MORGAN G. HUNTINGTON AND ASSOCIATES
MINERAL MARKETING AND ORE DRESSING CONSULTANTS - MINE EXAMINATIONS

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R E P O R T O N

T H E P R O P O S E D O P E R A T I O N

O F T H E

S O C O R R O M A N G A N E S E P R O J E C T

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Albuquerque, New Mexico
August 21, 1950

Morgan G. Huntington

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ORDER OF PRESENTATION

SUMMARY

The Socorro Manganese Project, ten miles southwest of Socorro, New Mexico, was initiated by the writer in 1944. Nearly $300,000 in ferro-grade manganese ore has been produced during intermittent operation of a small pilot plant.

Indicated ore reserves, within 50 feet of the present excavated and erosion surfaces, are at least 2,500,000 tons of material which will yield three to five units of manganese in the form of a 44 per cent concentrate suitable for charging directly into blast furnaces.

The present mining and milling plant is inadequate for operation on an economic scale. Exploitation at the rate of 1,500 tons a day is recommended.

Mining and hauling can be contracted to responsible firms. If done on company account, the investment for equipment must be $300,000. A completely new crushing and concentrating plant with new diesel power must be erected at a cost of $250,000, priced at this writing.

This property is currently producing manganese for Government stockpile at about $1.00 a long ton unit. Operating at 40,000 tons a month, the proposed plant would have as a net monthly income, above cost and amortization reserve, $20,000 on 2 per cent ore, $40,000 on 2½ per cent ore, $60,000 on 3 per cent ore, and $100,000 on 4 per cent ore.

The depletion and reserve allowance on manganese ore is 50 per cent of the net operating profit up to 15 per cent of the gross metal sales.

INTRODUCTION

The purpose of this report is to present the complete analysis of the past as well as the proposed exploitation of the manganese deposits explored by the United Mining and Milling Corporation of New Mexico and later by the Socorro Corporation.

The data and information contained in this report have been accumulated over a period of more than six years. The writer, Morgan G. Huntington, is the original entrepreneur of this project and was general manager and president of the United Mining and Milling Corporation, as well as of the Socorro Corporation; and as such, was personally responsible for the exploration of the ore bodies and the development of the present metallurgical process.

The operation of this project has so far been no more than a test run of an experimental pilot plant. Mining, crushing, and concentrating equipment has not been adequate. To insure a satisfactory operating profit, it will be necessary to provide mechanical units which will permit the treatment of a more substantial daily tonnage.

HISTORY

During World War I, when prices were high, there was a very small production of hand-sorted manganese ore from the region about 8 to 10 miles southwest from Socorro, New Mexico. From the size of the excavations of the earlier prospecting, the total production could not have been more than two or three carloads of ore.

In 1942, when the writer was retained as engineer by the U. S. Bureau of Mines, he examined this entire area and recommended that the Bureau do a certain amount of exploration work. Both the mine exploration and the metallurgical research were carried on by the Bureau during early 1943 as Bureau of Mines project No. 350. The results of this test work led the writer to conclude that the ores of this district were amenable to gravity concentration and that a high percentage of the contained manganese could be cheaply and easily recovered in the form of a commercial ferro-grade manganese product.

In August, 1943, the writer resigned from the Bureau of Mines, interested some eastern capital, and spent about $30,000 in further preliminary exploration. In April of 1944, War Production Board priorities were obtained in order to erect the present concentrating plant. At the same time, a substantial Metals Reserve ore purchase contract was obtained. The United Mining and Milling Corporation was organized in May, 1944.

Further metallurgical research was pursued in the laboratories of several well known organizations such as the Dorr Company, the American Cyanmid Company and the Pan-American Engineering Company. Engineering design was begun by both the Western Machinery Company and the Southwestern Engineering Company. The contract for the final design was awarded to the Southwestern Engineering Company of Los Angeles.

Plant construction was begun in July and completed in October of 1944. Considerable difficulty was experienced in drilling for water through the unconsolidated valley fill and also in obtaining suitable pumping equipment. It was not until December of 1944 that water was delivered to the mill in adequate quantity.

