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PROPOSED ROUTLEDGE UNIT NO. 1
DISCUSSION OF IMPROVED ECONOMIC LIMIT
UNDER UNITIZED OPERATIONS

It is anticipated that, through battery consolidation in the proposed unit area, the annual overall battery operating cost would be reduced from $121,600, estimated as the cost under current competitive operations, to $52,100 under unitized operations. Overall battery operating costs include all costs associated with handling the fluid while at the battery site and the disposal of produced water. It does not include actual producing well costs or gathering system costs.

The above-indicated annual saving of $69,500 is the economic justification for the battery consolidation program. This saving will be responsible for lowering the economic limit on producing wells. This will then result in an increase in ultimate recovery from the area, in comparison to what may have been recovered on a competitive production basis.

The attached Appendix I presents calculations which indicate that, with unitization and subsequent battery consolidation, the economic limit will be extended to fluid production that is 98% water. It is estimated that the economic limit will be reached at production cutting 95% water under competitive operations.

APPENDIX 1

IMPROVEMENT OF ECONOMIC LIMIT BY UNITIZATION AND BATTERY CONSOLIDATION

A. Comparison of Battery Operating Costs Under Competitive and Unitized Operations

Currently there are 103 oilwells served by 22 batteries and seven salt water disposal facilities. The following indicates the major areas in which substantial savings in operating cost can be realized by a proposed battery consolidation scheme which would result in all the production being handled at four batteries.

(a) Labor and Transportation

The estimated labor and transportation requirements under a unitized operation without consolidation are six men and four vehicles. With consolidation the requirements would decrease to four men and three vehicles.

(b) Treaters

Under consolidated operations eight treaters would be required to handle all Unit production. Currently 27 treaters are in operation. It is estimated that the average annual maintenance and repair cost per treater is $800. This is based on the assumption that each treater will be cleaned annually; the fire tube will be replaced every second year; and major maintenance and plastic lining will be necessary every five years. Most of the treaters in the area are over 10 years old and are in generally poor condition.

(c) Tanks

Fifty-three storage tanks are in use in the proposed Unit area. With

consolidation only 16 tanks would be required. The estimated annual tank maintenance and repair cost per tank is $300 under existing conditions. With consolidation, the estimated cost per tank is $100 per year. The estimated costs are for cleaning, plastic lining and tank and deck replacement. The difference in cost under the two conditions is due to tank replacement being deferred, if not eliminated, under consolidated operation.

(d) Produced Water Disposal Facilities

There are currently seven produced water disposal facilities in the area which would be reduced to two by consolidation. It is estimated that, under existing conditions, the cost of repairs and maintenance of pumps, motors and buildings average $1,000 per facility per year. Due to the larger equipment necessary to handle the larger volumes under consolidated operations, it is estimated that the corresponding average cost per facility is $1,500 per year.

(e) Power

The power requirements (primarily for disposal facilities) would be reduced from 100 HP to 75 HP through consolidation. The corresponding costs are $6,000 and $4,500, respectively.

(f) Battery Maintenance and Repair

The costs incurred in this category include replacement of battery piping, painting, cultivating and general maintenance, and are estimated at $500 per year per battery. The need for piping replacement would be eliminated under a consolidated system, thus the cost per battery would be reduced to $300 per year.

(g) Propane and Labor for Thawing

Historically, batteries producing less than 50 BOPD have used from $600 to $800 worth of propane per year. Batteries producing from 50 to 100 BOPD could require $300 to $500 worth of propane per year. Batteries processing in excess of 100 BOPD may require no propane. Of the 22 batteries in the area, very few are considered to have sufficient gas production to eliminate the need for propane. It is estimated that the average propane and labor for thawing costs are $500 per battery per year. Propane costs would be eliminated under consolidated operation because of the higher volumes of oil and gas being handled at batteries.

A comparison of battery operating costs for competitive and consolidated operations are presented on Table I.

B. Comparison of Competitive Operation and Unit Operation at Economic Limit of Competitive Operation (i.e., 95% Water Cut)

The following assumptions were made in order to compare competitive and consolidated Unit operations at the economic limit for competitive operations:

1. Economic limit under competitive operations will be 4 BOPD/well with a water cut of 95%.
2. Saving in operating cost through consolidated unitized operations is $69,500 annually.
3. Battery operating cost is the same for oil and for water.
4. One half of the wells will have ceased production.

At the economic limit for competitive operations, the annual production would be:

Oil (4 x 54) (365)	=	78,800 bbls.
Water @ 95% cut	=	1,498,800 bbls.
Total Fluid		1,576,800 bbls.

The battery operating cost per barrel of fluid would be 7.7¢.

