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Court Values Versus Reality: A Rebuttal to "Making Money Winning Environmental Lawsuits"

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Abstract

We analyze a case where "drilling in the courtroom" proved to be more profitable than exploring in the oil patch itself. Total awards came to $26,000 per acre for an undrilled tract without a barrel of discovered reserves and not proximate to production. Litigating for profit was presented in 1995 at this Symposium by Rose and Jones in a paper entitled "Making Money Winning Environmental Lawsuits". The authors valued an exploration play in Michigan, demonstrating that the 2680 untested acres were worth (1987) at least $71 million. We focus on the quantum of compensation itself, how it was calculated, and how it was reported by Rose and Jones. This study illustrates the potential hazards, as well a the possible profitability, of the judicial process. It also illustrates the elasticity of expert testimony and the opportunities which can be exploited before an indulgent court. The case is particularly useful since the entire argumentation is accessible in the public record. That fact permits a clinical review.

The "courtroom oil" was dramatically overvalued. We have tested that overvaluation in six ways: Reality checks suggest a priori that the value is implausible. The usual indicators of value were dramatically exceeded -- (a) according to Rose and Jones the lost property would have yielded a risk-adjusted ROR of 129%, much higher than typical expectations; (b) speculative resources were valued at more than the going price for proven, producing reserves; (c) the claimed per-acre value of the property was 100 times higher than average experience. Six computation errors will be documented. The first overstated the probability of success by a factor of five-to-one. The others, taken together, inflated the value sixfold. Rose and Jones used improper analog for projecting possible hydrocarbon recoveries and ignored a proximate analog. This inflated the projected reserves by a factor of 3.5. Rose and Jones ignored a sale of the property itself, the best indicator of market value. One could calculate the value at a maximum of some $2.84 million from plaintiff's own files. Rose and Jones omitted a proximate sale which commanded a price 170 times smaller than their claim. The article ignored lease bonuses. All real transactions show lower values -- a distortion factor of 35.

Our analysis shows that the reported valuation is seriously overstated. First, the reality checks flag sharp disparities with practice. Second, the actual sales show lower figures. Third, standard appraisal methods lead to a much lower figure. Fourth, the demonstrable errors and exaggerations show how the inflated figure was in fact obtained -- mathematical error and geological exaggeration account for the difference between computed value and revealed worth.

The case study illustrates the pitfalls of complex technical evidence where the court is ill-equipped to assess accuracy or error.

Introduction

We analyze here a new dimension to the oil industry, a case where "drilling in the courtroom" proved to be much more profitable than exploring in the oil patch itself. This "courtroom venture" was dramatically lucrative -- total awards came to more than $71 million, a sum which is equivalent to about $26,000 per acre for a tract which was undrilled and untested, without a single barrel of discovered reserves and not proximate to established production.

Here we shall address how this was possible -- how Michigan courts concluded that undrilled acreage which is miles distant from proven reserves could be more valuable than prospects elsewhere or that such acreage could be more valuable than proven, producing properties in more attractive areas.

The question of litigating for profit was presented in 1995 in the JPT by Rose and Jones in an article,[1] the original version of which was entitled "Making Money Winning Environmental Lawsuits".[2] In both versions the authors outline how they valued an exploration play in Michigan, demonstrating that the 2680 untested acres were worth (1987) at least $71 million.

The acreage at issue is located some 25-30 miles to the southwest of the main fairway in the Niagaran reef play in northwestern Michigan. Uncontested is the fact that exploratory drilling was suspended when the Michigan Department of Natural Resources denied drilling permits, citing the environmental sensitivity of the Nordhouse Dunes area. To be challenged here is the estimated value of the property. Nonetheless, the authors' clients prevailed before the Michigan Court of Claims, using the valuation described in the JPT as the basis for compensation. The Court, supported by the Court of Appeals[3], accepted without adjustment the claimed value of $71 million, plus interest.

We focus on the question of the value of the property interest -- not on the merits of the legal question as to whether or not the property had indeed been taken by the State, nor on the related question as to whether the taking had been temporary or permanent. The latter are the reserve of the lawyers. Our concern here is the quantum of compensation itself, how it was calculated, and how it was reported to the readership of the JPT by Rose and Jones, not the question of whether the taking was just or compensable.

This case study is important for the E&P industry, because it illustrates the potential hazards, as well as the possible profitability, of the judicial process. It also illustrates the elasticity of expert testimony and the opportunities which can be exploited before an indulgent court. The case is particularly useful since the entire argumentation, with all supporting documentation, is accessible in the public record. That fact permits a rare possibility for clinical, professional review.

Rose and Jones were respectively consultant and counsel to Miller Bros., a Michigan-based E&P firm which filed the largest claim in this case. Similarly, the authors of this follow-on article were retained, late in the case, by the State of Michigan. We shall complement the Rose and Jones' JPT article by summarizing the analytical results and benchmark data which were omitted in their piece. Using their own data, we shall show that the figure of $71 million was implausibly high in relation to available market-based information, and we shall also show, step by step, how that inflated value was obtained.

Specifically, Section Two below lays out the "reality checks" which suggest that the award was almost 100-times too high. In Section Three we detail the systematic errors and omissions by Rose in his risk analysis and choice of discount rate. Those errors alone increase the "value" almost sevenfold. Thereafter, in Section Four we review the geological judgments which additionally inflated the "value" factor of five or more. Section Five documents the violations of accepted appraisal practices.

The first set of errors (Section Three) is analytical, the second set (Section Four) involves arguable exercises of judgment, and the third (Section Five) reflects violations of standard appraisal practice. Section Six then summarizes the competing valuation of the property and sketches the implications of "drilling in the courtroom" for the industry.

Reality Checks

Reality checks provide the first clue that the Rose and Jones valuation is implausible. Simple tests suffice to show that their conclusion is improbable even before any deeper inquiry into their methodology. While such "reality" screenings are not definitive, they do provide quick and important litmus tests of plausibility.

Price per Acre. The first such test is the claimed value per acre in relation to sales of comparable properties. Rose and Jones do not report the unit figure, but their data show that the asserted market value was equivalent to some $26,000 per acre. The parcel involved approximately 2680 acres, for which the total claimed value amounted to $71 million. Thus the equivalent price per acre is $71 million divided by 2680, or $26,500.

That value per acre -- $26,500 for undrilled, untested and non-producing acreage in Michigan -- is palpably out of line. We emphasize again that the acreage was undrilled, unproven, undeveloped, and non-producing. That value cannot be reconciled with market transactions in Michigan, elsewhere in the lower 48 states, or Western Canada. It is almost two orders of magnitude higher than typical values.

Three examples highlight the disparity. First, leases or mineral rights in Michigan rarely sold for more than several hundred dollars per acre, even for properties closer to the main Niagaran trend, as discussed in detail in Section 5 below.[4] Second, there are extensive data on lease sales of Crown lands in Canada where prices averaged at most some $75 per acre in the reference years 1986-88 (equivalent to some $200-250 per acre for the total rights).[5] Third, OCS lease sales, involving the prime acreage in the US, averaged less than $400 per acre during that same period (equivalent to $1000-1200/acre for the rights).[6] The latter two sets of figures are averages, but the disparity is so large that the claimed high value per acre for Niagaran prospects is still suspect. The claimed value thus fails the first test.

Prior Sale. A second test is an actual sale which included the parcel in question. That transaction was not cited by the authors, but those data, too, are part of the public record in the case. This test, too, (discussed in more detail later) clearly suggests gross overvaluation. Rights for the entire tract of 23,000 acres sold at arm's-length for one-ninth of the value determined by Rose and Jones for ten percent of the acreage, a disparity of about 90 to 1. The part is less than the whole; there was no basis for believing that the small part was worth ten times more than the much larger "whole".[7]

Price per BOE. A third indicator is a comparison with the price per barrel of oil paid in contemporary acquisitions of <u>proved producing</u> reserves. This indicates an upper bound, since the Rose-Jones figure for the value per BOE in this case refers to less valuable resources. Those "reserves" are purely speculative, since the area is exploratory acreage, and the "reserves" in the denominator of their calculation are hypothetical at best.

Rose and Jones claim that the property would yield 10.7 MMBOE of recoverable, producible reserves, of which 7.6 mn are attributable to the leasehold interests being valued. Thus, their value for the undiscovered resources is almost $6/BOE, i.e $46 million divided by 7.6 million. This figure, too, casts doubt on Rose's calculations. Proven producing reserves sold for circa $4 in that period[8]; the "reserves" valued by Rose and Jones were not producing, nor were they developed, nor were they proven, nor were they even discovered. Indeed, there was no deep drilling on the property nor any discoveries in the immediate vicinity. Thus, their price for purely notional hydrocarbon resources was at higher than the typical figure for actual transactions which involved proven producing reserves, i.e. oil known to exist which had already been found and for which the development costs had already been incurred. Again, the figure may not be impossible, but it is unlikely that exploratory acreage in Michigan could command so astounding a premium.

