CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

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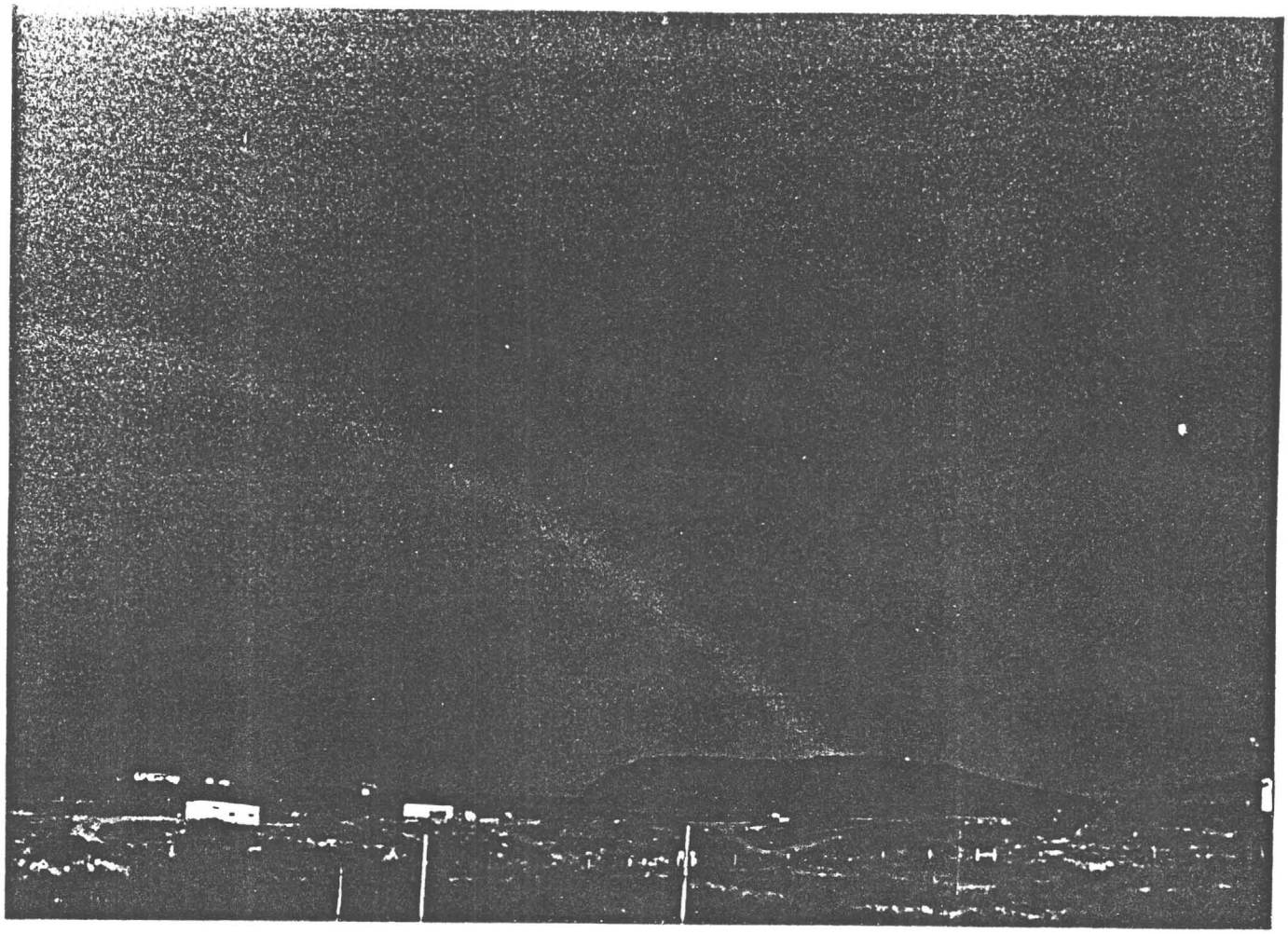

T O M B S T O N E E X P L O R A T I O N I N C O R P O R A T E D

SUMMARY OF OPERATIONS REPORT

by

Dustin L. Escapule

General Manager and Vice President

TOMBSTONE EXPLORATION, INC.
P.O. BOX 610
TOMBSTONE, ARIZONA 85638
(602) 457-2231

June 1st 1982

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INTRODUCTION

This report was prepared in order to give an overall view of operations conducted by Tombstone Exploration, Inc. Certain information was collected from external sources that TEI considers reliable. These include the Butler Report (written by the U.S. Bureau of Mines and the University of Arizona), the Ransome Report, the Newell Dissertation, and data gathered by Dr. David Rabb from the files of the AIME and the Arizona Bureau of Mines. Other information has been verified by independent companies such as Fox Incorporated, chartered public accountants, and Dames & Moore, consulting engineers.

A glossary is included at the end of this report to define certain unfamiliar terms.

HISTORY OF THE TOMBSTONE MINING DISTRICT

In 1857 Frederick Brunckow located and began working the Bronco claim, five miles from the present town of Tombstone. In 1877, Ed Schieffelin, the son of a forty-niner, visited the Brunckow mine while on a trip to Fort Huachuca. An army friend had warned him that in this Apache territory all he would find would be his own tombstone. Schieffelin noticed that the direction of ore was trending northeast from the Bronco, and following this trend he found what is now known as the Tombstone Mining District.

With his partners, Schieffelin located and staked a claim to the Lucky Cuss, and then the Toughnut. They then split the Contention and the Grand Central with a new partner. These two mines were to become the major producing silver mines of the early 1880's.

The town of Tombstone sprang up in 1879, following the news of Schieffelin's strike, and two years later it achieved international notoriety after the gunfight at the O.K. Corral.

By 1883 many major mines had become producers for the Tombstone Mining District. These included the Flora Morrison, Naumkeg, south extension of the Grand Central, Emerald, Moonlight, Grand Dipper, Vizina, Head Center, Good Enough, Tranquility and Silver Thread mines. Yearly production at its peak appears to have exceeded $5,000,000 at the metal prices of that time.

During the mid 1890's, the mining industry in the Tombstone district faced a number of problems. Many claims were tied up in litigation over ownership, mining costs were increasing, working mines had ineffective pumping systems, and precious metal prices were dropping. In the late 1890's, Mr. E. B. Gage raised enough money to consolidate 95% of the Tombstone mines. The company operated with many difficulties including fires and inadequate steam boilers to power their machinery. In the early 1920's, Tombstone Consolidated Mines sold all of their holdings to Bunker Hill Mining Company, a subsidiary of Phelps Dodge. By this time the pumps had been shut down, and the water had risen back to the 600 foot level. Bunker Hill did not attempt to dewater the mines, but reworked the gob or backfill from the water table to the surface, and did further mining on high grade veins in the upper levels. In the mid 1930's they sold their holdings to Tombstone Development Company (T.D.C.).

Production in the Tombstone District virtually ceased. Silver was now at $0.23 an ounce, compared with the $1.20 an ounce it had commanded in the 1870's, when the mines were first discovered. Wages and costs had increased, and mining was not economically viable.

In the early 1950's, after prolonged dormancy of the mines, and after the Gold Closing Act of World War II had been rescinded, T.D.C. was sold to the Newmont Mining Company. During this period gold remained constant at $35 an ounce, and silver increased from the 1930's level of $0.23 an ounce to $0.85 an ounce, but wages and operating costs had more than tripled. Reopening of the mines at that time appeared uneconomical. T.D.C. was sold to a group of Nebraska investors who have held the properties to the present day.

Over the past forty years T.D.C. has leased portions of its holding to small mining companies. It is virtually impossible to obtain any production records from these companies.

In February, 1979, Tombstone Exploration Inc. acquired a favorable mineral lease on all the mineral rights and lands of T.D.C. This property covers almost 2000 acres and includes 87 patented and 18 unpatented claims.

MINERAL PROPERTIES, PRESENT AND PROJECTED MINE SITES

TEI geologists and management have located fourteen areas of mineralization, which include opportunities for incline shaft, vertical shaft, and open pit mining.

The mining consulting company, Dames & Moore, surveyed the Girard-Toughnut (Girard Underground Mine, or GUM) and recommended a two phase drilling and development operation. The GUM was only one of the major producing mines in the district, and it would not be unreasonable to assume that other mines in the TEI holdings might have similar potential.

During production history in the Tombstone Mining District, the Contention-Grand Central mine has been the largest producer. This is the site of the current open pit operation at TEI. As with other mines in the area, there was very little production after 1920. This was not due to a lack of mineralization, but rather, high operating costs and low metal prices.

TEI's efforts are, at present, concentrated on the Contention-Grand Central mine. Ore qualities and placement, current precious metal prices, and comparative economic studies have shown this to be the most viable target for development.

PRODUCTION

Reserves

Early mining records showed that the largest tonnage and maybe the highest grade of ore came from the areas above the 300 foot level. Production tapered off as the mines moved to lower levels. At the 600 foot level water was encountered and pumped out, allowing mining to continue to the 1,000 foot level. Some of the pumps burned out and the water again rose to the 600 foot level where it is today. Early mining production reports from the Contention Mine dated 1880 to 1885, 1910 to 1911, 1928 to 1929, and 1940 indicated the total production amounted to almost 5.5 million ounces of silver and N/A troy ounces of gold. The postulated distribution is as follows:

0 - 100 level	1.6 million oz. silver	N/A million oz. gold
100 - 200 level	1.2 million oz. silver	N/A million oz. gold
200 - 300 level	1.0 million oz. silver	N/A million oz. gold
300 - 400 level	0.8 million oz. silver	N/A million oz. gold
400 - 500 level	0.5 million oz. silver	N/A million oz. gold
below 500 level	0.3 million oz. silver	N/A million oz. gold

The long section (see Plate 1) and cross section (Plates 2, 3, 4 and 5) show the ore placement and distribution in the area currently being mined by TEI. In the last thirty two months, 65% of the elevation between the original surface and the #1 level of the old mine workings has been removed. From the 410,000 tons of ore averaging one ounce of silver per ton, TEI has recovered 210,000 ounces of dore', with an average gold content of 1.5%, and an average silver content of 92%.

The remaining material between the existing pit bottom and the #1 level (see Plate 1) is expected to yield 110,000 ounces of dore'. At TEI current production rate this should take six months to complete.

From information from the U.S. Bureau of Mines files, TEI's production is 20% of past production at Grand Central and Contention mines. TEI anticipates that this ratio will continue to apply to the material between the first and second levels, with a yield of 343,230 ounces of dore'. This projection is considered to be conservative because:

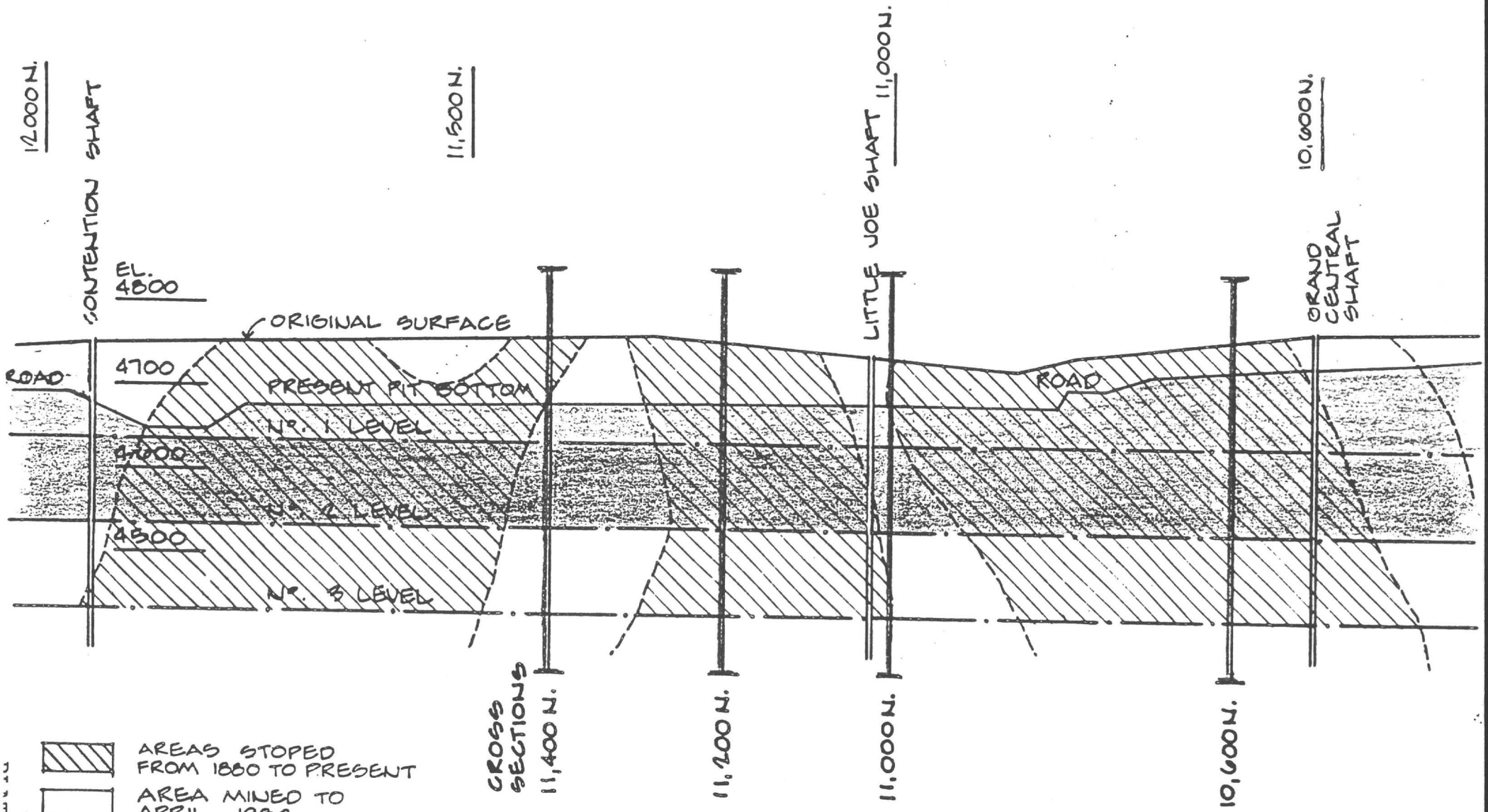
a) the surface to #1 level had been much more extensively mined for high grade ore than the first and second level.

b) during the time of underground mining from the first and second level, the price of silver dropped from $1.50 to $0.25 per ounce.

c) mining costs became higher with greater depths and around the Little Joe shaft the ore is very crumbly, further increasing mining costs.

d) Butler, Ransome and Blake have all documented that the values increase substantially with greater depth (during the mine's past production, values were extracted to the 1,000 foot level).

At TEI's current production rate, excavation between the first and second levels of the mine would take one and a half years to complete.



AREAS STOPED FROM 1880 TO PRESENT

AREA MINED TO APRIL, 1982

AREA TO MINE TO Nº. 1 LEVEL

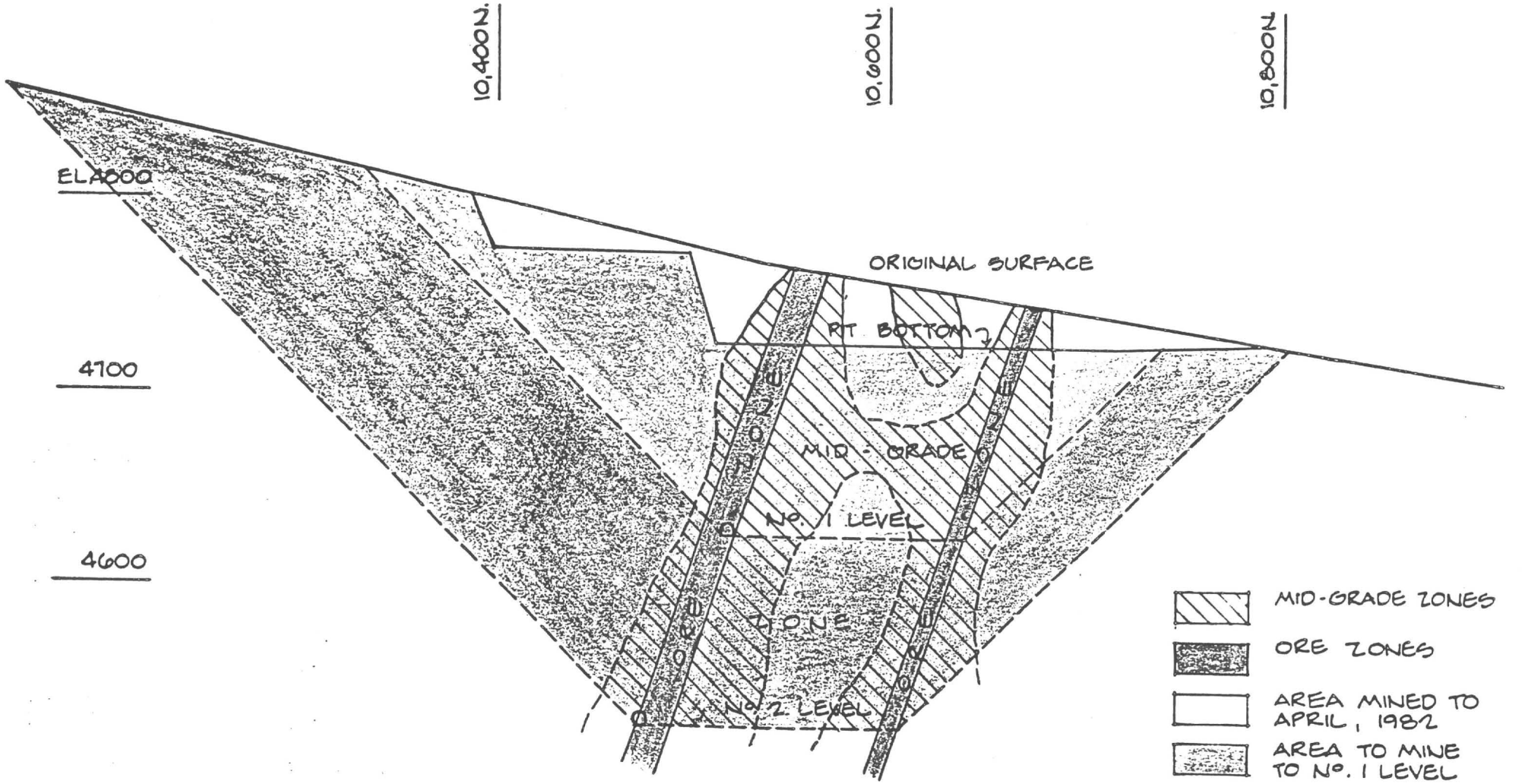
AREA TO MINE FROM Nº. 1 TO Nº. 2 LEVEL

VERTICAL - LONGITUDINAL SECTION LOOKING EAST N 20°E

SCALE: 1" = 166'

