

NORTH DAKOTA GEOLOGICAL SURVEY

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NORTH DAKOTA CRUDE OIL INVENTORY AS OF JANUARY 1, 1971

by

Clarence B. Folsom, Jr. P.E.

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NORTH DAKOTA CRUDE OIL INVENTORY AS OF 1 JANUARY 1971

by

Clarence B. Folsom, Jr. P. E.¹

ABSTRACT

North Dakota's reserves of crude oil, recoverable with present technical knowledge, available equipment and current operating practices, were 670,404,566 barrels on 1 January 1971. This figure is an increase from the 653,553,548 barrels reported for 1 January 1970.

The increase in inventory reflected development drilling activity in the state during 1970 as well as new energy supplementation projects.

315,744,495 barrels, or 47% of the total reserves, will be recovered by energy supplementation.

Reports of 129 well completions were received by the Geological Survey in 1970. Of these 30 were completed as producing wells. About 51.8% of the production in the month of December, 1970 came from unit operations and 33.4% of the producing wells are considered to be marginal, or stripper wells.

Two new pools were opened during the year. With permits issued for 68 wildcat prospects the success ratio was 1 in 34.

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 1971 North Dakota's reserves of crude oil were 670,404,566 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 1971 was 350,339,179 Barrels. Production for the year of 1970 was 21,993,495 barrels, an average of 43.4 barrels per well per producing day. The total production for 1970 was 7% below that for 1969.

Energy supplementation was under way in 29 of the 126 producing pools and 47% of the reserves will be recovered from these pools. Two new projects were initiated in 1970.

During 1970 there were 15 producing wells abandoned and only 30 new producers completed. Operators completed 86 dry holes. Two new pools were discovered as the result of the 68 wildcats drilled.

¹Chief Petroleum Engineer, North Dakota Geological Survey

There were 2031 wells capable of producing oil at the end of the year. Of these 679 were classified as marginal on the basis of their production in December². This represented an increase of 70, or 11.5% during 1970. Seventy-three wells became marginal and 3 were plugged, or converted to service wells.

Only one stratigraphic test was drilled in 1970, and is not included in the 68 wells mentioned above, since it was not given a permit or API number. The North Dakota Geological Survey issued 171 permits and received 129 completion reports. There were 76 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.

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.

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 1970. These wells account for about 4000 barrels per day of production. They also represent about 18% of the producing acreage in North Dakota.

Review of 1970 Events

A shortage of energy hit with dramatic effect. 'Brownouts' across the country demonstrated that the predictions of fuel crises were indeed true.

The coal industry had been suffering, for many years, from increasing wage costs, rising taxes, excessive safety requirements, and stringent air pollution standards. As the smaller mines closed the consumers started shifting to natural gas.

With the large shift in the market demand, supplies of natural gas began to dwindle. Just as was the case with coal the gas producers had a long history of trouble. Rising costs and taxes, the reduction in the depletion allowance, and the low prices set by the FPC had made exploration for gas unprofitable and, therefore, unattractive to the individual investor with risk capital. For a decade the oil and gas industry had been telling the people of this country that such policies must eventually mean depletion of reserves and the loss of service to many consumers. It happened in the summer of '70.

Despite the warnings of economists and others in the oil business, the consumers were told that they could count on an unending supply of cheap fuel oil, made from cheap imported crude. Efforts were made to remove the mandatory import quotas, depletion allowances were reduced, and attempts made to drive the price of domestic crude oil down.

Disruption of the Trans-Arabian Pipeline, cutbacks in production in Libya, and a shortage of bottoms caused tanker rates to soar and by mid-July the 'cheap' foreign oil was 75 cents higher (on the east coast) than domestic crude from Louisiana and Texas.

As a result of these rapid developments, the crude oil producers in North Dakota were notified of a 25¢/barrel increase on November 16th. Unfortunately it only tended to offset the increased taxes resulting from the lower depletion allowance.

During the year, producers were also facing an October first deadline for the abandonment of unlined, surface, salt-water pits. NDGS fieldmen spent the summer inspecting salt-water handling facilities, approving some and condemning others. By the time snow came, most of the inspection had been completed but some operators still had work to do. This new policy will increase the cost of production for many operators, and add to the pressure for further price increases.

A sharp reduction in drilling was reflected in the drop in productive capacity. This should not be considered a factor in the drop of total production for the year. The fact that many operators were forced to halt production while they took care of their salt-water problems is deemed to have been the major cause of the reduction.

The increase in recoverable reserves was a reflection of successful attempts to extend some fields and the initiation of two additional energy supplementation projects. The two fields newly discovered had not had enough development, by year's end, to provide any firm estimate of large reserves.

In 1970, the NDGS was able to offer producers and consultants the use of micro-filmed logs and well files. Production, GOR's, and BHP's will also be available in this form. These films can be used at Grand Forks office, where equipment has been installed for the purpose.

Outlook for 1971

It now appears that the Alyeska pipeline, from the Alaskan North Slope, will not be in operation for some years. By the time it becomes operational the volumes of oil transported are likely to be little more than enough to offset increased demand.

There do not appear to be any other sources of heat energy ready to assume the increasing energy load. Generating plants are unable to expand rapidly enough because of the rising concern over environmental impact and the failure of nuclear generators to meet the schedules projected in the fifties.

Tanker charter rates are not apt to come down soon and there are indications that some mid-east countries are on the verge of nationalizing the oil operations there. Under the circumstances it can be expected that domestic oil exploration will expand, and that North Dakota will share in that expansion.

However, much will depend on the atmosphere prevailing in the oil business. Further price increases can be expected to improve the climate.