The difference is in fact greater. The authors reckoned the gas at 6 MCF = 1 BOE; the conversion more consistent with such valuations at the time is 10 to 1, reflecting the low wellhead price for gas. If converted more conventionally, their claimed value is yet more out of line -- ca $7/BOE.

Rate of Return. The claimed profitability for the project also raises a red flag. The project would have been one of the most spectacularly profitable ventures in the industry. This is the "Cinderella effect", or inflated expectations, so well known in arbitrations and insurance disputes. A worksheet in the public record reveals that the expected rate of return for the venture would have been no less than 129%. We emphasize here that this is the rate of return which the authors claim would have been realized net of all exploration and finding costs and after weighting all dry holes, i.e. it is their interpretation of a risk-adjusted rate of return. We emphasize that the rate of return is that earned after allowing for exploration failures.

Such a high expected rate of return -- 129 percent -- suggests exaggeration. Rose declared that the reasonable expected rate of return in the industry was 12.5%. Hence the claimed rate of return of 129 percent is more than ten times the rate which Rose indicated was expected by oil companies in Michigan. He asserted that 12.5 percent is the pre-tax rate of return (BFIT) which an investor would have expected from a pure exploration play!

Bonanzas do occur -- every explorationist aspires to such good fortune. But such extraordinary profitability is not likely, thus the very high ROR is yet another red flag suggesting that something was wrong with the Rose-Jones valuation. This indicator, too, is not conclusive, but it adds to the cloud of doubt.

Overview of Reality Checks. The Rose-Jones article is conspicuously silent on this matter, and the Michigan court gave no weight to evidence as to the inconsistencies in the basic valuation. The valuation fails all of the reality checks, a clear signal that something was wrong (Fig. 1). Indicative of the Court's logic, however, is the reasoning of Judge Peter Houk in refusing to consider the evidence on actual lease bonuses in the area as indicators of real market value: "The Court also rejects the "lease bonus" method which was used by Defendant's expert to value the mineral owners' interest...[description of method]...The Court finds that the lease/bonus method is not the method which is utilized by the industry in establishing fair market value for transactions. Neither is it used for determining whether property has potential value great enough to merit the investment of development capital."[9]

This dismissal of market information does not reflect industry practice, nor does it reflect insight into petroleum economics. That statement notwithstanding, all of the independent reality checks lead inexorably to the same conclusion -- the "value" is an extreme outlier, the "value" is suspect, and, therefore, it is important to dissect that valuation in order to test it further.

Systematic Errors and Inconsistencies

Economic and Risk Analysis. Major errors undermine the property valuation reported by Rose and Jones, and their conclusions are substantially changed when those errors are rectified. However, none of these errors can be discovered in the published paper itself; one must reach to the underlying worksheets. By delving into the exhibits and testimony, one can recalculate their results and thus uncover that series of errors. Each of the errors was in the same direction, each inflated the valuation, and in each instance the method which is incorrectly applied in the testimony is correctly applied in other published works by Rose or in references cited by him.

The errors are triply serious: 1) all contribute to overstating the resulting calculation; 2) all are inconsistent with the author's published articles or sources; and 3) the impact of all taken together is quite large -- the value, corrected for those errors alone plummets from $59.4 to circa $10 million.

At issue in this section is not the "income" method for valuation as such, but, rather, its correct application. Even if one accepts that method for risk analysis, and even if one accepts all of the authors' geological assessments, one still find that the "value" has been overstated by a factor of six-to-one, an error of 500%. In this section we address only these purely analytical errors, but we note that the method itself should not have been used at all. The case record showed ample market information on transactions for comparable properties, including a recent sale of the land in question and purchase of similar properties; thus such analytical overkill was unnecessary, quite aside from having been implemented incorrectly.

The published article glosses over the calculation of the value, but from the record one determines that Rose "risked" the venture by determining the "Risk-Adjusted Value". This method, described in a number of recent articles,[10] is based upon modern risk-preference theory. It implicitly corrects for risk and uncertainty by deducting from the expected value an adjustment proportional to the square of the variance of that value, i.e. a "discount" related to the measured uncertainty of the venture.[11] The rudimentary version of that theory used by Rose is expressed in Equation (1):

$$RAV = 1/r \ln \left\{ pe^{-r(R-C)} + qe^{rC} \right\} \qquad (1)$$

In that equation, r is the risk aversion coefficient, p refers to the probability of successful discovery, C is the cost per exploration play, and R is the net present value (NPV) of successful venture. q is the probability of failure, equal to (1-p). It is argued that this method for risk-weighting is superior to the more common practice of adding a risk premium to the discount rate in order to reflect the uncertainty of exploration.

Rose calculated that the exploration venture was 99.6% certain to be successful, and then used that figure for the "success probability" in Equation 1 to compute that the risk-adjusted value. He determined it to be \$59.4 million -- i.e. only one percent less than the expected NPV of \$59.8 million. Thus he purported to show mathematically that both the risk and the risk adjustment were nugatory. The court adopted that conclusion, as did the appeals court, and both stressed in their rulings that the project was all but a sure thing: "..plaintiffs persuasively demonstrated that they almost certainly would have discovered some oil and gas had they been allowed to drill in the protected area."[12]

Rose's calculations are incorrect, and the conclusions of the courts are accordingly unfounded. Six demonstrable errors are at the heart of the inflated valuation and the conclusion of "certainty"; we shall detail each, illustrating the contribution of each to inflating the value or distorting the probabilities. We emphasize again that all calculations in this section are based entirely upon Rose's own data, from the public record, and upon applications of his own methodology as described in his own articles or in publications cited in those articles.

Erroneous Probability. The first error lies in the calculation of the probability of success. Rose stated that the probability of success was 99.6%. This figure is the probability of achieving eight dry holes out of eight tries, where the assumed probability p of success for each wildcat well is 0.50. That is indeed the probability of success in the narrow sense of the elementary version of the Gambler's Ruin problem, which defines "success" as achieving at least one non-zero result:

$$p_{success} = 1.0 - (1 - 0.50)^8 = 1 - 0.50^8 = 0.996 \quad (2)$$

Rose then used that figure incorrectly in Equation (1). He related the probability of 99.6% of success to an expected NPV of \$59.8 million. That is patently erroneous. The figure of 99.6% is the probability of at least one commercial discovery prospect in a series of eight wildcats, i.e. the probability of not failing with eight dry holes. The outcome, i.e. the value of R which he used in Equation (1), on the other hand, is \$59.8 million. That is the value to be expected from a 16-well exploration program under with a probability of success of 0.36. His errors were threefold in this calculation: different definitions of success, different numbers of wells in the ventures, and different probabilities of success.

The probability and the result do not track; the juxtaposition is false. The correct probability of realizing \$59.8 million, given the assumed values, is 0.1848, not 0.996. Rose indeed does report the correct value in the body of his testimony. However, he used the erroneous value of 0.996 to determine the risk-adjusted value and to conclude that the exploration venture was all but certain, a conclusion adopted by the Courts.

This elementary error has two important consequences: 1) it leads to serious understatement of the riskiness of the venture and 2) it results in a gross understatement of the risk adjustment (RAV). The probability of achieving the claimed value of \$59 million is 18%, not 99.6%, so that the success likelihood is overstated by a factor of five: 99.6% versus the real figure of 18.5%. Further, the risk-adjusted value, if calculated consistently, differs markedly from that reported by Rose:

$RAV_{testimony}$	=	\$59.4 million
$RAV_{consistent}$	=	\$3.9 million
ERROR	=	\$55.5 million

That error is very large and is basic. The author mismatched the probability of one or more discoveries out of eight tries with the expected value for six successes out of 16 tries. The corrected value is the RAV for the case of a binomial exploration play with success probability 0.36 and a point value for the outcome of \$59.9 million.

Incorrect Equation. Further, the error was even more serious because the equation itself was incorrect. The version used by Rose applies to the case of a single event, such as an exploration play with but one exploration well. The actual venture was quite different. Rose and Jones describe the venture quite precisely as 16 exploration wells, with an expected outcome of six identical commercial reef discoveries (probability of success = 0.36, so that 16 times 0.36 = 5.76, successes, rounded up to 6.0).

Equation (1), used by Rose, is wrong. A more general form of the RAV equation must be used for such a multi-well program. That correct form, described and illustrated in several of the sources cited by Rose in his own publications, is:

$$RAV = 1/r \ln \left\{ p_1 e^{-r(R_1 - C)} + p_2 e^{-r(R_2 - C)} + \ldots + p_n e^{-r(R_n - C)} \right\} \quad (3)$$

In Equation (3) p_i refers to the probability of i discoveries out of N exploration wells and R_i is the contingent net present value of the i^{th} success. C as before is the front-end cost of the exploration program. The distribution of the p_i's is multinomial with p=0.36 and N=16 and is shown in Figure 6 of the published paper; the contingent value of a success is \$59 mn /5.76 or \$10.3 mn; the cost of exploration per the authors is \$3.2 million.

