March 28, 1924.

Mr. C. H. McWhinnie,

Commissioner of Public Lands,

Capitol Building.

Dear Mr. McWhinnie:

In accordance with your instructions I have made a study of the production records of the NE¼ of Section 24 Township 20 Range 78 in the Rock River field. I have gone over carefully the report Mr. Morgan made two years ago, also the statements and curves presented by the representatives of the Ohio Oil Company. I have also taken the production figures from the records of your office and have prepared a graph of them, giving the average production per well per month from April 1920 to date.

Investigations of the decline of oil wells in all parts of the United States have demonstrated that the decline is governed by natural laws and that this decline can be expressed on paper by a curve known as the parabola, which applies either to individual wells or groups of wells on the same property. Each individual well or group of wells, however, has its own particular curve which is determined by the decline during the first few years of production, and if the curve is prepared with these years of initial production as a basis, the future production of the well or group of wells will be found to agree with the curve within reasonable limits. Investigations have disclosed, however, that while the curve or curves represent a decline in production of an average well or

property all wells are not average and consequently many of them will depart from the curve to as much as thirty percent in some cases. A curve to be of the most value must be based upon uninterrupted natural decline of the well or wells producing at full capacity. Whenever the wells are shut in either in whole or in part for a portion of their production period, the curve resulting from platting the production figures will not truly represent the natural decline of the property. Consequently a curve based upon such figures could not be expected to furnish an entirely reliable prediction as to the future production.

In Mr. Morgan's report made two years ago he states that his "investigation can only be considered as tentative and preliminary, inasmuch as the lease has not produced long enough to develop a very reliable decline curve. Then again we must take into consideration that production has been artificially curtailed during the last six months." Mr. Morgan states also, "Owing to the curtailment of production in January, there has not been as much cleaning out and stimulation in the wells as would be done under normal times." It is therefore evident that parts of the production records prior to January 1922 cannot be fully relied upon as representing natural decline for the purpose of preparing a curve for the estimation of future production. My graph showing average production per well per month will illustrate this. In preparing this graph the production figures on file in the Commissioner's Office were used and were divided by the number of wells capable of producing during each respective month, omitting well #6, which is producing from a different sand in very small quantity and which should not be averaged with the other wells for that reason.

The dates of completion for the deep sand wells on the property are as follows:

Well #1	September 30, 1918.
Well #2	March 22, 1920
Well #3	October 3, 1920
Well #4	November 19, 1920
Well #5	March 20, 1921

continued--

Well #6	Not a deep sand well
Well #7	October 5, 1922
Well #8	March 1923
Well #9	February 1923
Well #10	Not completed, commenced 7-21-23.
Well #11	November 1923

The bringing in of new wells at various times during the period under discussion also has its effect in distorting the curve. A much more reliable study of the past and future production of this property could be made if we had the individual monthly records of each well. I have requested the Ohio Oil Company to furnish these records, and they state that it is impossible to furnish the exact records, owing to the fact that the wells are not gaged individually but the oil from all of the wells is pumped into two different sets of receiving tanks, and the only check on the production of an individual well is from an estimate made by the pumper. Such estimates will not be far off, as there are times when some of the wells are shut down for repairs, at which time the production of the other wells is more accurately known. The Ohio Oil Company has promised me these figures, but has not yet submitted them. If they arrive in time for a study of them before the next Board meeting, this will be done and the results submitted. Owing to the fact, however, that they are based upon estimates rather than upon actual gaging records, there is some doubt as to whether they will have much more reliability than the figures already presented. In checking over the average well decline curve submitted by the Ohio Oil Company I find that the productions which they have used for the years 1922 and 1923 do not check with the production records in the Commissioner's Office, the latter being somewhat higher figures than those used by the company. I have therefore platted the curve with figures from the Commissioner's records on this plat in red ink and have also applied these figures to the logarithmic cross section paper and have derived a curve of future production which is shown in red ink, dotted, on the same plat with the Ohio Oil Company's curve, for comparison.

This correction of the figures and estimate of future production gives the following result per well:

Year	Estimated production per well.
1924	16,500 barrels.
1925	10,000
1926	6,400
1927	4,150
1928	2,650
1929	1,300
1930	1,100
1931	720
1932	500
1933	330
1934	230
1935	160
1936	100

There will be ten wells as soon as well #10 is completed, which will produce from the deep sands, with an average production per well of 44,420 barrels, total future production of the ten wells should be 440,200 barrels, which is approximately 60% greater than the company's estimate of 275,800 barrels. As stated previously, such an estimate may vary as much as 30% from the actual resulting production.

