# Appendix 1 - REASONABLE FORESEEABLE DEVELOPMENT SCENARIO

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**PART I-The General Setting in Southeastern Ohio**

The exploration for commercial accumulations of oil and gas revolves around attempting to locate porous and/or fractured, permeable “reservoir rocks” which contain oil and gas that has migrated into the reservoir rocks from “source rocks”, and has been prevented from migrating further to shallower depths within the reservoir rocks by the presence of impermeable formations above the reservoir rocks, and the presence of a “trapping mechanism” along the oil and gas’ “migration path”. Traps block the movement of oil and gas migrating through porous and permeable rock.

Oil and gas production within southeastern Ohio is from sediments deposited in the Appalachian Basin. Commercial oil and gas production within southeastern Ohio dates back to the earliest period of exploration and development within the country. The second well drilled specifically for oil and gas was drilled in 1860 in the Marietta area, shortly after the Drake well was completed in Pennsylvania. To date, only a few formations have yielded significant quantities of oil and gas in the area; specifically the Berea, the Clinton-Medina and the Ohio Shale. However, additional formations currently being explored within the State are likely to generate some interest within the area of the Wayne National Forest within the next twenty years; specifically the Trenton-Black River, the Glenwood, the Beekmantown, Rose Run, and the Mt. Simon.

In general, oil and gas fields which have discovered within the southeastern Ohio to date can be grouped into three major field types based upon the type of trap present within these fields. It is anticipated that exploration for oil and gas within the area being considered in this document will continue to centered upon attempts to find undiscovered oil and gas fields which fit into these general categories. A brief description of each field type follows:

## Shallow, Stratigraphic and Mildly-Deformed & Structurally Related Fields

Bedrock in the National Forest is composed of shale, siltstone, sandstone, conglomerate, and limestone of the Mississippian, Pennsylvanian, and Permian systems. Outcropping rock units in the vicinity of Wayne National Forest occur as northeast-southwest striking bands. The oldest band occurs to the northwest, and the youngest to the southeast. This pattern is formed because rocks in the Wayne dip to the southeast. Dip is gentle, averaging less than five degrees.

The southeasterly dip of rock formations in the Wayne is due to the correspondence of the Appalachian Plateau with the Appalachian Basin. Above the unconformity lying at the base of the Silurian-aged Clinton sandstone, dip represents the only known major structural feature within the Athens and Ironton Units and changes in permeability and porosity due to changes in lithology account for the numerous stratigraphic traps present within the area. Within the Marietta Unit, mild deformation of these relatively shallow sediments is evidenced by the presence of the north-south trending Burning Springs Anticline which has many smaller features on its flanks. Though some of the oil and gas fields present within the Marietta Unit are clearly structurally related, their extent and productivity are still heavily influenced by changes in lithology and they are considered to be structural/stratigraphic fields. Though oil and gas production has been established from numerous formations within the area, three formations are the primary exploration targets within the area; the Berea Sandstone, the Ohio Shale, and the Clinton-Medina sandstone. A discussion of each of these formations follows:

### The Berea Sandstone

"The Lower Mississippian Berea sandstone has two major facies, which were deposited as part of a wedge of clastic sediments. A lower "channeled" sandstone facies cuts into underlying Bedford shales and locally may reach more than 200 ft. in thickness. An upper "blanket" sandstone facies is thinner (20 to 40

ft.), but more widespread, covering nearly all of eastern Ohio. Classically the Berea has been interpreted as a fluvial-deltaic deposit which prograded from north to south across central Ohio (Pepper, de Witt, and Demarest, 1954). More recent studies (Lewis, 1967, 1976) have interpreted the Berea as a marine-deltaic deposit which built westward from an eastern area.

"The Berea generally ranges from fine to coarse grained sandstone but may also be quite silty in places. Thickness ranges widely, from 5 ft. to 235 ft., depending upon the presence or absence of the thick, massive lower units. Porosities calculated from logs commonly range from 4% to 14%. Permeability of the formation ranges from 0.01 millidarcies to .22 millidarcies. [Author's Note: The upper limit for this parameter is actually around 20 md.]

"On January 8, 1982, an application for tight sand classification was presented to the Federal Energy Regulatory Commission (FERC) for that area of southeastern Ohio underlain by the so-called "Second Berea" sandstone. See Figure 3c. The "Second Berea" is about 95 miles long and 3-15 miles wide. Thickness of the sand averages about 20 ft. It has been interpreted as a barrier bar which flanked the eastern margin of the "Bedford delta", which extended through central Ohio in a north-south direction." (Pepper, de Witt, and Demarest, 1954)." (Quoted from Gray, 1982).