The risk-adjusted value may readily be calculated from Equation (3) and is found to be rather less than that claimed by Rose:

$RAV_{per\ Rose}$	=	\$59.4 million
Actual $RAV_{formula\ correction}$	=	\$54.8 million
ERROR	=	\$ 4.6 million

The correct value is ten percent lower than the erroneous figure of \$59.4 million reported by Rose and the risk adjustment is not \$500,000 but \$5 million. This is the correction for the erroneous choice of equation taken by itself. It is modest but the impact is much larger when all of the non-linear corrections are carried out together (see below).

Discount Rate. Rose used the figure of 12.5% as the discount rate applicable to a wildcat play in an area which was undrilled and which was distant from production or proven reserves. That figure is not supportable. A discount rate of 18% or higher, before interest and taxes (BFIT) would typically be used for producing properties, and some higher rate yet would be used for riskier, non-producing properties or prospects. Industry readers recognize this relationship, so it need not be belabored here. Later in the case another witness for the plaintiffs adjusted the discount rate to 18%, a figure still lower than the grey zone, which resulted in another significant downward adjustment in the claimed value:

RAV_{Rose}	=	\$59.4 million
$RAV_{18\%}$	=	\$46.4 million
ERROR	=	\$ 13 million

Rose's undocumentable discount rate thus added some 30% to the valuation.

Point Values for Field Sizes. The fourth error was the failure to include the distribution of field sizes; this distribution was known, it was prepared for the authors, and it was discussed and displayed in considerable detail in the case record; see Fig. 2. The authors ignored that part of their own record and assumed instead that each field was exactly the same size. That unnecessary assumption skews the risk analysis. Risk is intrinsically the concern over dispersion of outcomes; by using only a single point-value for the expected field size, and ignoring their own data on the distribution of field sizes, the authors understated the dispersion of results, overstated the certainty of the outcome and consequently overstated the risk-adjusted value (RAV).

The RAV can be recalculated properly using the authors' empirical data on the field size distribution from the unpublished case record and combining that data with the binomial assumptions reported by the authors in the paper. A closed form solution is not possible, but a Monte Carlo calculation converges quickly. Again, this error, too, results in a material overstatement of the RAV:

$RAV_{authors}$	=	\$ 59.4 million
$RAV_{corrected\ for\ field\text{-}size\ distribution}$	=	\$ 45.0 million
ERROR	=	\$ 14.4 million

The RAV is substantially less; that omission taken alone increased the valuation by 30 percent. Exploration experience in Michigan confirms that there is considerable dispersion in field size, so that much of the expected value of any play is concentrated in the least probable, larger reefs. Hence the real-world dispersion of outcomes is much greater than indicated by the authors, and the RAV is accordingly much lower.

Undocumented Measure of Risk Aversion. The fifth error is the arbitrary choice of the value for the risk aversion coefficient r, which plays a critical role in the risk theory used by Rose and Jones. Their risk analysis, as detailed in the case record, used a figure of 0.02 for r. That value is insupportably low; it is inconsistent with the empirical evidence and is also distinctly lower than the value derivable from the author's own published writings.

The record shows that Rose used a value for the risk aversion coefficient equal to the reciprocal of the assumed exploration budget of \$50 million (measured in units of one million), i.e. r = 0.02 (= 1 / 50). This cannot be justified. First, Rose's own writings note that the typical value should be calculated as 4 to 5 divided by the budget -- i.e. 5.0/Budget rather than 1.0/Budget. His own publications thus indicate a value for r of 0.08-0.10, rather than the figure used in his testimony. Second, the one available empirical study by Walls and Dyer[13] indicates that the appropriate value is higher yet for a firm with an exploration budget of that size; only the very largest firms are identified with a risk aversion coefficient even approaching 0.02.

The risk penalty is therefore seriously understated by the choice of that parameter; if r is taken as 0.10, consistent with Rose's published analysis and Walls' results, we can determine an upper bound for the risk-adjusted value:

$RAV_{Rose\ published}$	=	\$ 59.4 million
$RAV_{Rose\ testimony}$	=	\$ 48.2 million
ERROR	=	\$ 11.2 million

Once again the error, due to this effect by itself, results in an overstatement of the present value of the property -- this time by \$11.2 million or more than 20%.

Confusion of Expected Value with Fair Market Value. The sixth error is more subtle. The authors asserted that an informed buyer would have paid an amount for the mineral rights equal to the risk-adjusted value of the mineral rights. That is not supportable, but we must quickly distinguish here between two concepts: 1) the fair market value where the parties are equally well informed, which is part of the definition of fair market value and 2) an auction where the parties intrinsically do not know the outcome.

In the latter case, as is painfully well known to the industry, the "greater fool" prevails, i.e. the bidder whose imperfect information is biased upwards wins the lease and usually overpays. Here a different standard applies: both parties are presumed to have access to the same information.

Fair market value is therefore less than the expected value. The reason is straightforward and is discussed in Rose's published papers. An informed buyer would pay the expected value only if one of two restrictive conditions were met: 1) the buyer has an infinite capital budget or 2) the buyer has fewer prospects with a net positive PV than his budget and the buyer is required to spend the budget irrespective of the quality of the prospects.

No profit-maximizing investor would pay risk-adjusted expected value. A buyer who paid a price equal to the NPV would have an Expected NPV (ENPV) for the venture of zero, i.e. the contingent value of the venture less his purchase price equals zero. But buyers pick those projects which have positive ENPV's, using any of several different selection rules. But irrespective of the selection rule, a project with zero ENPV is not a likely candidate for a rationally chosen portfolio. It would be the last project chosen -- only if projects were scarce or if the budget were infinite.

Infinite budgets or imprudent buyers are not the standard. While it is well to understand that FMV is less than ENPV, there is no unique correction, unlike the previously discussed errors. However, Rose himself provides guidance, albeit in his previously published articles rather than in his testimony. He identifies two methods for scaling down an expected NPV or RAV to estimate the fair market price which an informed buyer might pay.

The first method noted by Rose is to double the discount rate for the development stage; applied here that involves recalculating the RAV at a discount rate of 25%, rather than 12.5% (or at 36% using his revised discount rate).[14] This leads to a figure of some $22 million, exclusive of the other needed corrections. The second method advanced by Rose in his published work is to scale the ERAV downwards by a judgmental factor.[15] Rose reports a scale factor of 0.35. Both lead to lower values, but the results are not unequivocal. The net result is displayed as a range to illustrate the difference between the testimony and the published work, as well as to indicate the direction and magnitude of the adjustment from expected value to market value.

$FMV_{claimed}$	=	$ 59.4 million
$FMV_{doubling\ rule}$	=	$ 22.1 million
or $FMV_{35\%\ rule}$	=	$ 20.8 million
ERROR	=	$27.3 to 28.6 million

Rose elsewhere emphasizes this very point. He noted that a buyer who paid the full expected value would be simply trading dollars and that the negotiated price would be below the expected value. The corrected values are less than half the claimed figure. Once again, this is the result only of this adjustment alone; the value, after elimination of all errors is much less still (see below).

Net Impact: All Corrections. The net effect of all the corrections does not equal the sum of the separate corrections noted above. They cannot be added because the adjustments interact and because the effects are highly nonlinear. Instead, one must rerun the Monte Carlo calculation incorporating all corrections simultaneously. The results of each correction taken alone, plus the result of incorporating all of them together, are displayed in **Table** 1.

The first error overstated the probability of success -- inflating it from 18% to 99.6%. The second through the fifth errors affect the figure for the value itself and can be corrected with precision. All overstate the value. The sixth error cannot be corrected with the same precision; the impact of the market value factor is very large, based upon Rose's own methods from the published work, but only a range can be specified.

Finally, all errors can be eliminated together in an overall calculation. The corrected **Table 1** fair market value, after correction of all errors, lies between $7.6 and $13.1 million. That range is based entirely upon plaintiffs' own data and is conformed to their experts' own writings. The difference is dramatic: $7.6 or even $13.1 million is very much less indeed than the figure reported in the authors' paper. Their sequence of analytical errors inflated the result by a factor of at least 4.5 and probably more than eight-to-one. We emphasize again that this corrected figure includes only rectification of errors or omissions in the financial calculations; insofar as the reserves were also overstated, or the costs understated, the ultimate corrections are still greater.

Geological Exaggerations

We turn now to the geological part of the paper, where we disagree with Rose and Jones regarding four key geological issues. We note that differences in judgment are a major part of this disagreement, but argue that their determinations are unacceptably beyond the limits of any grey area:

1. Dubious Assumption: Their argument that the Protected Area is on-trend with discovered reefs miles distant elsewhere in the Niagaran reef play.

2. Misleading Extrapolation: Their using reservoir parameters from a distant analog to the Protected Area, disregarding another, much closer, analog, which is doubly an error of commission and omission.