During the year 1923 the price of crude oil was very low and in a great many fields production was artificially curtailed. If this curtailment has been practised in the Rock River field the result when applied to the graph would show a decided decline during the year 1923, which would be a greater decline than the ordinary natural decline of the well, and if such figures were used in preparing a curve for estimating the future production, this curve would have a tendency to strike too low and would result in an underestimation of the future production. Consequently if the wells on this property have been pinched in at various times during the year or have not been cleaned out properly and made to produce their natural production, the curves prepared by the Ohio Oil Company and by myself would both be too low when extended into the future years. In view of the fact that production was curtailed in various other fields in the

state it is only reasonable to suppose that there was some curtailment in this field and that the error in our curves if any is on the side of underestimation, possibly more than the maximum error or 30% which is possible when using such curves. The curve, however, is given as representing the best we are able to determine from the information available.

In comparing the recent figures with the estimate Mr. Morgan made two years ago, it is found that Mr. Morgan's estimate is a great deal higher. It will be found also that Mr. Morgan's estimate for the years 1922 and 1923 were very much higher than what the production actually amounted to; consequently it is only to be expected that as his estimate was high for those two years that it is high for the remaining years. The conclusions drawn from these curves must take into consideration the amount of curtailment of production, if any, during the year 1923. In July 1923 Mr. Phil S. Hoyt, Oil and Gas Inspector, made an inspection of the Rock River field for the purpose of investigating conditions and status of operations on state and university lands, and to determine whether all state lands have been properly offset against adjoining patented lands and to ascertain if wells on state lands were getting their share of the production. His report shows that the NE¼ of Section 34 was getting its full share of production or possibly a little better, and that the proper offsets were drilled and producing. His report, however, does not give any evidence of curtailment at that time. The drop in production in November and December 1923 indicates some possible curtailment then, as the production has been rising during January and February. In conclusion, then, I believe that it is safe to assume that there has been some curtailment in production during the latter part of the year, which would produce a tendency in the future production curve to strike too low, and that future production can be safely figured about 25% or 30% higher than the tabulation given above, and it is possible that actual production will turn out to be even a little higher than this.

On the subject of lifting cost of this oil, it is difficult for us to be able to present any reliable figures. Reports of investigations of the Bureau of Mines, Series 2530, September 1923, on the subject of lifting cost at oil wells, gives tabulation of lifting cost data collected from oil companies in many different fields in the United States, and the lifting cost has been found to vary from 4¢ per barrel to 70¢ per barrel, showing that there is a wide range of possibility for such costs. For wells pumped on the beam in Louisiana fields from the depth of 1193 feet to 2666 feet, the lifting expense per barrel ran from 15¢ for wells producing approximately 2000 barrels per month each from a depth of 1143 feet, to $7.66 per barrel for wells producing about 160 barrels. The wells in the Rock River field are pumped on the beam instead of from a central station, which involves greater pumping expense. The sand from which the oil is being produced has a tendency to come up with the oil and results in damage to the pumps, requiring the wells to be cleaned out more often, resulting in lower percentage of possible production and additional lifting cost. I believe, however, that while the Ohio's figure of 32¢ may be applicable to the lifting cost during the last few years of the life of the field, that they are a little high for the lifting cost of the next year or two, when the greater portion of the oil will be removed. According to the average production lifting cost curve given in the Bureau of Mines report, the lifting cost would be below 30¢ for wells producing 30 barrels per day or more, this however, being the average cost curve. The high cost curve indicates that for wells producing 70 barrels per day the cost would be approximately 30¢ per barrel. At the present time the average well production of the Rock River field is about 50 barrels per day, which would indicate that at the present time the lifting cost is not far below 30¢.

In regard to the prices of crude oil which the Oil Company has estimated at $1.80 per barrel: I can state that the price at the present time is $1.70. The low price during the past year was due to tremendous overproduction from California fields where wells were drilled on town lots and a tremendous amount

of oil obtained in a short time. The peak of production was passed in November. On account of the large number of wells the decline from those fields will be very rapid. The latest statistics indicate that the domestic production of crude oil in the United States plus imports is less than the domestic consumption, the consumption only recently having equalled the production plus imports. It is very unlikely that new fields will again be discovered in the midst of incorporated cities and towns and that such a condition as occured last year will occur again. The consumption curve is rising very rapidly, as the tremendous output of automobiles in the country is creating a rapidly expanding market for oil. It is therefore to be expected that during the remainder of this lease, especially during the next two or three years, when the greater amount of oil will be produced, the price of oil will be at least as high as at present, that is $1.70, or possibly higher.

In conclusion, then, for the next five years I would not be inclined to make any change in their estimated lifting cost of 32¢ per barrel. I would, however, expect the oil to sell at $1.70 per barrel and that the production would be at least in accordance with the tabulation I have given above and probably 30% higher.

Respectfully submitted,

[A. B. Barnett]

State Geologist.

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