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Arizona Department of Mines and Mineral Resources Mining Collection

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PRINTED: 08/29/2001

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES AZMILS DATA

PRIMARY NAME: HOLBROOK POTASH DEPOSIT

ALTERNATE NAMES:
SUPAI SALT BASIN

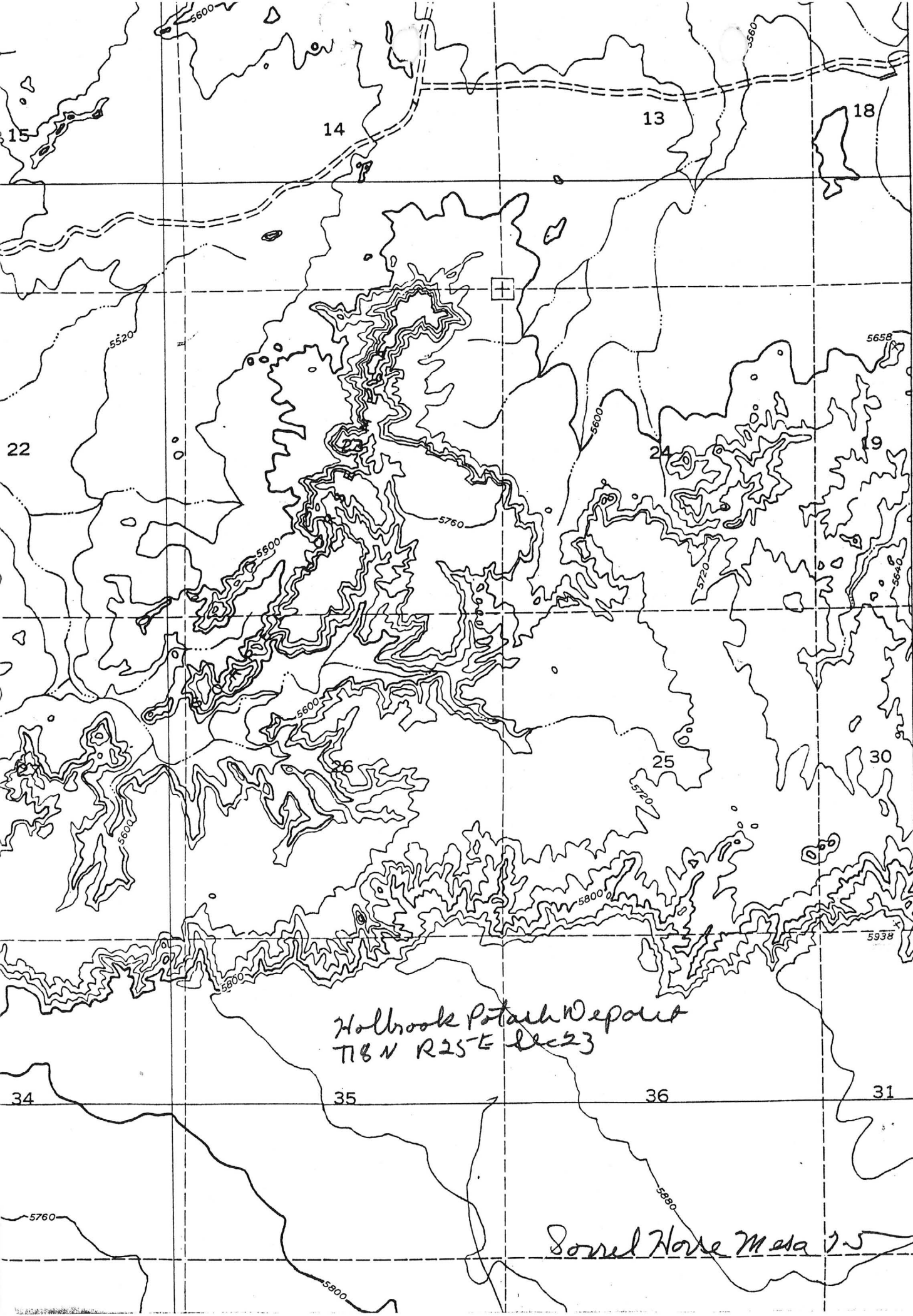
APACHE COUNTY MILS NUMBER: 308

LOCATION: TOWNSHIP 18 N RANGE 25 E SECTION 23 QUARTER
LATITUDE: N 34DEG 56MIN 47SEC LONGITUDE: W 109DEG 39MIN 23SEC
TOPO MAP NAME: SORREL HORSE MESA - 7.5 MIN

CURRENT STATUS: EXP PROSPECT

COMMODITY:
POTASH SYLVITE
SODIUM SALT
GYPSUM ANHYDRITE

BIBLIOGRAPHY:
ADMMR HOLBROOK POTASH DEPOSIT
AZBM BULL 180, P. 421
PIERCE, H. WESLY, EVAPORITE DEPOSITS OF THE
PERMIAN HOLBROOK BASIN, AZ. GEO FILE
A DISCOVERY WELL WAS DRILLED IN THIS SEC.
BUT THE RESOURCE IS FAR MORE EXTENSIVE.
AGSU OFR 00-03 PERMIAN SALT IN HOLBROOK BASIN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Holbrook Potash Deposit
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Sorrel Horse Mesa 7.5
T. 18 N.
T. 17 N.

NZ Legacy

Top of Evaporite Interval

Holbrook Salt Basin

Sun Valley

Goodwater

Adamana Propane
Salt Deposit Storage

Holbrook

HOLBROOK

Woodruff

Zuni
Heaven

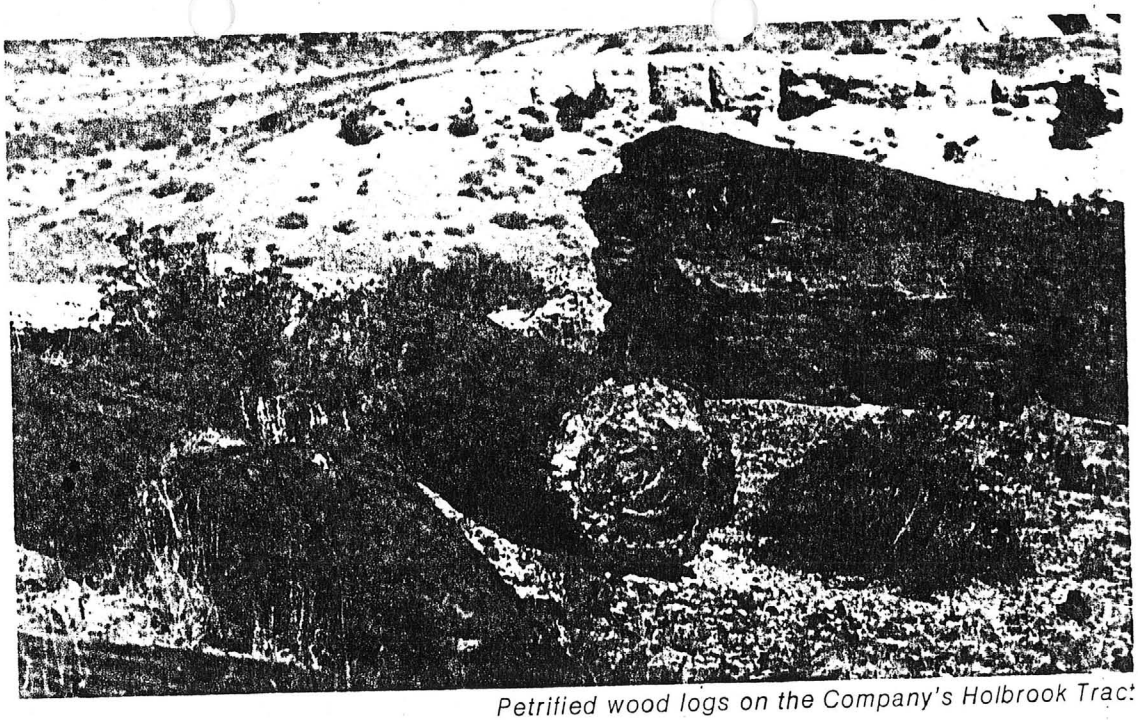
Hunt

Woodridge

- NZ / Legacy
- Tribal Land
- BLM Land
- State Land
- Petrified Forest National Park
- Proposed PFNP Boundry Expansion
- Proposed COS (Conservation Open Space)
- Proposed ESDA (Environmentaly Sensitive Development Area)
- Proposed LADA (Landscape Accenting Development Area)

ESPIRITU LOCI
The Spirit of the Place

07 APRIL 2004



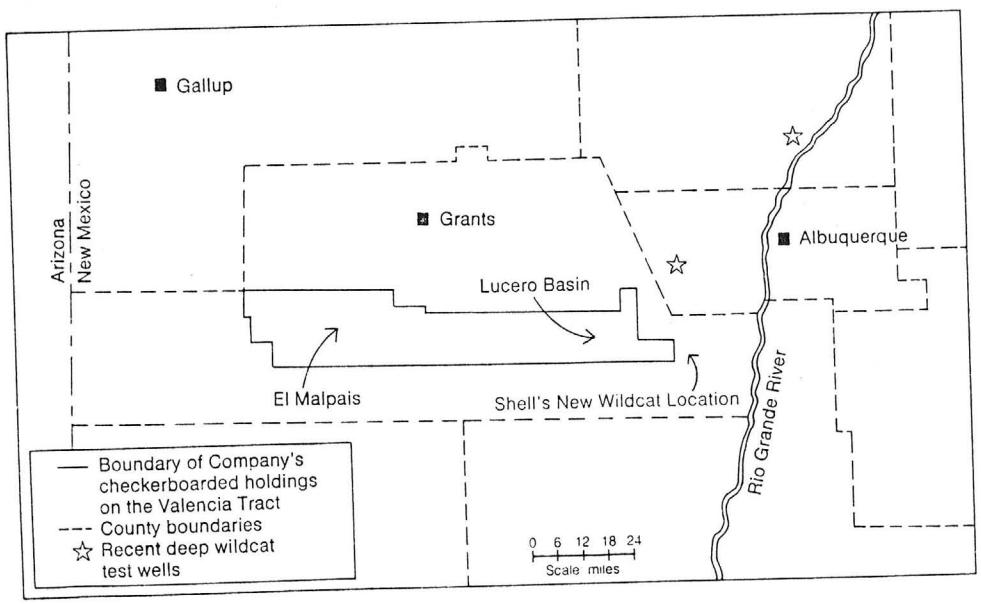
Petrified wood logs on the Company's Holbrook Tract

HOLBROOK POTASH

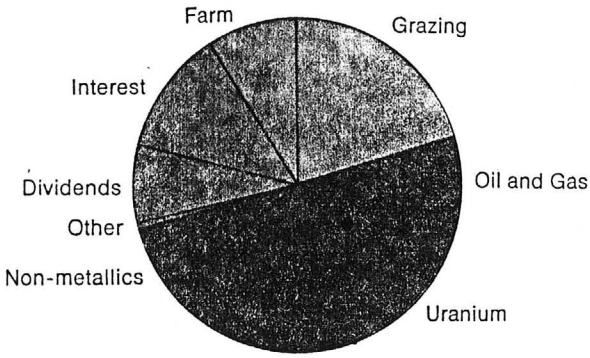
Potash. The Company's large, low grade potash deposit (some 72 million tons containing 12.5% potassium oxide) on its Holbrook Tract remained undeveloped throughout the year due to depressed world markets for this commodity.

Limestone. The Company has over 50 million tons of travertine limestone, reportedly of high calcium content, on its lands of the Valencia Tract. Efforts are under way to determine if this limestone is of commercial significance to industry.

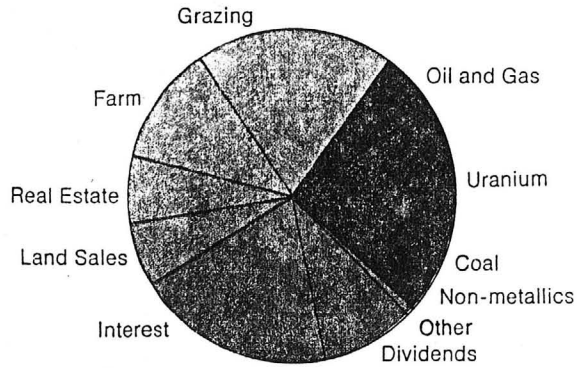
Other Prospects. Efforts are constantly being made by management to fully and accurately define your Company's total mineral estate. Enough regional geological data has been assembled to at least indicate the possibility of other mineral prospects on Company lands. These include prospects for copper, molybdenum, gold, fire clay, kaolin, and construction materials. Most of these prospects are of marginal probability. The true potential of these prospects will be learned only through patient efforts and the expenditures of risk capital for exploration.



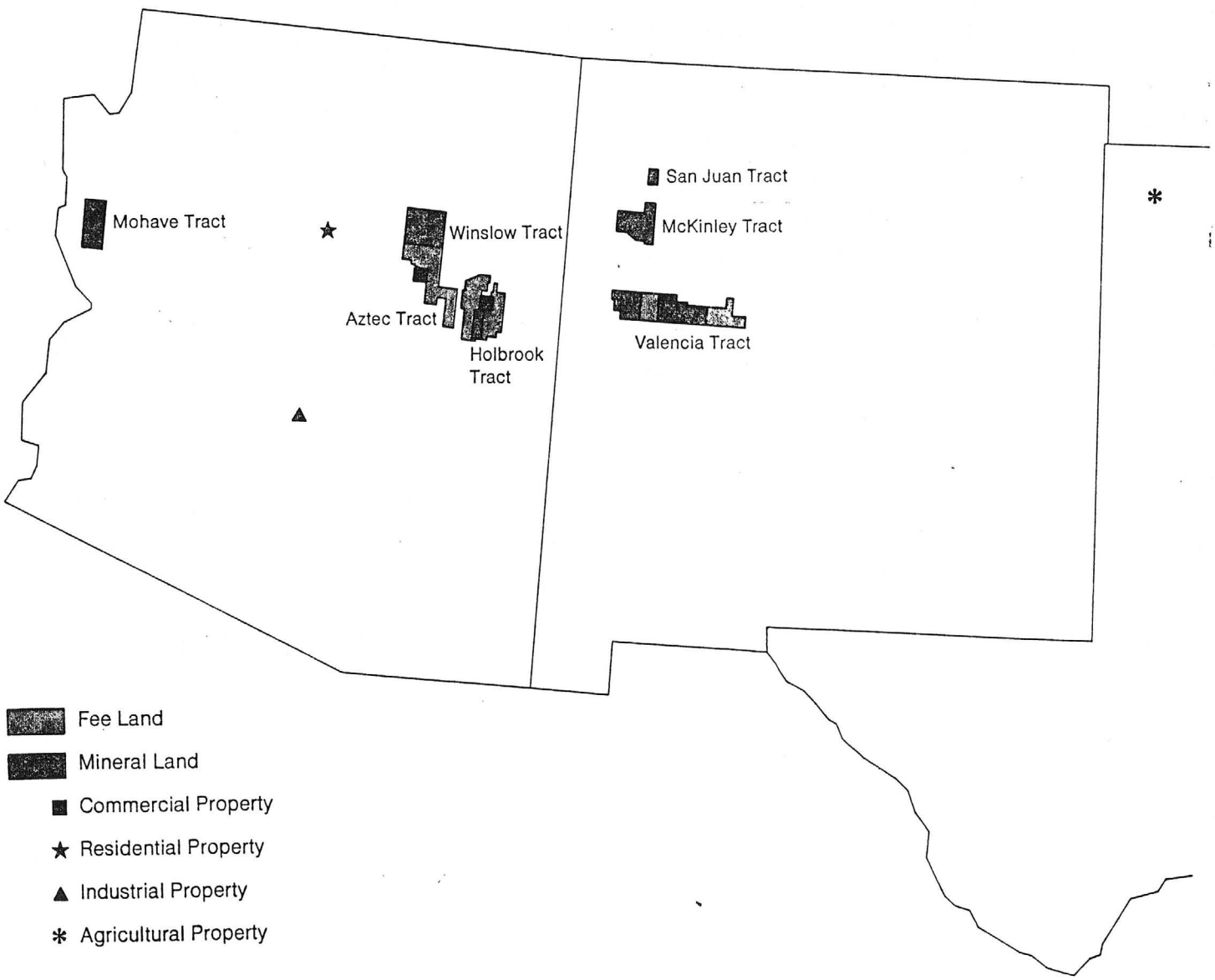
FROM NEW MEXICO AND ARIZONA LAND CO. 1973 ANNUAL REPORT

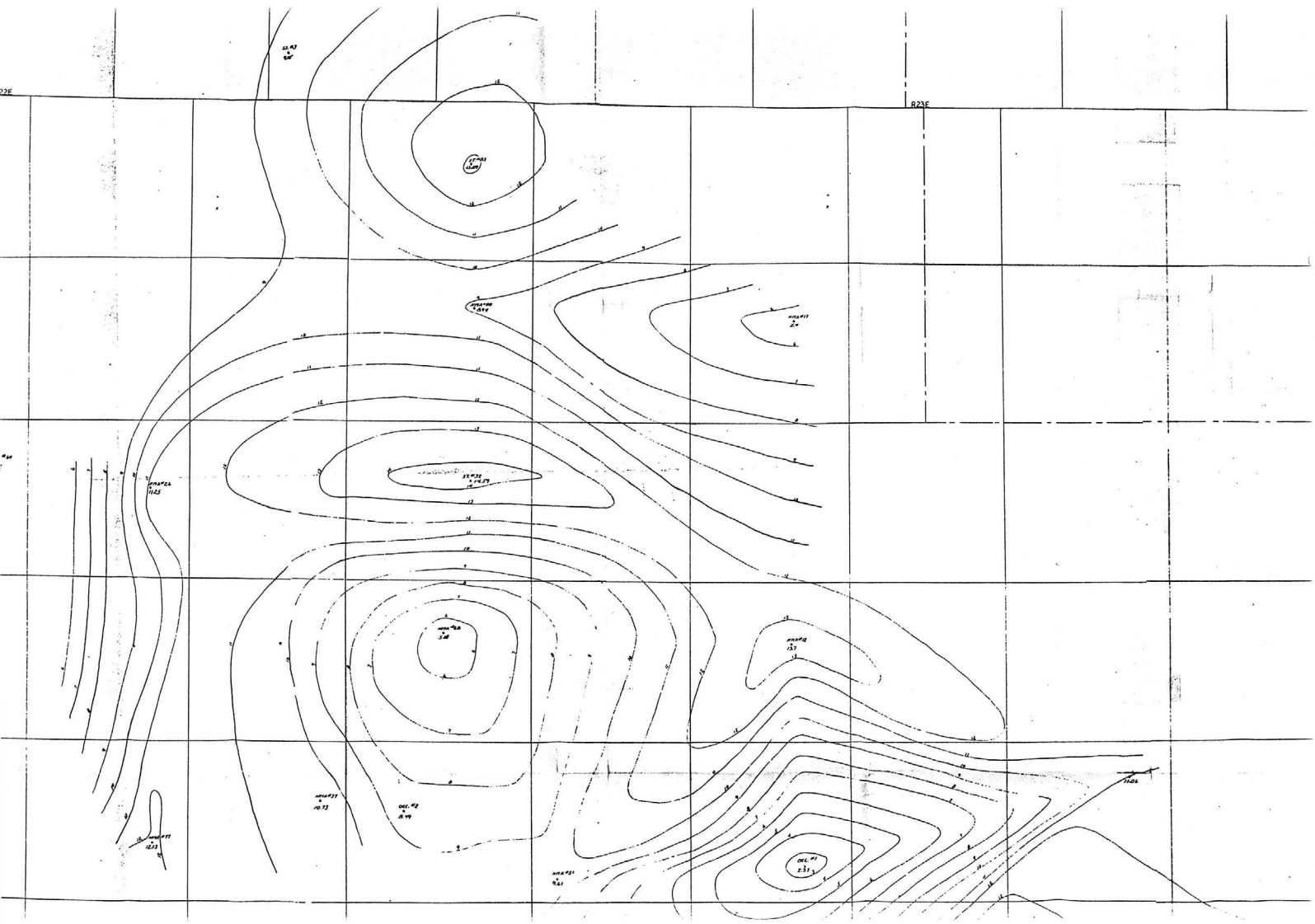


1972 Gross Income Sources



1973 Gross Income Sources

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(Appendix B)

TABLE 7

MINE - ORE GRADE 12.5% K_2O

PRODUCTION COST ESTIMATE

Product: Potash Ore — Symbol:
At: Holbrook, Arizona — Company: Arkla Exploration Company
Estimated By: Arthur G. McKee & Company — Date: February 1966

At: San Francisco, California

ASSUMPTIONS

Mine production: design rate 5,700,000 tons per yr; 16,600 tons per day
Hoisting: design rate 830 tons per hr, 20 hr per day
Mining method: room and pillar, flat bed, with continuous borers.
Primary mine extraction 52.5 percent, final extraction 85.7 percent.
Haulage in mine by roof-suspended, rope belt conveyors
Ore grade: 19.8 percent KCl, equivalent to 12.5 percent K_2O.
Ore bed height, 48 to 60 inches

Refinery recovery, 92 percent of KCl in ore, product grade 96.6 to 98.2 percent KCl, equivalent to 61 to 62 percent K_2O.
Connected motor load = 8850 hp

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

Ton quantities are short tons of 2000 pounds.