3. Exaggerated Reserves: Their use of 1.8 million BOE as the expected average field size for hypothetical fields to be discovered in the Protected Area.

4. Overstated Reef Density: Their estimate that 1.41 reef-fields per square mile will be discovered in the Protected Area.

In the latter two instances, the authors also ignored the less favorable data from the much closer analog. More generally, each of these judgmental choices skewed the resulting valuation in the same direction toward a higher figure.

On-Trend Issue. There is not an acceptable level of certainty that the Northern Niagaran Reef Trend extends across the Protected Area in Mason County. Alternative interpretations of the geological information on the Niagaran trend (or trends) in this area should be considered. No one interpretation, given the absence of subsurface data in the Protected Area, is so overwhelmingly persuasive, or uniquely compelling, as to be accepted by all reasonable interpreters. In particular, the interpretation so presented cannot be argued to be definitive.

Four alternative interpretations of the reef trend are illustrated in Fig. 3. Each map has both advantages and disadvantages, and reasonable doubts exist as to the validity of any single representation. The distribution of oil, gas and water in the reefs is represented. A transition (coming generally out of the basin) from gas-prone to oil-prone and then to wet reefs is evident.

When attempting to predict subsurface geology, it is important to use multiple interpretations in order to fully explore the many possibilities that can exist in an imperfectly understood natural environment. Analysis of all of the available data, rather than statistical projection from a dubious analog area is essential. The use of multiple working hypotheses tends to mitigate the risks related to subjective interpretations and the biases of individual interpreters.

In an area such as western Mason County, where subsurface data are sparse, multiple different interpretations are possible, each of which might be defensible. Given that uncertainty, it is inappropriate to base a hypothetical cash flow model upon one single analog of questionable validity, all the more so when the oil or gas potential of the area being valued is purely speculative.

Best Analog Issue. Rose and Jones based their valuation upon a doubly insupportable choice of geological analog. First, they extrapolated to the Protected Area the data from a distant producing area. Second, they omitted the data from immediately proximate areas. They thus gave full weight to the least relevant data but totally excluded the most applicable information.

The authors extrapolated to the target area the reservoir properties from a producing area some 20-30 miles to the northeast (see Fig. 4). That area is a mature exploration and development sub-province in the Northern Niagaran Trend (designated Sector 3 in Fig. 4), but it is too far removed from the Nordhouse Dunes to be a valid analog, given the small closures and episodicity of the reef plays. Indeed Miller Brothers actually note a better analog in their own investment prospectus. In that brochure, describing Miller Brothers' North Victory Project[16], they declared: "The local reefing province is the Miller Brothers' Hamlin-Victory Niagaran Pinnacle Reef Field in Mason County".

That field is indeed the closest analog. The Hamlin-Victory Field Area, the only producing area near the Nordhouse Dunes, is located 1 to 10 miles (average of about 6 miles) south and southeast of the Protected Area. It has been extensively explored by Miller Brothers and others and has supported modest production from Niagaran reefs for over 20 years. This is a proven, producing area much closer to the Nordhouse Dunes, but it was ignored as an analog by Rose and Jones. It is the best analog, but not supportive of plaintiffs' claim. Hamlin-Victory yielded only modest volumes of Niagaran hydrocarbons, principally gas, compared with the more distant Sector 3. Hamlin-Victory has a high degree of exploration maturity, but its potential is much lower than that of Sector 3, hence use of that analog would result in a sharply lower value attributable to the disputed area.

The level of exploration and development maturity in the Protected Area is insufficient to establish that drilling, production and success rates results such as those obtained in Sector 3 should be expected. Given that the area was undrilled and unproven, its oil and gas potential is purely speculative, and results such as those obtained in the Hamlin-Victory Area are much more likely since the latter is much more proximate and since there was no evidence suggesting better performance.

Expected Field Size Issue. By choosing a distant analog, and ignoring the next-door fields, Rose and Jones overstate reserves greatly. The analog areas closest to the Protected Area have the poorest reservoir performance. Rose and Jones projected an average field size of 1.8 million BOE for the reefs they hypothesized to be discovered in the Protected Area. That was based on an average of fields in the prolific Middle Fairway, the distant analog, of Sector 3 and adjacent Manistee County. This is inappropriate, as shown above. The estimated ultimate recovery of hydrocarbons decreases dramatically from Sector 3 to the Hamlin Victory Area (Table 2).

The productive reefs closest to the Protected Area are situated approximately two miles to the southeast, in the NE and SW quarters of Section 5 in Victory Township. These two reefs are predominantly gas-bearing, not oil-bearing, as assumed by the Plaintiffs in their hypothetical cash flows for speculative reefs in the Protected Area. The northern reef in Section 5 produced only 565,760 MCF of gas and a minimal 1604 bbls of oil (95,897 BOE) from one well before it was shut-in in 1986; the other reef produced 149,769 MCF of gas and a similarly small amount of oil, 2096 bbls (27,058 BOE) from one well before it was shut-in in 1983. A second potentially productive gas well was drilled into the northern reef but was not yet producing as of April 23, 1987. Therefore, at that date, only three wells had penetrated the two reefs closest to the Protected Area. All three were predominantly gas wells and all were ultimately short-lived. None is currently producing.

The contrast is dramatic between the average actual Ultimate Recoverable reserves for these closest producing reefs and the Plaintiffs' predicted reserves (Estimated Ultimate Recoverable) for the Protected Area. Actual produced reserves for these reefs only average about 61,000 BOE per reef, and the commodity was overwhelmingly gas. The Plaintiffs' projected base case for Protected Area reefs is 1,800,000 BOE per reef, or 30 times the average reserves known to exist in the closest reefs. This 30-fold discrepancy is additional evidence that the Sector 3 production analog is dubious.

Reef Density Issue. Reef densities (Table 2) are much lower in the proximate Hamlin-Victory Area than in Sector 3, the distant analog used by the authors. Sector 3, one of the most prolific portions of the Trend, has one of the highest reef densities, reported by Rose and Jones to be 1.41 reefs (or reef-fields) per square mile. Other areas, such as their Sector 2 (1.37 reefs per square mile) and their Sector 1 (1.1 reefs per square mile), have lower reef densities.

The Hamlin-Victory Area includes 17 reefs in a 33-square-mile area, yielding a reef density of 0.51 reefs per square mile. Even if the analog is restricted to a smaller area of about 18 square miles that includes these reefs, the reef density is still only 0.95 reefs per square mile. This is almost one-third less than the value of 1.41 reefs per square mile that Rose and Jones assumed.

Geological Conclusion. The geological judgments of Rose and Jones are doubly flawed and are important. There is an error of commission in using a remote analog to estimate the hydrocarbon potential and a second error of omission in their ignoring the much nearer, but much less favorable analog found adjacent to the area being valued. The impact is large -- possible hydrocarbons are overstated by a factor of 3.4 -- and the estimated value is inflated by a factor of about 5-to-one. These skewed choices increase the ostensible value of the property from a maximum of $9 million to the claimed figure of $46 million, even if all other errors are ignored.

Violations of Accepted Appraisal Practices

We turn here to the authors' violations of several fundamental principles of the appraisal profession. As is true with all types of appraisals, be they of real or personal property, certain standards of practice must be followed. Thus, the standards of appraisal have been thoroughly developed in the daily practice of thousands of appraisers and by courts; they have also been promulgated in two important documents. The first of the latter is the "Uniform Standards of Professional Appraisal Practice" (USPAP), published on a regular basis by the Appraisal Foundation, Washington, D.C., and adopted by many states as the standards of practice for appraisal.

Second, specific to federal land acquisitions, condemnations and other takings is the "Uniform Appraisal Standards for Federal Land Acquisitions" (UASFLA), published by the Interagency Land Acquisition Conference first time in 1973 and with the current version dated 1992.

Omission of "Highest and Best Use" Analysis. It is fundamental in all appraisals that the appraiser first must determine the *Highest and Best Use* of a property. The simplest form of the hierarchy of such uses in the oil and gas industry is:

1. Producing properties.
2. Undrilled development sites offsetting producing wells.
3. Exploratory prospects of various types.
4. Land positions with no geological anomaly.

The authors totally ignored such analysis and instead jumped to the conclusion that the property would contain oil and gas and would produce income therefrom. In contrast, and in conformance with standard appraisal practices, the property must first be examined for its *Highest and Best Use*, defined as:

"Either some existing use on the date of the transaction, or one which the evidence shows was so <u>reasonably likely</u> in the near future that the use would have affected its market price on the date of the transaction and would have been taken into account by a purchaser under fair market conditions" (emphasis added).[17]

Different parts of an oil property can have substantially different *Highest and Best Uses*, depending on their stage of development. Clearly, the *Highest and Best Use* of a producing oil property is realizing income from the sale of production. Likewise, at the other end of the spectrum, the measure of the *Highest and Best Use* of "goat pasture", i.e. rank wildcat acreage, is the cash from bonuses and rentals which oil companies might pay to add such a property to an inventory of exploration leases. Between these two extremes, properties may be non-producing, although the reserves may be proven, or the property may be a prospect defined by seismic data, by subsurface control, or by other means.

