

NORTH DAKOTA GEOLOGICAL SURVEY

E. A. Noble, State Geologist

NORTH DAKOTA CRUDE OIL INVENTORY AS OF JANUARY 1, 1970.

by

Clarence B. Folsom, Jr. P. E.

Miscellaneous Series #41

Grand Forks, North Dakota, 1970

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ABSTRACT

North Dakota's reserves of crude oil, recoverable with present technical knowledge, available equipment, and current operating practices, were 653,553,548 barrels on 1 January 1970. This figure is a decrease from the 663,623,900 barrels reported for 1 January 1969.

The decrease in inventory reflected decreased drilling activity in the state during 1969 as well as fewer new energy supplementation projects.

311,869,102 barrels, or 47.7% of the total reserves, will be recovered by energy supplementation.

Reports of 213 well completions were received by the Geological Survey in 1969. Of these, 51 were completed as producing wells. About 95.5% of the production in the month of December, 1969 came from unit operation and 30.3% of the producing wells are considered to be marginal, or stripper wells.

Four new pools were opened during the year. With permits issued for 129 wildcat prospects the success ratio was 1 in 32.

The methods used, the data sources, and the assumptions made in previous reports in this series have been followed so that the results may be compared and valid conclusions drawn therefrom.

Results of the Study

On 1 January 1970 North Dakota's reserves of crude oil were 653,553,548 Stock Tank Barrels. This oil is considered to be technically recoverable with present equipment and techniques. Because of economic factors ultimate recovery may be less, but it is expected that improved techniques will offset this and may even add to the total.

Cumulative production to 1 January 1970 was 330,333,612 Barrels. Production for the year of 1969 was 23,635,247 barrels, an average of 45.35 barrels per well per producing day. The total production for 1969 was 3.8% below that for 1968.

Energy supplementation was under way in 27 of the 118 producing pools and 47.7% of the reserves will be recovered from these pools. Two new projects were initiated in 1969.

During 1969 there were 48 producing wells abandoned and only 43 new producers completed. Operators completed 168 dry holes. Four new pools were discovered as the result of the 129 wildcats staked. Golden Valley joined the ranks of oil producing counties with the discovery of the Square Butte Field.

There were 2006 wells capable of producing oil at the end of the year. Of these, 609 were classified as marginal on the basis of their production in December². This represented an increase of 37, or 6.4% during 1969. Forty-one wells became marginal and 4 were plugged, or converted to service wells.

¹Chief Petroleum Engineer, North Dakota Geological Survey.

²A well is classified as marginal if it produces less than ten barrels of oil per day. The average is computed on the basis of the actual number of days produced.

Twenty-three stratigraphic tests were drilled in 1969, but they are not included in the 172 wells mentioned above, since they were given permits or API numbers. The North Dakota Geological Survey issued 227 permits and received 223 completion reports. There were 67 active locations at the end of the year.

The results of the study have been tabulated in several ways and the tables appear 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:

$$R = 7758 A h p (1-s) r / B \text{ where}$$

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, 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.

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.

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 1970 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.

The reserves found in the Heath Formation are credited to the Permo-Pennsylvanian, reflecting the present thinking of the subsurface section of the Survey.

A word of caution should be given concerning the figures in the column headed "Producing Acres." The figures shown are the total of all producing spacing units in the pool. Thus, where there are several pools in a field, the same acreage may be included in one or all of the pools. The area classified as productive will be less than that shown, but no effort was made to account for this in the tabulation. Perhaps this can be included in future reports.

Totals for "Fields" and "Pools" are given in Table II only since marketing districts are defined in such a way that no "field" or "pool" crosses a marketing district boundary, although they can, and do, cross county lines.

Stripper Well Survey

Table IVa provides data on the stripper wells in North Dakota. Table IVb shows comparable data for 1 January 1969. These wells account for about 4000 barrels per day of production. They also represent about 17% of the producing acreage in North Dakota.

Outlook for 1970

The final decision on the Oil Import Program will have a great deal to do with the future development of the oil industry in North Dakota. Canadian oil has always been the major competitor for North Dakota since it enjoys a price advantage in the Twin City marketing area, and it is not restricted under the Import Program.