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 1-1-71 Bbls. STO	Remaining Recoverable Bbls. STO	% of Total	Fields Discovered to 1-1-71	Pools Discovered to 1-1-71	Fields Abandoned	Pools Abandoned	Producing Acres
District I	359727550	282691495	642419045	232344267	410074778	61.2	36	57	1	6	166555
District IIa	69388200	9297000	78685200	28527575	50157625	7.4	23	23	4	4	66103
District IIb	100447000	235000	100682000	40602974	60079026	8.9	31	32	5	6	62190
District IIc	44086500	10938000	55024500	20616726	34407774	5.2	17	18	2	2	35665
District IIIa	30239000	1655000	31894000	2458961	29435039	4.4	2	2	-	-	3061
District IIIb	101111000	10928000	112039000	25189867	86849133	12.9	13	17	4	5	36118
	704999250	315744495	1020743745	349740370	671003375		122	149	16	23	369692
Gasoline Plant Recovery & Misc.				598809							
				350339179	670404566						

TABLE II

Crude Oil Inventory in North Dakota

	Primary Reserves Bbls. STO	Secondary Reserves Bbls. STO	Total Recoverable Bbls. STO	Production to 1-1-71 Bbls. STO	Remaining Recoverable Bbls. STO	% of Total	Fields Discovered to 1-1-71	Pools Discovered to 1-1-71	Fields Abandoned	Pools Abandoned	Producing Acres
Billings	4865500	4750000	54615500	16570573	38044927	5.6	5	8	2	3	23669
Bottineau	88696500	10938000	99634500	33223473	66411027	9.9	28	29	3	3	57665
Bowman	47510500	6178000	53688500	7372280	46316220	6.9	5	6	2	2	9729
Burke	79798200	27106750	106904950	38595775	68309175	10.2	23	23	3	3	68685
Divide	14906000	9052500	23958500	4190139	19768361	3.0	8	8	1	1	8798
Dunn	390000	- -	390000	333985	56015		1	1	-	-	360
Golden Valley	390000	- -	390000	97152	292848		1	1	-	-	1000
MoHenry	3230000	- -	3230000	350351	2879649	0.4	1	1	-	-	1000
McKenzie	142589000	71317495	213906495	83989905	129916590	19.3	16	28	1	6	63846
Mountrail	28329000	43944000	72273000	25178258	47094742	7.0	3	3	-	-	15060
Renville	33908000	235000	34143000	20206616	13936384	2.1	13	13	1	1	22530
Slope	1713000	- -	1713000	376971	1336029	0.2	1	1	-	-	720
Stark	15346000	- -	15346000	6200610	9145390	1.4	5	6	1	2	13160
Ward	3353000	- -	3353000	1034416	2318584	0.3	3	3	-	-	3500
Williams	194974550	142222750	337197300	112019866	225177434	33.6	11	20	-	-	79970
	704999250	315744495	1020743745	349740370	671003375						369692
Gasoline Plant Recovery & Misc.				598809							
				350339179	670404566						

TABLE III

Crude Oil Inventory in North Dakota

	Primary Reserves Bbls. STO	Secondary Reserves Bbls. STO	Total Recoverable Bbls. STO	Production to 1-1-71 Bbls. STO	Remaining Recoverable Bbls. STO	% of Total	Fields Discovered to 1-1-71	Pools Discovered to 1-1-71	Fields Abandoned	Pools Abandoned	Producing Acres
Devonian	54465000	36670000	91135000	25913170	65221821	9.7		18		6	26151
Mississippian	505438450	262252000	767690450	276746014	490944436	73.2		105		13	270047
Ordovician	57962300	6178000	64140300	9875594	54264706	8.1		11		2	19589
Permian-Penn	43148000		43148000	15613099	27534901	4.1		7		1	22829
Silurian	15725000	644495	16369495	5646187	10723308	1.6		4		1	10171
Triassic	28260500	10000000	38260500	15946298	22314202	3.3		4		-	20905
	704999250	315744495	1020743745	349740370	671003375						369692
Gasoline Plant Recovery & Misc.				598809							
				350339179	670404566						

TABLE IVa

North Dakota Stripper Wells

	Number of Wells	1970 Prod. Bbls.	Acres	Abandoned 1970	Remaining Primary Reserves 1-1-71	Secondary Reserves 1-1-71	Ave. Daily Production Dec. 1970	Ave. Daily Production Per Well 1970
Billings	20	40613	5680	1	6329943	1643500	7.22	5.5
Bottineau	93	169117	5544	1	5182640	621708	6.44	4.9
Bowman	4	5834	320	0	2037128	327434	5.88	4.0
Durke	128	171548	15966	0	10179958	5226880	3.97	3.7
Divide	3	3638	480	0	581704	860962	7.87	3.3
Funn	0	-	-	-	-	-	-	-
Golden Valley	0	-	-	-	-	-	-	-
McHenry	1	1905	80	0	194649	-	0	5.2
McKenzie	132	170018	12221	0	7569951	13893158	5.68	3.5
Mountrail	68	57824	5400	0	979242	17313936	6.8	2.3
Renville	25	43421	2000	1	978980	-	6.98	4.7
Slope	0	-	-	-	-	-	-	-
Stark	7	32223	1440	0	574650	-	6.17	12.6
Ward	1	0	80	0	12000	-	-	-
Williams	197	157615	16420	0	13705627	52496648	5.8	11.8
	679	853756	65631	3	48326472	92384050		5.6

TABLE IV
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

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, Range 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, Lake Darling, Lansford, Lone Tree, Mackobe Coulee, Mohall, North Maxbass, South Antler Creek, Southwest Haas, Tolley Chola, South Lone Tree, 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.