At this time the Unit would be producing 19 barrels of water with each barrel of oil, thus the battery operating cost per barrel of oil would be:

$$20(7.7) = \$1.54$$

Under Unit operations, with a battery operating cost of $52,100 annually (see Table I), the cost per barrel of fluid would be 3.3¢. The estimated cost per barrel of oil would be:

$$20(3.3) = 66¢$$

At this stage the Unit could justify handling additional water to the extent of 88¢ per barrel of oil (i.e., $1.54 - .66 = .88). At the cost per barrel of fluid, this would permit handling of an additional 27 barrels of water (i.e., 88 ÷ 3.3 = 27).

The additional water that could be handled would result in the water cut increasing to 98% (i.e., (19 + 27) ÷ (19 + 27 + 1) = 97.8%).

This calculation assumes that the incremental water can be handled at the same cost as the rest of the fluid (i.e., 3.3¢ per barrel). It is likely that the incremental water can be handled at a lower unit battery operating cost than the rest of the fluid; however, it is impractical to estimate what this reduced cost might be.

The above calculation suggests that under Unit operation the battery operating cost handling production cutting 98% water would be equivalent to competitive operations handling production cutting 95% water. This suggests a decided lowering of the economic limit through consolidation under a unitized operation.

C. Discussion

It might reasonably be questioned that the annual overall battery operating costs would remain constant at the estimated $121,600 and $52,100 for the competitive and Unit operations, respectively, for the life of the project. Indications are that these costs will both escalate with time but that they will escalate proportionately such that the saving in annual operating cost will increase with time.

The additional cost (other than battery operating costs) for handling the additional volumes of water at a time approaching the economic limit under Unit operation would not be disproportionately higher inasmuch as additional facilities would not be required. The facilities would have been called upon to handle larger volumes of water earlier in the life of the project.

The water cut at the economic limit under competitive operations (i.e., 95%) could be questioned. Based on experience it is a realistic limit; however, it is not a critical factor in establishing the incremental water cut at the economic limit for a unitized operation. As can be seen under section B above, a substantial amount of additional water can be handled under unitized operations after the limit has been reached under competitive operations.

D. Conclusion

Based on experience, an economic limit employing a water cut of 95% is realistic for competitive operations in the area.

It is concluded that a realistic economic limit for unitized operations is one that employs a water cut of 98%. This represents producing in excess of 25 barrels of water per barrel of oil that it would not be economically feasible to produce under competitive operations.

T A B L E I

COMPARISON OF BATTERY OPERATING COSTS
COMPETITIVE AND CONSOLIDATED OPERATIONS

Competitive Operations		Consolidated Operations	
Labor and Transportation			
6 Men	= $42,500/yr.	4	= $29,500/yr.
4 Vehicles	= 7,500	3	= 5,900
Treaters (Clean, Repair)			
27 @ $800/yr.	= 21,600	8 @ $800/yr.	= 6,400
Tanks (Maintenance and Repair)			
53 @ $300/yr.	= 16,000	16 @ $100/yr.	= 1,600
Disposal Plants (Maintenance and Repair)			
7 @ $1,000/yr.	= 7,000	2 @ $1,500/yr.	= 3,000
Power			
100 HP @ $5/HP/M	= 6,000	75 HP @ $5/HP/M	= 4,500
Battery Maintenance and Repair			
22 @ $500/yr.	= 11,000	4 @ $300/yr.	= 1,200
Propane and Labour for Thawing			
20 Btrys @ $500/yr/Btry	= 10,000		
	$121,000		$52,100

Other factors not considered but which would be significantly reduced under Unit operations:

1. Replacement of producing equipment
2. Winter snow removal
3. Lost production resulting from shutdown due to cold weather operation

Discussion of the Unitization and Participation Formula for the Proposed Routledge Unit No. 1

It is anticipated that the ultimate recovery of oil will be increased under unitized operations. The increase will be due to a more efficient operation because of the flexibility permitted by Unit formation.

The unitization of any field or a portion of a field requires incentive for both the working and royalty interest owners. We feel there is sufficient incentive for the formation of the Routledge Unit in the form of increased oil recovery from within the Unit area. Lower capital and producing costs, as compared to costs associated with competitive operations, will result in a reduction in the economic limit permitting the recovery of additional oil and, thus, a substantial increase in income for both the working and royalty interest owners.

A major factor in accomplishing the unitization of a producing area is to determine the most suitable basis for participation. It is important that the dislocation of current income for all owners be kept to a minimum.