The first two months of experimental operation of the plant proved that the metallurgical process which had been indicated by much laboratory research was not at all satisfactory. During this first trial run, the recovery of manganese was exceedingly poor although the analysis of the resulting product was quite acceptable.

At this time, it became apparent that the project was underfinanced. In fact, in January of 1944, there were more than $100,000 of various liens and claims against the United Mining and Milling Corporation. Since the metallurgical process obviously would require further experiment, no large scale production could be counted on to pull the company out of the hole. Therefore, the writer went to Washington and procured a Smaller War Plants Corporation loan of $120,000, as well as a substantial amount of additional private capital.

In April, 1945, experimental operation of the Socorro plant was resumed. Much delay was encountered in obtaining suitable hauling equipment for transporting the ore from the mine to the mill since new trucks were simply not available. At any rate, during 1945, operating on a purely experimental basis, about $130,000 worth of product was sole to the Metals Reserve Company.

At the end of 1945, the Metals Reserve Company suddenly ceased buying manganese ore. During 1946, only about 1,100 tons of concentrate was produced for the purpose of performing smelting tests on the eastern coast in furnaces belonging to E. J. Levino and Company. Toward the end of 1946, the metallurgical process had evolved where it appeared possible to make an extremely high recovery. Entirely different equipment was necessary in order to employ the new process on a commercial scale. Since no manufacturing company could promise to build the apparatus on the job. The new machine was ready for large scale tests by the end of March, 1947. The recovery of manganese by the new method was approximately three times what it had been under the original process. The results of this test-run indicated that had the first 10,000 tons been treated by the new flow-sheet, the financial position of the United Mining and Milling Corporation would have been better by some $400,000.

In all, the United Mining and Milling Corporation, under the direction of the writer, spent more than $900,000 in exploring the mining properties, building access roads, developing the metallurgical process, and exploring markets for both the manganese and important quantities of crushed rock by-products. About $200,000 worth of manganese ore was sold.

The principal stockholders, largely for reasons of taxation, chose to allow the United Mining and Milling Corporation to be liquidated by its creditors.

In July, 1949, E. C. Iden and the writer formed the Socorro Corporation to take over the properties herein described.

At present, John J. Emmons, doing business as the Rock Products Company has the properties under lease from the Socorro Corporation.

GENERAL INFORMATION

Location and Access:

The manganese deposits discussed in this report consist of three groups of unpatented mining claims aggregating nearly 400 acres. These are referred to locally as the Huntington manganese properties and are about nine miles southwest from Socorro, New Mexico. Access is had from Socorro six miles south on U. S. Highway 60, thence west about three miles by graded road.

The Albuquerque-El Paso line of the A. T. & S. F. Railroad is about five miles east of the property. A siding for the exclusive use of this project accommodates five railroad cars. However, only three can be loaded from the truck ramp per train servicing. The siding is exactly four miles east of the present concentrator and is reached by a graded road having an average grade of 2½ per cent in favor of the load.

The properties lie between 5,000 and 6,000 feet above sea level in the eastern foothills of the Magdalena mountains. The annual precipitation is about nine inches, the greater part of which occurs as violent thunder showers in the summer months. Although sub-freezing temperatures prevail at night during December, January, and February, snow fall is light, seldom exceeding a few inches and rarely sufficient to halt traffic.

The vegetation consists of sparsely growing juniper and brush and clumps of bear grass. A certain amount of other grasses make the land of some value for grazing.

The topography of the mineral deposits is fairly abrupt. However, all deposits may now be reached by car over fair graded roads of a maximum grade of six per cent. The most remote deposit is about $3\frac{1}{2}$ miles from the present mill. The closest is about 1 1/3 miles. For some time, it is expected that the principal production will come from the Black Hill group of claims which is about 1 3/4 miles from the present concentrator. The proposed new mill site would lessen these hauling distances by one mile.

Labor and Living Conditions:

At the outset of the proposed operation, fewer than 25 men will be employed. Except for a few men of the higher skills, such as shovel operators, this labor is available locally at from $1.00 to $1.50 an hour. Since the town of Socorro is but a few miles distant, there are no living accommodations at the mine or mill; and except for the possible dwellings of one or two foremen and mechanics, it is not anticipated that housing facilities need be provided by the operating company.