While a price reduction might appear attractive as a means of recovering some of this market it should be considered carefully because of some of the undesirable effects it would have on exploration and development. A price cut would certainly bring about the premature abandonment of most of the stripper wells.

Some theoreticians hold this to be desirable since it would open up additional market space for production from more "efficient" wells. Unfortunately, all of North Dakota's wells are operating at capacity and little or no additional production would be available to replace the 4000 barrels per day from these marginal wells.

A lower price, together with the reduction in the depletion allowance will make it difficult to find the risk capital which is needed for exploratory drilling, and would discourage development drilling in cases where the risk is great, such as around the edges of a field.

With natural decline being a normal pattern in all oil pools it is imperative that exploration and development continue at a pace sufficient to maintain reserves and productive capacity.

ACKNOWLEDGMENTS

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. F. E. Wilborn, Jr., Assistant Petroleum Engineer for the Survey, and Mr. Ray Simons, the Survey's Statistician.

TABLE I
CRUDE OIL INVENTORY IN NORTH DAKOTA

	Primary Reserves Bbls. STO	Secondary Reserves Bbls. STO	Total Recoverable Bbls. STO	Production to 1-1-70 Bbls. STO	Remaining Recoverable Bbls. STO	% of Total	Fields Discovered to 1-1-70	Pools Discovered to 1-1-70	Fields Abandoned to 1-1-70	Fields Producing 1-1-70	Pools Producing 1-1-70	Producing Acres
District I	358438950	282647000	641085950	223368927	417717023	63.9	31	53	2	29	48	166205
District IIa	68521200	9222000	77743200	27228672	50514528	7.7	17	17	4	13	13	65465
District IIb	93098500	235000	93333500	35711734	57621766	8.8	31	32	6	25	25	57090
District IIc	42876500	10938000	53814500	18751275	35063225	5.4	17	18	2	15	16	35445
District IIIa	6688000		6688000	2296861	4391139	0.7	2	2	0	2	2	4148
District IIIb	99752500	10928000	110680500	22434633	88245867	13.5	13	17	3	10	14	32487
	669375650	313970000	983345650	329792102			111	139	17	94	118	360840
Less Gasoline Plant Recovery and other unclassified				541510								
				330333612	653553548	100						

TABLE II
CRUDE OIL INVENTORY IN NORTH DAKOTA

	Primary Reserves Bbls. STO	Secondary Reserves Bbls. STO	Total Recoverable Bbls. STO	Production to 1-1-70 Bbls. STO	Remaining Recoverable Bbls. STO	% of Total	Fields Discovered to 1-1-70	Pools Discovered to 1-1-70	Fields Abandoned to 1-1-70	Fields Producing 1-1-70	Pools Producing 1-1-70	Producing Acres
Billings	47014500	4750000	51764500	14693111	37071389	5.6	5	8	2	3	6	21278
Bottineau	87429500	10938000	98367500	30627035	67740465	10.3	28	29	4	24	25	57405
Bowman	47434500	6178000	53612500	6623549	46988951	7.2	5	6	2	3	4	9129
Burke	79636200	27031750	106667950	36842721	69825229	10.6	17	17	3	14	14	68485
Divide	14201000	9052500	23253500	3900186	19353314	2.9	8	8	1	7	7	8360
Dunn	390000		390000	322343	67657	Less than 0.1	1	1	0	1	1	360
Golden Valley	140500		140500	39023	101477		1	1	0	1	1	360
McHenry	3230000		3230000	328908	2901092		0.4	1	1	0	1	1
McKenzie	144356000	71273000	215629000	79982822	135646178	20.7	15	28	1	14	22	63446
Mountrail	28329000	43944000	72273000	24500547	47772453	7.3	3	3	0	3	3	15060
Renville	32331500	235000	32566500	18525481	14041019	2.2	12	12	3	9	9	21230
Slope	1713000		1713000	332257	1380743	0.2	1	1	0	1	1	720
Stark	10936000		10936000	4306656	6629344	1.1	5	6	1	3	4	10440
Ward	2048000		2048000	674929	1373071	0.3	2	2	0	2	2	2460
Williams	170185950	140567750	310753700	108092534	202661166	31.1	12	20	1	13	19	80917
	669375650	313970000	983345650	329792102								360840
Less Gasoline Plant Recovery and other Unclassified				541510								