Ore feed rate to plant	5,400,000 tons per yr; 625 tons per hr					
Production of refinery plant	1,000,000 tons per yr of potassium chloride (KCl)					
Capital Costs			Life, years	Annual depreciation		
Shaft and stations	$1,842,000		20	$ 92,100		
Underground development	399,000		20	20,000		
Surface plant and hoists	1,858,000		15	123,900		
Underground equipment	6,489,000		10	648,900		
Total Capital Costs (Ip)	$10,588,000			$884,900		
RAW MATERIALS Units	**AMOUNT** per yr	**$ PER** unit	$ per yr	$ per yr	$ per ton of ore	$ per ton of product
TOTAL RAW MATERIALS						
Labor (L)			2,299,128		0.426	2.299
Supervision (S)			186,888		.035	.187
Labor Benefits 20 percent of L + S			497,203		.092	.497
Steam						
Electricity kwhr	57,024,000	0.01	570,240		.106	.570
Air	included					
Water – Purch. or Process	allowance		2,000			.002
Water – Plant or Cooling						
Fuel – Gas - Coal - Oil	allowance		3,000		.001	.003
Operating supplies			2,176,200		.403	2.176
Maintenance – Minor (M)			2,117,564		.392	2.118
Maintenance – Major (M)						
Factory Supplies	included in operating supplies					
Laboratory			32,400		.006	.032
DIRECT CONVERSION				7,884,623	1.460	7.885
Depreciation See schedule above			884,900		.164	.885
Controllable Indirect 35% of L + S + M			1,611,200		.298	1.611
Non-Controllable Indirect 3% of Ip			317,640		.059	.31
INDIRECT CONVERSION				2,813,740	.521	2.814
TOTAL COST IN BULK				10,698,363	1.981	10.698
Rounded				10,700,000	1.98	10.70
Packing Cost						
Shipping Cost						
TOTAL COST F.O.B.						

ARTHUR G. McKEE & COMPANY
NONFERROUS METALS & MINERALS DIVISION

G-11

(Appendix B)
TABLE 8

MINE - ORE GRADE 16.0% K_2O

PRODUCTION COST ESTIMATE

Product Potash Ore Symbol
At Holbrook, Arizona Company Arkla Exploration Company
Estimated By Arthur G. McKee & Company Date February 1966
At San Francisco, California

ASSUMPTIONS

Mine production: design rate 4,400,000 tons per yr
12,900 tons per day
Hoisting: design rate 645 tons per hr, 20 hr per day
Mining method: room and pillar, flat bed, with continuous borers.
Primary mine extraction 52.5 percent, final extraction 85.7 percent
Haulage in mine by roof-suspended conveyor belts.
Ore grade: 25.4 percent KCl, equivalent to 16.0 percent K_2O.
Ore bed height, 48 to 60 inches.

Refinery recovery, 92 percent of KCl in ore, product grade 96.6 to 98.2 percent KCl, equivalent to 61 to 62 percent K_2O

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

Ton quantities are short tons of 2000 pounds.

Ore feed rate to plant	4,210,000 tons per yr 512 tons per hr					
Production of refinery plant	1,000,000 tons per yr of potassium chloride (KCl)					
Capital Costs			Life, years	Annual depreciation		
Shaft and stations	$1,842,000		20	$ 92,100		
Underground development	349,000		20	17,450		
Surface plant and hoists	1,548,000		15	103,200		
Underground equipment	5,408,000		10	540,800		
Total Capital Costs (Ip)	$9,147,000			$753,550		
RAW MATERIALS Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr	$ per ton of ore	$ per ton of product
TOTAL RAW MATERIALS						
Labor (L)			1,793,460		0.426	
Supervision (S)			147,350		.035	
Labor Benefits 20 percent of L + S			388,192		.092	
Steam						
Electricity kwhr	44,626,000	0.01	446,260		.106	
Air	included					
Water – Purch. or Process						
Water – Plant or Cooling)	allowance		4,200		.001	
Fuel – Gas - Coal - Oil)						
Operating Supplies			1,696,630		.403	
Maintenance – Minor) (M)			1,829,400		.435	
Maintenance – Major)						
Factory Supplies included in operating supplies						
Laboratory			25,260		.006	
DIRECT CONVERSION				6,330,752	1.504	6.331
Depreciation See schedule above			753,550		.179	
Controllable Indirect 35% of L + S + M			1,320,000		.314	
Non-Controllable Indirect			267,600		.064	
INDIRECT CONVERSION				2,341,150	.556	2.341
TOTAL ~~MFG~~ COST IN BULK				8,671,902	2.060	8.672
Rounded				8,670,000	2.06	8.67
Packing Cost						
Shipping Cost						
TOTAL COST F.O.B.						

ARTHUR G. McKEE & COMPANY
NONFERROUS METALS & MINERALS DIVISION

MINE - ORE GRADE 20.0% K_2O

TABLE 9

PRODUCTION COST ESTIMATE

Product: Potash Ore — Symbol:
At: Holbrook, Arizona — Company: Arkla Exploration Company
Estimated By: Arthur G. McKee & Company — Date: February 1966

At: San Francisco, California

ASSUMPTIONS

Mine production: design rate 3,500,000 tons per yr
10,200 tons per day

Hoisting: design rate 510 tons per hr, 20 hr per day

Mining method: room and pillar, flat bed, with continuous borer.

Primary mine extraction 52.5 percent, final extraction 85.7 percent

Haulage in mine by roof-suspended, rope belt conveyors.

Ore grade: 31.7 percent KCl, equivalent to 20.0 percent K_2O.
Ore bed height, 48 to 60 inches

Refinery recovery, 92 percent of KCl in ore, product grade 96.6 to 98.2 percent KCl, equivalent to 61 to 62 percent K_2O.

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

Ton quantities are short tons of 2000 pounds.

ARTHUR G. McKEE & COMPANY
NONFERROUS METALS & MINERALS DIVISION

Ore feed rate to plant	3,370,000 tons per yr 410 tons per day					
Production of refinery plant	1,000,000 tons per yr of potassium chloride (KCl)					
Capital Costs			Life, years	Annual depreciation		
Shaft and stations	$1,842,000		20	$ 92,100		
Underground development	313,000		20	15,650		
Surface plant and hoists	1,327,000		15	88,470		
Underground equipment	4,635,000		10	463,500		
Total Capital Costs (Ip)	$8,117,000			$ 659,720		
RAW MATERIALS Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr	$ per ton of ore	$ per ton of product
TOTAL RAW MATERIALS						
Labor (L)			1,435,620		0.426	
Supervision (S)			117,950		.035	
Labor Benefits 20 percent of L + S			310,714		.092	
Steam						
Electricity kwhr	35,722,000	0.01	357,220		.106	
Air						
Water – Purch. or Process						
Water – Plant or Cooling)	allowance		3,600		.001	
Fuel – Gas - Coal - Oil)						
Operating supplies			1,358,110		.403	
Maintenance – Minor) (M)			1,623,400		.482	
Maintenance – Major)						
Factory Supplies included in operating supplies						
Laboratory			20,220		.006	
DIRECT CONVERSION				5,226,834	1.551	5.227
Depreciation See schedule above			659,720			
Controllable Indirect 35% of L+S+M			1,110,000			
Non-Controllable Indirect			231,750			
INDIRECT CONVERSION				2,001,470	.594	2.001
TOTAL COST IN BULK				7,228,304	2.145	7.228
Rounded				7,230,000	2.14	7.23
Packing Cost						
Shipping Cost						
TOTAL COST F.O.B.						

(Appendix B)

TABLE 10

FEED PREPARATION - 12.5% K_2O

PRODUCTION COST ESTIMATE

Product: Crushed, deslimed potash ore, Holbrook, Arizona — Symbol:
Company: Arkla Exploration Company
Estimated By: Arthur G. McKee & Company — Date: February 1966
At: San Francisco, California

ASSUMPTIONS

The ore averages 19.8 percent potassium chloride, equivalent to 12.5 percent K_2O.

The ore contains 2.75 percent insolubles (clay, etc.). Removing the insolubles in a desliming operation, and washing and settling the slimes to recover the contained potash, requires one pound of Separan (guar) per ton of slime solids.

Labor includes three men per shift, with a total of three shifts per day, twelve men total.

Connected power load is 1100 hp, equivalent to (1100)(0.8)(0.746)(5600) or 3,676,000 kwhr per year.

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK
Separan (guar)	lb	$1.20			$1.25

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

Ton quantities are short tons of 2000 pounds.

Ore feed rate	5,400,000 tons per yr
Production of potassium chloride	1,000,000 tons per yr
Capital Investment, Ip	$ 4,140,000

RAW MATERIALS	Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr	$ per ton of ore feed	$ per ton of KCl
Separan (guar)	lb	148,500	1.25	185,600			
TOTAL RAW MATERIALS					185,600	0.034	0.186
Labor (L)	man-years	12	7,000.	84,000		.016	
Supervision (S) = 10% of L				8,400		.002	
Labor Benefits 20% of L + S				18,480		.003	
Steam							
Electricity	kwhr	3,676,000	0.01	36,760		.007	
Air		allowance		1,000			
Water – Purch. or Process	1000 gal	910,000	.03	27,300		.005	
Water – Plant or Cooling							
Fuel – Gas - Coal - Oil		allowance		3,000		.001	
Maintenance – Minor)(M) = 2% of Ip				82,800		.015	
Maintenance – Major)							
Factory Supplies 0.5% of Ip				20,700		.004	
Laboratory							
DIRECT CONVERSION					282,440	.052	.282
Depreciation 15 years, linear				276,000		.051	
Controllable Indirect 35% of L+S+M				61,320		.011	
Non-Controllable Indirect 3% of Ip				124,200		.023	
INDIRECT CONVERSION					461,520	.085	.462
TOTAL ~~XXX~~ COST IN BULK					929,560	.172	.930
Rounded					930,000	.17	.93
Packing Cost							
Shipping Cost							
TOTAL COST F.O.B.							

TABLE 11

FEED PREPARATION - 16.0% K_2O

PRODUCTION COST ESTIMATE

Product: Crushed, deslimed potash ore — Symbol:
Holbrook, Arizona — Company: Arkle Exploration Company
Estimated By: Arthur G. McKee & Company — Date: February 1966
At: San Francisco, California

ASSUMPTIONS

The ore averages 25.4 percent potassium chloride, equivalent to 16.0 percent K_2O.

The ore contains 2.75 percent insolubles (clay, etc.). Removing the insolubles in a desliming operation, and washing and settling the slimes to recover the contained potash, requires one pound of Separan (guar) per ton of slime solids.

Labor includes three men per shift, with a total of three shifts per day, twelve men total.

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK
Separan (guar)	lb	$1.20			$1.25

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

Ton quantities are short tons of 2000 pounds.

Ore feed rate	4,210,000 tons per yr
Production of potassium chloride	1.000,000 tons per yr
Capital Investment, Ip	$3,450,000

RAW MATERIALS	Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr	$ per ton of ore feed	$per ton of KCl
Separan (guar)	lb	117,800	1.25	147,250			
TOTAL RAW MATERIALS					147,250	0.035	0.147
Labor (L)	man-years	12	7,000	84,000		.020	
Supervision (S) = 10% of L				8,400		.002	
Labor Benefits 20% of L + S				18,480		.004	
Steam							
Electricity	kwhr	3,000,000	0.01	30,000		.007	
Air		allowance		1,000			
Water – Purch. or Process	1000 gal	709,000	.03	21,270		.005	
Water – Plant or Cooling		allowance		2,500		.001	
Fuel – Gas - Coal - Oil							
Maintenance – Minor) (M) = 2% of Ip				69,000		.016	
Maintenance – Major)							
Factory Supplies 0.5% of Ip				17,250		.004	
Laboratory							
DIRECT CONVERSION					251,900	.060	.252
Depreciation 15 years, linear				230,000		.055	
Controllable Indirect 35% of L+S+M				56,490		.013	
Non-Controllable Indirect 3% of Ip				103,500		.025	
INDIRECT CONVERSION					389,990	.093	.390
TOTAL COST IN BULK					789,140	.187	.789
Rounded					790,000	.19	.79
Packing Cost							
Shipping Cost							
TOTAL COST F.O.B.							

FEED PREPARTION - 20.0% K_2O

PRODUCTION COST ESTIMATE

TABLE 12

Product Crushed, deslimed potash ore Symbol
At Holbrook, Arizona Company Arkla Exploration Company
Estimated By Arthur G. McKee & Company Date February 1966
At San Francisco, California

ASSUMPTIONS

The ore averages 31.7 percent potassium chloride, equivalent to 20.0 percent K_2O.

The ore contains 2.75 percent insolubles (clay, etc.). Removing the insolubles in a desliming operation, and washing and settling the slimes to recover the contained potash, requires one pound of Separan (guar) per ton of slime solids.

Labor includes three men per shift, with a total of three shifts per day, twelve men total.

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK
Separan (guar)	lb	$1.20			$1.25

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

Ton quantities are short tons of 2000 pounds.

Ore feed rate	3,370,000 tons per yr
Production of potassium chloride	1,000,000 tons per yr
Capital Investment, Ip	$ 2,960.000

RAW MATERIALS Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr	$ per ton of ore feed	$ per ton of KCl
Separan (guar) lb	92,700	1.25	115,875			
TOTAL RAW MATERIALS				115,875	0.034	0.116
Labor (L) man-years	12	7,000	84,000		.025	
Supervision (S) = 10% of L			8,400		.002	
Labor Benefits 20% of L+S			18,480		.005	
Steam						
Electricity kwhr	2,250,000	0.01	22,500		.007	
Air	allowance		1,000			
Water – Purch. or Process 1000 gal	567,000	.03	17,010		.005	
Water – Plant or Cooling						
Fuel – Gas - Coal - Oil	allowance		2,000		.001	
Maintenance – Minor) (M) = 2% of Ip			59,200		.018	
Maintenance – Major)						
Factory Supplies 0.5% of Ip			14,800		.004	
Laboratory						
DIRECT CONVERSION				227,390	.067	.227
Depreciation 15 years, linear			197,330		.059	
Controllable Indirect 35% of L+S+M			53,060		.016	
Non-Controllable Indirect 3% of Ip			88,800		.026	
INDIRECT CONVERSION				339,190	.101	.339
TOTAL COST IN BULK				682,455	.203	.682
Rounded				680,000	.20	.68
Packing Cost						
Shipping Cost						
TOTAL COST F.O.B.						

TABLE 13

FLOTATION REFINING OF POTASH ORE (12.5% K_2O)
FLOTATION SECTION

PRODUCTION COST ESTIMATE

Product: Potassium Chloride — Symbol: KCl
Location: Holbrook, Arizona — Company: Arkla Exploration Company
Estimated By: Arthur G. McKee & Company — Date: February 1966
At: San Francisco, California

ASSUMPTIONS

	Total Men	Annual Rate	Wages
Labor: Four shifts with two men each	8	$ 7,000	$ 56,000
One reagent tender	1	6,500	6,500
One laborer	1	6,000	6,000
Total	10		$ 68,500
Supervision: One foreman	1	7,500	7,500

Power: connected load, 3100 hp, not counting spares.
at 8400 hr per yr, this totals 15,540,000 kwhr per yr

REAGENT AND RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK
Starch	lb	$0.08	delivered	$0.01	$0.09
"Armac T"	lb	.38			.39
Methyl Isobutyl Carbinol	lb	.20			.20

PACKING COST

Kind	
Capacity	
Cost of Container	
Cost of Liner	
Packing Labor	
Other Costs	
Total Cost per Container	
Proportion Each Type	

NOTES

1. Ton quantities are short tons of 2000 pounds.
2. To obtain the total production cost per ton of potassium chloride product, the costs from the last column of Table 16 must be added to the costs in the last column of this table.

Mined ore rate (12.5% K_2O) (The feed to this section is actually "crushed de-slimed ore" - see Table 10): 5,400,000 tons per yr

Production of potassium chloride (KCl): 775,000 tons per yr (225,000 tons more comes from a small leaching - crystallizing section. See Table 16.)

Capital Investment, Ip: $ 3,500,000

RAW MATERIALS	Units	AMOUNT per year	$ PER unit	$ per yr	$ per yr	$ per ton of mined ore	$ per ton of total KCl product
Starch (0.1 lb per ton ore)	lb	540,000	0.09	48,600			
"Armac T" (0.3 lb per ton of ore)	lb	1,620,000	.39	631,800			(See note 2)
*Methyl Isobutyl Carbinol (0.1 lb per ton ore)	lb	540,000	.20	108,000			
*or Pine Oil							
TOTAL RAW MATERIALS					788,400	0.146	0.788
Labor (L) See assumptions				68,500			
Supervision (S)				7,500			
Labor Benefits 20 percent of L+S				15,200			
Steam	allowance			1,500			
Electricity	kwhr	15,540,000	.01	155,400			
Air	allowance			1,000			
Water – Purch. or Process	see feed preparation						
Water – Plant or Cooling	allowance			1,000			
Fuel – Gas - Coal - Oil							
Maintenance – Minor) (M) = 2.5% of Ip				87,500			
Maintenance – Major)							
Factory Supplies				30,000			
Laboratory							
DIRECT CONVERSION					367,600	.068	.368
Depreciation 15 years, linear				233,300			
Controllable Indirect 35% of L+S+M				57,225			
Non-Controllable Indirect 3% of Ip				105,000			
INDIRECT CONVERSION					395,525	.073	.396
TOTAL COST IN BULK					1,551,525	.287	1.552
Rounded					1,550,000	.29	1.55
Packing Cost							
Shipping Cost							
TOTAL COST F.O.B.							

ARTHUR G. McKEE & COMPANY
NONFERROUS METALS & MINERALS DIVISION

FLOTATION REFINING OF POTASH ORE (16.0% K_2O)
FLOTATION SECTION

PRODUCTION COST ESTIMATE

TABLE 14

Product Potassium Chloride Symbol KCl
At Holbrook, Arizona Company Arkla Exploration Company
Estimated By Arthur G. McKee & Company Date February 1966
At San Francisco, California

ASSUMPTIONS

	Total Men	Annual Rate	Wages
Labor: Four shifts with two men each	8	$ 7,000	$ 56,000
One reagent tender	1	6,500	6,500
One laborer	1	6,000	6,000
Total	10		$ 68,500
Supervision: One foreman	1	7,500	7,500

Power: connected load, 2600 hp, not counting spares, at 8400 hr per yr, this totals 13,030,000 kwhr per yr

REAGENT AND RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK
Starch	lb	$0.08			$0.09
"Armac T"	lb	.38	delivered	$0.01	.39
~~Methyl Isobutyl Carbinol~~	lb	.20			.20

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

1. Ton quantities are short tons of 2000 pounds.
2. To obtain the total production cost per ton of potassium chloride product, the costs from the last column of Table 16 must be added to the costs in the last column of this table.

Mined ore rate (16.0% K_2O) (The feed to this section is actually "crushed de-slimed ore" - see Table 10): 4,210,000 tons per yr

Production of potassium chloride (KCl): 850,000 tons per yr (150,000 more tons come from a small leaching - crystallizing section. See Table 16.)

Capital Investment, Ip: $2,500,000

RAW MATERIALS Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr	$ per ton of mined ore	$ per ton of total KCl product
Starch (0.133 lb per ton ore) lb	540,000	0.09	48,600			
"Armac T" (0.39 lb per ton of ore) lb	1,620,000	.39	631,800			(See note 2)
*Methyl Isobutyl Carbinol (0.133 lb per ton ore) lb	540,000	.20	108,000			
*or Pine Oil						
TOTAL RAW MATERIALS				788,400	0.187	0.788
Labor (L) See assumptions			68,500			
Supervision (S)			7,500			
Labor Benefits 20 percent of L + S			15,200			
Steam	allowance		1,500			
Electricity kwhr	13,030,000	.01	130,300			
Air	allowance		1,000			
Water – Purch. or Process	see feed preparation					
Water – Plant or Cooling						
Fuel – Gas - Coal - Oil	allowance		1,000			
Maintenance – Minor) (M) = 2.5% of Ip			62,500			
Maintenance – Major)						
Factory Supplies						
Laboratory			30,000			
DIRECT CONVERSION				317,500	.075	.318
Depreciation 15 years, linear			166,670			
Controllable Indirect 35% of L+S+M			48,475			
Non-Controllable Indirect 3% of Ip			75,000			
INDIRECT CONVERSION				290,145	.069	.290
TOTAL ~~XXX~~ COST IN BULK				1,396,045	.332	1.396
Rounded				1,400,000	.33	1.40
Packing Cost						
Shipping Cost						
TOTAL COST F.O.B.						

(Appendix B)

TABLE 15

FLOTATION REFINING OF POTASH ORE (20.0% K_2O)
FLOTATION SECTION

PRODUCTION COST ESTIMATE

Product Potassium Chloride Symbol KCl
At Holbrook, Arizona Company Arkla Exploration Company
Estimated By Arthur G. McKee & Company Date February 1966

At San Francisco, California

ASSUMPTIONS

	Total Men	Annual Rate	Wages
Labor: Four shifts with two men each	8	$ 7,000	$ 56,000
One reagent tender	1	6,500	6,500
One laborer	1	6,000	6,000
Total	10		$ 68,500
Supervision: One foreman	1	7,500	7,500

Power: connected load, 2200 hp, not counting spares, at 8400 hr per yr, this totals 11,030,000 kwhr per yr

REAGENT AND RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK
Starch	lb	$0.08			$0.09
"Armac T"	lb	.38	delivered	$0.01	.39
Methyl Isobutyl Carbinol	lb	.20			.20

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

1. Ton quantities are short tons of 2000 pounds.
2. To obtain the total production cost per ton of potassium chloride product, the costs from the last column of Table 16 must be added to the costs in the last column of this table.