Power and Water:

Electrical power is generated at the mill by a 360 horsepower Fairbanks-Morse diesel electric set which has not proven reliable. It would be possible to take power from a recently installed R.E.A. substation about eight miles distant. However, since continuity of service is not guaranteed and power installation and cost is excessive, it is recommended that the proposed plant be diesel powered by new medium speed units.

Water is pumped from a 520-foot by 12-inch well, 4,000 feet to the present mill. This well now furnishes about 500 gallons a minute which is ample for the proposed operation. It is estimated that this same well can produce as much as 1,500 gallons a minute without serious draw-down. An additional six-thousand feet of eight-inch pipe and a 50 horsepower booster pump must be added to deliver adequate water to the proposed new plant site.

Property and Ownership:

The Red Hill group of claims are located on State land and are under lease from the State of New Mexico. The total lease-hold from the State is less than 100 acres and contains the least important of the three principal manganese deposits. Contiguous to and immediately to the west of the State lease is the Black Hill group of claims which are unpatented and located on Federal land. One mile northwest from the Black Hill group is the Big Basin group of unpatented lode mining claims located on Federal land. The total area of mineral claims is about 400 acres.

On ores removed from State owned land, the State of New Mexico receives 2 per cent of the net smelter returns. The Federal Government is paid no royalty on these ores whether from state or Federal land.

The present concentrator is constructed on located mill sites on Federal land about $1\frac{1}{2}$ miles due east from the State lease. The new mill site is about one mile west of the present plant and is also on Government land.

The Socorro Corporation has from the Reconstruction Finance Corporation a lease with option to purchase all the properties and equipment here described.

THE ORE DEPOSITS

General Geology:

The eastern base of the Magdalena mountains is composed of a series of rhyolitic flows and breccias varying in total thickness from at least 500 feet to probably 1,500 feet. These are underlain by older sediments which include Paleozoic. Since many rocks of sedimentary origin are to some extent manganiferous, it is possible that the underlying sediments may have been the source of the manganese occurring in fractures in the later flows.

Parallelling the north-south course of the Rio Grande river valley are numerous fractures of both pre- and post-mineral evidence. Adjustments along some of those fractures have been so great as to develop shear zones in the rhyolite several hundred feet wide.

Occurrence of Deposits:

Several of the more pronounced shear zones are heavily cross-fractured and even brecciated. The rhyolite is generally very hard and unaltered, and hence such fracturing and brecciation provides a substantial percentage of interstitial space. This is important since the mineral does not replace the host rock. In such interstices the manganese mineral occurs, deposited, it is believed, from aqueous solution at nearly atmospheric temperatures and pressures.

Character of Ore:

The mineral has been determined by the U. S. Geological Survey as both psilomelane and its anhydrous form, hollandite. The mineral on fresh fracture is blue-black. It is unusually hard, being about 6 on Mohs' scale of hardness. It has conchoidal fracture and its specific gravity is about 5. The average chemical analysis of the pure mineral is approximately 50 per cent manganese, 2 per cent iron, 11 per cent barium oxide, 6 per cent silica and alumina, less than 1/10 of 1 per cent phosphorous, no sulphur and only minor traces of the base metals, zinc, lead and copper.

Chunks of pure mineral larger than a few pounds are rare since single openings afforded in the rock are not as a rule very large. The grade of ore is apparently a function of the hardness of the rock and the degree of fracture. Therefore, substantial tonnages of ore seldom contain more than 10 per cent mineral by volume. The first 100,000 tons of ore mined has averaged more than 6 per cent manganese. Included were several thousand tons of very low-grade material containing less than 2 per cent manganese which was milled for experimental purposes.

It has been found that the manganese mineral is nearly as hard as the host rock itself and that fairly satisfactory liberation is obtained by crushing to ½-inch. Good recovery, even from the lower grade material, is possible because the manganese mineral tends to break rather cleanly from the rock. The average analysis of about 5,000 tons of product from the present concentrator is more than 44 per cent manganese even though the mill heads were sometimes as low as $1\frac{1}{2}$ per cent.