## The Ohio Shale

The Devonian aged Ohio Shale is present throughout eastern Ohio, and is subdivided in outcrop into three members, which in ascending order are the Huron, the Chagrin, and the Cleveland. The Cleveland Shale is absent in eastern Ohio. The Bedford Shale, a Mississippian aged unit, is lithologically similar to the Chagrin Member of the Ohio Shale in the east, and cannot be easily differentiated in the subsurface. Consequently, many drillers do not report the top of the Bedford, but rather report it as the top of the Ohio Shale, or as the base of

the Berea. A simple stratigraphic column illustrating these formations is given as Figure 3d to this report.

Production from the Chagrin Member of the Ohio Shale largely consists of gas and oil from fractured sandstone and siltstone layers interbedded within the dark shales. Production from the underlying Huron Member is from fractured shales. The shales are believed to be the source beds for the Ohio Shale production, and for the Huron Member they are the reservoir beds as well. Exploration for oil and gas in the Huron Member largely centers on determining the range and variability of radioactive zones within the shales. Current theory holds that the organic matter deposited in the sediments forming the shales, caused preferential precipitation of uranium from sea water. Hence, the more organic-rich a zone was, the greater its radioactivity should be, and the greater its gas production.

Production data for the Ohio Shale is difficult to obtain, but two generalizations are found throughout the literature dealing with it; wells have low initial production, and produce at a fairly steady rate for an extensive period of time. An averaged production decline curve for 14 Huron Member wells in Lawrence County, Ohio is shown in Figure 4. Based upon Figure 4, a well with an initial production rate of 13 MMCF per year, will experience a steady production decline, but still be producing 6.5 MMCF per year after 45 years of production.

## The "Clinton"

"The term "Clinton" is a drillers name referring to a sequence of lower Silurian clastic rocks. The term is a misnomer, and these rocks actually correlate with the Medina Group of New York and Pennsylvania. However, the term Clinton sandstone has been used in Ohio for nearly 100 years, and hence it is not likely to be corrected.

"The Clinton interval consists of a series of interbedded sandstone, siltstones, and shales which were deposited under shallow marine and deltaic conditions at the distal portion of an early Silurian clastic wedge (Knight, 1969; Overby and Henninger, 1971). To the east the Clinton grades into the nearshore marine and continental facies of the Tuscarora sandstone. To the west the deltaic rocks pinch out and are replaced by marine shales and carbonates. The westward change marks the western limit of Clinton oil and gas fields in central Ohio (Fig. 8). (Figure 5 of this section).

"The Clinton section is generally found in eastern Ohio at depths ranging from 3,000 ft. to 5,000 ft. [Authors's Note: The Clinton is approximately 6,000' to 7,000' deep in the Marietta Unit. The source of the 5,000' depth given by Gray is unknown.] Thickness of the section increases from about 100 ft. in central Ohio to 200 ft. in eastern Ohio and is characterized by considerable lateral variation in lithology. In general, the Clinton consists of multistacked, coalescing, lenticular sandstone bodies. Individual lenses may range from a few hundred feet wide to more than 1/2 mile wide. Net sandstone thickness ranges from 0 ft. to 90 ft.; porosity ranges from 6% to 12% in most productive lenses; permeability generally ranges from 0.1 millidarcy to 1 millidarcy. However, all of these parameters may change considerably in distances as short as those between offset wells.

"Initial development of Clinton fields was along the western sandstone boundary where producing zones were shallowest and porosities were highest. Since the early 1900s, the Clinton drilling activity has moved progressively eastward and deeper in this easterly dipping bed, searching for porous zones. The search has been aided greatly by the advent of hydro fracture stimulation techniques, which have extended the areas of producing potential in many places. The approximate eastern boundary of Clinton drilling is shown in Figure 8. (Figure 5 in this report). The few wells that have been drilled east of this line have been uneconomical. Porosity of the sandstone in some of these wells has been reported to be about

3%." (Quoted from Gray, 1982). The eastern boundary of economic Clinton production is subject to constant revision as more wells are drilled.

Secondary Productive Zones

As stated above, oil and gas production has been found in numerous formations above the base of the Clinton sandstone. Though they are usually less productive, these zones have played a major role in the exploration plans of numerous operators in the area, and will continue to be of exploration significance into the indefinite future.

The vast majority of secondary zones are found in Pennsylvanian and Mississippian aged rocks. The actual number of productive zones present in this interval is unknown, however, a reliable source operating within the Wayne National Forest believes there are currently twelve known productive zones above the Lower Mississippian aged Berea sandstone within the Marietta Unit.

