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The following file is part of the Kelsey Boltz Mining Collection

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PRESCOTT, ARIZONA 86301
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TO: Joe Walton, Herb Miller, Bob Ford & Dent Hand DATE: July 1, 1970

FROM: Kelsey Boltz RE: Arizona Salt - Jerry Grott Prospect

Attached herewith are data relative to the Arizona Salt Company operation west of Phoenix which I have previously mentioned to some of you. While this data is somewhat out of date, it does give a good background concerning salt reserves and market projections.

The principal founder of Arizona Salt Company, Jerry Grott, has an excellent background in chemical processing. I consider him very intelligent and innovative; however, as a result of his dislike for day to day management, he turned the operation over to an associate who subsequently ruined their only extraction well.

The total investment in the operation to date is approximately $150,000. The company finds itself needing additional capital for a new well and operating funds.

Grott had approached us with the prospect of selling to us a production payment in order to secure $25,000 for a new well. Of course, we would not be interested in such an arrangement but further discussions with Grott revealed the possibility of our acquiring the entire operation on an equitable basis.

Grott has estimated that the total operation may show a net before taxes of from $250,000 to $350,000 per year.

The capital required to place the operation at design capacity may extend up to $100,000 according to Grott. I suggest that we check further into this project in view of the fact that it may offer a cash flow operation and is situated on our back doorstep.

Profits at 75,000 tons/year

	Prices Reduced 10%	Prices Reduced 15%	Prices Reduced 25%
Average Price Per Ton(1)	$ 10.80	$ 10.20	$ 9.00
Annual Sales	$816,000.00	$765,000.00	$675,000.00
Costs	473,700.00	473,700.00	473,700.00
Gross Margin	$342,300.00	$291,300.00	$201,300.00
Tax Free Depletion Allowance is 10% of Lowest Product Price	72,900.00	68,850.00	60,750.00
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(1) Product Mix at present prices averages $12.00 per ton for Bulk Salt, f.o.b. plant. This price is calculated by deducting delivery costs from the lowest delivered carload or truckload prices currently paid by the largest customers in the Phoenix area. Other customers pay substantially more. Bagging and Palletizing extra charges adequately cover the extra costs of these services.

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This "inside Arizona" market has been growing somewhat faster than the population of Arizona and is expected to continue to exceed the rate of population growth. The increase from the 20,000 tons used in 1961 has been at the fantastic rate of nearly 20 per cent per year compounded.

While it is expected that such a rate cannot be maintained, even an annual rate of half this will increase the usage to above 130,000 tons by 1975.

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The feed salt is primarily used for mixing into feed lot feeds and into range supplement. The average feed lot animal consumes 20 pounds of feed per day containing 1% salt or 73 pounds per animal year. Range animals do best on about the same amount of salt.

Cattlemen have learned to use salt as a "regulator" to control the consumption of range supplement and this use is increasing. Given the opportunity, cattle will eat more of the valuable supplement than they need unless it is mixed with salt. However, when salt is mixed-in the cattle eat only until they consume their customary salt. Range supplement containing about four ounces of salt to a day's feeding can be put out on the range in bulk feeders without concern about "overeating." This system, and the growing use of loose salt on a "free choice" basis, have resulted in a general increase in the total salt used by cattlemen and will continue to do so.

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Hide curing will use as much as one pound of salt per pound of hide, or as little as 0.3 pounds per pound, depending on the method used and the care exercised. All firms curing hides

have been included in the market surveys as have all the major meat packers. While the number of cattle slaughtered is expected to increase, increased efficiency in use is expected to keep this market about the same.

Water Softener Salt

A detailed study has been conducted in the Phoenix Metropolitan area where buyers of about 8500 tons per year have been contacted. This is believed to represent 70 - 80 per cent of the total usage in the Phoenix area. Users have been fully cooperative in providing information by grade and supplier.

In addition, most willingly discussed the technical requirements of salt for their particular use and offered suggestions for improving service.

The total market in Arizona is estimated at 21,000 tons. Southern Pacific Railroad has indicated that rail freight will allow Arizona Salt Company to be competitive along their lines as far east as El Paso, Texas and west to El Centro, California. This could add another 3,000 - 4,000 tons per year to sales for water softeners.

Industrial Salt

Today, the only user of salt in metallurgical process applications is the Lakeshore Mine of El Paso Natural Gas Company. This copper producer uses the "segregation" process wherein the reaction of oxide copper ore, coke and salt in a gas-fired rotary kiln causes the copper ore to be reduced to metallic copper that "segregates" onto the coke.

The kiln at the Lakeshore Mine is 10 feet in diameter by 200 feet long and processes 800 tons of ore per day using 16 tons (2%) salt. The kiln operates continuously.

While the same process has operated for some time in Africa, this is the first use in the United States. More significant, it is the first commercial recovery of copper from oxide ore containing too much limestone for economical acid leaching. There are more deposits of this type ore in Arizona and the success of the Lakeshore Mine will spark their development. It is still too early for reliable projections but this development can markedly increase the use of salt in Arizona.

Food Processors

A survey of the major producers of "pickled" food products in the Phoenix area shows usage at about 1800 tons per year. A modest growth is anticipated.

Chemicals

There are prospects for manufacturers of chlorine for city water treatment and chlorine compounds for treating swimming pools. The feasibility of operations using 4,000 - 6,000 tons of salt per year are being investigated. There is little immediate prospect for the large scale use of salt for manufacturing chemicals but over one-third of all United States salt is used in this manner and eventually Arizona will have a similar industry.

Roads

Excellent results are now being obtained in the stabilization of sub-base for highways by using salt instead of cement. Also, a mixture of salt and calcium chloride in small amounts has been proved to prevent washboarding in most dirt and gravel roads. Adoption of either of these proved practices by state or county road departments could dramatically increase the use of salt in Arizona.

Growth

In 1961, the last year for which U. S. Bureau of Mines data is available, shipments of salt into Arizona totaled 20,000 tons: of the 75,000 - 80,000 tons of salt now used each year,

about 50,000 tons represents growth in just the last seven years. The Arizona market for salt has grown rapidly in the last few years and it appears that the real growth is just now starting.

One great stimulant to market growth is low cost material. Arizona Salt Company is cooperating with El Paso Natural Gas Company in their development of underground storage facilities for natural gas.

El Paso Natural Gas Company has assured Arizona Salt Company that, should they excavate salt to create underground storage cavities, this salt would be made available to Arizona Salt Company; that El Paso is not interested in entering the salt business and will not allow the salt to be used in competition with Arizona Salt Company.

Prospects are good for Arizona Salt Company to receive about 2,000,000 tons of "as mined" salt at little or no cost. Such a vast supply of low cost salt could greatly stimulate market growth.

Salt Production Methods

Solution Mining - The salt will be dissolved with water to make brine. Steel tubing will be lowered down the well to far below the casing. Fresh water will be pumped down this tubing with enough pressure to force brine up the hole in the salt into the annulus between the casing and tubing and out at the top. Although the flow path could be reversed, the shape of the cavity can best be controlled by sending the fresh water down the tubing.

Settling and Processing - The brine first goes to settling ponds so that any dirt carried up with the brine can settle out. It then flows to "solar ponds" where the water evaporates and the salt crystallizes out.

This salt is harvested and processed by screening, washing, drying, grinding, etc., using equipment much like that used in processing sand and gravel.

This produces salt of a purity above 99.5 per cent which is ample for all uses other than table salt.

Other Factors - Everyone asks, "After the salt is dissolved won't the ground collapse into the cavity?" For our particular

well it would be very difficult to make the cavity collapse as there is a very thick and compact bed of gypsum on top of the salt. However, even if there were no gypsum at all there is no danger with the precautions being taken.

The simplest precaution is to leave a very thick section of undissolved salt above the cavity. This roof of rock salt protects the cavity from collapse. The second is just as simple: use techniques to produce a cavity shaped like a vertical post hole to keep the roof area small. These techniques for cavity control are proved, they are simple, they work, and they cost only a cent or two more per ton of salt than haphazard operation.

The next question is, "What keeps the brine out of the neighbors' fresh water wells?" First, brine is heavier than fresh water and already underlies the fresh water in our neighbor's wells. Wells drilled too deep, say below 600 - 700 feet, already hit salt water but this is a high sulfate water that we do not want either. Our well is cased through the fresh water and the salty water, through the gypsum to the solid salt.

The well casing was pressure cemented in place from the bottom up. Cement was pumped down the casing and back up the space between the casing and the drill hole to completely

seal off the water stratas from the salt, from the casing, and from each other. Water pressure was applied inside the casing with no loss of pressure proving that the casing has no leaks.

Circulation in the drill hole after drilling out the cement plug in the bottom of the cemented casing proved that there was no leakage through the salt. Should any leakage through the salt develop during salt production this will immediately show up and corrective measures, like cementing that section, will be taken.

Should the salt well make connection with water in the salt or around it, it will only be necessary to reverse the procedure, and the brine will be pumped out just like irrigation water.

Exploration and Development

The possibility of commercial salt in West Phoenix was first noted by G. J. Grott in November 1967. Investigation showed that the existence of some salt was known to at least a few people but had not been previously explored or examined by geologists for exploration purposes. A search for information was started. This search uncovered some little-known drill data and some recent and relatively unknown public data collected by U.S.G.S. for the Central Arizona Project. This latter data disclosed a gravity anomoly of considerable magnitude. Discussions with competent geologists and a geophysicist strongly indicated the possibility of a major occurrence of salt.

A lease was obtained in early 1968 on the Roach-Baker Ranch; approximately 360 acres along West Glendale Avenue and Dysart Road. Detailed market and engineering studies showed that a high level of profitability was possible because the market for salt in Arizona has increased rapidly in recent years and there are no Arizona producers.

Present suppliers of solar salt are located in the Bay Area near San Francisco, at San Diego, and at Black Warrior on the Pacific Coast of Baja California. Mined rock salt for cattle

feed comes from Danby Lake in California and from Carlsbad, New Mexico. On bulk salt, the freight to Phoenix varies from 35% of delivered cost from Danby Lake to 50% of delivered cost for solar salt from the docks of San Pedro, California (originated on Baja California).

This situation would allow Arizona Salt Company to maintain a good profit even should the out-of-state producers cut prices severely.

With this indication that a proved salt deposit in the Phoenix area would have a high value, a test was scheduled for October, 1968. The gamble of drilling a full size hole, not just a test hole, was taken and the gamble paid off.

We hit salt at 880 feet and drilled salt to 2812 feet, at which time El Paso Natural Gas Company was invited to join us in the drilling in return for information about the hole. We knew El Paso was looking for a large salt deposit in which to make a large underground storage cavity for natural gas. Within 48 hours Arizona Salt Company had a letter agreement to drill further and to log the hole. Logging was possible only because of the full size hole. Otherwise El Paso would not have been able to get the data they wanted.

The hole was continued to 4502 feet, in salt all the way, and in salt when drilling was stopped. The total thickness of drilled salt was a bit over 3620 feet.