Sampling and Assaying:

It is important to remark that the assay for manganese is not necessarily indicative of the value of the ore. It is rather the character of the ore which will determine whether or not a satisfactory product may be obtained by gravity concentration. Those ores which contain wad or sooty manganese are of no value whatsoever even though the assay reports may show a high percentage of manganese. Only the material which contains the hard, flinty minerals, psilomelane or hollandite, it considered as "ore" regardless of what the assay may indicate in the way of contained manganese.

It has been learned through costly experience that the only practical means of evaluating such deposits as these is to actually mine and treat at a pilot plant substantial tonnages from each area. This has been done in the case of nearly every block considered in the following tonnage estimates.

At the beginning of this project, thousands of feet were drilled with both churn and compressed air machines. The assay results of such drillings, it was found, gave misleading information. With increased experience, it was learned that the writer and other men on the job could estimate very closely the recovery to be obtained from broken ore, simply by macroscopic inspection.

A company assay record of the ore crushed and fed to the mill was kept by the United Mining and Milling Corporation and is available.

Ore Reserves:

The limits of the ore bodies are determined by assary rather than by physical walls. The price of manganese and the price of crushed rock by-products will, from time to time, cause the ore reserve tonnage figures to be readjusted. At the present time, however, with a market price of about $1.00 a long ton unit for manganese and $1.50 a short ton for rock chips, both f.o.b. cars at the railroad siding, the extreme lower economic limit is about 2 units per ton recoverable manganese. On the basis of a cut-off grade of concentrating ratio of approximately 22 to 1, the total ore reserves on the combined three groups of claims comprise several millions of tons.

The total measured, indicated and geologically inferred tonnage can easily approach 15 million tons. The Big Basin claims alone have at least 6,000 linear feet of out-crops ranging in width from 20 to 200 feet. With the exception of about 50,000 tons of ore on the Black Hill, which may be termed "measured" because it is exposed on two faces, practically all tonnage estimates must be made on "indicated" basis.

The indicated tonnages, that is, ore exposed on one face by natural erosion, by trenches, drill holes, or other openings, and projected 50 feet or less below the present erosion or excavated surface, are as follows:

State lease, 200,000 tons.

Black Hill, 400,000 tons.

Big Basin, 2,000,000 tons.

The geological inference is that several times this tonnage may be developed.

The average grade of some 100,000 tons of ore already mined and milled contained 6 per cent manganese. The present metallurgical system yields about 4 units of manganese in the form of a metallurgical grade concentrate of about 44 per cent. The average ratio of concentration with the present metallurgy is expected to be on the indicated tonnage about 11 tons of ore per ton of concentrate.

DEVELOPMENT

As all the manganese deposits are to be mined by open-cut methods, development work is confined to constructing roads at bench levels. All of the deposits are accessible by roads of a maximum grade of 6 per cent. As there is little or no over-burden to be removed before mining, the blasting of roads across the ore bodies at bench intervals is the only preparatory work necessary.

All primary roads and many secondary bench roads have been completed on most of the ore bodies which are considered important.

MINING

Drilling:

The rock is extremely hard. Compressed air wagon drills can drill only relatively short, vertical holes because of the ravelly nature of the ore. Benches as high as 24 feet have been attempted with poor success since effective toe-holes are impossible. Twelve-foot benches have been generally employed in the past since a 14-foot hole is possible. However, the footage per machine shift when drilling 8-foot holes with wagon drills is three to four times greater than when drilling 14-foot holes with the same machine.

From all past experience on this project with compressed air drills, best results and lowest costs can be obtained by drilling 9 or 10-foot holes on 4x5-foot centers and maintaining about an 8-foot bench interval. However, proper cable-tool blast-hole machines can no doubt produce broken ore most cheaply.