APRIL, 1982 A.J. GRAVES

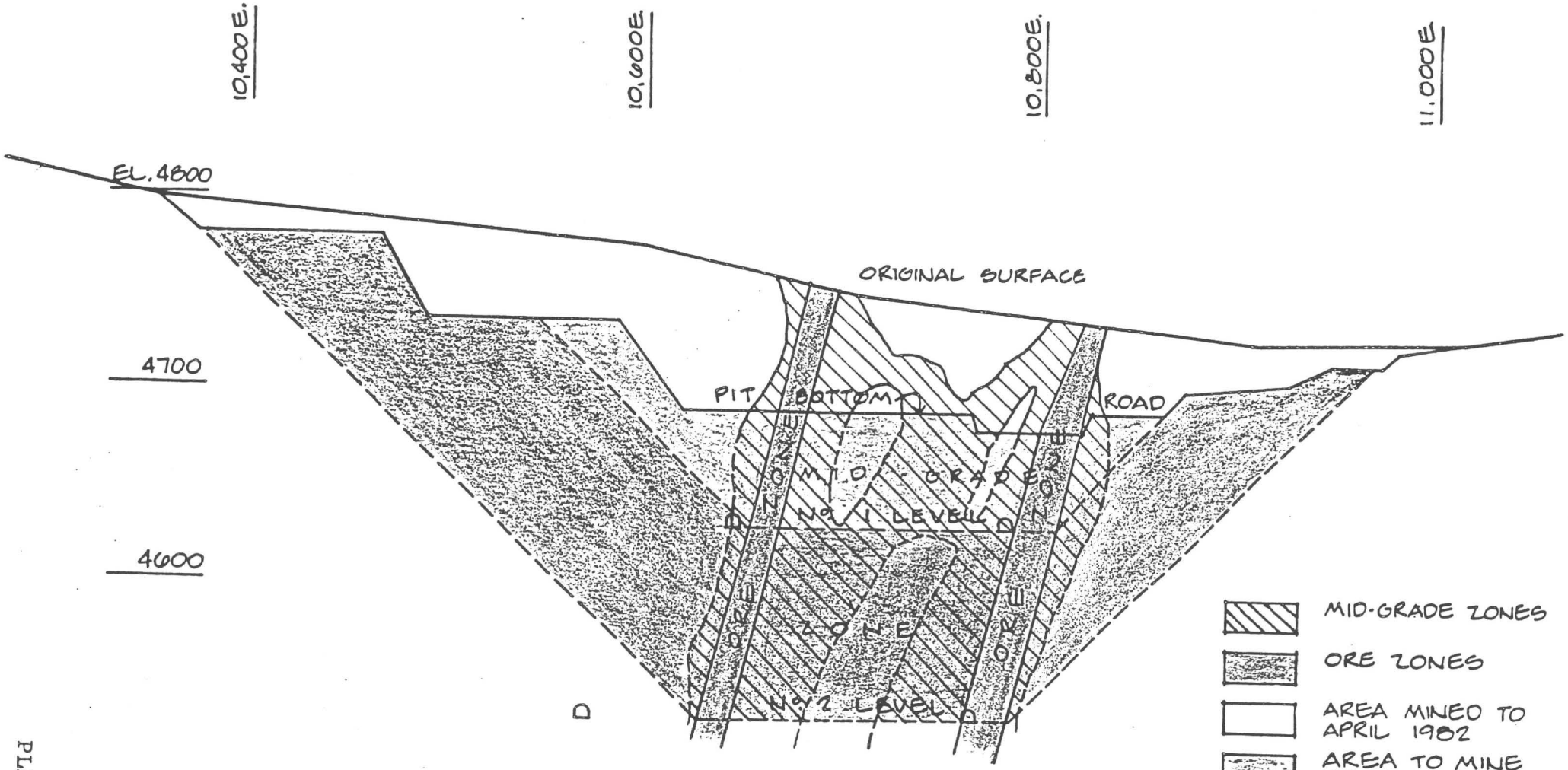
CONTENTION - GRAND CENTRAL ORE ZONE
UPPER LEVELS ALONG ORE ZONE



PIT CROSS SECTIONS
SCALE: 1" = 77'
APRIL, 1982 A.J. GRAVES

10600 N X-SECTION

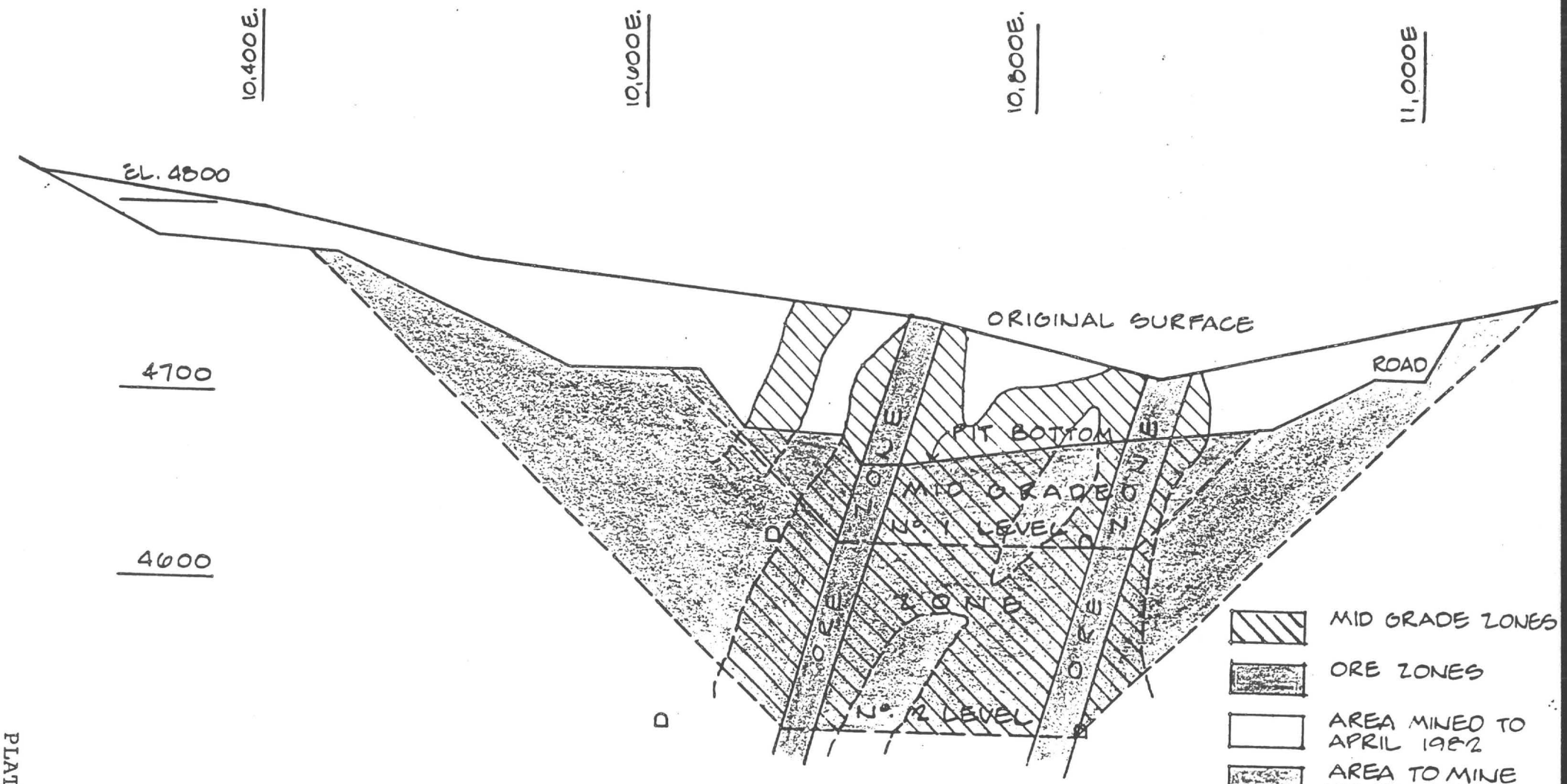
PLATE 2



11,000 N. X-SECTION

PIT CROSS SECTIONS
SCALE: 1" = 77'
APRIL, 1982 A.J. GRAVES

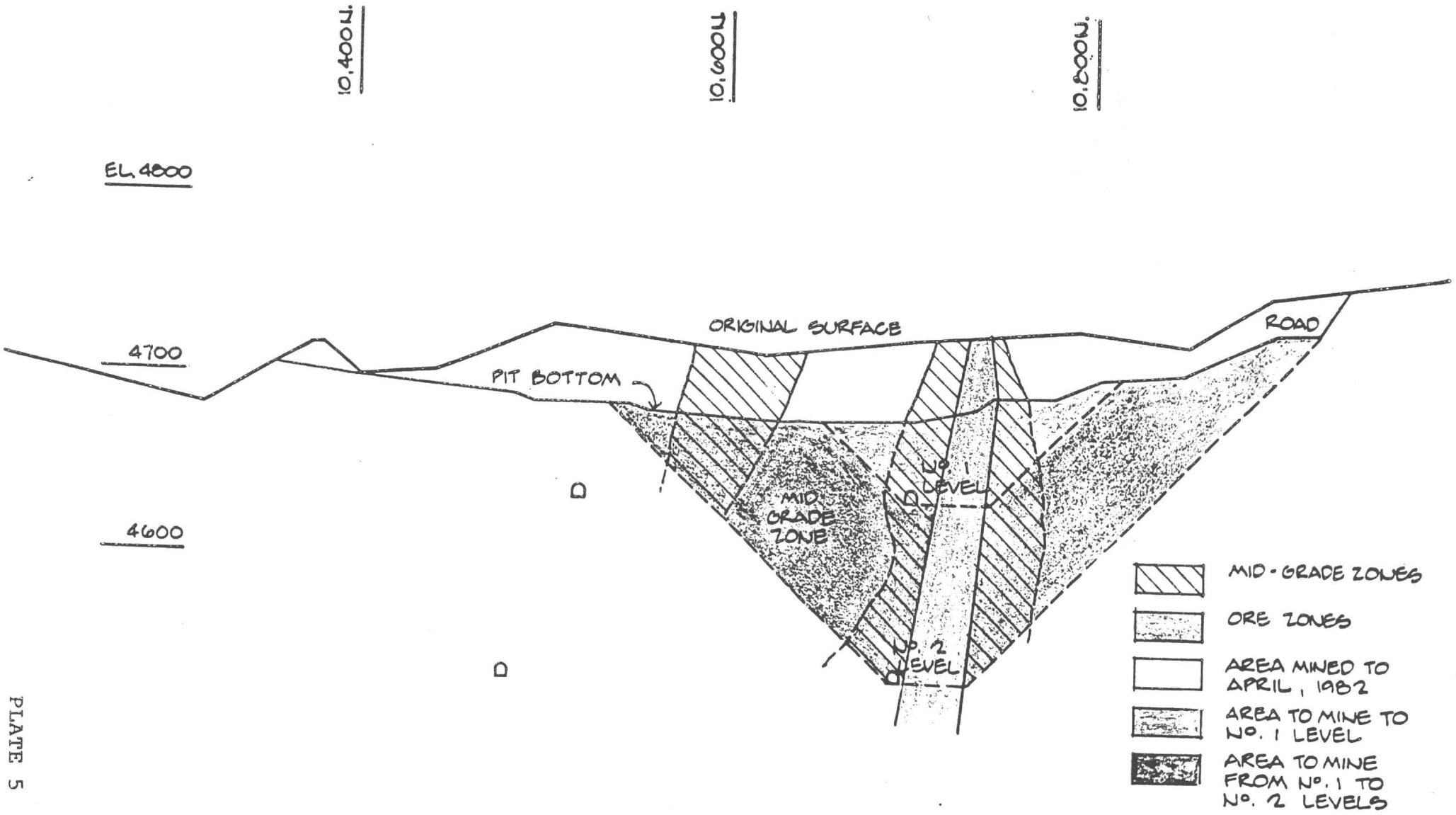
PLATE 3



11,200 N. X-SECTION

PIT CROSS SECTIONS
SCALE: 1" = 77'
APRIL, 1982 A.N. GRAVES

PLATE 4



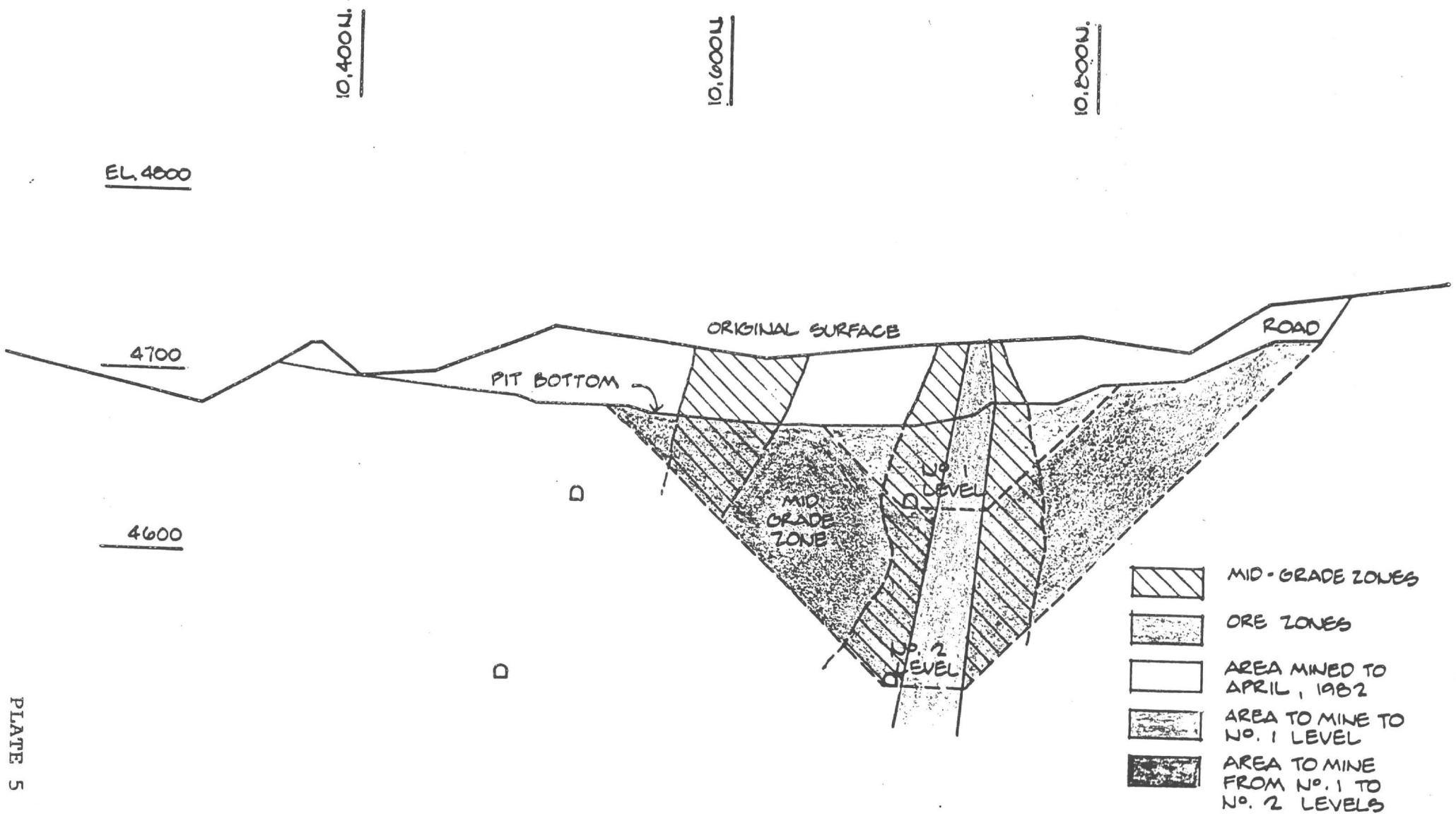
PIT CROSS SECTIONS

SCALE: 1" = 77'