A Slumberger Oil Well Services crew was brought in from Farmington, New Mexico. A Compensated Formation Density Log, Dual Induction-Laterlog, and Sidewall Neutron Porosity Logs were run (along with duplicate caliper logs) from top of hole to total depth. These logs, along with samples of cuttings from each ten feet of hole are available for examination by responsible parties on a confidential basis.

The well is now completed. It was cased down to the salt and the casing pressure-cemented in place to completely seal off the salt and the casing from all overlying water strata. This cementing job was done by a Halliburton Oil Well Services crew brought in from Sante Fe Springs, California. The well is now ready for production as soon as pump and tubing are installed.

The Salt Deposit

The salt deposit might be described as being shaped like a "table top mountain" buried under the valley fill of the Phoenix Basin. The top of the mountain is in the vicinity of West Glendale Avenue and Dysart Road where Arizona Salt has its lease.

The size of the "table top" can only be inferred from geologic data and logs of water wells in the area, but it apparently covers more than two square miles. A large part of the "table top" lies to the west and south of the lease. This is covered by Thunderbird Homes of Luke Field, other subdivided areas, and by property owned primarily by Goodyear Farms.

The Arizona Salt Company lease area is the only large acreage in the known "table top" area already leveled and suitable for solar ponds. Goodyear Farms owns the adjoining desert land to the east and south. They first found rock salt in 1952 when drilling for deep water. Goodyear has shown no interest in the salt business, but since then when they have sold any land Goodyear has retained the mineral rights. In mid-1968 they refused to sell or even to lease land for salt production.

From all information available at this time, other solar salt producers must locate at least a mile from Arizona Salt

Company's "discovery well" and in less favorable areas. No one is going to start in the salt business "right next to" Arizona Salt Company.

Salt Purity - Samples of cuttings were taken for each ten feet of the hole. Samples of drilling fluid were saved as each joint of pipe was added, about thirty feet of hole. About eighteen inches of rock salt core were recovered from a test at 2812 feet.

All samples and the density and porosity logs indicate that the salt body is over 90 per cent sodium chloride except for scattered thin bands.

To check the suitability of the salt for production, drill cuttings were washed and then drained and dissolved to make brine. The solids were allowed to settle out and the brine was evaporated to make salt. This salt was checked by spectrograph by Arizona Bureau of Mines: impurities were very low compared with market needs. Only calcium and magnesium were detected; calcium at a few hundredths of one per cent and magnesium at a few thousandths of one per cent.

The methods used in making salt from these drill cuttings are the same that would be used on a larger scale in production. Any and all grades of salt required in the market can be made satisfactorily.

Reserves - An acre foot of pure solid rock salt weights about 2840 short tons. Figuring reserves at 90 per cent, 2560 tons per acre foot is reasonable. A one-acre area 3620 feet thick contains 9,250,000 tons. Arizona Salt Company's 360 acres could hold over three billion tons based on these calculations and, of course, the salt has not been drilled to bottom so there is probably a bit more.

More pertinent, recovery of some 5,000,000 tons or more from the present well is a reasonable and conservative expectation: at present consumption rates, this would last about sixty to seventy years.

Leases

Mineral Lease

This 360 acre lease costs $0.25 per acre per year plus royalties. Royalties are 1/8 on oil or gas and 3% on minerals or salines other than for common salt in solid form, on which the royalty is $0.25/short ton. The lease runs while a well is being drilled, for one year after a well is drilled, for as long as there is production from the property, or for $500.00 per month should none of the other provisions be met.

Surface Lease

The surface lease and option to lease covers about 120 acres. It runs east 1/4 mile and north 3/4 miles from the intersection of West Glendale and Dysart Roads. The land has been leveled except for "pump back" ponds covering about two acres. There is about 100 acres of irrigated cropland and 17 acres of irrigated pasture.

The rental is $60.00 per acre per year for the land taken for use. This rental is revised each ten years to conform to the average rental for vegetable cropland in Maricopa County. The lease and option run as long as the rental is paid.

An escrow fund of $250 per acre of land used for solar ponds will be built by setting aside $0.02 per ton (two cents per ton) of salt sold. Should solar ponds be abandoned the $250 per acre is for reclaiming the land. Any balance in the fund after reclamation will be divided equally between lessor and lessee.

The initial lease covers the 17 acres of pasture and 30 acres of the cropland with the option to lease any or all of the balance as required for salt production. This land is ideal for solar salt production. It requires only rolling and sealing plus building the berms to contain brine in the ponds. There is an ample supply of water and water rights are included in our lease.

Arizona Public Service has a main power transmission line and a 5 inch high pressure gas line along the north side of West Glendale Avenue. Our well was drilled about 500 feet from these utility lines.

This prime property has the great advantage of a perpetual lease at cropland prices.

e Geological Society of America, Inc
O. Box 1719, Boulder, Colorado 80302
03) 447-2020

ABSTRACT FORM--Section Meetings
Mail both copies of abstract to
Section Program Chairman

LUKE DOME - A HALOKINETIC SALT MASS NEAR PHOENIX, ARIZONA

Eaton, Gordon P. and Donald L. Peterson, U.S. Geological Survey, Denver, Colorado 80225 and Herbert H. Schumann, U.S. Geological Survey, Phoenix, Arizona 85025

A major salt dome, with plan dimensions of 2.5 x 5.5 miles, occurs 400 feet below the surface of the desert in the western Salt River Valley, 17 miles west-northwest of Phoenix, Arizona. In addition to a pronounced gravity expression, its presence is indicated by anomalies in topography, drainage pattern, groundwater flow patterns, hydrogeochemistry, lithofacies variations in the valley fill sediments, and by the existence of a fracture system which appears to owe its location, at least in part, to the dome.

The geologic setting is unusual for an American salt dome: it occurs within an intermontane valley of the Basin and Range Province; it is apparently Cenozoic in age; and it was emplaced in Cenozoic valley fill sediments. It is not known whether the salt is marine or non-marine in origin. The general setting implies a non-marine origin, however, part of the section of the western Salt River Valley is of markedly similar lithology and probably contemporaneous with the marine to brackish-water Bouse formation of Pliocene age in the Yuma-Blythe area.

A deep hole, drilled on the northeast flank of the dome, and bottoming in the salt, encountered an anhydrite cap 90 feet thick above a column of salt more than 3,600 feet thick. Interpretation of gravity data suggests that the maximum thickness of the dome is roughly 8,000 feet, but isolation of that part of the gravity field arising from the salt is subjective and knowledge of the density stratification of the sediments in the basin is lacking, so the gravity data are not amenable to a highly accurate interpretation.

Classification (Please underline the single classification that most nearly encompasses the topic of your paper):

Coal	General	Geophysics	Oceanography	Sedimentology
Economic	Geochemistry	Hydrogeology	Paleontology	Stratigraphy
Engineering	Geology Education	Information Exchange	Petrology	Structure
Extraterrestrial	Geomorphology	Mineralogy	Pleistocene	Vertebrate Paleontology

Only 2 X 2 inch-wide mask slides will be permitted. (There will be no provision for 3 1/4 X 4 inch lantern slide projection.) Employer's permission to publish, if required, is the author's responsibility

Speaker Gordon P. Eaton Indicate authors who are not on mailing lists of GSA or of any of the Associated Societies _____

Temporary address of first author, with dates _____

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A detailed study has been conducted in the Phoenix Metropolitan area where buyers of about 8500 tons per year have been contacted. This is believed to represent 70 - 80 per cent of the total usage in the Phoenix area. Users have been fully cooperative in providing information by grade and supplier.

In addition, most willingly discussed the technical requirements of salt for their particular use and offered suggestions for improving service.

The total market in Arizona is estimated at 21,000 tons. Southern Pacific Railroad has indicated that rail freight will allow Arizona Salt Company to be competitive along their lines as far east as El Paso, Texas and west to El Centro, California. This could add another 3,000 - 4,000 tons per year to sales for water softeners.

Industrial Salt

Today, the only user of salt in metallurgical process applications is the Lakeshore Mine of El Paso Natural Gas Company. This copper producer uses the "segregation" process wherein the reaction of oxide copper ore, coke and salt in a gas-fired rotary kiln causes the copper ore to be reduced to metallic copper that "segregates" onto the coke.

The kiln at the Lakeshore Mine is 10 feet in diameter by 200 feet long and processes 800 tons of ore per day using 16 tons (2%) salt. The kiln operates continuously.

While the same process has operated for some time in Africa, this is the first use in the United States. More significant, it is the first commercial recovery of copper from oxide ore containing too much limestone for economical acid leaching. There are more deposits of this type ore in Arizona and the success of the Lakeshore Mine will spark their development. It is still too early for reliable projections but this development can markedly increase the use of salt in Arizona.

Food Processors

A survey of the major producers of "pickled" food products in the Phoenix area shows usage at about 1800 tons per year. A modest growth is anticipated.

Chemicals

There are prospects for manufacturers of chlorine for city water treatment and chlorine compounds for treating swimming pools. The feasibility of operations using 4,000 - 6,000 tons of salt per year are being investigated. There is little immediate prospect for the large scale use of salt for manufacturing chemicals but over one-third of all United States salt is used in this manner and eventually Arizona will have a similar industry.

Roads

Excellent results are now being obtained in the stabilization of sub-base for highways by using salt instead of cement. Also, a mixture of salt and calcium chloride in small amounts has been proved to prevent washboarding in most dirt and gravel roads. Adoption of either of these proved practices by state or county road departments could dramatically increase the use of salt in Arizona.

Growth

In 1961, the last year for which U. S. Bureau of Mines data is available, shipments of salt into Arizona totaled 20,000 tons: of the 75,000 - 80,000 tons of salt now used each year,

about 50,000 tons represents growth in just the last seven years. The Arizona market for salt has grown rapidly in the last few years and it appears that the real growth is just now starting.

One great stimulant to market growth is low cost material. Arizona Salt Company is cooperating with El Paso Natural Gas Company in their development of underground storage facilities for natural gas.

El Paso Natural Gas Company has assured Arizona Salt Company that, should they excavate salt to create underground storage cavities, this salt would be made available to Arizona Salt Company; that El Paso is not interested in entering the salt business and will not allow the salt to be used in competition with Arizona Salt Company.

Prospects are good for Arizona Salt Company to receive about 2,000,000 tons of "as mined" salt at little or no cost. Such a vast supply of low cost salt could greatly stimulate market growth.

Salt Production Methods

Solution Mining - The salt will be dissolved with water to make brine. Steel tubing will be lowered down the well to far below the casing. Fresh water will be pumped down this tubing with enough pressure to force brine up the hole in the salt into the annulus between the casing and tubing and out at the top. Although the flow path could be reversed, the shape of the cavity can best be controlled by sending the fresh water down the tubing.

Settling and Processing - The brine first goes to settling ponds so that any dirt carried up with the brine can settle out. It then flows to "solar ponds" where the water evaporates and the salt crystallizes out.

This salt is harvested and processed by screening, washing, drying, grinding, etc., using equipment much like that used in processing sand and gravel.

This produces salt of a purity above 99.5 per cent which is ample for all uses other than table salt.