Blasting:

Experience here has been almost entirely confined to blasting holes drilled with compressed air machines. Greater distance between holes, which involves springing to accommodate large charges of powder, has been only partly satisfactory. The resulting ragged bottom is extremely hard on shovels and frequent lost holes result in much wasted time. It has been found best from the standpoints of fragmentation and bottom grade to drill on the rather close spacing of about 4x5 feet with 1 3/4-inch tungsten carbide bits. These holes should be drilled one or two feet below grade and loaded with 40 per cent free running bag powder. The charge should be calculated on the basis of about one pound of explosive per cubic yard of rock in place. On this spacing, this is $\frac{1}{2}$ bag, or $6\frac{1}{4}$ pounds per hole drilled for an 8-foot bench interval. Several rows of holes loaded with bag powder and primed with one stick of 40 per cent gelatin are fired by instantaneous electric primers in a single circuit. As the powder does not come within three or four feet of the collar of the hole, there is practically no fly rock. No attempt is made to break toward the face since the benches are too low for much advantage. Instead, the entire drilled area is loaded with a charge sufficient to lift and shatter the whole block. The powder ratio works out to be slightly less than $\frac{1}{2}$ pound of explosive per short ton of rock produced.

Some limited experience with churn drill holes six to nine inches in diameter indicates that considerable economy may be achieved by this method of drilling and blasting.

Stemming is in all cases dry-wash sand or mill tailing screened through 4-mesh.

Loading:

All the deposits dip nearly vertically and there is almost no over-burden and no stripping necessary. Practically all the deposits which are considered as mineable are of sufficient width to allow for the swing of at least a $1\frac{1}{2}$--yard power shovel. Open cut mining by shovels and trucks on horizontal benches is, therefore, satisfactory.

Although the material is rock, when properly blasted, it is so thoroughly fragmented that a standard $1\frac{1}{2}$-yard shovel with heavy-duty rock bucket will load 800 tons per 8-hour shift. The rock is so hard that regardless of the size of the shovel no digging can be done without thorough blasting.

Hauling:

Hauling of the ore from the mine to the mill can be contracted for about 15 cents a tone mile. The contract price so far is 30 cents from the Black Hill area and 60 cents a long ton from the Big Basin area. Local contractors, each of whomowns and drive his own light truck, are available in sufficient numbers.

The contract price of about 15 cents a ton mile can be lowered only by purchasing special off-the-highway types of heavy-duty hauling equipment and operating on company account.

MILLING

The original flow sheet provided for discarding plus 2-inch material except for hand-picked coarse ore. About 40 per cent of the mine-run was discarded as plus 2-inch waste in an effort to increase the crushing and milling capacity. The under-size and the sorted-in coarse high-grade was crushed in two stages through a 3/8-inch screen. The minus 3/8-inch mill feed was sized by screens into five products; the four coarse sizes were jigged separately in two-cell Pan-American fixed-sieve jigs. The minus 10-mesh was de-slimed and hydraulically classified into six sizes and treated on six different Wilfley sand tables.

This original flow sheet was a la Richards and reflected the advice of several experienced ore dressing consultants, including the writer. At any rate, the original flow sheet was a failure so far as recovery was concerned.

First of all, the jig beds were too dead and the capacities were far lower than was anticipated. Great difficulty was expereienced in drawing concentrate from the beds.

Second, the recovery on the tables was very poor. The mineral, having conchoidal fracture, offered far too great a surface in proportion to volume to be amenable to treatment by moving-film concentration. Those fragments which were fairly cubical in shape rode up in the concentrate; the greater part, however, was washed down into the middling and tailing.

Third, the 4x5-foot open Marcey ball mill, which was re-grinding both jig and table middlings for the purpose of liberating locked particles, produced much slimed mineral. This resulted in the loss of the greater part of the mineral in the middling circuit.

After the first few months of operation, the history of the metallurgical evolution has been one of progressive simplification. One screen after another was eliminated until the jig feed was unsized the the total concentrate was made from the fixed-sieve jigs. The tables were finally abandoned and removed. The first 3,000 tons of concentrate was produced by roughing on the fixed-sieve jigs and cleaning through a hindered settling classifier after Richards.

However, in spite of every effort to improve the jigging method, the average recovery of manganese from the first 100,000 tons milled was a discouraging 30 per cent of the manganese contained in the ore as mined.