APRIL, 1982 A.J. GRAVES

114 00N X-SECTION

PLATE 5

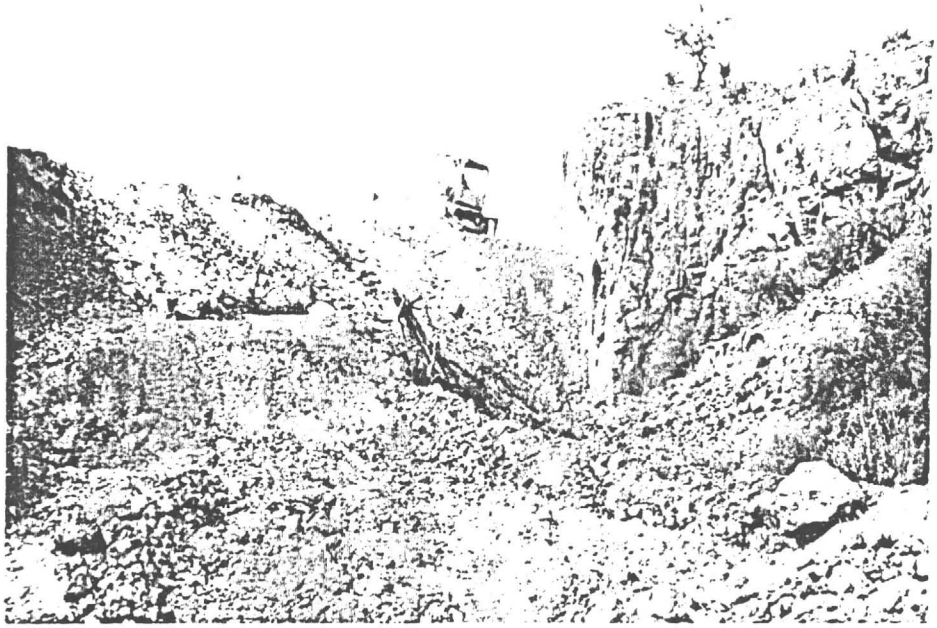


PIT CROSS SECTIONS
SCALE: 1" = 77'
APRIL, 1982 A.J. GRAVES

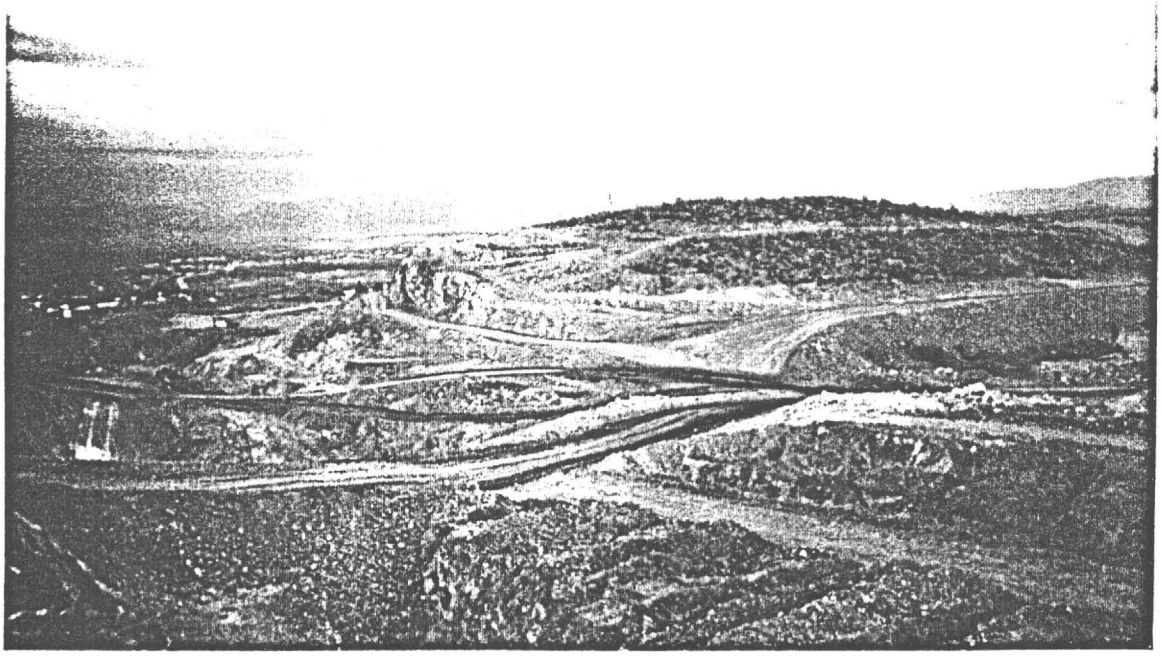
114 00N X-SECTION

PLATE 5

CONTENTION-GRAND CENTRAL PIT



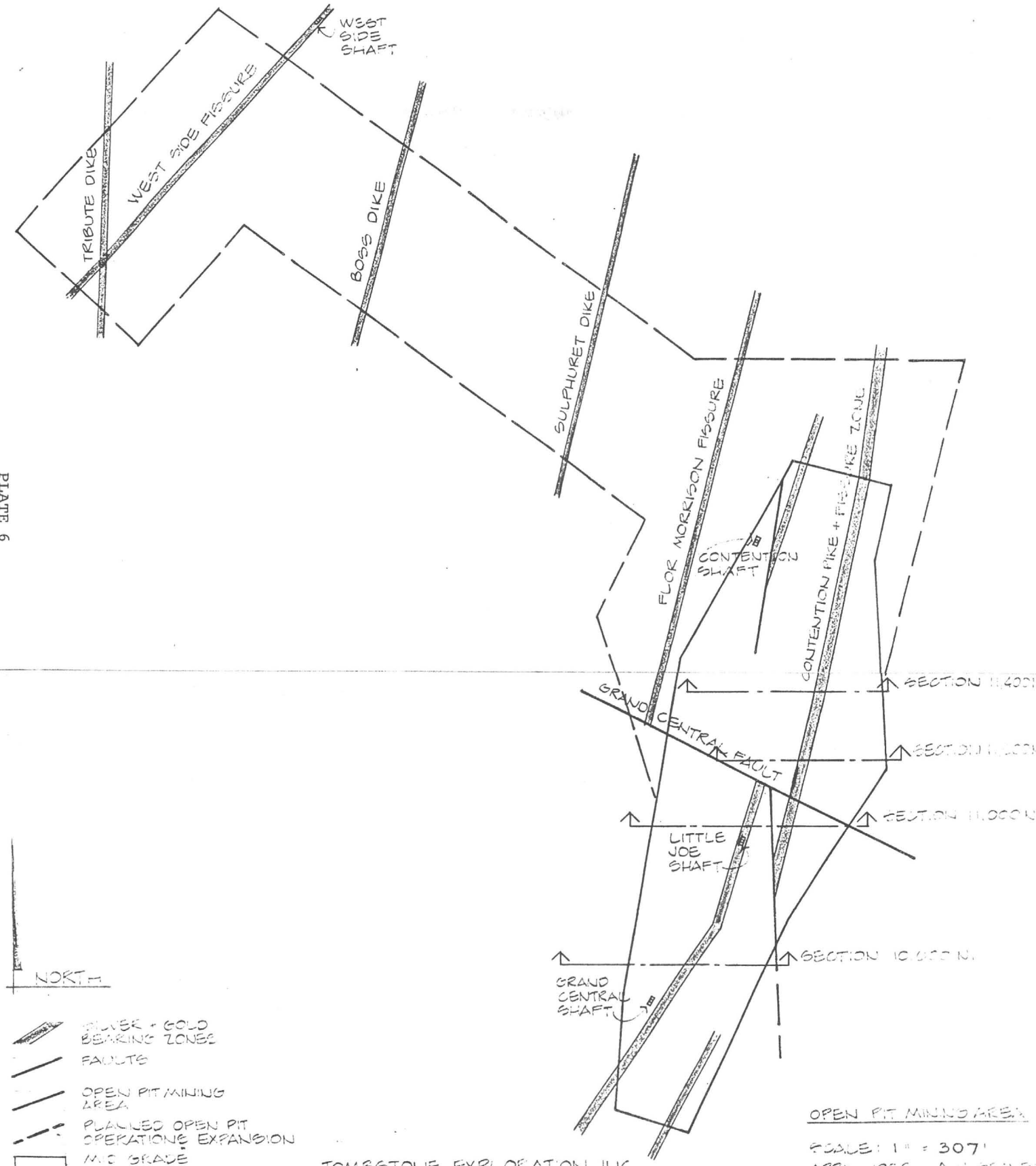
1979



Current Pit

Extension of the Contention-Grand Central Pit

The pit has an approximate length of 1500 feet and approximate width of 1000 feet (on Plate 6, the present mining operation is delineated by a solid green line). It is anticipated that it will extend 800 feet through the south extension of Grand Central and a half mile north-west through the Flora Morrison, Sulphuret, Chance, Boss and the West Side (on Plate 6, the broken green line delineates the projected open pit operation. Plate 7 describes the West Side fissure in detail). This will make available one mile of ore zones that can be mined and processed with existing TEI facilities.



TOMBSTONE EXPLORATION, INC.

OPEN PIT MINING AREA

SCALE: 1" = 307'

APRIL, 1980

PLATE 6

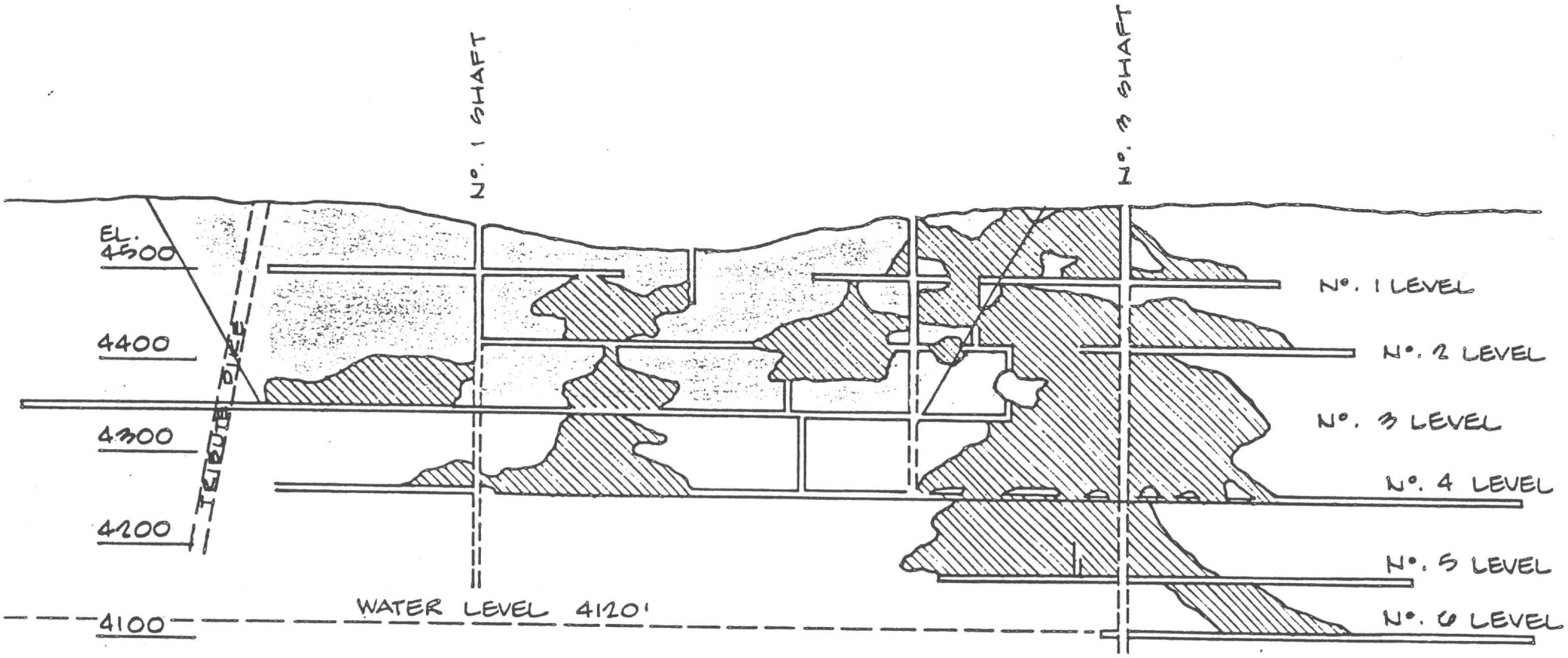


PLATE 7

HIGH GRADE STOPES ALONG THE FISSURE

PLANNED OPEN PIT

WEST SIDE FISSURE

LONGITUDINAL SECTION
LOOKING WEST

SCALE: 1" = 166'
APRIL, 1982 A.J. GRAVES

TEI Production:

The following are monthly sales records of bullion produced by TEI in 1981 and 1982.

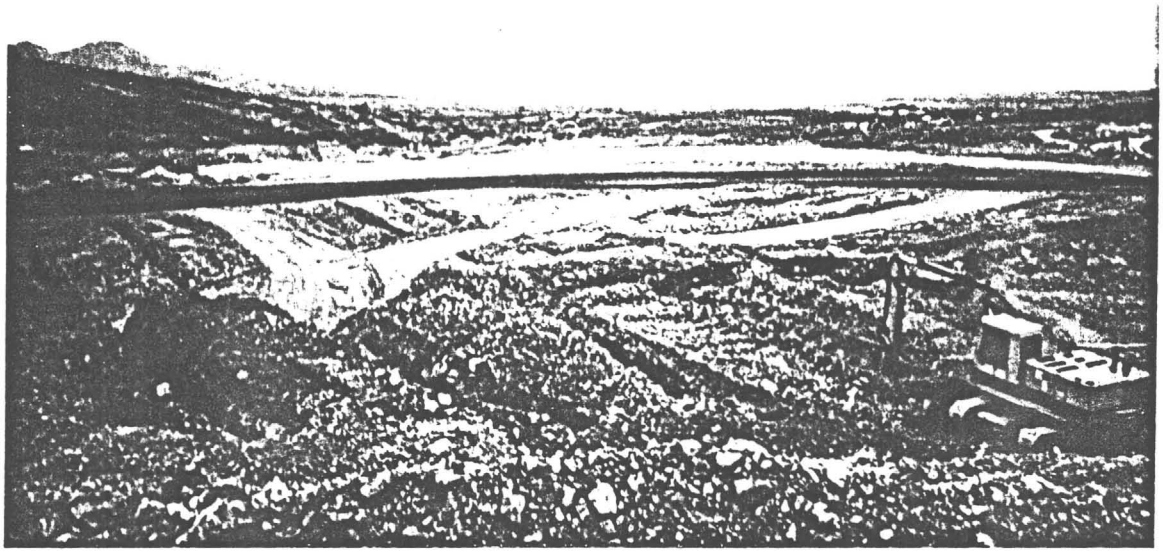
DATE	OUNCES GOLD	AMOUNT	OUNCES SILVER	AMOUNT
Jan 81	91.83	$51,597.28	5,235.20	$76,259.79
Feb 81	92.25	44,657.99	2,071.44	26,244.98
Mar 81	22.68	11,958.12	3,469.55	41,862.55
Apr 81	43.82	21,373.11	4,056.44	44,301.21
May 81	35.11	16,317.31	2,191.74	23,197.02
Jun 81	38.43	16,266.13	621.12	7,402.72
Jul 81	83.35	33,360.13	7,223.16	62,368.60
Aug 81	253.96	103,882.63	18,504.60	171,898.32
Sep 81	434.04	188,308.45	15,777.30	165,920.52
Oct 81	246.44	107,840.31	13,884.94	128,695.01
Nov 81	549.75	235,713.04	28,688.93	259,944.34
Dec 81	293.71	125,854.73	17,280.36	156,387.26
TOTAL 1981	2,185.37	$957,129.23	119,004.78	$1,164,482.32

DATE	OUNCES GOLD	AMOUNT	OUNCES SILVER	AMOUNT
Jan 82	415.00	$174,823.75	30,890.00	$272,082.30
Feb 82	344.51	141,709.11	15,014.14	126,149.79
Mar 82	337.04	140,661.22	14,238.42	122,507.88
Apr 82	436.05	183,271.71	23,778.03	206,555.39
TOTAL YEAR TO DATE:	1,532.60	$640,465.79	83,920.59	$727,295.36

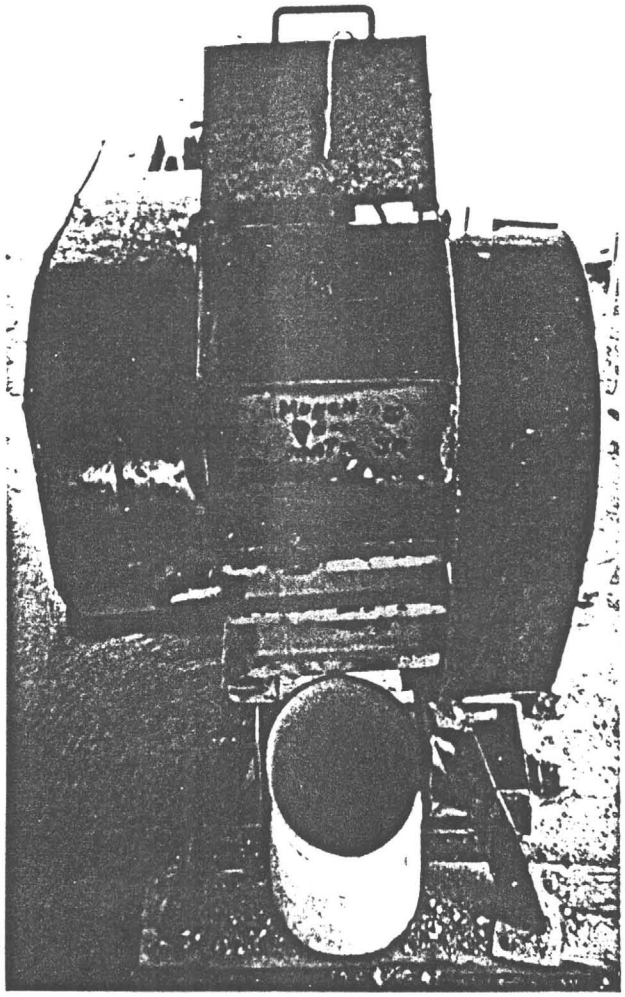
Highest 1981 price: $591.16 per oz. gold, $16.02 per oz. silver
Lowest 1981 price: $365.72 per oz. gold, $ 7.84 per oz. silver

Highest 1982 price: $426.00 per oz. gold, $ 8.83 per oz. silver
Lowest 1982 price: $350.00 per oz. gold, $ 7.34 per oz. silver

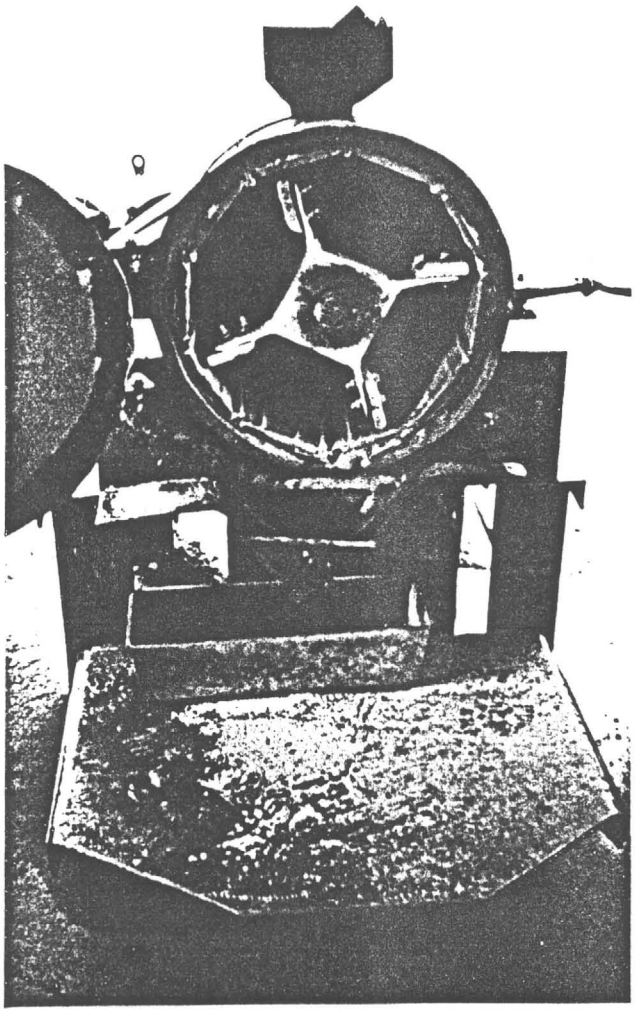
SAMPLING



Trenches and excavator



Sample crusher



Impact mill

OPERATIONS AT THE CONTENTION-GRAND CENTRAL MINE

Sampling Department

TEI considers careful and exact sampling to be of primary importance; every phase of the mining operation is dependent on a valid sampling technique.

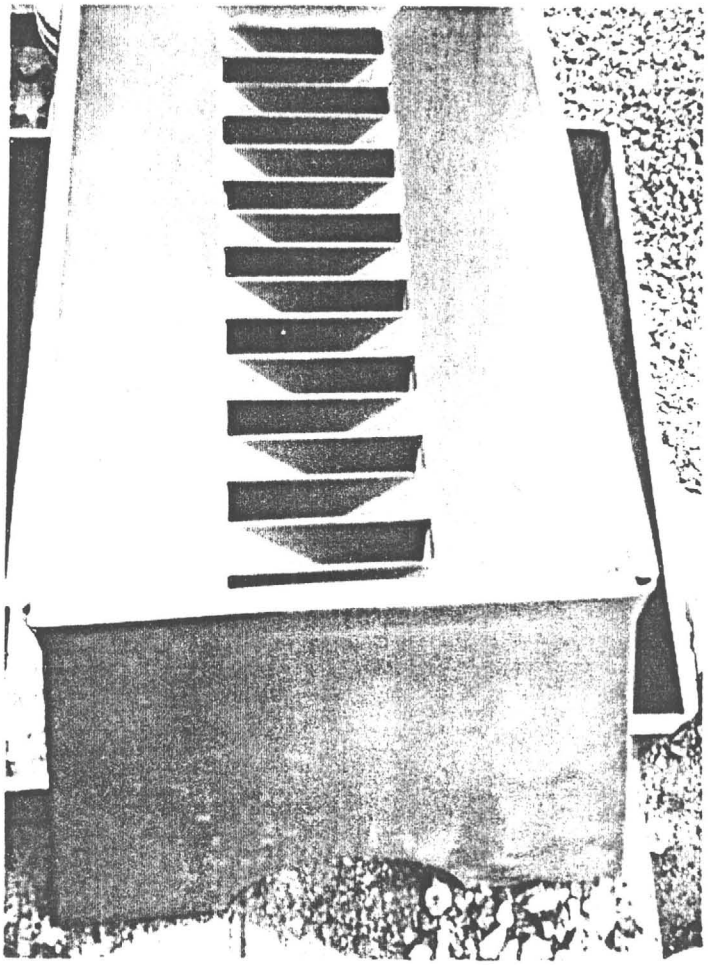
A study by TEI determined that core drilling, percussion drilling or reverse circulation drilling would not be effective in the area. It was determined that a better indication of ore grade would be provided by channel sampling, a method which also has the advantages of exposing the ore zone and preparing it for mining. Drilling costs to determine ore zones would exceed TEI's total costs of mining and processing that ore, and TEI believes that results obtained from drilling would further need channel sampling to determine accurate ore grades for the operation of the open pit mine.