ARTHUR G. McKEE & COMPANY
NONFERROUS METALS & MINERALS DIVISION

Mined ore rate (20.0% K_2O) 3,370,000 tons per yr
(The feed to this section is actually "crushed de-slimed ore" - see Table 10)

Production of potassium chloride (KCl) 850,000 tons per yr (150,000 more tons come from a small leaching - crystallizing section. See Table 16.)

Capitol Investment, Ip $2,190,000

RAW MATERIALS	Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr	$ per ton of mined ore	$ per ton of total
Starch (0.16 lb per ton ore)	lb	540,000	0.09	48,600			KCl product (See note 2)
"Armac T" (0.48 lb per ton of ore)	lb	1,620,000	.39	631,800			
*Methyl Isobutyl Carbinol (0.16 lb per ton ore)	lb	540,000	.20	108,000			
*or Pine Oil							
TOTAL RAW MATERIALS					788,400	0.234	0.7
Labor (L) See assumptions				68,500			
Supervision (S)				7,500			
Labor Benefits 20 percent of L+S				15,200			
Steam		allowance		1,500			
Electricity	kwhr	11,030,000	.01	110,300			
Air		allowance		1,000			
Water – Purch. or Process		see feed preparation					
Water – Plant or Cooling							
Fuel – Gas - Coal - Oil		allowance		1,000			
Maintenance – Minor) (M) = 2.5% of Ip				54,750			
Maintenance – Major)							
Factory Supplies				30,000			
Laboratory							
DIRECT CONVERSION					289,750	.086	.290
Depreciation 15 years, linear				146,000			
Controllable Indirect 35% of L+S+M				45,760			
Non-Controllable Indirect 3 percent of Ip				65,700			
INDIRECT CONVERSION					257,460	.076	.257
TOTAL ~~XXXX~~ COST IN BULK					1,335,610	.396	1.336
Rounded					1,340,000	.40	1.34
Packing Cost							
Shipping Cost							
TOTAL COST F.O.B.							

TABLE 16

FLOTATION REFINING OF POTASH ORE
LEACHING - CRYSTALLIZING SECTION

PRODUCTION COST ESTIMATE

Product: Potassium Chloride — Symbol: KCl
At: Holbrook, Arizona — Company: Arkla Exploration Company
Estimated By: Arthur G. McKee & Company — Date: February 1966

At: San Francisco, California

Mined ore rate	5,400,000 to 3,370,000 tons per yr
Production of potassium chloride crystals	225,000 tons per yr
	(See tables 13 to 15 for flotation production of an additional 775,000 to 850,000 tons of potassium chloride per year for a total plant production of 1,000,000 tons.)
Capital Investment, Ip	$ 4,700,000

ASSUMPTIONS

This small leaching-crystallizing section recovers potash that would otherwise be lost in the desliming operation, and permits the reworking to satisfactory particle sizes of dust from product handling operations.

Labor: Crystallizer operators, four shifts, each with two men.

Power: Connected load, 1300 hp not counting spares.
At 8000 hr per yr, this totals 6,210,000 kwhr per yr

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK

PACKING COST

Kind					
Capacity					
Cost of Container					
Cost of Liner					
Packing Labor					
Other Costs					
Total Cost per Container					
Proportion Each Type					

NOTES

1. Ton quantities are short tons of 2000 pounds.
2. To obtain the total production cost per ton of potassium chloride product, the costs from the last column of this table must be added to the costs in the last column of Table 13, 14 or 15.

RAW MATERIALS	Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr		$ per ton of total KCl prodn (see note 2)
TOTAL RAW MATERIALS							
Labor (L)	man-years	8	7,000	56,000			
Supervision (S) = 10% of L				5,600			
Labor Benefits 20 percent of L + S				12,320			
Steam	1000 lb	240,000	0.65	156,000			
Electricity	kwhr	6,210,000	.01	62,100			
Air		allowance		500			
Water – Purch. or Process	1000 gal	96,000	.10	9,600			
Water – Plant or Cooling	1000 gal	998,000	.03	29,940			
Fuel – Gas - Coal - Oil		allowance		1,000			
Maintenance – Minor) (M) = 2% of Ip				94,000			
Maintenance – Major)							
Factory Supplies 1 percent of Ip				47,000			
Laboratory				30,000			
DIRECT CONVERSION					504,060		0.504
Depreciation 15 years, linear				313,300			
Controllable Indirect 35% of L+S+M				54,460			
Non-Controllable Indirect 3% of Ip				141,000			
INDIRECT CONVERSION					508,760		.509
TOTAL ~~XXX~~ COST IN BULK					1,012,820		1.013
Rounded					1,010,000		1.01
Packing Cost							
Shipping Cost							
TOTAL COST F.O.B.							

(Appendix B)

TABLE 17

REFINING BY LEACHING, CRYSTALLIZATION (12.5% K_2O)
(FLOTATION NOT USED)

PRODUCTION COST ESTIMATE

Product Potassium Chloride Symbol KCl
At Holbrook, Arizona Company Arkla Exploration Company
Estimated By Arthur G. McKee & Company Date February 1966
At San Francisco, California

ASSUMPTIONS

Ore averages 19.8 percent KCl, equivalent to 12.5 percent K_2O

Power: connected motor load 2600 hp, equivalent to 1580 kw for 8000 hr per yr.

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

All ton quantities are short tons of 2000 pounds.

Ore feed rate	5,400,000 tons per yr
Production of potassium chloride	1,000,000 tons per yr
Capital Investment, Ip	$ 14,000,000

RAW MATERIALS	Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr	$ per ton of ore	$ per ton of KCl product
TOTAL RAW MATERIALS							
Labor (L)	man-years	8	7,000	56,000			
Supervision (S) = 10% of L				5,600			
Labor Benefits 20% of L + S				12,320			
Steam	1000 lb	480,000	0.65	312,000			
Electricity	kwhr	12,640,000	.01	126,400			
Air		allowance		1,000			
Water - Purch. or Process	1000 gal	192,000	.10	19,200			
Water - Plant or Cooling	1000 gal	1,996,000	.03	59,880			
Fuel - Gas - Coal - Oil		allowance		2,000			
Maintenance - Minor) (M) = two percent of Ip				280,000			
Maintenance - Major)							
Factory Supplies one percent of Ip				140,000			
Laboratory				60,000			
DIRECT CONVERSION					1,074,400	0.199	1.074
Depreciation 15 years, linear				933,300			
Controllable Indirect 35% of L+S+M				119,560			
Non-Controllable Indirect 3% of Ip				420,000			
INDIRECT CONVERSION					1,472,860	.273	1.473
TOTAL ~~MFG.~~ COST IN BULK					2,547,260	.472	2.547
Rounded					2,550,000	.47	2.55
Packing Cost							
Shipping Cost							
TOTAL COST F.O.B.							

ARTHUR G. McKEE & COMPANY
NONFERROUS METALS & MINERALS DIVISION

TABLE 18

REFINING BY LEACHING, CRYSTALLIZATION (16.0% K_2O)
(FLOTATION NOT USED)

PRODUCTION COST ESTIMATE

Product: Potassium Chloride — Symbol: KCl
Holbrook, Arizona — Company: Arkla Exploration Company
Estimated By: Arthur G. McKee & Company — Date: February 1966
At: San Francisco, California

Ore feed rate	4,210,000 tons per yr
Production of potassium chloride	1,000,000 tons per yr
Capital Investment, Ip	$12,650,000

ASSUMPTIONS

Ore averages 25.4 percent KCl, equivalent to 16.0 percent K_2O.

Power: connected motor load 2160 hp, equivalent to 1360 kw for 8000 hr per yr.

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

All ton quantities are short tons of 2000 pounds.

RAW MATERIALS	Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr	$ per ton of ore	$ per ton of KCl product
TOTAL RAW MATERIALS							
Labor (L)	man-years	8	7,000	56,000			
Supervision (S) = 10% of L				5,600			
Labor Benefits 20% of L + S				12,320			
Steam	1000 lb	400,000	0.65	260,000			
Electricity	kwhr	10,880,000	.01	108,800			
Air		allowance		1,000			
Water – Purch. or Process	1000 gal	160,000	.10	16,000			
Water – Plant or Cooling	1000 gal	1,660,000	.03	49,800			
Fuel – Gas - Coal - Oil		allowance		2,000			
Maintenance – Minor) (M) = 2% of Ip				253,000			
Maintenance – Major)							
Factory Supplies 1% of Ip				126,500			
Laboratory				60,000			
DIRECT CONVERSION					951,020	0.226	0.951
Depreciation 15 years, linear				843,300			
Controllable Indirect 35% of L+S+M				110,100			
Non-Controllable Indirect 3% of Ip				379,500			
INDIRECT CONVERSION					1,332,900	.317	1.333
TOTAL ~~MFG.~~ COST IN BULK					2,283,920	.542	2.284
Rounded					2,280,000	.54	2.28
Packing Cost							
Shipping Cost							
TOTAL COST F.O.B.							

(Appendix B)

TABLE 19

REFINING BY LEACHING, CRYSTALLIZATION (20.0% K_2O)
(FLOTATION NOT USED)

PRODUCTION COST ESTIMATE

Product: Potassium Chloride Symbol: KCl
At: Holbrook, Arizona Company: Arkla Exploration Company
Estimated By: Arthur G. McKee & Company Date: February 1966
At: San Francisco, California

Ore feed rate	3,370,000 tons per yr
Production of potassium chloride	1,000,000 tons per yr
Capital Investment, Ip	$11,700,000

ASSUMPTIONS

Ore averages 31.7 percent KCl, equivalent to 20.0 percent K_2O.

Power: connected motor load 1860 hp, equivalent to 1140 kw for 8000 hr per yr.

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

ton quantities are short tons of 2000 pounds.

RAW MATERIALS	Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr	$ per ton of ore	$ per ton of KCl product
TOTAL RAW MATERIALS							
Labor (L)	man-years	8	7,000	56,000			
Supervision (S) = 10% of L				5,600			
Labor Benefits 20% of L + S				12,320			
Steam	1000 lb	342,000	0.65	222,300			
Electricity	kwhr	9,120,000	.01	91,200			
Air		allowance		1,000			
Water – Purch. or Process	1000 gal	137,000	.10	13,700			
Water – Plant or Cooling		1,420,000	.03	42,600			
Fuel – Gas - Coal - Oil		allowance		2,000			
Maintenance – Minor) (M) = 2% of Ip				234,000			
Maintenance – Major)							
Factory Supplies 1% of Ip				117,000			
Laboratory				60,000			
DIRECT CONVERSION					857,720	0.255	0.858
Depreciation 15 years, linear				780,000			
Controllable Indirect 35% of L +S + M				103,460			
Non-Controllable Indirect 3% of Ip				351,000			
INDIRECT CONVERSION					1,234,460	.366	1.234
TOTAL ~~MFG~~ COST IN BULK					2,092,180	.621	2.092
Rounded					2,090,000	62	2.09
Packing Cost							
Shipping Cost							
TOTAL COST F.O.B.							

TABLE 20

11

COMPACTION SECTION

PRODUCTION COST ESTIMATE

Product Granular Potassium Chloride Symbol KCl

At Holbrook, Arizona Company Arkla Exploration Company

Estimated By Arthur G. McKee & Company Date February 1966

At San Francisco, California

ASSUMPTIONS

This section includes two Allis-Chalmers presses, model 2424C
Operating time per year is 7875 hours.
Each press uses 15 gpm of water.
Power: connected load is 554 hp, or a total of 335 kw for 7875 hr.
Labor: half the time of one operator (from dryer section) on each of three shifts per day. One half man, times four crews, is two man-years.

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

Production Rate	100,000 tons per yr 304 tons per day 12.7 tons per hr
Capital Investment, Ip	$ 750,000

RAW MATERIALS	Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr	$ per ton of compacted product	$ per ton of Total KCl production
TOTAL RAW MATERIALS							
Labor (L)	man-years	2	7,000	14,000			
Supervision (S) - 10% of L				1,400			
Labor Benefits 20% of L + S				3,080			
Steam		allowance		200			
Electricity	kwhr	2,638,000	.01	26,380			
Air		allowance		100			
Water – Purch. or Process							
Water – Plant or Cooling	1000 gal	14,200	.03	426			
Fuel – Gas - Coal - Oil							
Maintenance – Minor) (M) = 4% of Ip				30,000			
Maintenance – Major)							
Factory Supplies 1% of Ip				7,500			
Laboratory		allowance		3,000			
DIRECT CONVERSION					86,086	0.861	0.086
Depreciation 15 years, linear				50,000			
Controllable Indirect 35% of L + S + M				15,890			
Non-Controllable Indirect 3% of Ip				22,500			
INDIRECT CONVERSION					88,390	.884	.088
TOTAL ~~XXXX~~ COST IN BULK					174,476	1.745	.174
Rounded					170,000	1.74	.17
Packing Cost							
Shipping Cost							
TOTAL COST F.O.B.							

ARTHUR G. McKEE & COMPANY
NONFERROUS METALS & MINERALS DIVISION

TABLE 21

DRYING SECTION

PRODUCTION COST ESTIMATE

Product: Dried Potassium Chloride — Symbol: KCl

Plant: Holbrook, Arizona — Company: Arkla Exploration Company

Estimated By: Arthur G. McKee & Company — Date: February 1966

At: San Francisco, California

Production rate (Includes both flotation and crystallizer products.)	1,000,000 tons per yr
Capital Investment, Ip	$ 850,000 (Includes feed belts to dryer and delivery to screen section.)

ASSUMPTIONS

The use of three dryers is assumed, one each for granular, coarse, and standard product.

~~Moisture content of feed is 6 percent, of product is 0.1 percent.~~

The fuel is natural gas with 1100 Btu(gross) per cubic foot.

Fuel oil is a standby fuel.

Operating time is 8400 hr per yr.

Power: connected load is 500 hp, or 300 kw for 8400 hr.

Labor: assume one-half man per shift, 3 shifts per day (four crews) or two man-years.

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

RAW MATERIALS	Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr		$ per ton of total KCl product
TOTAL RAW MATERIALS							
Labor (L)	man-years	2	7,000	14,000			
Supervision (S) = 10% of L				1,400			
Labor Benefits 20% of L + S				3,080			
Steam							
Electricity	kwhr	2,520,000	0.01	25,200			
Air		allowance		250			
Water – Purch. or Process							
Water – Plant or Cooling							
Fuel – Gas ~~Coal x Oil~~	1000 cu ft	375,000	.30	112,500			
Maintenance – Minor) (M) = 2% of Ip				17,000			
Maintenance – Major)							
Factory Supplies 0.5% of Ip				4,250			
Laboratory				5,000			
DIRECT CONVERSION					182,680		0.183
Depreciation 15 years, linear				56,670			
Controllable Indirect 35% of L + S + M				11,340			
Non-Controllable Indirect 3% of Ip				25,500			
INDIRECT CONVERSION					93,510		.093
TOTAL ~~MFG~~ COST IN BULK					276,190		.276
Rounded					280,000		.28
Packing Cost							
Shipping Cost							
TOTAL COST F.O.B.							

S-11

S EENING, STORAGE, AND LC DING

PRODUCTION COST ESTIMATE

Product Potassium Chloride Symbol KCl

At Holbrook, Arizona Company Arkla Exploration Company

Estimated By Arthur G. McKee and Company Date February 1966

At San Francisco, California

Production rate	1,000,000 tons per yr 125 tons per hr (screening)
Design particle size ratio:	Granular 25% Coarse 25% Standard 50%
Capital Investment, Ip	$ 3,700,000

ASSUMPTIONS

The product is produced in three grades based on particle size: granular, coarse, and standard.

Screening will operate 3 shifts per day, 8400 hr per yr.

Loading and shipping operates 2 shifts per day, 4000 hr per yr.

Labor:

Screening, 2 men per shift, 4 crews, plus 1 laborer. Total men = 9

Storage, loading 19

RAW MATERIAL COST

MATERIAL	UNIT	AT SOURCE	FREIGHT	UNLOADING	IN STOCK

PACKING COST

Kind				
Capacity				
Cost of Container				
Cost of Liner				
Packing Labor				
Other Costs				
Total Cost per Container				
Proportion Each Type				

NOTES

ack or bag charges are not included since these are generally passed on to the uyer at or near cost, resulting in the same net return on sacked or bulk material.

RAW MATERIALS	Units	AMOUNT per yr	$ PER unit	$ per yr	$ per yr		$ per ton of product
TOTAL RAW MATERIALS							
Labor (L)	man-years	28	6,000	168,000			
Supervision (S) = 10% of L				16,800			
Labor Benefits 20% of L + S				36,960			
Steam							
Electricity	kwhr	880,000	0.01	8,800			
Air		allowance		1,000			
Water – Purch. or Process							
Water – Plant or Cooling							
Fuel – Gas - Coal - Oil							
Maintenance – Minor) (M) = 2% of Ip				74,000			
Maintenance – Major)							
Factory Supplies 0.5% of Ip				18,500			
Laboratory				60,000			
DIRECT CONVERSION					384,060		0.384
Depreciation 15 years, linear				246,670			
Controllable Indirect 35% of L + S + M				90,580			
Non-Controllable Indirect 3% of Ip				111,000			
INDIRECT CONVERSION					448,250		.448
TOTAL COST IN BULK					832,310		.832
Rounded					830,000		.83
Packing Cost							
Shipping Cost							
TOTAL COST F.O.B.							

ARTHUR G. McKEE & COMPANY

NONFERROUS METALS & MINERALS DIVISION

TABLE 1-A
CAPITAL AND OPERATING COST SUMMARY
(FLOTATION PROCESS)

Plant for production of 1,000,000 tons per year of potassium chloride (KCl).
Arkla Exploration Company, Holbrook, Arizona

ORE ANALYSIS:

Plant Section	12.5% K_2O equivalent Capital Cost $	12.5% K_2O equivalent Capital Cost $	12.5% K_2O equivalent Production Cost $ per ton of ore	12.5% K_2O equivalent Production Cost $ per ton of product	16.0% K_2O equivalent Capital Cost $	16.0% K_2O equivalent Capital Cost $	16.0% K_2O equivalent Production Cost $ per ton of ore	16.0% K_2O equivalent Production Cost $ per ton of product	20.0% K_2O equivalent Capitol Cost $	20.0% K_2O equivalent Capitol Cost $	20.0% K_2O equivalent Production Cost $ per ton of ore	20.0% K_2O equivalent Production Cost $ per ton of product
Mine												
Shafts and stations	1,842,000				1,842,000				1,842,000			
Underground development	399,000				349,000				313,000			
Surface plant and hoists	1,858,000				1,548,000				1,327,000			
Underground equipment	6,489,000				5,408,000				4,635,000			
		10,588,000	1.98	10.70		9,147,000	2.06	8.67		8,117,000	2.14	7.23
Process Plant												
Feed preparation	4,140,000		.17	.93	3,450,000		.19	.79	2,960,000		.20	.68
Flotation	3,500,000		.29	1.55	2,500,000		.33	1.40	2,190,000		.40	1.34
Leaching, crystallizing	4,700,000		.19	1.01	4,700,000		.24	1.01	4,700,000		.30	1.01
Compaction	750,000		.03	.17	750,000		.04	.17	750,000		.05	.17
Drying	850,000		.05	.28	850,000		.07	.28	850,000		.08	.28
Screening, storage, loading	3,700,000		.15	.83	3,700,000		.20	.83	3,700,000		.25	.83
		17,640,000				15,950,000				15,150,000		
Utilities		1,360,000				1,360,000				1,360,000		
Non-process Facilities		1,550,000				1,550,000				1,550,000		
Mine and Plant Capital Cost		31,138,000				28,007,000				26,177,000		
Working Capital		5,600,000				5,100,000				4,800,000		
Total Investment		36,738,000				33,107,000				30,977,000		
Total Production Costs			2.86	15.47			3.13	13.15			3.42	11.54

TABLE 1-B
CAPITAL AND OPERATING COST SUMMARY
(LEACH-CRYSTALLIZATION PROCESS)

Plant for production of 1,000,000 tons per year of potassium chloride (KCl).
Arkla Exploration Company, Holbrook, Arizona

ORE ANALYSIS:	12.5% K_2O equivalent				16.0% K_2O equivalent				20.0% K_2O equivalent			
	Capital Cost		Production Cost		Capital Cost		Production Cost		Capital Cost		Production Cost	
Plant Section	$	$	$ per ton of ore	$ per ton of product	$	$	$ per ton of ore	$ per ton of product	$	$	$ per ton of ore	$ per ton of product
Mine												
Shafts and stations	1,842,000				1,842,000				1,842,000			
Underground development	399,000				349,000				313,000			
Surface plant and hoists	1,858,000				1,548,000				1,327,000			
Underground equipment	6,489,000				5,408,000				4,635,000			
		10,588,000	1.98	10.70		9,147,000	2.06	8.67		8,117,000	2.14	7.23
Process Plant												
Feed preparation	4,140,000		.17	.93	3,450,000		.19	.79	2,960,000		.20	.68
Leaching, crystallizing	14,000,000		.47	2.55	12,650,000		.54	2.28	11,700,000		.62	2.09
Drying	850,000		.05	.28	850,000		.07	.28	850,000		.08	.28
Screening, storage, loading	3,700,000		.15	.83	3,700,000		.20	.83	3,700,000		.25	.83
		22,690,000				20,650,000				19,210,000		
Utilities		1,360,000				1,360,000				1,360,000		
Non-process Facilities		1,550,000				1,550,000				1,550,000		
Mine and Plant Capital Cost		36,188,000				32,707,000				30,237,000		
Working Capital		5,600,000				5,100,000				4,800,000		
Total Investment		41,788,000				37,807,000				35,037,000		
Total Production Costs			2.82	15.29			3.06	12.85			3.29	11.11