"Stout and others (1935, p. 898-903) listed 19 Pennsylvanian sands that have produced oil and gas in the county. The exact number of commercially producing sands that are assigned to the Pennsylvanian system in Washington County differs, however, from author to author. Drillers in this area have applied as many as 22 names to shallow "pay" sand; others have named as few as 7 producing zones. Some of this confusion arises from differences in definition of commercial sands. However, the principal problem arises from the difficulty in making reliable correlations of these sands." (Collins and Smith, 1977).

Prior to 1974, information on the Pennsylvanian-Mississippian section in s.e. Ohio was extremely limited, and the only reliable statement about the section was that it was considered to have been deposited in a deltaic environment, and consisted of lenticular bodies without lateral continuity. Operators drilling in this section were plagued with data from wells without accurate location descriptions, a multitude of names for the same productive zone, and vague descriptions of

the formations encountered in the well. A period of intense drilling activity between 1974 and 1985, resulted in the generation of numerous reliable well logs and considerable sample data from which a broader understanding of this section has emerged, particularly within the Marietta Unit. Unfortunately, much of this information and understanding remains with local operators and has yet to become part of the public domain.

**Rose Run Unconformity Surface Fields**

The Rose Run Sandstone is located stratigraphically slightly below the Cambro-Ordovician Knox unconformity, and has become a primary exploration target within eastern Ohio. Where it is present, it consists of tightly cemented, clean sandstones with interbedded dolomites. Exploration for the Rose Run currently is centered around finding erosional remnants, “hills of sand”, of the formation which are present below the Knox unconformity. These remnants are located along a broad band running northeast-southwest in eastern Ohio, and are located by running seismic. Once a suitably sized feature is seismically-delineated, an exploratory well is drilled to determine if the feature has entrapped hydrocarbons. When productive, the features usually contain gas, and additional wells are drilled if it is deemed warranted.. Though little data about the size of Rose Run fields is available, the size range and distribution of Rose Run remnants is probably fractal and it is anticipated that with additional drilling the fractal pattern will eventually be discernable.

Successful completion of a Rose Run well can be technically difficult, and numerous Rose Run wells have reportedly been abandoned solely due to engineering failures while attempting to complete the wells. Based upon available data, the band of erosional Rose Run remnants lies west of the lands being evaluated for this lease sale and consequently it is unlikely that exploration for such targets is likely to occur if these lands are leased. Conversely, exploration for such targets is not likely to be hindered if these lands are not leased.

**Deep, Structurally Related Fields**

Exploration below the base of the unconformity lying at the base of the Clinton sandstone largely centers around structurally- related features which have been delineated by seismic. Prospective formations below this unconformity currently consist of the Trenton-Black River Dolomite, the Glenwood Sandstone, the Beekmantown Dolomite, Rose Run Sandstone , and the Mt. Simon Sandstone

Sporadic drilling for these formations within the area of the Wayne National Forest has occurred, but the results to date have been discouraging. It is possible, but unlikely, that exploration for these targets will be fostered or hindered by a leasing decision regarding the lands being evaluated. Exploration for such targets would be preceded by acquisition of seismic data, and the decision to acquire seismic data would largely hinge upon the results of drilling on adjoining private lands in the area being evaluated.

**PART II-Prognostications**

Drilling activity, Proposed Lease Sale

Estimates of the number of wells which can be reasonably expected to be drilled on, or adjoining, the lands being considered in this evaluation if they are made available for leasing are given in this section. For ease of analysis, the estimates are given on a Unit (Marietta, Athens, Ironton) basis.

While the type of trap these wells are likely to be drilled for can be anticipated with a fairly high degree of certainty, the exact number and location of specific wells that a lessee would like to drill is, for the most part, subject to considerably less certainty. Though estimates made by individuals will vary, estimates made by large numbers of people will probably fall within a very narrow bell curve. All estimates given below were made as the result of geologic evaluations of data

available to Dave Lachance of the Bureau of Land Management's Milwaukee Field Office Staff.

## ATHENS UNIT

Exploration and development in the Athens Unit area started in the Corning area during the early 1890's, and has expanded throughout the Athens Unit over time.

Two principal exploration targets are present throughout the western area of the Athens Unit, the Clinton-Medina zones, and Berea sandstones. Of the two, the Clinton-Medina zone is clearly the dominant producer, although production within the area was first established in the shallower Berea. Traces of oil and gas are common in other formations above the Clinton, but to date no significant production has been established from these zones in this area. Drilling is rare below the Clinton, and as such it is difficult to project the probability of exploration below this formation. However, based upon current market conditions, and exploration activity in the area, it is likely that exploration below the Clinton will be fairly limited for the foreseeable future, until market conditions change dramatically.