330333612 653553548

TABLE III
CRUDE OIL INVENTORY IN NORTH DAKOTA

	Primary Reserves Bbls. STO	Secondary Reserves Bbls. STO	Total Recoverable Bbls. STO	Production to 1-1-70 Bbls. STO	Remaining Recoverable Bbls. STO	% of Total	Fields Discovered to 1-1-70	Pools Discovered to 1-1-70	Fields Abandoned to 1-1-70	Fields Producing 1-1-70	Pools Producing 1-1-70	Producing Acres
Devonian	188682000	36670000	225352000	32130047	193221953	29.5		15		11		
Mississippian	344941750	260522000	605463750	255273233	350190517	53.5		99		62		
Ordovician	57277500	6178000	63455500	8561808	54893692	8.4		11		9		
Permo-Penn	35845500		35845500	12645615	23199885	3.6		7		6		
Silurian	14368400	600000	14968400	6755900	8212500	1.3		3		2		
Triassic	28260500	10000000	38260500	14425499	23835001	3.7		4		4		
	669375650	313970000	983345650	329792102	653553548							
Less Gasoline Plant Recovery and other Unclassified				541510								
				330333612				139		94		

TABLE IVa
NORTH DAKOTA STRIPPER WELLS

	Number of Wells	1969 Prod. Bbls.	Acres	Abandoned 1969	Remaining Primary Reserves 1-1-70	Secondary Reserves 1-1-70	Ave. Daily Production Dec. 1969	Ave. Daily Production Per Well 1969
Billings	19	49122	5200	0	6284590	1648140	7.57	7.1
Bottineau	76	118203	5432.83	0	3490315	3729180	6.13	4.3
Bowman	6	38237	480	0	2837945	496800	6.60	17.4
Burke	128	223973	15961.12	1	11489238	5659160	6.17	4.8
Divide	3	4568	480	0	727418	1099350	9.19	4.2
Dunn	0	0	0	0	0	0	0	0
Golden Valley	0	0	0	0	0	0	0	0
McHenry	0	0	0	0	0	0	0	0
McKenzie	104	191394	10802.30	0	11174873	12349510	6.21	5.0
Mountrail	61	49433	4847.47	1	1583486	14622820	5.55	2.2
Renville	22	60606	2000	2	1840335	89520	5.51	7.5
Slope	0	0	0	0	0	0	0	0
Stark	2	7599	320	0	21626	0	6.87	10.4
Ward	1	0	80	0	3383	0	0	0
Williams	187	227789	15297.63	0	15481608	34592980	6.15	3.3
	609	970924	60901.35	4	54934817	74287460	6.18	4.36

TABLE IVb
North Dakota Stripper Wells

	Number of Wells	1968 Prod. Bbls	Acres	Abandoned 1968	Primary Reserves 1-1-69 Bbls.	Secondary Reserves 1-1-69 Bbls.	Ave. Daily Production Dec. 1968	Ave. Daily Production Per Well 1968
Billings	17	53988	4560	0	7296222	0	6.95	8.7
Bottineau	101	183183	7796	1	7453790	1481136	6.36	5.0
Bowman	2	10472	160	0	1072002	165602	8.21	14.3
Burke	150	229520	18120	9	13417508	6322186	6.16	4.2
Divide	0	-	-	-	-	-	-	-
Dunn	0	-	-	-	-	-	-	-
McHenry	3	11269	240	0	663644	0	6.66	10.1
McKenzie	89	178750	8206	8	7772745	7957592	6.48	5.5
Mountrail	55	85185	4372	1	1653100	14657695	4.90	4.2
Renville	14	43521	1120	0	929633	0	6.53	8.5
Slope	0	-	-	-	-	-	-	-
Stark	0	-	-	-	-	-	-	-
Ward	1	55	80	0	0	0	0	0.1
Williams	140	256713	11728	1	8948018	28185827	5.33	5.0
	572	1052656	56382	20	49206662	58770038	5.6	5.0

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, East Goose Lake, 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 districts or subdistricts.

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

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: Alexander, Little Missouri, Cedar Creek, Coyote Creek, Horse Creek, Medicine Pole Hills, Rocky Ridge, Round Prairie, Fryburg, Medora, Rough Rider, and Square Butte.