TABLE 2
DATA FOR PROFIT ANALYSIS

PROCESS:

DOLLARS IN THOUSANDS

No.	Item	Data Source	Flotation Process 12.5	Flotation Process 16.0	Flotation Process 20.0	Leach-Crystallization Process 12.5	Leach-Crystallization Process 16.0	Leach-Crystallization Process 20.0
	Ore Analysis, % K_2O:							
1.	Process investment (mine and plant)	Tables 1-A, B	28,228	25,097	23,267	33,278	29,797	27,327
2.	Utilities investment	Table 3	1,360	1,360	1,360	1,360	1,360	1,360
3.	Non-process investment	Table 4	1,550	1,550	1,550	1,550	1,550	1,550
4.	Pre-production and exploration expense	allowance	2,000	2,000	2,000	2,000	2,000	2,000
5.	Interest charges during construction (One year on items 1 to 4 at 5.5 percent)		1,823	1,650	1,550	2,100	1,909	1,773
6.	Total Fixed Capital (Sum of items 1 to 5)		34,961	31,657	29,727	40,288	36,616	34,010
7.	Working Capital	Table 6	5,600	5,100	4,800	5,600	5,100	4,800
8.	Total Capital Investment (Sum of items 6, 7)		40,561	36,757	34,527	45,888	41,716	38,810
9.	Annual net sales (1,000,000 tons at $27 per ton)		27,000	27,000	27,000	27,000	27,000	27,000
10.	Annual production costs (includes depreciation)	Tables 7-22	15,470	13,150	11,540	15,290	12,850	11,110
11.	Annual gross plant profit (Item 9 less item 10)		11,530	13,850	15,460	11,710	14,150	15,890
	Expenses:							
12.	Administration, sales, research (6 percent of item 9)		1,620	1,620	1,620	1,620	1,620	1,620
13.	Royalties (allowance of $1.05 per ton product)		1,050	1,050	1,050	1,050	1,050	1,050
14.	Annual interest charges (5.5 percent of item 6)		1,923	1,741	1,635	2,216	2,014	1,871
15.	Profit before taxes (Item 11 minus sum of items 12 to 14)		6,937	9,439	11,155	6,824	9,466	11,349
16.	Depletion ($1 per ton)	allowance	1,000	1,000	1,000	1,000	1,000	1,000
17.	Taxable income (Item 15 minus item 16)		5,937	8,439	10,155	5,824	8,466	10,349
18.	Federal income tax (50 percent of item 17)	allowance	2,968	4,220	5,078	2,912	4,233	5,174
19.	Profit after taxes (Item 17 minus item 18)		2,969	4,219	5,077	2,912	4,233	5,175
20.	Depreciation plus Depletion	Item 16 and Tables 7-22	3,073	2,834	2,690	3,410	3,147	2,961
21.	Cash Flow (Item 19 plus item 20)		6,042	7,053	7,767	6,322	7,380	8,136
22.	Percent return on original invest ($\frac{100 \times \text{item } 21}{\text{item } 8}$)		14.9	19.2	22.5	13.8	17.7	20.9
23.	Payout time, years ($\frac{\text{Item } 6}{\text{Item } 21}$)		5.8	4.5	3.8	6.4	5.0	4.2

TABLE 6

WORKING CAPITAL ESTIMATE

	Flotation Process			Leach-Crystallization Process		
Ore Analysis, % K_2O	12.5	16.0	20.0	12.5	16.0	20.0
Production Cost from Table 1, $ per ton KCl	15.47	13.15	11.54	15.29	12.85	11.11
	Thousands of dollars					
1) Cash: (30 days production cost)	1,289	1,096	962	1,274	1,071	926
2) Accounts Receivable: (1/12 of annual sales)	2,250	2,250	2,250	2,250	2,250	2,250
3) Inventories:						
a) Stored product (100,000 tons)	1,547	1,315	1,154	1,529	1,285	1,111
b) Reagents, operating supplies	25	25	25	25	25	25
c) Materials in process	50	50	50	50	50	50
d) Spare parts	200	200	200	200	200	200
4) Plant Startup, 1% of Capital Cost of Proc. plant and utilities	190	173	165	241	220	206
Total Working Capital	5,551	5,109	4,806	5,569	5,101	4,768
Rounded	5,600	5,100	4,800	5,600	5,100	4,800

Note: This table has been computed from average percentages derived from reports of companies in the industry. The figures could be exceeded in years when potash is in long supply and inventory costs are higher.

HOLBROOK POTASH DEPOSIT APACHE COUNTY

NJN WR 9/2/83: Provided Hal Susie and Mark Jordan of the Arizona State Land Department with information on the Holbrook Potash Deposit from our New Mexico and Arizona Land Co. file and Arkla Exploration file. Mr. Jordan reported that they have additional information on the deposit from a drilling project which occurred in the 1970's. The State Land Department is evaluating its lands in Apache and Navajo Counties south of the Indian reservation to see which it should trade/sell/consolidate before the Navajo-Hopi relocation takes place.

NJN WR 4/29/83: Provided mineralogical data on some evaporite and potash minerals to Coyd Yost, registered consulting geologist. Mr. Yost was doing some work for a client interested in the potash potential of the Holbrook Evaporite Basin, Navajo County.

NJN WR 4/17/87: Created a Holbrook Potash Deposit file, Navajo County. This file contains information from the Arkla file (Arkansas Louisiana Gas Co) and has been added to ~~Navajo~~ Apache MILS.

ARKLA EXPLORATION
COMPANY
P. O. BOX 1734 SHREVEPORT, LOUISIANA 71102

April 30, 1965

Mr. E. L. Gorsuch
New Mexico Arizona Land Company
808 Bank of New Mexico Bldg.
Albuquerque, New Mexico

Chemical Assays on (1) Holbrook Area
(2) Santa Claus Area

Dear Lee:

Attached is a zerox copy of a chemical assay received today on A.E.C. #25 Pete in the Santa Claus Area and A.E.C. #14 State in the Holbrook Area.

I will keep you informed on any phone calls I receive.

Very truly yours,

ARKLA EXPLORATION COMPANY

R. L. Breedlove
Chief Geologist

RLB:aw

cc: Mr. W. H. Thomas
Mr. W. C. Bradford

ARKLA EXPLORATION COMPANY
COMPANY

INTERNAL CORRESPONDENCE

DATED AT HOLBROOK, ARIZONA
APRIL 6, 1965

TO: MR. R. L. BREEDLOVE

FROM: MR. W. E. CARR

SUBJECT: CORE ANALYSIS RESULTS, ARKLA NO. 27X NMA

SIXTEEN SAMPLES FROM TWO CORES WERE SHIPPED VIA AIR FREIGHT TO CORE LABORATORIES, FARMINGTON, NEW MEXICO. RESULTS ARE AS FOLLOWS:

CORE NO. 3 714-723.4 RECOVERED 9.4'. SHALE TO 716.4, COCONINO SANDSTONE 716.4-723.4.

DEPTH	PERMEABILITY-MD	POROSITY-%	WATER SATURATION-%
717	58	13.9	87.8
717.5	93	15.7	89.1
718.5	81	15.2	89.5
719.5	118	17.4	89.0
720.5	67	18.0	92.8
721.5	121	17.8	91.1
722.5	102	16.2	85.8
723.4	134	17.9	80.5

CORE NO. 4 723.4-731.4 RECOVERED 8' COCONINO SANDSTONE.

DEPTH	PERMEABILITY-MD	POROSITY-%	WATER SATURATION-%
723.9	94	17.4	90.8
724.9	89	17.1	87.7
725.9	164	14.8	85.2
726.9	73	19.6	88.8
727.9	29	19.9	87.4
728.9	69	15.5	86.5
729.9	181	20.5	86.8
730.9	132	17.8	90.0

APPEARANCE OF THE CORES SUGGESTS THAT THERE WAS CONSIDERABLE FILTRATE INVASION, AND IT IS BELEIVED THAT TRUE WATER SATURATION WOULD BE SOMEWHAT LESS THAN INDICATED BY ANALYSIS. HOWEVER, ELECTRICAL LOGS INDICATE THAT THE PENETRATED PART OF THE COCONINO WOULD BE WATER PRODUCTIVE.

Warren

WEC/SK

13X. to
L Gorsuch w
NMA

ARKLA EXPLORATION COMPANY
COMPANY

INTERNAL CORRESPONDENCE

DATED AT HOLBROOK, ARIZONA
APRIL 28, 1965

TO: MR. R. L. BREEDLOVE

FROM: MR. W. E. CARR

SUBJECT: RADIOMETRIC AND CHEMICAL ANALYSIS BY CSM RESEARCH FOUNDATION, AEC #14 STATE

DEPTH	RADIOMETRIC	CHEMICAL
1002.7-03	1.0	
03-04	1.6	
04-05	4.4	2.68
05-06	9.0	8.13
06-07	10.7	6.42
07-08	14.0	9.78
08-09	8.5	7.36
09-10	4.6	3.20
1010-11	8.7	7.57
11-12	5.2	4.86
12-13	3.9 /	2.22 /
13-14	18.2	17.7
14-15	18.8	17.4
15-16	9.6 14%	6.11 10%
16-17	5.1	4.46
17-18	4.9 /	3.83 /
18-19	4.1	3.14
19-20	6.3	4.26
1020-21	8.2	7.67
21-22	5.0	
22-23	3.5	

WEC/SK

Warren

State of Arizona
Arizona Geological Survey
416 W. Congress, Suite 100
Tucson, Arizona 85701
(520) 770-3500

Jane Dee Hull
Governor

Larry D. Fellows
Director and State Geologist

January 8, 1998

Nyal Niemuth
ADMMR
1502 W. Washington
Phoenix, AZ 85007

Nyal:

Enclosed is the assay and lithology log for the well in A(18-25)24. It is our well #2053, and is named KCL #8 (for Kern County Land Co.).

I hope it's a good year for you!

Sincerely,

Tom McGarvin
Geologist

#2053

Kern County Land Company #8

T18N, R25E, Sec 24

ASSAY REPORT AND DISCUSSION

Depth From	Depth To	Interval (ft)	K_2O as S	K_2O as C	Analysis K_2O	Na	Mg	Ca	Cl	SO_4	Insol H_2O	Insol acid	Minerals H	S	C	A
1352.60	1353.75	1.15	3.31	0.39	3.70	25.99	0.20	0.40	68.09	0.96	17.40	12.40	73.69	5.26	2.29	1.36
1353.75	1355.10	1.45	3.33	0.62	3.73	22.35	0.32	0.47	38.94	1.13	31.77	25.10	58.08	4.89	3.36	1.60
1358.50	1359.55	1.05	0.51	0.10	0.61	36.53	0.05	0.19	56.90	0.46	5.14	2.75	92.86	0.73	0.57	0.65
1359.55	1360.00	0.45	0.71	0.04	0.75	37.82	0.02	0.07	53.92	0.17	2.29	0.61	96.13	1.11	0.23	0.24
1360.00	1360.60	0.60	1.88	0.64	2.52	25.63	0.33	0.82	42.46	1.97	25.18	16.50	65.27	2.99	3.77	2.79
1360.60	1361.15	0.55	2.78	0.58	3.36	26.32	0.30	0.90	44.02	2.16	22.18	15.98	66.90	4.43	3.63	3.06
1361.15	1362.45	1.30	0.62	0.06	0.68	37.27	0.03	0.40	58.05	0.96	2.60	0.52	94.71	0.99	0.34	1.36
1362.45	1363.90	1.45	0.31	0.06	0.37	37.45	0.03	0.58	58.12	1.29	1.99	0.12	95.19	0.51	0.34	1.37
1363.90	1364.30	0.40	0.12	0.04	0.16	38.30	0.02	0.16	59.26	0.38	1.66	0.01	97.35	0.22	0.23	0.54
1364.30	1364.90	0.60	21.54	0.66	22.20	23.38	0.34	0.52	53.77	1.25	0.80	---	59.43	34.11	3.89	2.57
1364.90	1366.35	1.45	2.72	2.27	4.99	30.38	1.17	0.85	54.06	2.04	2.16	---	77.22	4.36	13.37	5.05
1366.35	1366.75	0.40	0.89	1.69	1.97	30.27	0.77	1.70	50.39	4.07	7.75	---	76.94	0.74	8.80	13.52
1366.75	1367.25	0.50	0.71	2.40	3.11	16.49	1.24	3.20	31.38	7.68	31.92	---	41.92	1.12	14.17	42.79
1367.25	1367.70	0.45	0.13	0.70	0.83	36.97	0.36	0.29	58.67	0.70	0.72	0.01	93.97	0.21	4.11	1.71
1367.70	1368.65	0.95	0.21	1.01	1.82	34.72	0.83	0.11	57.32	0.26	1.56	---	88.26	0.32	9.49	1.93
1368.65	1369.10	0.45	7.66	6.95	14.61	17.45	3.59	0.57	48.34	1.37	0.59	---	44.36	12.08	41.03	2.53
1369.10	1369.80	0.70	14.50	3.04	17.54	20.91	1.57	1.16	49.99	2.79	2.04	0.05	53.15	22.93	17.94	3.94
1369.80	1370.50	0.70	1.04	3.41	4.45	25.94	1.76	0.42	48.48	1.01	10.87	8.78	65.94	1.65	20.11	1.43
1370.50	1371.20	0.70	12.13	1.94	14.07	24.94	1.00	0.14	51.99	0.33	5.46	4.22	63.40	19.23	11.43	0.48
1371.20	1372.30	1.10	7.62	2.96	10.58	24.79	1.53	0.32	50.63	0.77	6.39	4.43	63.01	12.02	17.49	1.09
1372.30	1372.80	0.50	0.65	2.77	3.42	30.85	1.43	0.97	54.36	2.32	0.87	0.15	78.42	1.08	16.34	3.29
1372.80	1374.30	1.50	0.12	2.60	2.72	31.22	1.34	1.08	54.11	2.59	1.44	0.15	79.36	0.22	15.31	3.67
1374.30	1375.00	0.75	0.02	1.61	1.63	34.26	0.83	0.59	56.48	1.41	1.39	0.05	87.08	0.04	9.49	2.00
												4.38				
1369.10	1372.30	3.20	3.67	2.86	11.53											

Bbd No. 2

July 10, 1964

orm 3-A

DUVAL CORPORATION

Core Lithology, Supplemental Page

ELL NO. KCL-8 CORE LITHOLOGY PAGE NO. 1

T18N, R25E, Sec. 24

DEPTH (Feet) From	To	INTERVAL Feet		ESTIM. % Shale	A	DESCRIPTION	
		Abbreviations:				H - Halite	G - Gypsum
						A - Anhydrite	C-S - Clay-Silt
						P - Polyhalite	med.g. - medium grained
						S - Sylvite	clr - clear
						C - Carnallite	occ. - occasional
						f.g. - fine grained	v - very
						c.g. - coarse grained	incr. - increasing
						incl. - inclusions	decr. - decreasing
						irreg. - irregular	brn - brown
1284	9					STARTED CORING	
1284	9	1294	2	9	3	-	100 A, lt. gray, mottled.
1294	2	1300	3	6	1	97	3 C-S, red-brn., soft; few small white A blebs,
							irreg. 0.1' band at 1295.5'.
1300	3	1301	7	1	4	-	100 A, lt. gray.
1301	7						TOP OF SALT
1301	7	1302	5	0	8	1	3 H, clr., med.g.; few small white A stringers;
							v. few small red-brn. C-S incls.
1302	5	1305	2	2	7	5	1 H, med. - c.g.; few small - med. brn. C-S
							incls., 0.1' 80% zone at 1302.9'; v. few
							small white A stringers.
1305	2	1307	3	2	1	2	6 H, med.g.; several small-med. white A
							stringers; few small brn. C-S incls.
1307	3	1309	6	2	3	-	2 H, v. clr., med.g.; few small white A stringers
							& tan A/? zones.

3-A

DUVAL CORPORATION

Core Lithology, Supplemental Page

NO. KCL-8 CORE LITHOLOGY PAGE NO. 2

DEPTH (Feet) From		To		INTERVAL Feet		ESTIM % Shale	Ss	DESCRIPTION
09	6	1310	3	0	7	25	4	H, f.g.-med.; many med.-lg. brn. C-S incls.; several small white A blebs & stringers.
10	3	1311	8	1	5	55	3	C-S, brn., med. hd., & H, med.g., as irreg. zones; few med. white A blebs.
11	8	1313	6	1	8	12	3	H, f.g.-med.; several med. brn. C-S incls.; few small white A stringers.
13	6	1314	0	0	4	70	1	C-S, brn., med. soft; some H, med.; v. few small white A stringers.
14	0	1316	6	2	6	20	3	H, f.g.-med.; many small-lg. brn. C-S incls. & zones; few small-med. white A stringers.
16	6	1317	3	0	7	75	4	C-S, lt. red-brn., med. hd.; some H, f.g.-med., as irreg. zones & veinlets.
17	3	1318	8	1	5	20	2	H, med.g.; many lg. brn. C-S incls., few small white A blebs.
18	8	1320	5	1	7	35	2	H, med.g.; many small-lg. brn. C-S incls., 0.2' 80% sonerat top; few small white A stringers.
0	5	1321	7	1	2	75	2	C-S, lt. brn., med. hd.; some H, f.g.- med.; few small white A stringers & blebs.
21	7	1323	3	1	6	8	2	H, med.g., numerous small brn. C-S incls; few white A blebs & stringers.
23	3	1327	2	3	9	3	2	H, med.g.; few small brn. C-S incls. grading out down; few small white A stringers.

Form 3-A

DUVAL CORPORATION

Core Lithology, Supplemental Page

WELL NO. KCL-8 — CORE LITHOLOGY — PAGE NO. 3

DEPTH (Feet) From		To		INTERVAL Feet		ESTIM % Shale	A	DESCRIPTION
1327	2	1333	6	6	4	-	95	A, lt. gray to white; few small H intergrowths
								in the middle 1/3.
1333	6	1333	8	0	2	25	75	A, white, some brn. C-S.
1333	8	1335	1	1	3	4	6	H, clr. med.g.; few small brn. C-S incls.
								grading in down; numerous white A stringers
								in upper 2/3. 1/2" band at top.
1335	1	1338	7	3	6	40	4	H, f.g. to med.; many v. lg. brn. C-S incls.
								& zones, 0.4' 70% zone at 1337.0'; few small
								white A stringers.
1338	7	1340	6	1	9	18	3	H, med.g.; numerous small to med. brn. C-S
								incls. decr. down from 25% to 10%, $\frac{1}{2}$" band
								at base.; few med. white A blebs.
1340	6	1343	0	2	4	5	3	H, med.g.; some small to lg. brn. C-S incls.,
								few small white A stringers.
1343	0	1344	1	1	1	8	2	H, med.-c.g.; several small-med. brn. C-S
								incls.; few small white A stringers.
1344	1	1346	2	2	1	3	2	H, clr., med.g.; few small - med. brn. C-S
								incls. & small white A stringers.
1346	2	1349	6	3	4	4	2	H, med.g.; few small-med. brn. C-S incls.
								decr. down from 6% to 2%; few small white
								A stringers.
1349	6	1350	4	0	8	3	3	H, clr., med.g.; few small white A stringers;
								occ. brn. C-S incls.

Form 1-A

DUVAL CORPORATION

Core Lithology, Supplemental Page

WELL NO. KCL-8 — CORE LITHOLOGY — PAGE NO. 4

DEPTH (Feet) From		To		INTERVAL Feet		ESTIM % Sheaf	A	DESCRIPTION
1350	4	1350	9	0	5	25	3	H, f.g.- med.; numerous small-med. brn. C-S incls.; few small white A stringers; occ. small red S blebs. Est. K_2O/S = 1%.
1350	9	1352	6	1	7	75	1	C-S, brn., med. soft; some med. H incls. & pink schistose fracture fillings; v. few white A blebs.
1352	60	1353	75	1	15	18	2	H, med.g.; some med.-lg. brn. C-S incls.; few small red S blebs & white A stringers. Est. K_2O/S = 3%.
1353	75	1355	20	1	45	22	1	H, f.g.-med.; some lg. brn. C-S incls; few small red-rimmed milky S blebs; v. few red C blebs & white A stringers. Est. K_2O/S = 3% Est. S = 2%.
1355	20	1356	20	1	0	60	-	C-S, brn., 0.35' 80% zone at top, 0.25' 80% zone at base; H, med.; few small red S blebs. Est. K_2O/S = 2%.
1356	20	1356	80	0	60	18	-	H, med.g.; some brn. C-S incls., decr. down from 30% to 5%; occ. v. small red S blebs. Est. K_2O/S = less than 1%.
1356	80	1358	20	1	40	22	2	H, med.g.; numerous small-lg. brn. C-S incls. decr. down from 30% to 1%; few small white A stringers & red S blebs. Est. K_2O/S = 1%.