The eastern area of the Athens Unit is characterized by production from the Clinton and the Berea/Second Berea sandstones. Of the two, the Berea/Second Berea are clearly the historically dominant producers. Minor production has been established in the Pennsylvanian aged Cow Run, Salt, Brill and Maxton sandstones, and Mississippian aged Big Injun sandstone. Production below the Second Berea is limited to the Clinton, which has experienced only limited exploration, due to reservoir characteristics, greater depth, and the high success rate of wells drilled in the Berea. However, with a slight increase in gas prices, the Clinton has the potential to become a major target in this area due to improvements in drilling and well stimulation technology.

The potential for exploration below the Clinton has been largely ignored due to the high success rate for wells drilled in the Berea and Second Berea. Wells targeted for the Mt. Simon sandstone are currently being drilled within the vicinity of the lands being evaluated, and consequently further deep drilling can be expected in this area. However, the lack of significant deep production in the immediate area of these lands make it unlikely that more than one deep test (below the Clinton) associated with the lands being evaluated would be conducted in the foreseeable future.

Based upon the above information, it is anticipated that exploration associated with the lands being evaluated will be confined to exploration for the Clinton, and deeper formations. Any wells drilled deeper than the Clinton are likely to be dry, and production from the Clinton is likely to be low-volume gas.

An estimate of the number of wells which are likely to be drilled on, or associated with the lands being evaluated are given below:

| Target | Minimum | Maximum | Most Likely |
|---|---|---|---|
| **Clinton Sandstone Number of Wells** | 0 | 1 | 1 |
| **Below the Clinton Number of Wells** | 0 | 1 | 0 |
| **Total # of Wells, Athens Unit** | 0 | 2 | 1 |

## IRONTON UNIT

Two principal potentially productive targets are present throughout the Ironton Unit; the Ohio Shale, and the Clinton-Medina. Secondary targets present throughout the Ironton Unit consist of gas production from the Glenwood, the Beekmantown, the Rose Run, and the Mt. Simon formations. Minor production from the Berea, and other potentially productive zones could be established on

an opportunistic basis, i.e., development would occur from a zone which was not specifically drilled for by a well drilling for a primary or secondary target.

Production from the Ohio Shale in the area of the Ironton Unit dates from 1913, leading to a series of gas discoveries in the late twenties and early thirties. Drilling for the Shale continues to the present, although in a somewhat limited fashion. The Ohio Shale is present throughout the unit, and consequently its resource potential is quite high. However, interest in the Ohio Shale in this area of the state is low, due to the fact that reservoir conditions in the Shale become less favorable for production moving away from the state border.

Production from the Clinton-Medina in the area of the Ironton Unit dates from 1925, with a string of isolated gas discoveries leading to the present. The Clinton is present throughout the Ironton Unit, however, reservoir conditions in the Clinton are poor in this part of the state due to relatively low permeability and porosity within the sands.

Opportunistic oil and gas production has been found in isolated areas of the Ironton unit. As stated earlier, opportunistic production consists of production from a zone which was not the intended target of the well drilled. In the Ironton Unit, this has usually resulted in drilling from at most two to three wells to exploit the shallow zone. A notable exception to this pattern is the recent success Mitchell Energy has had in Lawrence Co., Mason Township. Briefly, Mitchell discovered production in the 1st Cow Run, a Pennsylvanian aged sand, while drilling a Clinton prospect. In this case production was established in both the Clinton and the 1st Cow Run. Total field development has come to a near conclusion with a total of approximately 40 wells drilled on a spacing ranging from five to twenty acres. The probability of making a similar discovery is difficult to accurately assess, however based upon available data there is a 5% chance that a development play of this magnitude would be discovered somewhere within the Ironton Unit over the foreseeable future.

Noncommercial gas production has been found in the Beekmantown within the Ironton Unit's boundaries. The potential for deeper production has been recognized for years, but largely ignored due to the high success rate for wells drilled in shallower zones such as the Clinton-Medina. As with the lands in the Athens Unit, the lack of significant deep production in the immediate area of the Ironton Unit, make it unlikely that deep tests will be drilled that will be associated with the lands being evaluated for this sale.

Based upon the above information, it is anticipated that exploration associated with the lands being evaluated will be confined to exploration for the Clinton, and production from the Clinton is likely to be low-volume gas.

