CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
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Phoenix, AZ 85007
602-771-1601
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Arizona Department of Mines and Mineral Resources Mining Collection

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PRINTED: 05/30/2002

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES AZMILS DATA

PRIMARY NAME: PINTO VALLEY MINE

ALTERNATE NAMES:
CONTINENTAL GROUP
CASTLE DOME PROPERTY
MAGMA PINTO VALLEY MINE
BHP PINTO VALLEY MINE
BROKEN HILL PRPRIETARY PINTO V

GILA COUNTY MILS NUMBER: 140C

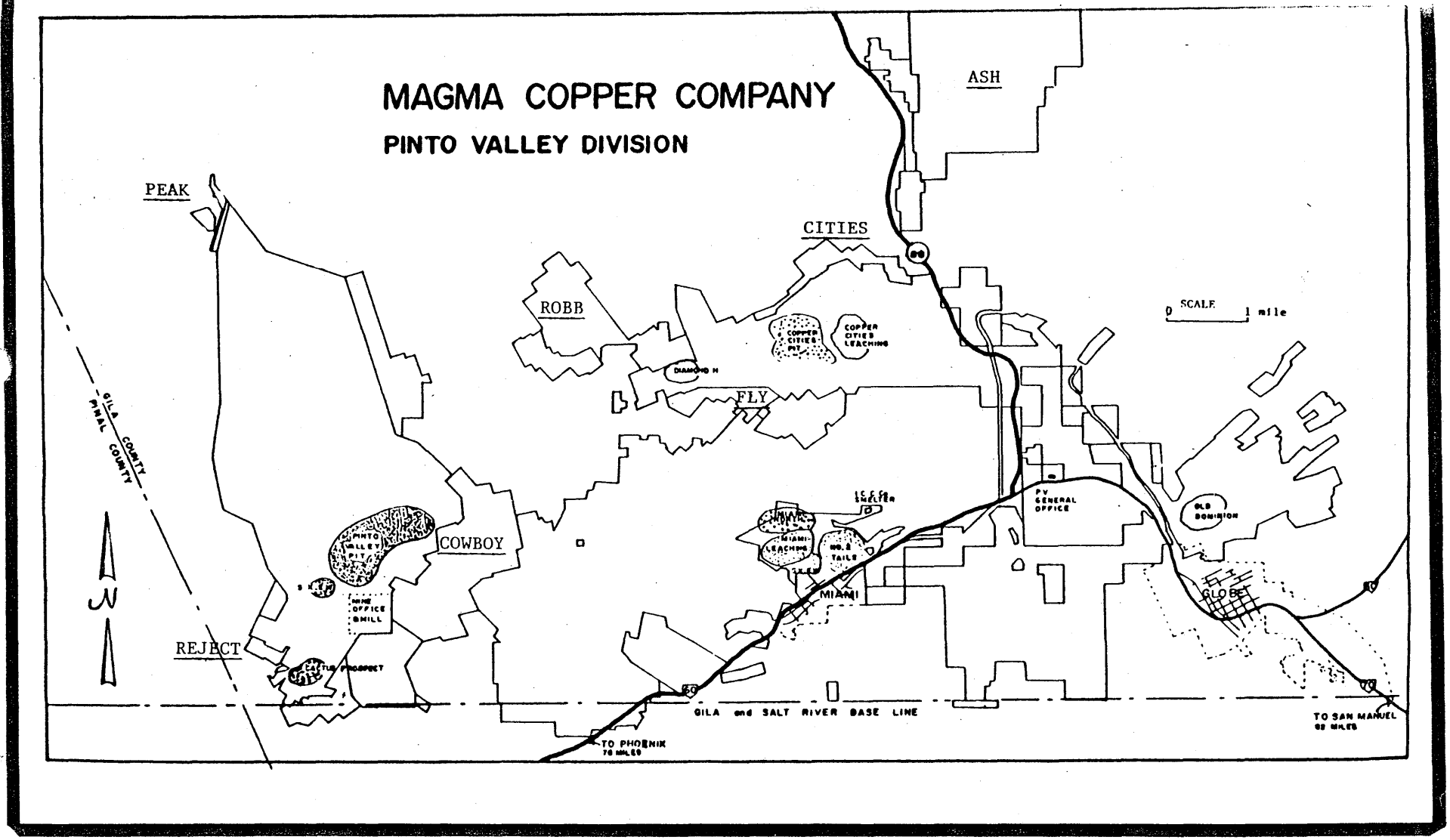
LOCATION: TOWNSHIP 1 N RANGE 14 E SECTION 20 QUARTER W2
LATITUDE: N 33DEG 24MIN 40SEC LONGITUDE: W 110DEG 57MIN 20SEC
TOPO MAP NAME: INSPIRATION - 7.5 MIN

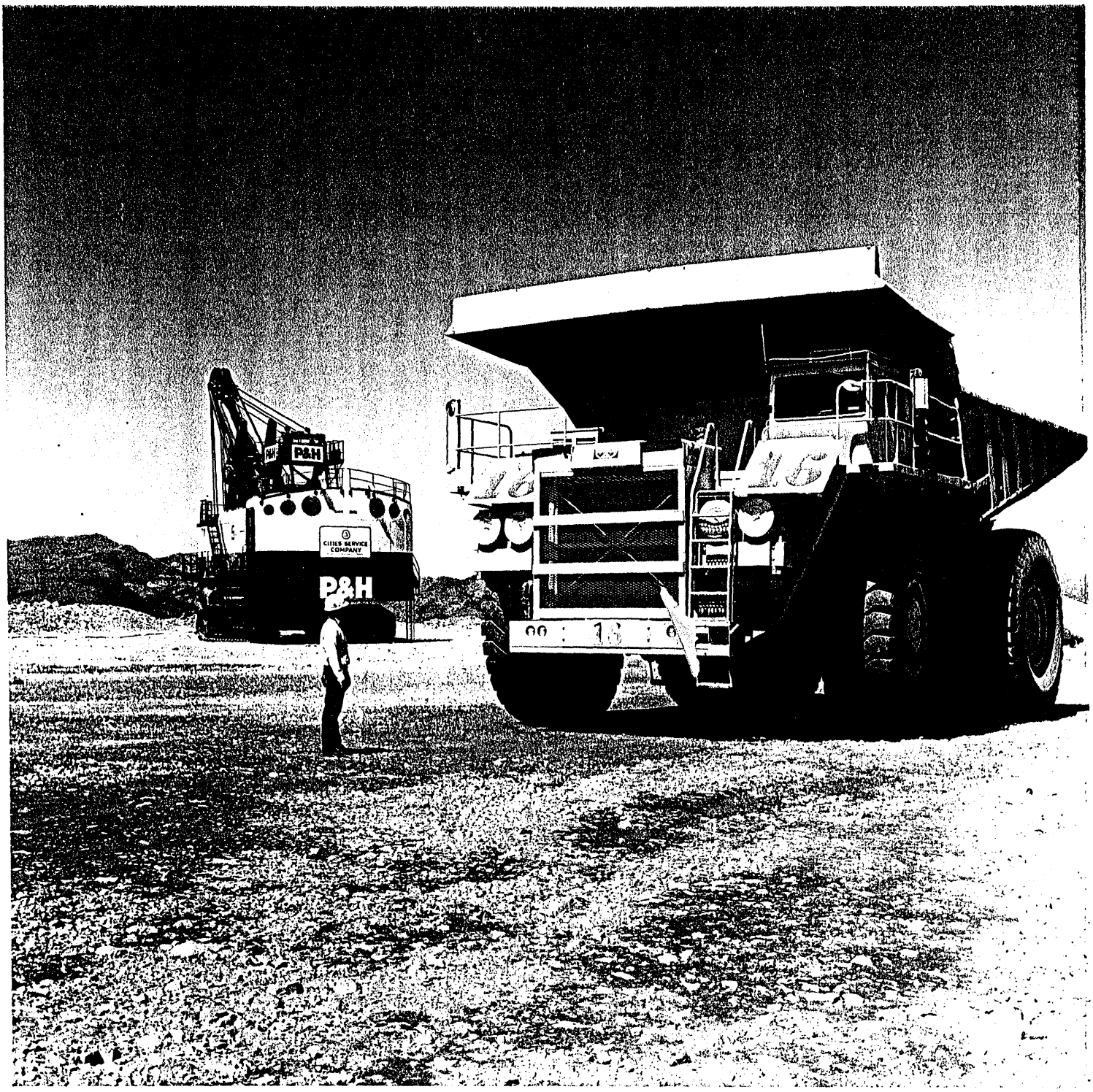
CURRENT STATUS: PRODUCER

COMMODITY:
COPPER SULFIDE
COPPER OXIDE (DUMP)
SILVER
MOLYBDENUM SULFIDE
GEMSTONE TURQUOISE
FLUORINE FLOURITE
BARIUM BARITE
URANIUM

BIBLIOGRAPHY:
ADMMR PINTO VALLEY MINE FILE
BLM MINING DISTRICT SHEET 154
US AEC PRELIM RECONN RPT 172-480 GILA CTY
PETERSON N P ETAL GEOG & ORE DPSTS CASTLE DOME AREA USGS BULL 971 1951
ELEVATORSKI E A AZ FLUR 1971 P 29,30
RANSOME F L GEOL GLOBE CU DIST USGS PP 12 1903 P 159; MSHA MINE INFO SUPP
ADMMR 7 U/G PLAN MAPS (FLAT FILE DRAWER 1[illegible]) 15 CASTLE DOME
ADMMR CASTLE DOME COPPER MINE COLVO FILE

F O R E S T
Red Flat
Continental Spr
CONTINENTAL TUNNEL
Spring
Jewell Hill
Webster
Porphyry Mtn
CASTLE DOME MINE
Bootlegger Spr
Goose Spr
Reservoir
Tank
Tailings Pond
BLACK TUNNEL
Spring
Miller Spr
Pinto Valley Mine
Grizzly Bear Spr
Creek
COTTONWOOD
TAILINGS
POND
PINTO SHAFT
HAMILTON SHAFT
Well
Manitou Hill
Inspiration
250000 FEET


MAGMA COPPER COMPANY
PINTO VALLEY DIVISION
ASH
PEAK
CITIES
ROBB
FLY
COWBOY
REJECT
MIAMI
GLOBE
SCALE
1 mile
GILA COUNTY
PINAL COUNTY
GILA and SALT RIVER BASE LINE
TO PHOENIX
TO SAN MANUEL



A-150-40

C-1980

7

Dump trucks


P&H
CITIES SERVICE COMPANY
P&H
16
16
16

A-150-39

C-1980

5 Overview

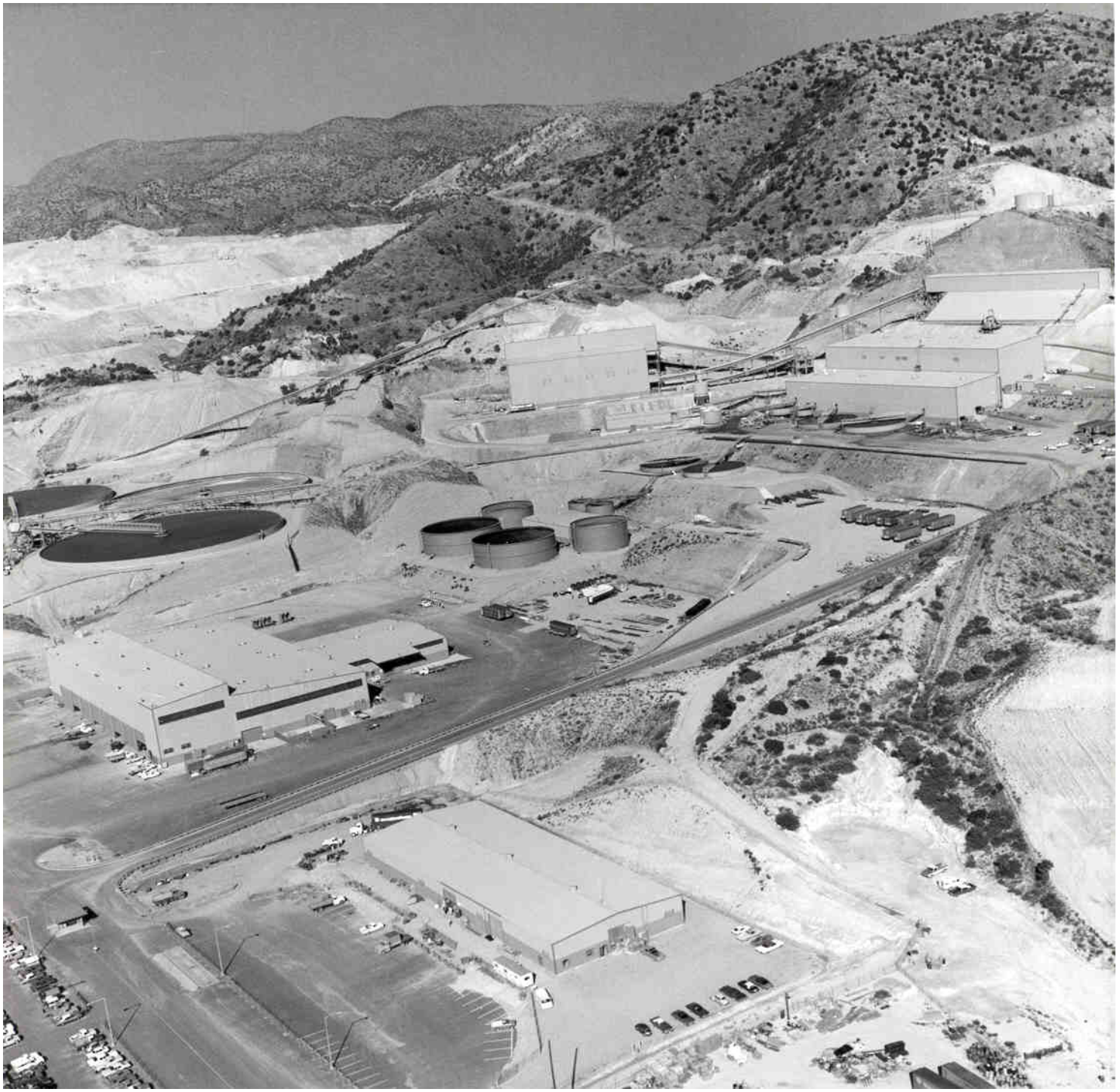


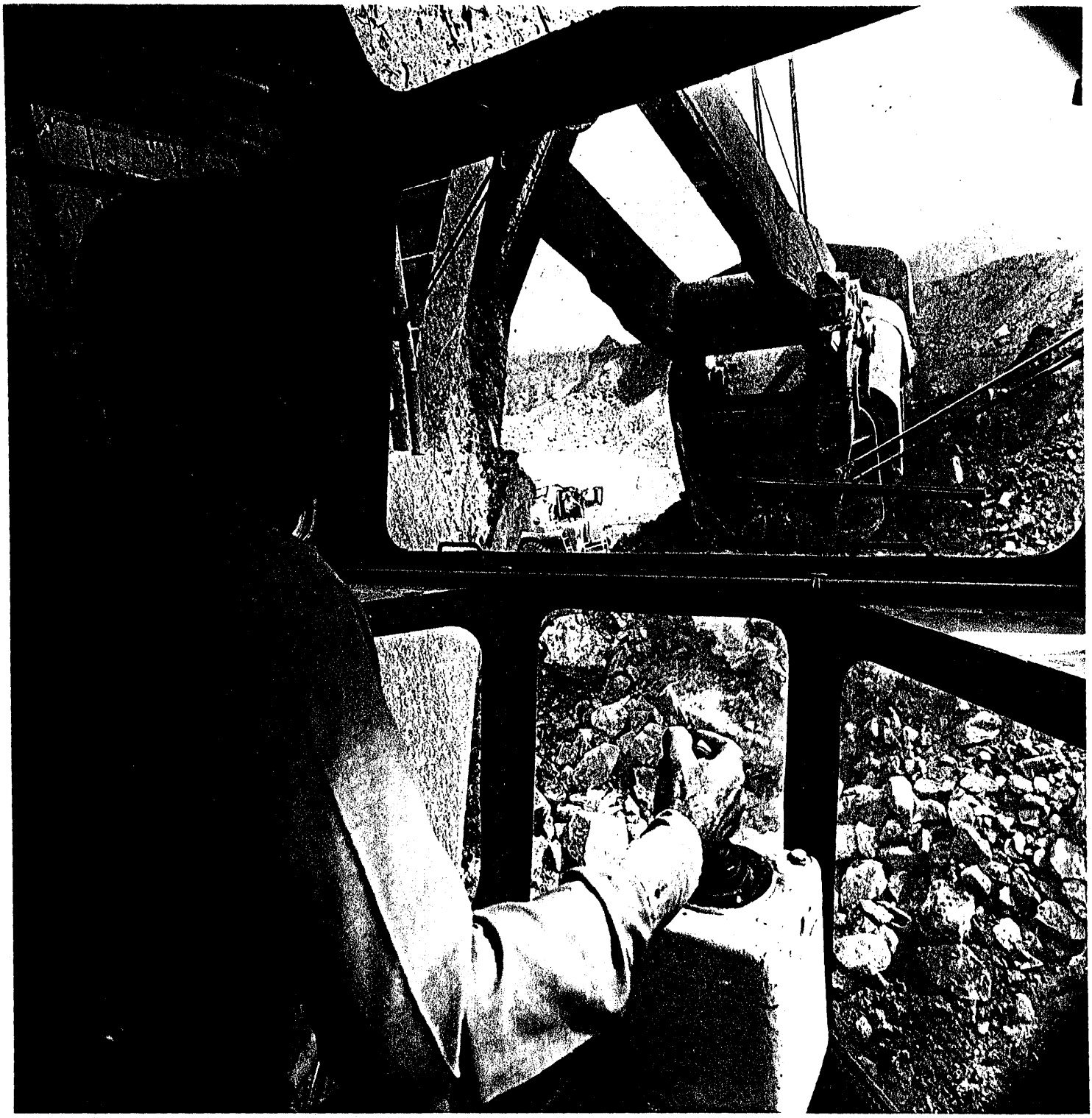
Figure . Blast during mine development, Pinto Valley operation, Gila County, Arizona. (Courtesy, Cities Service Co.

A-150-37

C-1980

Blast

Figure . Blast during mine development, Pinto Valley operation, Gila County, Arizona. (Courtesy, Cities Service Co.)



A-150 - 38

c. 1880

8 From the mail

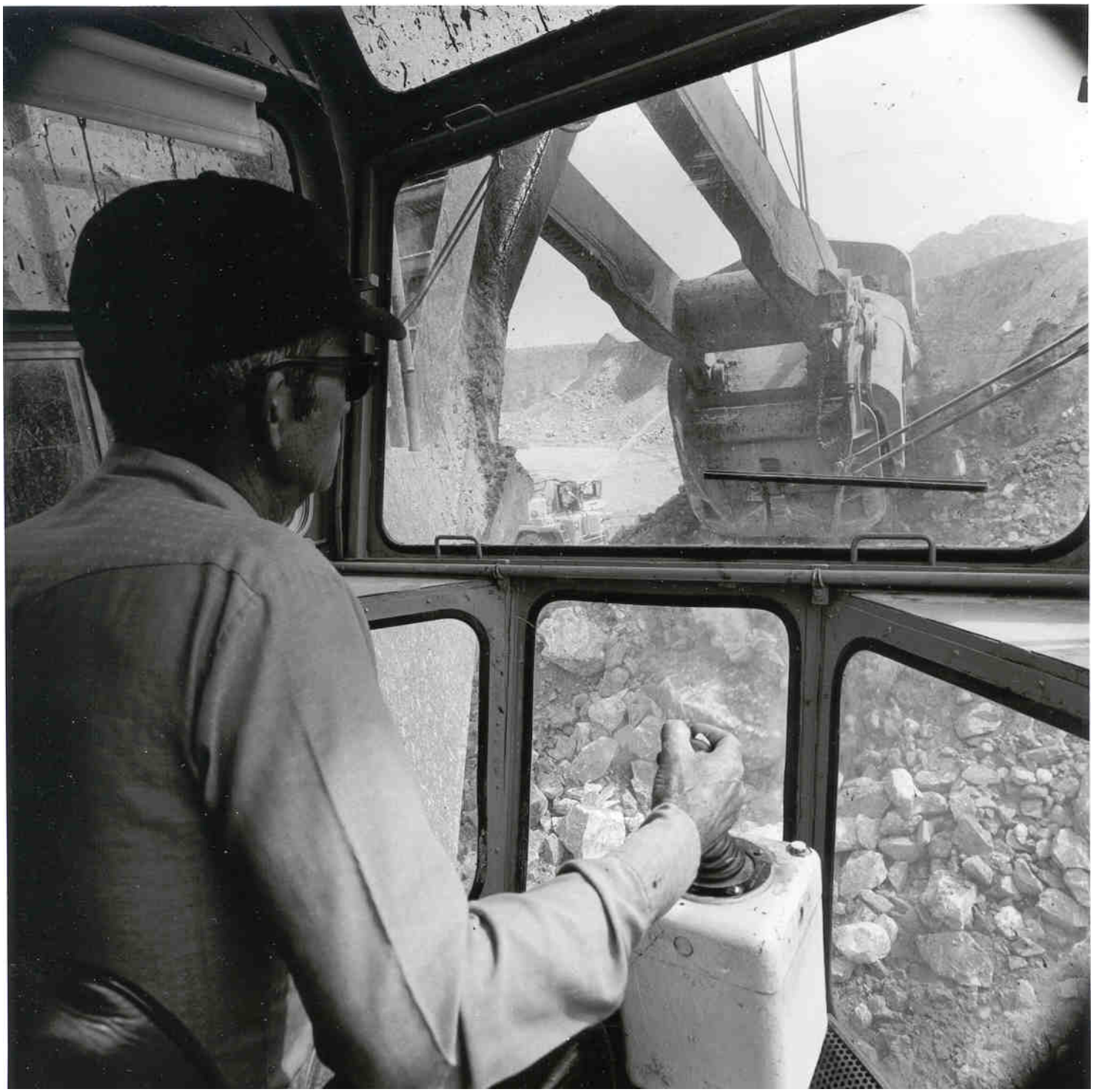


Figure . Crus
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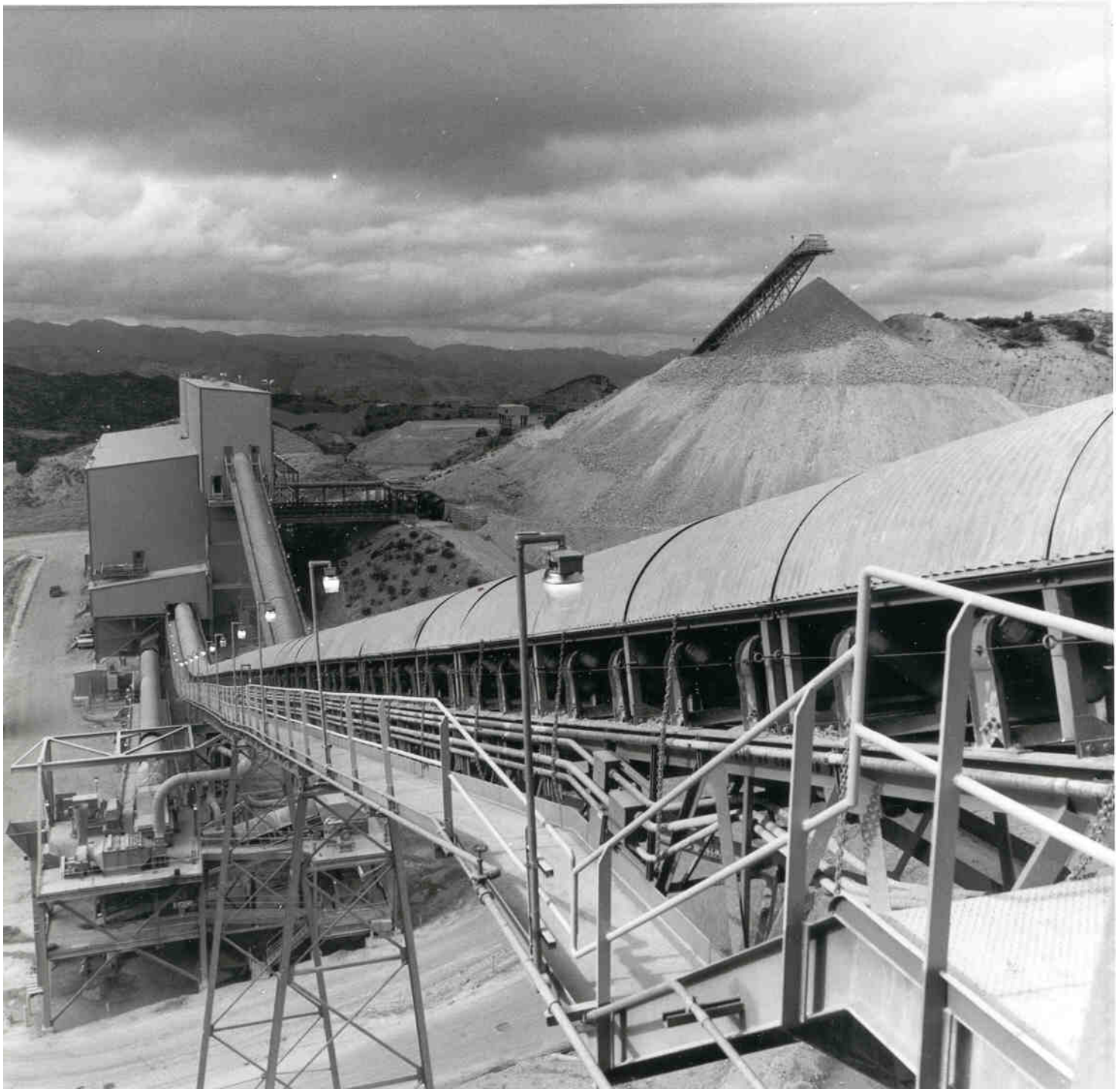
A-150-36