Form 3-A

DUVAL CORPORATION

Core Lithology, Supplemental Page

WELL NO. KCL-8 CORE LITHOLOGY PAGE NO. 5

DEPTH (Feet) From		DEPTH (Feet) To		INTERVAL Feet		ESTIM. % Shale	ESTIM. % Sd	DESCRIPTION
1358	20	1358	50	0	30	65	-	C-S, brn.; few thin H, f.g., veinlets; 0.1'
								90% H at top.
1358	50	1359	55	1	05	4	2	H, med.g.; few small brn. C-S incls., grading
								out down; few small red-rimmed milky S blebs
								& white A stringers; v. few red C blebs.
								Est. K_2O/S = 2%, Est. C = 1%
1359	55	1360	00	0	45	2	2	H, clr., med.g.; few lg. brn. C-S incls. &
								small white A stringers; v. few red. S blebs.
								Est. K_2O/S = 1%.
1360	00	1360	60	0	60	60	3	C-S, brn., med. soft; some H, med.g., as irreg.
								zones; few small white A blebs.
								Est. K_2O/S = 0%.
1360	60	1361	15	0	55	18	-	H, f.g.-med.; some v. lg. brn. C-S incls.;
								few small red S blebs.
								Est. K_2O/S = 1%.
1361	15	1362	45	1	30	2	1	H, med.g.; few small red to milky S blebs &
								brown C-S incls.; v. few small white A blebs.
							0.7	Est. K_2O/S = 3%.
1362	45	1363	90	1	45	-	4	H, clr. med. to c.g.; few small white A
								stringers & v. small red S blebs.
							0.4	Est. K_2O/S = 1%.
1363	90	1364	30	0	40	-	2	H, v. clr. med. to c.g.; few v. small white A
								stringers & small maroon C blebs; occ. clr. S
							0.2	blebs. Est. K2O/S is less than 1%; C = 1

Form 3-A

DUVAL CORPORATION

Core Lithology, Supplemental Page

WELL NO. KCL-8 CORE LITHOLOGY PAGE NO. 6

DEPTH (Feet) From		To		INTERVAL Feet		ESTIM. % Shale	A	DESCRIPTION
1364	30	1364	90	0	60	-	4	H, clr. med. to c.g. & S, c.g., milky; few
								small white A stringers grading in down; v.
								few maroon C blebs.
							22.2	Est. K_2O/S = 25%, Est. C = 1%
1364	90	1366	35	1	45	-	6	H, clr. med. to c.g.; several small white A
								stringers; few med.g., clr. S blebs & small C
								blebs.
							5.2	Est. K_2O/S = 4%, Est. C = 2%.
1366	35	1366	75	-	40	-	25	H, clr., c.g.; some light gray A, 0.1' 60%
								zone at top, 0.1' 40% zone at base; few small
								clr. S blebs & tan C blebs.
							2.1	Est. K_2O/S = 1%; Est. C = 2%.
1366	75	1367	25	-	50	-	55	A, lt. gray; some H, med.g. intergrowths; few
								small maroon C blebs.
							3.4	Est. C = 6%.
1367	25	1367	70	-	45	-	2	H, clr. med.g.; few med. clr. C blebs & small
								white A stringers.
							0.8	Est. C = 2%.
1367	70	1368	65	-	95	-	-	H, v. clr., med. to c.g.; v. few small clr. C
								blebs.
								Est. C = 2%.
								(Approx. 0.2' broken chips recovered)

DUVAL CORPORATION

Core Lithology, Supplemental Page

O. KCL-8 CORE LITHOLOGY PAGE NO. 7

DEPTH (Feet) From		To		INTERVAL Feet		ESTIM. % Sheln	A	DESCRIPTION
68	65	1369	10	-	45	-	5	H, med. to c.g.; several irreg. lg. maroon
								C blebs, few med. S blebs & gray A stringers.
							14.6	Est. C = 12% Est. K_2O/S = 2%.
369	10	1369	80	-	70	-	6	H, clr. c.g.; some lg. red-rimmed milky S
								blebs; 0.1' 80% S zone at top; several irreg.
								red C blebs & zones, & white A stringers.
								v. few green C-S incls.
							18.7	Est. K_2O/S = 15% Est C = 11%
369	80	1370	50	-	70	6	4	H, med.g.; some lg. red C blebs & zones,
								few lg. gray-green C-S incls. few small clr.
								S blebs & white A stringers.
							4.6	Est. C = 30%, Est. K_2O/S = 4%.
370	50	1371	20	-	70	5	3	H, med.g.; some lg. red-rimmed milky S blebs,
								few irreg. red C zones; few green C-S incls.
								& white A stringers.
							14.4	Est. K_2O/S = 16%; Est. C = 4%.
1371	20	20	1372	30	1	10	5	2 H, med.g.; some med. red-rimmed milky S blebs
								& irreg. red C zones Several small gray to
								green C-S incls.; few small white A blebs.
							11.2	Est. K_2O/S = 13% Est. C = 6%

Form 3-A

DUVAL CORPORATION

Core Lithology, Supplemental Page

WELL NO. KCL-8 CORE LITHOLOGY PAGE NO. 8

DEPTH (Feet) From		To		INTERVAL Feet		ESTIM. % Sheb	A	DESCRIPTION
1372	30	1372	80	-	50	3	6	H, med.g.; some lg. irreg. red C blebs; few small green C-S incls. & white A blebs; thin A parting at base; v. few small clr. to red S blebs. Est. C = 5% Est. K_2O/S is less than 1%
1372	80	1374	30	1	50	1	12	H, clr. med.g.; several small white A stringers, thin irreg. partings at 1373.40 & 1373.70; several small orange to red C blebs & zones, 0.1' 50% C zone at 1373.90; few small clr. S blebs; v. few small green C-S incls. Est. K_2O/S = 1% Est. C = 8%
1374	30	1375	00	0	70	-	8	H, clr., med.-c.g.; some med. white A stringers; few small maroon C blebs. Est. C = 3%.
1375	00	1376	4	1	4	1	2	H, clr., med.g.; few small white A stringers; v. few small brn. C-S incls., grading out down; v. few small milky S blebs. Est. K_2O/S = less than 1%.
1376	4	1378	4	2	0	45	6	H, f.g.-med., & C-S, red-brn., soft, incr. down from 25% to 65%; few med. white A stringers, ½" band at top.
1378	4	1378	5	0	1	-	-	C, red-clr., f.g. Est. C = 100%.

DUVAL CORPORATION

Core Lithology, Supplemental Page

L NO. KCL-8 CORE LITHOLOGY PAGE NO. 9

DEPTH (Feet) From		To		INTERVAL Feet		ESTIM % Shale		DESCRIPTION
373	5	1380	9	2	4	85	2	C-S, red-brn., soft; some H, f.g.-med., few small white A stringers & blebs.
380	9	1381	6	0	7	45	2	H, f.g.-med.,& C-S, red-brn.; few small white A stringers.
381	6	1384	9	3	3	22	3	H, med. to c.g.; several small to lg. brn. C-S incls. decr. down from 30% to 8%, 0.3' 80% at 1381.7; few small white A stringers.
384	9	1389	7	3	8	1	3	H, clr. to v. clr, med. to c.g.; few small white A stringers; ¼" band at 1387.7; v. few small brn. C-S incls.
389	7	1394	5	4	8	2	2	H, clr., med. to c.g.; few small brn. C-S incls. in top & bottom thirds; few small white A stringers, ½" band at base.
394	5	1397	6	3	1	70	6	C-S, red-brn., med. soft, decr. down from 80% to 60%; some H, med.g.; few med. A blebs & zones.
97	6	1399	6	2	0	9	3	H, med.g.; some small brn. C-S incls decr. down from 12% to 6%; few med. white A stringers.
99	6	1403	4	3	8	3	2	H, f.g. to med.; few small brn. C-S incls. & white A stringers.
403	4	1405	6	2	2	2	3	H, clr. in lower ½, med.g.; few small white A stringers & tan A/P blebs; few small brn. C-S incls. grading out down.

Form 3-A

DUVAL CORPORATION

Core Lithology, Supplemental Page

WELL NO. KCL-8 CORE LITHOLOGY PAGE NO. 10

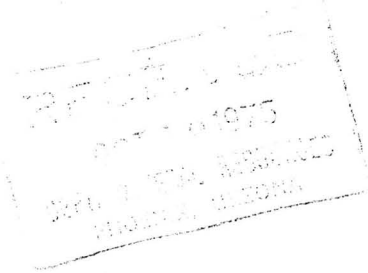
DEPTH (Feet) From		To		INTERVAL Feet		ESTIM. % Shale		DESCRIPTION
1405	6	1407	4	1	8	1	3	H, med.g.; few small white A stringers & tan A/P blebs; v. few small brn. C-S incls. grading out down.
1407	4	1411	4	4	0	-	2	H, v. clr., med. to c.g.; few small white A stringers.
1411	4	1413	2	1	8	90	4	C-S, red-brn., v. soft; few med. H. incls. & zones & white A blebs.
1413	2	1418	7	5	5	4	4	H, med.g.; some small brn. C-S incls. & white A stringers.
1418	7	1420	0	1	3	-	3	H, med. to c.g., clr.; few small tan A/P zones; occ. small brn. C-S incls.
1420								TOTAL DEPTH
								LOGGED BY Karl E. Ehlers

NEW MEXICO and ARIZONA LAND COMPANY

Camel Square, Suite 140B • 4350 East Camelback Road • Phoenix, Arizona 85018 • Telephone 602/959-8250

J. D. Sphar
Vice President—Minerals

October 18, 1976



Mr. John H. Jett, Director
Arizona Department of Mineral Resources
Mineral Building - Fairgrounds
Phoenix, Arizona 85007

Dear Mr. Jett:

Thank you for the recent courtesy you extended to us at your office. Enclosed is a copy of our engineering report on portions of the Holbrook salt basin containing potash deposits. This information is not considered confidential at this time.

Please note the the "black lines" on the copy are the result of the xerox machine, and were in fact highlighted in yellow crayon on my copy.

Regards,

J. D. Sphar

Enclosure

JDS:ko

ARTHUR G. McKEE & COMPANY
NONFERROUS METALS & MINERALS DIVISION
ENGINEERS AND CONTRACTORS

650 FIFTH STREET
SAN FRANCISCO, CALIF. 94107

CABLE ADDRESS
WKECO

March 18, 1966

Potash commodity
Holbrook Potash

ARKLA EXPLORATION COMPANY
P. O. Box 1439
Oklahoma City, Oklahoma

Attention: Mr. William C. Bradford
Exploration Coordinator

Reference: McKee Job No. 942-1
Arizona Potash Project
Preliminary Feasibility Study

Gentlemen:

The results of our Preliminary Feasibility Study of your potash prospect in the Holbrook Area in Arizona are presented in the attached report authorized by your letter dated December 22, 1965. Eleven copies are being sent according to the distribution given below.

The purpose of this initial study is to determine the economic feasibility of mining and processing potash ores using a 1,000,000 ton per year (60% K_2O) mine and plant complex as a base case. The capital and operating costs and profitability analyses developed indicate that the Holbrook deposit is not economically attractive. This report is preliminary in nature, but it will serve to reduce the "risk" element in your decision making and is as right as available factors allowed.

The opportunity to assist you with this study is appreciated. [redacted] We believe this report provides complete information within the scope of work. Please do not hesitate to call if there is any question whatsoever on the report.

Very truly yours,

ARTHUR G. McKEE & COMPANY
Nonferrous Metals & Minerals Division

R. K. Young
Manager Engineering

RKY:ws

cc: Mr. W.C.Bradford - 5 copies
Mr. W.Thomas - 3 copies
Mr. E.L.Gorsuch - 3 copies

ARIZONA POTASH PROJECT
PRELIMINARY FEASIBILITY STUDY

prepared for
ARKLA EXPLORATION COMPANY
Oklahoma City, Oklahoma

March 1966
McKee Report 942-1
Copy No. _____

ARTHUR G. McKEE & COMPANY
Nonferrous Metals & Minerals Division
San Francisco, California

TABLE OF CONTENTS

1. INTRODUCTION

This report presents the results of a preliminary technical and economic evaluation of a proposed project to mine and process potash ore from a deposit near Holbrook, Arizona.

The work of the evaluation was authorized by Arkla Exploration Company (Arkla) in their letter of December 22, 1965. That letter authorizes a preliminary feasibility study as described in a letter dated August 11, 1965, from Western Knapp Engineering, a division of Arthur G. McKee & Company (McKee).

For the purposes of this evaluation the capacities of the mine and processing plant are specified as large enough to produce 1,000,000 short tons per year of potassium chloride (potash). Product purity is 96.6 to 98.1 percent potassium chloride, equivalent to 61 to 62 percent potassium oxide (K_2O).

The scope of the evaluation includes consideration of ore reserves, mining plan, processing plant, non-process facilities and utilities, mine and plant capital and operating costs, and the economics of the project.

Capital and operating costs have been prepared from data for similar installations and factored to fit the Arkla design criteria.

2. SUMMARY

[redacted] time. The minimum acceptable return on investment [redacted] K_2O [redacted].

The basic design criteria for a mine and plant to produce 1,000,000 tons of potassium chloride (KCl) per year were developed from corehole data submitted by Arkla. [redacted] Further exploration is needed to establish an adequate reserve for twenty years of operation at the proposed rate. Details concerning the location of the ore bodies are shown in Figure 942-1X of Appendix C.

Two processes are in general use for recovery of a potassium chloride product from a potash ore: flotation; and leaching followed by crystallization. Costs were estimated for treating the ore by each of these processes. After the work of preparing the cost estimates had been nearly completed, laboratory test data was obtained that indicated that the flotation process would not give a suitable grade or yield of product, and that it would therefore be necessary to treat the ore by the leach-crystallization process.

The summarized capital and operating costs for both processes and three grades of ore are given in Tables 1A and 1B of Appendix B. The mine and leach-crystallization process plant

will cost about 36 million dollars, complete with utilities and supporting non-process facilities. The total mine and plant production cost will be $15.29 per ton of potassium chloride product. Details of the development of these costs are outlined in Tables 7 through 22 in Appendix B.

The leverage of grade on mining and on certain of the processing costs is so great that it appeared desirable to highlight this effect by comparison of a 12.5 percent deposit with deposits having 16 and 20 percent of equivalent. The costs for these three ore grades are developed in Tables 7 through 22.

A profit analysis for the two processes and the three ore grades is given in Table 2 in Appendix B. The return on the original investment is 13.8 percent for 12.5 percent K_2O ore and would increase to 17.7 and 20.9 percent for ore with 16 and 20 percent K_2O, respectively. Payout time is 6.4, 5.0, and 4.2 years for ore with 12.5, 16, and 20 percent K_2O, respectively. The returns would be slightly higher and the payout times shorter if the flotation process could be used.

3. CONCLUSIONS

In this study the return on investment is the annual cash flow (after-tax profit plus depreciation and depletion) as a percentage of the total investment, including working capital. Although cost estimates were prepared for the flotation process and for the leach-crystallization process, only the latter is considered technically feasible for this ore. The return on investment for the selected production level of 1,000,000 tons per year of potassium chloride by leach-crystallization is given below for mine-run ore grades of 12.5, 16.0, and 20.0 percent K_2O. The economic data is developed in more detail in Table 2 (Appendix B).

Grade of Ore, percent K_2O equivalent	Total Capital	Potash Costs, fob Plant $ per short ton	Payout, years	Return, percent
[redacted]				
16.0	41,716,000	12.85	5.0	17.7
20.0	38,810,000	11.11	4.2	20.9

Payout time in years is obtained by dividing the fixed capital investment by the annual cash flow.

[redacted]

The target ore reserve for an operation producing 5,400,000 tons of ore per year over a period of 20 years would be approximately 15 sections or less than half a township. This is rather a small target when compared to the acreage held by Arkla, [redacted]

[redacted] work has not developed any "teaser" areas, nor do any of the holes warrant offset drilling to confirm original results or to develop ore trends in a reduced area of influence per drill hole.

The ratio of coverage is 28 out of 220 or 1 to 8. It is generally considered that one-tenth of the number of holes needed for complete coverage is enough to give a fair estimate of the value of a flat-bedded ore deposit. Based on our experience, it would appear [redacted]

4. ORE RESERVES

Potash deposits have recently been discovered in northern Arizona as a result of exploration by Arkla. An extensive bed and related salts was located in the vicinity of the Petrified Forest National Monument. Core samples from some parts of this deposit have been studied and the results are discussed here for the purpose of estimating the quantity and grade of ore that can be extracted.

The ore zones are approximately 13 miles east of Holbrook on highway US 260. The potash occurs in relatively flat-lying beds of evaporite consisting of halite, sylvite, carnallite, anhydrite, related salts and varying amounts of clay. The ore zone lies from 670 to 1302 feet below the surface. A total of nine holes penetrated ore four feet or more in thickness containing 12 percent or more of K_2O equivalent. Six of these holes penetrated ore five feet or more in thickness with more than 12 percent of K_2O equivalent.

Estimations regarding indicated ore reserves were based on information received from Arkla. In order to verify the work completed and the results obtained, McKee examined the property in January 1966.

The preliminary field exploration by Arkla consisted of core drilling a pattern of widely-spaced vertical holes from the surface into the mineralized zone. The holes were as much as two miles apart in some cases. Vertical core samples were taken and sometimes additional samples were obtained by whip-stocking.

To date, 36 holes have been drilled, representing a total of 52,972 feet of drilling. Core recovery has been in the range of 100 percent in the ore zone. Field exploration is continuing on the north side of the property. Samples were sent to various laboratories for verification of field testing and chemical analysis. The results of the assays run by T. J. Futch, Carlsbad, were accepted as most accurate by industry standards.

Ore Reserve Calculations

The estimate of the indicated ore reserves for this study is presented in three classifications: "Proven Ore", "Probable Ore", and "Possible Ore". In order to clarify these terms, definitions taken from "Mineral Valuations of the Future" by C. K. Leith (Maple Press, York, Pennsylvania) are quoted here: "Proved or assured ore is ore blocked out in three dimensions by actual underground mining operations, or by drilling, but it includes in addition minor extensions beyond the actual openings and drill holes, where the geological factors that limit the ore body are definitely known and where chance of failure of the ore body to reach these limits is so remote as not to be a factor in the practical planning of mining operations.

"Probable or semi-proven ore covers extensions near at hand, where the conditions are such that ore will probably be found but where the extent and limiting conditions cannot be so precisely defined as for proved ore. Semi-proven may also mean ore that has been cut by scattered drill holes but too widely spaced to assure continuity.

"Ore is classed as possible where the relations of the land to adjacent ore bodies and to geological structures warrant some presumption that ore will be found but where lack of exploration and development data precludes anything like certainty of its actual location or extent."

The estimated quantity and grade of the indicated ore reserves were calculated from Arkla data using the following assumptions:

1) The cutoff grade of the ore is 12 percent K_2O equivalent
2) The bulk density of the ore in place is 16 cubic feet to the ton

For calculation purposes, isocons of equal grade were plotted using thicknesses of four feet or greater and five feet or greater. The map included as drawing 942-1X in Appendix C shows the isocons based on thicknesses of 4 feet or greater. In estimating ore boundaries beyond the areas where drilling had been done, the contours were projected at similar intervals beyond the holes at the edges of the explored areas.

The ore was assumed to be a continuous layer between holes, but the grade varies. The isocon map, drill hole footage, and grade table are included in Appendix C.

A summary of estimated ore reserves follows:

Ore bed four feet or more in thickness

Hole No.	Area sq mi	Grade % K_2O	Thickness ft	Ore Reserves tons
38	0.3	12.4	4	2,091,000
83	.5	12.2	5	4,356,000
77	.1	12.0	5	871,000
1	.5	12.1	4	3,484,000
12,32	3.2	12.3	4 to 5	24,288,000
1,59,99	5.0	12.3	4 to 5	37,730,000
Averages		12.3	4.3	
Totals	9.6			72,820,000

Ore bed five feet or more in thickness

38	0.1	12.4	5	871,000
83	.6	12.6	5	5,227,000
32	.2	12.2	5	1,742,000
77	.1	12.1	5	871,000
1	.3	12.2	6	3,139,000
99	.2	12.4	8	2,790,000
Averages		12.4	5.3	
Totals	1.4			14,640,000

5. MINING PLAN

The criteria used in this evaluation are listed below:

Design rate of potassium chloride production, tons per year	1,000,000
Design grade of the product, percent KCl	96.6 to 98.1
Design grade of the product, percent K_2O equivalent	61 to 62
Plant recovery, percent of potash values in the ore	92
Mine Extraction, (percent of potash values extracted from the deposit)	85.7
Deposit density, cu ft per ton, in place	16
Ore reserve, years	20
Height of cut mined out	48 to 60 inches
Grade of mined ore, percent K_2O equivalent	12.5

Mining production required:

$$\frac{(1{,}000{,}000 \text{ ton/yr})\ (0.62)}{(0.125)\ (0.92)} = 5{,}400{,}000 \text{ tons ore per year}$$

Assuming five percent down time and contingencies, the average mining rate should be, say, 5,700,000 tons of ore per year

Ore reserves required for 20 year life:

$$\frac{(5{,}400{,}000)\ (20)}{(0.85)} = 125{,}000{,}000 \text{ tons of ore in place}$$

Assuming operation 360 days per year, 20 shifts per week, the required mine production is as follows:

tons per week	5,700,000 ton/51.4 weeks	=	110,850
tons per shift	110,850 ton/20 shifts	=	5,540
tons per day	(5,540 ton) (3 shifts)	=	16,600

Shafts

Two shafts are recommended: both of them 19 ft inside diameter and adjacent to the plant. The exact location of the shafts would be determined by an evaluation that would consider the economics of haulage over the life of the 20-year deposit.

The production shaft will hoist ore and exhaust bad air. It will feature a concrete headframe. A multi-rope friction hoist will be mounted in the concrete penthouse tower. Hoisting will be done in 18-ton skips.

The service shaft, with a steel head frame, will transport men, materials and equipment, and convey fresh air. The doubledrum hoist will be mounted at ground level in a hoist house. A large cage will be used in conjunction with a counterweight.