An estimate of the number of wells which are likely to be drilled on, or associated with the lands being evaluated are given below:

| Target | Minimum | Maximum | Most Likely |
|---|---|---|---|
| **Clinton Sandstone # of Wells** | 0 | 3 | 1 |
| **Total # of Wells-Ironton District** | 0 | 3 | 1 |

## MARIETTA UNIT

Exploration and development in the Marietta Unit dates back to the infancy of the U.S. oil and gas industry. The second well drilled specifically for oil and gas was drilled in 1860 in the Marietta area, shortly after the Drake well was completed in Pennsylvania. The Drake well is considered to mark the birth of the oil and gas industry in this country. Drilling in the Marietta area was spurred by the known occurrence of oil and gas in wells drilled for brine as early as 1819.

Exploration within the Marietta Unit is dominated by the Ohio Shale, and a variety of shallow oil and gas targets present throughout the stratigraphic column above the Ohio Shale.

The exact number of productive intervals lying above the Ohio Shale is unknown, but the list includes the easily recognized Berea and Second Berea sandstones, and commonly reported Big Injun, Cow Run, Maxton, Salt and Squaw sands. The complex stratigraphy in the area, and relatively few reliable marker beds has made correlation of individual beds and zones a matter of considerable difficulty and subjective judgement. Many operators label a producing zone with the name of the stratigraphically closest, commonly known producer. This has hindered efficient development of the area, but is such an intensely entrenched practice, that it is likely to continue indefinitely.

Drilling for gas in the Ohio Shale is spurred by its steady production potential and a heavy demand for gas in the heavily industrialized and populated east. Activity associated with the Ohio Shale is currently at a relatively low pace due to depressed market conditions.

Drilling below the Ohio Shale is relatively rare, although limited production has been found in the Clinton and Oriskany sandstones. It is important to note that the Clinton sandstone is one of the most commonly drilled formations in Ohio and it is present beneath the Marietta Unit, however it is typically regarded as uneconomic to drill below 6,000 feet. The Clinton passes below 6,000 feet just to the west of the Marietta, and under current economic conditions wells drilled specifically for the Clinton in this area are not very likely to occur.

As with the Athens and Ironton Units, the possibility of drilling wells below the Clinton commercial production below the Clinton has largely ignored due to the high success rate for wells drilled in the shallower zones, and the lack of significant, successful deep wells in the area. Current market conditions and the lack of existing deeper wells make it unlikely that deep tests will be conducted which will be associated with lands being evaluated for this sale for the foreseeable future.

Based upon the above information, it is anticipated that exploration associated with the lands being evaluated will be confined to exploration for the Berea and the Ohio Shale. Production from the Berea is expected to be oil, whereas production from the Ohio Shale is expected to be low-volume gas.

An estimate of the number of wells which are likely to be drilled on, or associated with the lands being evaluated are given below:

| Target | Minimum | Maximum | Most Likely |
|---|---|---|---|
| **Brea Sandstone # of Wells** | 0 | 3 | 1 |
| **Ohio Shale # of Wells** | 0 | 3 | 1 |
| **Total** | 0 | 6 | 2 |

**Summary**

Number of wells Which Can Be Expected To Be Drilled If These Lands Are Leased.

| Type | Minimum | Maximum | Most Likely |
|---|---|---|---|
| Brea | 0 | 3 | 1 |
| Ohio Shale | 0 | 3 | 1 |
| Clinton | 0 | 4 | 2 |
| Below the Clinton | 0 | 1 | 0 |
| **Total** | **0** | **11** | **4** |

Bonus Bid Estimates, Proposed lease Sale

Historically, the oil and gas industry has always been touted by the various business schools as being the type industry that makes decisions under conditions of uncertainty, and there are several standard ways of estimating potential income.

The min/max/ml figures I've provided are used in a method called the Monte Carlo method, and its the one the OCS uses to make economic estimates. Consequently, I'm most familiar with that one. With the Monte Carlo method, every variable that is not known with precision is given estimated values which range from a minimum to a maximum value, and a most likely value is then assigned which fits somewhere on range. Then, using a random number generator, you estimate the cash flow numerous times to get a bell-curve of possible economic outcomes.

For one estimate, the random number generator may say you've encountered a reservoir with 30% porosity, 25 md permeability, but the reservoir has no oil or gas in it. The next estimate may say you've encountered a reservoir with the same porosity and permeability, but there is gas in it. These estimates are run numerous times and the bell curve comes out of it accordingly.

**Minimum Bid:** For bonus bid, we know the minimum is $2 per acre, but despite everything we do, it's possible that not a single tract would get bid on. Therefore the minimum bonus bid income would be $0.00.

**Maximum Bid:** Theoretically, every tract we offer could bring in millions of dollars per acre, but we know that is not realistic. This is obviously a somewhat subjective assessment, but as stated before the oil and gas industry operates under high uncertainty, and consequently subjective estimates are inevitable. However, lands within the Wayne National Forest have not attracted high bids due to the relatively low volumes of oil and gas that can be expected from wells drilled on these lands. Bids tend to be submitted by operators who have assembled a “lease position” in the area, and are merely expanding their holdings to drill additional wells. Consequently, bids tend to be low and are usually the minimum bid; $2 per acre.