Other Factors - Everyone asks, "After the salt is dissolved won't the ground collapse into the cavity?" For our particular

well it would be very difficult to make the cavity collapse as there is a very thick and compact bed of gypsum on top of the salt. However, even if there were no gypsum at all there is no danger with the precautions being taken.

The simplest precaution is to leave a very thick section of undissolved salt above the cavity. This roof of rock salt protects the cavity from collapse. The second is just as simple: use techniques to produce a cavity shaped like a vertical post hole to keep the roof area small. These techniques for cavity control are proved, they are simple, they work, and they cost only a cent or two more per ton of salt than haphazard operation.

The next question is, "What keeps the brine out of the neighbors' fresh water wells?" First, brine is heavier than fresh water and already underlies the fresh water in our neighbor's wells. Wells drilled too deep, say below 600 - 700 feet, already hit salt water but this is a high sulfate water that we do not want either. Our well is cased through the fresh water and the salty water, through the gypsum to the solid salt.

The well casing was pressure cemented in place from the bottom up. Cement was pumped down the casing and back up the space between the casing and the drill hole to completely

seal off the water stratas from the salt, from the casing, and from each other. Water pressure was applied inside the casing with no loss of pressure proving that the casing has no leaks.

Circulation in the drill hole after drilling out the cement plug in the bottom of the cemented casing proved that there was no leakage through the salt. Should any leakage through the salt develop during salt production this will immediately show up and corrective measures, like cementing that section, will be taken.

Should the salt well make connection with water in the salt or around it, it will only be necessary to reverse the procedure, and the brine will be pumped out just like irrigation water.

Exploration and Development

The possibility of commercial salt in West Phoenix was first noted by G. J. Grott in November 1967. Investigation showed that the existence of some salt was known to at least a few people but had not been previously explored or examined by geologists for exploration purposes. A search for information was started. This search uncovered some little-known drill data and some recent and relatively unknown public data collected by U.S.G.S. for the Central Arizona Project. This latter data disclosed a gravity anomoly of considerable magnitude. Discussions with competent geologists and a geophysicist strongly indicated the possibility of a major occurrence of salt.

A lease was obtained in early 1968 on the Roach-Baker Ranch; approximately 360 acres along West Glendale Avenue and Dysart Road. Detailed market and engineering studies showed that a high level of profitability was possible because the market for salt in Arizona has increased rapidly in recent years and there are no Arizona producers.

Present suppliers of solar salt are located in the Bay Area near San Francisco, at San Diego, and at Black Warrior on the Pacific Coast of Baja California. Mined rock salt for cattle

feed comes from Danby Lake in California and from Carlsbad, New Mexico. On bulk salt, the freight to Phoenix varies from 35% of delivered cost from Danby Lake to 50% of delivered cost for solar salt from the docks of San Pedro, California (originated on Baja California).

This situation would allow Arizona Salt Company to maintain a good profit even should the out-of-state producers cut prices severely.

With this indication that a proved salt deposit in the Phoenix area would have a high value, a test was scheduled for October, 1968. The gamble of drilling a full size hole, not just a test hole, was taken and the gamble paid off.

We hit salt at 880 feet and drilled salt to 2812 feet, at which time El Paso Natural Gas Company was invited to join us in the drilling in return for information about the hole. We knew El Paso was looking for a large salt deposit in which to make a large underground storage cavity for natural gas. Within 48 hours Arizona Salt Company had a letter agreement to drill further and to log the hole. Logging was possible only because of the full size hole. Otherwise El Paso would not have been able to get the data they wanted.

The hole was continued to 4502 feet, in salt all the way, and in salt when drilling was stopped. The total thickness of drilled salt was a bit over 3620 feet.

A Slumberger Oil Well Services crew was brought in from Farmington, New Mexico. A Compensated Formation Density Log, Dual Induction-Laterlog, and Sidewall Neutron Porosity Logs were run (along with duplicate caliper logs) from top of hole to total depth. These logs, along with samples of cuttings from each ten feet of hole are available for examination by responsible parties on a confidential basis.

The well is now completed. It was cased down to the salt and the casing pressure-cemented in place to completely seal off the salt and the casing from all overlying water strata. This cementing job was done by a Halliburton Oil Well Services crew brought in from Sante Fe Springs, California. The well is now ready for production as soon as pump and tubing are installed.

The Salt Deposit

The salt deposit might be described as being shaped like a "table top mountain" buried under the valley fill of the Phoenix Basin. The top of the mountain is in the vicinity of West Glendale Avenue and Dysart Road where Arizona Salt has its lease.

The size of the "table top" can only be inferred from geologic data and logs of water wells in the area, but it apparently covers more than two square miles. A large part of the "table top" lies to the west and south of the lease. This is covered by Thunderbird Homes of Luke Field, other subdivided areas, and by property owned primarily by Goodyear Farms.

The Arizona Salt Company lease area is the only large acreage in the known "table top" area already leveled and suitable for solar ponds. Goodyear Farms owns the adjoining desert land to the east and south. They first found rock salt in 1952 when drilling for deep water. Goodyear has shown no interest in the salt business, but since then when they have sold any land Goodyear has retained the mineral rights. In mid-1968 they refused to sell or even to lease land for salt production.

From all information available at this time, other solar salt producers must locate at least a mile from Arizona Salt

Company's "discovery well" and in less favorable areas. No one is going to start in the salt business "right next to" Arizona Salt Company.

Salt Purity - Samples of cuttings were taken for each ten feet of the hole. Samples of drilling fluid were saved as each joint of pipe was added, about thirty feet of hole. About eighteen inches of rock salt core were recovered from a test at 2812 feet.

All samples and the density and porosity logs indicate that the salt body is over 90 per cent sodium chloride except for scattered thin bands.

To check the suitability of the salt for production, drill cuttings were washed and then drained and dissolved to make brine. The solids were allowed to settle out and the brine was evaporated to make salt. This salt was checked by spectrograph by Arizona Bureau of Mines: impurities were very low compared with market needs. Only calcium and magnesium were detected; calcium at a few hundredths of one per cent and magnesium at a few thousandths of one per cent.

The methods used in making salt from these drill cuttings are the same that would be used on a larger scale in production. Any and all grades of salt required in the market can be made satisfactorily.

Reserves - An acre foot of pure solid rock salt weights about 2840 short tons. Figuring reserves at 90 per cent, 2560 tons per acre foot is reasonable. A one-acre area 3620 feet thick contains 9,250,000 tons. Arizona Salt Company's 360 acres could hold over three billion tons based on these calculations and, of course, the salt has not been drilled to bottom so there is probably a bit more.

More pertinent, recovery of some 5,000,000 tons or more from the present well is a reasonable and conservative expectation: at present consumption rates, this would last about sixty to seventy years.

Leases

Mineral Lease

This 360 acre lease costs $0.25 per acre per year plus royalties. Royalties are 1/8 on oil or gas and 3% on minerals or salines other than for common salt in solid form, on which the royalty is $0.25/short ton. The lease runs while a well is being drilled, for one year after a well is drilled, for as long as there is production from the property, or for $500.00 per month should none of the other provisions be met.

Surface Lease

The surface lease and option to lease covers about 120 acres. It runs east 1/4 mile and north 3/4 miles from the intersection of West Glendale and Dysart Roads. The land has been leveled except for "pump back" ponds covering about two acres. There is about 100 acres of irrigated cropland and 17 acres of irrigated pasture.

The rental is $60.00 per acre per year for the land taken for use. This rental is revised each ten years to conform to the average rental for vegetable cropland in Maricopa County. The lease and option run as long as the rental is paid.

An escrow fund of $250 per acre of land used for solar ponds will be built by setting aside $0.02 per ton (two cents per ton) of salt sold. Should solar ponds be abandoned the $250 per acre is for reclaiming the land. Any balance in the fund after reclamation will be divided equally between lessor and lessee.

The initial lease covers the 17 acres of pasture and 30 acres of the cropland with the option to lease any or all of the balance as required for salt production. This land is ideal for solar salt production. It requires only rolling and sealing plus building the berms to contain brine in the ponds. There is an ample supply of water and water rights are included in our lease.

Arizona Public Service has a main power transmission line and a 5 inch high pressure gas line along the north side of West Glendale Avenue. Our well was drilled about 500 feet from these utility lines.

This prime property has the great advantage of a perpetual lease at cropland prices.

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ABSTRACT FORM--Section Meetings
Mail both copies of abstract to
Section Program Chairman

LUKE DOME - A HALOKINETIC SALT MASS NEAR PHOENIX, ARIZONA

Eaton, Gordon P. and Donald L. Peterson, U.S. Geological Survey, Denver, Colorado 80225 and Herbert H. Schumann, U.S. Geological Survey, Phoenix, Arizona 85025

A major salt dome, with plan dimensions of 2.5 x 5.5 miles, occurs 400 feet below the surface of the desert in the western Salt River Valley, 17 miles west-northwest of Phoenix, Arizona. In addition to a pronounced gravity expression, its presence is indicated by anomalies in topography, drainage pattern, groundwater flow patterns, hydrogeochemistry, lithofacies variations in the valley fill sediments, and by the existence of a fracture system which appears to owe its location, at least in part, to the dome.

The geologic setting is unusual for an American salt dome: it occurs within an intermontane valley of the Basin and Range Province; it is apparently Cenozoic in age; and it was emplaced in Cenozoic valley fill sediments. It is not known whether the salt is marine or non-marine in origin. The general setting implies a non-marine origin, however, part of the section of the western Salt River Valley is of markedly similar lithology and probably contemporaneous with the marine to brackish-water Bouse formation of Pliocene age in the Yuma-Blythe area.

A deep hole, drilled on the northeast flank of the dome, and bottoming in the salt, encountered an anhydrite cap 90 feet thick above a column of salt more than 3,600 feet thick. Interpretation of gravity data suggests that the maximum thickness of the dome is roughly 8,000 feet, but isolation of that part of the gravity field arising from the salt is subjective and knowledge of the density stratification of the sediments in the basin is lacking, so the gravity data are not amenable to a highly accurate interpretation.