Shaft pillar development will include the shaft stations and approximately 7000 feet of drifts for ventilation fans, stopes, warehouse, and electrical facilities. The storage bin and tripper-conveyor tunnel will also be near the production shaft.

Mining Method

Room and pillar mining is recommended using two low-height continuous borers per section. This method eliminates handling of explosives and their resulting fumes. It also avoids the danger of fracturing the back, which could then require roof bolting.

The main entry system will consist of six entry units with cross entry units turned off and developed on approximately 4000 feet centers. Panels will be developed off the cross entries.

Each panel will be eight entry units wide and approximately 2000 feet long. Rooms will be developed on 90 ft centers and will be 28 ft wide. Primary mining extraction will be 52.5 percent, leaving 62 by 62 ft pillars. Panels will be developed on primary extraction to full depth of cut, which is approximately 2000 feet. Pillars will then be mined on retreat out of the panel, with an estimated final mining extraction of 85.7 percent being achieved.

The ore is broken from the face and discharged on the ground behind the borer. Loaders pick up the ore and fill shuttle cars. The shuttle cars carry the ore to the conveyor system and discharge it onto the panel conveyor belts. Each section should produce 500 tons per shift per machine, or 1000 tons for each panel or entry section using two borers. Minimum mining height for a continuous potash boring machine should be 4.5 feet.

Haulage and Storage

The panel conveyor belts are 42 inches wide and the cross entry conveyor belts are 48 inches wide. Both are rope belt conveyors suspended from the roof and extended in increments of 180 feet. The panel conveyor discharges onto the cross entry conveyor, which in turn discharges onto the main entry conveyor.

The main entry conveyor is extendable in units up to 4800 feet. The belt discharges onto the tripper conveyor which spreads its discharge into an underground storage bin holding 3000 tons. Plow feeders regulate the flow of material onto a reclaim belt. The reclaim belt discharges into the shaft surge bin. In the bottom of the surge bin, volumetric skip loaders portion the material into the skips whenever they are in loading position.

Men, supplies and repair equipment are carried in diesel-powered trucks equipped with exhaust scrubbers. Supervisors are furnished with battery operated jeeps.

Mining Cost Estimate

Estimated mine operating costs are shown in Tables 7, 8, and 9 of Appendix B. These costs are based on the mine design criteria stated earlier in this report. The estimated production per man-shift for the mine is calculated at 37.0 tons. This is based on the proposed mining schedule for personnel and on an estimated face production target of 500 tons per continuous borer shift.

Due to the preliminary nature of the exploration work and consequently of the ore reserve determinations, it has been considered desirable to calculate production cost estimates for two higher grades of mine-run ores. The two additional cost estimates are based on ore grades with 16 and 20 percent K_2O equivalent and mining at heights of 48 to 60 inches. These calculations illustrate the effect of mining grade upon production costs. The capital costs have been factored from the original cost estimate for a mining grade of 12.5 percent K_2O equivalent.

The mine shafts, stations, and underground development are depreciated over 20-year periods. The surface plant and hoists are generally depreciated over 10 to 20 years, depending upon type and usage of equipment. For this report, an average figure of 15 years has been used. Underground mining equipment is depreciated over a 10 year period, but the direct operating maintenance costs include an allowance for rebuild funds, since major overhauls will be required during the ten-year depreciation period.

Controllable indirect costs are calculated at 35 percent of the total of mine labor, supervision, and maintenance materials costs. Maintenance labor total costs of $670,000, $522,000, and $418,000 per year are included in the respective controllable indirect cost for mining ore with 12.5, 16, and 20 percent of K_2O equivalent. Non-controllable indirect costs are calculated at three percent of capital investment and cover local taxes and insurance.

6. ORE PROCESSING

Two different processes are in use for the recovery of a commercial grade of potassium chloride from mined potash ore. The process that is generally favored is flotation, since it requires a smaller capital investment. The other process, leaching and crystallization, has certain advantages, and is a necessary alternative whenever the character of the ore is such that the flotation process will not produce a good yield of a satisfactory product.

Costs have been estimated for treating the ore by each of these processes. The costs are given in Appendix B in tables 7 to 22 and summarized in Tables 1-A and 1-B. The presence of carnallite in the ore and the results of laboratory heavy-media tests indicate, however, that a suitable grade of product can not be obtained from this ore body by the flotation process. If the heavy-media test cannot give a satisfactory product, there is no hope that flotation will do it. It will be necessary, therefore, to treat the ore entirely by leaching and crystallization. (See report from T. J. Futch in Appendix A.)

Flotation

In preparation for flotation (See 942-SK1, Appendix C) the ore from the mine is crushed to a size that frees crystals of sylvite (potassium chloride) from the halite (sodium chloride) and other barren minerals. The crushed material is then pulped in brine and agitated or "scrubbed" to free it from clay. The clay is removed because it would otherwise consume excessive amounts of flotation reagents. The scrubbed

ore is conditioned with reagents and then fed to the flotation cells where the potash values are "floated" out in the froth that overflows from the cells. There are additional steps that clean and concentrate the floated product, which is then dried and screened to produce the desired particle-size grades of potassium chloride product.

Much of the product from the flotation cells is too fine and must be processed in a compaction unit to increase the particle size.

Because considerable potash is removed with the clay slimes in scrubbing, it is necessary to leach and wash these slimes, then recover the potash from the leach brine in a small crystallization unit. The crystal product can be made in the size range desired.

Leaching and Crystallizing

When the ore is processed entirely by leaching and crystallization, (See 942-SK2, Appendix C) the equipment is larger and more expensive than the units that treat only the slimes from the scrubbers of the flotation process. However, no compaction unit is needed and the equipment can be designed to make the product crystals in the size ranges desired. Scrubbing of the ore is usually not required.

The ore is leached in agitated tanks at an elevated temperature. The rich brine then flows through a series of two or more vacuum crystallizers that progressively cool the brine and crystallize out a pure grade of potassium chloride. The crystals are separated from the brine, then washed, dried, and screened. They are then ready for shipment or storage. The lean brine is then returned to the leach tanks to dissolve more potash.

Grade of Ore

The probable mineralogical composition of the ore from the Holbrook deposit has been calculated from the analyses reported for the composite core sample sent in for test:

Mineral	Chemical formula	Percent
Sylvite	KCl	16.9
Halite	NaCl	69.4
Carnallite	$MgCl_2 \cdot KCl \cdot 6H_2O$	7.0
Polyhalite	$2CaSO_4 \cdot MgSO_4 \cdot K_2SO_4 \cdot 2H_2O$	2.3
Anhydrite	$CaSO_4$	.6

The remainder is miscellaneous salts and insolubles.

The composition indicates that the potash values will be lost in the tailings if the ore is processed by flotation. This is confirmed by the laboratory tests mentioned. Carnallite will decompose in the scrubbing brine, but much of the potash from it can be recovered in the leach-crystallization treatment of the scrubber slimes. This treatment requires bleeding the circuit to control the magnesium chloride content of the brine, resulting in some loss of potash.

The following chemical analysis, representing the weighted average of 100 samples from representative core holes on the site, has been used in the evaluation of costs:

Constituent		Percent
Potassium	(as K)	10.31 to 10.49
	(as K_2O)	12.42 to 12.64
Sodium	(Na)	27.47 to 27.41
Magnesium	(Mg)	.80 to .70
Calcium	(Ca)	.62
Choride	(Cl)	53.87 to 53.59
Sulfate	(SO_4)	1.71 to 1.79
Water-insolubles		2.77 to 2.73

The remainder is assumed to be water and carbonates.

APPENDIX A

FLOTATION ANALYSES

Appendix A

T. J. FUTCH
ANALYTICAL CHEMIST
918 NORTH ALAMEDA PHONE TU 5-2755 AREA CODE 505
CARLSBAD, NEW MEXICO
88220

February 14, 1966

Mr. J.H. Jensen, Manager Process
Arthur G. McKee & Company
Nonferrous Metals & Minerals Division
650 Fifth Street
San Francisco, California

Re : Potash Project
McKee # 942

Dear Mr. Jensen :

Enclosed are a report of heavy liquid separation of carnallite and sylvite from float fractions received from you numbered 761, 764 and 767, analyses of the separated portions and analysis of the -65 mesh fraction from your test work.

I had hoped that a physical separation would produce a product of above 60 % K_2O grade, but apparently the sylvite-halite middlings coupled with the sylvite-carnallite middlings of a density greater than 1.85 prevent this. Leaching, of course, would solve the problem in a plant process and would leave only the recovery of K from the carnallite to consider.

I want to again thank you for this work and I hope that I may be of some help to you in the future.

Sincerely,

T.J. Futch

February 14, 1966

Arthur G. McKee & Company

Potash Project - McKee #942.

Heavy liquid separation of carnallite and sylvite from float fractions numbered 761, 764 and 767.

Density of liquid - 1.85

Weight of fractions separated -

761 F	+14 Mesh	Float	6.9 gms
761 S	+14 Mesh	Sink	22.3 gms
764 F	-14+28 Mesh	Float	7.9 gms
764 S	-14+28 Mesh	Sink	29.6 gms
767 F	-28+65 Mesh	Float	14.1 gms
767 S	-28+65 Mesh	Sink	42.4 gms

Analyses of the above samples are shown on a separate sheet under the same identifying numbers.

Calculations show a small amount of carnallite, anhydrite and from 2 % to almost 13 % halite in the sink fractions where it was expected that 60 % K_2O grade might be achieved. The float fractions calculate about 90 % carnallite, 4 % to 5 % sylvite and 1 % to 4 % halite, except for No. 767 F showing about 27 % sylvite and 72 % carnallite.

The sink portion at -28+65 mesh (767S), where one would certainly expect to make grade, shows by calculation the following minerals and approximate percentages :

Sylvite	92.4
Carnallite	4.5
Halite	2.1
Anhydrite	0.4
Clay	0.6

F.J. Futch - Analyst

February 14, 1966

Arthur G. McKee & Company

Samples - Fractions separated by heavy liquid, at density 1.85, from float portions of test samples numbered 761, 764 and 767 under Potash Project-McKee #942.

Portions for analysis dried at 60°C. Figures in percentage by weight.

STATEMENT OF ANALYSIS

Sample No.		H_2O Insol.	Ca	Mg	K	Na (Calc.)	Cl	SO_4	K as K_2O
761F	+14 Mesh Float	0.71	0.09	8.05	14.94	1.58	39.47	0.21	18.00
761S	+14 Mesh Sink	1.74	0.21	0.60	41.93	5.04	47.48	0.60	50.51
764F	-14+28 Mesh Float	0.45	0.11	8.10	15.92	0.46	38.77	0.25	19.18
764S	-14+28 Mesh Sink	1.24	0.23	0.25	47.24	2.40	47.34	0.46	56.91
767F	-28+65 Mesh Float	0.37	0.11	6.42	24.35	0.22	41.16	0.25	29.33
767S	-28+65 Mesh Sink	0.58	0.15	0.40	49.07	0.81	46.99	0.27	59.11

T.J. Futch - Analyst

Appendix A

February 14, 1966

Arthur G. McKee & Company

Sample - Shipment by air parcel post 2-8-66. Potash project - McKee #942. Sink-float fraction of potash ore numbered as shown below.

Portion for analysis dried at 60°C. Figures in percentage by weight.

STATEMENT OF ANALYSIS

Sample No.		H_2O Insol.	Ca	Mg	K	Na (Calc.)	Cl	SO_4	K as K_2O
769	-65 Mesh	3.87	0.74	0.99	11.27	25.41	52.19	1.90	13.58

T. J. Futch - Analyst

Appendix A

APPENDIX B

LIST OF TABLES

TABLE 3

UTILITIES

CAPITAL COST ESTIMATE

		Capital Cost
Electric power distribution		$ 300,000
Water supply system		
Four wells and pumps, 750 ft deep, 600 gpm each	$100,000	
Pipeline, 1 mile of 16-inch	75,000	
Reservoir tank, 150,000 gal	16,000	
Distribution, etc.	84,000	
Potable water	25,000	
		300,000
Fire protection system		50,000
Sanitary system		30,000
Steam plant		350,000
Compressed air (instrument, plant)		75,000
Tailings disposal		
Pipeline, 16-inch	$ 75,000	
Starter dam	25,000	
		100,000
Fuel oil and gas distribution		30,000
Cooling tower		125,000
Total		1,360,000

TABLE 4

NON-PROCESS FACILITIES

CAPITAL COST ESTIMATE

	Capital Cost
Office, including furnishings	$ 150,000
Laboratory, including equipment	75,000
Process plant change house, including furnishings	35,000
Warehouse, including racks, bins, etc.	50,000
Shop, including equipment	200,000
Plant garage	30,000
Foreman's office	25,000
Gatehouse, fences, etc.	10,000
Plant roads, including site access road and site preparation	50,000
Plant rail system, including switcher, car movers, track scale, etc.	100,000
Plant spur (equivalent to 15 miles of straight track, no bridges)	750,000
Automotive equipment, trucks, fork trucks, etc.	75,000
Total Non-Process	$ 1,550,000

Note: Underground mine warehouse, shop, and foreman's office is included in mine capital cost. (Tables 7 to 9)

TABLE 5

LABORATORY OPERATING COSTS*

	Flotation Process			Leach-Crystallization Process		
Ore Analysis, % K_2O	12.5	16.0	20.0	12.5	16.0	20.0
Mine	32	25	20	32	25	20
Flotation	30	30	30			
Leach-Crystallize	30	30	30	60	60	60
Compaction	3	3	3			
Drying	5	5	5	5	5	5
Screen, store, load	60	60	60	60	60	60
Total	160	153	148	157	150	145

Note: These costs are sufficient for plant control and for testing in connection with mine exploration and development. They have been assigned to the various mine and plant sections on the basis of experience with this type of plant. The costs would not be adequate for research, except that associated with minor plant improvements. The laboratory operates 24 hours per day and uses a total of 14 employees.

*Thousands of dollars per year

TABLE 23
ORE DEPOSIT SURVEY
DRILL HOLE DATA

Hole No.		Surface Elevation (ft above sea level)	Depth of Hole ft	Hole Bottom Elevation ft	Ore Bed Thickness ft	Ore Grade % K_2O
NMA	1	5502.5	1274	4228.5	4	12.3
NMA	5	5521.4				Nil
NMA	7	5391.0	995	4396.0	4	7.3
NMA	11	5516.4	1131	4385.4	4	6.74
NMA	12	5372.2	989	4383.2	4	13.7
NMA	17	5444.5	1124	4320.5	4	5.4
NMA	26	5394.9	900	4294.9	4	11.25
NMA	27	5681.3	1259	4422.3	5	4 Approx.
NMA	36	5450.6	1163	4287.6	5	8.33
NMA	37	5279.0	792	4487.0	4	10.73
NMA	38	5551.8	1302	4249.8	4	14.50
NMA	39	5365.8	1056.8	4209.0	4.5	7.05
NMA	51	5377.5	974	4303.5	4	9.61
NMA	68	5354.1	888	4466.1	4	5.18
NMA	77	5253.0	709	4544.0	5	12.13
NMA	88	5425.8	1031	4394.8	5	8.94
(STATE)						
STATE	1	5443.1	975	4468.1	4	14.74
STATE	3	5316.5	892.5	4423.0	4	9.15
STATE	7	5282.5	911.5	4371.0	4	4.84
STATE	14	5336.4	1018.5	4317.9	4	11.05
STATE	32	5393.9	975	4218.9	4	14.59
(NMA)						
STATE	56	5397.9	1139	4258.9	5	11.13
STATE	59	5329.4	1030.5	4298.9	4	12.15
STATE	64	5210.0	670	4540.0		Nil
STATE	83	5399.7	1040	4359.7	4	13.09
STATE	99	5294.6	927	4367.6	4	14.00
OCC.	1	5319.5	934.2	4385.3	4	2.37
OCC.	2	5308.2	858	4450.2	4	8.49

31
85
10
15
19
20
23
44

Note: KCl = 1.5830 times K_2O.

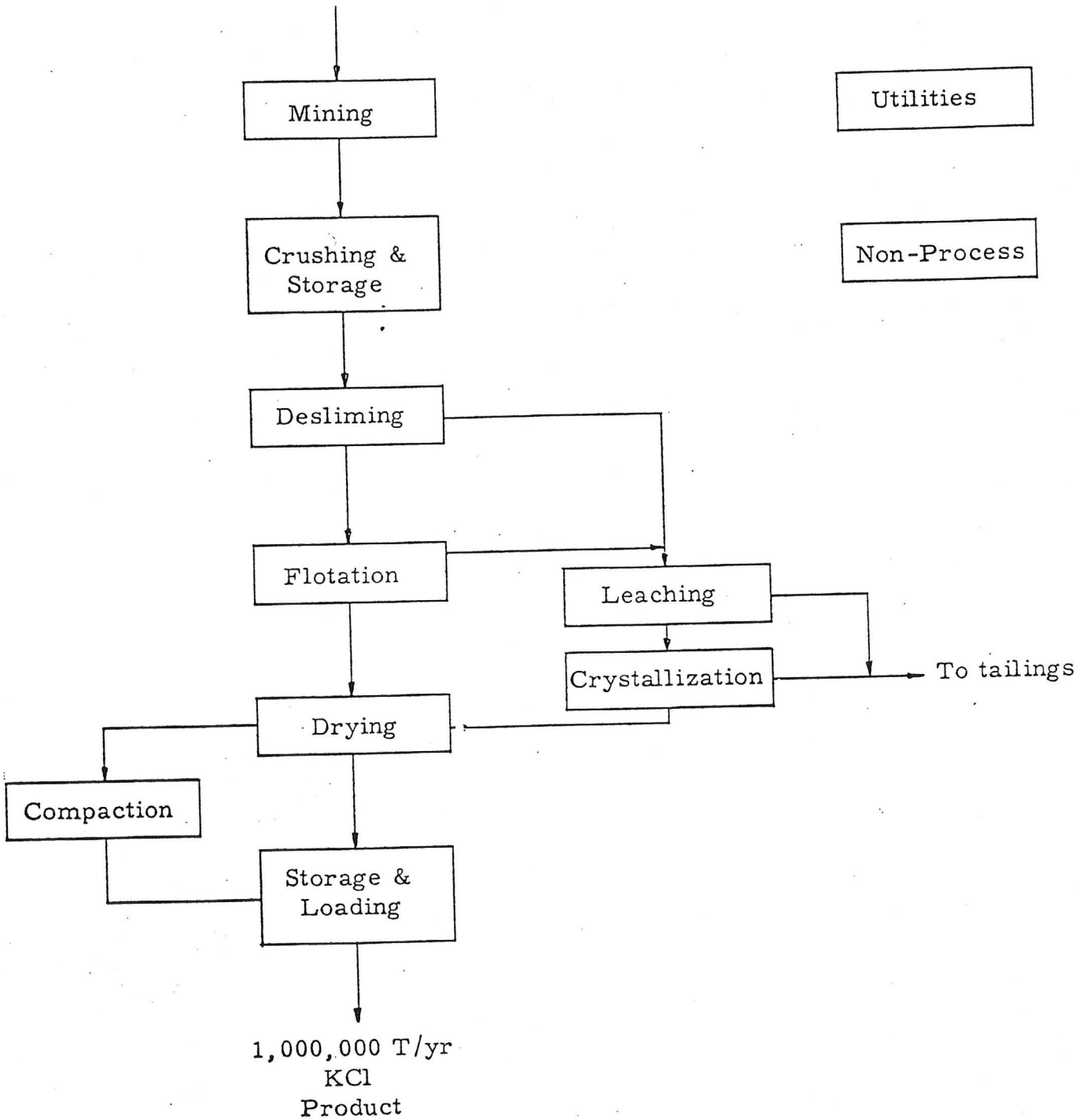
APPENDIX C

DRAWINGS

Drawing Number	Title
942-SK1	Process Flow Diagram - Flotation
942-SK2	Process Flow Diagram - Leaching and Crystallization
942-1X	Isocon - Percent K_2O

ORE PRODUCTION

5,400,000 ton/yr with 12.5% K_2O
4,210,000 ton/yr with 16% K_2O
3,370,000 ton/yr with 20% K_2O



FLOTATION PROCESS

WESTERN KNAPP ENGINEERING CO., SAN FRANCISCO, CALIFORNIA — DIVISION OF ARTHUR G. McKEE & CO.