C-1980

4 Crushing Circuit



A-150 -35

C-1980

03/20/90

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES FILE DATA

PRIMARY NAME: PINTO VALLEY MINE

ALTERNATE NAMES:
CONTINENTAL GROUP
CASTLE DOME PROPERTY

GILA COUNTY MILS NUMBER: 140C

LOCATION: TOWNSHIP 1 N RANGE 14 E SECTION 20 QUARTER W2
LATITUDE: N 33DEG 24MIN 40SEC LONGITUDE: W 110DEG 57MIN 20SEC
TOPO MAP NAME: INSPIRATION - 7.5 MIN

CURRENT STATUS: PRODUCER

COMMODITY:
COPPER SULFIDE
SILVER
URANIUM
FLUORINE FLUORSPAR
BARIUM BARITE

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ADMMR PINTO VALLEY MINE FILE
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RANSOME F L GEOL GLOBE CU DIST USGS PP 12 1903 P 159; MSHA MINE INFO SUPP
ADMMR 7 U/G PLAN MAPS (FLAT FILE DRAWER 18)
ADMMR CASTLE DOME COPPER MINE COLVO FILE

08/22/86

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES FILE DATA

PRIMARY NAME: PINTO VALLEY MILL

ALTERNATE NAMES:

GILA COUNTY MILS NUMBER: 140A

LOCATION: TOWNSHIP 1 N RANGE 14 E SECTION 20 QUARTER E2
LATITUDE: N 33DEG 24MIN 40SEC LONGITUDE: W 110DEG 56MIN 50SEC
TOPO MAP NAME: INSPIRATION - 7.5 MIN

CURRENT STATUS: PRODUCER

COMMODITY:
COPPER
MOLYBDENUM

BIBLIOGRAPHY:
ADMMR PINTO VALLEY MINE FILE
MSHA MINE INFO SUPP

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1992

Gila County

MAGMA COPPER COMPANY

Corporate Headquarters
7400 N. Oracle Rd, Tucson, AZ 85704- Phone 575-5600
President and CEO J. Burgess Winter
Pinto Valley Mine T1N R14E Sec. 20
P.O. Box 100, Miami, AZ 85539 - Phone 425-7611 - Employees: 620 - Open pit copper-molybdenum mine - 63,000 TPD concentrator - Dump leach - Solvent extraction - electrowining plant - In-situ leach - Tailings reclaim leach - Solvent extraction electrowining plant.
Vice President/General Manager K. Lee Browne
Manager Mining Operations Charles D. O'Coyne
Manager of Miami Unit Leaching/SX-EW Robert V. Wasanock
Manager of Concentrator Operations Jack D. Conklin

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1991

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Vice President/General Manager ..... W. Glen Martin
Manager Mining Operations ..... Dan L. Goar
Superintendent of Miami Unit Leaching/SX-EW ..... William A. Bennett
Superintendent Concentrator Operations .... Lorin D. Hallin

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Vice President/General Manager ..... W. Glen Martin
Manager Mining Operations ..... Dan L. Goar
Superintendent of Miami Unit Leaching/SX-EW ..... William A. Bennett
Superintendent Concentrator Operations .... Lorin D. Hallin

ABSTRACTED FROM ADMMR ACTIVE MINES DIRECTORY, 1989

MAGMA COPPER COMPANY

Corporate Responsibilities
P.O. Box M, San Manuel 85631 - Phone 385-3100

Chairman of the Board (New York) ..... Donald J. Donahue
President ..... Burgis Winter
Vice President Mining Operations .....W. Glenn Martin
Vice President Planning & Development ..... Brad Mills
Controller ..... Bob Lemons
Treasurer ..... Bill Diggin
Corporate Director Personnel ..... Marsh Campbell
Corporate Director Environmental Affairs ..... Eldon Helmer
Public Relations Officer ..... Frank R. Harris
Manager, Rod Production ..... Lee Browne
Land Manager ..... Alex Acosta

Pinto Valley T1N R14E Sec. 20
Miami Tailings T1N R15E Sec. 30
P.O. Box 100, Miami 85539 - Phone 425-7611 - Employees 650 - Open pit copper-molybdenum mine - 60,000 TPD concentrator - Dump leach - Solvent extraction-electrowinning plant. Tailings reclaim leach solvent extraction electrowinning plant.

Vice President Mining Operations ..... W. Glenn Martin
General Superintendent ..... W.G. Slack
Mine Superintendent ..... D.L. Goar
Concentrator Superintendent ..... Loren Hallin
Leaching Superintendent ..... J.R. Sosh
Manager, Purchasing ..... B.L. Beydler

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MAGMA COPPER COMPANY

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P.O. Box M, San Manuel 85631 - Phone 385-3100

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President ..... Burgis Winter
Vice President Mining Operations .....W. Glenn Martin
Vice President Projects & Plant ..... Tom E. Hearon
Vice President Corporate Planning ..... John W. Goss
Controller ..... Bob Lemons
Treasurer ..... Bill Diggin
Corporate Director Personnel ..... Marsh Campbell
Corporate Director Environmental Affairs ..... Eldon Helmer
Public Relations Officer ..... Frank R. Harris
Manager, Rod Production ..... Lee Browne
Land Manager ..... Alex Acosta

Pinto Valley Division T1N R14E Sec. 2
P.O. Box 100, Miami 85539 - Phone 425-7611 - Employees 595 - Open pit copper-molybdenum mine - 60,000 TPD concentrator - Dump leach solvent extraction-electrowinning plant.

Vice President Mining Operations ..... W. Glenn Martin
General Superintendent ..... W.G. Slack
Mine Superintendent ..... D.L. Goar
Concentrator Superintendent ..... Loren Hallin
Leaching Superintendent ..... J.R. Sosh
Personnel Coordinator ..... David R. Weitzel
Manager, Purchasing ..... B.L. Beydler

Location S27, 1N, 14E

CASTLE DOME DIVISION MIAMI COPPER COMPANY

Mining World March 1958, p. 71

Metal Mining & Processing April 1964, p. 25

AEC 172-480 p. 44 RED HILL AND CASTLE DOME uranium 0.223

IC 8341 p. 10, 15, 22, 31

USGS P.P. 342 p. 95 - Pinto Valley Co.

USGS 971, p. 93

ABM Bull. 180, p. 351, 363

Arizona Mining Journal May 1, 1922 p. 47

See: Geology File - Hardwick, Wm., Williams, Frank & Soule, John, Safford Project-Copper-Minerals for War Reports

CASTLE DOME DIVISION MIAMI COPPER CO.

Active Mine List Oct. 1961 - B. R. Coil, Gen. Mgr., Miami Copper Co., Box 100, Miami
Active Mine List Feb. 1962 - " " " " " " " " " "
Active Mine List Oct. 1962 - " " " " " " " " " "
Active Mine List Oct. 1967 - 732 men
Active Mine List April 1968
Active Mine List Oct. 1968 - 671 men - B. R. Coil, Gen. Mgr. Miami Copper Co.
Active Mine List April 1969

Visited Castle Dome - Shut down due to water. FTJ WR 11-28-69

Active Mine List May 1970 - 724 men - B. R. Coil, Gen. Mgr.
Active Mine List Oc.t 1970 - 776 men - R. P. Hughes, Gen. Mgr.

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES

INFORMATION FROM MINE CARDS IN MUSEUM

ARIZONA

GILA COUNTY (West of Miami)

PINTO VALLEY MINE
(Formerly Castle Dome Mine)

MILS # 140C
PINTO VALLEY
MINE (file)
2-AKA's

CARD # 1

MM 228 Cap Rock
229 Ore, Typical
230 " "
231 Rock Waste
232 Pyrite
233 Chalcopyrite
234 Cuprite
235 Meta-Torbernite
236 Dihydrite
237 Turquoise
238 Chalcanthite
239 Ore - prepared for grinding
-A Sulphide Ore
-B Mixed Sulphide-Oxide Ore
240 Tailings
-A Sulphide Ore
-B Mixed Sulphide-oxide ore
241 Sulfide Concentrates
242 Concentrates, Mixed Sulfide-Oxide Ore
243 Concentrate, Molbydenum Sulfide

ARIZONA

GILA COUNTY (West of Miami)

PINTO VALLEY MINE
(Formerly Castle Dome Mine)

MILS #140C

CARD # 2

MM-244 Molybdenum Trioxide
247 Copper Sulphate Solution
248 Concentration Ratio
249 Molybdenite
250 Chalcocite
251 Native Copper
252 Chrysocolla
253 Quartz Crystals
254 Malachite
255 Chalcocite
256 Covellite
257 Azurite
258 Copper, Native
259 Molybdenite
260 Galena
261 Cuprite
262 "
263 Pyrite
264 Chalcopyrite
265 Bornite

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES

INFORMATION FROM MINE CARDS IN MUSEUM

ARIZONA

GILA COUNTY (West of Miami)
PINTO VALLEY MINE
(Formerly Castle Dome Mine)

MICS #140C

CARD #3

2992 FLUORITE (FL)
2993 FLUORITE (FL)
MM4244 Turquoise seam in qtz. matr

NAME OF MINE: Castle Dome

COUNTY: Gila
DISTRICT:
METALS:

OPERATOR AND ADDRESS:		MINE STATUS	
DATE:		DATE:	
	[redacted] Miami, Ariz.		Mining & Milling

(under Miami Copper management)

ADMMR
Arizona Department of Mines and Mineral Resources
1502 West Washington, Phoenix, AZ 85007 Phone 602-771-1600
1-800-446-4259 in Arizona FAX 602-771-1616 www.mines.az.gov

***Pinto Valley Restart* presented by Michael Eamon, General Manager, BHP Copper to Maricopa SME Meeting, Sept. 20, 2007.**

From notes taken by Nyal Niemuth, Chief Mining Engineer, ADMMR*

The Pinto Valley concentrator was built in 1972, operating capacity in 1974 was 54k tpd. The original resource was 388 million tons grading 0.43 % Cu. Operations were curtailed in 1998 after having moved a total of 980 million tons of material. The mining fleet and concentrate filter plant were totally gone. The only activity (excluding Miami) was the dump leach operation that produced 3.6(?) million lb. of cathode copper this year. The new mining will put about 37 million metric tons on dumps for leaching. The Slice 6 pushback was mostly completed prior to the shutdown. It contains 85 million tons at 0.41 % Cu, 37 million tons at 0.21% for leach, and 8 million tons waste.

The **"restart maintenance project"** consisted of rehabilitating the sulfide concentrator circuit. The tailings thickeners were completely rebuilt and a new concentrate filtrate plant was constructed. There will be 270 new plant employees and a total workforce of about 600. The rebuild project had a budget of $140 million, actual cost will be somewhat higher. BHP has issued a $300 million mining contract to the Washington Group whose mining fleet will consist of one 35-yard shovel, two cat 994 loaders, twenty-two cat 785 trucks. The mill circuit includes three 7-foot primary crushers, six 7-foot short head secondary crushers plus a tertiary crushing circuit, six 18-foot diameter ball mills, a flotation circuit with two regrind mills, and a molybdenum circuit.

The previous plant received some care-and-maintenance until 2002, but some copper concentrate was left in the mills, ore in storage bins, etc., resulting in extensive galvanic corruption.

Rebuild Challenges

Safety training of up to 3 hours per day was required for the new generation of workers and to comply with new regulations. Turnover for some of the construction contractors was up to 46 %. Extensive supervision of maintenance jobs by construction workers was required or the work was not done well. Constructions workers are not ideal for maintenance work. The workforce is 39% female. There is a huge shortage of heavy-duty mechanics and electricians.

Conversion from of the control panel board controls to DCS (digital control systems) turned out to be difficult. The mill's restart was mostly a maintenance project with a small amount of new construction. Maintenance means repairs. New construction included concentrate storage and new concentrate thickeners (Dorr Oliver plate and press thickener). The crushing circuit required an extensive rebuild. The fine ore storage building supports were all corroded. Most of the pipelines were plugged. Lines less than 3 inches were replaced. Dewatering the pit has resulted in 1 billion gallons of water stored in the tailings ponds. Concentrates will go to a trans-load facility at San Manuel to get loaded onto rail. A new concentrate storage and loading building has been built. All loading will be done inside the building, with the truck being washed prior to leaving. Mining resumed the third week of September 2007. The mills were in relatively good shape, as they were jacked and drained. The flotation plant and mine project is scheduled for to run for 4 ½ years. The construction phase was completed August 30. Pre-commissioning will be done by Sept 30 and commissioning was scheduled for October 15, but will likely be the end of the month. Full production will be at a rate of 75.5 k ton per day should be reached by December. Copper production of 70 k metric tons per year (`150 million lb.) is forecast.

Questions and answers.

BHP choose to do all the mill repairs upfront unlike Phelps Dodge who flipped the mill switch on at Morenci and is making repairs as needed. Concentrates produced at the reopened plant will be trucked to San Manuel, railed to Guaymas, Sonora, Mexico and then exported to Asian smelters. The molybdenum circuit will be operated and is an important part of the economic contribution. Cutoff grade for mill feed is 0.27 % Cu. The rehabilitated plant could be a good "starter mill" for Resolution Copper. Resolution's

material has a hardness of 15, [illegible]pared to Pinto Valley's ore being 10. [illegible]le shut down work was done at shutdown as BHP management team at the time thought they would sell Pinto Valley or never operate it again. In hindsight, the plant and mine should have been sold while they were running or much more preventive maintenance work completed. BHP will look at the next slice to see if it can be mined economically.

The staff includes many experienced management technical personnel that includes many rehires. Production workers are assessed weekly and complete a 60-day probation. Performance Associates did operator training.

Gibson Mine Cleanup. The Friars inherited an environmental mess. Carlota Copper volunteered to assist with the clean up as part of the permitting related to Pinto Creek. BHP agreed to accept the material and it was placed on Pinto Valley's dumps. Arizona DEQ, Carlota and BHP all worked together to make the clean up successful. The sulfide-mineralized material, consisting largely of pyrite and chalcopyrite, is now being leached.

* The speaker announced that all units were in metric tones unless otherwise noted.

PINTO VALLEY (H GILA

ADMMR
Arizona Department of Mines and Mineral Resources
1502 West Washington, Phoenix, AZ 85007 Phone (602) 255-3795
1-800-446-4259 in Arizona FAX (602) 255-3777 www.admmr.state.az.us

Verbal Information Summary

Nyal Niemuth Mining Engineer, ADMMR

Copper Leaching at BHP Billiton:
M. Laustra, BHP Pinto Valley, Houston, TX
presented at the Annual Meeting of the Arizona Conference, Tucson, December 8-9, 2002

The talked reviewed the leach technologies and expertise available in-house at BHP Billiton properties world wide. Included below are only the comments specific to Pinto Valley.

Whole sulfide ore (chalcopyrite) leach research at Pinto Valley.
Looking at low cost approach as there is a lot of low-grade tonnage available. The focus is on bio leaching, but are looking at other ideas also taking a multi-disciplinary approach. Pinto Valley was chosen as a test site for large-scale demonstration of ideas.

Why Pinto Valley? 2 reasons: 100 percent chalcopyrite mineralization and existing infrastructure – 23 million pounds annual SX-EW capacity available. The open pit supplied sulfide material averaging 0.22% to leach and waste dumps 5 years ago. BHP-Billiton is currently leaching 100 acres (?) and recovering about 7,000 tons of copper per year with no new material.

Three stages: 1) Optimize existing dump leaches. 2) Test sulfide leaching at pit scale – large enough to prove the process. 3) Could be applied to Pinto Valley satellite deposits and at other BHP-Billiton projects.

CITIES SERVICE COMPANY
(Castle Dome Copper Company)

GILA CO.

MG/WR 10/25/79 - Oxide Ore may eventually come from the nearby Cactus Mine, (Castle Dome Copper Company). This deposit is being drilled now to determine more precisely the nature of the mineralization and extent. Sulfides occur at depth. Chalcocite occurs as thin coating of pyrite. Spencer said the company would buy the adjacent Carlota deposit if a reasonable price could be negotiated with the owner.

NJN WR 11/27/87: Joe Orlando of Hardy Turquoise reports that Hardy is giving up their contract to mine turquoise at the Pinto Valley (file) Gila County at the end of 1987. The contract will be picked up by Yellow Hair Trading and Mining Company, Bill Preston, President, 962 Linda Vista Drive, Globe, AZ 85501, 425-3778.

---

rrb wr 6/24/88: Visited Pinto Valley Division, Magma Copper Co to gather information for Copper Report. Bill Slack, Gen Supt. gave me a comprehensive tour of the property.

PINTO VALLEY (P) 939100 55 042053

mountain states mineral enterprises, inc.

4370 South Fremont Avenue
Tucson, Arizona 85714-1629
Phone (602) 792-2800
FAX (602) 294-3841
Telex: TWX 5106007949
ELN 62914139

MAR 0 1 1989

February 28, 1989

Gary

State Mine Inspector's Office
1616 W. Adams St., Room 411
Phoenix, Arizona 85007

Subj: Job 4234
Pinto Valley Rougher Flotation Expansion
Start of Construction
4234-TLV-004, File 1.12

Gentlemen:

Please note that construction activities on subject project began on February 27, 1989.

The location of the work is at the south end of the Magma Copper Company, Pinto Valley Division concentrator building. The MSME field office is also located in this vicinity.

The project includes installation of two banks of seven 1000 cubic foot capacity flotation cells and related piping and electrical work. The concentrator building and two retaining walls will be extended to the south to enclose the new facilities and an existing bank of five 1000 cubic foot capacity flotation cells. The expanded flotation capacity will provide a longer flotation process retention time, thus resulting in a higher copper bearing mineral recovery from the ground ore.

The MSME project Manager is D. A. Schultz, located at telephone number (602) 792-2800, Ext 390.

Very truly yours,

D. A. Schultz

D. A. Schultz
Project Manager

DAS:wm

cc: W. A. Bennett - Magma
D. Staton - MSME

RECEIVED
APR 12 1989
OF MINES &
MINERAL RESOURCES

PINTO VALLEY (f) K-8391703

Triple Nichol, Inc.

Gary

Post Office Box 167
1750 North Broad Street

Globe, Arizona 85502
Monty Nichols, Contractor

Telephone 425-7006
425-8116 / 425-8117

April 29, 1988

STATE MINE INSPECTOR
MAY 04 1988

MSHA, HEALTH AND SAFETY
P. O.Box 25367
Denver, Colorado 80255

RE: Magma Copper Company
Pinto Valley Operation
Miami, Arizona

Dear Sir:

This letter serves as our official notification that Triple Nichol, Inc., will be working with Magma Copper Company, Pinto Valley Operation, Miami, Arizona. We will be constructing tailings dams on No. 2-1/2, 3 and 4 Tailings Dam. The contract is for one year, beginning on January 22, 1988 and lasting thru December, 31, 1988. Our first project under this contract began in March 1988. We will be working there throughout the year. We will have approximately twelve persons working on this project.

Any further informationcan be obtained from our office at 1750 North Broad, Globe, Arizona or by calling us at 602-425-7006.

Sincerely,

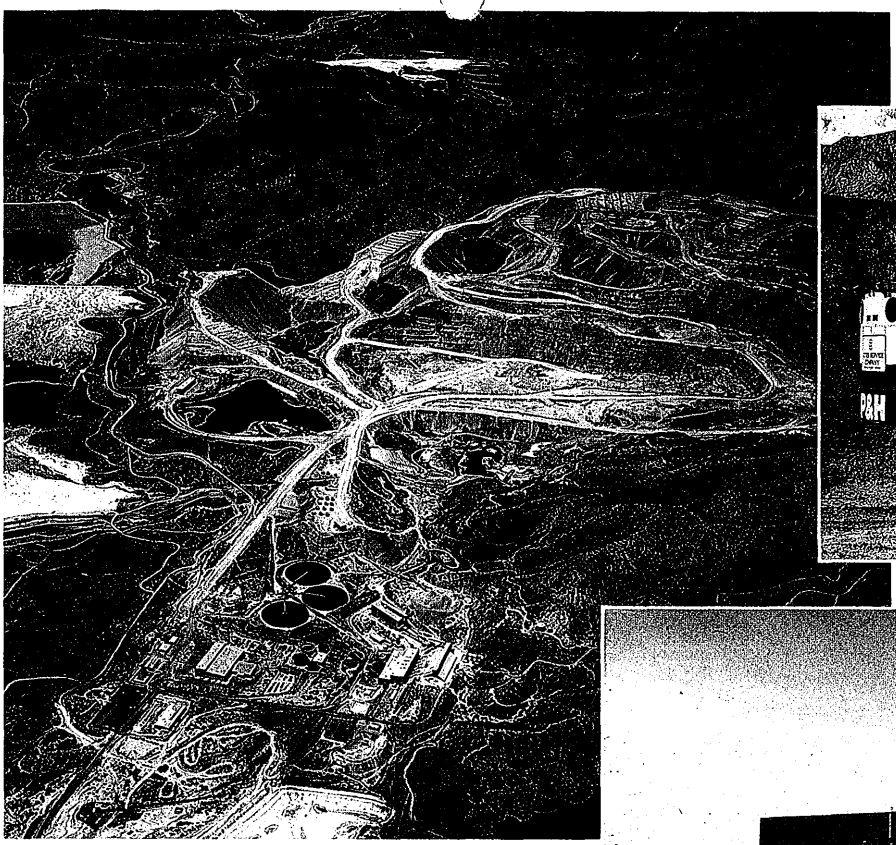
Jackie Hesketh

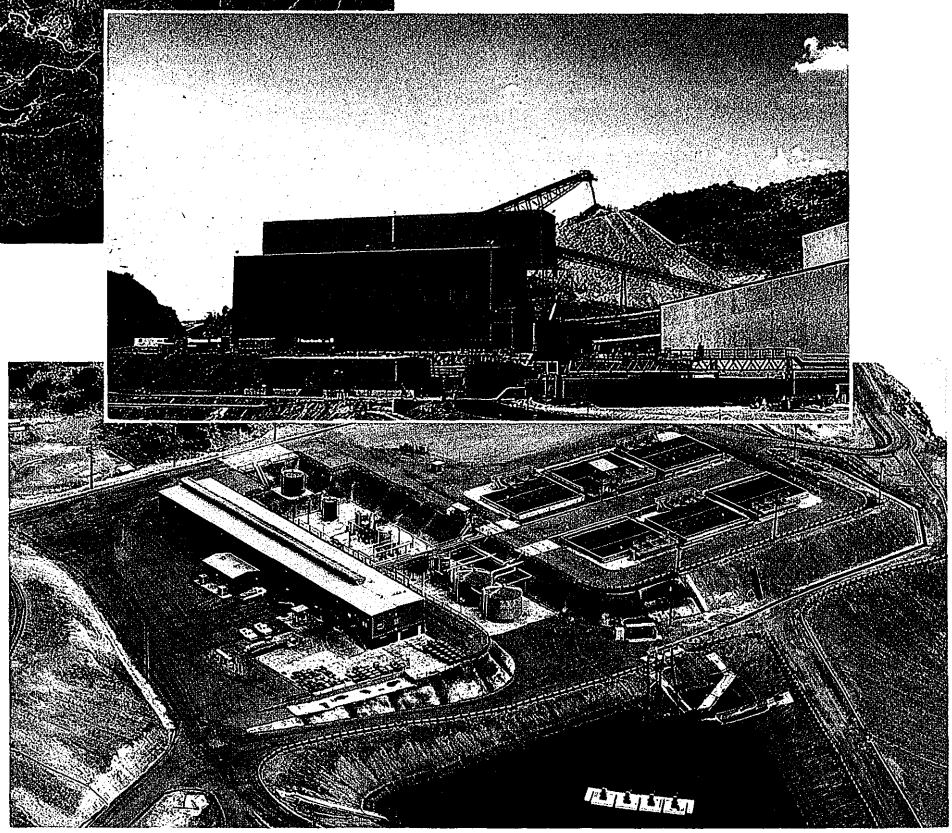
Jackie Hesketh
Secretary

JH/jh

CC: Office of the State Mine Inspector

Pinto Valley





PINTO VALLEY

The Pinto Valley Division operates a large open pit sulfide mine and flotation concentrator, dump leaching of sulfide waste, in-situ leaching, tailings leaching, and two solvent extraction-electrowinning plants.