It is interesting to note that the capacity of the fixed-sieve jigs is about what Taggart predicts. The highest recovery was obtained when the feed to the eight 42-inch jig cells was held below six long dry tons an hour. This was true regardless of grade of feed. Conclusions as to capacity of fixed-sieve jigs are made after many carefully controlled experiments. The total effective screen area was about 88 square feet. For highest recovery, the capacity is 1.63 long dry tons per square foot per 24 hours. And even at this rate of feed, locked particles and "fltas" continued to escape over the tail board.

Many small scale experiments were carried out by the writer which involved the use of sand suspensions as jig medium. It was discovered such a medium could be autogenously built up which would have a density approaching 2. The free mineral has a specific gravity of 5 and the gangue about 2.5. The ratio of specific gravities is, then, in air 2 to 1; in water, less than 2.7 to 1. But in a quicksand made up of fine mineral and gangue having a specific gravity approaching 2, the ratio becomes 6 to 1. The writer concluded that almost anyone could jig successfully under these last conditions.

A modified Hancock type movable-sieve jig was then designed and built on the job. The screen area was 60 square feet, being 3 feet wide and 20 feet long. The vertical and horizontal throws are each about $\frac{1}{2}$-inch. The machine is run at about 200 strokes per minute. The first 10 feet of the jig discharges on to the lower end of a drag elevator which de-waters and conveys the rougher concentrate to two 2-celled fixed-sieve cleaner jigs. Tailings are de-watered by a similar drage elevator. Products from the last 10 feet of the movable-sieve jig screen are recirculated as jig middling by an air lift. This rougher jig has recently been widened to $4\frac{1}{2}$ feet.

Unsized minus $\frac{1}{2}$-inch material is fed to the head end of the movable-sieve jig. Enough water is added at the head and hutch to provide a slight overflow at the lower weir. The suspension is maintained automatically at nearly 2, since whatever material is too thick or too heavy to stay in suspension simply is removed by either of the two drags.

The fixed-sieve cleaner jigs make four products:

1. Clean concentrate.
2. A middling consisting principally of locked particles.
3. A dirty hutch product which is re-cleaned on a single cell, fixed-sieve jig.
4. Tailings which are returned to the head end of the movable-sieve rougher jig.

This ore dressing flow sheet is simple yet practically three times as effective as the original and much more complicated system. The recovery on the new process is often above 85 per cent of the contained manganese in the mill heads on ores where liberation is high.

The increase in recovery is due primarily to the separation of locked particles and "flats" which under the earlier system went out of the mill with the tailings.

Under the present system, the only water leaving the mill, except for the moisture contained in the various products, is that which is directed upon the screen which separates the minus 8-mesh from the tailings in order to produce chips for road material. Previously, about 1,100 gallons a minute of water was discharged with the tailings.

Although the screen grid is immersed from 6 to 24 inches below the suspended media surface, this rougher apparatus is, in effect, a cross between a riffled sluice, a shaking conveyor, a jig, and an autogenous sink-float machine.

The capacity of the movable-sieve rougher machine on this ore is not over 5 long tons of new feed per foot of screen width per hour for optimum recovery. The circulating load of cleaner jig tailing and middling from the second half of the bed area is about equal to the new feed. A parallel circuit should be provided for this circulating load, thereby practically doubling the rougher capacity.

Market requirements are such that the product must be not less than 85 per cent pure mineral. This requires a total fixed-sieve cleaning jig area of about 15 square feet per ton of concentrate per hour.

Ore which is poorly liberated at the initial ½-inch crushing can be made to yield as much as the more amenable material by passing the tailing through rolls set at 1/8-inch or 3/16-inch and re-jigging.

All the ores on the property which have been investigated will make 50 per cent or more clean tailing at minus two inches when treated by the ferrosilicon heavy media process. This offers the possibility of more than doubling plant capacity through the installation of such a sink-float unit. One of the by-products would be salable railroad ballast.

MARKETING

Manganese:

Ferro-grade manganese ore, containing between 40 and 50 per cent of manganese, is smelted in an iron blast furnace to produce ferromanganese. This alloy of manganese, iron and carbon, is employed in deoxidizing, desulfurizing, and recarburizing steel in the open hearth steel process. This produces more than 90 per cent of the nations' steel. Fourteen pounds of metallic manganese is absolutely essential in the manufacture of even the common, ordinary garden-variety of steel.