DESCRIPTION	DRAWN	CK'D	DATE	SCALE:
				DRAWN:
				CK'D:

Process Flow Diagram
1,000,000 ton/yr Potash Plant
Arkla Exploration Company

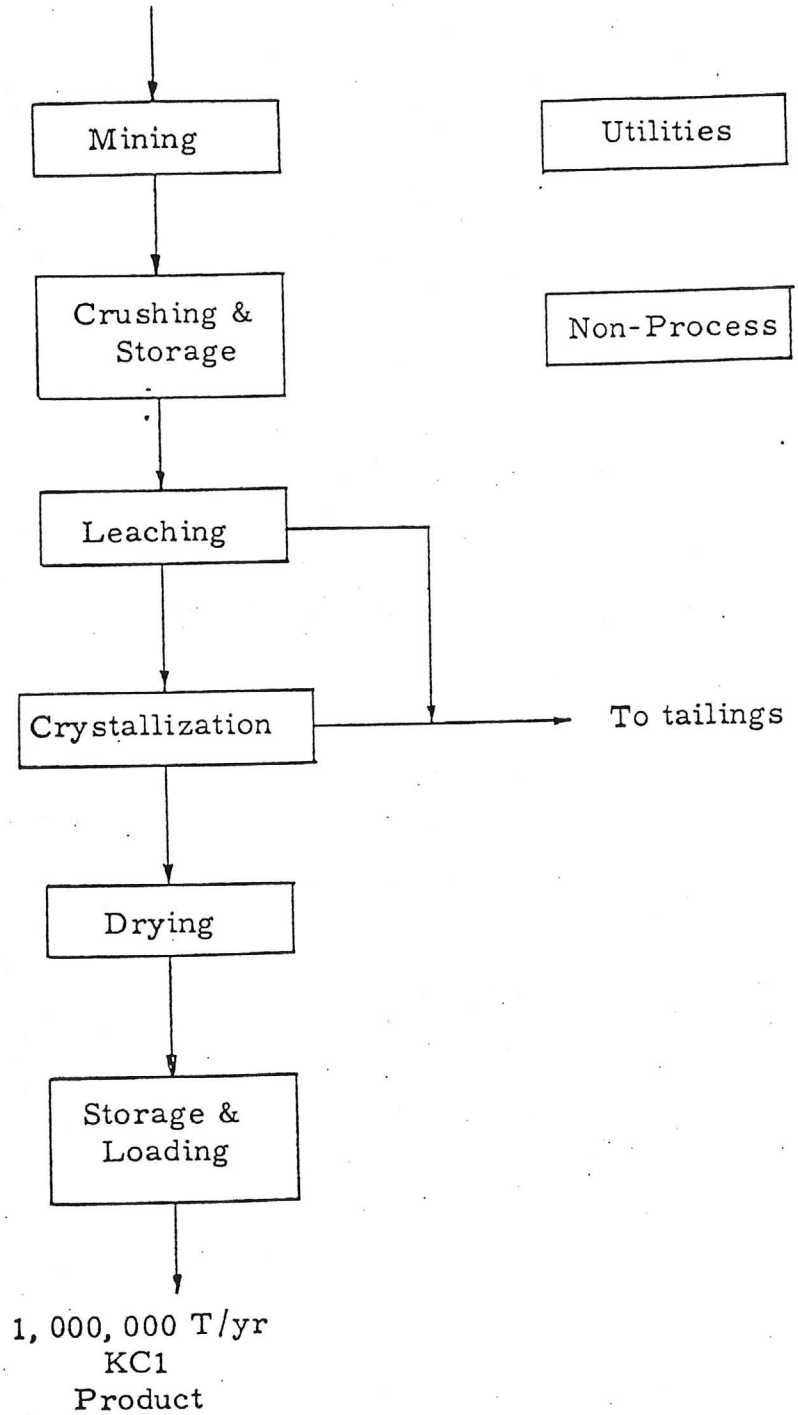
SKETCH NO. 942-SK1

REV.

(Appendix C)

ORE PRODUCTION

5, 400, 000 ton/yr with 12.5% K_2O
4, 210, 000 ton/yr with 16% K_2O
3, 370, 000 ton/yr with 20% K_2O



LEACHING AND CRYSTALLIZATION PROCESS

WESTERN KNAPP ENGINEERING CO., SAN FRANCISCO, CALIFORNIA — DIVISION OF ARTHUR G. McKEE & Co.

DESCRIPTION	DRAWN	CK'D	DATE	SCALE:
				DRAWN:
				CK'D:
				APP:

Process Flow Diagram
1, 000, 000 ton/yr Potash Plant
Arkla Exploration Company

SKETCH NO. 942-SK2 | REV.

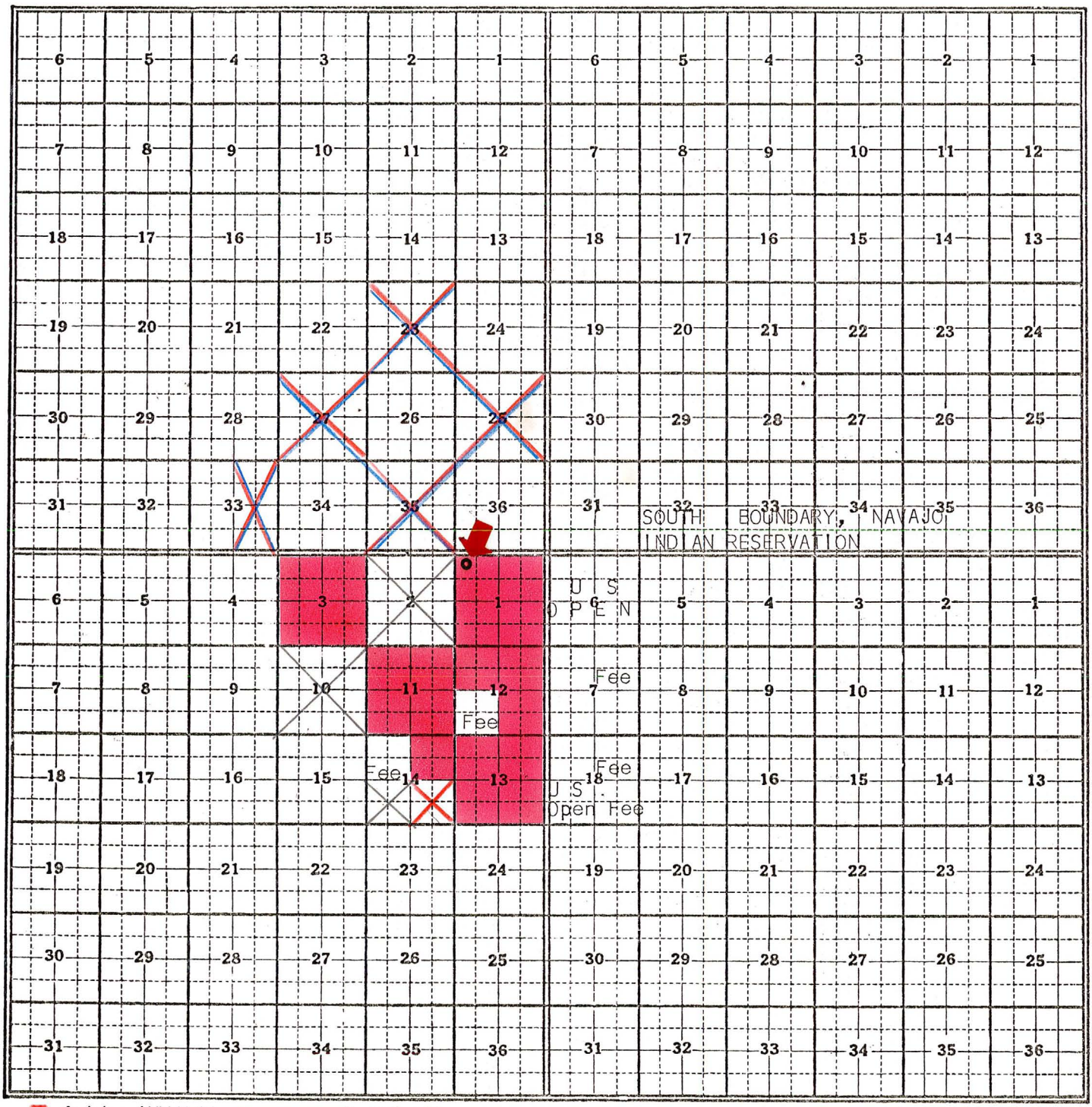
SMITH BUTTE PROSP[illegible]T

NAVAJO County, ARIZONA

Township 21N, Range 18E. Township 21N, Range 19E

Township 20N, Range 18E Township 20N, Range 19E

Form 104—Four on Township—In Stock and For Sale by Triangle Blue Print & Supply Co., Tulsa, Okla.



Arkla (NMALC) Acreage, 3,198.08 ac.
Approx. Total Acreage in Prospect Outline 15,030 ac
Released NMALC Acreage, 2,880 ac.
Probable drillsite location
Cutoff if restricted to ± 10,000 ac.

X State Open
X State Leased
U.S. Open
U.S. Leased
Fee Land

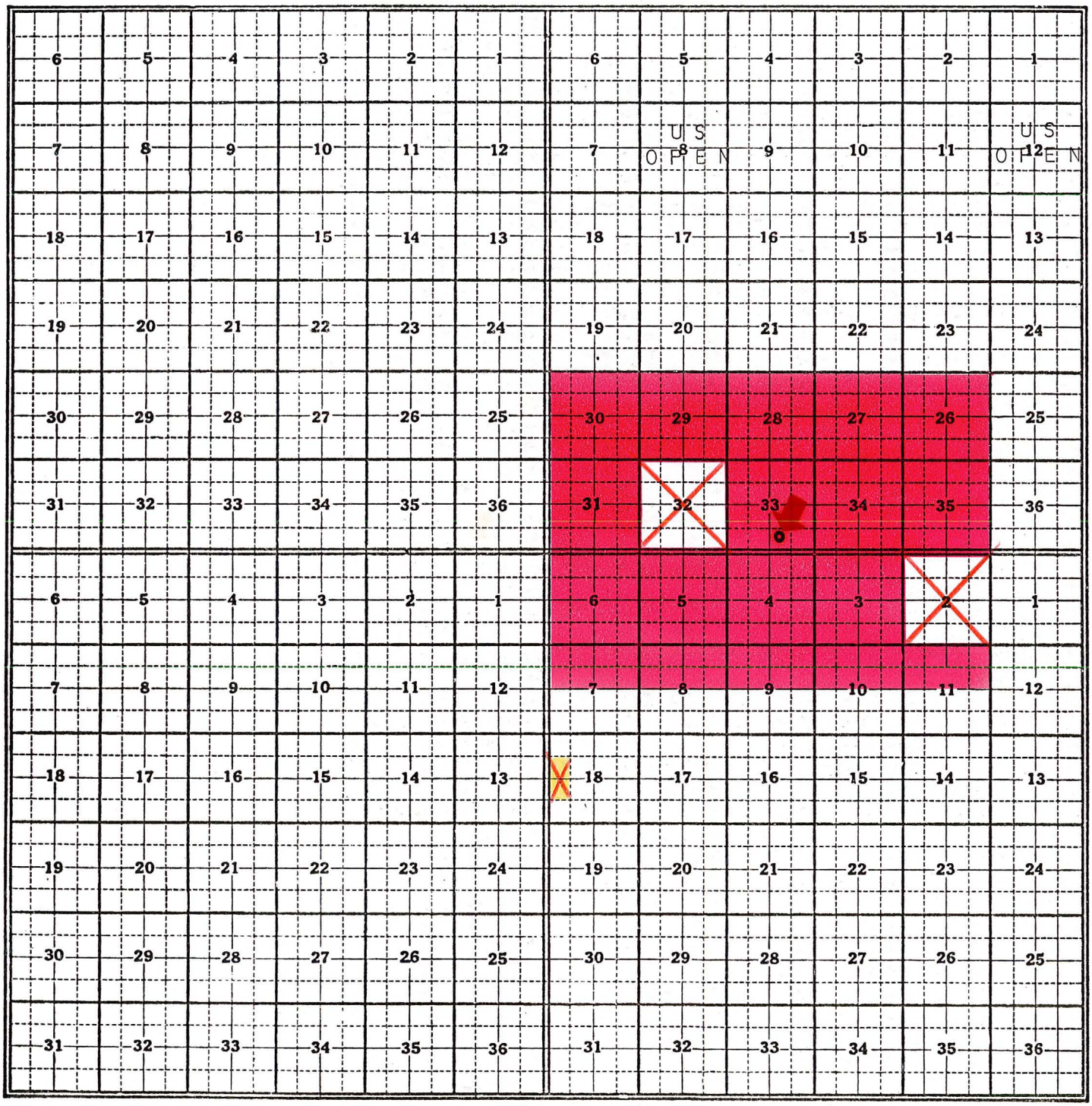
SILVER CREEK PROSPECT

NAVAJO County, ARIZONA

Township ____, Range ____ Township 15N, Range 22E

Township ____, Range ____ Township 14N, Range 22E

Form 104—Four on Township—In Stock and For Sale by Triangle Blue Print & Supply Co., Tulsa, Okla.



Arkla (NMALC) Acreage, 10,020 ac.
o Probable drillsite location
Total Acreage in prospect outline, approx., 10,020

X State Open
X State Leased
U.S. Open
U.S. Leased
Fee Land

Arkla Expl Co, Fed Oil & G, Leases

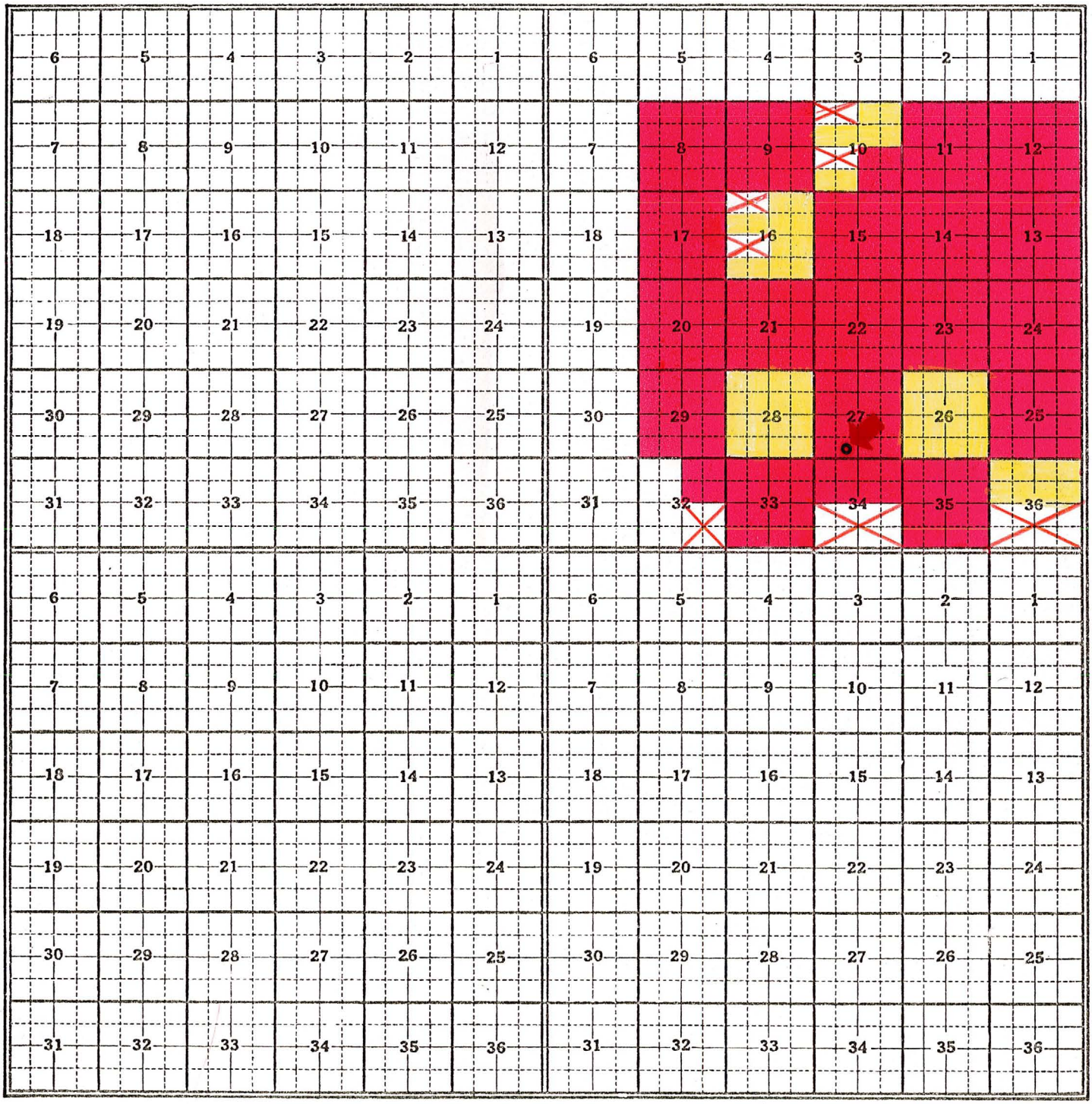
N.W. STINKING SPRINGS AREA

APACHE County, ARIZONA

Township 15N, Range 25E. Township ____, Range ____

Township ____, Range ____. Township ____, Range ____

Form 104—Four on Township—In Stock and For Sale by Triangle Blue Print & Supply Co., Tulsa, Okla.



Arkla (NMALC) Acreage, 8,294.30 ac.
Approx. Total Acreage in Prospect outline, 19,730 ac.
Probable drillsite location
Cutoff if restricted to approx. 10,000 ac.
Arkla Oil & Gas Leases

X State Leased

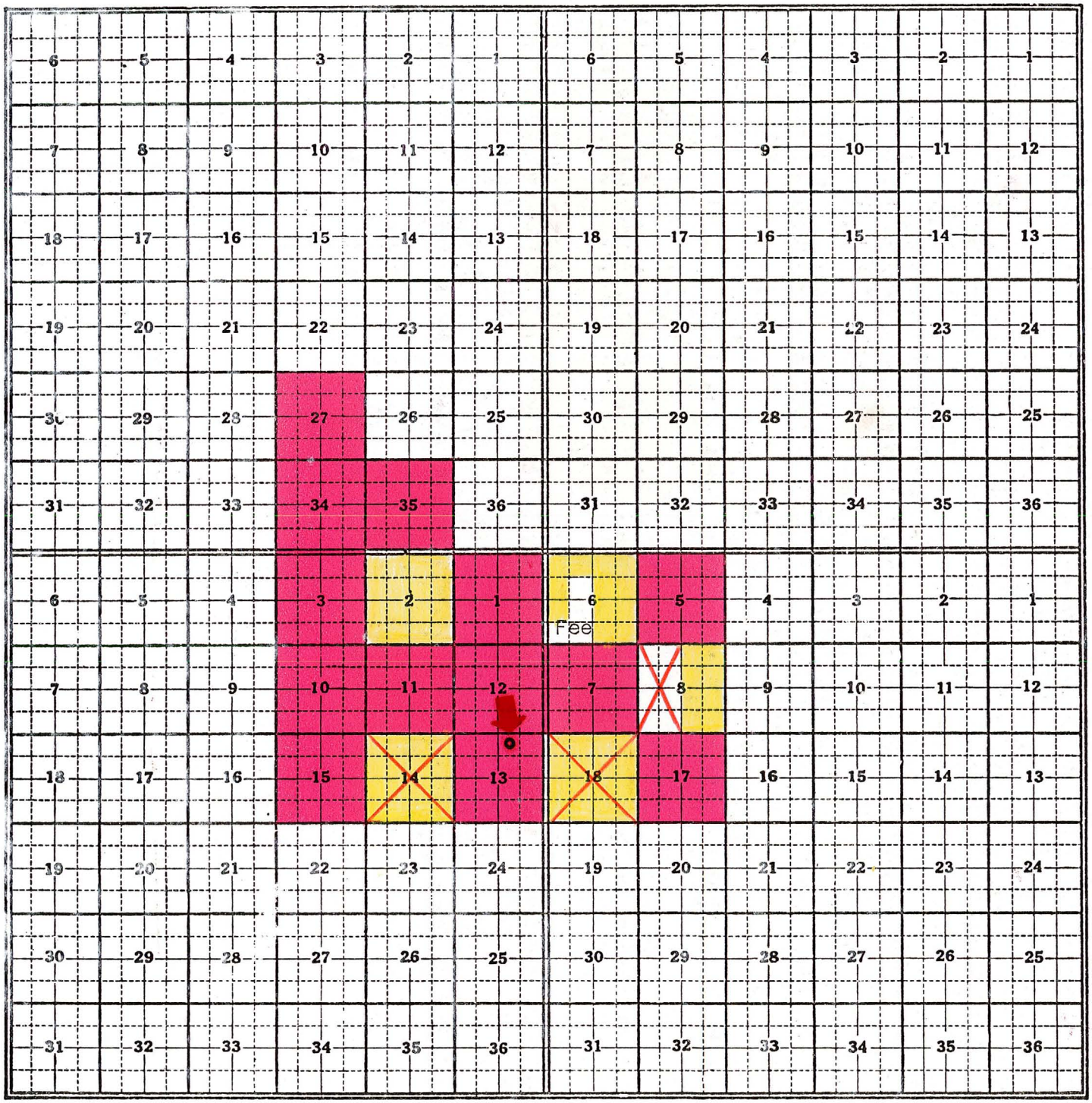
MESA REDONDA PROSPECT

APACHE County, ARIZONA

Township 13N, Range 24E. Township 13N, Range 25E

Township 12N, Range 24E. Township 12N, Range 25E

Form 104—Four on Township—In Stock and For Sale by Triangle Blue Print & Supply Co., Tulsa, Okla.