TEI uses a grid system based on the Cartesian coordinate system, incorporating north, east, and elevation coordinates for its samples. A Caterpillar 225 Excavator is used to dig east/west trenches at intervals of 25 feet, and to a maximum depth of six feet. Along the trenches, at intervals of no more than ten feet, with the actual interval governed by rock formation and structure, a channel approximately three inches wide and one inch deep is cut in the rock face. This yields a sample weighing approximately twenty five pounds, which conforms to two requirements: it is representative, and it is manageable by one person.

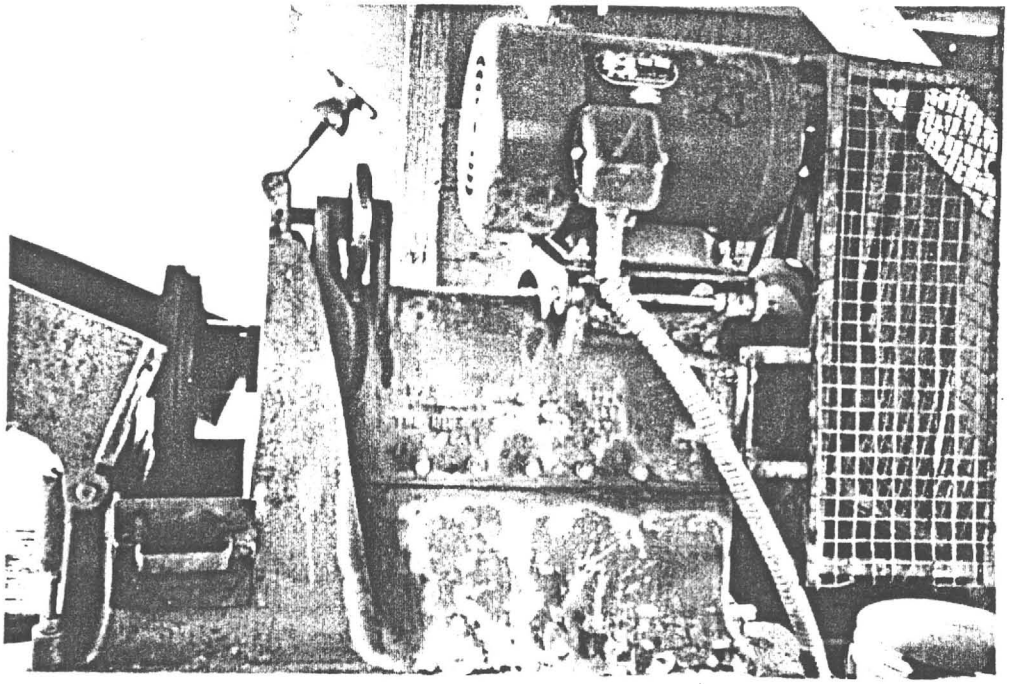
The collected sample is prepared for assay in five stages. It is crushed to minus one inch and a split is taken. This split in then impact milled and another split is taken, which is then pulverized and sent to the assay laboratory. By using progressive splitting, the final assay results are much more representative than those obtained by simple one stage pulverizing.

When the assay report is returned, the assay value of the sample, using its specific coordinates, is plotted on a map. When all the assays for a particular bench have been plotted, grades are designated for the ore, using the weighted average method.

SAMPLING



Splitter



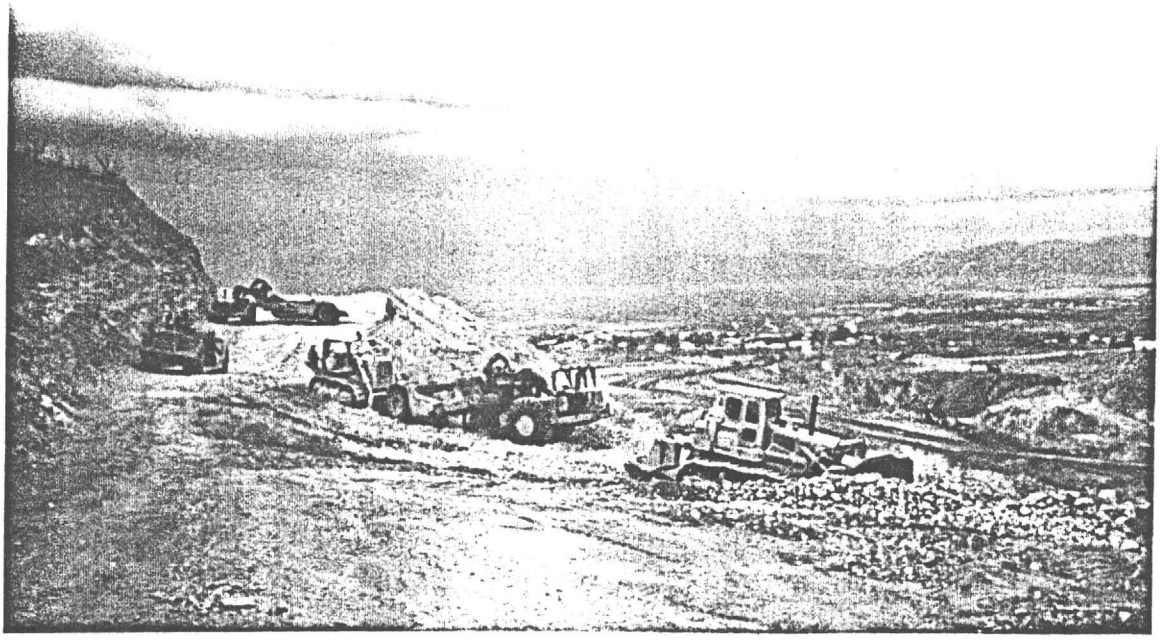
Pulverizer

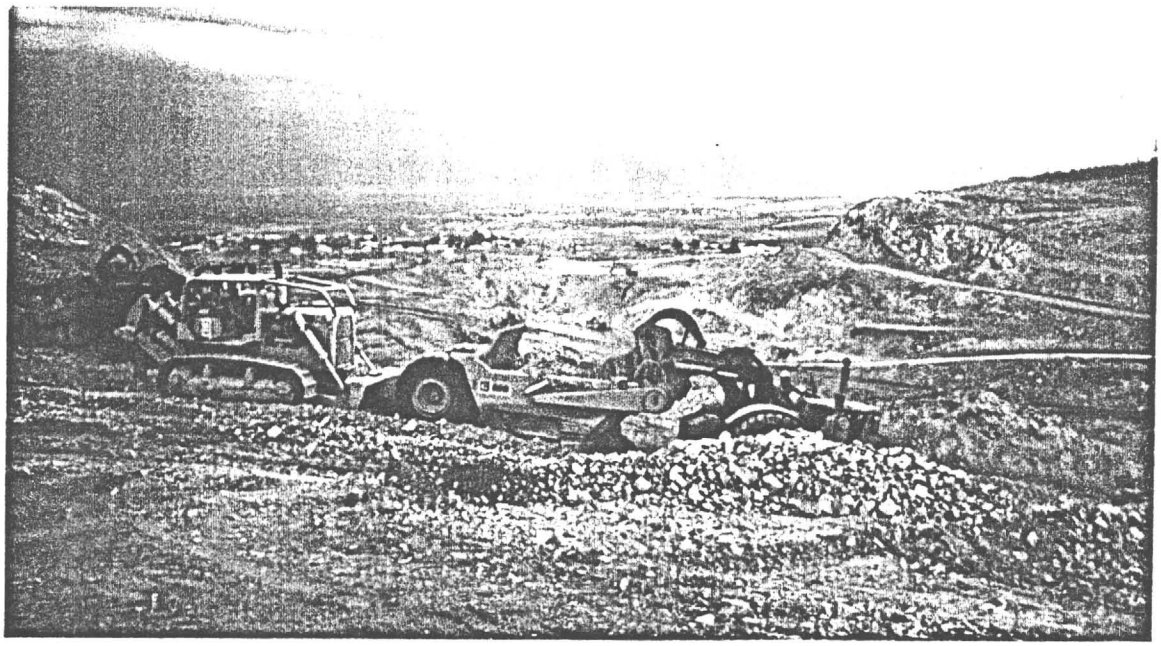
TEI has established four grades for the rock which it mines, based on silver content per ton of rock, (gold content in the ore at TEI has, on average, an equivalent dollar value to the silver content) The grades are: waste (less than .25 ounces of silver per ton), mid grade (0.25 to 1.0 ounces of silver per ton), ore (1.0 to 10.0 ounces of silver per ton), and high grade (above 10.0 ounces of silver per ton).

After the average grade has been determined, tonnage is calculated for the volume of ore. The ore zone is then marked on the bench with color-coded flags for mining.

The individual samples taken are each representative of, on average, 150 tons of ore, allowing TEI geologists precise definition of ore zones and geological structures.

MINING





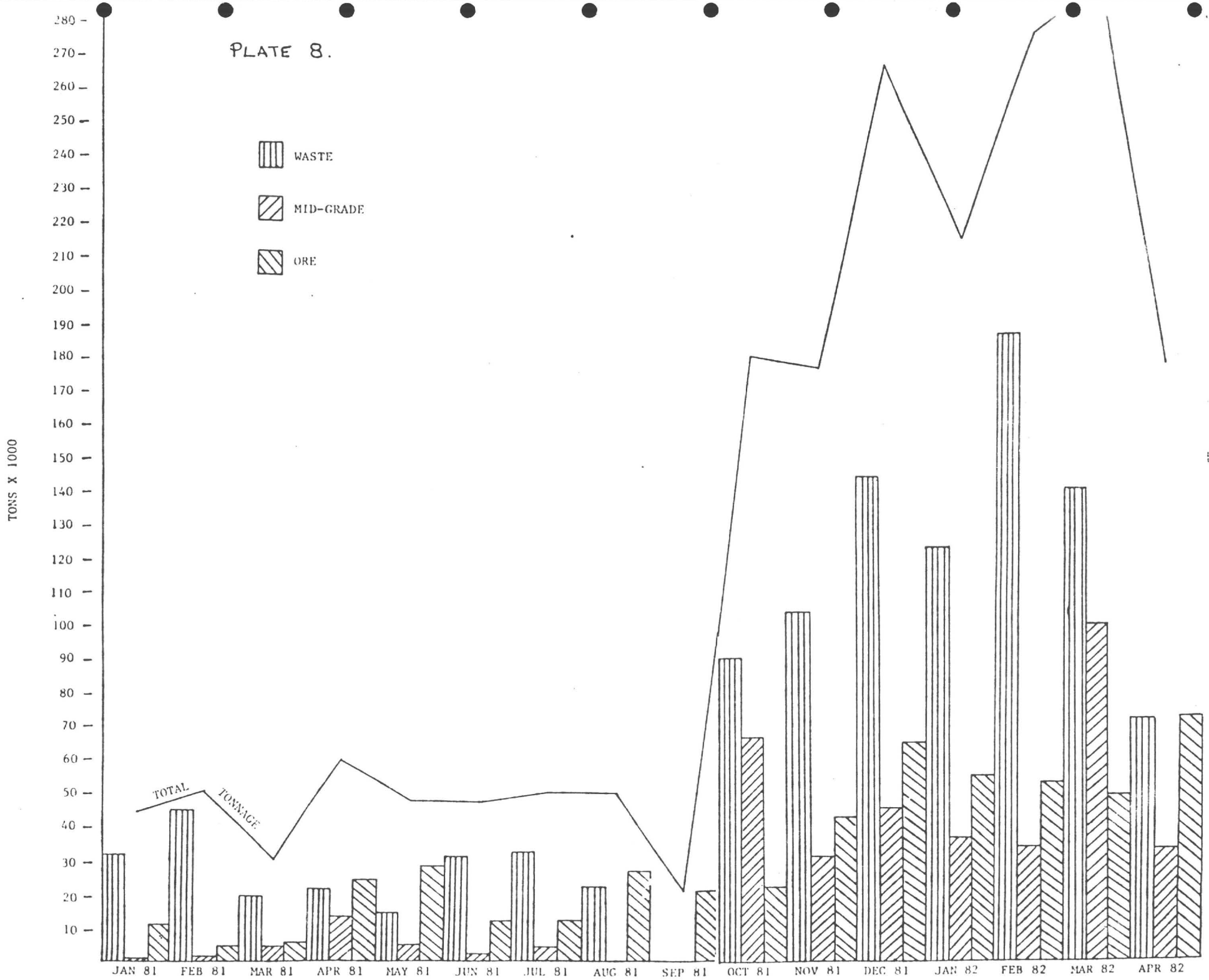
Mining Department

TEI uses the mining method of ripper and scraper haulage. Less than 10% of the rock requires drilling and blasting, and the resulting mining cost per ton is low for an open pit operation.

The mining is subcontracted to Magini Leasing and Contracting. Equipment employed by the contractor includes five 631B Caterpillar scrapers and three D9G Caterpillar bulldozers. Magini moves about 7500 tons of TEI material per day.

The mined ore is transported by scraper to a stockpile; from there a front end loader moves it to the crusher.

PLATE 8.


WASTE
MID-GRADE
ORE
TOTAL TONNAGE
TONS X 1000
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
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JAN 81
FEB 81
MAR 81
APR 81
MAY 81
JUN 81
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AUG 81
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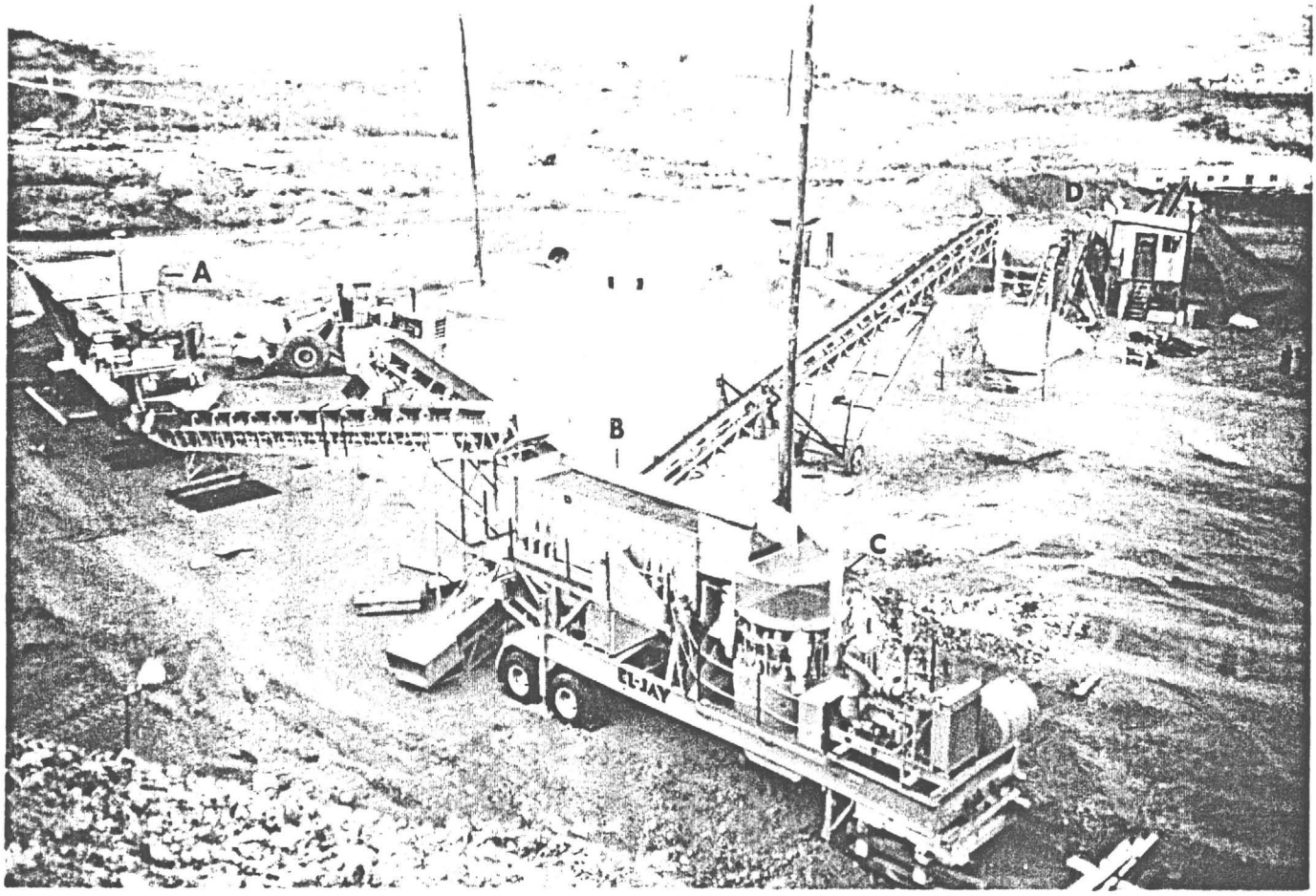
OCT 81
NOV 81
DEC 81
JAN 82
FEB 82
MAR 82
APR 82

CRUSHING CIRCUIT



A. Primary crusher

B. Shaker screen

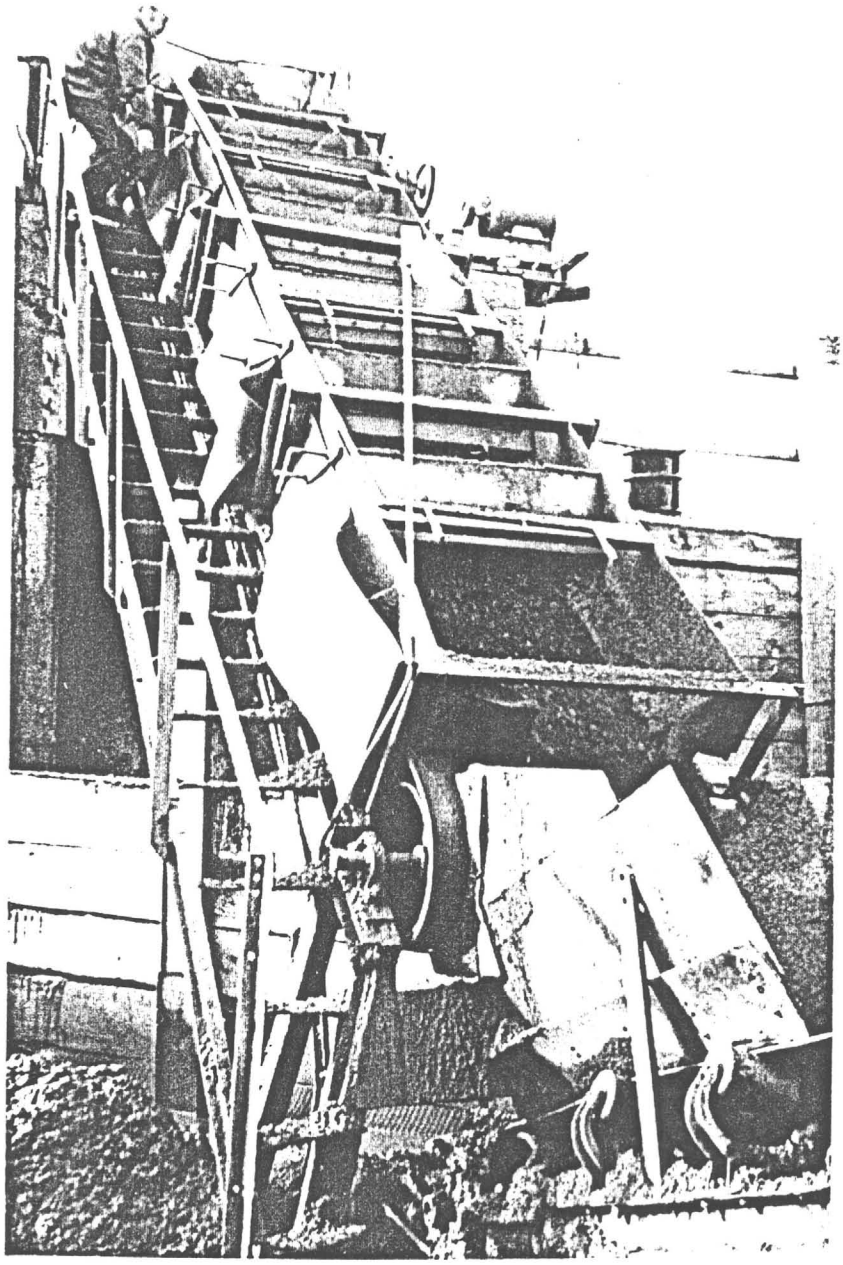
C. Cone crusher

D. Pelletizer

Crushing Department

Ore from the stockpile is fed into the vibrating hopper of the primary crusher. The oversize ore is scalped by the grizzly, and the rock is crushed to 3" to 4" in diameter. The fines and crushed rock fall onto the under primary belt, and are then dumped onto the feed belt going to the shaker screen. As the ore passes over the screen, all the fines and minus 3/4" material goes through the screens and onto the underscreen belt. The oversize material continues across the screening decks and into the secondary crusher. This ore falls onto a return belt, which dumps onto the same screen feed belt, combining the larger and smaller crushed material, which continues over the screen to join the other material already on the underscreen belt. This material is then dumped on a stacker belt which transports it to the pelletizer.