The Pinto Valley Unit open pit mine, mill, dump leaching and SX-EW plant are five miles west of Miami, Arizona and the Miami Unit in-situ, tailings leach project and SX-EW plant are adjacent to the community of Miami.

There are 600 employees at the Division which has a production capacity of approximately 260,000 tons per year of concentrates containing approximately 80,000 tons of copper. Approximately 20,000 tons per year of electrowon copper are produced. Also produced are small amounts of molybdenite concentrate and precious metals which are recovered in electrolytic refining.

The concentrates are shipped to San Manuel for smelting, electrolytic refining, and rod casting. The electrowon cathodes are shipped directly to the rod plant.

The Miami Unit in-situ leaching and SX-EW plant have been in operation since 1942. This operation leaches the rubblized ore of the former Miami underground mine which was mined by block caving from the early 1900's through 1959.

The tailings leaching project currently under construction is scheduled to start production of electrowon copper in May 1989 at a rate of 8,000 tons per annum through a system of hydraulic mining, leaching, solvent-extraction and electrowinning.

Sulfuric acid for the Miami Unit in-situ and tailings leaching is supplied by the San Manuel sulfuric acid plant.

MAGMA

Magma Copper Company
Pinto Valley Division
P.O. Box 100
Miami, AZ 85539
Telephone 602-425-7611

Pinto Valley Mine file Gila Co.

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Governor Jane Dee Hull John F. Hagen, Acting Director

NOTICE OF THE PRELIMINARY DECISION TO ISSUE A MAJOR MODIFICATION TO AN INDIVIDUAL AQUIFER PROTECTION PERMIT

Public Notice 29-99 APP published in the Arizona Silver Belt on Wednesday, April 21, 1999.

Pursuant to Arizona Administrative Code, Title 18, Chapter 9, Article 1, the Director of the Arizona Department of Environmental Quality intends to issue a major modification to the Individual Aquifer Protection Permit P100329 to the following permittee:

BHP Copper, Inc.
Pinto Valley Operations
Box 100
Miami, AZ 85539

The BHP Pinto Valley Operations are located approximately 8 miles west of Miami, Arizona, in Gila County, over groundwater of the Salt River groundwater basin in Township 01 N, Ranges 13E and 14E, Gila and Salt River Base Line and Meridian:

Latitude	33° 24' 33.0"	North
Longitude	110° 57' 48.0"	West

The Pinto Valley Operations is authorized to operate an open pit copper mine, pregnant leach solution (PLS) and raffinate processing facilities, seepage and stormwater retention facilities, surface water facilities, tailing impoundments and ponds, leach dumps, waste rock dumps, the concentrator area and ancillary facilities according to the design and operational plans approved by the Arizona Department of Environmental Quality (ADEQ) Aquifer Protection Permit Program.

The facility mines both millable and leach-grade copper and molybdenum ore. Millable ore is crushed and concentrated on-site then shipped off-site for smelting and refining. Low-grade copper ore is deposited on the Gold Gulch dump leach. Raffinate solution consisting of weak sulfuric acid is sprayed over the low-grade ore. The resulting pregnant leach solution (PLS) is collected in a double-lined pond and pumped to the SX/EW plant for processing. The resulting cathode copper is shipped off-site for further refining.

The permit and related materials are available for public review, with 24 hour notice, Monday through Friday 8:00 a.m. to 5:00 p.m. at the Arizona Department of Environmental Quality, Records Management Center, Lower Level, (with 24-hour notice - call 602-207-4378), 3033 N. Central Ave., Phoenix, AZ 85012.

PINTO VALLEY (F) GILA CO

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Governor Jane Dee Hull Russell F. Rhoades, Director

NOTICE OF DECISION TO ISSUE A TEMPORARY INDIVIDUAL AQUIFER PROTECTION PERMIT

Pursuant to Arizona Administrative Code, Title 18, Chapter 9, Article 1, the Director of the Arizona Department of Environmental Quality is issuing a temporary individual Aquifer Protection Permit to the following applicant:

Public Notice No. 08-98 AZAP

On or about
February 4, 1998

Pinto Valley Mining Division
BHP Copper Co.
Box 100
Miami, AZ 85539
Temporary Aquifer Protection Permit No. P-100329T

The BHP Pinto Valley Operations are located approximately 8 miles west of Miami, Arizona, in Gila County, over groundwater of the Salt River groundwater basin in Township 01 N, Ranges 13E and 14E, Gila and Salt River Base Line and Meridian:

Latitude	33° 24' 33.0"	North
Longitude	110° 57' 48.0"	West

The Pinto Valley Mining Division is authorized to conduct restoration activities related to a breach in the Number 2 tailing facility resulting in an unauthorized discharge into Pinto Creek. The activities include constructing and operating temporary discharging facilities consisting of impoundments, staging areas, berms, cut-off dams, stormwater runoff ponds, and diversion ditches according to the design and operational plans approved by the Arizona Department of Environmental Quality (ADEQ), Aquifer Protection Program. This temporary permit shall remain in effect for one year from the date of signature by the Division Director.

The permit and related materials are available for public review with 24 hour notice, Monday through Friday 8:00 a.m. to 5:00 p.m. at the Arizona Department of Environmental Quality, Records Management Center, Lower Level, Phoenix, AZ 85012.

Persons may submit written comments, within thirty (30) days from the date of this notice to: Tony Bode, Water Permits Section, Mining Unit, Arizona Department of Environmental Quality, 3033 N. Central Ave., Phoenix AZ, 85012.

j:\app\permits\process\100329\pubnor_t.wpd

AQUIFER PROTECTION PERMIT NO. P- 100329

RESPONSIVENESS SUMMARY

September 17, 1996

Facility: Pinto Valley Mining Division

Permittee: BHP Copper Company
Pinto Valley Mining Division
Box 100
Miami AZ 85539

Comments (C) and Responses (R):
The Department modified language throughout the permit to make it consistent with Aquifer Protection Program laws regarding permittable and exempt facilities, monitoring requirements, and miscellaneous grammatical corrections.

The Department received one external comment during the public comment period.

Comment (**C**) from Cindy Lester, Chief, Arizona Section, Army Corps of Engineers; Response (**R**) received from William Gray of BHP Copper Co., summarized by Shirin Tolle:

C1: We do not oppose the issuance of an APP permit for this mine, however, the proposed mine expansion (addition of waste rock dumps) will require a Department of the Army permit under Section 404 of the Clean Water Act. In addition to the Section 404 permit, water quality certification under Section 401 of the Clean Water Act is required from the Arizona Department of Environmental Quality.

R1: Waters of the US surveys have been conducted in all areas where future disturbance is planned at Pinto Valley Operations. Correspondence with the Army Corps of Engineers (CoE) was initiated and a subsequent site tour with CoE personnel was conducted. The jurisdictional areas were established by Marjorie Blaine of CoE.

BHP plans to expand its Pinto Valley Operations in the near future. All of these future plans and associated facilities have been disclosed and discussed in the APP application. Some of these areas are on Federal lands. A Plan of Operations has been submitted and a NEPA analysis is being performed.

A description of the site features included in the expansion plans and a discussion of the CoE jurisdiction follows:

- *Pit Expansion A and Associated Haul Road and Perimeter Road*
  About 126 acres will be affected by the advancing pit wall to the southeast. There are no jurisdictional waters or wetlands in this area.

- *Pit Expansion R*
  About 22 acres will be affected by a small extension of the same existing active pit to the east. There are no jurisdictional waters or wetlands in this area.

- *East Dump*
  A small waste dump located adjacent and northeast of Pit Expansion A will affect about 14 acres. There are no jurisdictional waters or wetlands in this area.

- *19 Dump Extension*
  A new waste dump is planned directly adjacent and north of the existing 19 Dump. This facility will affect about 78 acres. There is less than one acre of Waters of the US within the footprint of this facility. A Nationwide #26 permit is available for the facility and a 401 Water Quality certification will be obtained from the Arizona Department of Environmental Quality prior to any disturbance.

- *North Dump*
  There is a possibility that sometime in the future an additional waste rock facility may be needed, though it is not anticipated at this time. The North Dump is the "contingency" dump. This facility is located north of the active pit and encompasses about 141 acres as it is currently envisioned. There are about 1.2 acres of Water of the US that would be affected by this dump. BHP has no immediate plans to proceed with 404 permitting for this facility because it is not known whether the facility is needed, and the 404 permit would expire prior to the planned construction of the facility.

Comment **(C)** received during the public notice period from BHP Copper Co.; Response **(R)** summarized by Shirin Tolle:

C1: PART I, Line 16, Page 1
Please add 'and Table I.B' after 'part IV, TABLE I.A'.

R1: Table I.B - Exempt Facilities, has been removed from the permit. This change was not incorporated into the permit.

C2: PART II, Line 2, Page 7
Please add 'not' after 'requested changes shall'. The word 'not' was in the version of this permit just prior to its public notice and must have been inadvertently omitted from the public version of the permit. Changes in an analyte list or sampling frequency do not constitute a major modification.

R2: Changes to monitoring requirements constitute either a minor or a major modification depending on whether the change is an increase or decrease of testing frequency or parameters. The following language has been added to the permit:

"Requested changes that increase the frequency of monitoring or number of parameters constitute a minor modification of the permit. Reductions in monitoring frequencies or parameters constitute a major modification to the permit."

C3: PART II, Line 8, Page 12
This requirement appears to be redundant and unnecessary. The Emergency Response Unit was established to act as a clearinghouse for coordination of response to emergency situations. As such, this unit is responsible for notification of appropriate agencies including the APP Unit of ADEQ. Separate notification of the APP Unit and the Emergency Response Unit represents a duplication of effort.

R3: The Pinto Valley Mining Division emergency response coordinator is required to notify the ADEQ Emergency Response unit only in the event that there is a release of hazardous substances of a reportable quantity as defined 40 CFR 302 et seq. Spill and other emergency events can occur at the mine site that do not result in reportable quantity releases, but are addressed under the contingency plans in the APP permit Therefore, BHP Copper Co. must notify ADEQ Aquifer Protection Permit Compliance in the event of emergencies that trigger contingency requirements or present an imminent and substantial endangerment to public health or the environment. Therefore, this comment was not incorporated into the permit.

C4: PART IV, Table I.A, page 21
For the facility named Gold Gulch Dam No. 1 and PLS Pond, please change the facility status to 'existing' from 'new'.

R4: The change has been incorporated into the permit.

C5: PART IV, Table I.A, page 22

For the facility named Gold Gulch Dam No. 1A and PLS Pond, please change the facility status to 'existing' from 'new'.

R5: This change has been incorporated into the permit.

C6: PART IV, Table II.A, Suite A, page 33
For the parameter row of pH, under the columns of MONITORING FREQUENCY and REPORTING FREQUENCY, please change sample points to '001, 004, 005, and 006'. This change will make the sample points match the sampling point numbers listed immediately above Suite A.

R6: This change has been incorporated into the permit.

C7: PART IV, Table IV, page 39
The sampling point number for the West side Dump, 006, is the same as the sampling point number for the Raffinate Pond in TABLE II.A. The sampling point number here in TABLE IV and in TABLE V.A (page 40) should be renumbered by increasing each by one.

R7: This change has been incorporated into the permit.

C8: PART IV, Table V.A, page 40
The sampling point numbers should all be increased by one (see Comment No. 7).

R8: This change has been incorporated into the permit.

C9: PART IV, Table V.A, page 40
Please add 'Spring'; to the beginning of sample identifier 'North Draw 1'.

R9: This change has been incorporated into the permit.

C10: PART IV, Table V.A, page 40
In Footnote 1, please change the number '14' to '15'. The total number of points of compliance is 15.

R10: This change has been incorporated into the permit.

C11: PART IV, Table V.B, page 47
Please change the header 'Suite D - Whitman Draw (Raff...)' to 'Suite D - Raffinate Pond (Raff...)' to be consistent with the rest of the table.

R11: Whitman Draw is the location identifier for this table. This change has not been incorporated into the permit.

C12: PART IV, Table V.B, page 51
Please delete 'Spring North Draw 1' from the Total Trace Elements header so that it reads 'Total Trace Elements: Suite F - Cottonwood'.

R12: This change has been incorporated into the permit.

C13: PART IV, Table V.B, page 52
Please change the header 'Suite G - Monitor Well APP-7' to 'Suite G - North Draw' so that the parameters suite refers to a drainage basin.

R13: This change has been incorporated into the permit

C14: PART IV, Table V.B, page 52
In the Common Ions header, please replace 'North spring Draw 1' with 'Spring North Draw 1'.

R14: This change has been incorporated into the permit.

EXECUTIVE SUMMARY
AQUIFER PROTECTION PERMIT NO. P-100329

Facility Name: Pinto Valley Operations
Pinto Valley Mining Division

Owner:
BHP Copper Inc.
7400 North Oracle Road
Suite 200
Tucson, AZ 85704

Operator:
BHP Copper Inc.
Pinto Valley Mining Division
Pinto Valley Operations
P. O. Box 100
Miami, AZ 85539

Facility Location:
The Pinto Valley Operation is located approximately 8 miles west of Miami, Arizona, in Gila County, over groundwater of the Salt River groundwater basin in Township 01 N, Ranges 13E and 14E, Gila and Salt River Base Line and Meridian:

Latitude	33° 24′ 33.0"	North
Longitude	110° 57′ 48.0"	West

Facility Description:
The Pinto Valley Operation is an open pit copper and molybdenum mine, dump leaching and solvent extraction/electrowinning (SX/EW) operation. The facility is authorized to operate a ore crushing and concentrating operations, dump leaching and SX/EW operations, tailings impoundments, waste dumps, process solution ponds, stormwater runoff ponds, process pipelines and ancillary maintenance operation facilities according to the design and operational plans approved by the Arizona Department of Environmental Quality (ADEQ) Aquifer Protection Program.

Best Available Demonstrated Control Technology (BADCT):
The Pinto Valley Operation relies on engineered controls and operational procedures to demonstrate BADCT. A detailed description of facility BADCT is included in Part II, Section B of the permit.

Monitoring Requirements
Initial ambient groundwater quality monitoring will be conducted for eight quarters at the 15 hazardous and non hazardous points of compliance (POC's) according to Part IV, Table V.B. The initial ambient groundwater monitoring will be used to establish alert levels (AL's) and Aquifer Quality Limits (AQL's) which will be incorporated into the permit. After the initial ambient groundwater monitoring is completed, the POC's will be monitored on a quarterly basis according to the compliance groundwater monitoring requirements in Part IV, Table V.C. Once every two years (biennially), the Permittee will sample for the original analyte list

given in Part IV, Table V.B.

The groundwater contingency plan in Part II., Section E.2, is activated if compliance groundwater monitoring shows exceedances of AL's or AQL's. Contingency groundwater monitoring parameters are included in Part IV, Table V.B. Contingency groundwater monitoring shall be conducted on a quarterly basis per Part IV, Table V.B,. until the results from two consecutive quarters show no further exceedances.

The leaching process solution will be monitored according to Part IV, Table II.A. The leaching process solution will monitored once every three years for the lifetime of the facility.

The leak collection and recovery system (LCRS) for the pregnant leach impoundments in Gold Gulch will be monitored according to Part IV, Table II.B, of the permit. The contingency plan included in Part II, Section E.1., of the permit will be activated if monitoring shows that action leakage rates (ALR's) for the LCRS are exceeded. Inspection and operational requirements are included for leaching circuit and impoundment's in Part IV, Table VI.

The acid generation potential of the waste rock from the active waste rock dumps will monitored according to Table IV of the permit. Tests will be conducted for every 10 million tons placed per active dump.

Inspection and operational requirements are included in Part IV, Table VI, for stormwater and process water retention ponds, caisson and seepage collection systems, tailings impoundment's, waste rock dumps, wash racks, stormwater diversion ditches, monitoring wells, barge pumps and sump pumps.

Part II, Section I.2, of the permit is a compliance schedule for upgrades to the raffinate pond. Operational and inspection requirements will be added to the permit after the upgrade plan for the raffinate pond is approved.

Compliance with Aquifer Water Quality Standards (AWQS):
Since the start-up of the Pinto Valley Operation, the facility has not caused or contributed to violations of numeric AWQS. Because of this past history and the demonstrations provided in the APP application, BHP has adequately demonstrated that AWQS will be maintained at the point of compliance. The compliance schedule in this permit requires BHP to complete a study to demonstrate that the attenuation capacity of the geologic media beneath the Pinto Valley Operations will not be consumed as long as operations are ongoing. Also given that BHP is aggressively remedying the problems associated with the raffinate pond, the leakage from this pond will not violate AWQS. Finally, to insure compliance with AWQS, this permit requires BHP to monitor downgradient groundwater quality as stated above.

Point of Compliance:
The 15 hazardous and non hazardous POC's are listed in Part IV, Table V.A.

Storm/Surface Water Considerations:

All impacted stormwater runoff is captured in stormwater retention facilities designed to contain a 100-year, 24-hour storm or greater. Pumping equipment and backup power sources are maintained where necessary to control stormwater runoff and recycle it to the process water control system.

Four National Pollutant Discharge Elimination System (NPDES) point source discharge points are located on the property. Only one of these NPDES points discharges on a continual basis. This discharge currently meets NPDES permit requirements.

Zoning Requirements:
The permittee has submitted evidence from the Gila County Planning and Zoning Department that states that the Pinto Valley Operation is consistent with zoning requirements for Gila County.

Financial Capability:
BHP Copper Co. has submitted a financial report for BHP Pinto Valley Operations. The Chief Financial Officer of BHP Copper Co. has provided a letter of guaranty that guarantees that the costs of closure and post-closure care will be met. BHP Copper Co. has provided the financial information required pursuant to A.A.C. R18-9-108.B.8.

Technical Capability:
BHP Copper Co. took over the operations of the Pinto Valley Mining Division in 1995. Prior to this time, the operation was owned and operated by Magma Copper Co. BHP Copper Co. has submitted résumés for personnel from both BHP Copper Co. and Hargis and Associates, the consulting company which prepared the APP application. A review of these résumés has determined that BHP Copper Co. and its consultant are technically capable.

BHP COPPER INC.

AIME FIELD TRIP
PINTO VALLEY OPERATIONS

March 14, 1996

40 lbs/hd/day
400 Animal day/acre

BHP Copper Inc.