The value of a non-producing property can still be calculated from projected income from production, but only if such income is reasonably certain and reasonably close in the future. On the other hand, an exploratory prospect cannot be considered to be anywhere near "income from production," partially because there is a very substantial question with regard to actual discovery of reserves, and partially because the timing of drilling may be impossible to determine.

We can estimate the value for each category of acreage within the Protected Area by comparing the subparcels with their analogs in the nearby Hamlin-Victory Field. These include properties spanning practically every type of *Highest and Best Use* known to the oil industry. There is a market for each of these categories, so that market values on a per-acre or on a per-barrel-of-oil basis can be established. These increase in value from the non-prospective acreage in the low end of the spectrum to producing wells in the high end.

Producing Properties. There is no Niagaran reef production inside the Protected Area, nor is there any well deep enough to penetrate the Niagaran Formation. However, 1 to 10 miles to the southeast thereof is the only proximate production, producing sour gas from Niagaran reef structures in the Hamlin-Victory Field Area. The producing wells in that field therefore represent a test for the *Highest and Best Use* of income from oil and gas production.

Undrilled Development Sites. In the area of the Hamlin-Victory Field, there are also likely one or two developmental locations immediately offsetting some of the producing wells which, until they are drilled, would represent the second category of *Highest and Best Use* of undrilled development sites.

Exploratory Drilling Prospects. The third category, namely exploratory drilling prospects, is represented both inside and outside the Protected Area as having been identified by seismic data acquired in the 1970's, in 1980 or in 1984-85. The nature of the seismic data and its interpretation are such that the interpretation does not <u>prove</u> the existence of oil and gas or even a reef, but rather shows the possibility of a reef structure, subject to the skill and subjective opinion of a geophysicist.

<u>If</u> the data is good, and <u>if</u> the geophysicist is correct in his interpretation, and <u>if</u> an exploratory well is drilled, and <u>if</u> it penetrates the reef, and <u>if</u> the reef contains pore space and <u>if</u> the pore space contains oil or gas instead of water, and <u>if</u> the oil or gas can be produced economically and brought to market in a pipeline, then, and only then can income be derived from such production. These drilling prospects cannot be valued in terms of speculative oil production, contingent upon discovery of oil. Instead, such drilling prospects must be valued *per se*, i.e. in terms of the market information for the traded value of such prospects, given that there is a brisk trade in drilling prospects, as discussed below.

Land Positions with No Geological Anomaly. Such acreage must be valued on basis of market information for either sales or leasing of comparable acreage.

Conclusions with Regard to Highest and Best Use. The Fair

Market Value is estimated with reference to the *Highest and Best Use* of each class of parcel in the property -- that is, the highest and most profitable use for which the property is suited or the use to which it might reasonably, absent speculation, be put in the near future.

It was agreed that exploratory drilling for oil and gas was reasonably probable in 1987 and might be conducted in the near future on certain tracts. Potential buyers would have known that. Consequently, the *Highest and Best Use* of specific portions of the appraisal property is as Drilling Prospects. Other tracts were less prospective; they contain seismic anomalies or leads whose *Highest and Best Use* is as farmouts or seismic options for additional evaluation. The remainder of the appraisal property does not contain Niagaran reef drilling prospects, and its *Highest and Best Use* is limited to what the mineral rights owner might garner by leasing out the oil and gas exploration rights.

Having established the *Highest and Best Uses* for each parcel of a property, an appraiser can then apply that appraisal method which best suits those parcels. Four appraisal methods are standard in practically all types of appraisal: 1) any prior sale, 2) comparable sales, 3) the income approach and 4) the cost approach.

The authors failed to differentiate *Highest and Best Uses* for different subparcels. They further failed to include and weigh prior sales and comparable sales, as will be discussed below. Finally, they erred by applying an appraisal method based on forecasts of income from purely speculative production, in a situation where concrete market data was readily available.

Failure to Consider All Available Data. Rose and Jones have violated one of the very important rules of the appraisal professions by not including consideration to all available data. They stated that "because of the large number of pinnacle-reef fields, their widespread distribution with the well-defined reef trend, and the relatively good quality of production data, the Niagaran pinnacle-reef trend of Northern Michigan is uniquely well suited to statistical analysis".[18] They referred further to a "production database... covering all 705 pinnacle-reef fields in the Niagaran trend of Northern Michigan".[19] The statements are true, but hardly relevant, because the fields so discussed do not span or even abut the area being valued. The argument is doubly irrelevant because the authors ignore the fact that the nearest producing field area is relatively poor. That area, the Hamlin Victory Field Area, with wells operated by Miller Bros., produces sour gas and has ultimate reserves only of the order of 700,000 BOE per reef field, in contrast to the authors' figure of 1.8 mn BOE per field, which was derived statistically from the richer, more remote area (see **Fig.** 4). In any appraisal where a nearby property shows such a drastic deviation from an alleged trend, a disclosure must be made and that fact must be included in the appraisal report. This failure to disclose is a direct violation of the appraisal standards.

Ignoring Comparable Sales. Rose and Jones also ignored an actual sale. In further violation of the disclosure standard to include all available data, the authors, in spite of their statement that the "just compensation amount claimed by Miller Bros. was based on solid research and expert testimony that established a realistic value for the expected oil and gas reserves",[20] failed to mention an important comparable sale by the plaintiffs themselves. During the period from 1983 to 1985, the Miller Bros. sold part interests in a larger tract which in fact included the Protected Area of Nordhouse Dunes. That sale, at a time of high oil prices, thus provides an upper bound to the value of the component acreage.

In total, a 62% working interest was sold to 6-7 other oil companies and investors for an amount, which, upon adjustment for drilling commitments and other factors, was equivalent to a market price of $125 per acre for the for the total area. If all value were assumed to be in the Protected Area, an extreme case, the maximum assignable value would be $1060 per acre. That is clearly an upper bound. First, the other acreage with the tract had value. Second, the only value changes in the local area between 1985 and 1987 were in a downward direction, due to the 1986 drop in oil prices; third, no significant wells were drilled in the neighborhood which might have added to the value.

This omitted transaction is important. The maximum assignable market price of $1060 per acre is much less than the authors' "projected expected value" of $17,000 per acre (equal to the trial court's judgment of $46 million divided by 2680 acres). Thus, the authors mislead the JPT readers by stating that their valuation was based on "comparison with any available analog sales of record as a basis of Fair Market Value of Nordhouse Dunes disputed tract". That statement is simply false -- it is wrong by a factor of at least sixteen-to-one.

Neglecting Prior Sale of Mineral Estate. Indeed, Rose and Jones also ignored another contemporary sale in the immediate vicinity; note in Fig. 4 the location of the Huntley tract. The buyer, Plumb Enterprises purchased, not just leased, the entire mineral estate on 640 acres from the Huntleys for $64,000 -- i.e. $100 per acre. The transaction, which met the market test of a willing buyer and willing seller, took place on 27 January 1987, shortly before the taking of the leases in the Protected Area. The Huntley property lies only 2-3 miles east of the Protected Area. Since the value of a lease by definition is less than or at a maximum equal to the value of the entire mineral estate, this actual market transaction implies that a value 170 times higher than market has been awarded by the Court ($17,000 divided by $100).

Neglecting Market Data on Leases. A further element was left out. The experienced reader will undoubtedly at this time ask the obvious question: "What was the market in Northern Michigan for oil and gas leases?" Rose and Jones fail to even mention this subject, although oil and gas appraisers, for many years, have recognized lease transactions as important indicators of value. Appraisers use a rule-of-thumb relationship between lease bonuses and the Fair Market Value of undeveloped oil and gas properties. The mineral estate is worth approximately 2 1/2 times the going bonus amount for exploratory acreage, a lower multiple when prospective acreage is considered. The lease itself (a portion of the overall mineral estate) is typically worth a fraction thereof, from 25 to 80 percent also depending on nearness to production (see Fig. 5, which shows the breakdown of overall value between leaseholder and landowner).

Readily available market data, included in the trial record, reveal that properties in the central part of the reef trend (25-30 miles to the north of the Protected Area) leased for $250-$300 per acre, while reserving an average of 20-25 percent royalty. Tracts in exploratory parts of the broad trend leased for 25-175 dollars per acre with a 3/16ths royalty (see Fig. 6). Bonuses in the immediately adjacent area to the Protected Area were still less.

Even if one uses the maximum lease bonus from Rose and Jones' analog area, $300 per acre, the claimed value is implausibly high. On that basis, using the 2 1/2 times rule-of-thumb, one quickly determines that the overall mineral estate is worth $750 per acre as the total Fair Market Value. This figure is an upper bound. This market data, omitted from the article, produces values dramatically less than the authors' figure of $26,500 per acre for the entire mineral estate. The authors failed to report the market data which contradicted their value, which is 35 times higher than the market signals. Also, this example, where market information was omitted, highlights the importance in any appraisal of incorporating all available information in the valuation.