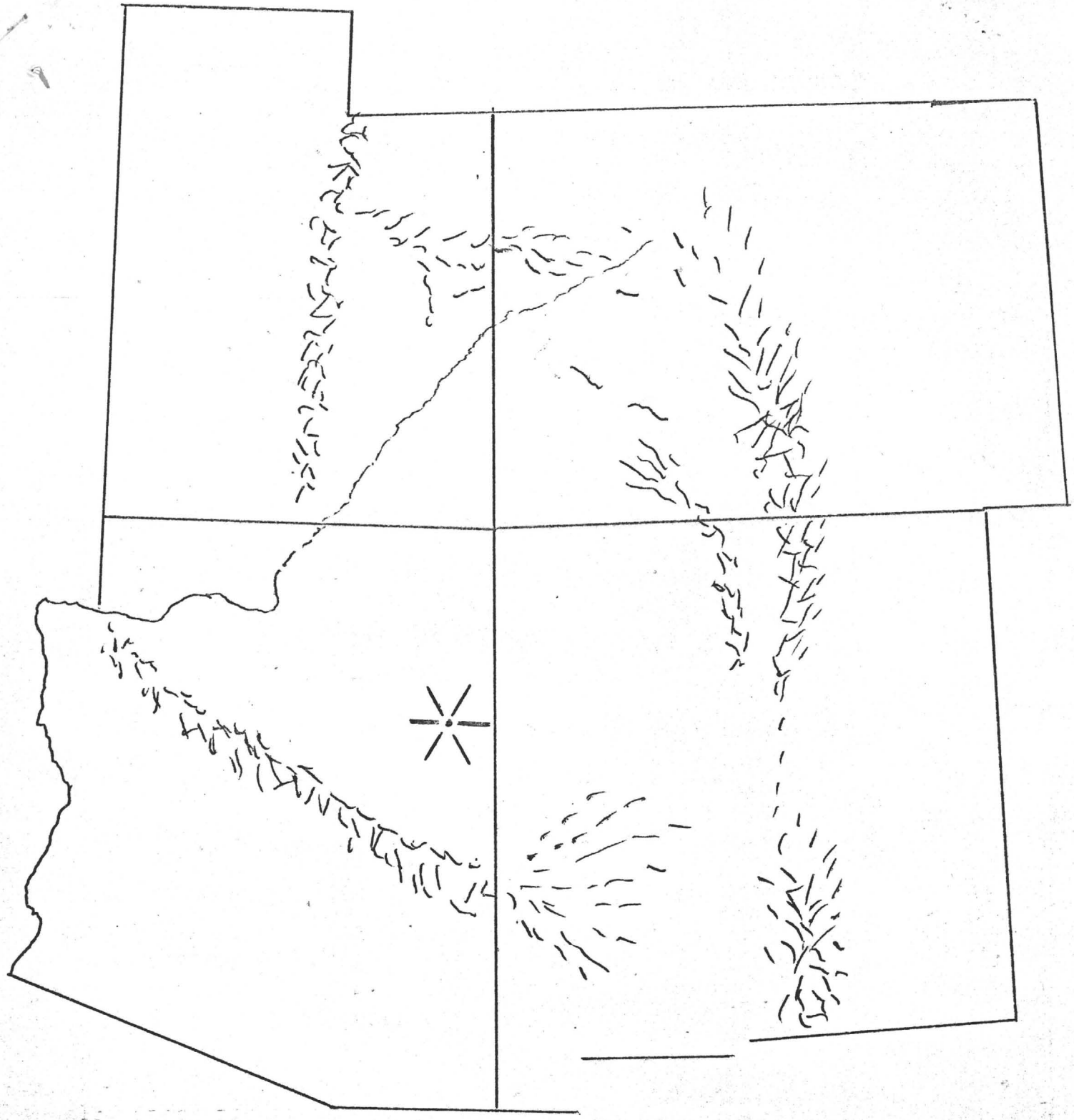
Classification (Please underline the single classification that most nearly encompasses the topic of your paper):

Coal	General	Geophysics	Oceanography	Sedimentology
Economic	Geochemistry	Hydrogeology	Paleontology	Stratigraphy
Engineering	Geology Education	Information Exchange	Petrology	<u>Structure</u>
Extraterrestrial	Geomorphology	Mineralogy	Pleistocene	Vertebrate Paleontology

Only 2 X 2 inch-wide mask slides will be permitted. (There will be <u>no</u> provision for 3 1/4 X 4 inch lantern slide projection.) Employer's permission to publish, if required, is the author's responsibility

Speaker Gordon P. Eaton Indicate authors who are not on mailing lists of GSA or of any of the Associated Societies _____

Temporary address of first author, with dates _____



FOUR CORNERS SALT CO.

Four Corners Salt Company

Hauling salt just 200 miles costs more than producing the salt: it pays to locate near the customers whenever possible. Selling salt profitably requires a knowledge of both the customers and the competitors.

Four Corners Salt Company has chosen a market area on the Colorado Plateau where profit margins will be generous. Competitors are located 470 to 940 miles away and must climb through passes at about 7000 feet elevation to cross the mountains encircling the area.

The industrial salt is being shipped around 800 miles and the major users are but 122 miles from Four Corners Salt Company.

A detailed study was made of the costs of New Mexico Salt Company in Carlsbad, New Mexico because this company produced all of the road salt, and most of the feed salt, sold in Northern New Mexico last year. Our area was selected and pricing was set so that this company cannot possibly compete on feed salt.

However, it was also learned that special conditions will keep us from getting any appreciable part of the state highway contracts for salt for ice and snow control so no great effort will be made in this direction.

Four Corners Salt Company will be a modest operation tailored to a specific area to yield an exceptionally high return on investment.

Source of the Salt

The Holbrook Basin encompasses an area of about 2200 square miles of salt bed. This is of Permian Age and in places the salt contains some potash which was the cause of a large drilling program several years ago.

Four Corners Salt Company will locate on the east of Holbrook along the north side of the Santa Fe and just east of the city limits. Here the salt is about 30 feet thick in the first two holes. The brine has tested very low in potash so there will be no problem in producing to the requirements of the uranium mills.

Development

An agreement has been reached with Eagleton Engineering of Houston, Texas, that allows development of this salt in stages at a minimum of investment for Four Corners Salt Company.

Eagleton Engineering will develop storage cavities for propane by dissolving out the salt in a controlled pattern. Four Corners Salt Company will purchase salt "in place" and pay Eagleton Engineering a fee for dissolving out the salt and delivering the saturated brine to our ponds. These ponds will be located on Eagleton Engineering's land or leased land

The total cost of purchasing the salt, the mining fee, and the land rental is to be approximately $1.50/ton of salt.

Half is to be paid on delivery of the brine and half when the salt is sold.

The initial cavity will supply about 35-40,000 tons of salt and it is expected that an additional cavity will be developed each year for several years. Eagleton Engineering has the option to produce all the brine we need but, should they not wish to produce beyond their storage requirements, then Four Corners Salt Company can produce its own brine.

Financial

The ponds will be built to take the brine as Eagleton produces it, but no other construction will be done until the salt is ready for harvest.

The initial brine will be about 100 acre feet. 25 acres of ponds will be built at a cost of about $25,000 including supervision and overhead expense.

Total Initial Financing

40,000 tons salt (in brine) at $0.75/ton	$30,000
25 Acres Ponds	25,000
Interim Expense - planning, testing, etc.	5,000
	$60,000

The harvesting of salt will be primarily with leased heavy equipment. First sales to the uranium mills and for road deicing does not require kiln drying, so the usual

plant is not required.

It is expected that the working capital for inventory and carrying sales can be obtained on much more advantageous terms when the salt is ready for sale.

The attached financial projection gives an expected After Tax Cash Flow of about $165,000 per year. This projection justified considerably more equity financing than is being done at this stage leaving room for additional financing should this be required.

FINANCIAL PROJECTION

	SALES - TONS PER YEAR		
	40,000	50,000	70,000
Average Price (Net) FOB Plant	$10.30/ton	$10.30/ton	$ 9.27/ton
Total Sales	$ 412,000	$ 515,000	$ 649,000
Total Costs	226,200	240,500	269,100
Gross Profits	$ 185,800	$ 274,500	$ 379,900
Depletion Allowance*	36,000	45,000	63,000
Taxable Income	$ 149,800	$ 229,500	$ 316,900
Taxes at 52%	77,900	119,300	164,800
After Tax Profits	$ 71,900	$ 110,200	$ 152,100
Depletion Allowance	36,000	45,000	63,000
Depreciation (*)	10,000	10,000	10,000
Total Cash Flow Annually	$ 117,900	$ 165,200	$ 225,100

* Tax Free Depletion Allowance is 10% based on Value of First Salable Product

(*) Assumes Bank Loan on $40,000 Additional Equipment

Markets and Salt Grades

Uranium Mills

Anaconda and Kerr-Mac are at Ambrosia Lake, New Mexico, about 120 miles east of Pinta. Shipment is by rail to Anaconda and by rail-truck combination to Kerr-Mac which is 25 miles from rail.

The salt is dumped into concrete tanks for making brine. Salt must be coarse and free from potash and with a minimum of dirt. Salt Lake City salt is too fine, Kansas salt is too dirty, and Carlsbad salt contains potash. They buy from Morton's mine at Grand Saline, Texas, 790 miles east of Ambrosia Lake. Price is $15.80/ton by rail. Kerr-Mac pays extra for the 25-mile truck haul.

The present market is about 1000 tons per month and the mills have started increasing production by 50 percent. Volume will be 18,000 tons per year by next spring. Anaconda has all production sold through 1982 and Kerr-Mac says they too have a market. This assures the long term nature of the salt usage; about one pound of salt per pound of uranium.

Cattle Salt

The cattle are primarily range cattle with a few dairy herds and feed lots. Salt is mostly "free-choice" run-of-mill

sizing and kiln drying is not required. Blocks are used to some extent, say about 15 - 20 percent of the total consumption. We expect to sell all of the salt in our primary area on good quality at a price cut of $2.00 - $3.00 per ton. This pricing takes all of the profit out of the competitors' sales in this area. The writer recently thoroughly studied the costs of the New Mexico company producing much of the salt sold in our primary area and their costs are known exactly. Costs of the only other New Mexico company are estimated to be higher.

Salt for Curing Hides

All curing operations in our primary areas are pit type operations and a clean, coarse, salt is desired. It need not be kiln dried. New Mexico salt is not suitable and Kansas salt is used only as a last resort. Grand Saline furnishes the hide salt in New Mexico. Salt Lake City supplies the hide salt in S.W. Colorado but the packers want a coarser salt. Salt Lake salt is fine grain and none is recovered as secondary salt for reuse. This increases salt consumption about 50 percent.

There is a secondary marketing area, for hide salt only, in the great feed lot area developed between Clovis, New Mexico and Amarillo, Texas. Copy from a recent clipping is attached. The hide salt now comes primarily from Grand Saline, the feed salt primarily from Carlsbad, New Mexico.