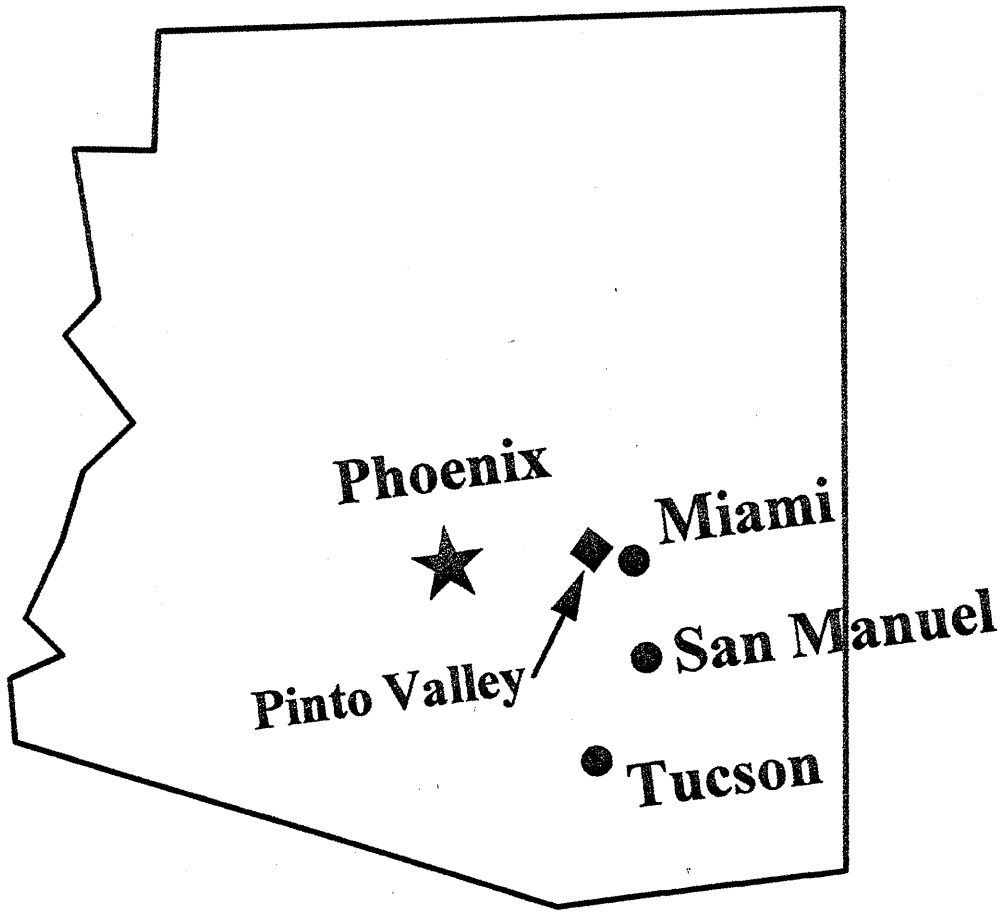
Pinto Valley Operations

AIME Tour - March 14, 1996 Slide 1

Ken Phillips - AzDMMR

Pinto Valley/Miami

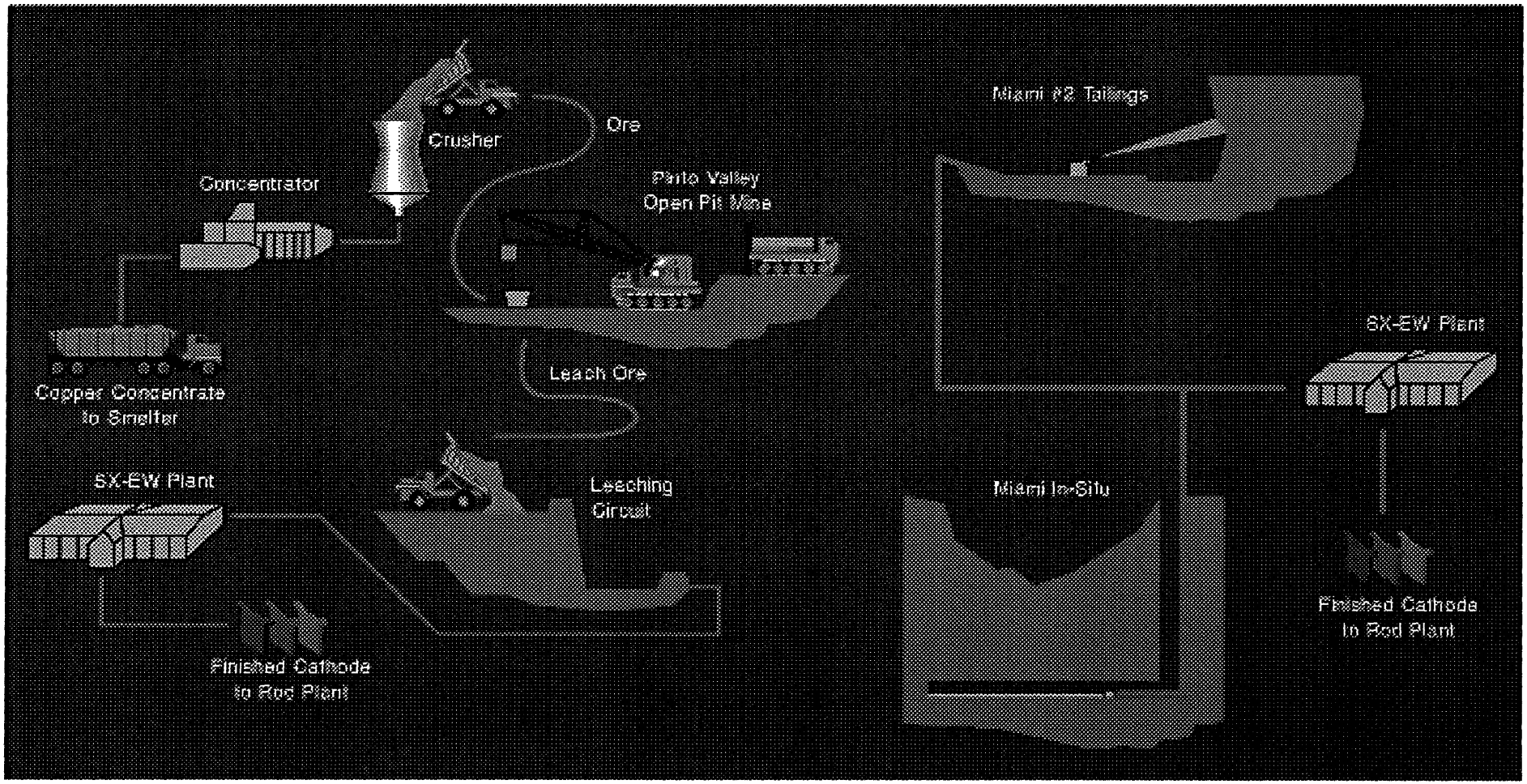
Area Location Map



Pinto Valley Operations

Pinto Valley

Miami Unit



BHP Copper Inc.

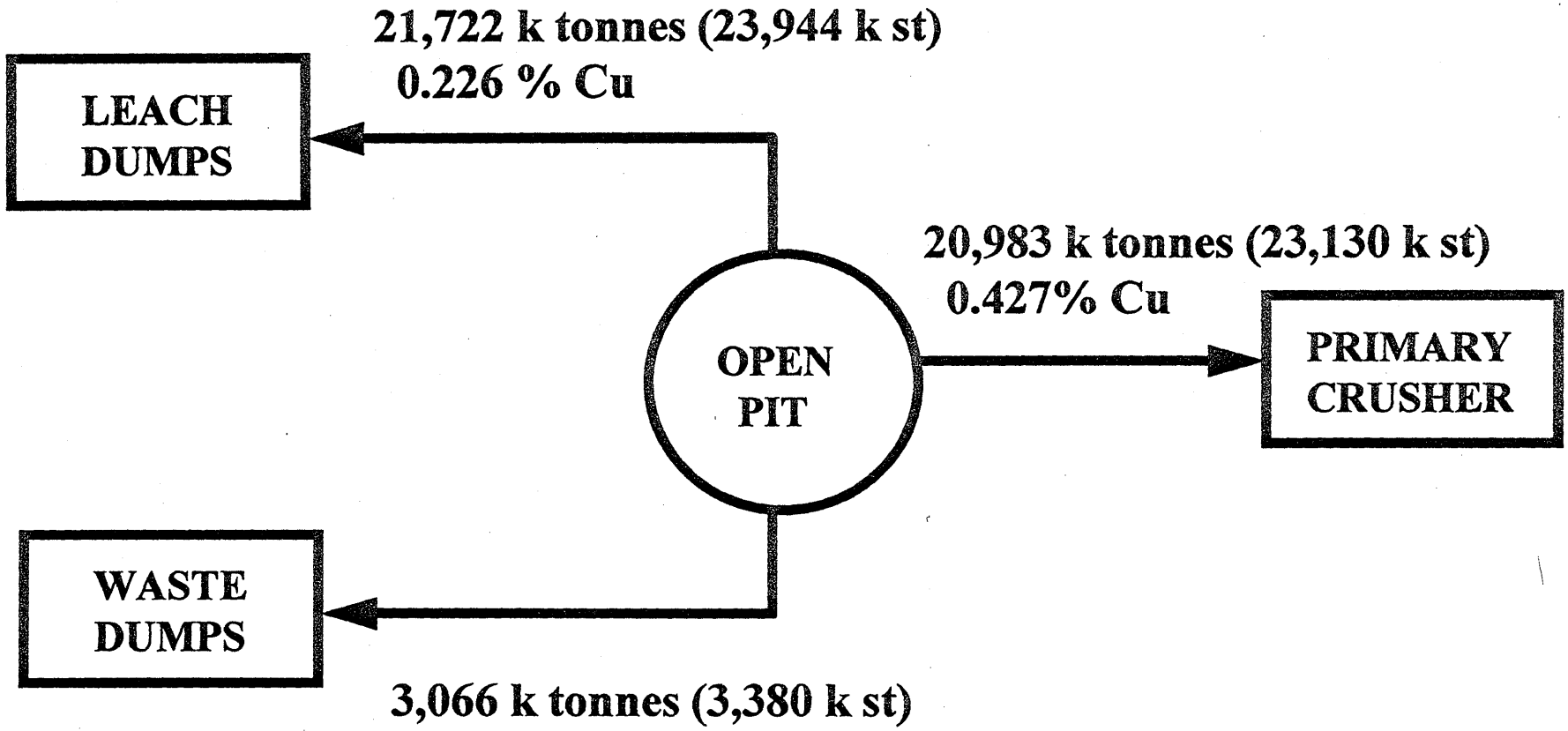
Mine Equipment Fleet

1995 YTD

DRILLING	LOADING	HAULAGE	SUPPORT
Drill Tech D90KS	P&H 2300XP 21 m^3 (27 yd^3)	20 Dresser 685E 172 tonnes (190 st)	2 CAT 16G
2 Marion M4	P&H 2300M2 19 m^3 (25 yd^3)	2 Water Trks 94,625 l (25,000 gal.) & 60,560 l (16,000 gal.)	3 CAT D10N
	P&H 2300M1 (2) 15 m^3 (20 yd^3)		2 CAT D9N
	P&H 2100BL 14 m^3 (18 yd^3)		2 CAT D9H
	CAT 994 16 m^3 (21 yd^3)		2 CAT 824
			246 Misc. Light Vehicles

Mine Flowsheet

1995 YTD

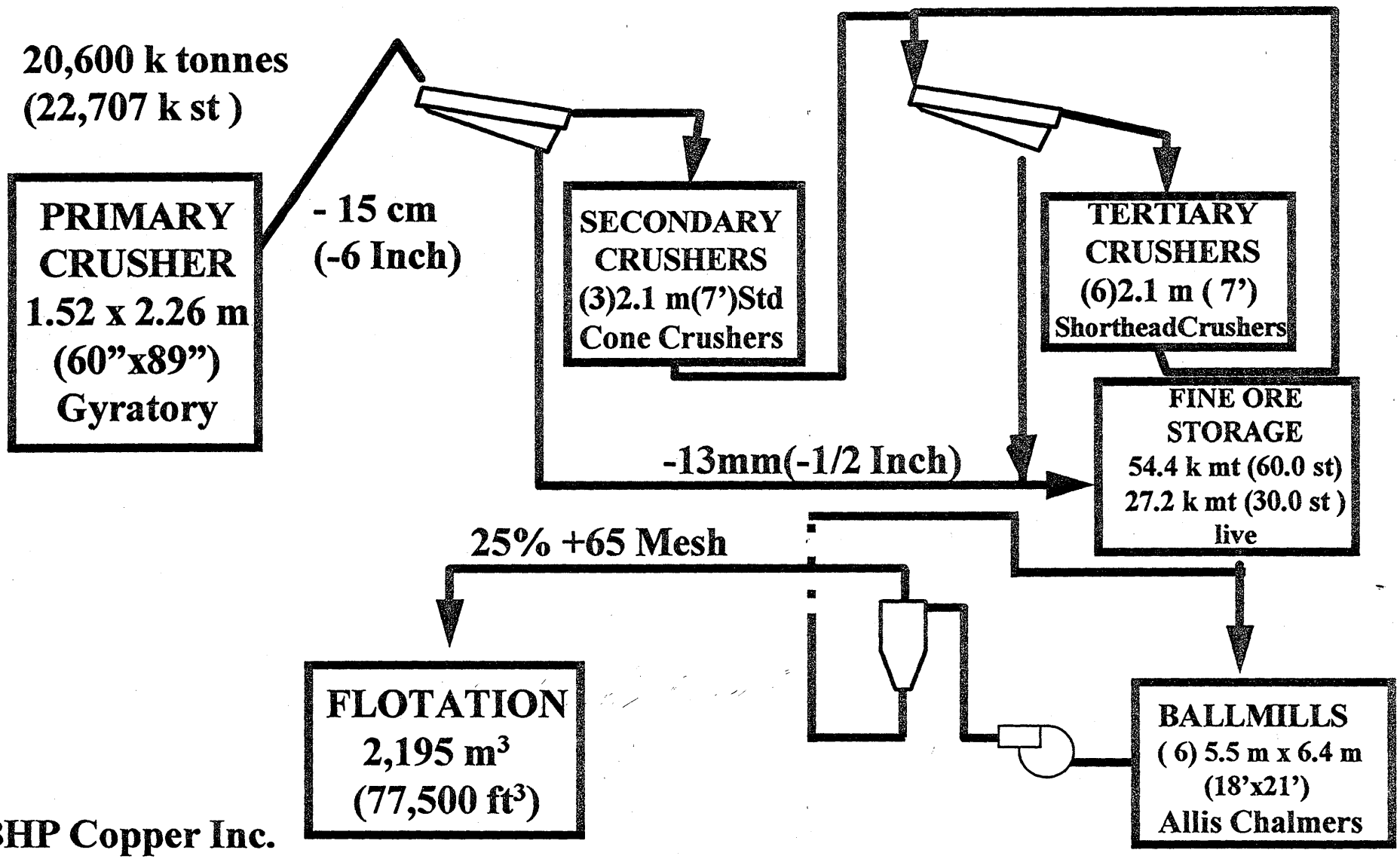


BHP Copper Inc.

Pinto Valley Operations

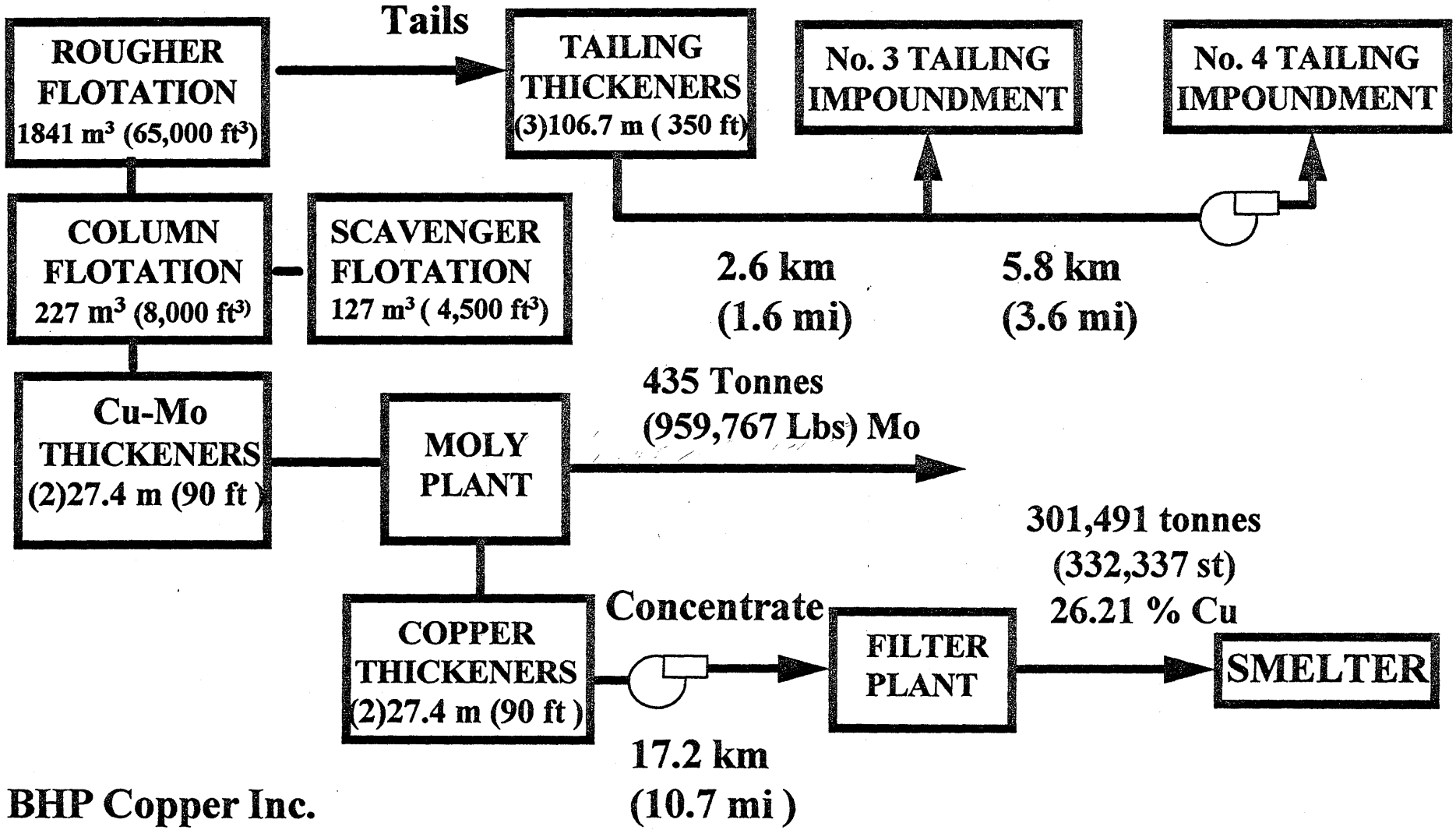
Mill Flowsheet

1995 YTD



Mill Flowsheet (con't)

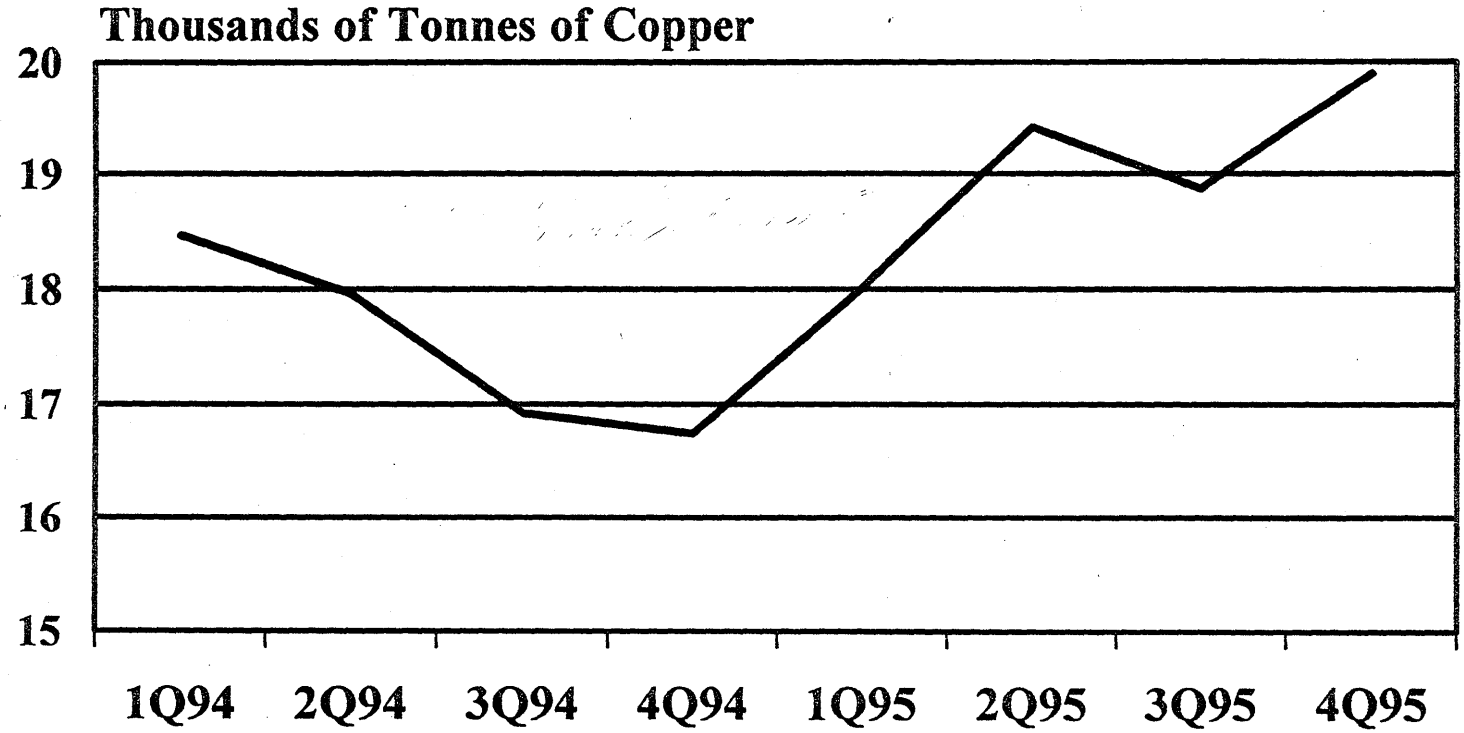
1995 YTD



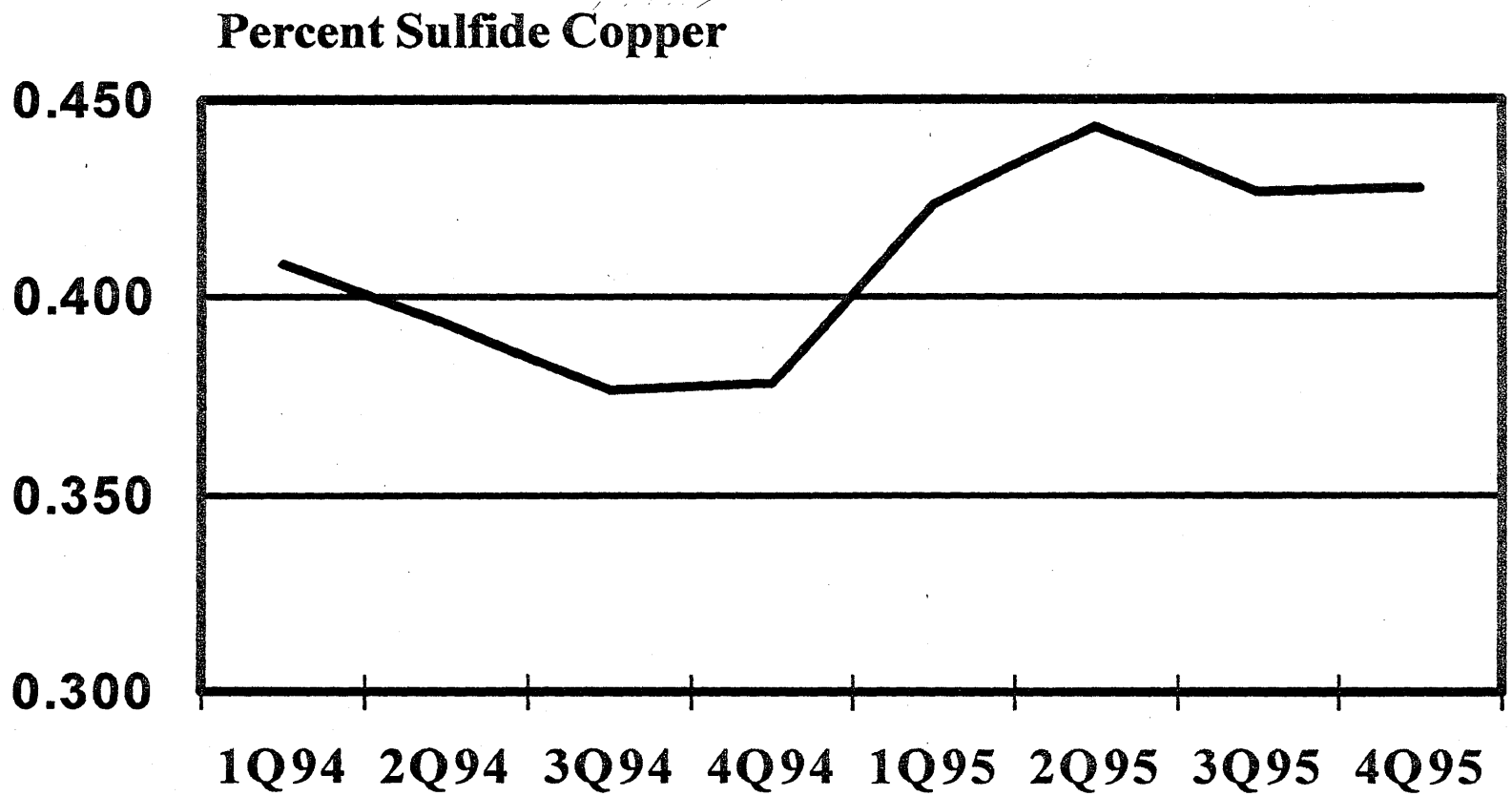
BHP Copper Inc.

