 80% of the royalty interest has agreed on a plan of unitization.

The year of 1965 saw a number of small producers selling their properties in North Dakota. Most of these were purchased by larger companies.

#### Discussion of tables

The percentage of total reserves credited to Marketing District I dropped from 73.06% as of 1 January 1965 to 66.92% as of 1 January 1966. The largest increase was in District IIb which went from 6.13% to 10.49% during the year.

Williams County continued to lead the producing counties with almost 1/3 of the recoverable reserves.

Distribution of reserves by geologic interval remained relatively unchanged, with Mississippian Pools providing 80% of the recoverable reserves.

#### Outlook

With the apparent surplus of crude oil rapidly disappearing, more drilling activity can be expected. If the success ratio of former years can be re-established, a number of new fields should result.

Developments in the southwestern quarter of the state will generate more interest in the construction of pipeline facilities in that area.

Production during 1966 should reach 27 million barrels. Drilling forecasts include 400 completions; 160 wildcat permits; and 7 new pool discoveries.

#### Stripper Well Survey

Table IVb, from Miscellaneous Series No. 25, is included here as Table IVa, for the purpose of comparison. The new table IVb reflects the same information for 1 January 1966.

On that date there were 1,935 wells in North Dakota capable of producing oil. Of these, 257 were classified as sub-marginal on the basis of their performance during December, 1965. This represented 12.9% of the producing wells, and these wells accounted for 2.5% of total oil production in the state for 1965.

The average production from sub-marginal wells during 1965 was 5.06 barrels /day/well as compared to 7.26 barrels /day/well in 1964.

Abandonments remained the same with 13 sub-marginal wells being abandoned in both 1964 and 1965.

#### Acknowledgements

All of the information and data used in making this inventory was obtained from the files and records of the North Dakota State Industrial Commission, at the Office of the North Dakota Geological Survey in Grand Forks.

In addition to Mr. Anderson, recognition is herewith given to the help and assistance of Mr. Wesley D. Norton and Miss Juanita Williams, Assistant Petroleum Engineers for the Survey, and Mr. F. E. Wilborn, Jr., the Survey's Statistician.

TABLE I

CRUDE OIL INVENTORY IN NORTH DAKOTA

	Primary Reserves STO	Secondary Reserves STO	Total Recoverable OIL-STO	Production To 1-1-66	Remaining Recoverable Oil 1-1-66	% of Total	Fields	Pools	Fields Abandoned 1-1-66	Fields Producing 1-1-66	Pools Producing 1-1-66	Producing Acres
District I	339267500	249301000	588568500	166254389	422314111	66.92	30	47	1	29	43	171544
District IIa	63953000	2000000	65953000	19675817	46277183	7.33	21	21	3	18	18	57800
District IIb	84704000		84704000	18490079	66213921	10.49	23	24	3	20	20	41240
District IIc	58192500	834000	59026500	12029800	46996700	7.45	17	18	1	16	17	31560
District IIIa	3192000		3192000	1595110	1596890	0.25	1	1		1	1	3040
District IIIb	51878000	6178000	58056000	10369208	47686792	7.56	8	12	2	7	10	29269
	601187000	258313000	859500000	228414403	631085597	100.00	100	123	10	91	109	334453
Less Gasoline Plant Recovery					306431							

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TABLE II

CRUDE OIL INVENTORY IN NORTH DAKOTA

	Primary Reserves STO	Secondary Reserves STO	Total Recoverable Oil-STO	Production To 1-1-66	Remaining Recoverable Oil 1-1-66	% of Total	Fields	Pools	Fields Abandoned 1-1-66	Fields Producing 1-1-66	Pools Producing 1-1-66	Producing Acres
Billings	38322500		38322500	5909157	32413343	5.14	5	8	2	3	6	20980
Bottineau	96680500	834000	97514500	19702655	77811845	12.33	28	29	1	27	28	52040
Bowman	10105500	6178000	16283500	3874406	12409094	1.97	2	3		2	2	7289
Burke	75757000	19809750	95566750	26785781	68780969	10.90	22	22	2	20	20	62640
Divide	13512000	9052500	22564500	2642173	19922327	3.16	7	7	1	6	6	7875
Dunn	648000		648000	230768	417232	0.07	1	1		1	1	360
McHenry	3230000		3230000	187735	3042265	0.48	1	1		1	1	1000
McKenzie	138640000	42177000	180817000	55713721	125103279	19.82	15	27	1	14	23	72500
Mountrail	28329000	43994000	72323000	20126057	52200943	8.27	3	3		3	3	15060
Renville	41411500		41411500	10256036	31155464	4.94	9	9	2	7	7	17220
Stark	1475500		1475500	326887	1148613	0.18	2	3	1	1	1	1880
Ward	99000		99000	46566	52434	0.01	1	1		1	1	660
Williams	152976500	136267750	289244250	82612461	206627789	32.73	10	15		10	15	74949
	601187000	258313000	859500000	228414403	631085597	100.00	106	129	10	96	114	334453
Less Gasoline Plant Recovery					306431							