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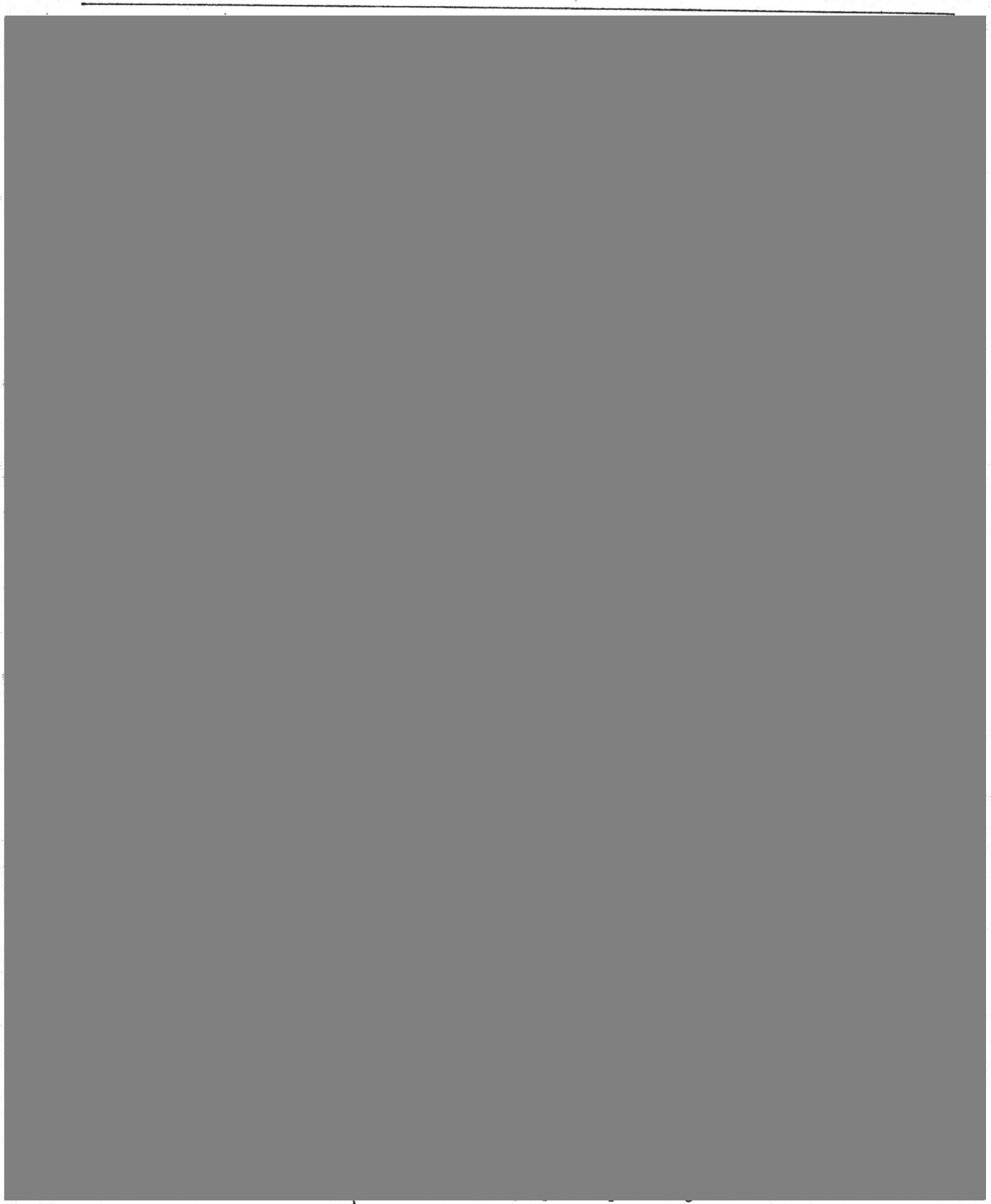
BEEF SALES BOOM AND SO DO PRICES



The major packing plants are located at Hereford, Frionia, and Bovina, Texas.

Pinta enjoys a small shipping advantage being 65 - 100 miles closer than Grand Saline. It is expected that this will be offset by the traditional railroad practice of charging greater rates for going east than for going west.

The available market is estimated at 44,000 tons combined hide and water softener salt. A market penetration of 30 percent appears to be reasonable at the projected pricing. The margin is far lower than in the primary market area but is still acceptable. No attempt will be made to sell any of the 100,000 tons per year of feed salt used in the area.

Water Softener Salt

The market is scattered but is mostly along the Rio Grande valley and the Eastern New Mexico - Western Texas area. The salt will be produced by kiln drying and screening and grinding stack run salt; the coarse salt is for water softeners and the fines for grinding into grades used for mixing into dairy feeds and range or feed lot supplements.

Sales Forecasts

The total market in New Mexico, Colorado, Arizona, and Utah is about 500,000 - 600,000 tons. Four Corners Salt Company has elected to compete aggressively for about one-eighth of this market, some 70,000 tons, on the basis of selecting salt grades

PRIMARY MARKET

	SELECTED MARKETS VOLUME TONS/YR.	PROJECTED SALES; VOLUME TONS/YR.	$/TON PRICE; FOB PLANT	GROSS SALES; FOB PLANT
ARIZONA				
4 N.E. COUNTIES	4000	4000	12.00	48,000
UTAH				
4 S.E. COUNTIES	2000	2000	10.50	21000
NEW MEXICO				
8 N.W. COUNTIES				
Cattle, 180,000 hd	6300	5000	10.50	52,500
Sheep, 306,000 hd	1180	900	10.50	9,450
STATE ROADS	3400	400	9.00	3,600
OTHER ROADS	2000	1500	9.00	13,500
WATER SOFTENER	1500	1200	10.50	12,600
HIDE CURING	3500	2800	9.00	25,200
URANIUM MILLS	18000	15000	10.50	157,500
COLORADO				
18 SW COUNTIES				
CATTLE 460,000 hd	16100	12800	10.50	134400
SHEEP 498,000 hd	1900	1500	10.50	15750
HIDES	2500	2000	10.50	21000
HIGHWAYS	1200	1000	9.00	9000
	63,180 TONS	50,100 TONS	$10.45/TON	$523,500

SECONDARY MARKETS

	SELECTED MARKETS TONS/YR	PROJECTED SALES TONS/YR	$/TON PRICE; FOB PLANT	GROSS SALES; FOB PLANT
NEW MEXICO 6 PERIPHERAL COUNTIES				
CATTLE 250,000 hd	8750	4300	8.50	36,550
SHEEP 48,000 hd	180	90	8.50	765
HIDES	600	480	10.50	5040
WATER SOFTENER	400	400	10.50	4200
CLOVIS, N.M to HEREFORD, TEX.				
HIDES	40000	12000	6.00	72000
WATER SOFTENER	4000	1200	6.00	7200
	53,930 TONS	18,470 TONS	@ 6 70/TON	$125,755

and areas in which there is a decided freight advantage over competitors' comparable grades.

This primary market might be defined as one in which grades are selected according to those in which an average penetration of 80 percent appears very reasonable at the prices selected.

The summation for the primary market is about 50,000 tons and F.O.B. Plant Sales are about $520,000.

Additional sales of about 18,400 tons are forecast for other areas outside the primary markets. The additional F.O.B. Plant Sales of about $125,000 are at a greatly reduced margin per ton and greatly reduced market penetration but the incremental profits are well worthwhile.

Future Growth

Additional uranium discoveries in the Four Corners area indicate a continuing long term growth of this market. The livestock market is expected to remain stable. The water softener salt usage will increase faster.than the population as lower quality sources are brought into production.

There is some chance that the area may take a dramatic growth. A clipping is attached to illustrate this point.

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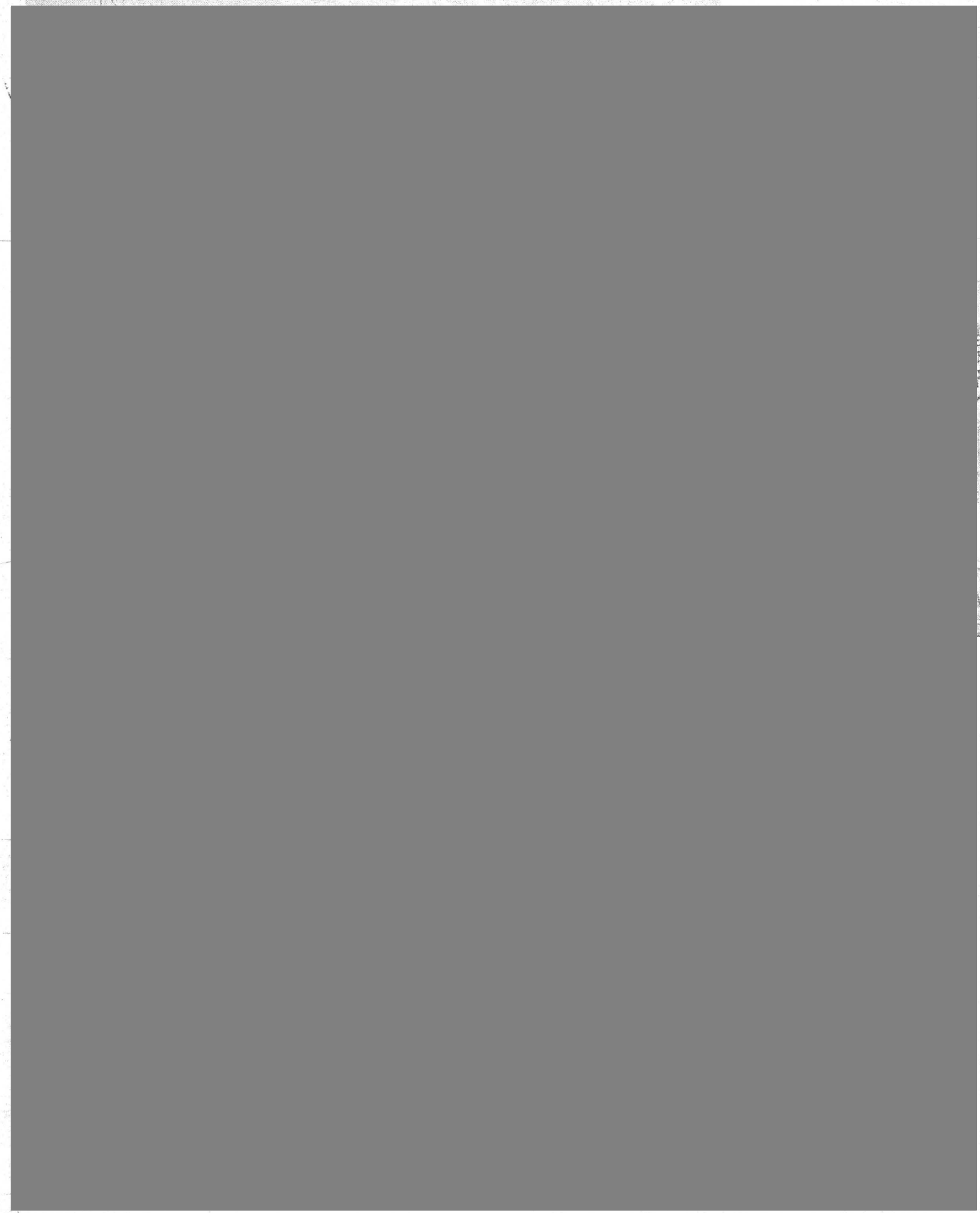
A MODEL CITY FOR INDIAN LANDS