Pinto Valley Operations

Copper in Concentrate Production



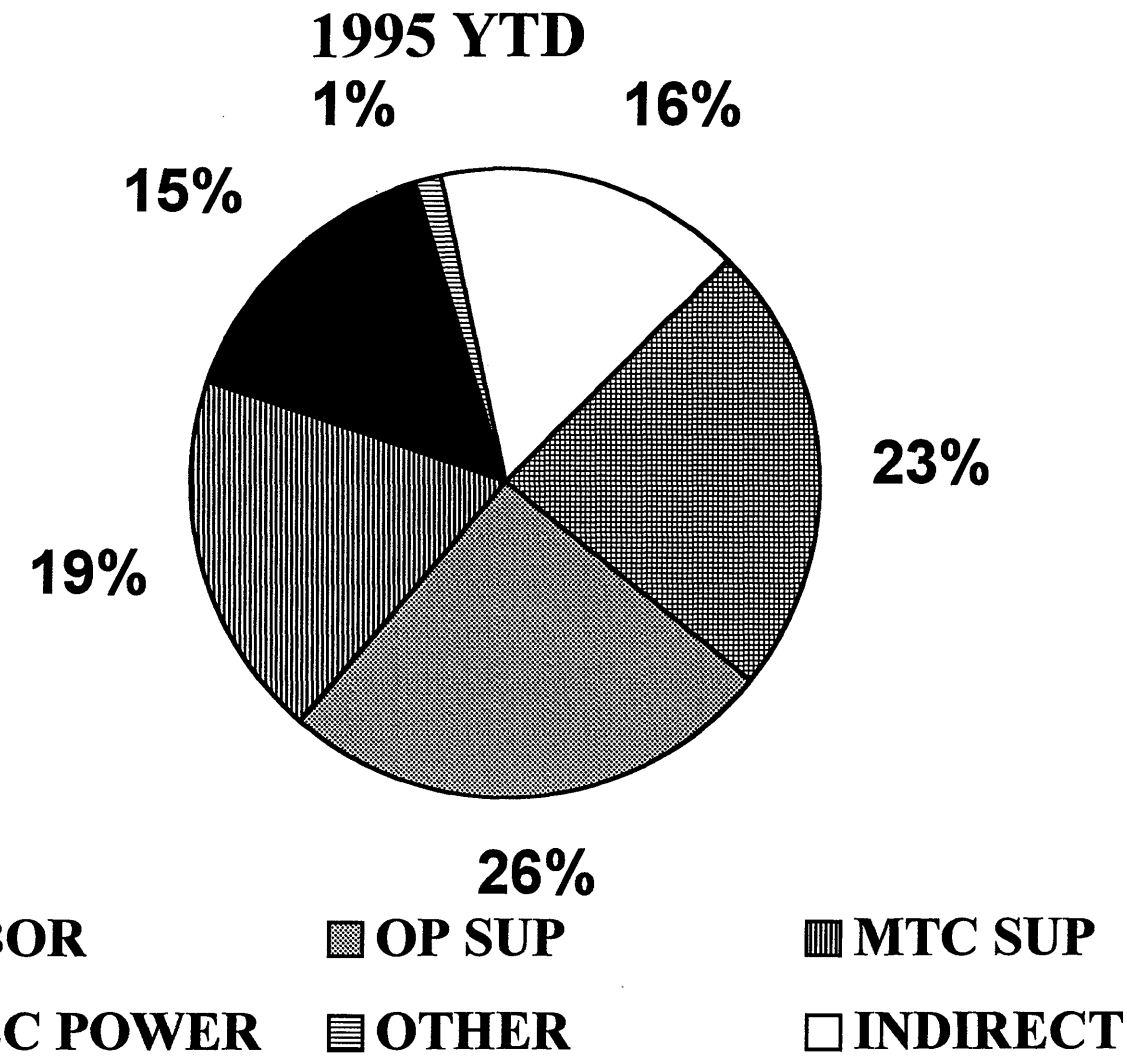
Pinto Valley Ore Grade



Concentrate Cash Cost

1993	**$1459/tonne**
	$0.662/lb
1994	**$1268/tonne**
	$0.575/lb

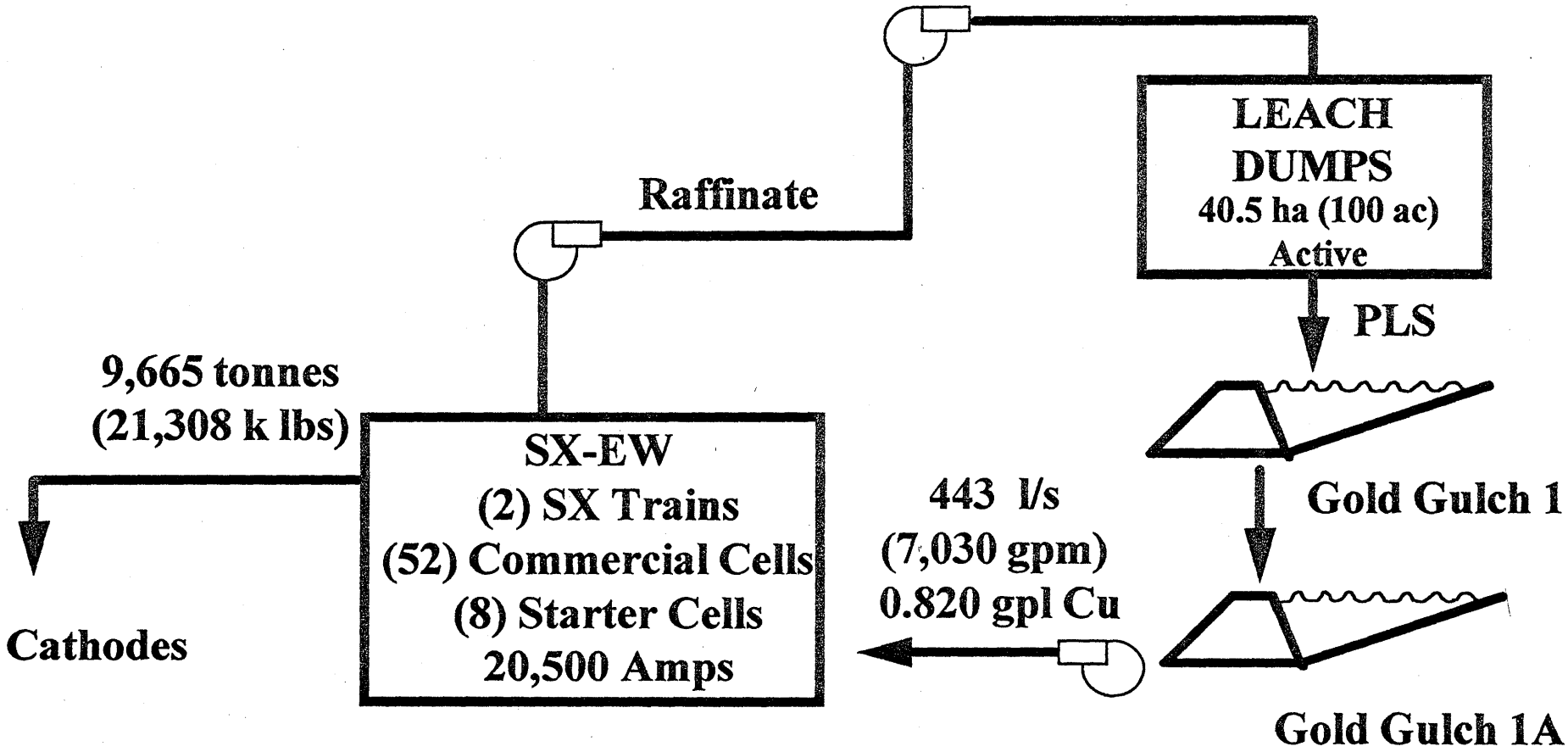
Concentrate Cash Cost Components



BHP Copper Inc.

Pinto Valley Operations

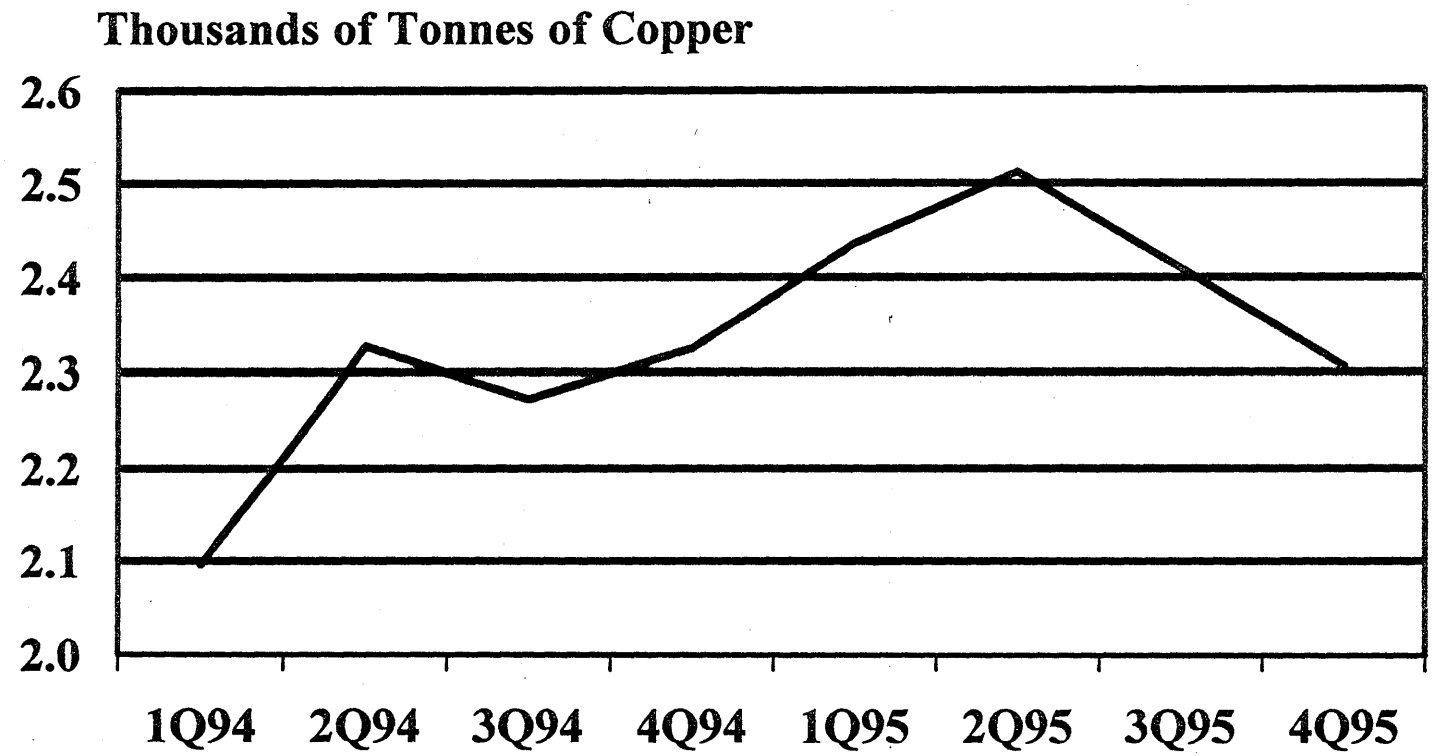
Pinto Valley SX-EW Flowsheet



BHP Copper Inc.

Pinto Valley Operations

Pinto Valley SX-EW Production

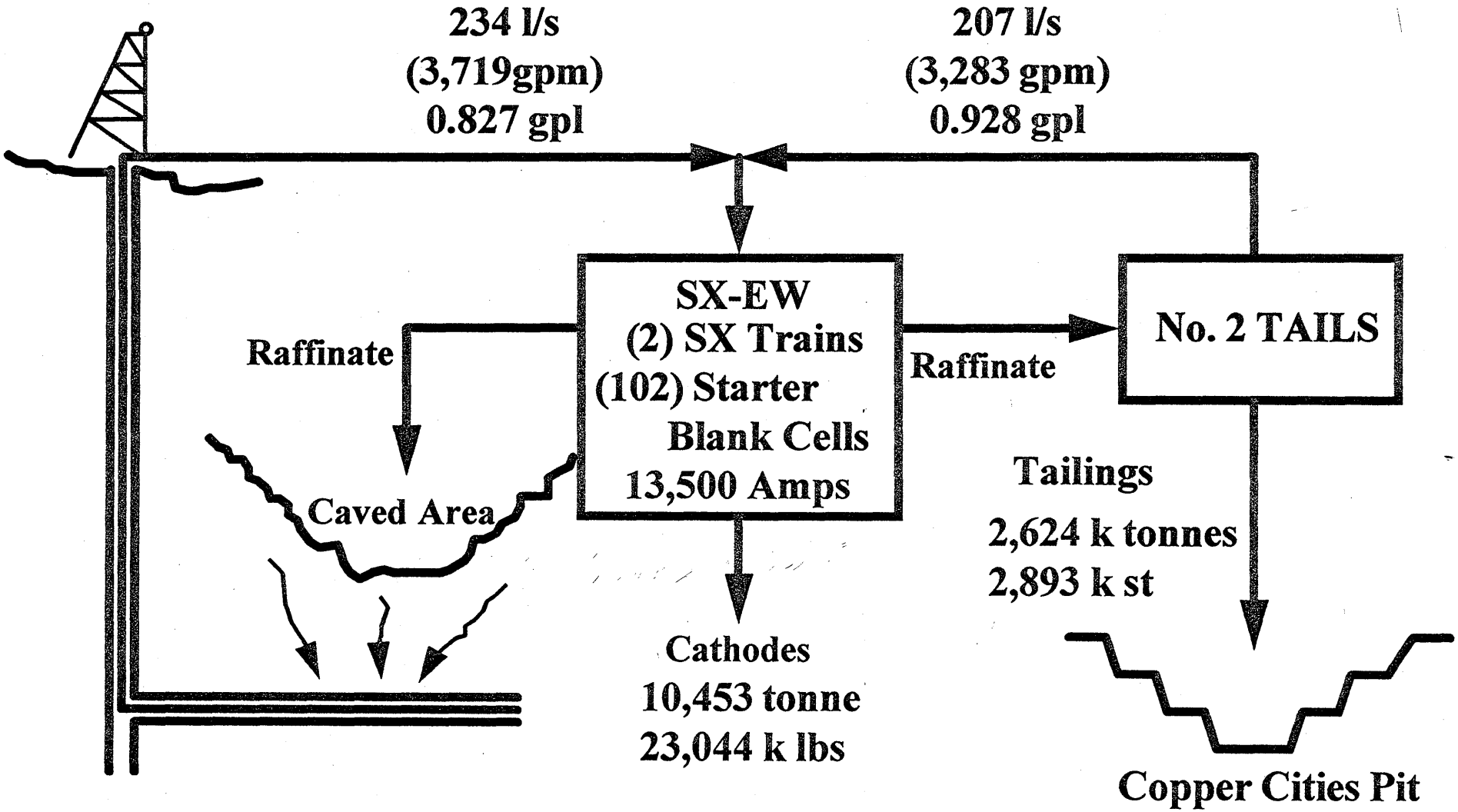


Pinto Valley SX-EW Cash Cost

1993	**$847/tonne**
	$0.384/lb
1994	**$758/tonne**
	$0.344/lb

Miami Unit Flowsheet

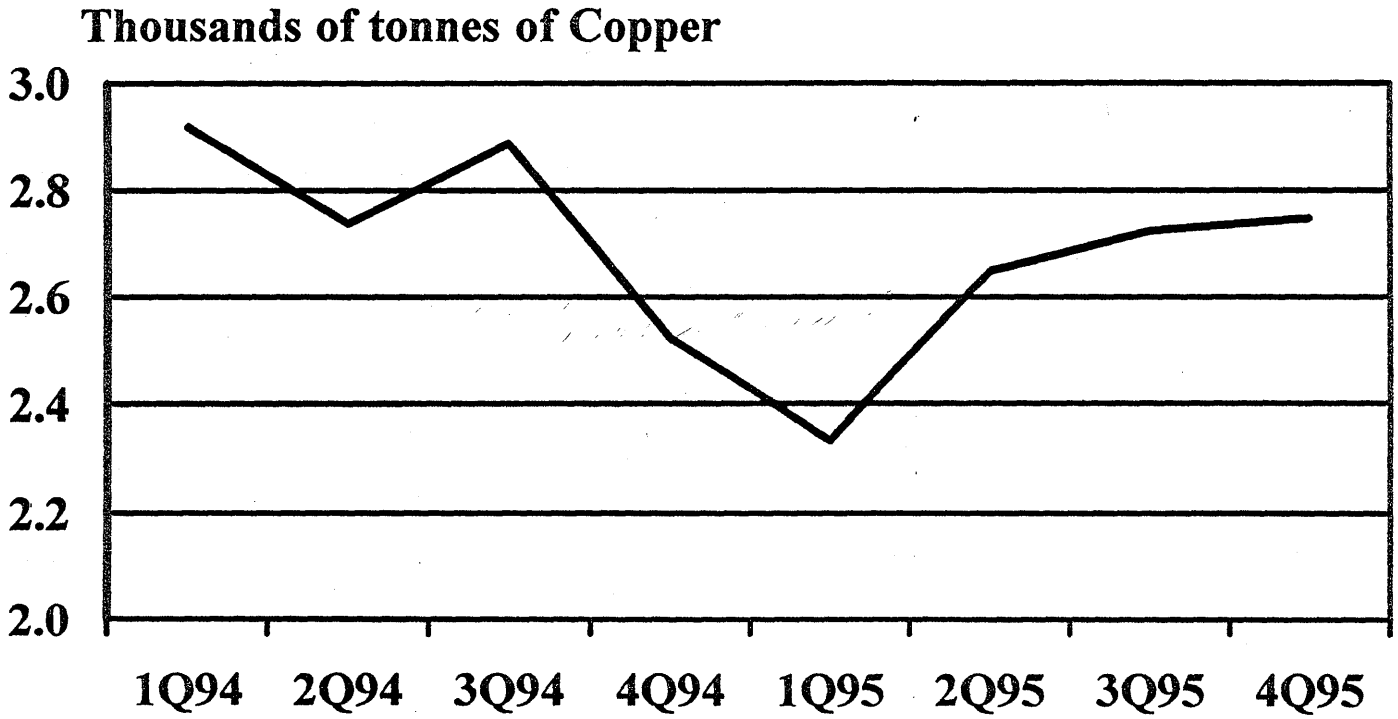
1995 YTD



BHP Copper Inc.

Pinto Valley Operations

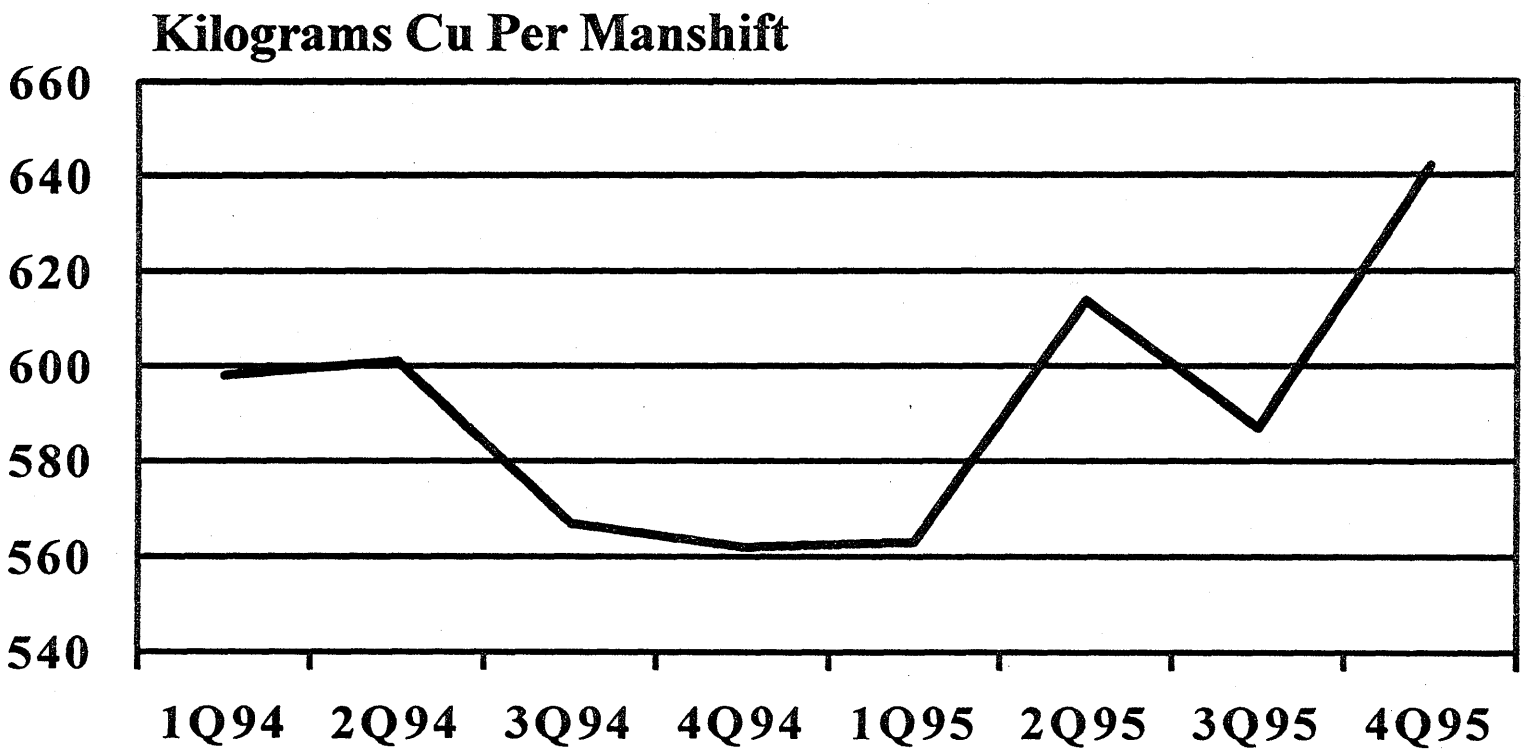
Miami Unit Production



Miami Unit Cash Cost

1993	**$1153/tonne**
	$0.523/lb
1994	**$1107/tonne**
	$0.502/lb

Division Productivity



Employees

	12/31/93	12/31/94	12/31/95
Hourly	470	449	470
Salary	163	151	151
Total	633	600	621

In-Situ Expansion Opportunity

- **In-Situ Expansion Feasibility Study**
  - **Completed 37 drill holes with over 30K feet of core**
  - **Modeling and metallurgical tests in progress**
  - **Final report due in 3Q 1996**
  - **Potential for 50 million lbs/yr**
  - **Possible start date 1998**

Slice 7 Expansion Opportunity

- Slice 7
  - Additional 737 million pounds of reserves
  - 1997 start pre-development stripping
  - Primary production 2002-2006
  - 170 million lbs/yr average copper in concentrate
  - 13 million lbs/yr average EW copper
  - $51 million stripping capital / $30 million equipment capital

Pinto Valley Mining Co.

WMC - PV Staff

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Fife Symington, Governor Russell F. Rhoades, Director

NOTICE OF THE PRELIMINARY DECISION TO ISSUE AN INDIVIDUAL AQUIFER PROTECTION PERMIT

Pursuant to Arizona Administrative Code, Title 18, Chapter 9, Article 1, the Director of the Arizona Department of Environmental Quality intends to issue an individual Aquifer Protection Permit to the following applicant(s):

Public Notice No. 50-96AZAP
Pinto Valley Mining Division

On or about June 27, 1996

BHP Copper Co.
Box 100
Miami, AZ 85539

Aquifer Protection Permit No. P-100329

The Pinto Valley Operations are located approximately 8 miles west of Miami, Arizona, in Gila County, over groundwater of the Salt River groundwater basin in Township 01 N, Ranges 13E and 14E, Gila and Salt River Base Line and Meridian:

Latitude	33° 24′ 33.0"	North
Longitude	110° 57′ 48.0"	West

The Pinto Valley Mining Division will be authorized to operate an open pit copper mine, pregnant leach solution (PLS) and raffinate processing facilities, seepage and stormwater retention facilities, surface runon/runoff facilities, tailings impoundments and ponds, leach dumps, waste rock dumps, the concentrator area and ancillary facilities according to the design and operational plans approved by the Arizona Department of Environmental Quality (ADEQ) Aquifer Protection Program Section.