PELLETIZING



Pelletizing Department

After the ore is crushed, lime is added. Then both the fines and the larger particles and fragments are gravity-fed into the pelletizer. The crushed ore slides down an inclined conveyor belt which is moving upward against the flow of ore. The broken ore is sprayed with cyanide. The larger particles or fragments adhere to the fines, thereby increasing their own already relatively large mass. The advantages produced by this process are significant. The crushing tends to break the ore-bearing rock along its fracture or cleavage planes or lines. The smaller the post-crushing particles, the greater the total surface area exposed. The fines (particles under one half inch in diameter) tend to be captured by the larger particles or fragments. They adhere in irregular patterns, not in smooth concentric layers. This prevents compaction of fines into a non-permeable, low porosity mass. Increasing porosity and permeability facilitates greater recoveries from the leaching process in less time.

The pelletized ore is dumped onto stacker belts and piled for haulage.

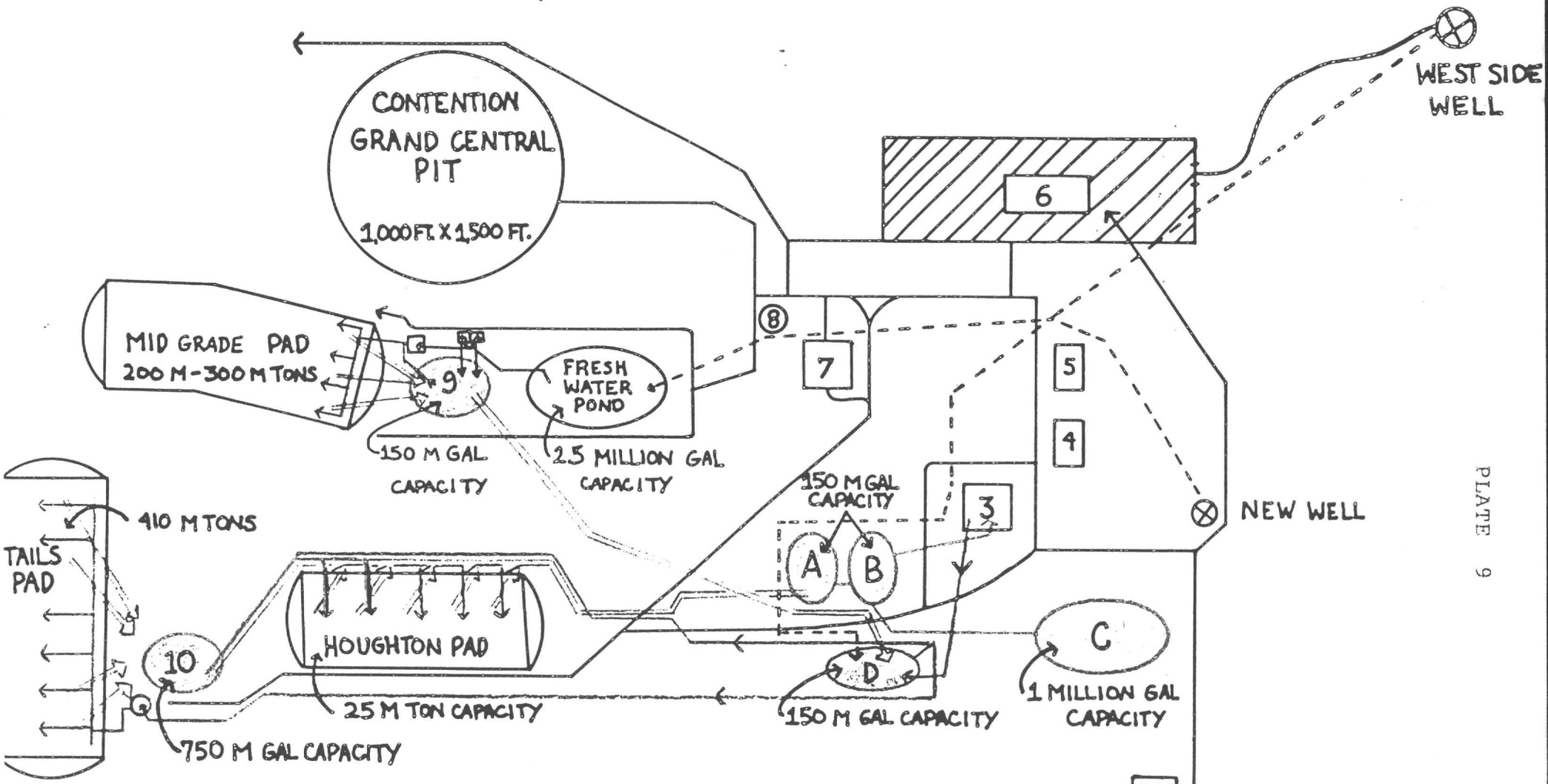
Leaching Department

TEI has four major ponds in their production circuit (see plate #9). Spray pond "D" consists of barren solution. 250 gallons per minute of barren solution are pumped to the production pads for silver and gold stripping. The return, or effluent, from the pads is gathered in preg ponds "A" and "B". Pond "A" acts as a settling pond which overflows into preg pond "B". Pumps bring the pregnated solution from pond "B" into the plants where an adequate amount of zinc dust is added. Zinc dust causes the precipitation of the gold and silver from the solution. Simple sodium sulfide tests are performed to justify the amount of zinc used. There is a third main preg pond "C", which collects any excess pregnant solution from pond "B". This excess is pumped back when pond "B" is low. The barren solution, stripped of silver and gold, leaves the plants, and goes directly to spray pond "D" at an average rate of 250 gallons per minute. In return, 250 gallons per minute of solution with the adequate cyanide content is pumped to the production pads. In excess of one pound of cyanide per ton of solution is needed to extract silver and gold from the ore. Lime and caustic soda are added to keep the pH level above 9.5.

The tails pad consists of ore that has already been leached. When the effluent return from an ore pad gets down to .75 ounce of silver per ton, the spraying there is stopped. All ore at that level is transfered to the tails pad for further leaching. Approximately 320 gallons of barren and recirculated slightly pregnated solution is being sprayed at one time on the tails pad. A wash plant has been installed to extract further values (see Innovations and Projects).

The mid-grade pads consist of uncrushed and unpelletized mid-grade ore. Cyanide and lime are added to fresh water from the reservoir in a mix tank, and the resultant barren solution is sprayed onto the pile. A three million ton mid-grade pad is currently under construction (see Innovations and Projects).

There are five ore production pads, each 100′ x 200′ x 8′, located at the Houghton claim. Each pad holds 5,000 tons of ore. The pregnant solution from mid-grade and tailings pads is used as spray solution for the ore pads. This has the correct amount of cyanide and lime, and already has silver and gold values. These values in the solution tend to allow a greater extraction of silver and gold from the ore than if a barren solution is used.

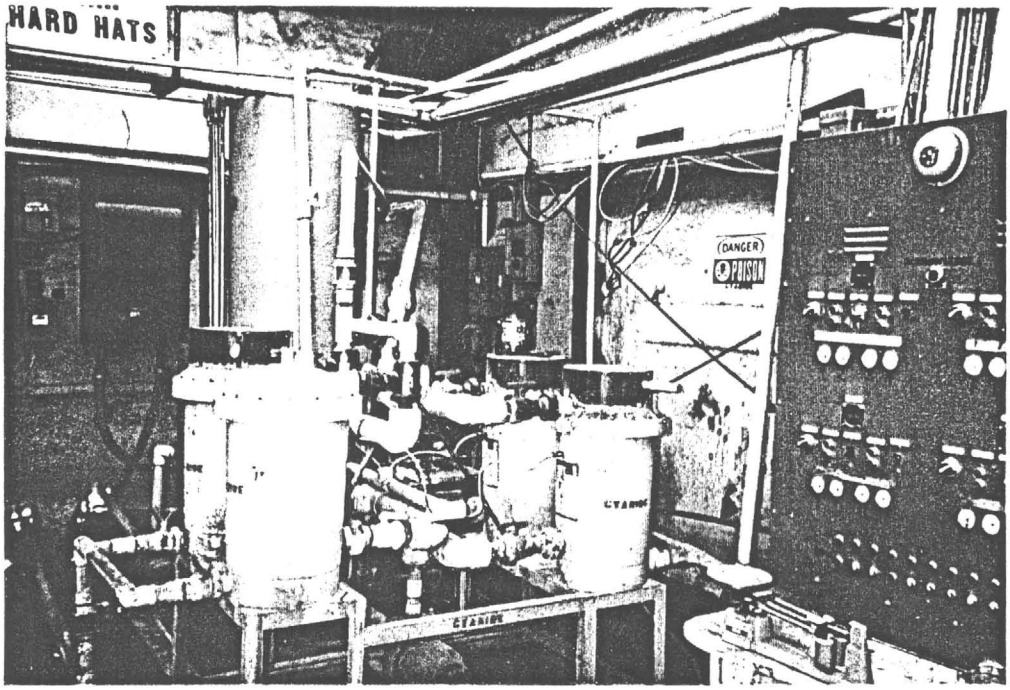


1 GUARD HOUSE
2 SMELTER
3 PLANT
4 OFFICE TRAILER
5 OFFICE TRAILER
6 LABORATORY
7 CRUSHER + PELLETIZER
8 FRESH WATER TANK
9 MID-GRADE POND + MIX TANK
10 TAILS POND + MIX TANKS

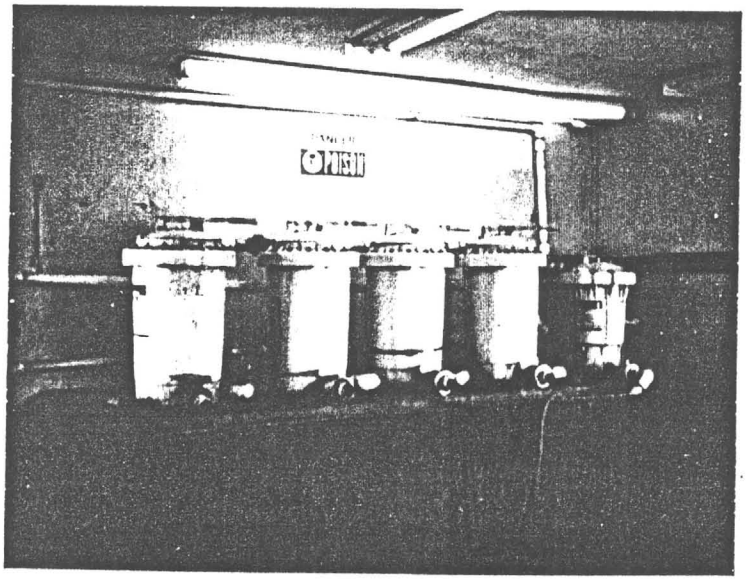
PADS
PONDS
BUILDINGS
FRESH WATER LINES FROM WELLS
ROADWAYS
WELLS

PREGNANT SOLUTION
SPRAY SOLUTION
EFFLUENT SOLUTION

PLATE 9



One precipitation plant



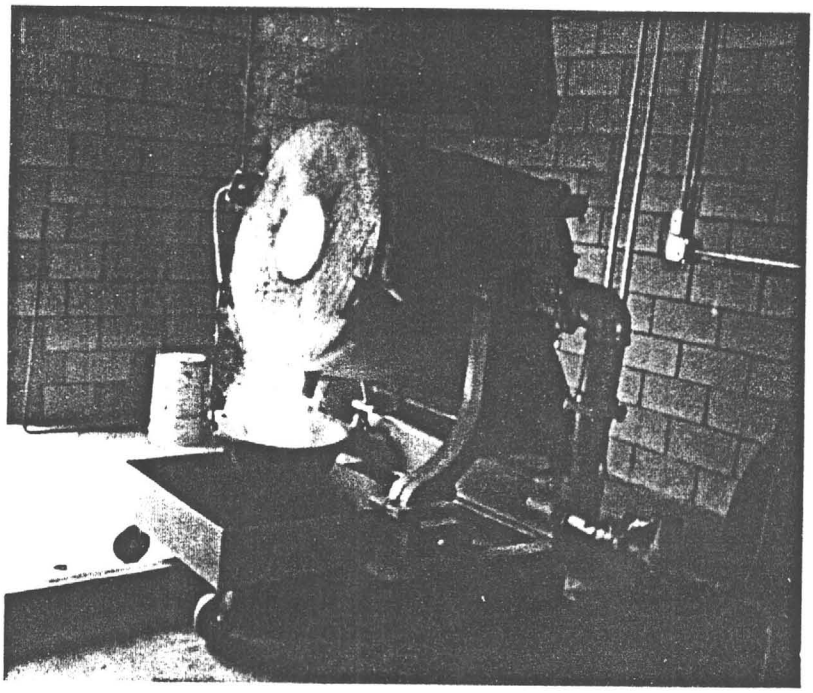
Secure collection area

Plant Department

TEI has incorporated four Merrill Crowe zinc precipitation plants manufactured by the State of Maine Mining Company. Each plant has a rating of 300 tons of solution per day, for a total of 1200 tons of solution per day. Innovations and efficient operation by the plant supervisor have increased the capacity of the plants to a total of 1400 tons of solution per day. Each precipitating plant can operate separately or in conjunction with the others. In the event of any component failure on one plant, the entire processing does not shut down.

The precipitates are pumped into a secure area, where access is limited to a few key personnel. They are then dried in a drying oven and shipped to the smelter, Chrysaor Laboratories, located on TEI property.

SMELTING



Smelter

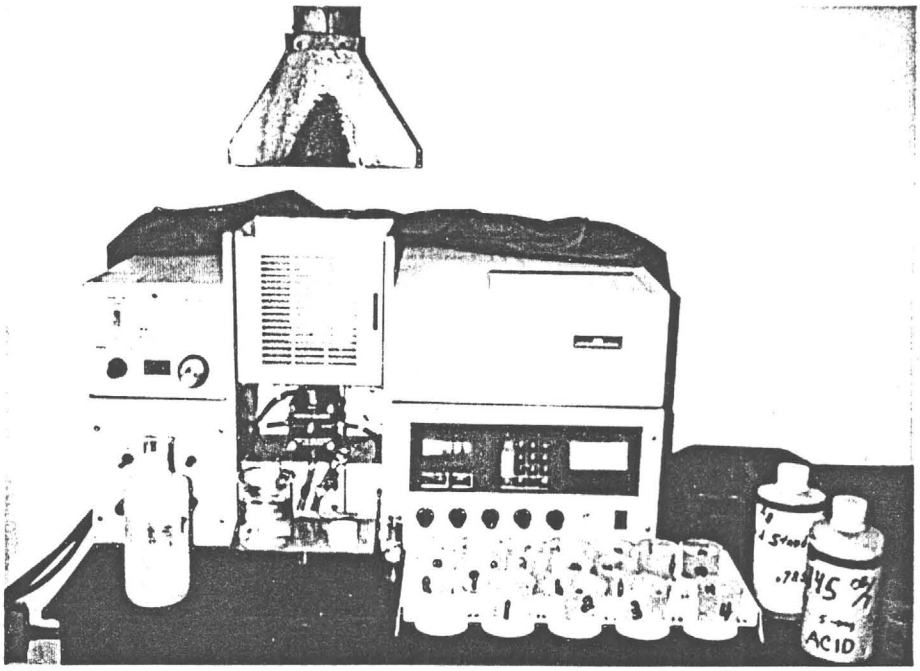
Vibrating table & slag

Smelting Department

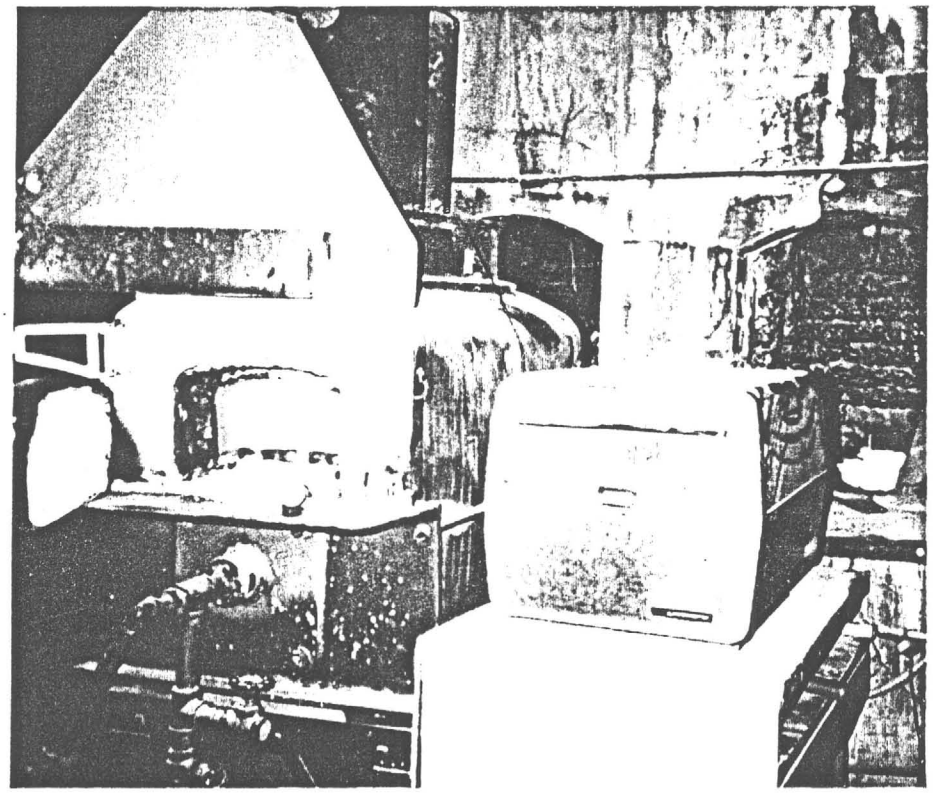
Chrysaor has a fully automated tilt furnace that uses a #300 crucible. Present smelting is 96 hours or 2600 pounds of precipitates per week, approximately 50% of capacity.