Production history has in the past been shown to be an equitable basis for participation. Porosity, permeability and effective oil saturation are all factors which contribute to well performance. Where porosity, permeability and oil saturation are high, they should generally be reflected by a good producing rate and low water cut. These conditions will generally reflect a high effective reserve. Conversely, low producing rates and high water cut would be indicative of a lower effective reserve.

The presently producing wells in the proposed Unit area cover a wide range of productivities. In addition, there is a certain amount of month to month variation in the production from specific wells. Because of this, a stipulated six

month test period was selected by the Working Interest Owners in arriving at a representative current production rate for each well. This has been expressed as a current production factor and is the percentage calculated by dividing the oil production for each tract during the test interval by the total oil production of all tracts during the test interval, and multiplied by one hundred.

This portion of the participation factor represents the current worth of each well and can be thought of as the basis for the allocation of that primary depletion oil that is recoverable under competitive operations.

A further consideration in determining participation is to provide a fair basis for sharing the additional oil which will be recovered as a result of unitization. Production history is a measure of the effective reserves for each well, with the wells having higher effective reserves displaying a better production history. Inasmuch as it is desirable to allocate the additional reserves in proportion to the effective reserves, it is reasonable to make the allocation on the basis of past production history.

For two wells having similar initial producing characteristics, the one which has produced for the longer time will have reached the more advanced stage of depletion and will have exhibited the greater production decline. Consequently, this well could not be expected to have as much oil left to produce under unitized operations. It is, therefore, recognized that the length of time during which a well has been on production and the decline rate it has established are factors to be considered. The amount of current water production is also a factor that must be considered. A parameter which is readily calculable and generally

recognizes all of these considerations is a cumulative average monthly producing rate to which has been applied a water production penalty. This factor is referred to as the penalized average monthly oil production factor. A detailed description of the method followed in arriving at this factor is outlined in the "Plan for Unit Operations."

There was unanimous agreement by the members of the Operating Committee for the proposed Routledge Unit No. 1 that the current production factor and the penalized average monthly oil production factor provide a satisfactory basis for unitization. These two factors have the advantage of being readily and precisely determinable.

A further consideration then becomes the relative weighting to give to each factor in providing a participation formula. It is anticipated that, of the 8,300,000 barrels of remaining oil recoverable under Unit operations, 4,300,000 barrels would be recoverable under competitive operations, the 4,000,000 barrels of additional oil being attributable to Unit operations. It is apparent that greater emphasis must be placed on the production which is recoverable in the earlier years of the unitized operation; essentially, this would be the reserves recoverable under competitive operations.

By applying the present value concept to the production forecast under Unit operation and comparing the discounted value of the first 4,300,000 barrels with the discounted value of the remaining 4,000,000 barrels, the ratio obtained is approximately 3 to 1. This then would indicate that a reasonable participation formula would give three times as much weighting to the reserves allocable under competitive operations (i.e., current production factor) as it would for

the additional reserves due to unitization (i.e., penalized average monthly oil production factor).

The Operating Committee has unanimously agreed that the participation formula consist of the sum of 75% of the current production factor and 25% of the penalized average monthly oil production factor.

This in summary outlines the development of the participation formula which is being presented, and the reasoning behind the recommendation that it is an equitable basis for unitization.

Application For a Unit Maximum Permissible Rate of Production

The applicants propose that a degree of production flexibility, which is consistent with good engineering practice, be provided for the Unit.

At the present time, production may be considered to be unrestricted, since the majority of the wells are being produced at reservoir capacity. It is the applicants' contention that no reservoir damage has resulted from producing these wells at capacity.

Most of those wells that are not being produced at reservoir capacity are those that produce large volumes of water and, therefore, require facilities for gathering and disposing of these large volumes of water. This requirement is often prohibitive for a competitive operation.

It is intended that, with the formation of the proposed Unit, adequate facilities will be provided to handle much larger volumes of fluid than would otherwise be available. There would be an attempt made to install high volume withdrawal equipment at judiciously selected producing wells in the area in order to recover the greatest amount of oil economically.

It is possible that, with the installation of high volume pumping equipment, some wells may be capable of producing oil at rates in excess of the current allowable producing rate. It is anticipated that it will be desirable to withdraw in excess of 1,500 barrels of fluid per day from certain wells.

Disposal of produced water will be into judiciously chosen disposal wells or producing wells converted to disposal service. It is possible that this disposal may increase the productive capacity of certain wells in the vicinity of

the disposal wells.

There is no reason to believe that reservoir damage would result from producing, at unrestricted rates, the existing high capacity wells or those wells in the vicinity of disposal wells at which the productive capacity has been increased.

The applicants respectfully request that, on and after the first day that the Routledge Unit No. 1 becomes effective, the Unit be excluded from any provisions governing the limitations and allocation of the production of oil.