The facility mines low-grade copper and molybdenum ore at a permitted rate of 87,600 tons per day. Both millable and leach-grade ore are mined. Millable ore is crushed and concentrated in on-site facilities. Copper concentrate is shipped to off-site facilities for smelting and refining. These off-site facilities are not part of this permit. Molybdenum concentrates are containerized and shipped off-site. Low-grade ore is deposited in the dump leaching area referred to as Gold Gulch. Raffinate solutions consisting of weak sulfuric acid are sprayed over the low-grade ore. The resulting pregnant leach solution (PLS) is collected in a double-lined facility with leak detection

and pumped to the SX/EW plant where it is processed using an organic solvent and electrowinning process. Resulting cathode copper is shipped off-site for further refining.

The permit and related materials are available for public review Monday through Friday 8:00 a.m. to 5:00 p.m. at the Arizona Department of Environmental Quality, Plan Review and Permits Section, 3003 N. Central Avenue, 5th Floor, Phoenix, AZ 85012.

Persons may submit comments or request a public hearing on the proposed action, in writing, to:

Shirin Tolle
Mining Unit
Water Protection Approvals
Arizona Department of Environmental Quality
3033 N. Central Ave.
Phoenix AZ, 85012

within thirty (30) days from the date of this notice. Public hearing request must include the reason for such a request.

PINTO VALLEY - TECH PAPER
RCh

ALTERNATIVES IN LOADING EQUIPMENT
ARIZONA CONFERENCE, DECEMBER 6TH, 1993

C.D. O'COYNE & R.W.THOMAS
MAGMA COPPER, PINTO VALLEY

Introduction

During the past several years, electric cable shovels have dominated the copper industry as the most favored low cost, high productivity loading tool. However, an aggressive mine plan may best be optimized by loading equipment which offers greater mobility and can operate in more confined locations. These loading options are currently being investigated at Magma Copper's Pinto Valley Mine.

The Pinto Valley Mining Division is located approximately six miles west of the town of Miami in Gila County, Arizona at an elevation of 4,000 feet. Development of the Pinto Valley open pit began in 1972 with the mine and concentrator starting production in 1974. The open pit mines at a total rate of 145,000 TPD, of which 63,000 TPD is milled and concentrated. Copper production from the open pit and concentrator alone averages over 76,000 tons per year.

The hydrothermal ore deposits in the Globe-Miami mining district comprise vein deposits and typical porphyry copper deposits. The Pinto Valley deposit is a hypogene ore body with chalcopyrite, pyrite, and minor molybdenite as the only significant primary sulfide minerals. It is the underlying protore of the chalcocite-enriched Castle Dome deposit which was mined between 1943 through 1953 from the Castle Dome Pit. The host rock for the porphyry copper deposit is the Precambrian Lost Gulch Quartz Monzonite, which is equivalent to the Ruin Granite. This material is generally silicious, fairly hard and abrasive in nature. Ore grade at Pinto Valley averages approximately 0.39% sulfide copper.

A Departure From Traditional Loading Equipment

Prior to 1992, the primary loading fleet consisted of two P & H model 2100 electric shovels, and three model 2300 electric cable shovels. These shovels were purchased between 1972 and 1982, and vary in bucket size between 15 and 27 cubic yards. Throughout the mine life, production per machine has varied between 12,000 to 21,000 tons per eight hour shift from a nominal bench height of 45 feet. Working areas averaged 260 feet wide to accommodate double side loading with the existing cable shovel fleet.

In an effort to lower stripping rates and reduce mining costs, more aggressive mine plans were evaluated during 1992 utilizing smaller push-back widths and less operating locations. Push-back widths were reduced to less than 220 feet on the west side of the pit.

While this type of strategy is effective in reducing the overall mining rate, it also decreases operational flexibility and productivity, and increases logistical constraints. Thus, more mobile and flexible loading equipment was sought to satisfy production requirements in tighter working areas. Both high capacity wheel loaders and hydraulic shovels were considered as possibilities.

Wheel Loaders

The first machine evaluated by Pinto Valley was a new high capacity wheel loader. There are currently three companies competing in the large loader market. Based on several factors, the Caterpillar 994 was selected as the best fit for the requirements at Pinto Valley. The new loader was delivered and ready for production on November 1, 1992. This loader was equipped with a high lift capability, 53.5 x 57 tires, and a 245 inch wide bucket (21 cubic yards) to help protect the front tires while at the digging face.

With the high lift option, the 994 has demonstrated that it is capable of loading 170 to 240 ton trucks with similar productivity. Pinto Valley utilizes a smaller 49.5 x 57 Goodyear tire due to increased operator comfort while loading on inclined surfaces. Loader tire life has exceeded the 2000 hours mark at this time.

Availability of the 994 for the first year on the property averaged 86.5%. This lower than anticipated availability was due to operator awareness and minor problems in the hydraulic pumps. During the last several months, the loader's availability has ranged from the low to middle 90%.

Although wheel loaders continue to exhibit higher unit loading costs than cable shovels, overall loading costs can be reduced by allowing cable shovels to be less mobile, thereby increasing productivity and decreasing shovel undercarriage wear. The mobility of a wheel loader makes it more effective at several loading applications than a cable shovel. Some of the loader applications and production rates as demonstrated at Pinto Valley are:

1) Primary Loading	16,000 to 18,000 tons per shift
2) Rehandling Stockpiled Ore	14,000 to 16,000 tons per shift
3) Mining Drop Cuts	12,000 to 14,000 tons per shift
4) Cleaning Final Banks	10,000 to 14,000 tons per shift
5) Mining Off Berms, Mud, & Chasing Low Banks	8,000 to 10,000 tons per shift

The increased flexibility of a wheel loader has increased the overall productivity of the entire loading fleet at Pinto Valley. During the first six months of 1993, loading costs were reduced by over 20%, even though the wheel loader costs were dramatically higher than cable shovel costs on a unit cost per hour basis. Thus, the higher productivity of cable shovels easily offset the higher costs and lower productivity of the wheel loader, resulting in lower overall loading costs for the entire loading fleet.

Hydraulic Shovels

The cable shovels operated at Pinto Valley are relatively small for the 190 ton haul trucks operated at the open pit, requiring four to six passes to load a truck. Since the mine plan stipulated reduced working faces, engineering and operations sought to evaluate a larger shovel which could also effectively operate in tighter areas.

A Demag 485S hydraulic mining shovel is being leased by Pinto Valley for one year to analyze how effective a hydraulic shovel will fit into the Pinto Valley mine plan. It will also help to determine if the mine can support the material movement from a shovel with a 40 yard bucket or larger, and how hydraulic loading costs compare to cable shovel costs.

There are presently seventeen 485S machines operating throughout the world. Three of these are diesel; the rest are electric. Pinto Valley's machine is equipped with a 44 cubic yard bucket and a 2800 HP electric over hydraulic power configuration. The hydraulic system of six main pumps has a volumetric capacity of 1428 GPM, developing 472,500 pounds of digging force. The shovel is designed to load 240 ton haul trucks with three pass loading, and mine a bench height of 50 feet, with a maximum reach of 59 feet. A 300 foot cable reeler on the rear of the shovel is synchronized to reel in and out as the shovel moves. The shovel also propels at nearly twice the speed, and requires 20% less working room, than that of comparable cable shovels.

With regard to assembly, the 485S was delivered the first week of July, 1993 and was ready for production on August 2, 1993. Except for a minor delay in the arrival of the electric motor, the erection of the shovel went smoothly and was completed on schedule in less than one month.

Since the shovel has started operation, the availability has averaged 91.2% with a utilization of over 99%. These numbers are indicative of the operators' acceptance of making a hydraulic shovel work well in an open pit copper environment. As the shovel operators began training during the first month, shovel productivity averaged only 18,000 tons per shift. During the month of November, 1993 productivity has increased to 27,000 tons per shift, with a maximum productivity of over 33,000 tons per shift.

Summary

Although electric cable shovels have dominated the copper industry as a low cost, high productivity loading tool, other loading alternatives exist. An aggressive mine plan consisting of smaller push-backs may be best optimized by loading equipment which offers greater mobility and operates in more confined locations. At Pinto Valley, the increased flexibility of a wheel loader has resulted in lowering overall unit loading costs by allowing cable shovels to remain more productive. The flexibility and productivity of a large hydraulic shovel is still being evaluated, but appears to be favorable at this time.

Pinto Valley Mine (Fire)

K

Minerals in Society Workshop

June 6, 1994

–Magma Copper Company

–Pinto Valley Field Trip

Pinto Valley Open Pit Copper Mine

- Orebody — TYPICAL ARIZONA PORPHYRY COPPER DEPOSIT
- OVERBURDEN — GILA AND WHITE TAIL CONGLOMERATES
- Host Rock
  - QUARTZ MONZANITE
  - GRANITE PORPHYRY
  - GRANO-DIORITE
  - DIABASE
  - PINAL SHIST

Pinto Valley Open Pit Copper Mine

- Mineralogy

– CHALCOPYRITE	CUFES2
– COVELLITE	CUS
– CHALCOCITE	CU2S
– MOLYBDENITE	MOS2
– PYRITE	FES2
– SPHALERITE	ZNS
– GOLD	AU
– SILVER	AG

Pinto Valley Open Pit Copper Mine

- **Structure**
  - DISEMINATED CU AND MOS2 WITH FES2
  - MICRO-MACRO VEINS OF CU-MOS2 WIITH FES2
  - POST INTRUSIVE QUARTZ VEINING
  - "ENRICHMENT BLANKET"

Pinto Valley Open Pit Copper Mine

- **Mining Statistics**

  - MINING RATE : 145,OOO TO 150,000 TPD

  - MILL ORE : 63,000 TPD @ + 0.27 % CU
  - LEACH ORE : @ 0.1 - 0.27 % CU
  - WASTE : @ < 0.1 CU

Pinto Valley Open Pit Copper Mine

- **Mining Sequence**

  - LAY OUT BLAST PATTERNS
    - » 33' X 33'
  - ROTARY DRILL BLAST HOLES
    - » 12 3/4" DIA. X 50' DEEP
  - LOAD ANFO EXPLOSIVES
  - BLAST
  - ELECTRIC AND HYDRAULIC SHOVEL LOADING
  - 190 TON TRUCK HAULAGE

Pinto Valley Open Pit Copper Mine

- **Ore Size Reduction**
  - PRIMARY CRUSHING
    - » ROM>>>>>> 6" 60" X 89" CRUSHER
  - CONVEY TO LIVE STOCKPILE
  - FINE CRUSHING PLANT
    - » 6">>>>>>>>>1/2"
    - » 7' STANDARD CONE CRUSHER
    - » 7' SHORT HEAD TERTIARY CRUSHER
    - » SIZING ON 8' X 20' VIBRATING SCREENS

Pinto Valley Copper - Moly Concentrator

- **Comminution -"Grinding and Classification"**
  - BALL MILLS 18' X 21' ALLIS CHALMERS OVERFLOW
  - SIZE REDUCTION FROM 1/2" TO +/- 150 MESH
  - BALL CHARGE 2 - 21/2" STEEL CAST BALLS
  - LINERS- CAST STEEL
  - MILLING RATE 450 TPH 63,000 TPD
  - HYDROCYCLONE SIZE CLASSIFICATION KREBS 33" DIA
    - » OVERFLOW: TO FLOTATION - 65MESH
    - » UNDERFLOW: BACK TO BALL MILL

Pinto Valley Copper - Moly Concentrator

- **REAGENTS: CHEMICAL CONDITIONING FOR COPPER RECOVERY**
  - COLLECTOR: XANTHTE DI-THIO-PHOSPHATE
  - FROTHER: ALCOHOL GLYCOL
  - pH MODIFIER: LIME (PYRITE DEPRESSION)
- **Froth Flotation**
  - DEFINITION: PHYSIO-CHEMICAL CONDITIONING OF MINERAL SURFACES TO AFFECT A SELECTIVE RECOVERY OF MINERALS FROM A SLURRY
  - MACHINERY: FLOTATION CELLS WEMCO 100 AND 300 CU FT
  - COLUMN FLOTATION CELLS

Pinto Valley Copper - Moly Concentrator

- **FEED TO PLANT: + .2 –.4 % CU**
- **CONCENTRATE: +/- 30 % CU**
- **TAILINGS: +/- .04 % CU**
- **RECOVERY: +/- 90%**

  - REGRINDING: 150 TO 400 MESH
    - » COPPER-GANGUE LIBERATION
    - » CONCENTRATE UPGRADING

Pinto Valley Copper - Moly Concentrator

- Copper - Moly Separation
  - BULK COPPER-MOLY CONCENTRATE 30% CU AND 0.5 % MOS2
  - CHEMICAL CONDITIONING
  - MOLY PRODUCT 85 TO 88% MOS2 AND 2% CU
- Thickening - Filtration
  - THICKENING: DENSIFICATION OF SOLIDS FOR WATER RECOVERY
  - FILTRATION: REMOVAL OF WATER IN PREPARATION FOR DRYING SOLIDS

Pinto Valley Copper - Moly Concentrator

- Tailings Disposal
  - WASTE SANDS CYCLONED AND STACKED FOR DISPOSAL
  - PROCESS WATER RECLAIMED FOR REUSE IN PLANT - 60 %
- Tailings Reclaimation
  - ENVIRONMENTAL LANDSCAPING AND WHOLISTIC RANGE MANAGEMENT FOR RECLAMATION
  - CATTLE AND NATIVE VEGETATION

Pinto Valley - SX- EW

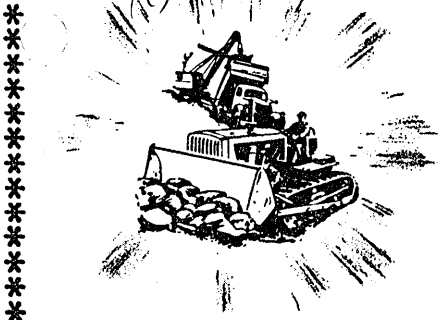
- Leaching - ACID SOLUABILITY OF COPPER MINERALS
  - MINERALOGY:
    - » SULFIDES: COVELLITE
      CHALCOCITE
    - » OXIDES: AZURITE
      MALACHITE
      TENORITE
      CHRYSACOLLA

Pinto Valley - SX- EW

- LEACHING METHOD
  - MINED ORE TO HEAPS 50' LIFTS
  - POLYETHELENE AND STAINLESS PIPING FOR SOLUTION DISTRIBUTION
  - SPRINKLERS
  - SULFURIC ACID (H_2SO_4) LEACH SOLUTION
  - COLLECTION OF PREGNANT SOLUTION IN PONDS
  - PUMPING TO SOLVENT EXTRACTION PLANT

NICHOLS DEVELOPMENT CORPORATION

HEAVY EQUIPMENT RENTAL
Box 167
Globe, Az. 85502
Phone 425-7006 • 425-8116



63904160

GARY

October 20, 1986

State of Arizona -State Mine Inspector
705 West Wing Capitol Building
Phoenix, Arizona 85007

Dear Sir:

This letter serves as notification that Nichols Development Corporation will be working with Pinto Valley Copper Corporation, under bid number 1011754. Work on this project began on October 16, 1986, and will last approximately two months.

This project consists of the following:

#3 Tailings Dam	constructing 3 tailing dam
#2½ Tailings Dam	dam to be constructed of all dirt
#2 Tailings Dam	dam to be constructed with crawler tractors

The job site will be at the Pinto Valley operations and there will be ten persons working on this project.

Any further information can be obtained by call our office at 425-7006. We are located at 1750 North Broad, Globe, Arizona.

Sincerely,

Jackie Hesketh

Jackie Hesketh
Secretary

cc: Mine Health & Safety Administration
Mr. G. J. Klein
Mr. Paul Francom

STATE MINE INSPECTOR

OCT 22 1986

PINTO VALLEY (P)

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

ROSE MOFFORD, GOVERNOR
RANDOLPH WOOD, DIRECTOR

JOINT NOTICE OF PROPOSED ACTION

by the

U. S. Environmental Protection Agency
Region 9 (W-5-1)
215 Fremont Street
San Francisco, CA 94105

Telephone: (415) 974-8105

On Application for National Pollutant Discharge Elimination System (NPDES) Permit to Discharge Pollutants to Waters of the United States

State of Arizona
Department of Environmental Quality
2005 North Central Avenue-Room 202
Phoenix, AZ 85004

Telephone: (602) 257-2270

On Application for Certification for Compliance with Applicable Effluent Limitations and Appropriate Requirements of the State of Arizona

The Environmental Protection Agency (EPA), Region 9, San Francisco, California, and the Arizona Department of Environmental Quality (ADEQ) are jointly issuing the following notice of proposed action under the Clean Water Act (CWA).

The Environmental Protection Agency, Region 9, San Francisco, California, has received a complete application for a National Pollutant Discharge Elimination System (NPDES) permit and has prepared tentative determinations regarding the permit.

On the basis of preliminary review of the requirements of the Clean Water Act, as amended, the implementing regulations, the Regional Administrator, Region 9 Environmental Protection Agency, proposes to issue an NPDES permit to discharge to the following applicant, subject to certain effluent limitations and special conditions.

Public Notice No. 17-89-AZ July 3, 1989

Magma Copper Company
Pinto Valley Division
P. O. Box 100
Miami, Arizona 85539
NPDES Permit No. AZ0020401

The applicant operates the Pinto Valley Copper Mine located approximately eight (8) miles west of Miami in Gila County. They have four (4) discharge points. Three (3) of the discharge points (002 - latitude 33° 23' 29" N, longitude 110° 59' 05" W; 003 - latitude 33° 25' 20" N, longitude 110° 59' 50" W; and, 004 - latitude 33° 23' 02" N, longitude 110° 58' 12" W) discharge as a result of excess precipitation. The remaining discharge point (005 - latitude 33° 22' 44" N, longitude 110° 57' 23" W) has a continuous discharge. On October 10, 1984, the Water Quality Control Council granted a mixing zone for discharge points 002, 003 and 004 to the Pinto Valley Mine. All discharges are to Pinto Creek in the Salt River Basin. Pinto Creek has protected uses of Aquatic and Wildlife, Incidental Human Contact, Agriculture Irrigation and Agriculture Livestock Watering. The proposed permit contains effluent limits for Suspended Solids, Cadmium, Copper, Lead, Mercury, Zinc and pH. The proposed permit will expire approximately five (5) years after it becomes effective.

The State of Arizona is considering a request to certify the discharge described above, pursuant to Section 401 of the Clean Water Act. The certification will set forth any limitations and monitoring requirements necessary to assure compliance with water quality standards under Section 303, areawide waste treatment management plans under Section 208(e), effluent limitations under Sections 301 and 302, standards of performance under Section 306, or prohibitions, effluent standards or pretreatment standards under Section 307 of the CWA, and any other appropriate requirement of State law.

The State may certify a draft permit and specify conditions which are more stringent than those in the original draft permit, where the State finds such conditions necessary to meet the requirements of the CWA. For each more stringent condition, the certifying State agency shall cite the CWA or State law references upon which that condition is based. Review of appeals of limitations and conditions attributable to State certification shall be made through the applicable procedures of the State.

The Administrative Record, which includes the application, draft permit conditions and other relevant documents, is available for public review Monday through Friday from 9:00 a.m. to 4:00 p.m. at the EPA address below. A copy of the draft permit and other pertinent documents may be obtained by calling or writing to the addresses below.

Persons wishing to comment upon or object to the proposed determinations or request a public hearing pursuant to 40 CFR 124.12 should submit their comments or request in writing within 30 days from the date of this notice, either in person or by mail to:

U. S. Environmental Protection Agency
Region 9 (W-5-1)
Attn: Jon Hangartner
215 Fremont Street
San Francisco, CA 94105

Telephone: (415) 974-8299

State of Arizona
Department of Environmental Quality
Attn: Wayne H. Palsma - Room 202
2005 North Central Avenue
Phoenix, AZ 85004

Telephone: (602) 257-2270

All comments or objections submitted within 30 days from the date of this notice will be considered in the formulation of the final determinations regarding the application. If the response to this notice indicates a significant degree of public desire for a public hearing, the Regional Administrator shall hold one in accordance with 40 CFR 124.12. A public notice of such hearing will be issued at least 30 days prior to the hearing. A request for a public hearing shall be in writing and shall state the nature of the issues proposed to be raised in the hearing.

The permit will become effective 33 days following the date of mailing by the EPA of the final permit. If no comments request a change in the draft permit, the permit will become effective three (3) days from the date of mailing.

A request for an evidentiary hearing may be submitted to the Permits Record Coordinator, (W-5-1), within 33 days following the mailing of the final determination, in accordance with 40 CFR 124.74. If granted, applicable provisions of the permit will be stayed pending the hearing.

Please bring the foregoing notice to the attention of all persons you know would be interested in this matter.

P to Valley file

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

ROSE MOFFORD, GOVERNOR
RANDOLPH WOOD, DIRECTOR

JOINT NOTICE OF PROPOSED ACTION

by the

U. S. Environmental Protection Agency
Region 9 (W-5-1)
75 Hawthorne Street
San Francisco, CA 94105

Telephone: (415) 744-1923

On Application for National Pollutant Discharge Elimination System (NPDES) Permit to Discharge Pollutants to Waters of the United States

State of Arizona
Department of Environmental Quality
2005 North Central Avenue-Room 202
Phoenix, AZ 85004

Telephone: (602) 257-2270

On Application for Certification for Compliance with Applicable Effluent Limitations and Appropriate Requirements of the State of Arizona

The Environmental Protection Agency (EPA), Region 9, San Francisco, California, and the Arizona Department of Environmental Quality (ADEQ) are jointly issuing the following notice of proposed action under the Clean Water Act (CWA).

The Environmental Protection Agency, Region 9, San Francisco, California, has received a complete application for a National Pollutant Discharge Elimination System (NPDES) permit and has prepared tentative determinations regarding the permit.

On the basis of preliminary review of the requirements of the Clean Water Act, as amended, the implementing regulations, the Regional Administrator, Region 9 Environmental Protection Agency, proposes to issue a NPDES permit to discharge to the following applicant, subject to certain effluent limitations and special conditions:

Public Notice No. 18-91-AZ March 4, 1991

Magma Copper Company
Pinto Valley Division
P. O. Box 100
Miami, Arizona 85539
NPDES Permit No. AZ0020419

The applicant operates an existing copper mine located approximately 3 miles north of Miami in Gila County. This mine is presently inactive. They normally operate in a no discharge mode. If they do discharge, their discharge would consist of seepage and runoff from inactive dumps and related areas. They have three discharge points: No. 002 to Pinal Creek via Tinhorn Wash and Miami Wash at latitude 33° 26' 25" N, longitude 110° 51' 41" W; No. 003 to Pinal Creek via Unnamed Drainage at latitude 33° 27' 27" N, longitude 100° 51' 31" W; and, No. 004 to Pinal Creek via Unnamed Drainage at latitude 33° 27' 35" N, longitude 110° 51' 10" W. Miami Wash has protected uses of Aquatic and Wildlife, Agriculture Irrigation and Agriculture Livestock Watering. Pinal Creek has protected uses of Aquatic and Wildlife, Incidental Human Contact, Agriculture Irrigation and Agriculture Livestock Watering. The proposed permit contains effluent limits for Cadmium, Copper, Lead, Mercury, Zinc, Cyanide and pH. The proposed permit will expire approximately five years after it becomes effective.

The State of Arizona is considering a request to certify the discharge described above, pursuant to Section 401 of the Clean Water Act. The certification will set forth any limitations and monitoring requirements necessary to assure compliance with water quality standards under Section 303, areawide waste treatment management plans under Section 208(e), effluent limitations under Sections 301 and 302, standards of performance under Section 306, or prohibitions, effluent standards or pretreatment standards under Section 307 of the CWA, and any other appropriate requirement of State law.