Manganese is number one on the list of strategic materials since the modern steel industry cannot operate effectively without it. About 1,200,000 tons of ferro-grade manganese ore is consumed annually in the United States. At the best, domestic mines have never supplied over 15 per cent of the demand.

Manganese is sold by the long ton unit. This is 22.4 pounds of contained manganese. One long ton (2,240 lbs.) of a 44 per cent ore contains 44 units of manganese.

At the time the present concentrator was built and until the end of 1945, the Government was buying manganese at $1.00 a unit f. o. b. shipping points. In 1947, the United Mining and Milling Corporation secured an order from the Bureau of Federal Supply for 20,000 long tons of ferro-grade ore at 85 cents a unit of manganese, f. o. b. the rail point. This was under the Stockpiling Act of 1946 which continues in effect. At present, the Government is purchasing this product at about 95 cents.

There is reason to expect that a substantially higher price will be offered before long because manganese continues in dangerously short supply.

The subsidy realized in dealing with the Government so far has amounted to no more than the rail freight. Operating at the scale proposed in the body of this report would produce manganese at a price which would be competitive on the open market.

Rock By-Products:

The rock in which the manganese occurs is very hard and unusually resistant to abrasion. In the normal process of separation, all the ore is crushed to ½-inch. After the recovery of the manganese, before passing from the mill, the tailings are passed over an 8-mesh screen. The fines are eliminated and the plus 8-mesh, minus half-inch material is conveyed to stockpile. All this material which the mill has produced has been disposed of to the State Highway Department as "chips" for the final black-top road surface. The price has ranged from $1.25 to $2.00 a short ton at the plant.

PROPOSALS

The mining and concentrating equipment were procured second-hand during the past war. All of it is of insufficient capacity and in unreliable mechanical condition. Because of the inadequate mechanical equipment, this project has been operated at a rate of only 200 to 300 tons a day. This volume is too small for successful operation.

From the information at hand, it seems obvious that this project would prove highly profitable if exploited at the rate of 1,000 to 1,500 tons a day. Through the provision of suitable mining, hauling and milling equipment, the tonnage could be brought up and held at the level desired.

Mining:

The drilling, blasting, loading and hauling can be done by well-equipped excavating contractors which would involve no capital outlay. Bids received from two reputable firms were not unreasonably high. However, the contractors' margin appeared to be about 30 per cent of the bid price.

In order to properly equip the project for mining 1,500 tons a day, the following equipment would be necessary.

3 - Cable-tool, Blast-hole Machines	$ 45,000
2 - $1\frac{1}{2}$ Cubic-yard Power Shovels	70,000
4 - 22-Ton off-the-highway Dump Trucks	120,000
1. - Tractor with Dozer	15,000
2 - Portable Air Compressors	20,000
- - Miscellaneous Equipment (air drills, etc.)	10,000
Total Cost of Mining and Hauling Equipment	$310,000

Milling:

To crush and concentrate 1,500 long tons of ore daily, an entirely new plant must be constructed. The total cost of this concentrator, including pumping equipment and all diesel power, is about $250,000 based on August 1, 1950 prices.

Proposed Concentrator Equipment List
Socorro Project - August, 1950

1.	Reciprocating Feeder, 36"x8'	5 hp	... $ 2,000
2.	Cantilever Grizzly, 3'x5'x4"	--	... 500
3.	Jaw Crusher - Single Toggle, 32"x40"	125 hp	... 18,000
4.	Conveyor Belt, 36"x115'	25 hp	... 5,500
5.	Cantilever Grizzly, 3'x6'x1"	--	... 500
6.	Cone Crusher, $4\frac{1}{4}$-ft. Symons Std.	125 hp	... 24,000
7.	Conveyor Belt, 30"x120'	20 hp	... 5,500
8.	2 Caterpillar Diesel Units, D-13000, 950 RPM, Flat Belted. One to each crusher @ $5,900..	--	... 11,800

