State of North Dakota P1 Oil Reserves Project

By Lynn Helms

In August of 2005, the Oil and Gas Division (OGD) of the Department of Mineral Resources (DMR) began a project to estimate the proved developed producing (P1) oil reserves of all producing pools within the state of North Dakota. These reserve estimates are available from the OGD for $10 and can be used for economic forecasting, infrastructure planning, as well as estimating probable (P2) reserves and possible (P6) reserves.

P1 reserves are defined as economically recoverable volumes with a probability of recovery greater than ninety (90%) percent.

The total P1 reserves estimated within North Dakota are over 550 million barrels.

The process of estimating P1 reserves involves the evaluation of the decline curves of each pool. Evaluating the decline curves was initiated with the setting of the basic parameters. An economic limit for all pools that are all or partially within a unit was set at three (3) barrels of oil per day (BOPD)[1]. The economic limit for all non-unitized pools in counties except Bottineau, Burke, and Renville was set at five (5) BOPD per well and at two and one-half (2.5) BOPD per well for pools in Bottineau, Burke, and Renville Counties. Fields that were still producing but below the 5 BOPD or 2.5 BOPD economic limits were assumed to be economic and were projected out to 2.5 BOPD or 1 BOPD, respectively[2]. In all cases where applicable, the decline curves were generated from a "Field Curve Fit" utilizing production data between the last peak in production to the last production point and setting a maximum remaining productive life of fifty (50) years.

A simultaneous review of the "Field Performance" history and the "Field Curve Fit" data was performed. In reviewing the two datasets, a period of natural decline (a period when no new wells were added or no significant changes in the production decline were indicated) was sought in order to establish a decline rate.

There were three typical curves that were evaluated:

- A curve that exhibits a steady decline in production with minimal or no peaks.
- A curve that exhibits a steady decline in production but with large peaks due to the influence of in-fill drilling, enhanced recovery operations, etc.
- A curve that is on an incline.

[1]Analyses performed by David J. McCusker
[2]Analyses performed by James R. Legerski

A production curve that exhibits a steady decline, independent of the peaks in production, was generally evaluated utilizing a best fit decline method. This method typically generated a hyperbolic curve fit. In most cases, the hyperbolic curve fit gave an optimistic Estimated Ultimate Recovery (EUR), especially since a fifty (50) year remaining well life was used. An exponential curve fit was generally pessimistic. To provide a more accurate result, a hyperbolic curve fit with a switch over to an exponential decline at a pre-determined decline rate was employed. The pre-determined decline rate was established by a period of natural decline as discussed earlier. However, when tested in non-unitized pools the best fit hyperbolic curve with a switch over to a pre-determined exponential decline rate was generally even more pessimistic than the exponential curve fit. In those cases, the hyperbolic curve fit and exponential curve fit were projected to the economic limit and an average of the two EUR values was used. Figure 1 is an example of this technique. A production curve that is on an incline due to in-fill drilling, enhanced recovery operations, etc. was evaluated utilizing an exponential decline curve projected from the last production point. The projected production was forced to decline at a pre-determined rate established by a period of natural decline as mentioned earlier.

A unique scenario presented itself where, prior to unitization, the wells in a pool were artificially restricted in the volume of oil that could be produced by Order of the North Dakota Industrial Commission. The restrictions were eliminated following the unitization of the pool in which these wells are located. However, the production was and is now being influenced by the in-fill drilling of many new wells and subsequent conversion to injection of some of the new wells. Since the inception of the unit, production has been on an incline. Therefore, the production from the unit has never exhibited a period of natural decline. In this case, a review of similar neighboring units was performed in order to determine a decline rate. An exponential decline was projected from the last production point on the unique unit and forced to decline at the average rate determined from the neighboring units.

Table 1 is an example of the listing provided for each pool in North Dakota with its EUR plus its cumulative production and Remaining P1 Reserves as of September 1, 2005.