The State may certify a draft permit and specify conditions which are more stringent than those in the original draft permit, where the State finds such conditions necessary to meet the requirements of the CWA. For each more stringent condition, the certifying State agency shall cite the CWA or State law references upon which that condition is based. Review of appeals of limitations and conditions attributable to State certification shall be made through the applicable procedures of the State.

The Administrative Record, which includes the application, draft permit conditions and other relevant documents, is available for public review Monday through Friday from 9:00 a.m. to 4:00 p.m. at the EPA address below. A copy of the draft permit and other pertinent documents may be obtained by calling or writing to the addresses below.

Persons wishing to comment upon or object to the proposed determinations or request a public hearing pursuant to 40 CFR 124.12 should submit their comments or request in writing within 30 days from the date of this notice, either in person or by mail to:

U. S. Environmental Protection Agency
Region 9 (W-5-1)
Attn: L. Silva
75 Hawthorne Street
San Francisco, CA 94105

Telephone: (415) 744-1923

State of Arizona
Department of Environmental Quality
Attn: Wayne H. Palsma - Room 202
2005 North Central Avenue
Phoenix, AZ 85004

Telephone: (602) 257-2270

All comments or objections submitted within 30 days from the date of this notice will be considered in the formulation of the final determinations regarding the application. If the response to this notice indicates a significant degree of public desire for a public hearing, the Regional Administrator shall hold one in accordance with 40 CFR 124.12. A public notice of such hearing will be issued at least 30 days prior to the hearing. A request for a public hearing shall be in writing and shall state the nature of the issues proposed to be raised in the hearing.

The permit will become effective 33 days following the date of mailing by the EPA of the final permit. If no comments request a change in the draft permit, the permit will become effective three (3) days from the date of mailing.

A request for an evidentiary hearing may be submitted to the Permits Record Coordinator, (W-5-1), within 33 days following the mailing of the final determination, in accordance with 40 CFR 124.74. If granted, applicable provisions of the permit will be stayed pending the hearing.

Please bring the foregoing notice to the attention of all persons you know would be interested in this matter.

DEPARTMENT OF MINERAL RESOURCES
State of Arizona
MINE OWNER'S REPORT

Date September 26, 1958

1. Mine: Castle Dome Division, Miami Copper Company.
2. Location: Sec. unsurveyed Twp. 1N Range 13E Nearest Town Miami Distance 10 miles
   Direction East Nearest R.R. Southern Pacific Distance 10 miles
   Road Conditions Black top road to property.
3. Mining District and County: Miami Mining District, Gila County
4. Former Name of Mine: Castle Dome Mine - Pinto Valley Development Co.
5. Owner: Miami Copper Company
   Address: Miami, Arizona
6. Operator: Mined out.
   Address:
7. Principal Minerals: Copper
8. Number of Claims: Lode Patented Unpatented
   Placer Patented Unpatented
9. Type of Surrounding Terrain:
10. Geology and Mineralization:
11. Dimension and Value of Ore Body:

Please give as complete information as possible and attach copies of engineer's reports, shipment returns, maps, etc. if you wish to have them available in this Department's files for inspection by prospective leasors or buyers.

(over)

B-41

CASTLE DOME MIAMI See; MINING WORLD March, 1959, p 91

Total 1-1-52		$ 66,000,000	
1952	Gold & Silver	$ 38,474	
	Copper	12,743,000	(52,655,859 # @24.2)
1953	Gold & Silver	46,831	
	Copper	11,755,000	(40,815,598 # @28.8)
1954	Copper	244,000	(29.6) (815,190)
1955	copper	836,000	(2,229,277 # @37.5)
1956	Copper	2,187,000	(5,233,464 # @41.8)
1957	Copper	1,497,000	(4,990,745 # @30.0)
1958	Copper	1,358,000	(5,264,166 # @25.8)
1959	Copper	1,520,000	(4,902,751 # @31)
		$ 98,225,000	

B40

STATE OF ARIZONA
DEPARTMENT OF MINERAL RESOURCES
MINERAL BUILDING, FAIRGROUNDS
PHOENIX, ARIZONA 85007

July 20, 1976

COPY

Mr. R. P. Hughes,
Manager of Operations,
Cities Service Company
P. O. Box 100
Miami, Arizona 85539

Dear Mr. Hughes:

Thank you very much for furnishing the Department of Mineral Resources with the 1975 production data for your Arizona mining operations.

Enclosed is a copy of the completed 1974-1975 tabulations for all large Arizona copper producers.

If the Department, or I, can be of assistance to you at any time, please contact us.

Sincerely,

Glenn A. Miller
Mineral Resources Specialist

Enclosure

GAM:pp

File: Cities Servic
e, Pink Reading
Alpha "C" Copper Report, GAM file

B4

THE STORY OF THE MIAMI - INSPIRATION COPPER DISTRICT

The Miami-Inspiration Copper District attained a production of 181 million pounds of copper in 1951. Three large mines were responsible for practically all of it. They are the Inspiration, the Miami and the Castle Dome. The latter is a wholly owned subsidiary of the Miami Copper Company, and altho the Castle Dome ore-body is located miles away from the Inspiration-Miami ore system, its mineralization is related to that of the other low-grade copper deposits in the area, the generally accepted theory being that the older formations were intruded by the Schultze granite, providing an avenue for secondary enrichment along the contact.

History *

The major developments in the Miami-Inspiration district have all happened in the twentieth century. At the beginning of the century, chrysocolla, a blue-green copper silicate mineral containing when pure about 36 percent copper, had been mined at the Keystone Mine, and soon after, a vein of chrysocolla was stoped at the Live Oak. Both of the veins were in granite porphyry and did not extend into the schist. Several years later the Woodson tunnel was driven in the north side of Inspiration Ridge. This tunnel cut disseminated chalcocite, a black-grey copper sulphide mineral containing when pure about 80 percent copper, and some crude ore was mined from a zone of stringers in the schist. In 1906 the General Development Company sank a shaft on the Captain claim and another on the Red Rock, the latter striking ore at a depth of 220 feet. The Miami Copper Company was organized in November of that year and development work was actively undertaken. By 1909 the railroad had been extended to Miami from Globe, and in 1911 the first concentrates were produced after an intensive construction period which saw the completion of a mill, power plant, and other surface equipment.

During this period the Inspiration Copper Company and the Live Oak Development Company were also engaged in development work. At Inspiration active development by shafts, drifts, and crosscuts, as well as churn drilling, was begun in 1909. Two years later, 21,000,000 tons of ore had been outlined. The Live Oak had by 1912 developed 15 million tons of ore despite the fact that much of the ore body lies deeper than at either Miami or Inspiration and is covered by porphyry and Gila conglomerate. The Live Oak and Inspiration merged in January, 1912 as the Inspiration Consolidated Copper Company with ore reserves of 45,300,000 tons averaging 2 percent copper.

Further developments and refinements in mining and milling methods have greatly increased the ore reserves of both major companies.

Between 1906, when J. Parke Channing examined the deposits at Miami and exploratory shafts were started, and 1911, when the Miami Copper Company began to produce concentrates, almost ten million dollars had been expended in the preparation for production.

Development of the Inspiration ore-bodies began in 1909 and about fifteen millions had been spent before the production of copper in 1915. In 1915 the International Smelting Company erected a three million dollar smelter at Miami.

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* From a paper presented by G. R. Rubley to the A.I.M.& M.E.at Tucson,Nov.1938.

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The third big producer, the Castle Dome mine, is located about nine miles by highway west of Miami and some three miles north of Pinto Creek. The first systematic exploration work was initiated in the early twenties by the Pinto Valley Mining Company. Jackson Hoagland has written a good description of the Castle Dome operations and much of this history of the Castle Dome area has been taken from his description, written in 1946. The churn drilling conducted from 1924 until 1931 proved the existence of the deposit - and provided valuable information as to its size and grade. Subsequent mining operations by Castle Dome Mining Company have verified the accuracy of the earlier determination.

Miami Copper first b ecame interested in the region when it acquired the Continental group of claims adjoining the Castle Dome group through its purchase of the Old Dominion Company. Because the surface geology indicated the possibility of copper values underlying a considerable area, an option was acquired on the Pinto Valley Mining Company holdings and extensive surveys and churn drilling were undertaken to determine the extent and grade of the deposit.

Miami Copper had considered the property as a possible future reserve, but about that time the government became vitally interested in increasing copper output. Consequently, arrangements were completed for the RFC subsidiary, Defense Plant Corporation, to provide the funds necessary to equip the property, and, late in 1941, Miami Copper exercised its option on the Pinto Valley holdings. These claims, together with the Continental group, were then deeded to Castle Dome Copper Company.

One of the most remarkable achievements of the entire operation was the speed with which the property was brought into production once the decision to go ahead was reached. The project was granted top priority by the government and the W. A. Bechtel Company commenced preliminary work early in January of 1942 as engineer-contractor. Seventeen months later copper concentrates started moving from the company's mill to the International smelter at Miami.

Castle Dome took the mine over from the contractor on April 19, 1943, and accepted the concentrator on June 10 of that same year. By this time the Bechtel Company had stripped the orebody of nearly 14,000,000 tons of waste, stockpiled 473,000 tons of ore, constructed a 10,000-ton flotation plant and built a 4½-mile paved highway to the property.

To provide the necessary water, a 16" combination steel and wood stave pipe line was laid a distance of over 11 miles from the Old Dominion mine at Globe to Castle Dome and a 3,563,000-gallon reservoir was built. A power line was erected to connect the property with the Salt River Valley Water Users Association system.

The most remarkable achievement of this operation has been the fact that though the ore mined has contained only twelve to sixteen pounds of copper per ton, the Castle Dome Mining Company has paid in rental to the Defense Corporation a total of approximately sixteen million dollars, and has had net earnings of almost ten million dollars before depreciation and depletion.

Geology of the Miami-Inspiration District

The Pinal Range, which covers an area about 16 miles long and 12 miles wide, is made up largely of Pinal schist with considerable irregularly intruded quartz diorite and granite and also a younger intrusive, the Schultze granite. The disseminated copper deposits of Miami occur in the northeast corner of this area.

Probably the most important rock associated with the copper deposits of Inspiration, Miami and Castle Dome is the Schultze granite. This has been minutely fissured and the cracks have been filled with quartz and to a less extent with sulphides. The result is a very brittle and fragile mass that, with the crumbly character of the Pinal schist, is so essential to successful block-caving methods of mining.

The Miami district contains numerous faults[1] which have played an important part in the mineralization of the district. The metallic minerals of interest are native copper, native silver, molybdenite, galena[2], chalcocite[3], covellite[4], chalcopyrite[5], pyrite[6], cuprite[7], malachite[8], azurite[9], and chrysocolla[10].

The bodies of disseminated copper ore of Miami, Castle Dome and Inspiration may be characterized generally as undulating, flat-lying masses of irregular horizontal outline and variable thickness. As a rule these masses lack definite boundaries. Closely placed sampling and assays indicate a gradational passage from ore to country rock. The depth to the ore ranges greatly from place to place, as in many places the leached rock itself is overlain by dacite or Gila conglomerate.

In a general way the Miami ore-body is chiefly in schist, although a granite-porphyry dike cutting the schist has likewise been metallized. The Inspiration ore-body is also mainly in the schist, although in places this schist occurs beneath an intrusive sheet of the porphyry. The predominant feature of the Castle Dome orebody is the Dome or Turtleback fault which divides it into two parts. To the east of this fault the ore is largely of a soft nature with chalcocite the predominant copper-bearing mineral. To the west is a harder ore in which chalcopyrite is the principal source of copper.

Operations at Miami

The Miami Copper Company's property has been an underground mining operation with a block-caving system of mining to take out the ore. When the 6,000 ton mill was ready to start in 1911, gravity concentration was standard practice, and the mill was equipped with chilean mills for fine-crushing, and tables for concentration. The chilean mills were soon replaced by Hardinge ball and pebble mills, and a short time later steel balls replaced the pebbles. These

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1. Fault - a fracture in the earth's crust accompanied by displacement of one side of the fracture with reference to the other.
2. Galena - Lead sulphide - 87% lead, 13% sulphur.
3. Chalcocite - Copper sulphide - 80% copper, 20% sulphur.
4. Covellite - Copper sulphide - 66.5% copper, 33.5% sulphur.
5. Chalcopyrite - Copper Iron Sulphide - 35% copper, 30% iron, 35% sulphur.
6. Pyrite - Iron Sulphide - 47% iron; 53% sulphur.
7. Cuprite - Copper Oxide - 89% copper, 11% oxygen
8. Malachite - Copper Carbonate - Green - 57.5% copper.
9. Azurite - Copper Carbonate - Blue - 55.0% copper.
10. Chrysocolla - Copper Silicate - Green - 36.2% copper.

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technical improvements continued with the adoption of flotation. Indeed, the Miami Copper Company, like the other big copper companies, was continually spending money to enable it to profitably treat a gradually lowering grade of ore. In recent years it is now possible to make money in the treatment of ore containing as low as .75% copper (15 lbs.per ton). When the grade of ore dropped below 1 percent, milling capacity was increased to 17,500 tons per day.

It was necessary to do this or suspend operations entirely. A plan of mining operations was worked out on paper by Mr. Maclennan and his associates. They showed the directors of the Miami Company that it would be possible to mine this low-grade ore at a cost well below 50 cents per ton, and the directors authorized the expenditure of almost four million dollars to effect the expansion in plant capacity from 6600 to 17,500 tons daily.

The production of copper at a cost of 10 cents per pound from an ore giving a net yield of only 10.55 lbs per ton had never been achieved before. Economies effected both in mining and in concentrating as between 1923 and the later dates are due in part to the increased tonnage, but improved efficiency in many directions likewise is a factor. It is difficult to refrain from using extravagant adjectives to describe such figures as 35.7 cents per ton for mining and 24.9 cents for concentrating. The tailings discarded from the concentrator during the first three years of operation averaged 14.52 lb. of copper per ton. In November, 1930, the ore as mined and treated contained less copper than the ton of tailing rejected 15 years earlier.

The Miami ores contain very little gold and silver but since 1938, commercial quantities of molybdenum have been recovered from the copper ores, and have been a factor in keeping the mine in the profitable class. Leaching of the oxidized portion of the mixed ords produced by the mine, has also been employed by the Company in attaining the economic success of its operations. The Miami Copper Company has been a shining example of how a combination of capital, progressive business acumen and technical brains has converted common rock into useful metal.

Up to January 1, 1952, the Miami mine has produced over 140 million tons of ore from which have been recovered over 2100 million pounds of copper, which together with small values of gold, silver and molybdenum had an estimated total value of $330,000,000.

Operations at Inspiration

The Inspiration Consolidated Copper Company's plant at Miami, Arizona, was designed and built to make possible the profitable working of a low grade, finely disseminated copper deposit containing 100 million tons of ore averaging 1.54% copper.

From the beginning it was evident that the plant could not be kept integral but that a break would have to be made somewhere in the flow-sheet, removing at least the concentrator to a site more suitable than any available near the mine. It was finally decided to do the coarse crushing at the mine, to store the crushed rock in a bin from which it could be loaded into railroad cars and to haul it to the concentrator, an excellent site for which was available about 1-3/4 miles from the mine.

The original intention was to equip a plant to treat 7500 tons of ore per day, but through the acquisition and proving up of additional ore reserves, the introduction of the Ohio caving system, and the excellent results in the test mill (which made it possible to treat a lower-grade ore than had been thought possible) it was evident that a plant of much greater capacity should be

supplied. It was, therefore, decided to treat approximately 15,000 tons of ore per day.

A gravity test mill was erected and placed in operation near the Joe Bush shaft in November 1910, and its operation was continued until August, 1911. Soon after, flotation began to attract considerable attention, and a 600-ton test mill was designed and erected in 1913. That the large-scale test-mill method for working out flow-sheets for large plants is the only logical method, is evidenced by the fact that in nearly every stage of treatment either an entirely new machine has been adopted or a new application has been made of a standard machine; the result in each case being increased efficiency or a more economical arrangement. It may be interesting to note that six complete designs for the concentrator were executed, the idea being to keep this work abreast of the developments brought out by the test-mill.

The concentrator was no sooner erected than very marked changes in grinding machinery began to develop, the ultimate result of which was another altogether new arrangement for the entire mill.

As a result of preliminary studies, a dual arrangement of the mine plant was evolved. To insure continuity of service two shafts were used, and the whole mine plant was made duplicate in arrangement. A water supply for the concentrator was developed at Wheatfields, about 12 miles from the mill site, and later, wells were sunk on the flat below the tailing storage site. The best location was determined to be about 2½ miles from the mill, at the junction of two-fair-sized drainage channels receiving their supply from the Pinal Mountains about 10 miles away and 4000 ft. higher.

Electric power was obtained from two sources. The Reclamation Service of U. S. Government at Roosevelt Dam, 40 miles away, furnished some of the power, and in conjunction with the International Smelting Co., the Inspiration built a power house that utilized reverberatory waste heat and also produced power from oil-fired boilers (later gas-fired).

Throughout the early years of mill operation, research and experimentation developed improvements, until in the early twenties, when the Inspiration ore being mined at that time, began to show larger proportions of non-sulphide copper which was not amenable to efficient treatment by flotation. A search was made for a process that would successfully treat such mixed ores. The main sulphide copper mineral was chalcocite and the principal non-sulphide, chrysocolla. Laboratory and test-plant investigations conducted by G. D. Van Arsdale, together with the Inspiration staff, proved that such mixed ores could be successfully treated by leaching with ferric sulphate. Many millions of dollars were expended in these tests and in the construction of a suitable leaching and precipitating plant. And since 1926, this method of treating the Inspiration ore has been standard practice.

An open-pit development and sonstruction program was completed in March, 1948, and since that time almost half of the ore mined has come from the open pit. In 1949 all necessary work underground was completed for leaching in place certain mined out and caved areas in the mine to recover part of the remaining copper. Production from this source began in 1950.

By January 1, 1952, the Inspiration mine had produced over 130 million tons of ore, from which had been recovered 2500 million pounds of copper worth about 400 millions of dollars.

Castle-Dome Operations

Castle Dome Copper Company mines and mills over 12,000 tons of ore daily. The mine is a typical open-pit operation with the latest and most modern equipment known to the industry. Electric churn drills, electric shovels, and diesel trucks are used. The concentrator is also one of the most modern and efficient in the industry. Its simplicity of design and operation has permitted the use of women as operators, which is one reason why this property was not as seriously affected as others by the labor shortage problems during the war. Automatic feed control, first conceived by F. W. Maclennan, and worked out by Miami and Castle Dome staffs together with Westinghouse Electric and Mfg., Co., has increased the plant's efficiency both as to tonnage and metallurgy. Tied in with the feed control is a water control which adjusts the flow of water into the mill, maintaining a constant density. The importance of this control to an operation like Castle Dome becomes apparent when it is realized that no attempt is made to control the hardness and grindability of the ore mined and delivered to the concentrator for treatment. The ore is dumped into the coarse ore pocket as it best suits the mining operation. At times it may carry 1 percent copper and others 0.4 per cent. Moreover, on one day it may come from the eastern portion of the ore body where the ore is softer, and the next from the western side where it is harder.

By January 1, 1952, the Castle Dome mine had produced over 33 million tons of ore from which had been recovered over 420 million pounds of copper, over five hundred thousand ounces of silver and over eight thousand ounces of gold, with an estimated value of 66 million dollars.

The Castle Dome mine is approaching exhaustion of its orebody, but the owners are already making preparations to open up a new mine in the Miami area. The Miami Copper Co's wholly owned subsidiary "The Copper Cities Mining Co", will utilize the mining and milling equipment of the Castle Come Copper Co. when the latter has ended its operation.

Conclusion

The above facts tell the story of how intelligent observation and scientific reasoning can be brought to bear even on the exploratory phase of mining which has seemed usually so haphazzard. In the case of the Miami mine the sum of $400,000 was risked to ascertain whether there was enough ore to constitute a profitable mine; after that point was passed, the further development underground served merely to emphasize the bigness of the orebody and the consequent need of making financial provisions for operations on a big scale. The story of the Miamiand the Inspiration suggests also that the successful exploitation of an orebody may involve operations on a scale so big as to require the expenditure of sums of money that make the original purchase of the bare ground seem very cheap; it indicates that a mining claim without the intelligent use of capital is only second-rate scenery.

In connection with the early development of the Miami-Inspiration district, the names of "Black Jack Newman", F. C. Alsdorf and F. J. Elliott, the latter a Phoenix attorney, should be mentioned as responsible for Mr. Channing becoming interested in the Miami property. Henry Krumb, W. B.Thompson and Dr. Ricketts were the men chiefly responsible for the development of the Inspiration. Needless to say the managers and staffs of the two companies furnished the brains which brought about the success of both ventures.

The three mines have been the producers of over 300 million tons of ore, from which have been recovered a total of 5 billion pounds of copper with a value of over 800 million dollars. A result far beyond the dreams of Parke Channing and Henry Krumb!

Most of the eight hundred million dollars benefitted the State of Arizona in the form of wages for its citizens, education for its children, a market for its farmers, and a higher standard of living for everyone. It has been determined that "for every man engaged in mining and allied industries, 2-1/3 jobs were created in service industries and (on the basis of average family size) a total of 12 local persons are thereby supported." Every miner, every millman and every smelter man who has taken part in this creation of wealth may take just pride in his share of such constructive work.

Arizona Department of Mineral Resources

March, 1952

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F K Knight

CASTLE DOME MINE

Located: 9 miles west and north of Miami elev. at shop site 4350.

History: Work was started by the W.A. Bechtel Co., Engineer-Contractors for the Defense Plant Corp. on January 1942. The first job was pioneering a road into the property.

On April 19, 1943 the Castle Dome Copper Co., Inc. took over the operations on the Dome. The contractor had stripped 13,803,461 tons of waste capping.

Castle Dome carried on the stripping operation until June 10, 1943, when the concentrator was started. Since that time we have mined ore as required by the concentrator and have stripped waste on the development program.

The original elevation on top the Dome was 4830 - the first or top bench was 4750 - and the first ore was mined on the 4430 bench.

To date there are 13 benches (only 3 are active) and 4 more are planned.

Waste removed to 12-1-44	
By Contractor	13,803,461 Tons
By Castle Dome	13,422,867 Tons
Total	27,226,328 Tons
Ore mined to 12-1-44	5,464,522 Tons

Waste To Ore Ratio: From April 19, 1943 to May 1, 1944 the mine operated at a waste to ore ratio of 3.3 to 1.

From May 1, 1944 to Dec. 1, 1944 the mine operated at a waste to ore ratio of 1.2 to 1.

Equipment

7- Bucyrus - Erie 29T churn drills.
3- Marion 4161 - 5 c.y. electric shovels.
1- Northwest 80D- 2-1/2 c.y. diesel shovel.
14- Knuckey 30 Ton trucks powered by 150 J. P. Cummins diesel motors.
4- Euclid 14 ton diesel trucks.
6- Caterpiller D-8 dozer, buggy and winch equipped.
4- Gardner-Denver 365 cu. ft. diesel powered, air compressors.
5- Ingersoll-Rand FM 2 Wagon drills.

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Bench Height: The top 12 benches are 40 ft. in height. The lowest bench is 45 ft. and all future benches will be 45 ft. The backslope is 45 degrees overall, made up of a 20 ft. bench and a 1/2 to 1 slope on the 40 ft. bank.

Present operations:

Per 24 hours:
8 churn drill shifts.
6 electric shovel shifts.
30 Knuckey truck shifts.
7 days per week - men working 6 days.
Approximately 27,000 tons per 24 hours, of which 12,500 tons are ore and 14,500 tons waste.

Explosives and Blasting: We use 40% special gelatine dynamite in the 8x18 - 50 lb. cartridge and 20% quarry bag powder. Our monthly consumption will average 2/3 bag and 1/3 gel.