The dore', in cone form, is shipped to a refinery by armored car or by plane. A TEI representative is present at the weighing and assay of the dore'. A vacuum tube is used, under TEI's observation, to collect a homogeneous sample from the molten dore'. The sample is cut into thirds. One third remains with the refinery, one is sent to an independent laboratory, and one returns to TEI's testing department.

From the smelting process, TEI has a large volume of slag with appreciable metal values. A vibrating table and impact mill have been installed to process this material. Due to the efficient operation of the Smelting Department, this process can be done by the Smelting Department personnel, incurring no extra labor costs.



Atomic absorption spectrometer



Fire assay equipment

Testing Department

This department uses an atomic absorption spectrometer and full fire assay equipment. Sample testing is provided for the mining, leaching, plant and smelter departments.

Mining Department:

Pit samples received daily are assayed for gold and silver by both atomic absorption and fire assay. The mining department uses the assay report to designate the sampled area as either waste, mid-grade, ore, or high-grade.

Leaching Department:

Hourly samples are taken from the ore, mid-grade, and tails pads. The testing department assays for gold and silver values in solution. A careful monitoring of pH and cyanide content is conducted.

The testing department runs controls on the heads and tails of pad ore. This includes fire assay for gold and silver, and barrel tests for leachability and expected percentage recovery.

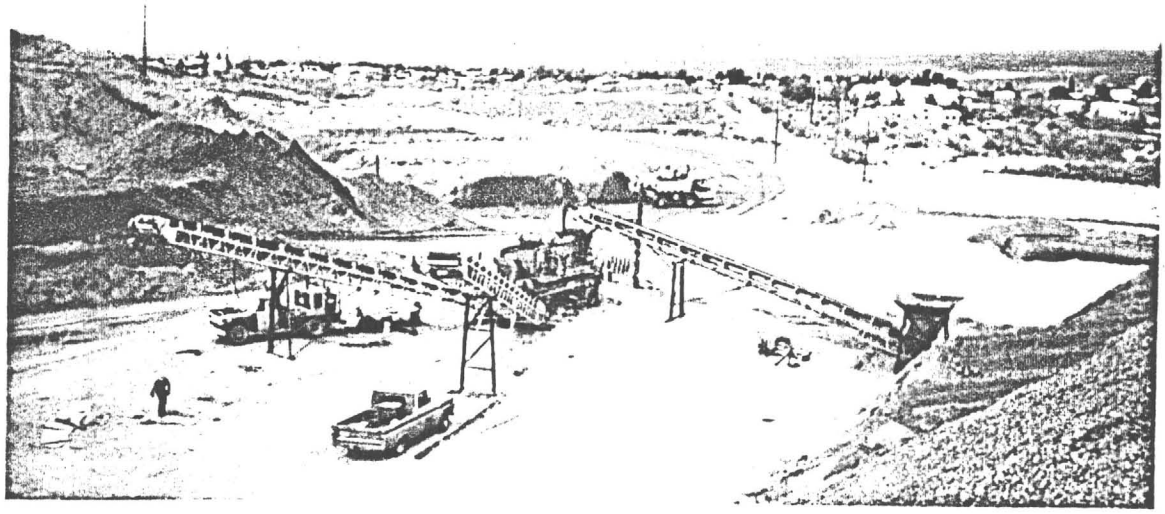
Plant Department:

Hourly samples are taken to determine the gold and silver values in the pregnant and barren solutions. Results of these assays are used for quality control by the plant supervisor.

Smelter Department:

Fire assays are run daily on precipitate lots received by the smelter from the plant department. This allows management to compare actual dore' ounces to both plant results and pit samples from the mining department.

WASH PLANT



INNOVATIONS AND PROJECTS

Wash Plant

TEI has accumulated more than 410,000 tons of crushed material which has already been leached on the production pad. 50% to 65% of the available silver and 85% of the gold has been recovered. To extract a further 10% to 15% of the precious metal values TEI has constructed a wash plant that uses a dilute cyanide solution. The material is classified and sprayed on a triple deck shaker screen, the finer material going as slurry to a settling pond. The material from the decks has the fines dropped out, leaving a clear pregnant solution to go to the processing plant.

The sorted and washed material from the screen is of specific size to be marketable as road surfacing. TEI material has an average hardness of 4, which makes it acceptable for that use. As the material is already mined and crushed, expense is minimal, so TEI can be very competitive in supplying road surfacing to Southern Arizona. The marketable price is $7 - $8 per ton.

Sales have already been made to the town of Tombstone and the State of Arizona. In effect, the normal waste products of a mining operation have become a valuable and marketable commodity.

Mid Grade Ore

TEI is currently leaching on approximately 220,000 tons of ore that has been assayed to be between .25 and 1 ounce silver per ton. The effluent and pregnant solution from the portion of material under leach has indicated very favorable results for a conventional heap leaching process on this mid-grade ore.

TEI's stripping ratio shows an increased amount of mid-grade ore with depth containing .25 to 1 ounce per ton of silver. To process this material, TEI is constructing approximately 20 acres of modular leaching pads, with a capacity of 3 million tons and a separate collection pond with a capacity of 3 million gallons of solution. It will be possible to spray a total of 2,400 gallons per minute in a recirculating system, until the pregnant solution is one ounce per ton or better, when it will be pumped to TEI's current processing facilities. The pads are being constructed in a natural valley, using waste material as a sub-base and an indigenous lime cement called coliche as the impermeable base. In the course of mining, waste must be moved to reach the ore of one ounce per ton and higher. By placing this waste as construction material for pads and as mid-grade ore, TEI is creating a large leaching operation at minimal expense. A conventional heap leach extracts approximately 1/3 of the precious metal values.

If precious metal prices increase, the mid-grade ore will be processed through TEI's crushing and pelletizing facilities. At a figure of $16 per troy ounce of silver, the cut off in the pit would be lowered to 1/2 oz. silver per ton, tripling the volume of ore that could be economically processed. The previously leached mid-grade material would also become a processable orebody.

High Grade Ore

TEI has encountered areas in the pit that are running in excess of ten ounces of silver per ton and up to two ounces of gold per ton. With existing facilities, TEI is able to process these concurrently but separately from other production, maintaining the different controls in cyanide amounts necessary for high grade ore. The ore is crushed finer than normal and placed on a separate pad. The pregnant solution is then blended into the pregnant solution from other production pads, bringing the average preg from one ounce up to a possible three or four ounces per ton.

Any ore of above 25 ounces of silver per ton will be processed by means of a small mill. TEI has used a pilot mill to determine percentage of recovery and optimum operating procedures. Extrapolating from the results of these tests, TEI should be able to build and operate a mill with a capacity of 150 to 200 tons per day at a construction cost of about $200,000. There is also, four miles away, a custom mill capable of handling high grade ore.

RESERVOIR

Reservoir

In the course of mining and processing operations TEI uses a large amount of fresh water. This is used at the crusher, the pads, and also by the water truck, which sprays to keep dust from the air. To ensure adequate water supply at all times, the company has built a reservoir with a capacity of two and a half million gallons. The reservoir was constructed with waste material, at a cost of about $2,000. The water supply for the reservoir is from a well on TEI property and from wells owned by the town of Tombstone.

Conveyor

TEI's present haulage system, moving the pelletized ore to the pads, consists of one 50 ton payhauler and one 12 yard loader. With increased production this will be inadequate. A possible solution would be the purchase or lease of an additional payhauler. This option would, however, have a continuous impact on operating costs, and involve additional labor. A proposed alternative is the installation of a conveyor system. Advantages of this are:

1) One system generating constant delivery to the pads
2) Extremely low maintenance and repair costs
3) Elimination of operating personnel
4) Implementation with minimal interruption of operations
5) Noticeable decrease in operational cost per ton in a short period of time.

The cost of installation and maintenance of the conveyor system would be:

Pelletizer to production pads:	1500 feet at $150 per foot	$225,000 (one time)
Production pads to tails pads:	2500 feet at $150 per foot	$375,000 (one time)
Repairs and maintenance:	$500 per month, $6,000 annually	

The present system, utilizing the payhauler and loader, has annual costs as follows:

350 payhauler:	initial cost $228,000	at $5,175 per month	$62,100 per year
400 loader:	initial cost $195,000	at $5,835 per month	$70,020 per year
Repair and maintenance:			$70,366 per year
Labor: 2 men, at $240 per week;			$24,960 per year
Total annual cost:			$227,446

The projected cost of the present system, with an additional payhauler, and related additional labor and maintenance costs, is $335,000 annually. The proposed conveyor system would have an installation cost of $600,000, and annual costs of $6,000. Comparison of these costs shows that the proposed system has a less than two year payback, and would then operate at 2% of the cost of a conventional system.

The conveyor system would have the capacity to move more ore than our present crusher circuit produces. The addition of another short head cone crusher and screen, installed and incorporated with the present crusher configuration, would increase crushed ore production by 50%, with a minimum total of 3,000 tons of crushed ore per day. This purchase and installation would cost $300,000, but in conjunction with the conveyor system it is believed that the overall cost per ton could be decreased substantially.

GEOLOGY

General

Tombstone deposits are vein structures which are characteristically irregular lenses and pods in favorable geologic bedding planes or slips, faults, fissures and brecciated shear zones. The favorable geologic horizons are in or near the Naco limestone, the Novaculite and the Blue limestone. Originally the ore solutions came up through rising vertical pipes as epigentic replacement deposits where release of pressure and the chemical changes induced precipitation of the mineral values.

Regional

The rock formations of the Tombstone Hills range from Pre-Cambrian to Recent. The Pre-Cambrian is represented by a granodiorite intrusive. Paleozoic rocks are the Cabrian Bolsa Quartizite and Abrigo Limestone, and the Pennsylvanian-Permian Naco group sediments. Mesozoic sediments are the Cretaceous Bisbee group sediments. The Tertiary Period is represented by the Schieffelin Granodiorite intrusive and andesite porphory dikes, the Uncle Sam Tuff and the Bronco Volcanics. Recent sediments consist of Quaternary Alluvium.

The Paleozoic and Mesozoic sediments in the Tombstone Hills have been folded, faulted during uplift, and intruded by late stage dikes of the Schieffelin Granodiorite.

Folding of the sediments has produced anticlines (rolls) which trend northwest. Later tectonism produced northeast trending fissures along which several dikes intruded the sediments. Emplacements of the Schieffelin Granodiorite and its late stage dikes, along with the extrusion of the Uncle Sam Tuff, took place in the Tertiary following the structural deformation. Mineralization has been inferred to be of the same age. Several episodes of faulting followed in Tertiary times after the intrusive emplacement. Late Tertiary and Quaternary have been an erosional period for the Tombstone Hills.

Local

The rocks exposed in current operations in the Contention-Grand Central pit are Bisbee group sediments which have been intruded by the northeast trending Contention dike. The Bisbee group sediments are a sequence of altered limestones, shales, and quartzites which strike generally N30 degrees E and dip 35 degrees to the southeast. Intrusion of the sediments along northeast trending fissures, by andesite emplacement by hydrothermal solutions.

Major ore zones are developed along the Contention dike in intrusive breccias and along the fault line breccias of the Tranquility fault. Hypogene minerals in the ore zones are thought to have been tetrahedrite and various tellurides. However, subsequent leaching above the water table produced the supergene ore minerals currently being mined. The supergene minerals are primarily Chlorargyrite, Bromargyrite, Native Silver and Gold.

Currently, geological mapping of lithology and structure, on a scale of one inch = 20 feet, is providing new information to be used to expand existing ore zones and target new ones.

SEQUENCE OF GEOLOGIC UNITS

		Geologic Units	Brief Description of Units
QUATERNARY		Phonolite porphyry dike	-very pale orange to pale yellowish-brown phonolite.
		Basalt intrusive	-dark gray to grayish black basalt has a micro-crystalline texture.
		Quaternary undivided	-Plio-Pleistocene Gila Conglomerate and modern gravel and alluvial deposits.
TERTIARY		Rhyolite porphyry: 63 m.y.	-grayish pink rhyolite with medium to fine grained phenocrysts in a devitrified groundmass.
CRETACEOUS		Hornblende andesite intrusives	-medium bluish gray to light olive gray andesite.
		Rhyodacite	-very pale orange to dark yellowish-orange rock with porphyritic-glassy texture.
		Granophyre dike	-grayish-orange-pink to pale yellowish-orange, medium grained rock with micrographic texture.
		Quartz latite porphyry	-light gray, holocrystalline rock with medium grained phenocrysts. This lacks a vitric groundmass and a pyroclastic texture.
		Uncle Sam Tuff: 71.9 ± 2.4 m.y.	-light yellowish-brown to light brown tuff- a lithic, crystal, vitric quartz latite porphyry intrusive.
		Schieffelin Granodiorite: 72 m.y.	-light gray to grayish pink, medium grained granodiorite.
		Andesite porphyry dikes	- 5 dikes, including the Boss dike. Dark greenish gray to grayish-orange andesite.
		Bronco volcanics Upper rhyolite member Lower andesite member	-pale orange to light gray rhyolite (tuffaceous beds and flows.) -greenish-gray to moderate-red andesite.
		Bisbee Formation: 3000 ft ±	-Basal Glance Conglomerate. Maroon sandstone and mudstones, minor limestone beds, and brown to buff sandstone.
PERMIAN	NACO GROUP	Concha Limestone: 1500 ft.	-medium-gray, thin to medium thick, silty limestone.
		Scherrer Quartzite: 150 ft.	-lower-red siltstone, then white to brownish sandstone and minor limestone, limestone and dolomite, and upper light brown to pink sandstone.
		Epitaph Dolomite: 780 ft.	-lower dolomite, then calcitic siltstone, dolomite, and upper limestone.
		Colina Limestone: 635 ft.	-dark gray to nearly black, medium to thick bedded, crystalline limestone. Color weathers to pale gray.
PENNSYLVANIAN		Earp Limestone: 595 ft.	-extremely varied; lower-dominantly shale with minor sandstone; upper - pink to reddish brown, medium to very thick limestone and dolomite beds.
		Horquilla Limestone: 1100 ft.	-light to dark gray, medium bedded to massive limestone; contains red and green mudstones.
MISSISSIPPIAN		Escabrosa Limestone: 780 ft.	-lower: white to light gray, massive limestone and dolomite. Two chert horizons - dark gray to black chert beds and brown nodules. Sandstone and shale are absent; corals, crinoids, and brachiopods are present.
DEVONIAN		Martin Limestone: 230 ft.	-dark gray to brownish black; chert, limestone, sandstone, and shale. At Tombstone sandstone and shale predominates.
CAMBRIAN		Abrigo Limestone: 844 ft.	-grayish-olive green to dark greenish-gray colors, thin beds of conglomerates. 3 parts: 1. lower shale, limestone, and conglomerates, 2. med. crystalline limestone, 3. upper sandy limestone and quartzite.
		Bolsa Quartzite: 440 ft.	-pale orange on fresh surfaces; light brown on weathering. Thick to very thick bedded medium to very coarse grained, somewhat cross-bedded quartzite.
PRECAMBRIAN		Granite	-pinkish-gray to light-gray, medium grained, biotite granite, with a poorly to moderately well defined gneissoid structure.
		Pinal Schist	-dark greenish-gray to brownish-gray, moderately to well-foliated, fine grained, quartz sericite schist.

MINERALOGY

Memorandum on the Grand Central-
Contention Ore Zone, Tombstone AZ

by Sidney A. Williams
April 21, 1982

General. The Grand Central Contention ore zone has been the most productive one in the Tombstone district, and virtually all ores produced occurred in the uppermost 500 feet of it. The zone is nearly vertical and over 3000 feet long. It is really a series of veins and veinlets generally paralleling a swarm of granodiorite dikes that strike slightly East or North and are en echelon.

Host rocks include gently dipping Bisbee group beds as well as the dikes that cut them. Within shales and quartzites of the Bisbee group ore is most apt to occur in veins, whereas in limy beds replacement type ores may occur. Ore also occurs in veins cutting the dikes as well as in the matrix of brecciated portions of the dikes where they have been disturbed by faulting.

The zone was discovered and first staked in 1878 by Boyer and Williams (Grand Central claim) and quickly followed to the north. In its first ten years it produced $10M, or almost exactly half of the entire production of the district.

Mineralization. There have been two episodes of mineralization. The earlier episode was volumetrically the major one including all of the replacement ores and most of the veins. Base metals (Cu, Pb, Zn) were a major constituent, the ores consisting primarily of galena, sphalerite, and chalcopyrite, often with abundant pyrite. Although the gold content of these ores was negligible, silver was abundant, occurring in tetrahedrite and probably as various species microscopically present in galena.

The younger episode of mineralization occurred in veins and stringers along the Grand Central-Contention zone just as the earlier episode but these ores were especially prone to occur in or close to the dikes. The minerals included tellurides of gold, silver, and perhaps of lead (as well as galena).

Both mineralizing events affected not only major structures, thus producing veins, but occurred disseminated on a myriad of fractures and joints within the Bisbee group beds. Thus, although values were concentrated in larger or more obvious veins, primary values were also dispersed in the wallrocks between them. Recent open pit mining along the zone shows

clearly that in addition to the larger veins mined in the past there are numerous small veins and veinlets, and that between them, sulfides were dispersed in small amount on virtually every joint surface within the Bisbee group rocks.

Oxidation: The role of oxidation has been critical in understanding the distribution of ores in the zone. From the present surface down to the 100-200 foot level (the depth is variable) leaching and oxidation have been severe. Except in the larger structures already mined out, most of the silver has been oxidized and generally carried downward in a continuous process of leaching and redeposition as silver halides (mainly chlorides and bromides). The halides that fix the silver as relatively insoluble ore minerals such as chlorargyrite or embolite have been provided by ground water and rain water that have continuously percolated down through the zone. Gold has behaved similarly but undoubtedly to a much lesser degree so that downward enrichment has been slight.

We know from Rasor's work that only partially oxidized and very rich ores occurred on the 400 level, and historical records indicate that ore grades dropped dramatically just below the 500 level (the current water level was then at about the 600 level). The grade of silver ore, then, should increase downward from the surface, culminating about in the region of the 400 level, for it must be remembered that all silver leached from the surface has been redeposited during its downward descent. As noted already, the gold shows similar behavior but to a much lesser degree, and grade should increase only slightly.

Sampling: Since the major veins have long since been removed, future mining must depend on the smaller veins and veinlets and on the ores disseminated throughout the zone on fracture and joint surfaces. Because of the extensive fracturing and jointing in the Bisbee group rocks they are crumbly, and separate readily on a myriad of surfaces. Because of severe oxidation, the ore minerals on these surfaces are friable and are readily dislodged from them.