Low Discount Rate. Rose and Jones' error in using a discounted cash flow method for a Fair Market Value estimate of speculative reserves has been discussed above. They compounded that error by using of an insupportably low discount rate. They indeed wrote that one must apply "a discount rate appropriate for the industry[21] to arrive at the Fair Market Value. That declaration notwithstanding, they used a discount rate of only 12.5% (subsequently amended to 18%). In other words, Rose and Jones assumed that industry would only discount the hypothetical future net cash flow, from undiscovered reserves, at 18 percent (with oil prices escalated at 7 percent per year and on a pre-tax basis). This was at a time in 1987 when the SPEE Annual Survey shows that the typical price escalation was 5% and *producing* reserves were selling at a present worth of about 22 percent.

The discount rate was wrong. It did not reflect the fact that exploration properties are riskier than developed production. Thus the discount rate applied to such a play must be higher than that for producing properties. Second, it is standard practice to apply a further risk adjustment -- the present value is multiplied by a factor less than one to reflect the risk. The scale factor is typically 0.95 for proved production and drops to circa 0.3-0.4 for undeveloped properties. For Possible Undeveloped reserves the median value for the risk factor was lower than 0.3 according to the SPEE Annual Survey.[22]

Suffice it for us to recognize that *reverse* calculation of discount rates from actual transactions involving even Probable reserves usually yield discount rates in the 30 to 50 percent range. Possible reserves would command even higher discount rates.

The low discount rate, of course, drastically increased the claimed value. Assuming for the moment that all of the other engineering assumptions and factors used by Rose and Jones were correct and that the geology was in fact similar to the reef hot spot 25-30 miles to the north, the difference between using the author's 12.5% percent and a 40 percent discount rate from market transactions is an almost tripling in the ostensible value (from $20 million to $59 million). In much simpler words: would an oil company buy Possible reserves, not yet discovered, using the same discount rate as it would use for purchasing Proved Producing reserves? Of course not. Rose and Jones' adjustment for this factor was to increase the discount rate from 12.5 to 18 percent, a figure still below that used for Proven Producing properties. We note that the authors did not risk the property as should be done when discounting the cash flow projected from undeveloped, undiscovered resources.

Summary and Conclusions

The authors' client, Mr. James Miller, testified that he proposed to "drill in the courtroom". We have shown here that drilling in the courtroom -- or "lawyering for oil" -- can be more profitable than real drilling. The value of litigation in this instance is very much higher than the likely value of the geological play.

The "courtroom oil", i.e. the value of the taken mineral rights as determined by the courts in this case, was dramatically overvalued. We have demonstrated or tested that overvaluation in six ways:

1. Reality Checks.
   Simple tests suggest a priori that the value is implausible. The usual indicators of value were dramatically exceeded -- a) according to Rose and Jones the lost property would have yielded a risk-adjusted ROR of 129%, much higher than typical expectations; b) speculative resources were valued at much more than the going price for proven, producing reserves; c) the claimed per-acre value of the property was 100 times higher than average experience.

2. Computation Errors.
   Six analytical errors were documented. The first overstated the probability of success by a factor of 5-to-one. The others, taken together, inflated the value sixfold. Those errors contributed $50 million to the overvaluation, inflating the claimed value from $9 million to $59 million.

3. Geological Exaggerations.
   Plaintiffs used an improper analog as the basis for projecting possible hydrocarbon recoveries and also ignored the most proximate, but less attractive, analog. This double effect inflated the projected reserves by a factor of 3.5 (independent of the purely analytical errors noted earlier).

4. Actual Sale of Property.
   Rose and Jones ignored a sale of the property itself, the best possible indicator of market value. By subtracting out the other interests included in that sale, one could calculate the value assignable to the Nordhouse Dunes tracts -- a

maximum of some $2.84 million. Thus plaintiffs' own files reveal a much lower value than claimed.

5. Adjacent Sale.
Rose and Jones omitted the most proximate sale -- 640 acres some 2 miles away, the closest transaction -- which commanded a price 170 times smaller than their claim.

6. Market Data - Lease Bonuses.
Finally, the article ignored extensive data on lease bonuses in the analog area as well as in areas neighboring the tract. The highest figure was $300 per acre, while the median values from the actual marketplace were considerably less, circa $60 per acre. Again, all real transactions show much lower values than claimed -- a distortion factor of 35.

The hierarchy of errors is important. The reality checks (item #1 above) were immediate, simple, industry-wide tests of the plausibility of the claimed value. These are not definitive indicators of error. However, the disparities are so large and so pervasive as to suggest very strongly that the valuation is flawed. At the very least such multiple red flags suggest that more careful review is needed to corroborate a valuation which is so markedly higher than industry expectations.

The statistical and analytical errors (#2) are incontrovertible; these partly explain how the high figure was obtained. The geological exaggerations (#3) are large and almost as important in inflating the value -- they alone resulted in a quadrupling of the possible reserves and thus explain in large part how the high value was computed. The joint effect of error and exaggeration was to increase the value from less than $3 million by a factor of about $20 to $59 million.

Market data also show that the claim is distorted. Particularly telling are two independent sets of data on local sales of mineral interests. First, the property itself had been sold as late as in 1985 for a figure equivalent to a maximum of $1060 per acre (#4). That price was 6% of the claimed value, where available evidence indicates that its value in 1987 would have been still less than that in 1985. Second, the closest sale revealed a market price 170 times less (#5). Third, bonuses in the better areas were worth a fraction of the claimed value for the marginal tract in the Protected Area (#6). Thus, the market had spoken and spoken clearly -- the property itself, as well as comparable properties, had all sold for substantially less, namely from $100 to $1060 per acre -- a far cry from the claimed value of $26,500 per acre. No market transaction, of the many recorded, was remotely close to the claimed value.

A four-tiered analysis thus shows that the reported valuation is seriously overstated. First, the reality checks flag sharp disparities with practice. Second, the actual sales show only very much lower figures. Third standard appraisal methods lead to a much lower figure. Fourth, the demonstrable errors and exaggerations show how the inflated figure was in fact obtained -- mathematical error and geological exaggeration account for the difference between computed value and revealed worth.

Drilling for oil in the courtroom can be lucrative even if the claimed valuations are unfounded as long as a court can be persuaded that they are relevant; the case at hand indicates that litigation can be much more profitable than drilling real prospects. The original title of the paper by Messrs. Rose and Jones was telling: "Making Money by Winning Environmental Lawsuits."[2] That title was prophetic, because the plaintiffs made a great deal of money, given that the governor of Michigan during the recent appeal action negotiated a settlement totalling about $95 million with both the leaseholders (about $60 million) as well as the mineral rights owners ($34.35 million).

Their return on the investment is quite attractive. According to Rose and Jones, total legal and consulting costs accumulated to some $3.2 million. Such a rate of return -- 3500 percent over eight years, or a compound ROI of at least 50% p.a. -- could rarely be achieved in the oil patch. Moreover, the front-end risk is small compared with the exploration and development capital which otherwise would have been put at risk if plaintiffs had elected to drill rather than litigate. "Lawyering for oil" in a courtroom appears to be distinctly more profitable than most known real-life exploration ventures, although the risk profile defies estimation -- one would be hard pressed to define a risk profile for this alternative, since it depends so much upon the skill of the attorneys and their witnesses as well as upon the indulgence of a court.

The case study is important for professional engineers, oil economists, and lawyers in the related practice. First, it illustrates the pitfalls of complex technical evidence where the court is ill-equipped to assess accuracy or error. Second, it is another example of how highly profitable junk science can be. Third, it is a reminder of the fact that the judicial process, too, like drilling for oil, is a stochastic process, except that the underlying probability distribution is unknown and unknowable. All that is clear is the fact that the procedure is not reliable, but also that the process admits of very profitable exploitation.

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19. Rose and Jones, p. 498.
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23. We note again that the authors, even when using the 18% discount rate, did not risk the property as would be done when discounting the cash flow projected from undeveloped, undiscovered resources.

TABLE 1 - SUMMARY OF CORRECTIONS: FAIR MARKET VALUE ANALYSIS
($ mn except otherwise noted)

	ORIGINAL VALUE	CORRECTED VALUE	EXAGGERATION MULTIPLE
INDIVIDUAL EFFECTS (2)			
1. Probability Figure	99.6%	18.5%	5.4 times
2. Formula Choice	59.4	54.8	1.1 times
3. Discount Rate	59.4	46.2	1.3 times
4. Size Distribution(*)	34.2	21.6	1.6 times
5. Risk Coefficient(*)	54.8	46.4	1.3 times
6. Market Value Factor	59.4	20-22	2.6-3.0 times
NET TOTAL IMPACT	59.4	7.6-13.1	4.5-7.8 times

(*) The asterisked corrections were calculated in relation to a partially corrected value, not with respect to Rose's original figure. The exaggeration multiple is understated.