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TABLE III

CRUDE OIL INVENTORY IN NORTH DAKOTA

	Primary Reserves STO	Secondary Reserves STO	Total Recoverable Oil-STO	Production To 1-1-66	Remaining Recoverable Oil 1-1-66	% of Total	Fields Pools	Fields Abandoned 1-1-66	Fields Producing 1-1-66	Pools Producing 1-1-66	Producing Acres
Devonian	65601000	33550000	99151000	19014608	80136392	12.70	16		13		30118
Mississippian	484912000	224163000	709075000	198598279	510476721	80.89	93		86		268053
Ordovician	12314000		12314000	4203132	8110868	1.29	5		4		14989
Pennsylvanian	23319000		23319000	3486532	19832468	3.14	5		3		12180
Silurian	13907000	600000	14507000	3072330	11434670	1.81	3		2		8771
Triassic	1134000		1134000	39522	1094478	0.17	1		1		360
	601187000	258313000	859500000	228414403	631085597	100.00	123		109		334453
Less Gasoline Plant Recovery					306431						
					630779166						

TABLE IVa  
NORTH DAKOTA STRIPPER WELLS

	No. of Wells	1964 Production	Acres	Abandoned 1964	Primary Reserves 1-1-65	Secondary Reserves 1-1-65	Average daily Production Dec. 1964	Average daily Production per Well 1964
Billings	4	8897	1164	1	1001871		15	3.0
Bottineau	54	131640	3840.87	1	6184527		9312	6.92
Bowman	7	24147	560	3	683040	494000	482	8.46
Burke	63	188778	7526.69	6	7236702	4102000	8463	7.44
Divide	1	2281	160	0	303025	543000		
McKenzie	25	52921	2391.87	3	3223594	1176000	3575	8.26
Mountrail	20	50649	1591.58	0	654241	2024000	3576	6.75
Renville	10	21991	820	4	1254304		523	6.79
Williams	42	123105	3886.10	0	9558882	5830000	6523	7.15
	266	604409	21941.11	18	30100186	14169000	32469	7.26 B/D/well

TABLE IVb  
NORTH DAKOTA STRIPPER WELLS

	No. of Wells	1965 Production	Acres	Abandoned 1965	Primary Reserves 1-1-66	Secondary Reserves 1-1-66	Average daily Production Dec. 1965	Average daily Production per Well 1965
Billings	4	15510	560	0	903392		38.06	9.52
Bottineau	71	149493	5001.24	4	8134002	148300	369.22	5.20
Bowman	3	11308	480	5	592104	496800	15.67	5.22
Burke	76	184027	9200	3	5556265	779360	394	5.18
Divide	1	888	80	0	21448			
McKenzie	25	74631	2173.08	1	3010049	2689920	90.74	3.63
Mountrail	22	38111	1760	0	526189	2749440	75.96	3.45
Renville	9	27370	720	1	275943		34.64	3.85
Williams	46	141203	3791.79	4	4528221	4793880	281.70	6.12
	257	642541	23766.11	18	23547613	11657700	1299.99	5.06 B/D/well

## APPENDIX "A"

### MARKETING DISTRICT I

Geographical description: Township 148 North to 161 North, Ranges 94 West to 97 West, inclusive.

Fields: Gros Ventre, Viking, North Tioga, Tioga, McGregor, West Tioga, East Tioga, White Earth, Beaver Lodge, Capa, Hofflund, Delta, Charlson, Blue Buttes, Antelope, Croff, Bear Den, Lost Bridge, Pershing, Camel Butte, Fancy Buttes, Dimmick Lake, Clear Creek, Keene, Sand Creek, Northwest McGregor, Stoneview, Wildrose, and Hawkeye.

### MARKETING DISTRICT II

#### Subdistrict A

Geographical description: Township 164 North, Ranges 88 West to 103 West, inclusive, Township 163 North, Ranges 88 West to 103 West, inclusive, Township 162 North, Ranges 88 West to 103 West, inclusive, Township 161 North, Ranges 88 West to 93 West, and 98 West to 103 West, inclusive, and Township 160 North, Ranges 88 West to 93 West, and 98 West to 103 West, inclusive.

Fields: Baukol-Noonan, Noonan, Short Creek, Columbus, Portal, Rival, Black Slough, Foothills, Northeast Foothills, Rennie Lake, Lignite, Flaxton, Stony Run, Woburn, Bowbells, and Perella.

#### Subdistrict B

Geographical description: All of the state not included in other district or subdistricts.

Fields: Dickinson, Haas, North Haas, Kuroki, Wayne, Wiley, Elmore, Sherwood, Eden Valley, Pratt, Glenburn, Lansford, Mohall, North Maxbass, South Antler Creek, Southwest Haas, Tolley, Chola, Southwest Aurelia, and Mouse River Park.

#### Subdistrict C

Geographical description: Townships 160 North to 164 North, Ranges 77 West to 80 West, inclusive.

Fields: North Souris, Scandia, Northeast Landa, Roth, Starbuck, South Starbuck, North Westhope, Westhope, South Westhope, Newburg, East Newburg, West Roth, Boundary Creek, and Russell.

### MARKETING DISTRICT III

#### Subdistrict A

Geographical description: Townships 158 North to 160 North, Ranges 98 West to 107 West, inclusive.

Fields: Grenora

#### Subdistrict B

Geographical description: Townships 129 North to 158 North, Ranges 98 West to 107 West, inclusive.

Fields: Little Missouri, Cedar Creek, Rocky Ridge, Fryburg, Medora, and Rough Rider.