Thus the best possible assay is the tenor of ore actually removed by bulk mining. But, as discussed earlier, this represents an absolute minimum value, for the silver removed from the rock already mined has been leached and carried downward. Since we know that the ore zone extends downward another 400-500 feet, how should this block of ground be best

sampled? At the upper surface this is relatively easy. Backhoe trenching can provide bulk samples that accurately reflect ore grade with minimal loss of pulverulent ores on fracture surfaces. For samples below the surface, drifts and crosscuts in the old workings should be rehabilitated and used for channel sampling or even bulk sampling (mined material).

The ore zone is essentially a vertical slab with a "matrix" of low grade ores disseminated on joint surfaces and laced irregularly with small but richer veins. To attempt to sample such a block of ground by a series of vertical rotary or churn drill holes would be prohibitively expensive, and to drill parallel to the plane of the structure is questionable practice. Also, the friable nature of mineralized material would cause some losses, resulting in unreliable samples.

Dr. Sidney A. Williams received his M.S. degree from Michigan Technological University (1957) and his PhD from the University of Arizona (1962). He is a member of the Society of Economic Geologists, the Mineralogical Society of Great Britain, the Japanese Mineralogical Society, and a fellow of the Mineralogical Society of America.

Previous positions include Assistant Professor (Michigan Technological University) 1960-1963; Mineralogist (Silver King Mines) 1963-1965; Director of Exploration Research (Phelps Dodge Corporation) 1965-1982. He is now a private consultant to the minerals exploration industry.

Dr. Williams is the author of some 50 publications, a few of which are noted below:

1. The Tombstone District; Min. Rec. 1980
2. Structural, Petrological, and Mineralogical Controls for the Dos Pobres Ore Body (with J. M. Langton); Univ. Ariz. Press 1982
3. Mineralogy of Arizona (with J. Anthony and R. Bideaux); Univ. Ariz. Press 1977
4. Oxidation of Sulfide ores of the Mildren and Sterre Mines; Econ. Geol. 1963

MINERALS PRESENT IN THE TOMBSTONE MINING DISTRICT

H designates hypogene mineralization

S designates supergene mineralization

Silver minerals	argentite (acanthite) Ag_2S	S
	stromeyerite $Ag_2S.\ Cu_2S$	S
	hessite Ag_2Te	H
	argentojarosite	S
	native silver Ag	S
	cerargyrite AgCl	S
	embolite Ag(Br,Cl)	S
	bromyrite AgBr	S
	argentiferous tetrahedrite	H
	argentiferous galena	H
Gold mineral	native gold Au	
Lead minerals	galena PbS	H
	bournonite $Cu_2S.2PbS.Sb_2S_3$	
	cerrussite $PbCO_3$	
	pyromorphite $9PbO.3P_2O_5.PbCl_2$	
	vanadinite $9PbO.3V_2O_5.PbCl_2$	
	descloizite $4(Pb,Zn)O.V_2O_5.H_2O$	
	mottramite (cuprodescloizite) $Pb(Cu,Zn)OH.(VO_4)_3$	
	anglesite $PbSO_4$	
	wulfenite PbMoO	
	plumbojarosite $PbO.3Fe_2O_3.4SiO_3.6H_2O$	
	bindheimite-hydrous antimonate of lead	
Copper minerals	native copper Cu	
	chalcocite Cu_2S	
	stromeyerite $Ag_2S.CuS$	

	covellite CuS	
	bornite Cu_5FeS_4	
	chalcopyrite $CuFeS$	H
	bournonite $Cu_2S.2PbS.Sb_2S_3$	
	tetrahedrite $5Cu_2S.2(Cu,Fe)S.2Sb_2S_3$	H
	famatinite $3Cu_2S.Sb_2S_5$	
	cuprite Cu_2O	
	tenorite CuO	
	malachite $CuCO_3.Cu(OH)_2$	
	azurite $2CuCO_3.Cu(OH)_2$	
	rosasite $(Cu,Zn)CO_3.(Cu,Zn)OH_2$	
	aurichalcite $2(Zn,Cu)CO_3.3(Zn,Cu)OH_2$	
	chrysocolla $CuSiO_3.2H_2O$	
	connellite $CuSO_4.2CuCl_2.19Cu(OH)_2.H_2O$	
	brochantite $CuSO_4.3Cu(OH)_2$	
	beaverite $CuO.PbO.Fe_2O_3.2SO_3.4H_2O$	
Manganese minerals	alabandite MnS	H
	hataerolite $ZnO.Mn_2O_3$	
	polianite MnO_2	
	pyrolusite MnO_2	
	manganite $Mn_2O_3.H_2O$	S
	psilomelane H_4MnO_5	
	rhodochrosite $MnCO_3$	
	"black" calcite contains minute Mn oxides	
Zinc minerals	sphalerite ZnS	H
	smithsonite $ZnCO_3$	
	hydrozincite $ZnCO_3.2Zn(OH)_2$	
	rosasite $(Cu,Zn)CO_3.(Cu,Zn)(OH)_2$	
	aurichalcite $2(Zn,Cu)CO_3.3(Zn,Cu)(OH)_2$	
	calamine (hemimorphite) $2ZnO.SiO_2.H_2O$	

GLOSSARY OF TERMS

Adit - a nearly horizontal passage from the surface by which a mine is entered and unwatered. In the U.S., an adit is usually called a tunnel, though the latter, strictly speaking, passes entirely through a hill and is open at both ends. frequently called "drift" or "adit" level.

Agglomerated ore - fine material clustered into larger particles for more efficient processing.

Alloy - a metal which is composed of two or more elements. In the process of alloying, intentional additions are made to improve the properties.

Alluvial - deposited by a stream.

Alteration - change in the mineral composition of a rock typically brought about by the action of hot water solutions.

Amenability - characteristic reaction of minerals to basic methods of mineral processing.

Anticline - a fold that is convex upward

Assay - to determine the amount of metal contained in an ore.

Back - the roof of an underground room or opening.

Bed - layer in a body of sedimentary rock stratum.

Bedrock - general term for the rock that underlies soil or gravel.

Beneficiation - treatment of crude ore to improve its quality for some specific purpose.

Breccia - rock consisting of angular fragments in a matrix of finger-grained material.

Composite Heap - material leached and dumped by previous operators, still containing recoverable precious metal values.

Concentrate - the valuable mineral separated from ore undergoing a specific treatment.

Cone Crusher - a machine for reducing the size of ore by means of a truncated cone revolving on its vertical axis within an outer chamber; the annular space between the outer chamber and cone being tapered.

Contact - bounding surface between two rock units

Core Drilling or Diamond Drilling - a drilling technique that produces a cylinder of rock utilizing a hollow diamond-studded drill bit.

Cross-cut - a horizontal opening driven across the direction of the main workings; a connection between two drifts, tunnels, or levels.

Development Work - work undertaken in order to open up orebodies as distinguished from the work of actual ore extraction.

Dip - the angle between a horizontal plane and the plane of the ore shot or vein, measured at right angles to the strike.

Disseminated Ore - ore in which the valuable mineral is fairly evenly distributed throughout the rock.

Drift - an underground passage, like a tunnel (but usually without portals) extending horizontally in the same direction as the long horizontal dimension of a vein. Such passages are driven and the work is called drifting, as in "drifting on the vein."

Exploration - the act of work involved in searching for ore.

Extrusive Rock - Igneous rock derived from magma that flowed at the earth's surface. Lava.

Face - in any adit, tunnel, or drift, the end at which work is progressing or was last done.

Fault - a break in a body of rock where one block moves relative to the other.

Fines - the particles of ore below a given size or mesh (undersize), as contrasted with the coarser particles.

Fire assay - the assaying of metallic ores by methods requiring furnace heat.

Fissure Vein - a crack (not necessarily a fault) in the earth's crust which has been mineralized. Open spaces not filled with minerals are called vugs.

Grade - percentage of a metal or mineral composition.

Grizzly - Apparatus used for scalping oversized material before it goes to crusher.

Horizon - Any of the distinct beds in a vertical section of land.

Igneous Rocks - rocks that are consolidated from a molten state.

Incline - an elevation or horizon in a mine which is developed for purposes of working the mine.

Leaching - the process of extracting precious metal values in solution form from ore.

Limestone - a sedimentary rock consisting mainly of calcium carbonate (the mineral calcite).

Lode - a vein or fissure in the rock filled with mineral.

Massive Sulfide - a term applied to a body of rock consisting entirely or almost entirely of sulfide minerals.

Merrill Crowe process - removal of gold and silver from pregnant cyanide solution by deoxygenization followed by precipitation on zinc dust.

Metamorphosed or Metamorphic Rocks - rocks changed by heat, pressure and other agencies, from one form to another, namely: limestone to marble; sandstone to quartzite; shale to slate; sandy shale to graywacke; most of these are further changed to various schists.

Mill - includes any ore mill, sampling works, concentrator, and any crushing, grinding or screening plant used in mining operations.

Mineral - an inorganic substance occurring in nature which has (1) a fairly definite chemical composition, and (2) distinctive physical properties or molecular structure. Most minerals are crystalline.

Gold or silver may occur in nature in the metal form or in a number of minerals. Gold typically occurs as native gold, gold-bearing pyrite (iron sulfide), gold-bearing arsenopyrite (arsenic-iron sulfide), or gold bearing oxides such as hematite and limonite.

Silver typically occurs as silver sulfide or silver chloride minerals as well as native silver. Among the more common silver minerals are: argentite (silver sulfide), cerargyrite (silver chloride), proustite (silver-arsenic-sulfide), pyrargyrite (silver-antimony sulfide), and tetrahedrite (a complex copper-silver mineral with sulphur). Silver commonly occurs with galena (lead sulfide), and in some places with sphalerite (zinc sulfide).

Ore - a material from which minerals and metals of economic value can be extracted at the present time.

Ore Mineral - the part of an ore, usually metallic, which is economically desirable.

Orebody - a continuous, well-defined mass of material of sufficient ore content to make extraction economically feasible.

Outcrop - surface exposure or rocks or vein.

Overburden - clay, sand boulder clay, and other unconsolidated materials over-lying bedrock.

Oxidation - the lateration of rock by weathering and the action of surface waters, with the result that sulfide minerals are converted into oxide, carbonate, or sulfate compounds or minerals.

Percussion Drilling - a drilling technique that uses an air powered percussion bit to produce drill cuttings or rock chips.

Placer - deposit of gold or other metal-bearing alluvial gravel.

Porphyry - any igneous rock with larger crystals in a finger-grained groundmass.

Precipitates - concentrates of silver, gold, zinc, diatomaceous earth, suitable for smelting and refining.

Primary Rock Minerals - those originally present in the rock, not introduced or formed by alteration or metomorphism.

Quartzite - a sedimentary or metamorphosed sedimentary rock consisting primarily of fine- to medium-sized quartz grains.

Raise - a vertical or inclined opening driven upward.

Reverse Circulation - a rotary drilling technique whereby the inside of the drill pipe is used to carry cuttings to the surface.

Rotary Drilling - the process of drilling which consists of rotating a column of drill pipe with a bit attached to the bottom. Drilling mud is pumped down through the pipe and carries cuttings (rock chips) to the surface outside the pipe.

Shaft - an opening, more or less perpendicular, sunk into the ground from the surface.

Shale - a laminated sedimentary rock in which the particles are mostly very fine-grained (clay-sized).

Shoot - Ore Shoot - that part of a deposit in which the valuable minerals are so concentrated that their extraction is commercially profitable.

Silicate - minerals containing silica, such as quartz, etc.

Sill - a body of rock similar to a dike but injected parallel to the layers of older rock.

Slag - the material left after the precious metals have been smelted from the precipitates.

Smelting - the reduction of a metal from a precipitate generally accomplished by heat.

Stope - an underground opening where the ore is broken and removed.

Strike - the bearing of a horizontal line in the plane of bed, vein or fault.

Stringer - a veinlet or small vein.

Stripping Ratio - the ratio of tons overburden to tons ore in an open-pit deposit.

Sulfide - a compound of sulfur and one or more elements. The term is usually limited to sulfides of metals.

Tailings - the resultant material from ore that has been leached for precious metal values.

Tunnel - a tunnel, strictly speaking, is a horizontal underground passage open at both ends.

Vein - a sheet-like body of mineralized rock that has filled a fracture or crack in the country rock. A typical vein consists of quartz together with lesser amounts of valuable metals concentrated in ore shoots randomly distributed in the vein.

Wall Rock - the rock enclosing a vein.

Wet Assay - the determination of the quality of a desired constituent in ores, metallurgical residues and alloys by the use of the process of solution, floatation or other liquid means.

T O M B S T O N E E X P L O R A T I O N , I N C .

INTRODUCTION TO THE RANDOL INTERNATIONAL, LTD. REPORT ON TOMBSTONE EXPLORATION, INC.

Randol International, Ltd. is an independant mineral economics consulting firm specialising in extractive metallurgical evaluations.

The president of Randol International, Dr. Hans von Michaelis, compiled the report on TEI. He has a broad background in chemistry and geochemistry with a metallurgical bias, and has consulting experience in the mineral industries on four continents.

Randol International's most recent major work has been a survey of the free world's silver and gold mining industries; the six volumes include information on innovative processes, concepts, and equipment, and define metallurgical frontiers that have significant effect on the silver and gold industries. Also included are over 1,000 industry contact addresses and several thousand literary references.

The Randol investigation into Innovations in Gold and Silver Recovery was sponsored by about 80 mining and engineering companies including nearly all the leading companies in this industry.

TOMBSTONE EXPLORATION INC

Summary Report

by

Randol International Limited
7510 West Mississippi Avenue
Suite 210
Lakewood, Colorado 80226

20 March, 1982.

INTRODUCTION

At the request of Mr. Tom Schloss, President of Tombstone Exploration Inc., Randol International Ltd. has undertaken this summary review of the silver recovery operations at Tombstone Exploration Inc.'s open cast silver and gold mining operation at Tombstone, Arizona.

This report is written on the basis of information gathered during a two hour visit to the property during May, 1981 during which data was collected for the Randol multi-client investigation on 'Innovations in Gold and Silver Recovery.' This was followed up by a visit for discussions with Mr. Tom Schloss in the New York offices of Tombstone Exploration Inc. and a further half day visit to the mine and plantsite on Thursday, February 18, 1982.

All information summarised in this report was provided by employees of Tombstone Exploration Inc. (TEI) and has not been quantitatively audited by Randol International Ltd. The helpful assistance of TEI employees, particularly Dustin L. Escapule Vice President and General Manager, is acknowledged. The objectives set for this assignment are as follows:

- To review the metallurgical process and procedure applied at TEI with a view to assessing the overall economics and efficiency of the metallurgical extraction process employed.
- To review the many innovations employed by TEI in the recovery process.
- To review the overall caliber of the operations, to comment on the degree of competence of the management team and the management philosophy employed at TEI.

This investigation specifically avoids the critical issue of general geology of the area as well as any assessment of ore reserves either proven, probable or potential on TEI claims as these will be independently assessed by other consultants.

It should also be noted that Randol International Ltd. has not received any remuneration from TEI other than for minor travel and accommodation expenses associated with the second visit. TEI is a Sponsor of the Randol multi-client investigation into Innovations in Gold and Silver Recovery. Randol International accepts no responsibility for any inaccuracies that may inadvertantly be included in this report.

CONCLUSIONS

1. From a metallurgical point of view Tombstone Exploration Inc. is a very fine operation with competent and innovative management appropriate for an operation of this size.
2. Several innovations employed at TEI have enabled recoveries to be significantly improved over earlier operations at the site. These innovations make this operation one of the most efficient of its kind in the world.

The innovations employed by TEI are specifically described below, and most of the innovations and experience at TEI could be applied to advantage at similar operations elsewhere.

3. One particularly noteworthy aspect of the TEI operation is the elegant simplicity of most of the innovations and the operation. There are no unnecessary frills or mechanical complexities that cannot be readily optimised or easily maintained on site. Wherever possible low maintenance items have been selected.

4. The TEI operation at Tombstone, Arizona is a medium scale operation at 2,000 short tons per day. The company is operated in a practical fashion with a management structure that enables rapid decisionmaking and maximum flexibility. The operation is however large enough to justify the necessary facilities and services required for a high class operation. That is, it is large enough to be able to avoid Heath-Robinson or makeshift methods or equipment.

5. The heap leaching process as practised at TEI can readily be applied on a larger scale, and the operation could easily be expanded if additional ore reserves were to be proven. The heap leaching process is applicable to oxidised ores such as those encountered thus far in the surface ores at TEI. As deeper ores are mined recoveries may be influenced if unoxidised sulfides are encountered. This applies both to ores recovered from the surface mining operation as the pit deepens as well as to ores from reopened underground workings.

6. Grades of surface ore currently being mined runs 1.5 oz Ag/st and 0.03-0.04 oz Au/st are relatively low. Heap leaching is the only process that would be applicable for the recovery of values from ores with this grade.

7. Gold and silver recoveries of 60-70% of the silver and 85% of the gold values are considered good for this type of ore and process.

8. After agglomerated ore has been leached at TEI, it is lifted from the pad and placed on the tailings heap where it is subjected to a second leaching process. This makes it possible to 'have a second bite at the cherry.' On the tailings heap there will be a different solution channel pattern which will make some of the ore that was not wetted on the primary heaps accessible to leaching.

9. Based on ore grades and recoveries and current metal prices of $7.25/oz for silver and $325/oz for gold, the recoverable values are $7.31/st for silver and $8.29 - 11.55/st for gold and $15.60-$18.86/st ore total. Although generally recognized as a silver district the gold:silver ratio of heap leachable ores at TEI has been steadily increasing and the point has now been reached where gold has become the primary product.

10. TEI uses a trenching technique to sample ore which is then mined in benches. Ore from each bench is crushed and agglomerated for heap leaching on the primary pad.

Wasterock is separated into low grade protore which is stockpiled and barren wasterock which is discarded to a wasterock pile. In this way a low grade resource is accumulating which can easily be reclaimed when justified by higher gold and silver prices.

TOMBSTONE EXPLORATION INC.

INNOVATIONS

Several innovations were observed at the Tombstone Explopration Inc. operation which are summarised below:

1. Trenching and channel sampling of the ore zones provides a better indication of ore grades than has been found using drilling.

2. The innovative crusher & screening circuit is designed to require a minimum of operators and the crushing operation has now been innovatively integrated with the agglomeration step.

3. A recently installed magnetic scalper on the crusher circuit conveyor belt has resulted in an improved operational availability of the crushing circuit.

4. The effective fine ore agglomeration step is low cost to operate and greatly enhances recovery by heap leaching.

5. Leaching in two stages firstly on the primary pad followed by intermittant leaching on the tailings heap provides a means of getting 'two bites at the cherry.'

6. The prudent use of small inventory settling ponds for preg solutions recovered from the leaching heaps provides a means of preclarifying the pregnant solution before it is fed to the recovery plant.

7. The application of off the shelf modular Merrill-Crowe zinc precipitation units reduces capital cost of the metallurgical plant and by using multiple units the plant has a very flexible capacity and an excellent operational availability.

8. The design of the metallurgical plant layout, despite the low capital cost is nevertheless designed for optimum security.

9. Continuous solution sampling devices make it possible to measure the precious metals in the pregnant and barrens solutions and make it possible to implement an operator incentive program based on the plant throughput and metal losses in the barrens.