(2) The effects of individual errors are not additive because of non-linearities. The total impact of all errors, corrected simultaneously, is the figure in the last row.

TABLE 2 - COMPARISON OF ANALOG AREAS

	Average Distance From Protected Area (Miles)	Estimated Ultimate Recovery Per Reef (BOE)	Reef Density Reef-Fields/Mi^2
Sector 3	28	1,647,000	1.41
Hamlin-Victory	6	718,000	0.95
DISTORTION		2.3 times	1.5 times

Figure 1

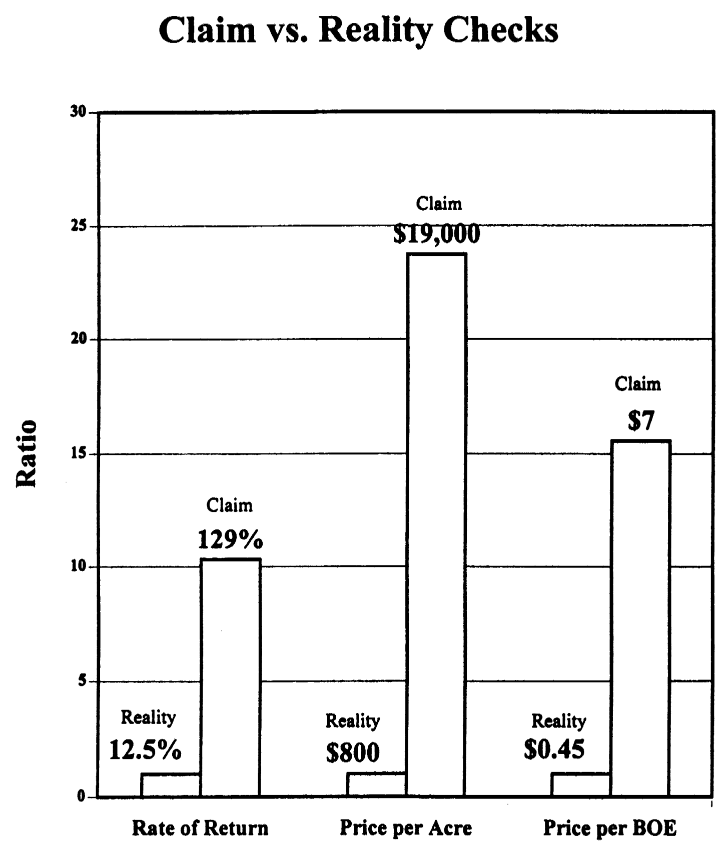
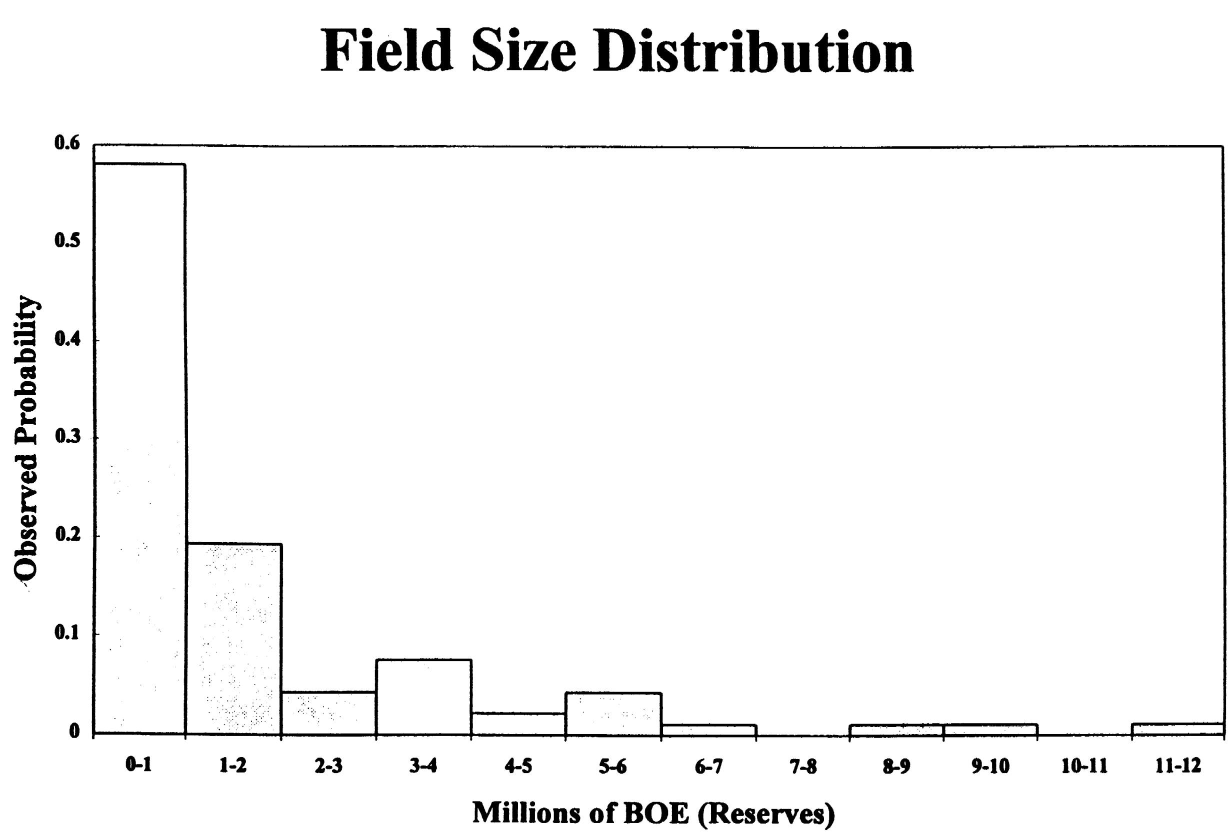


Figure 2



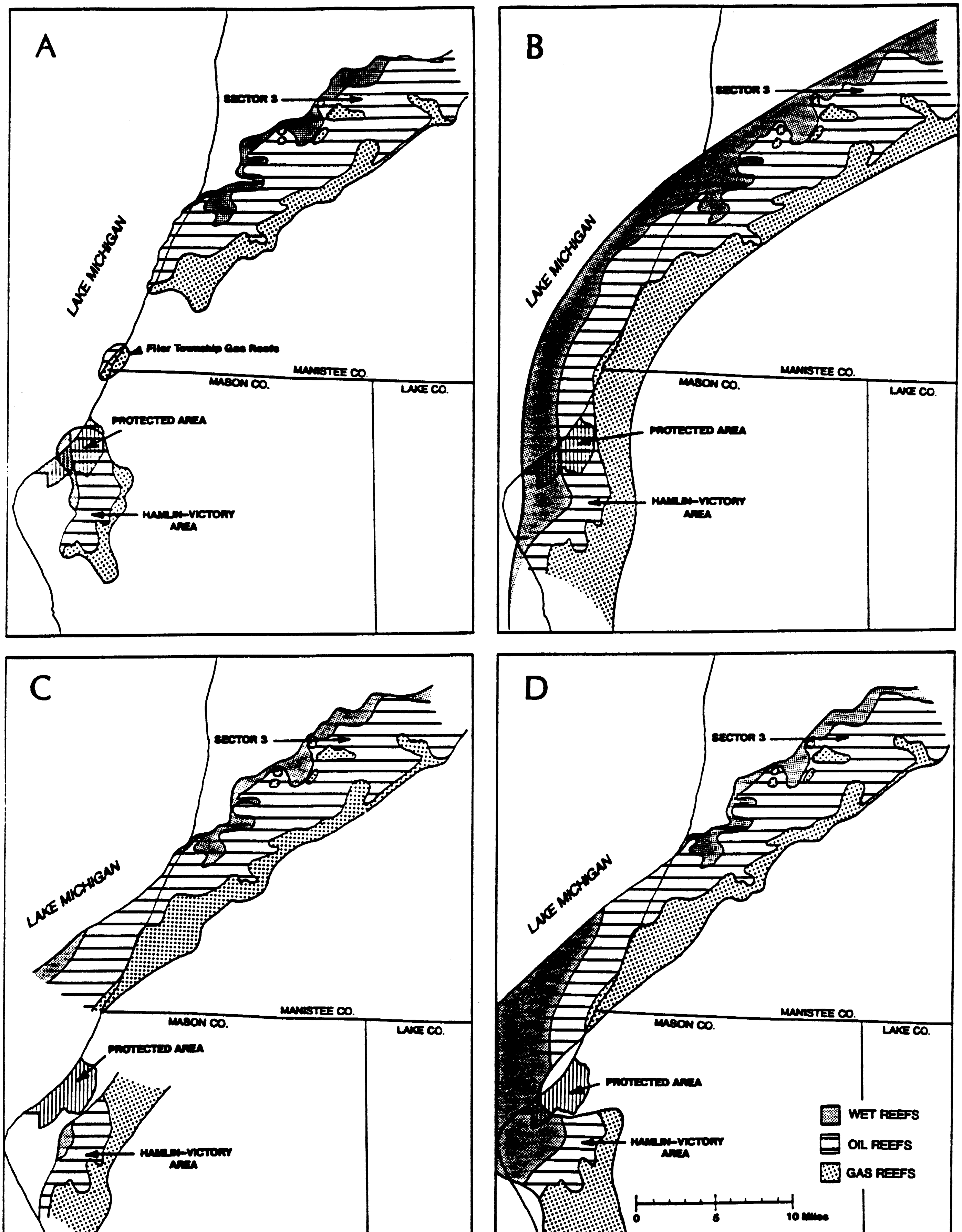


FIGURE 3 -Niagaran Reef Trend Interpretations.