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U.S.NEWS & WORLD REPORT

A MODEL CITY FOR INDIAN LANDS

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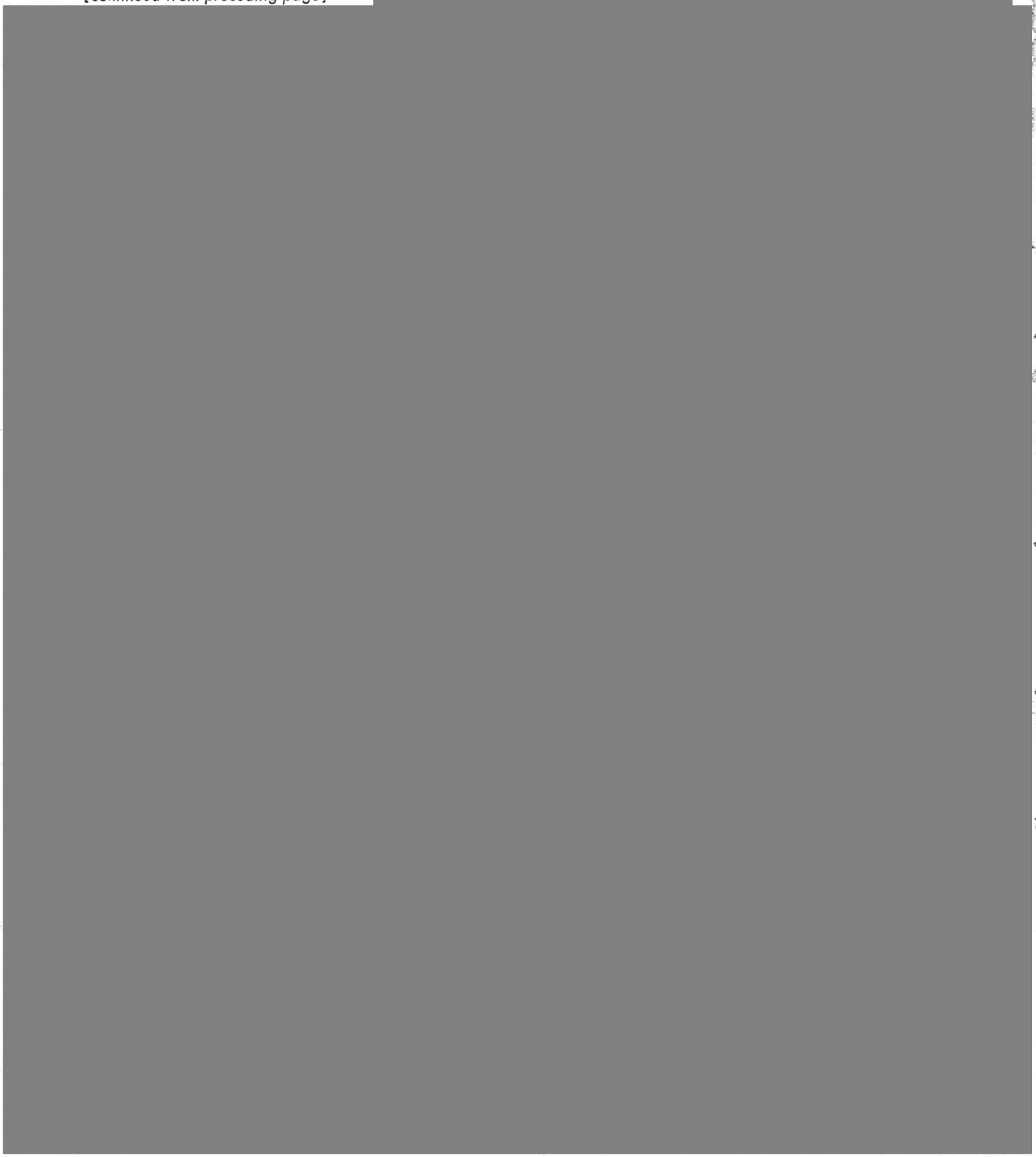

U.S.NEWS & WORLD REPORT

AN INDIAN TRIBE WITH LAWYERS, TECHNICIANS—AND NEW HOPES

File: Ariz. Maricopa Salt Company Re: J. Gatt

Objective

Arizona Salt Company has the objective of achieving a maximum growth of Stockholder Equity. This objective will be attained by Arizona Salt Company becoming the prime producer of salt for Arizona.

The relative costs of producing and transporting salt dictate that salt facilities be close to the market: shipping salt 200 miles overland costs more than producing the salt. Once the market is large enough for one salt producer, this producer can dominate that market for a long time through a pricing policy allowing good profits for one producer at high market penetration but neglibible profits for a second producer in a split market. This is the traditional practice in the salt trade.

The Arizona market, centered around Phoenix, has reached this point of good profitability. Arizona Salt Company, with its discovery of a major salt deposit in the center of the market area, will be the dominant producer.

Arizona Salt Company

Arizona Salt Company was incorporated in Arizona on October 8, 1968 for the purpose of developing a salt occurrence west of Phoenix on West Glendale Avenue.

The possibility of commercial salt in West Phoenix was first noted by G. J. Grott in November 1967. Investigation showed that the existence of some salt was known to at least a few people but had not been previously explored or examined by geologists for exploration purposes. A search for information was started. This search uncovered some little-known drill data and some recent and relatively unknown public data collected by U.S.G.S. for the Central Arizona Project. This latter data disclosed a gravity anomoly of considerable magnitude. Discussions with competent geologists and a geophysicist strongly indicated the possibility of a major occurrence of salt.

A lease was obtained in early 1968 on the Roach-Baker Ranch; approximately 360 acres along West Glendale Avenue and Dysart Road. Detailed market and engineering studies showed high level of profitability was possible because the market for salt in Arizona has increased rapidly in recent years and there are no Arizona producers.

The lowest rail and truck rates into Phoenix, for example, are $4.26 and $6.00 respectively for cattle feed salt (Danby, California area) and $6.23 and $7.50 respectively for water softener salt (rail from Newark, California and truck from Long Beach, California). The potentials in freight saving

allow for giving excellent quality and service while maintaining a respectable profit margin. This margin will withstand severe price cutting, to the point of present suppliers selling below their cost, without being exhausted. Thus it appeared that a commercial salt body in the West Phoenix location would be particularly valuable. (A highly reputable Arizona company proposed, prior to drilling, that they would pay $100,000 for half-interest in the company owning the lease providing commercial salt was proved.)

The lease was drilled to a depth of 4502 feet with salt continuous from 880 feet to total depth. The drilled thickness of salt is over 3600 feet, and the bottom of the salt has not been reached. Drilling was witnessed by Geologists from Arizona Bureau of Mines, U. S. Geological Survey, and El Paso Natural Gas Company.

A Compensated Formation Density Log, a Dual Induction-Laterlog, and a Sidewall Neutron Porosity Log, together with hole calipers, were run to total depth by a Slumberger crew from Farmington, New Mexico. These logs, along with drill samples taken each ten feet, are available for examination by responsible parties.

Present plans are to bring the proved lease into production at a total cost of approximately $195,000 including startup costs and working capital.

The well is now completed having been cased and pressure cemented to completely seal the salt from all overlying water strata. The cementing job was done by a Halliburton Oil Well

Services crew and equipment brought from Santa Fe, California. The actual cost of the well has been approximately $34,000 for outside services and material. (Supervisory and overhead costs are not included in this figure.) This $34,000 is included in the $195,000. This sum could be spread out over the four to six months it takes for building the solar ponds and their coming into production.

However, plans are to start production as soon as possible. Investment of about $16,000 will allow production of salt by burning natural gas to evaporate the water from the brine. Of this amount only about $2400 is for equipment other than that which will be needed for processing the salt from the solar ponds. Early production and sale is beneficial for several reasons including early market entry and providing income and a modest profit during the period the solar ponds are coming into production.

The production capacity will be 1500 - 2000 tons per month within thirty days from start of construction and it will grow to 7,000 - 8,000 tons per month by the second summer. Sales are expected to reach a rate of 4,000 tons per month by the end of the first year and 5,500 to 6,000 tons per month by the end of the second year.

Even after allowance for price cuts judged sufficient to gain substantially the total market, the return in after-tax earnings and tax free depletion allowance will be on the order of $150,000 to $175,000 per year.

The Salt Deposit

The salt deposit might be described as being shaped like a "table top mountain" buried under the valley fill of the Phoenix Basin. The top of the mountain is in the vicinity of West Glendale Avenue and Dysart Road where Arizona Salt has its lease.

The size of the "table top" can only be inferred from geologic data and logs of water wells in the area, but it apparently covers more than two square miles. A large part of the "table top" lies to the west and south of the lease. This is covered by Thunderbird Homes of Luke Field, other subdivided areas, and by property owned primarily by Goodyear Farms.

The Arizona Salt Company lease area is the only large acreage in the known "table top" area already leveled and suitable for solar ponds. Goodyear Farms owns the adjoining desert land to the east and south. They first found rock salt in 1952 when drilling for deep water but have shown no interest in the salt business. However, since then mineral rights have been retained by Goodyear Farms whenever they have sold any land. In mid-1968 Goodyear Farms refused to sell or even to lease land for salt production.

From all information available at this time, other solar salt producers must locate at least a mile from Arizona Salt Company's "discovery well" and in less favorable areas. If they find salt it will probably be at greater depths out on

the sloping edge of the salt body where risks of brine loss are greater. Unless one considers a mile away as being close, no one is going to start in the salt business "right next to" Arizona Salt Company.

Salt Purity - Samples of cuttings were taken for each ten feet of the hole. Samples of drilling fluid were saved from each joint of pipe, about thirty feet of hole. About eighteen inches of rock salt core were recovered from a test at 2812 feet.

All samples and the density and porosity logs indicate that the salt body is over 90 percent sodium chloride except for scattered thin bands.

To check the fitness of the salt for production, drill cuttings were washed and then drained and dissolved to make brine. The solids were allowed to settle out and the brine evaporated to make salt. This salt was checked by spectrograph by Arizona Bureau of Mines: impurities were very low compared with market needs. Only calcium and magnesium were detected; calcium at a few hundredths of one percent and magnesium at a few thousandths of one percent.

The methods used in making salt from these drill cuttings are the same that will be used on a larger scale in production. Any and all grades of salt required in the market can be made satisfactorily.

Reserves - An acre foot of pure solid rock salt weighs about 2840 short tons. Figuring reserves at 90 percent, 2560 tons per acre foot is reasonable. A one-acre area 3620 feet thick contains 9,250,000 tons. Arizona Salt Company's 360 acres could hold over three billion tons based on these calculations and, of course, the salt has not been drilled to bottom so there is probably a bit more.

More pertinent, recovery of some 5,000,000 tons or more from the present well is a reasonable and conservative expectation: at present consumption rates, this would last about sixty to seventy years.

The Market

The market for salt in Arizona is now above 75,000 tons per year. The livestock industry accounts for about two-thirds of this usage for feed salt, for curing hides, and in miscellaneous non-feed uses in the packing houses. About one-quarter is used for water softening and the balance in industrial processing. Best prospects for major expansion are in chemical manufacturing and in use for base stabilization in road building.

Cattle Feed

The feed salt is primarily used for mixing into feed lot feeds and into range supplement. The average feed lot animal consumes 20 pounds of feed per day containing a little over 3 ounces (1%) of salt. Range animals can use about the same amount of salt and will derive some from the graze and the water. However, range animals usually do not get as much salt as they can use unless they are fed loose "free choice" salt or a high salt content range supplement: they simply will not work on a salt block long enough.

Cattlemen have learned to use salt as a "regulator" to control the consumption of range supplement and this use is increasing. Given the opportunity, cattle will eat more of the valuable supplement than they need unless it is mixed with salt. However, when salt is mixed-in the cattle eat only until

they consume their customary salt. Range supplement containing about four ounces of salt to a day's feeding can be put out on the range in bulk feeders without concern about "overeating". This system, and the growing use of loose salt on a "free choice" basis, have resulted in a general increase in the total salt used by cattlemen and will continue to do so.