Though most of the lands being offered consists of “goat-pasture” and will not receive a bid, a possibility exists that all lands offered in the sale will receive a

minimum bid. Therefore, a maximum expected bid can be obtained by multiplying the total acreage being evaluated by $2 per acre and the maximum bid for these lands would be as follows:

| Unit | High Bid Per Acre | Acres Being Evaluated | Total High Bid |
|---|---|---|---|
| Athens | $2.00 | 286.84 | $573.68 |
| Ironton | $2.00 | 2,320.32 | $4,640.64 |
| Marietta | $2.00 | 2,001.83 | $4,003.66 |
| **Maximum Total High Bid** | **-** | **-** | **$9,217.98** |

**Most Likely Bid:** Because of its very nature the "most likely" value of anything is the most difficult to estimate.

Theoretically, all of the lands being offered have the potential for at least one underlying exploratory target ranging from the Berea to the Mt. Simon but, in reality, targets which are purely hypothetical in nature rarely attract bids and it is unlikely that all the lands being offered have a “valuable” exploration target.

One way to estimate a “most likely” value for bids is to estimate the total acreage needed to drill the number of wells which are believed to be most likely to be drilled. Berea and Ohio Shale wells are drilled on a 20 acre spacing, Clinton wells are drilled on a 40 acre spacing, and deeper wells are likely to effectively drain 80 to 160 acres.

In the previous section, it was estimated that “most likely” there would be two Berea/Ohio Shale wells, two Clinton wells, and no deep wells. Thus, theoretically, only 120 acres would have to be leased to support the entire drilling projected program; (2 x 20) + (2 x 40) = 120. However, in reality any Operator who wishes to drill these wells would have to bid on all the lands offered in a parcel to obtain any of the lands they wish to drill on, or be associated with, the five expected wells.

Assuming that, with the exception of the lands in Lawrence County, Symmes Township, one parcel is offered for each township with lands being evaluated for the sale, the average parcel size for the lands exclusive of Symmes Township would be 227.07 acres, and there are 14 such townships with lands being offered.

Assuming the lands being offered in Symmes Township are broken into parcels of approximately the same size as the rest of the parcels being offered, the lands in Symmes Township would have a little over 6 parcels.

Thus, the lands being offered in the proposed sale could be offered in approximately 20 parcels with an average size of 227 acres.

Assuming, the four wells which are most likely to be drilled as a result of the proposed sale are randomly spread out over the entire area and only one parcel is required to be leased to drill each well gives an estimated most likely value of 908 acres for the total acreage that is likely to be leased (4 x 227 = 908). Assuming these lands receive a minimum bid of $2 per acre gives an estimated most likely bid of $1,816 for the entire sale.

A summary of the total high bid anticipated for the sale is as follows:

| | **Minimum** | **Maximum** | **Most Likely** |
|---|---|---|---|
| **Total Bid** | $0 | $29,217.98 | $1,816 |

Royalty Estimates, Proposed lease Sale

Estimates to determine future royalties usually hinge around trying to determine the likelihood of successfully drilling exploratory or development wells, and determining their various reservoir characteristics for formations that are believed likely to contain oil and gas deposits.

Many of the reservoir characteristic estimates can be determined by using the Monte Carlo method I mentioned earlier, or some other modeling method. However, it is not unusual to make a "best guess" as to what the reservoir characteristics are, and use them to determine the amount of oil and gas which is likely to be produced.

The production estimates are then used to calculate revenues based upon average projected prices for oil and gas over the expected lifetime of the wells that are likely to be drilled. Needless to say, reliably projecting oil and gas prices for a specific point in the future is virtually impossible, but as with reservoir characteristics they can be modeled with min/max/ml estimates to come up with these figures. However, it's also possible to make estimates using average oil and gas prices which have occurred over a long time period; assuming that despite price fluctuations, they will average out over the projected time period.

## THE ATHENS UNIT

The lands being evaluated within the Athens Unit have potential for production from the Clinton sandstone, and formations below the Clinton; “deep” formations such as the Beekmantown dolomite or the Trenton-Black River limestone.

**Estimated Royalties, Clinton sandstone**

Assuming a successful Clinton well is drilled in this area, the well can be expected to produce approximately 15 MCF per day for a period of about 20 years or 109,500 MCF over a twenty year time period. (15 x 365 x 20) = 109,500.