9.	Belt Feeder	3 hp	$ 1,000
10.	Conveyor Belt to Mill, 24"x100'	10 hp	4,000
11.	Screen, Horizontal, Single Deck, 4'x12'x$\frac{1}{2}$"	15 hp	3,000
12.	Cone Crusher , 3-ft. Symons Std.	60 hp	13,700
13.	Conveyor Belt - Cone Product Return, 24"x60'	7 hp	2,400
14.	2 Movable-sieve Rougher Jigs (to be made locally) - Steel and Fabrication, 6'x20'	20 hp	10,000
15.	2 Fixed-sieve Cleaner Jigs, 6'x12' - Steel and Fabrication	--	8,000
16.	Fixed-sieve Fine Cleaner Jig, 6'x10' - Steel and Fabrication	--	4,000
17.	2 Tailing De-watering Drags, 4'x30'	30 hp	5,000
18.	Screen, Horizontal, Single Deck, 4'x12'	15 hp	3,000
19.	Crushing Rolls, 42"x24"	60 hp	7,000
20.	Concentrate Screen, Horizontal, 3'x6'	5 hp	1,500
21.	Concentrate Conveyor Belt, 18"x24'	5 hp	1,000
22.	2 Roots-Connerville Blowers for Air Lifts and Jigs, Type RCR, 10"x24"	60 hp	3,500
23.	D-375 Caterpillar Diesel, developing 265 continuous horsepower. Belted through counter-shaft to items numbered 12, 14, 17, 19 and 22.		12,000
24.	D-17000 Caterpillar Diesel-Electric Set - 100 KW. For minor equipment, lights, etc.		12,000
25.	Booster Pump, 500 gpm @ 400 feet		2,000
26.	D-17000 Caterpillar Diesel, belted to booster pump and present deep well pump		8,500
27.	Miscellaneous Equipment (Pipe lines, motors, etc.)		20,000
28.	Engineering, Construction, and Freight		58,000

ESTIMATES

There are many somewhat similar examples of quarrying, hauling, and crushing with which to compare estimates of cost. A good deal has been learned from the experience of running the present jig plant. The following estimates are based on 1,500 tons daily and can be readily checked.

Mining Costs:	Per Ton
Churn Drilling @ \$5/foot, breaking 20 tons per foot of hole	\$ .25
Explosives, $\frac{1}{2}$ pound per ton of ore	.08
Loading by $1\frac{1}{2}$ cu. yd. shovel @ \$15/hr	.15
Hauling average $1\frac{1}{2}$ miles @ 10¢ ton/mile	.15
General labor	.05
Supervision	.05
Total Mining and Hauling	\$ .73

Milling Costs:	
Power - 750 hp for 8 hrs. plus 450 hp for 16 hrs. @ $2\frac{1}{2}$¢ a horsepower hour	\$ .25
Labor - 8 men @ \$12/8hrs.	.06
Supervision - 4 men	.04
Repair and Replacements	.10
General labor, Cleanup, etc.	.05
Total Milling	\$ .50

Amortization:

The proposed capital outlay should be charged against about two and one-half million tons which would be mined in less than six years.

	Per Ton
$500,000 over 2,500,000 tons	$ .20

Other Expense:

Taxes	@ $3,000 a year
Insurance	@ $5,000 a year
Industrial Insurance	5% of payroll
Administration	

The total operating cost should not exceed $1.50 a long ton when operating at the rate of 1,500 long tons a day, or about 40,000 tons a month.

Estimate of Operating Profit:

Milling the lowest grade ore, which is included in the ore reserve figure and which has a concentrating ratio of 15 to 1 and a present value of $3.00 a ton, the monthly operating profit would be $60,000.

Milling average grade ore, having a concentration ratio of 11 to 1 and a present value of $4.00 a ton, the monthly profit would amount to $100,000.

Appraisal of Tax Aspect:

The depletion and reserve allowance when mining this type of ore is 50 per cent of the net operating profit up to 15 per cent of the gross metal sales. It would be necessary, then, to have 50 per cent of the net operating profit equal 15 per cent of the gross metal sales in order to realize the greatest tax advantage.

Depreciation rate varies with the type of equipment. However, as much as 33 1/3 per cent was allowed on similar undertakings during the last war.