10. TEI have designed and installed a low capital cost but very effective precipitate drying oven.

11. Valves which can be expensive and cause downtime due to mechanical failure have been replaced by extremely rudimentary three way gate valves of home design which are not only easy to build but also very easy to operate.

12. TEI have adapted a most elegant method for sampling dore bars during the smelting step. This technique was borrowed from the steel industry.

13. By charging dried precipitate to the crucible furnace in preweighed paper bags the smelting process is simplified. This simple step makes it possible to keep the smelter room much cleaner and reduce airborne losses of precipitate.

14. The remote controled tilting furnaces are designed for maximum operator safety and operator convenience and comfort. It is possible to operate this smelting step cleanly and efficiently because the operator can keep cool.

15. TEI have developed a mini-computor process control system for their heap leaching process which once perfected will make it possible to greatly improve the day to day control and efficiency of the process.

TOMBSTONE EXPLORATION INC.

ADVANTAGES

Tombstone Exploration Inc., despite the fact that the ore is relatively low grade, is blessed with several advantages which have an impact on both the operating and capital cost of the plant:

- Warm,arid climate permitting year-round outdoor operations.
- The relatively clean ore is claimed to be low in base metals and other cyanicides or species that would render the ore refractory.
- Excellent existing infrastructure due to location in the outskirts of the small town of Tombstone.
- Adequate local labor pool residing in the vicinity.
- Very favorable contract for mining ore and overburden at an excellent contract price.
- Soft oxidized ore which requires virtually no blasting.
- Available coliche material from which to build the leaching pads.
- Suitable topography and available land on which to build the leaching pade and the tailings and waste piles.
- Very creative and experienced local management and staff leadership.
- Because the ore contains both gold and silver there is some diversification of products.

MINE

TOMBSTONE EXPLORATION INC.
P.O. Box 610
Tombstone, AZ 85638

TELEPHONE

(602) 457-2231

CONTACT

Dustin L. Escapule, General Manager & Vice President
A. Joe Graves, Mine Superintendent

HEAD OFFICE

TOMBSTONE EXPLORATION INC.
17 E. 76 Street
New York City, NY 10022

TELEPHONE

(212) 628-8466

CONTACT

Tom Schloss, President

LOCATION

On the outskirts of the historic silver mining town of Tombstone, Arizona.

CLIMATE

Located at about 3,000 ft altitude in southern Arizona, Tombstone Exploration Inc. is located in a hot arid climate tempered to some extent by altitude. The climate is ideal for the operation of a heap leaching plant as problems with freezing in winter are altogether avoided. Other problems avoided are the crushing problems that can arise when wet ore is crushed .

Very occasionally storms may be anticipated which result in short periods of very high rainfall which could temporarily upset the water balance of the plant, but such occurrences are likely to be very infrequent and not disasterous to the operation.

HISTORY

The history of this property is described by McQuiston and Shoemaker (1980) under the title of 71 MINERALS LTD which closed down in 1978. 71 MINERALS LTD. processed several million tons of wasterock from earlier deep vein mining operations in the area with typical grades of 1.0 oz/st silver and around 0.01 - 0.02 oz gold per short ton.

TEI now control about four square miles in the Tombstone district covering numerous small underground workings. TEI own 87 patented claims which is about 80% of the total number of patented claims in the area and in addition control a further 18 unpatented claims.

A map of the claims and known underground workings in the area shows an extensive area from which high grade veins were mined in earlier times, and implies that a significant tonnage of lowgrade ore backfill and ore that was below the earlier mining cutoff grades could have been left underground.

ORE TYPE

TEI have delineated an area reaching from the surface to an as yet untested depth which is mineralised in fissures in the Bisbee Formation along three porphyry andesite dikes which have intruded into sandstone, quartzite, shales and limestone.

A known granodiorite intrusion is located 1-2 miles away but no mineralisation is directly associated with it. The geology of the area has been described by Ransome of the USBM first in the 1890's and later in 1926, and more recently by Butler in the 1930's and by Blake.

Ore currently being mined appears to be completely oxidized and the actual mineral species in which the gold and silver occurs was not discussed.

SAMPLING

The orebody is delineated and sampled by trenching at roughly 20ft intervals across the E-W trending ore zone, to a depth of 6 ft using a Cat 225 excavator that belongs to TEI and is operated by TEI employees. Channel samples are taken at 6' intervals along the walls of the trenches which are assayed. This technique is found to be more reliable than drilling which is the more commonly practised technique observed on other projects.

CAPACITY

2000 st per day ore is mined and prepared for leaching 5 days per week.

STRIP RATIO

About 4:1

MINING

All mining is carried out by a subcontractor, namely Magini Leasing and Contracting. The contracted price is $0.74 per cubic yard which works out to about $0.50 per short ton of rock moved. The contract covers mining and moving rock as appropriate to the plant crusher, to the low grade stockpile or to the waste rock dump. The ore is friable and usually does not require blasting. When necessary, however, the contractor also is responsible for blasting which is charged at the rate of $2.84 per blasthole foot drilled.

Mining equipment employed by the contractor includes:

Seven Cat 631G Scrapers
Three Cat DG9 Dozers

GRADE

About 1.5 oz Ag per short ton and 0.03-0.04 oz Au per short ton.

PROCESS SUMMARY

Mine, Crush, agglomerate with lime and cyanide, cure, stack heaps, leach with sprinkler irrigated solution, clarify, de-aerate, zinc precipitation, vacuum dewatering of precipitate, dry precipitate in oven, smelting to Dore.

CRUSHING

The crusher system was supplied by Kolberg Manufacturing Corporation of Yankton, South Dakota. It consists of a two stage crushing and screening plant.

Ore is dumped onto a vibrating feeder and screened across a vibrating grizzly. +2½" material is fed to a Cedar Rapids jaw crusher rated at 150 tph at -5/8". More recently the crusher has been set to give a product that is -3/4" and throughput has been increased to 240 tph. Operating at two shifts per day over a five day week, an average production rate of 2400-2500 st per day can be achieved.

The -2½" screen fraction is passed over a shaking screen with two decks (1½" and 3/4" apertures) in closed circuit with an ELJAY 54"Ø cone crusher set to crush at -3/4". Minus 3/4" crushed ore is stacked on a fine ore stockpile with a live bottom.

Recent improvements in the crusher circuit include the insertion of a magnetic scalper which removes considerable amounts of tramp steel including old iron tools from the earlier underground workings. Lime is added to the crushed ore directly onto the conveyor feeding the crushed ore stockpile. A new centrally located crusher control room is under construction from which the whole crushing and agglomeration operation can be observed. This is expected to make it possible to eliminate one of the crusher operators.

ACGLOMERATION

The crushed ore stockpile feeds a belt by gravity via a gate that is pneumatically controled from the control room. About 10% of the crushed ore is minus 100# (150 microns). 35-40% is minus ¼". Agglomeration is considered necessary to achieve adequate permeability of the heaps and has been found to result is a significant improvement in gold and silver recoveries.

Crushed ore with lime already added at the end of the crushing circuit is agglomerated on a sloping 48" wide conveyor belt which runs uphill against the flow of the material which rolls down the conveyor which being sprayed with cyanide solution. In this fashion fine particles attach themselves to the larger ones.

10 lbs lime and a total of one pound of sodium cyanide per ton of ore are added. The cyanide is added by spraying as a solution with a concentration of 30 pounds of NaCN per ton.

After agglomeration the ore is stacked in a heap on the ground and allowed to cure for at least 24 hours.

The agglomeration belt at TEI functions very well and appears to be relatively simple to operate and to control. TEI offers this system to others together with their knowhow for around $100,000.

PAD CONSTRUCTION

Leach pads are constructed from a naturally occurring coliche material that is available on the property, augmented by old mill tailings from earlier mining operations. The pads are constructed from 2' thick compacted material built up in 3-4" layers with 10-12% moisture content.

TEI property includes a considerable area of generally flat terrain that is suitable for the primary leaching pads.

A second pad also constructed of 2' thick coliche in 2-3" compacted layers has been constructed on which the tailings from the primary leaching pads are deposited in a very large heap. This provides a second leaching process applied to the same ore but this time in a heap with a new solution channel pattern and a much longer residence time

Pads are constructed using a Gallion T600 motor grader, a front end loader and a pneumatic compactor which is similar in appearance to the regular sheepsfoot compactor..

HEAPS

Heaps of cured agglomerated ore are stacked to heights varying between 10-12' on the primary leaching heaps. There are five primary leaching heaps that are rotated. Each is leached for four days before being lifted and dumped on the tailings heap which serves as a secondary leaching heap.

TEI owned equipment used for heap construction includes:

One International 400 12yd^3 loader
One International 560 6yd^3 loader
One International 350B Payhauler dumptruck
One Euclid R50 dumptruck.

HEAP CONSTRUCTION

Heaps are constructed using TEI owned and operated equipment.

SOLUTION APPLICATION

Solution is applied through Nelson Beta 45 sprinkler heads on a 10ft spacing along solution feeder lines.

1200 short tons per day of solution is applied to one of the primary leaching heaps containing 7000 st ore. Based on a 12' heap height and 100 lbs per ft^3 bulk density, the area occupied by each primary heap would be about 12,000 ft^2. This works out to 0.23 US gallons per square foot per minute assuming that the full 1200 st of solution is applied to only one primary leaching heap.

If 1200 st of solution is applied to 7000 st ore for 4 days this implies that 0.68 st of pregnant solution is recovered for each ton of ore treated in the primary leaching pad. Of course there will be some reduction in the volume of solution recovered on account of evaporation.

The much smaller rate of solution application on the larger tailings heaps also generates additional solutions containing gold and silver. These solutions are irrigated over only a small part of the heap at a time and the solutions are recirculated to bring the grades up. This pump recirculates 350 US gpm.

WATER SUPPLY

TEI water is supplied by two wells. One is in an old mineshaft and the second is located near the metallurgical plant. In the old underground workings excess water was one of the problems faced in earlier years which required special pumps, consequently it is implied that despite the arid climate at Tombstone, water supply is not likely to be a problem.

MANPOWER

The TEI operation is located in the town of Tombstone where it appears to be the largest employer. Apart from tourism and one or two smaller mines in the area there does not appear to be much other industry in the area. Southern Arizona offers a pleasant living environment and consequently TEI claims that they have little difficulty attracting manpower with an adequate aptitude for this type of operation.

The Vice President and General Manager in charge of the operation Mr. Dustin L.Escapule is clearly well organised, innovative, capable and able to control his workforce.

Mining costs are very low because of the contract arrangement which is very favorable indeed. Currently while capital spending and construction is in a severe recession in other sectors of the economy, it would appear that favorable contract terms will continue to be achieved. The viability of such a favorable contract when the rest of the economy improves might require some thought.

A schedule of TEI employees was not provided, but judging by the general appearance of the operation it is clear that TEI is neither overstaffed nor understaffed. The crushing and agglomerating station is operated in a way that requires a very small number of operators and this is being further streamlined. The Metallurgical plant is operated by one operator with one helper which is very labor efficient.

CYANIDE CONSUMPTION

1.8 lbs NaCN per ton of ore maximum. Cyanide costs $0.60 per lb delivered in 20 ton lots to Tombstone.

LIME ADDITION

A maximum of 10 lb lime is added per ton ore on the stacker belt ahead of agglomeration. By February 1982 the lime consumption had been cut back to 5 lbs per ton ore.

Lime purchased as $Ca(OH)_2$ costs $0.01 per lb.

POWER SUPPLY

TEI is located literally in the town of Tombstone and is served by utility power. A standby diesel generator is however installed in case there ever is a power failure. This generator is seldom if ever used and corrosion caused by rain entering the vertical exhaust pipe during infrequent desert storms might be a problem were it not for a very simple solution to the problem developed by TEI.

SCALING

TEI experiences a scaling problem both on sprinklers and in the plastic pipes used to convey solutions. Baroid S35 is used to inhibit scaling to some degree and appears to keep the problem under control. The anti-scaling reagent is added into the preg pond.

It is found that when the weather is hot (60° water), there is less of a tendency for scale formation. Below 40°F, however, scaling becomes more serious.

DUST CONTROL

Since Tombstone Exploration Inc. is within the city limits careful dust control is excercised by applying water through a hose spray from a tank truck.

METALLURGICAL PLANT

The metallurgical silver and gold recovery plant is simple and compact. 1200st per day of pregnant solution is processed through four State of Maine clarification and zinc precipitation modules each rated at 300 stpd. These units are each rated at 50 USgpm, but were operating at 55-60 USgpm at the time of the Februrary 1982 visit.

Solution feed lines to the plant are PVC schedule 40 pipe.

ZINC PRECIPITATION

Tombstone Exploration Inc has installed four State of Maine Mining units for clarification of pregnant liquor, de-aeration, and zinc precipitation. Each of these innovative units is rated at 300 st per day solution and cost $20,000 each.

When one of the Merrill-Crowe modules is filled to capacity, Zinc precipitated silver and gold is backflushed from the State of Maine modules to a series of filters located inside the security zone of the plant which is separated by a locked door. Outside the security area the zinc precipitate is not handled directly by any operator.

The complete metallurgical plant is operated by one operator and one helper whose main functions are to watch for pressure buildup in the filters as a signal for the need to recycle the filters and add fresh precoat after dumping the contents of the precipitate filters.

BARRENS

The plant operates on an employee incentive basis with a bonus paid for extra throughput and penalties for high barrens exceeding 0.5oz Ag per st solution. Average barrens are 0.01-0.02 oz Ag per st solution. Gold barrens are said to be much lower than this but were not specified.

SAMPLING

Barrens are sampled hourly. There is a further automatic sampler which collects a one gallon sample of barrens solution over each 8 hour shift. This latter composite sample is used to monitor the operator performance. The automatic sampler is locked and the operator has no access to it.

SMELTING

Zinc precipitated silver and gold are backflushed from the State of Maine zinc precipitation units in the metallurgical plant and pumped to a row of filters in the secure room at one end of the plant. When these filters are filled the contents are dumped into a long trough shaped vacuum pan filter and dewatered to about 30% moisture by applying vacuum. After dewatering, the precipitate which contains some silica added as precoat, is scooped out of the pan filter into steel pans made from steel oil drum ends, and placed into a homebuilt drying oven heated by the heating elements from a household cooking stovetop. The drying oven is made from steel sheet and is insulated. After drying for several hours at about 120°F the dry precipitate is carefully removed from the oven trays and placed into paper bags.

Dry precipitate in preweighed paper bags which prevent airborne losses is next taken to the smelter building which is kept separate from the other buildings for security reasons.

The dried silver-gold precipitate mixed with flux in the paper bags is charged into the gas fired crucible furnace. By loading the precipitate in this way TEI avoids airblown losses which would occur if precipitate were to be hand charged directly into the hot furnace using a shovel. The furnaces have been designed so that they can be tipped mechanically by remote control by one operator from behind a heat shielded glass screen. The conical molds into which the slag and metal contents of the furnace are poured are mounted on rails for easy handling, and maximum operator safety. The smelter area is fitted with a powerful extractor fan to withdraw any unwanted fumes.

TEI employ a very clean glass tube sampling device as a means of drawing a sample of hot silver from below the slag level in the mold. This is a much cleaner, faster and more reliable method of drawing a sample than the older technique of drilling into the final dore bar.

MAINTENANCE

2-4 full time maintenance workers are employed in the TEI workshops. Major repair jobs are contracted out. The mining equipment is maintained by the contractors on site using their own maintenance shop.

ASSAY FACILITIES

AA - Perkin Elmer 290
Fire Assay
Test Leaching - Lab scale bucket tests.

LEACH RECOVERY TEST

Tombstone Exploration Inc. carries out leaching tests regularly on a laboratory scale. A split down crushed sample of ore is drawn to fill a 5 gallon plastic bucket with perforated lid and bottom. The bucket with ore in it is placed in a plastic trough and a standard volume of cyanide solution added to the bath. Solution is recirculated to the top of the perforated lid of the bucket by a small submerged pump.

Pregnant solutions recirculated in this way are analysed by AA to determine the percentage of the gold and silver values that can be leached. Such tests are found to provide a good comparative measure of the leachability of one ore zone to the next. The procedure is simple and inexpensive and can be performed on several samples at once.

It was pointed out that the plastic evaporative cooler pump made by American Excelsior Company which is available in most hardware stores works very well for the purpose of recirculating solutions. TEI point out that pumps with brass shafts must be avoided for this application.

In other operations it was noted that a small carbon column was inserted in the recirculating solution circuit to remove gold and silver from the solution before re-applying it to the column. It is believed that in the absence of this measure, the results obtained by the TEI test may underestimate the leach recoveries obtainable in practice.

SECURITY

Tombstone Exploration employs several levels of security precautions. Firstly, a security guard screens and records details of each person entering or leaving the premises.

Secondly, in the metallurgical plant the operator and helper have no access to zinc precipitate which is backflushed directly from the filters into a secure area which is locked except when a responsible official is present during the recovery of precipitate.

The precipitate is dried and bagged in the secure area where at most one or two employees have any access to it. Bagged precipitate is added to the smelting furnace thereby avoiding further direct handling.

The smelter building is in a separate fenced in building in sight of the security guard.

Full details of the security system were not revealed to Randol International Ltd and are known to a very limited number of people which in itself is an added safety measure.

OPERATING COSTS

Operating costs were not fully disclosed during the brief visits. However, based on the following assumptions the direct operating costs per short ton of ore appear to be in the range of $9-$10.00

	Per Day (5 days/week)
Supervision & Management 3 men @ $150/d	450.00
Operators & Labor: 42 men $ 75/d	3,150.00
Contract Mining Costs 2,000st/d ore 8,000st/d protore & waste 10,000st/d total @ $0.50/st	5,000.00
Crushing, Agglomeration, Heap & Pad constr. 2,000st/d ore @ $1.50/st	3,000.00
Tails pile constr. & management 2,000st.d @ $0.50/st	1,000.00
Metallurgical Costs:	
NaCN 2,000st/d x 1.8lbs x $0.60	2,160.00
Lime 2,000st/d x 10 lbs x $0.01	200.00
Zinc guestimate	500.00
Precoat guestimate	200.00
Fluxes, crucibles etc	100.00
Power Costs guestimate (Crushing, Pumps,etc)	1,000.00
Maintenance Supplies	500.00
Diesel Costs : Included in cost of heaps etc.	
Laboratory & Office Supplies, Telephone etc. guesst.	300.00
TOTAL for 2,000 st/day ore	$17.560.00

Based on the above hypothetical cost structure the direct cost per ton of ore treated would be $8.78 /st. Additional costs would be incurred for taxes, insurances and claim fees, as weel as any royalties payable. This together with contingencies would bring total direct costs to the $9.00-10.00 per ton range.

MANPOWER ESTIMATE

The above cost estimate assumed 42 employees which was derived as follows:

Trenching & Sampling	2 men
Laboratory	2
Geologist	1
Mine Supervision	2
Maintenance	4
Metallurgical Plant 2 x 3 shifts	6
Heap supervision & operation	2
Heap construction	4
Tailings Pile construction	4
Leachpad construction	2
Watertruck operators	2
Refinery & Smelting	2
General Labour	1
Supplies	1
Accounts	2
Clerical	2
Security (1 per shift)	3
TOTAL	42

Note: The Operating cost estimate and the Manpower Estimate are a best efforts guestimate by Randol International Ltd. and can be used to gain an order of magnitude estimate of costs only. These numbers are subject to correction by Tombstone Exploration Inc. who can provide actual data.