Using an average gas price. of $2.25 per MCF over the twenty year time period gives a value for the gas produced from each well as $246,375. (2.25 x 109,500 = $246,375).

Using a one eighth royalty rate gives a value of $30,796.88 for the gas produced from each well over the twenty time period. ($246,375 x 1/8 = $30,796.88).

Assuming the well is dry, or no such well is drilled, the U.S. will receive no royalties and hence the minimum royalties for Clinton wells drilled as a result of leasing these lands would be $0.

Assuming the well is guaranteed to be productive, the estimates derived above are accurate, and the U.S. has a 100% interest in the lands affected by the well, the maximum amount of royalties for Clinton wells drilled as a result of leasing these lands would be $30,796.88

An estimated most likely value can be derived by multiplying the maximum royalties by the inverse of the projected well's "dry hole risk"; 100% - Dry Hole Risk.

A dry hole risk is a subjective best guess of the chance of drilling a dry hole. Though numerous methods exist to determine this number, it is inherently uncertain in its uncertainty. However, "risking" the estimated revenues to be derived from drilling a well provides a decision maker with a general idea of the amount of revenues which can be expected if numerous wells are drilled to the same formation in an area with similar characteristics.

For the purposes of this evaluation it is assumed that the hypothetical Clinton well to be drilled in this area has a 50% Dry Hole Risk. Hence, the U.S. has an estimated "most likely" royalty income of $15,398.44 ($30,796.88 x .50) = $15.398.44

Royalty estimates for Clinton production for lands being evaluated in the proposed sale for the Athens Unit are summarized as follows:

| **Clinton Production Athens Unit** | **Minimum** | **Maximum** | **Most Likely** |
|---|---|---|---|
| **Estimated Royalties** | $0 | $30,796.88 | $15,398.44 |

**Estimated Royalties, Deep Formations**

Assuming a successful deep well is drilled in this area, the well can be optimistically expected to produce approximately 1,000 MCF per day for a period of about 15 years or 5,475,000 MCF over a twenty year time period. (15 x 365 x 1,000) = 5,475,000.

Using an average gas price. of $2.25 per MCF over the twenty year time period gives a value for the gas produced from each well as $12,318,750. (2.25 x 5,475,000 = $12,318,750).

Using a one eighth royalty rate gives a value of $1,539,843.75 for the gas produced from each well over the fifteen year time period. ($12,318,750 x 1/8 = $1,539,843.75).

Assuming the well is dry, or no such well is drilled, the U.S. will receive no royalties and hence the minimum royalties for wells drilled below the Clinton as a result of leasing these lands would be $0.

Assuming the well is guaranteed to be productive, the estimates derived above are accurate, and the U.S. has a 100% interest in the lands affected by the well, the maximum amount of royalties for deep wells as a result of leasing these lands would be $1,539,843.75.

Earlier in this analysis, it was concluded that it was “most likely” that no deep wells would be drilled, and hence it is most likely that no royalties would generated from such wells; giving the U.S. a most likely value of $0 for deep production.

Royalty estimates for deep production for lands being evaluated in the proposed sale for the Athens Unit are summarized as follows:

| Deep Production, Athens Unit | Minimum | Maximum | Most Likely |
|---|---|---|---|
| **Estimated Royalties** | $0 | $1,539,843.75 | $0 |

Combining the two estimates gives the following royalty estimates for the lands being offered in the Athens Unit.

| All Formations, Athens Unit | Minimum | Maximum | Most Likely |
|---|---|---|---|
| **Estimated Royalties** | $0 | $1,570,640.63 | $15,398.44 |

## THE IRONTON UNIT

The lands being evaluated within the Ironton Unit have potential for production from the Clinton sandstone.

**Estimated Royalties, Clinton sandstone**

Successful Clinton wells drilled in this area can be expected to each produce approximately 15 MCF per day for a period of about 20 years or 109,500 MCF over a twenty year time period. (15 x 365 x 20) = 109,500.

Using an average gas price of $2.25 per MCF over the twenty year time period gives a value for the gas produced from each successful well as $246,375. (2.25 x 109,500 = $246,375).

Using a one eighth royalty rate gives a value of $30,796.88 for the gas produced from each successful well over the twenty time period. ($246,375 x 1/8 = $30,796.88).

Assuming all the wells are dry, or no such wells are drilled, U.S. will receive no royalties and hence the minimum royalties for Clinton wells drilled as a result of leasing these lands would be $0.

Assuming a maximum of three Clinton wells which are guaranteed to be productive are drilled as a result of leasing these lands, the estimates derived above are accurate, and the U.S. has a 100% interest in the lands affected by the three wells, the maximum amount of royalties for the three Clinton wells drilled as a result of leasing these lands would be $92,390.64 (3 x 30,796.88 = $92,390.64).