All EUR values have been entered into the OGD Risk Based Data Management System (RBDMS) so that P1 Remaining Reserves can be recalculated at any point in time. The OGD plans to update the EUR for each producing pool every 5 years.

As each pool was evaluated to estimate P1 reserves, those with analogous pools that have benefited from in-fill drilling, horizontal drilling, and/or enhanced oil recovery processes were identified as having potential for P2 reserves and were cataloged for evaluation in the second phase of this study.

Figure 1

Table 1
P1 Proved Developed Producing Oil Reserves
Unitized Pools

Name	Pool Nm	Spacing	Max Wells	Active Oil	Active Inj	Cum Oil	Remaining Oil	Estimated Ultimate Oil
MOUSE RIVER PARK	MADISON	U	40	29	6	2539688	468288	3007976
MOUSE RIVER PARK	MADISON	UN	14	11	2	1368015	850164	2218179
NEWBURG	SPEARFISH/CHARLES	U	129	66	41	33494370	5386577	38880947
NORTH ELKHORN RANCH	MADISON	U	47	21	6	15538320	5109803	20648123
NORTH GRANO	MADISON	U	5	3	2	517028	84079	601107
NORTH WESTHOPE	MADISON	U	20	4	2	1302294	133835	1436129
NORTHEAST FOOTHILLS	MADISON	U	15	7	1	1216831	8789	1225620
PLAZA	MADISON	U	13	8	1	2228826	986864	3215690
PLEASANT	MADISON	U	15	11	1	1760921	265326	2026247
RED WING CREEK	MADISON	U	13	12	1	15076868	3248868	18325736
RIVAL	MADISON	U	66	22	8	14550206	1396403	15946609
ROCKY RIDGE	HEATH	USE	3	2	1	1114988	54448	1169436
ROUGH RIDER	MADISON	UE	26	11	3	6893516	1076076	7969592
ROUGH RIDER	MADISON	UW	20	11	5	8813572	1526218	10339790
SCOTIA	MADISON	U	6	4	1	379639	117443	497082
SOUTH ANTLER CREEK	MADISON	U	13	5	4	1045040	130463	1175503
SOUTH HEART	HEATH	U	7	1	0	1483387	203809	1687196
SOUTH LANDA	MADISON	U	5	3	1	277428	44716	322144
SOUTH STARBUCK	MADISON	U	8	5	1	212588	138933	351521
SOUTH WESTHOPE	SPEARFISH/CHARLES	U	19	12	5	6946212	1606067	8552279
STADIUM	LODGEPOLE	U	5	4	1	10024484	1306623	11331107
STATE LINE	RED RIVER	U	2	1	1	981713	518176	1499889
STONEVIEW	STONEWALL	U	17	13	3	3898715	1466711	5365426
SUBDIVISION	LODGEPOLE	U	1	1	1	154813	23816	178629
T.R.	MADISON	U	22	18	2	8214960	6210400	14425360
TEMPLE	WINNIPEGOSIS	US	16	5	3	4292724	1050946	5343670
TIOGA	MADISON	U	264	24	1	58878723	1883415	60762138
TRACY MOUNTAIN	TYLER	U	13	8	4	3254482	917813	4172295
TRACY MOUNTAIN	TYLER	UN	1	1	1	127647	77117	204764
TRURO	MADISON	U	17	9	7	1282866	1605094	2887960
VERSIPPI	LODGEPOLE	U	2	1	1	443731	933192	1376923
WABEK	MADISON	U	28	13	6	6029853	215392	6245245
WEST DICKINSON	LODGEPOLE	U	3	2	1	4582873	772595	5355468
WILEY	MADISON	U	133	52	35	18096549	10335233	28431782
ZENITH	TYLER A	U	7	3	2	2816862	571113	3387975
ZENITH-NEWTON	HEATH	U	6	1	1	1082618	25811	1108429
TOTAL							393,235,726	1,201,971,645