Hides

Hide curing will use as much as one pound of salt per pound of hide, or as little as 0.3 pounds per pound, depending on the method used and the care exercised. While the number of cattle slaughtered is expected to increase, increased efficiency in use is expected to limit market growth in this area. All firms curing hides have been included in the market surveys as have all the major meat packers.

Water Softener Salt

A detailed study of this market has been conducted in the Phoenix Metropolitan area where buyers of about 8500 tons per year have been contacted. This is believed to represent 70 - 80 percent of the total usage in the Phoenix area. Users have been fully cooperative in providing information on usage by grade and supplier.

In addition, most willingly discussed the technical requirements of salt for their particular use and offered suggestions for improving service.

The total market in Arizona is estimated at 20,000 tons. Southern Pacific Railroad has indicated that rail freight will allow Arizona Salt Company to be competitive along their lines as far east as El Paso, Texas and west to El Centro, California. This could add another 3,000 - 4,000 tons per year to sales for water softeners.

Industrial Salt

Today, the only user of salt in process applications is the Lakeshore Mine of El Paso Natural Gas Company. This copper producer uses the "segregation" process wherein the reaction of oxide copper ore, coke and salt in a gas-fired rotary kiln causes the copper ore to be reduced to metallic copper that "segregates" onto the coke.

The kiln at the Lakeshore Mine is 10 feet in diameter by 200 feet long and processes 800 tons of ore per day using 16 tons (2%) salt. The kiln operates continuously.

While the same process has operated for some time in Africa, this is the first use in the United States. More significant, it is the first commercial recovery of copper from oxide ore containing too much limestone for economical acid leaching. There are more deposits of this type ore in Arizona and the success of the Lakeshore Mine will spark their development. It is still too early for reliable projections but this development can markedly increase the use of salt in Arizona.

Chemicals

There are prospects for manufacturers of chlorine for city water treatment and chlorine compounds for treating swimming pools. The feasibility of operations using 4,000 - 6,000 tons of salt per year are being investigated. There is little immediate prospect for the large scale use of salt for manufacturing chemicals but over one-third of all United States salt is used in this manner and eventually Arizona will have a similar industry.

Roads

Excellent results are now being obtained in the stabilization of sub-base for highways by using salt instead of cement. Also, a mixture of salt and calcium chloride in small amounts has been proved to prevent washboarding in most dirt and gravel roads. Adoption of either of these proved practices by state or county road departments could dramatically increase the use of salt in Arizona.

Growth

In 1961, the last year for which U. S. Bureau of Mines data is available, shipments of salt into Arizona totaled 20,000 tons: of the 75,000 - 80,000 tons of salt now used each year, about 50,000 tons represents growth in just the last seven years. And of this 50,000 tons, about 9,000 tons came during the last year, 1968. The Arizona market for salt has grown rapidly in the last few years and it appears that the real growth is just now starting.

One great stimulant to market growth is low cost material. Arizona Salt Company is cooperating with El Paso Natural Gas Company in their development of underground storage facilities for natural gas. (El Paso made a "bottom-hole" contribution covering 1700 feet of drilling and the cost of logging the hole drilled by Arizona Salt Company.)

El Paso Natural Gas Company has assured Arizona Salt Company that, should they excavate salt to create underground storage cavities, this salt would be made available to Arizona Salt Company; that El Paso is not interested in entering the salt business and will not allow the salt to be used in competition with Arizona Salt Company.

Prospects are good for Arizona Salt Company to receive about 2,000,000 tons of salt at little or no cost. Even should the salt be mined as brine this argues well for a vast supply of low cost salt to stimulate a rapid growth of markets.

Marketing

Details of a mutually exclusive marketing contract are being worked out. The contract calls for sales, transportation, and accounts receivable to be handled for a fee of approximately $2.00 per ton plus transportation at cost of ownership and operation of the trucks. This company is the largest manufacturer of custom feeds and, of course, is also the largest single salt customer in Arizona. The stockholder list of this company contains about 70 percent of Arizona's cattlemen. The company is also the largest purchaser of packing house by-products for manufacturing supplements. They expect to have no problem obtaining the cattlemen's and the packing house salt business.

A marketing company, Arizona Salt Sales, will be established to give some protective cover for sales to other cattle feed manufacturers. While it is not expected that the arrangement can be kept secret there is no need to rub one feed company's name into the other feed companys' faces.

The officers of this company feel that we should be able to sell just about every pound of salt used in Arizona, even without substantial price cuts.

Salt Production Methods

Solution Mining - The salt will be dissolved with water to make brine. Steel tubing will be lowered down the well to far below the casing. Fresh water will be pumped down this tubing with enough pressure to force brine up the hole in the salt into the annulus between the casing and tubing and out at the top. Although the flow path could be reversed, the shape of the cavity can best be controlled by sending the fresh water down the tubing.

Settling and Processing - The brine first goes to settling ponds so that any dirt carried up with the brine can settle out. It then flows to "solar ponds" where the water evaporates and the salt crystallizes out.

This salt is harvested and processed by screening, washing (in brine), drying, grinding, etc. using equipment much like that used in processing sand and gravel.

This produces salt of a purity above 99.5 percent which is ample for all uses other than table salt grades.

As a means of getting into production fast, an evaporator will be used in which natural gas is burned to "boil off" the water. This evaporator will be kept for meeting peak demands until an inventory can be built and for making high purity salt for use in food processing such as pickling operations.

Other Factors - Everyone asks, "After the salt is dissolved won't the ground collapse into the cavity?" For our particular well it would be very difficult to make the cavity collapse as there is a very thick and compact bed of gypsum on top of the salt. However, even if there were no gypsum at all there is no danger if reasonable precautions are taken and they will be.

The simplest precaution is to leave a very thick section of undissolved salt above the cavity. This roof protects the cavity from collapse. The second is just as simple: use techniques to produce a cavity shaped like a vertical post hole to keep the roof area small. These techniques for cavity control are proved, they are simple, they work, and they cost only a cent or two more per ton of salt than haphazard operation.

The next question is, "What keeps the brine out of the neighbors' fresh water wells?" First, brine is heavier than fresh water and already underlies the fresh water in our area. Wells drilled too deep, say below 600 - 700 feet, already hit salt water but this is a high sulfate water that we do not want either. Our well is cased through the fresh water and the salty water, through the gypsum and on to the solid salt.

The well casing was pressure cemented in place from the bottom up. Cement was pumped down the casing and back up the space between the casing and the drill hole to completely seal off the water stratas from the salt, from the casing, and from

each other. Water pressure was applied inside the casing with no loss of pressure proving that the casing has no leaks.

Circulation in the drill hole after drilling out the cement plug in the bottom of the cemented casing proved that there was no leakage through the salt. Should any leakage through the salt develop during salt production this will immediately show up and corrective measures, like cementing that section, will be taken.

Should the salt well make connection with water in the salt or around it, it will be necessary to reverse the procedure, and the brine will be pumped out just like irrigation water.

Profits and Strategy

Before the salt exploration was started a study was made of major salt producers in Baja California and in California. All of these operations were dominant in a given locality or market segment. Except in remote areas small salt works are not profitable; even owner-operators barely manage to exist.

It soon became apparent that the only strategy open is in determining just how far one must go in giving extra service, or quality, or in lowering price to get so mucy of the market that only the least aware investors would start another local company.

An examination of the table "Profit Margin Under Various Pricing Policies" pretty well tells the story.

Getting 40 percent of the market is not a worthwhile goal even at present pricing and is disastrous at price cuts of even a modest 15 percent.

Getting two-thirds of the market is worthwhile at price cuts to, say, 10 or perhaps even 15 percent, but it is less profitable than getting essentially all of the market by cutting price 25 percent.

The strategy then resolves to establishing a plant at the lowest possible investment to give acceptable costs in the volume range of 50,000 to 75,000 tons per year.

A thorough scouting of available used equipment and an evaluation of costs at various design levels led to a final

design for 50,000 tons per year operating three shifts, five days per week. Expansion to 60,000 tons per year is accomplished by going to six days per week. Increasing production to 75,000 tons per year takes an added investment of $20,000.

This design allows almost constant plant cost per ton throughout the range of 50,000 to 75,000 tons per year. While lower unit costs could be obtained at a higher design capacity, the return on the added initial investment is not that attractive.

Final strategy is to get started with two shifts and to get as many sales as possible at present price schedules. It is expected that something over 30,000 tons per year can be produced with two shifts and sold without price cuts. The marketing firm can assure that much from sales to stockholders and internally.

As the production crew gains experience and trained workers are available to complete the crews for three shifts, production will be increased to the rate of 50,000 tons per year. Prices will be cut only as necessary to sell the production.

From then on it is all fine tuning of the price-volume-profit relationship. A reasonable projection for 18 to 24 months from start appears to be somewhere above 4200 tons per month and above the rate of $150,000 per year for after-tax profits and tax-free Depletion Allowance.

Profit Margin Under Various Pricing Policies

Sales	30,000 tons/yr.	50,000 tons/yr.	75,000 tons/yr.
Sales Value at Cur. Pricing[1]	$350,000.00	$590,000.00	$894,100.00

	Profit before Depletion Allowance and Income Taxes					
	% of Sales	Dollars	%	Dollars	%	Dollars
Current Pricing	19.5	$68,100	38.6	$227,500	43.3	$387,300
5% Price Reduction[1]	14.5	50,600	33.6	198,000	38.3	342,600
10% Price Reduction[1]	9.5	33,100	28.6	168,500	33.3	297,900
15% Price Reduction[1]	4.5	15,600	23.6	139,000	28.3	253,200
20% Price Reduction[1]	0	(1,900)	18.6	109,500	23.3	208,500
25% Price Reduction[1]			13.6	80,000	18.3	163,800
30% Price Reduction[1]			8.6	50,500	13.3	119,100

[1] Percentage of F.O.B. Plant prices for Bulk Salt

Profit Calculations - 30,000 Tons per Year.

Product	Tons	Per Ton*	Total
Evaporated Salt, Kiln Dried	3,000	$14.50	$ 43,500.00
Solar Salt, Stack Run	4,000	12.50	50,000.00
Solar Salt, Stack Run, Kiln Dried	3,000	13.50	40,500.00
Feed Salt, No. 2, Kiln Dried	20,000	10.80	216,000.00
Total Sales	30,000		$350,000.00

Tax (1.5% of Sales)	$ 5,250.00	
Plant Costs	99,300.00	
Sales Costs	60,000.00	
Overhead	117,300.00	
		$281,850.00
Profit Margin is $2.27/ton; 19.5% of Sales		$ 68,150.00
Depletion Allowance per ton is 10% of sales value of first product; $1.08/ton, up to 50% of pretax profits - tax free Depletion Allowance		$ 32,400.00
Taxable Profits		$ 35,750.00

*These Minimum F.O.B. Plant Prices for Bulk Salt are calculated by deducting delivery costs from the lowest delivered car load or truck load prices currently paid by the largest customers in the Phoenix area. Other customers pay substantially more. Current Bagging and Palletizing extra charges adequately cover these extra costs incurred.