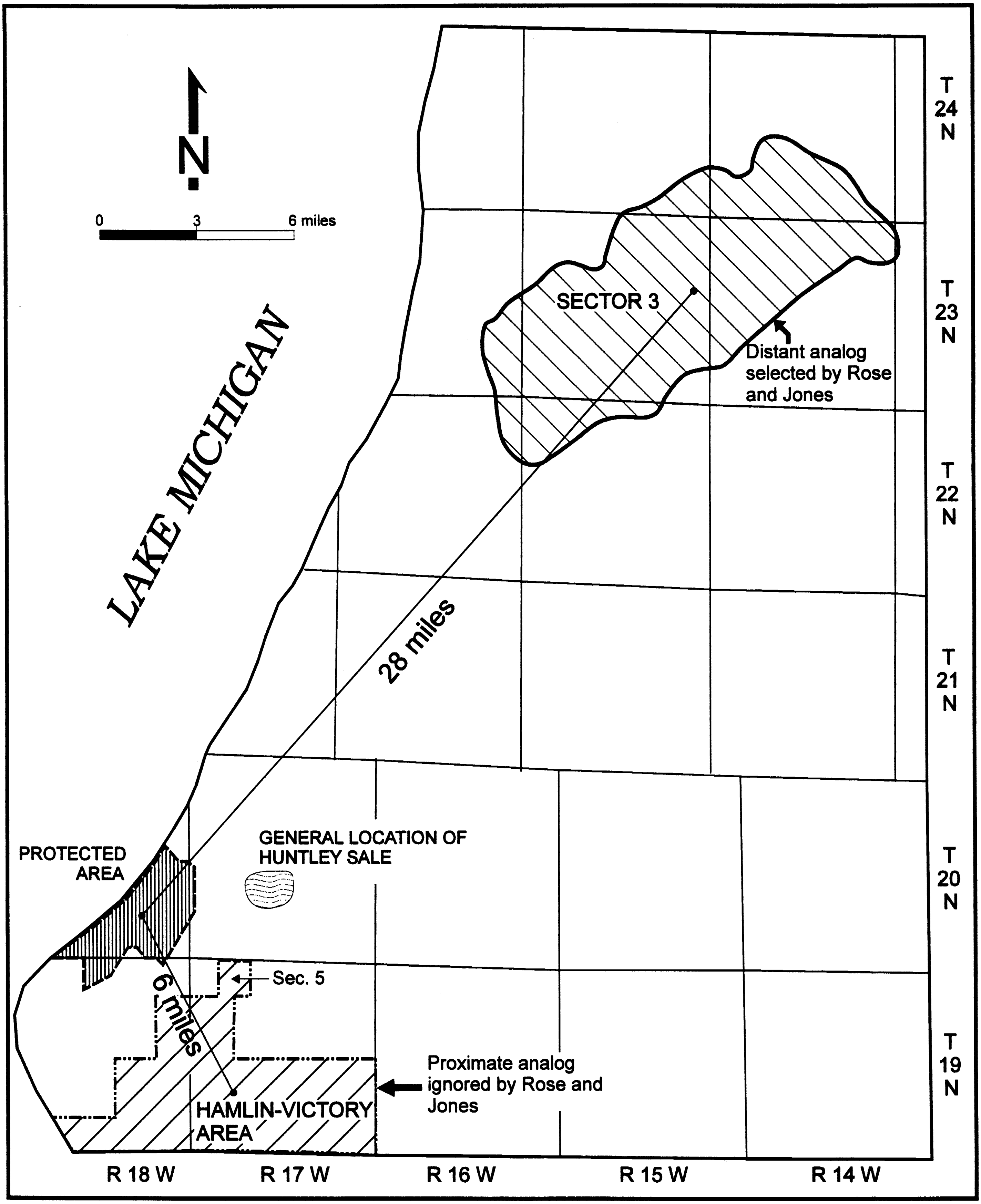


FIGURE 4 - Location of Protected Area relative to analog producing areas and other sales.

FIGURE 5

OIL PROPERTY VALUE ALLOCATIONS

(TYPICAL)

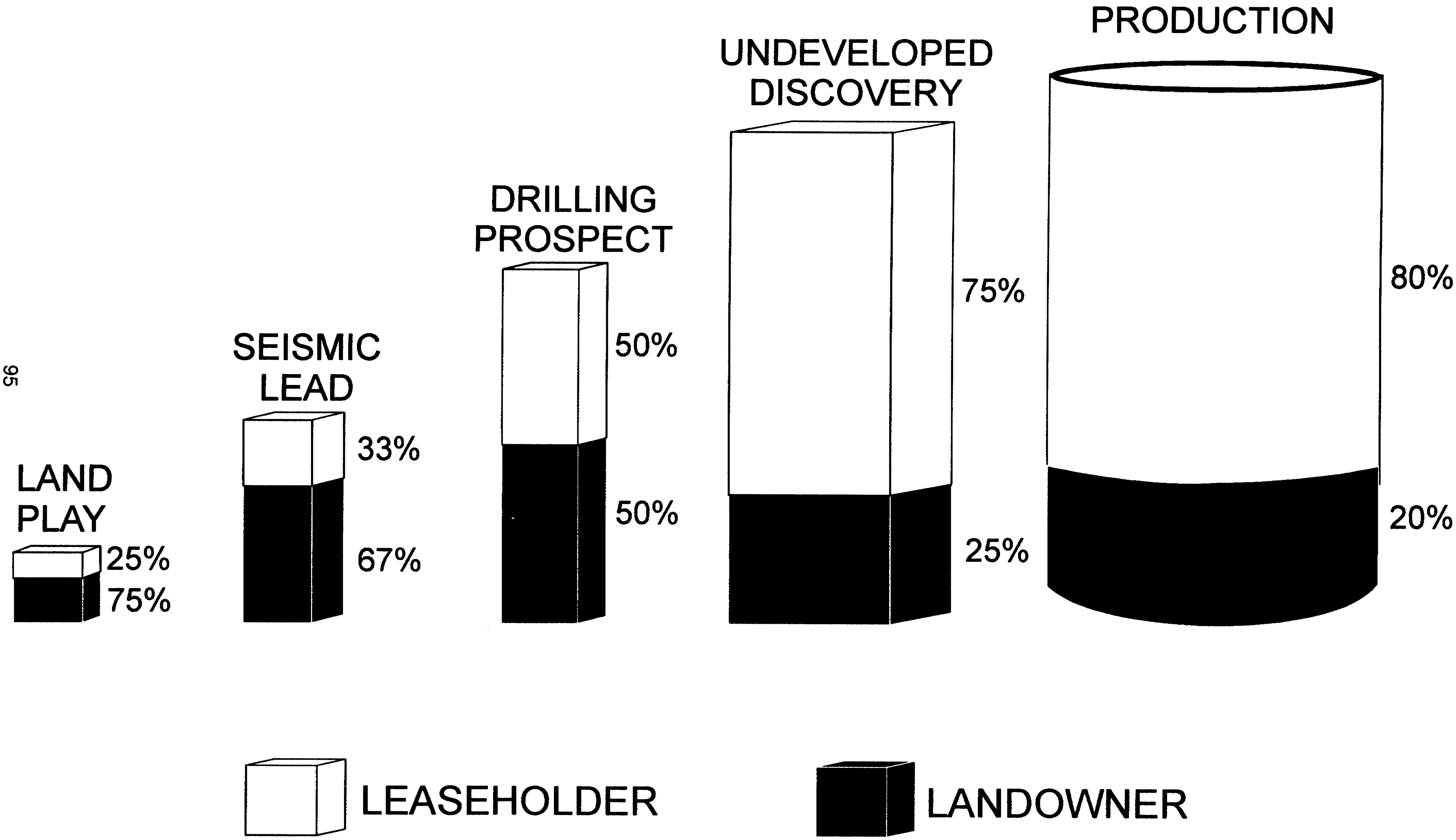


FIGURE 6

PERCENTAGE OF LEASES
VS
BONUS PAID IN $/ACRE