Earlier in this analysis, it was concluded that it was “most likely” that only one Clinton well would be drilled in this area. Assuming that the Clinton well has a 50% Dry Hole Risk, the U.S. has an estimated "most likely" royalty income of $15,398.44 ($30,796.88 x .50) = $15,398.44.

Royalty estimates for Clinton production for all lands being evaluated in the proposed sale for the Ironton Unit are summarized as follows:

| All Formations, Ironton Unit | Minimum | Maximum | Most Likely |
|---|---|---|---|
| **Estimated Royalties** | $0 | $92,390.64 | $15,398.44 |

## THE MARIETTA UNIT

The lands being evaluated within the Ironton Unit have potential for production from the Berea Sandstone and the Ohio Shale.

**Estimated Royalties, The Berea Sandstone**

Successful Berea wells drilled in this area can be expected to each produce approximately 8 barrels per day for a period of about 20 years or 58,400 barrels over a twenty year time period (8 x 365 x 20) = 58,400.

Using an average gas price of $22 per barrel over the twenty year time period gives a value for the oil produced from each successful well as $1,284,800. (22 x 58,400 = $1,284,800).

Using a one eighth royalty rate gives a value of $160,600 for the gas produced from each successful well over the twenty time period. ($1,284,800 x 1/8 = $160,600).

Assuming all the wells are dry, or no such wells are drilled, U.S. will receive no royalties and hence the minimum royalties for Berea wells drilled as a result of leasing these lands would be $0.

Assuming a maximum of three productive wells are drilled as a result of leasing these lands, the estimates derived above are accurate, and the U.S. has a 100% interest in the lands affected by the three wells, the maximum amount of royalties for the three Berea wells drilled as a result of leasing these lands would be $481,800 (3 x 160,600 = $481,800).

Earlier in this analysis, it was concluded that it was “most likely” that only one Berea well would be drilled in this area. Assuming that the Berea well has a 10% Dry Hole Risk, the U.S. has an estimated "most likely" royalty income of $144,540 ($160,600 x .90) = $144,540

Royalty estimates for Berea production for all lands being evaluated in the proposed sale for the Marietta Unit are summarized as follows:

| **Berea Production, Marietta Unit** | **Minimum** | **Maximum** | **Most Likely** |
|---|---|---|---|
| **Estimated Royalties** | $0 | $481,000 | $144,540 |

**Estimated Royalties, The Ohio Shale**

Successful Ohio Shale wells drilled in this area can be expected to each produce approximately 20 MCF per day for a period of about 20 years or 146,000 MCF over a twenty year time period (20 x 365 x 20) = 146,000.

Using an average gas price of $2.25 per MCF over the twenty year time period gives a value for the oil produced from each successful well as $328,500 (2.25 x 146,000 = $328,500).

Using a one eighth royalty rate gives a value of $18,250 for the gas produced from each successful well over the twenty time period. ($328,500 x 1/8 = $41,062.50).

Assuming all the wells are dry, or no such wells are drilled, U.S. will receive no royalties and hence the minimum royalties for Berea wells drilled as a result of leasing these lands would be $0.

Assuming a maximum of three productive wells are drilled as a result of leasing these lands, the estimates derived above are accurate, and the U.S. has a 100% interest in the lands affected by the three wells, the maximum amount of royalties for the three Ohio Shale wells drilled as a result of leasing these lands would be $123,187.50 (3 x 41,062.50 = $123,187.50).

Earlier in this analysis, it was concluded that it was “most likely” that only one Ohio Shale well would be drilled in this area. Assuming that the Ohio Shale well has a 10% Dry Hole Risk, the U.S. has an estimated "most likely" royalty income of $36,956.25 ($41,062.50 x .90) = $36,956.25.

Royalty estimates for Ohio Shale production for all lands being evaluated in the proposed sale for the Marietta Unit are summarized as follows:

| Ohio Shale Production, Marietta Unit | Minimum | Maximum | Most Likely |
|---|---|---|---|
| **Estimated Royalties** | $0 | $123,187.50 | $36,956.25 |

Royalty estimates for all lands being offered in the Marietta Unit are as follows:

| Production From All Formations, Marietta Unit | Minimum | Maximum | Most Likely |
|---|---|---|---|
| **Estimated Royalties** | $0 | $604,987.50 | $181,496.25 |

Royalty estimates for all lands being offered in the proposed lease sale are as follows:

| Production From All Formations, Proposed Lease Sale | Minimum | Maximum | Most Likely |
|---|---|---|---|
| **Estimated Royalties** | $0 | $2,268,018.77 | $212,293.13 |

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