Profit Calculations - 50,000 Tons per Year

Product	Tons	Per Ton*	Total
Evaporated Salt, Kiln Dried	4,000	$14.50	$ 58,000.00
Solar Salt, Stack Run	8,000	12.50	100,000.00
Solar Salt, Stack Run, Kiln Dried	8,000	13.50	108,000.00
Feed Salt, No. 2, Kiln Dried	30,000	10.80	324,000.00
Total Sales	50,000		$590,000.00

Tax (1.5% of Sales)	$ 8,850.00	
Plant Costs	132,500.00	
Sales Costs	100,000.00	
Overhead	121,100.00	
		$362,450.00
Profit Margin is $4.56/ton; 39.2% of Sales		$227,550.00

Effect of Price Reductions

	Prices Reduced 5%	Prices Reduced 10%	Prices Reduced 15%
Depletion Allowance	$ 51,300.00	$ 48,600.00	$ 45,700.00
Taxable Profits	146,750.00	119,950.00	93,350.00

*These Minimum F.O.B. Plant Prices for Bulk Salt are calculated by deducting delivery costs from the lowest delivered car load or truck load prices currently paid by the largest customers in the Phoenix area. Other customers pay substantially more. Current Bagging and Palletizing extra charges adequately cover these extra costs incurred.

Profit Calculations - 75,000 Tons per Year

Product	Tons	Per Ton*	Total
Evaporated Salt, Kiln Dried	4,000	$14.50	$ 58,000.00
Solar Salt, Stack Run	9,000	12.50	112,500.00
Solar Salt, Screen and Kiln Dried	20,000	13.50	270,000.00
Feed Salt, No. 2, Kiln Dried	42,000	10.80	453,600.00
Total Sales	75,000		$894,100.00

Tax (1.5% of Sales)	$ 13,400.00	
Plant Costs	204,000.00	
Sales Costs	150,000.00	
Overhead	139,400.00	
		$506,800.00
Profit Margin is $5.25/ton; 44% of Sales		$387,300.00

Effect of Price Reductions

	Prices Reduced 10%	Prices Reduced 15%	Prices Reduced 20%
Depletion Allowance	$ 72,900.00	$ 68,850.00	$ 64,800.00
Taxable Profits	224,990.00	194,335.00	143,680.00

*These Minimum F.O.B. Plant Prices for Bulk Salt are calculated by deducting delivery costs from the lowest delivered car load or truck load prices currently paid by the largest customers in the Phoenix area. Other customers pay substantially more. Current Bagging and Palletizing extra charges adequately cover these extra costs incurred.

Costs - 30,000 Tons/Year; 2,500 Tons/Month

Direct Costs		Per Month	Per Ton
Labor, direct	$4,057.00		
Labor, indirect (26%)	1,085.00		
Total Labor		$5,142.00	$2.05
Power - 57,800 KWH	$1,090.00		0.44
Gas - 32,170 therms	1,425.00		0.57
Royalties @$0.25/ton	625.00		0.25
		$3,140.00	
Total Direct Costs		$8,282.00	$3.31

Total Direct Per Year, 30,000 Tons @ $3.31/Ton $ 99,300.00

Overhead - Per Year

Depreciation, 15 years	$10,000.00	
Taxes & Insurance - 3%	4,500.00	
Maintenance-5% on Bldgs. & Eqpt.	7,500.00	
Salary Payroll, direct	52,800.00	
Salary Payroll, ind. (26%)	13,700.00	
Interest on Loan (8%)	10,800.00	
Office Expense	7,200.00	
Outside Prof. Services	6,000.00	
Travel, other than sales	4,800.00	
Total Overhead - $3.90/ton		$117,300.00
Outside Sales Services @ $2.00/ton		60,000.00
		$276,600.00

Costs - 50,000 Tons/Year; 4,167 Tons/Month

Direct Costs		Per Month	Per Ton
Labor, direct	$5,421.00		
Labor, indirect (26%)	1,409.00		
Total Labor		$ 6,830.00	$1.64
Power - 91,930 KWH	$1,259.00		0.30
Gas - 46,850 therms	1,917.00		0.46
Royalties	1,042.00		0.25
		$ 4,218.00	
Total Direct Costs		$11,048.00	$2.65

Total Direct Costs/Year, 50,000 Tons @ $2.65/Ton $132,500.00

Overhead - Per Year

Depreciation, 15 years	$10,000.00	
Taxes & Insurance - 3%	4,500.00	
Maintenance-5% of Bldgs. & Eqpt.	7,500.00	
Salary Payroll, direct	52,800.00	
Salary Payroll, ind. (26%)	13,700.00	
Interest on Loan (8%)	10,800.00	
Office Expense	7,800.00	
Outside Prof. Services	7,500.00	
Travel, other than sales	6,500.00	
Total Overhead - $2.42/Ton		$121,100.00
Outside Sales Services @ $2.00/ton		100,000.00
		$353,600.00

Costs - 75,000 Tons/Year; 6,250 Tons/Month

Direct Costs		Per Month	Per Ton
Labor, direct	$9,214.00		
Labor, indirect	2,396.00		
Total Labor		$11,610.00	$1.87
Power - 112,300 KWH	$1,435.00		0.18
Gas - 63,800 therms	2,579.00		0.42
Royalties	1,563.00		0.25
		$ 5,577.00	
Total Direct Costs		$17,187.00	$2.72

Total Direct Costs/Year, 75,000 Tons @ $2.72/Ton $204,000.00

Overhead - Per year

Depreciation, 15 years[1]	$12,000.00	
Taxes & Insurance - 3%[1]	5,100.00	
Maintenance-5% of Bldgs. & Eqpt.	5,500.00	
Salary Payroll, direct	69,600.00	
Salary Payroll, ind. (26%)	18,100.00	
Interest on Loan (8%)	10,800.00	
Office Expense	9,000.00	
Travel, other than sales	8,000.00	
Total overhead - $1.86/Ton		$139,400.00
Outside Sales Services @ $2.00/Ton		150,000.00
		$493,400.00

(1) Approximately $20,000 in additional facilities will be required to produce 75,000 tons/year.

Summary - Plant and Capital Equipment

Fresh Water System, 250 gallons per minute	$ 10,500.00
Brine Well and Settling Ponds	37,800.00
Fuel Burning Evaporator	5,700.00
Solar Pond System with Harvesting Equipment	28,600.00
Processing and Plant Equipment	20,460.00
Plant and Supporting Facilities	32,500.00
	$135,560.00
Contingency Reserve, 10%	13,560.00
	$149,120.00

Fresh Water System, Installed, $10,500.00

500' - 12" well, cased	$6,000.00
6" Pump, 25 H.P., used	2,500.00
10,000 gallon storage	950.00
2,000 gallon Pressure Tank	680.00
Pump, 1 H.P., and Piping	350.00
	$10,480.00

Above prices include installation per estimate by the pump company.

Brine Well - Complete with Settling Ponds, $37,800.00

4500' Well, Cased to 880	$34,000.00	
2200' - 3" tubing, heavy wall, upset ends	1,800.00	
2", 250 psi. Pump, 50 H.P. (used), with switchgear, power, foundation	740.00	
Tubing Installation	320.00	
Settling Ponds, 100,000 gallons	900.00	
		$37,760.00

Fuel Burning Evaporator, $5,700.00

Evaporator Body (10' Dia x 20' H.)	$950.00	
Anti-corrosion Coating (6800 sq. ft. at $0.75)	510.00	
Foundation and Installation	245.00	
Gas Piping, 300' installed	300.00	
Burners and valves, installed	325.00	
		$2,330.00
Brine Circulation Pump, 25 H.P., used	550.00	
Switchgear, power, foundations	130.00	
Installation, electrical	250.00	
Piping and Sprays	120.00	
Installation, Piping	120.00	
		1,170.00
Crystallizer Vats, 5000 sq. ft.		
Base Preparation	300.00	
Seal at $0.45/sq. yard	250.00	
Bottom Strips - 800' 2 x 2	150.00	
Sidewalls, coated, 400'	280.00	
Drag Bucket and Line	600.00	
Installation	200.00	
		1,750.00
Level and Oil Seal Work Area, 15,000 sq. ft. at $0.27/sq. yard	450.00	
		450.00
		$5,700.00

Solar Pond System, $28,600.00

40 Acres net effective Area Level and Compact Irrigated Field ($75.00/Acre)	$3,000.00	
Salt - 40 tons/acre at cost of brine ($0.50/ton cont'd salt)	800.00	
Bentonite - 1 ton/acre	1,200.00	
Reroll and compact sealed ponds ($75.00/Acre)	3,000.00	
Build Berms - 8' x 16' x 4.5' (6000 linear feet) at $0.20 per cubic yard	3,000.00	
		$11,000.00
Solar Salt Harvesting Equipment, 15 Tons/hour		
Transite Piping, 5000' - 6", in place	6,000.00	
Dredge and Pumping Barge, 50 H.P.	3,800.00	
Dewatering and Washing Screw, 24" x 16'	4,200.00	
Stockpiling Conveyor and Stacker	2,100.00	
Stockpile pad - 150' x 200' at $0.45/sq. yard	1,500.00	
		17,600.00
		$28,600.00

Processing and Plant Equipment, $20,460.00

Door Rake Classifier, 2 H.P.	$ 810.00	
Feeders, 2 H.P. (two)	750.00	
Rotary Drier, 4' x 25', 10 H.P.	4,500.00	
Screens, 3' x 6', 3 H.P., two	1,500.00	
Conveyors, 18" x 30", 1 H.P., (two)	900.00	
Bucket Elevator, 30', 3 H.P.	850.00	
Grinder, 50 H.P.	2,050.00	
Packaging Equipment	3,000.00	
Subtotal	$14,360.00	
Foundations and Installation at 30%	4,300.00	
Electrical Mats. and Installation (8 motors)	1,800.00	
		$20,460.00

Plant and Supporting Facilities, $32,500.00

Building - 5000 sq. ft. at $2.40/sq. ft.	$12,000.00	
Office Space - 300 sq. ft. enclosed	600.00	
Office Equipment	800.00	
Change Room and Facilities	750.00	
Maintenance Room, 200 sq. ft. enclosed	400.00	
Scale Room - 80 sq. ft. encl.	200.00	
Heating and Cooling	1,500.00	
Electrical Installation	450.00	
		$16,700.00
Truck Scale, Used, Installed		9,000.00
Maintenance Equipment & Inventory		
Electric Welder, used	400.00	
Oxy-acetylene equipment	140.00	
Power tools	150.00	
Hand Tools and Wrenches	180.00	
Workbenches, Cabinets	300.00	
Parts Inventory - approx. 3% of cost of Installed Equipment	3,000.00	
		4,170.00
Roads, Gates, etc.		
Blacktop Road - 300' of 18' road at $2.00/sq. yard	1,200.00	
Gates, two, installed	240.00	
Dust & Water Control, 60,000 sq. ft. oil sealed at $0.18 per square yard	1,200.00	
		2,640.00
		$32,510.00