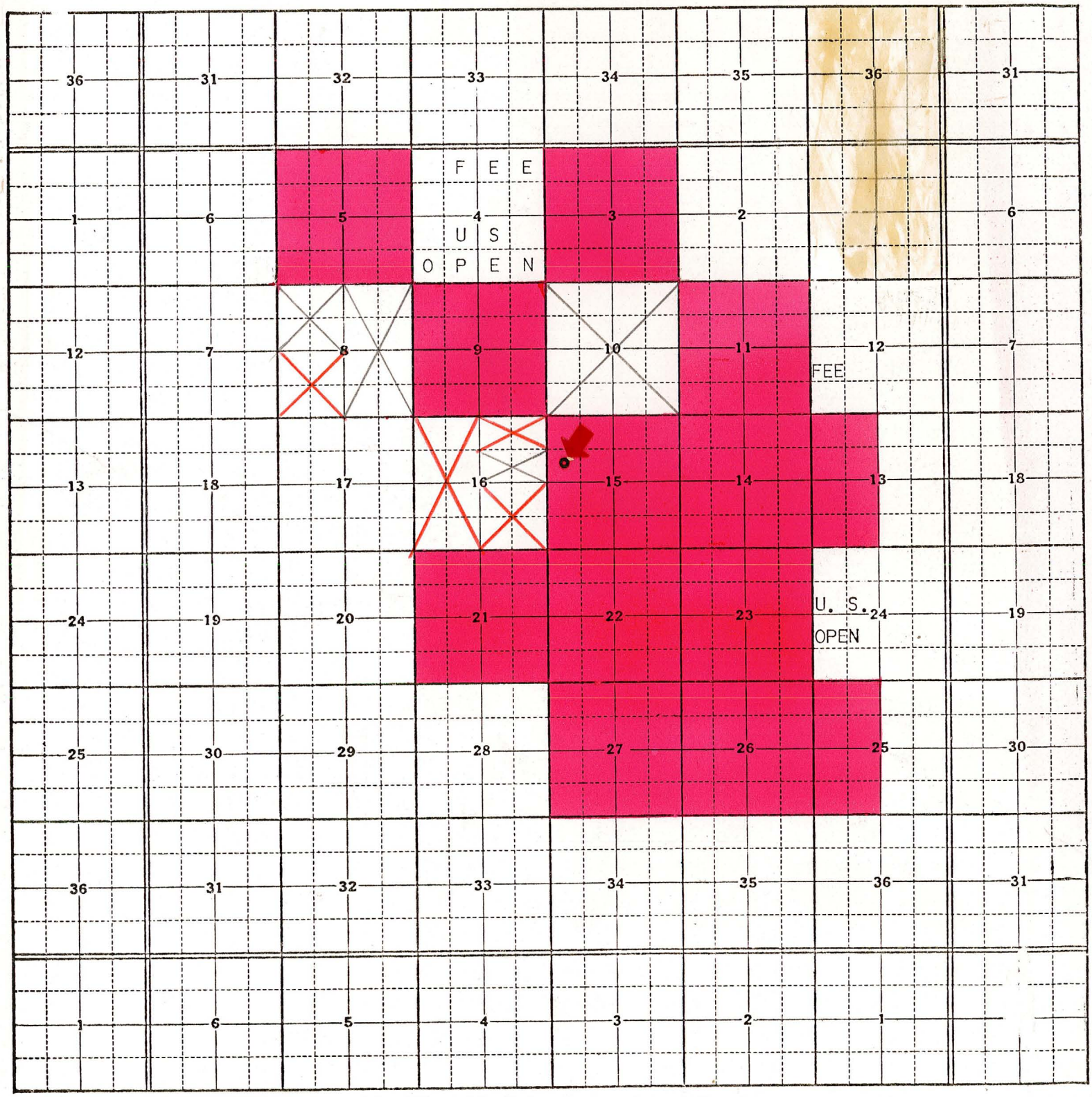


- Arkla (NMALC) Acreage, 7877
  Probable drillsite location
- Arkla Exploration Company State Oil & Gas Leases, 1,277.75
- Arkla Exploration Company Federal Oil & Gas Leases, 1,083.00
  Approx. Total in prospect outline, 10,237.75

- X State Open
- X State Leased
- U.S. Open
- U.S. Leased
- Fee Land

OSO NEGRO PROSPECTS

S(_____, Township 14N, Range 25E, APACHE County, State of ARIZONA



Island Township Plat. —Scale 1-inch to 1-mile—

Form 105-Island Township Plat- *—In stock and for sale by Triangle Blue Print & Supply Co.*

- Arkla (NMALC) Acreage, 7,683.84 ac.
  Total in prospect outline, approx. 11,524 ac.
- Probable drillsite location
  Cutoff if restricted to ± 10,000 ac

- State Open
- State Leased
- U.S. Open
- U.S. Leased
- Fee Land

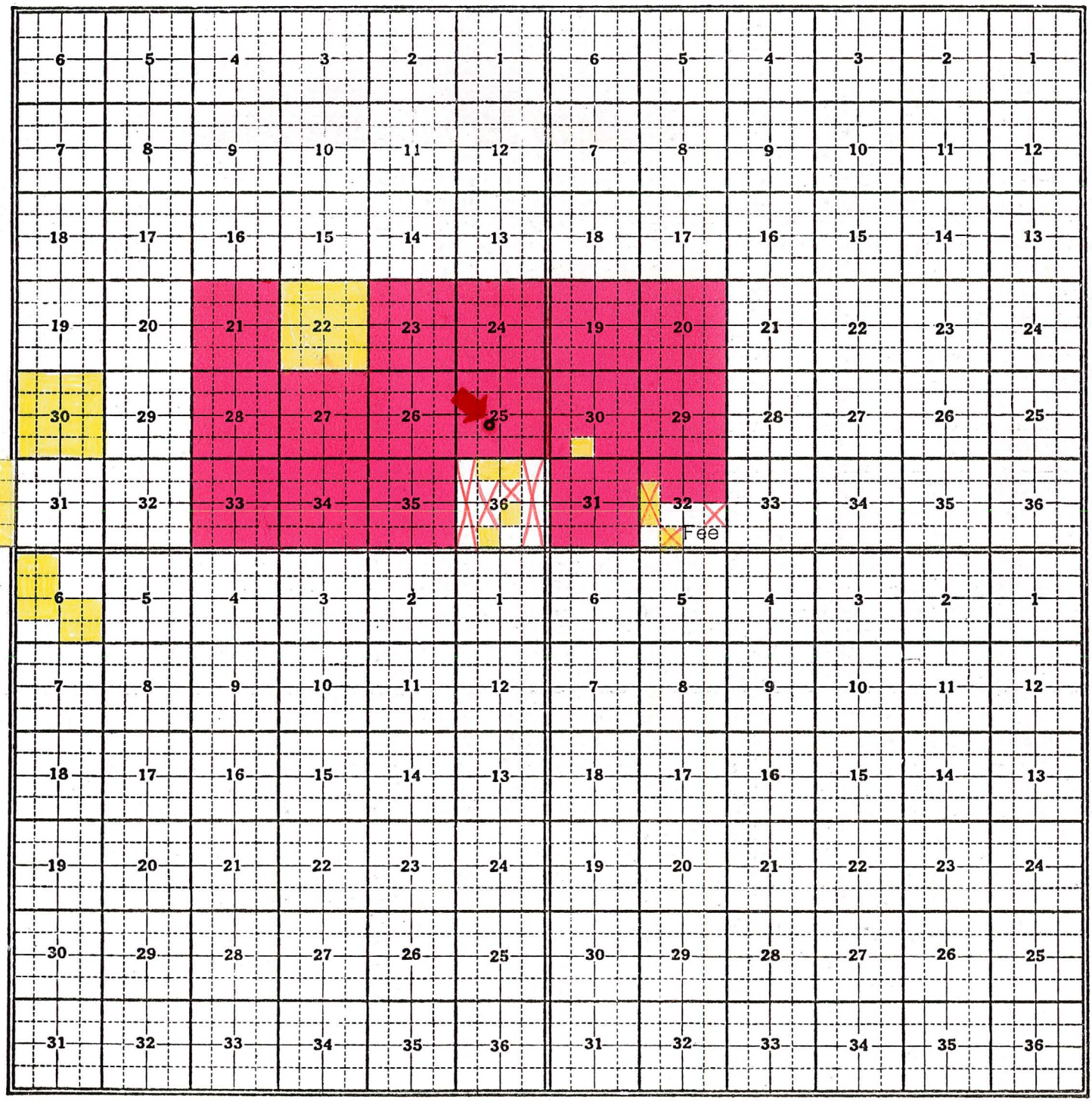
GOAT RANCH DRAW PROSPECT

APACHE County, ARIZONA

Township 15N, Range 24E. Township 15N, Range 25E

Township ____, Range ____. Township ____, Range ____

Form 104—Four on Township—In Stock and For Sale by Triangle Blue Print & Supply Co., Tulsa, Okla.



- Arkla (NMALC) Acreage, 9373 ac.
- Arkla Fed. O & Gas Lease, 120 ac.
- Arkla State O & G Leases, 760 ac.
- Probable drillsite location

Total Acreage in prospect outline, 10,253 Ac.

- State Open
- State Leased
- U.S. Open
- U.S. Leased
- Fee Land

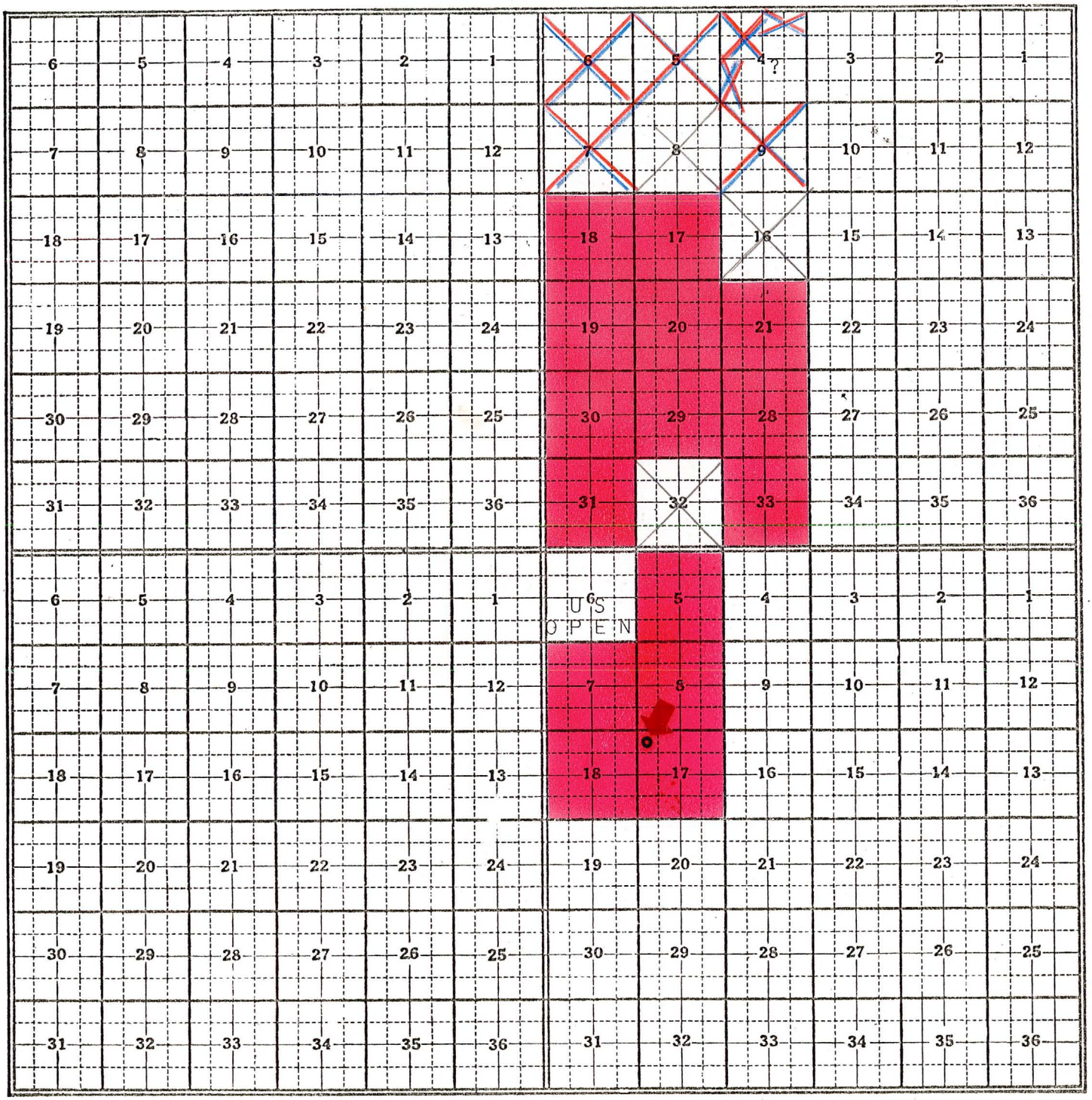
TORO NEGRO PROSPECT

NAVAJO County, ARIZONA

Township ____, Range ____. Township 13N, Range 23E

Township ____, Range ____ Township 12N, Range 23E

Form 104—Four on Township—In Stock and For Sale by Triangle Blue Print & Supply Co., Tulsa, Okla.



Arkla (NMALC) Acreage, 9,540.08 ac.
Released acreage NMALC, 2,976.28
Approx. Total in prospect outline, 15,085 ac.
Probable drillsite location
Cutoff if restricted to + 10,000 ac.

State Open
State Leased
U.S. Open
U.S. Leased
Fee Land

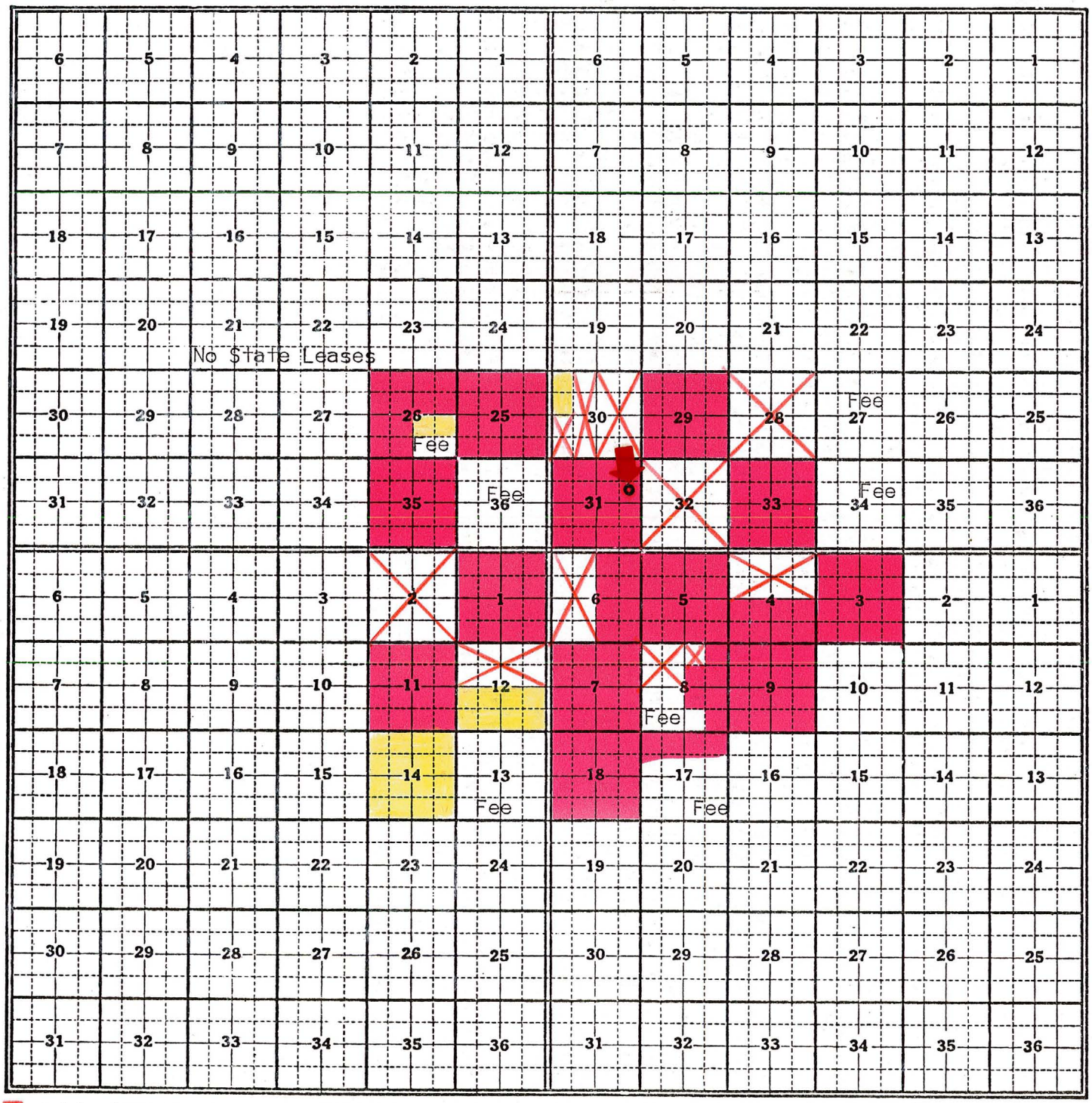
HAVRE PROSPECT

NAVAJO County, ARIZONA

Township 19N, Range 17E Township 19N, Range 18E

Township 18N, Range 17E Township 18N, Range 18E

Form 104—Four on Township—In Stock and For Sale by Triangle Blue Print & Supply Co., Tulsa, Okla.



Arkla (NMALC) Acreage, 9226.28 ac.
Probable drillsite location
Arkla Exploration Company State Oil & Gas Leases, 1120 ac.
Approx. Total Acreage in Prospect outline, 17,310 ac.

X State Open
X State Leased
U.S. Open
U.S. Leased
Fee Land

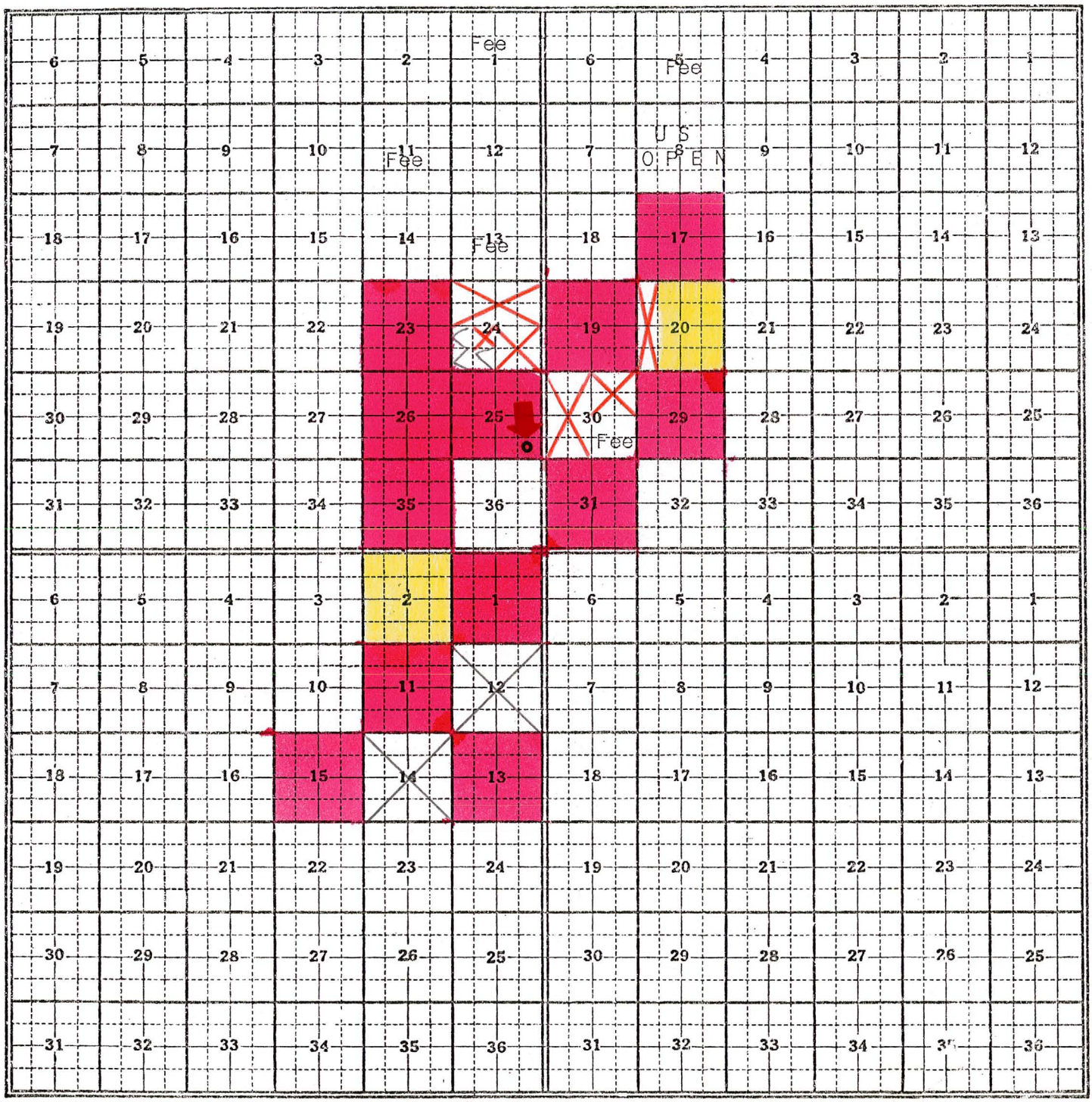
TOLTEC DIVIDE PROSPECT

NAVAJO County, ARIZONA

Township 20N, Range 15E Township 20N, Range 16E

Township 19N, Range 15E Township 19N, Range 16E

Form 104—Four on Township—In Stock and For Sale by Triangle Blue Print & Supply Co., Tulsa, Okla.



- Arkla (NMALC) Acreage, 7,614.30 ac.
- o Probable drillsite location
- Arkla Exploration Company State Oil & Gas Leases, 1,129.66 ac.

Approx. total acreage in Prospect outline, 12,800 ac.

- X State Open
- X State Leased
- U.S. Open
- U.S. Leased
- Fee Land