The churn drills use a 9" bit which gives a 10" blast hole. Holes are spaced approx. 18 ft. apart with 30 ft. of burden on the tow and are drilled 5 ft. below grade. The charge for each hole is calculated. Primacord is used for detonating the holes.

Efficiencies: November 1944
Marion Electric Shovel
4106.9 tons per shovel shift.

Knuckey trucks
934.6 tons per shift
29.1 tons per trip
32.1 trips per shift
1.03 avg. haul miles (round trip)
483.2 ton miles per shift. (load trip)

Churn drills
87.2 ft. per drill shift
88.2 ft. per bit use.

Blasting
5.0 tons per lb. of powder.
53.2 tons per ft. of drill hole.

MINING AND MILLING PRACTICE OF CASTLE DOME COPPER COMPANY

By
Jackson Hoagland
Editor, Mining World

Great demand, RFC financing, premium prices and good management have combined to make a low-grade, disseminated copper deposit near Miami, Arizona, that was considered to be merely a promising prospect prior to the war, into one of the state's most substantial producers. It is currently contributing about 10 per cent of Arizona's total output.

The mine is owned by Castle Dome Copper Company, a subsidiary of Miami Copper Company, and the plant and equipment are being leased on a royalty basis from the RFC.

The property is located about nine miles by highway west of Miami and some three miles north of Pinto Creek. The orebody occurs as a blanket formation in quartz monzonite porphyry with principal values in copper sulphides and only minor amounts of oxides. Its mineralization is related to that of the other low-grade copper deposits in the area, the generally accepted theory being that the older formations were intruded by the Schultze granite, providing an avenue for secondary enrichment along the contact.

The predominant feature of the Castle Dome orebody is the Dome or Turtleback fault which divides it into two parts. To the east of this fault the ore is largely of a soft nature with chalcocite the predominant copper-bearing mineral. To the west is a harder ore in which chalcopyrite is the principal source of copper.

Exploratory Work

Although Castle Dome is a new producer, it has been known for over 40 years that there was a low-grade copper deposit in the area. As early as 1906, three companies were undertaking exploratory work in the region, but in those days orebodies containing as little as 15 pounds of copper to the ton were not considered commercial. However, as time has gone on, developments in copper metallurgy and improvements in mining methods have steadily made the property appear more promising.

The first systematic exploration work was initiated in the early twenties by the Pinto Valley Mining Company which, between the years 1921 and 1924, acquired and consolidated the holdings of the Arizona National Copper Company, Cactus Copper Company, Pinto Mining Company and Castle Dome Development Company. Much credit for the successful development of the property is due to the enthusiasm and faith of the late Garret Mott, New York broker, in the deposit's possibilities. As president of the Pinto Valley Mining Company, he invested large amounts of his own capital in the exploration program and encouraged his friends to do likewise. He lived long enough to see his predictions come true.

Credit also is due T. R. Drummond of Hollywood, California, who supervised exploration work as general manager for the Pinto Valley Mining Company. The churn drilling program he conducted from 1924 until 1931 proved the existence of the deposit and provided valuable information as to its size and grade. Subsequent

mining operations by Castle Dome Copper Company have verified the accuracy of his work.

The Castle Dome orebody was first considered from the standpoint of underground mining methods. Initial cost was an important item to the operators who were confronted with the problems of a considerable trucking haul to the railroad and lack of water and power, the provision of which would require considerable expenditures. While it was known at the time that the ore could be successfully treated by flotation, a metallurgical treatment was sought that would give comparatively low first cost and yet produce results comparable to existing practice.

For several years experiments in leaching this ore were conducted by Harmon E. Keyes of Phoenix, first as metallurgical engineer for the United States Bureau of Mines, and later, after the Bureau of Mines had completed its work, as a member of the Pinto Valley staff. The first experiments were conducted on the so-called open drainage or heap leaching principal; later the possibility of leaching broken ore in place was investigated but low metal prices forced the suspension of all work in 1931 and nothing was done at the property until 1940 when Miami Copper began to survey its possibilities.

Miami Copper first became interested in the region when it acquired the Continental group of claims adjoining the Castle Dome group through its purchase of the Old Dominion Company. Because the surface geology indicated the possibility of copper values underlying a considerable area, an option was acquired on the Pinto Valley Mining Company holdings and extensive surveys and churn drilling were undertaken to determine the extent and grade of the deposit.

Miami Copper had considered the property as a possible future reserve, but about that time the government became vitally interested in increasing copper output. Consequently, arrangements were completed for the RFC subsidiary, Defense Plant Corporation, to provide the funds necessary to equip the property, and, late in 1941, Miami Copper exercised its option on the Pinto Valley holdings. These claims, together with the Continental group, were then deeded to Castle Dome Copper Company.

It was decided that the deposit would be mined by the open-pit method and that the ores would be concentrated by flotation. Estimates placed the amount of copper to be mined annually at 46,000,000 lbs., but actually the company has exceeded this figure materially during each full year of production. In 1945 it recovered 15 per cent more than originally anticipated.

One of the most remarkable achievements of the entire operation was the speed with which the property was brought into production once the decision to go ahead was reached. The project was granted top priority by the government and the W. A. Bechtel Company commenced preliminary work early in January of 1942 as engineer-contractor. Seventeen months later copper concentrates started moving from the company's mill to the International smelter at Miami.

Castle Dome took the mine over from the contractor on April 19, 1943, and accepted the concentrator on June 10 of that same year. By that time the Bechtel Company had stripped the orebody of nearly 14,000,000 tons of waste, stockpiled 473,000 tons of ore, constructed a 10,000-ton flotation plant and built a 4½-mile paved highway to the property.

To provide the necessary water, a 16" combination steel and wood stave

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pipe line laid a distance of over 11 miles from the Old Dominion mine at Globe to Castle Dome and a 3,563,000-gallon reservoir was built. A power line was erected to connect the property with the Salt River Valley Water Users Association system.

By the first of this year Castle Dome had milled 10,026,000 tons of ore from which it recovered 121,088,400 lbs. of copper, 211,755 ozs. of silver and 4,271 ozs. of gold. In doing so the company removed over 19,000,000 tons of waste bringing the total waste removed to 33,000,000 tons when the amount stripped by the Bechtel company is included. In 1945, 4,183,769 tons of ore and 5,339,387 tons of waste were mined.

Mining Methods

Castle Dome is now mining and milling over 12,000 tons of ore daily, having reached a peak of 12,225 tons in April. This is over 27 tons per employe. The company operates seven days a week and in April had 545 employes on its payroll working staggered shifts six days a week so that the average number of employes working daily that month was 450.31. Of the total employes, 163 worked in the mine, 172 in the mill, 188 in the shops and 22 at miscellaneous tasks.

The mine is a typical open-pit operation and when mining first started the benches were spaced at 40' intervals. However, experience proved that the shovels could operate against a higher working face and all levels below 4,310' are 45' apart. The 4,470' level was the top one on which ore was mined, work there having been done by the Bechtel company.

The first level to be worked by Castle Dome was the 4,430' level and since then everything has been mined out down to the 4,220' level where operations are currently in progress. The bulk of the ore will continue to come from this bench until next March when work will be concentrated on the 4,175' level which is now being prepared for mining. Ore extraction will continue until the 4,085' level is completely mined.

As can be noted in the accompanying cross section, the orebody widens with depth, but it also decreases in grade and its lower limits are determined by assay values. Castle Dome has not announced any plans for mining below 4,085' but it is understood that further prospecting and exploration will be undertaken to determine if operations at greater depth will be practical.

In the mining operation, holes are drilled with seven Bucyrus-Erie 29T electric churn drills using 9" bits. On the average, holes are spaced 7 yds. apart, extended 6' below grade and located so that the horizontal distance between them and the toe of the bench is 12 yds. The drills average 77' per shift and 75' per bit change.

Each hole is normally loaded with two 50-lb. 8 x 18" cartridges of 60 per-cent gelatin powder with separate primacord lines attached to each, above which are placed ten 50-lb. cases of bag powder followed by crushed ore stemming. Primacord lines from the charges are attached to a trunk line to permit simultaneous blasting of several holes. The company has been breaking 4.35 tons of rock per pound of powder or 52 tons per foot of hole.

The broken rock is loaded into trucks by Marion electric shovels equipped with 5-yd. dippers at the rate of 4,048 tons per shovel shift. The company has three of these shovels, one being used to mine ore, one for waste and the third is held in reserve on a standby basis.

Knuckey 30-ton rear dump trucks equipped with 150-h.p. Cummins Diesel engines are used to transport the mined material from the shovels either to the coarse ore pocket or the dump. Each truck has two rear driving axles with four wheels on each equipped with 1400 by 24" tires. The two front wheels use 1300 by 24" tires.

Fourteen of the Knuckey trucks are used in the operation and four 14-ton Euclid trucks are held in reserve as spares. On the average, the trucks haul 884 tons, traveling 473 ton miles, per shift. The average round trip is 1.07 miles.

Normally five trucks serve one shovel but six or seven may be used on the longer hauls which are as great as 8,000' round trip. The area around each shovel is kept clean by a Caterpillar RD8 bulldozer. The company has six of the bulldozers and those which are not used to serve the shovels are employed in road work and on miscellaneous jobs.

The excellent condition in which the pit roads are maintained contributes materially to the efficiency of the operation by reducing wear and tear on the trucks and tires and permitting maximum speeds on the dump trucks. In addition to the bulldozers, a road patrol is used for road work and the maximum grade is kept below 3 per cent.

The Concentrator

The Castle Dome concentrator is one of the most modern and efficient in the industry. Its simplicity of design and operation has permitted the use of women as crusher, ball mill and flotation machine operators which is one reason that this property was not as seriously affected as others by labor shortage problems during the war. As many as 55 women have been employed in the plant at one time.

Milling practice of the company provides for concentration of ore in the following manner:

1. Crushing of run-of-mine ore until it will pass a 5/16 by 1" screen.

2. Grinding in grate-discharge ball mills which reduce the ore to about 12 per cent plus 48 mesh. Each grinding mill is operated in closed circuit with a rake-type classifier, the load and density in the circuit being automatically controlled.

3. Recovery of copper sulphide minerals and depression of iron sulphides in the primary flotation circuit. The primary rougher concentrate is then treated in a 35' cleaner cell and the concentrate produced is reground and treated in two re-cleaner operations in the retreatment plant from which the middlings are returned to the primary rougher circuit. In this manner excessive grinding of all of the ore is avoided. All tailings are discharged from the primary rougher circuit and concentrates from the retreatment plant circuit.

4. Dewatering and filtering of the final concentrates.

The concentrator is now producing about 6,000 tons of concentrates monthly from the 12,000 tons of ore it mills daily, the ratio of concentration being about 59 to 1. It is recovering better than 91 percent of the sulphide values and over 88 per cent of the total values. The average grade of the final concentrate is 38.5 per cent copper, 19.5 per cent iron and 8 per cent insoluble.

The original capacity of the flotation mill was 10,550 tons daily, but two alterations have increased this to its present maximum of over 12,000 tons. The first was the installation of grate discharges in the ball mills to replace the free discharge system originally used. The second was the installation of automatic feed control in the grinding and classification circuit.

The grate discharges have permitted a greater load of ore and balls in the mills, increasing the tonnage of output from 12 to 15 per cent, but they have added correspondingly to costs. Steel, water and power consumption have risen proportionately.

The automatic feed control is one of the latest developments in the metallurgical field and was first conceived by F. W. Maclennan, vice-president and consulting engineer for Miami Copper Company. It was worked out by Miami and Castle Dome staffs together with engineers of the Westinghouse Electric and Manufacturing Company, and has increased the plant's efficiency both as to tonnage and metallurgy.

The purpose of the control is to maintain a constant circulating load in the grinding and classification circuit by automatically adjusting the feed to meet changes in the character of the ore. It is an electrical system whereby the amount of ore fed into the ball mill is governed by the circulating load returning from the classifier, increasing the feed as the classifier load decreases and vice versa.

Tied in with the feed control is a water control which adjusts the flow of water into the mill, maintaining a constant density. Another density controller adjusts the flow of water into the classifier.

The importance of this control to an operation like Castle Dome becomes apparent when it is realized that no attempt is made to control the hardness and grindability of the ore mined and delivered to the concentrator for treatment. The ore is dumped into the coarse ore pocket as it best suits the mining operation. At times it may carry 1 per cent copper and at others 0.4 per cent. Moreover, on one day it may come from the eastern portion of the orebody where the ore is softer and the next from the western side where it is harder.

The device has been installed in five sections and ordered for the remaining two, but it is still in the testing and experimental stage and it is too early to make a final accounting of the results. However, indications are that it has already boosted tonnage handled 3 to 5 percent and will add more to it in the future.

Crushing and Grinding

Another unique feature of the Castle Dome concentrator is its underground primary crushing plant located below the 2,000-ton coarse ore pocket near the edge of the pit. Ore is fed from the pocket by a 10'6" by 23' Stephens Adamson Company pan feeder to a heavy grizzly with 9" spacings, the oversize going to the primary crusher and the undersize by-passing it. The pan feeder is reported to be the widest ever constructed and was designed in that manner to prevent arching of the big rocks in the bottom of the pocket.

Ore is crushed to minus 8" in a 66 by 84" Allis-Chalmers jaw crusher powered by a 300-hp. motor and is conveyed across a canyon to the secondary crusher storage bin. The total length of conveyor is 2,350' and ore is carried over it on a 48" Goodrich cord belt at a speed of 450 f.p.m. The conveyor is

equipped with a dual drive consisting of a 200-hp. motor on the head and a 100-hp. motor on the tail and lifts the ore 190' on a 12° incline.

Every effort is made to keep dust at a minimum in the crushing plants by means of a comprehensive and efficient dust control system. Multiclone dust collectors are used for this purpose.

The secondary crushing plant consists of two identical units. In each, the ore from the 2,500-ton secondary crusher storage bin is fed by two 48" by 16'11" Link-Belt pan feeders to a conveyor belt which carries it under a Dings magnet to remove tramp iron and discharges it on a cantilever grizzly with 1½" spacings. The oversize from the grizzly is crushed by a 7' standard Symons cone crusher with 1½" set to discharge a 1½" product and the undersize by-passes it.

The minus 1½" material from each unit is next conveyed to a screen bin which discharges it onto four Ty-Rock screens with 5/16 by 1" openings. The undersize is the final crushed product; the oversize is conveyed to one of two short-head Symons cone crushers with 5/16" settings for further crushing and returned again to the screen bin. The secondary crusher product is conveyed over Toledo Chronoflow scales for weighing and then lifted 77' by a 42" by 1,200' conveyor and discharged into the 14,500-ton mill storage bin by means of a 42" Link-Belt tripper.

Ore passes out of the mill bin through ore feeders and is conveyed to 10' 6" by 11' Allis-Chalmers grate discharge ball mills for fine grinding. The mills are equipped with 600-h.p. Westinghouse motors, drum feeders and sand wheels and operate in closed circuit with 12 by 28' Dorr FX classifiers. There are seven grinding and classification units in the mill and the tailings of the concentrator average 11.8 per cent plus 48 mesh. The mills discharge at approximately 72 per cent solids. The water to solids ratio in he mill flow (tailing flow from the mill to the 225' Dorr thickeners) is 1 to 3.46.

In addition to the automatic feed control in the grinding circuit, which has already been discussed, the company has added two other interesting innovations to its milling process. One of these is the use of Chronoflow scales on the conveyor to each mill to determine the manner of its performance. The charts from the scales provide a permanent record which shows the exact tonnage handled at any given time.

The other is the manner in which grinding balls are charged to the mills. The balls travel from the ball bin down a pipe through the drum feeders to the mills and are never touched by hand. This system has resulted in substantial savings in the mill charging operation.

Flotation Process

The ground product is fed to the rougher flotation machines by a 9' diameter circular feed distributor. Miami type air lift flotation machines, designed by the Miami Copper Company and fabricated by the Allison Steel Manufacturing Company, are used throughout the plant and are noted for the small amount of labor required for operation.

The rougher flotation circuit consists of six 100' cells divided into 50' sections 5'4" wide and 3'4" deep. Air is provided by four Ingersoll-Rand 28,000 c.f.m. blowers.

B2

Rejects from the rougher circuit are discharged to two 225' Dorr torque tailings thickeners through a distributor box while the coarse concentrates produced pass on to the retreatment plant for further grinding and flotation. This section of the mill consists of a 7 by 12' Allis Chalmers ball mill with drum feeder and sand wheel, a 13' diameter Dorr bowl classifier and seven 35' Miami-type air lift flotation machines. Five of these machines are in operation and two are spares.

In the retreatment plant, the rougher concentrates are given a preliminary flotation treatment in either the No. 2 and 3 or No. 4 and 5 machines. They then are pumped by two 4" Wemco sand pumps to the bowl classifier for further classification, and, if necessary, grinding in the ball mill with which it operates in closed circuit. The material is classified before going to the ball mill in order to avoid unnecessary grinding.

The classifier overflow is given a final flotation treatment in the No. 1, 6 and 7 cells and the concentrates produced are discharged to the 60' Dorr torque concentrate thickener. Middlings rejected from the retreatment plant pass to a similar Dorr thickener and are pumped by two 4" Wemco sand pumps to the circular feed distributor at the head of the rougher flotation circuit. DeLaval pumps on each of the 60' thickeners return the overflow to the mill water circuit.

After thickening the concentrates pass to the filter plant for further dewatering by two six-leaf Oliver disc filters following which they are conveyed to the concentrate truck loading ramp and loaded into 18-ton Freuhauf trailers. The company uses six of these trailers and three Diesel Autocar prime movers equipped with 150-hp. Cummins Diesel motors to haul its concentrates to the railroad siding in Miami. While three of the trailers are being hauled to and from Miami the others are being loaded.

In Miami the concentrates are dumped into a 50-ton loading hopper and transferred from that to 50-ton railroad cars by a 24" by 82' conveyor. The loaded cars are then switched to the International Smelting and Refining Co.

Tailings Disposal

The final mill tailings, comprising 22.5 per cent solids, are delivered to two 225' Dorr torque thickeners for dewatering. The thickener overflow is collected in a sump and pumped back to the mill water circuit while the pulp, containing 46.5 per cent solids, is discharged into a header box from which it is piped a distance of about 2 miles to the tailings area. The tailings disposal method employed at Castle Dome follows very closely that of the Miami Copper Company.

The pipe consists of an 18" diameter continuous redwood stave line which follows a uniform grade of 0.8 per cent to the impounding dam. The latter is situated in a deep canyon which provides a 120-acre disposal area. At the present time the maximum depth of the tailings is 170' and the average about 100'.

At the tailings disposal area, the pipe travels along a wooden trestle near the crest of the dam and discharges its flow by means of arc or molasses-gate type valves through a short launder or box. The velocity developed by the falling pulp classifies the tailings, leaving the coarser sand along the crest of the dam and carrying the finer material and slimes farther away from it.

By depositing pulp progressively across the area, the face of the dam is kept practically level at all times and its crest is raised as necessary by

building a 2½' embankment of tailings. The tailings slope back from the dam on a descending grade of about 1 per cent, creating a pond away from its face and at the rear of the disposal area. Thus, the water accumulates at the back of the area where it flows into standpipes through decant boxes and is returned through an 18" concrete pipe line underneath the tailings to the sump located a short distance below the dam.

Because flash floods are not uncommon in the district, a concrete spillway has been erected at the edge of the tailings dam as an emergency flood control measure. By means of this spillway it is possible for water from the back areas to by-pass the dam.

The reclaimed water from the tailings dam sump is pumped through a 14" combination steel and redwood stave pipe line to the tailing thickener sump by four Ingersoll-Rand No. 4 Cameron pumps rated at 430 g.p.m. against a 430' head. There it joins the water reclaimed from the thickeners and is pumped back into the mill circuit by four Ingersoll-Rand Cameron No. 8 pumps with a capacity of 2,000 g.p.m. each against a 200' head.

All water possible is reclaimed from the concentrating process because of the high cost of fresh water and 87.5 per cent of the total used is recovered. From the tailings dam, water is returned at the rate of 1,315 g.p.m. or 155 gallons per ton of ore treated, and from the thickeners at the rate of 4,361 g.p.m. or 546 gallons per ton.

Although fresh water added to the circuit amounts to only 852 g.p.m. or 100 gallons per ton of ore milled, it uses 59 per cent of the total power consumed in water pumping operations. The reason is that this water is pumped over 11 miles from the Old Dominion mine in Globe and is raised some 2,400' to the Castle Dome reservoir.

The fresh water is pumped to the Castle Dome reservoir in three stages. It is first pumped from the 1,500' level of the Old Dominion mine to a booster pump station located in Pinal Creek wash by three submersible Byron-Jackson pumps. From the No. 1 booster station the water is delivered to the No. 2 booster station at Miami Copper Company by two Allis-Chalmers and two Goulds pumps. From the Miami Copper Company plant it is lifted 974' further through 5¼ miles of 16" steel pipe by three Byron-Jackson pumps rated at 750 g.p.m. and driven by 300-hp. motors.

The company maintains modern and completely equipped machine shops on the hill alongside the pit where necessary repairs to the equipment are made and bits are sharpened. In addition to its shops, the surface plant includes a weather station, an experimental laboratory and a systematically arranged sample building in which various rooms are devoted to assaying different classes of samples in order to prevent salting.

Power for the operation is obtained through a connection with the Salt River Valley Water Users Association 25-cycle, 110,000-volt transmission line. At the sub-station alongside the mill three Westinghouse transformers form a 10,000-kv.-a., three-phase bank and step the voltage down to 6,900 for the main Castle Dome system. It is then transmitted to various portions of the operation where other transformers further reduce the voltage as necessary for the equipment being used.

The Future

The Company reported its ore reserves on January 1, 1946, at a little over 19,000,000 tons assaying 0.74 per cent copper including 0.03 per cent copper oxide, and estimated that 6,000,000 additional tons would be developed by exploratory work. Assuming a total reserve of 25,000,000 tons, the property has a little less than six years of life remaining at the current rate of production.

However, the lower limits of the orebody are determined by assay values. There is no sharp demarcation between the ore and waste, but rather a progressive decrease in grade until a point is reached where the ore is not considered to carry sufficient values to be commercial.

This is the situation today, but what it may be six years from now is another matter. Further developments in the mining and metallurgical processing of copper may well add to the reserves just as those in the past have made current operations possible.

Castle Dome made a decided contribution to the war effort and will continue to play an important part in the reconversion program. Indications are strong that it will remain a substantial producer for many years to come.

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Operating Officials

R. W. Hughes	General Manager
B. R. Coil	General Superintendent
J. C. VanDeWater	Mine Superintendent
R. L. Mountjoy	Mill Superintendent
C. B. Hostetler	Chief Mine Engineer
J. J. Luchessa	Chief Mechanical Engineer
L. W. Bowling	Master Mechanic
E. B. Morf	Chief Electrician
F. L. Bishop	Purchasing Agent
J. W. Brady	Chief Clerk
A. G. Welch	Employment Agent

Mining Data

Production figures, 1945:

Tons of ore mined	4,183,769
Tons of waste mined	5,339,387
Tons of ore mined per day	12,000
Tons of waste mined per day	15,000
Tons of ore mined and concentrated daily per employe.	27

Churn drilling:

Feed drilled per churn drill shift	77
Feet drilled per bit change	75

Rock breaking:

Pounds of powder charge per hole	620
Tons of rock broken per hole	2,700
Tons of rock broken per pound of powder	4.35

Mining Data (Cont.)

Mining:	
Tons of ore mined per shovel shift	4,048
Haulage:	
Average round trip truck haul, miles	1.07
Tons hauled per truck per trip	29.2
Tons hauled per truck per shift	884
Ton miles per truck per shift	473

Metallurgical Data - 1945

Production:	
Total tons of ore milled	4,183,769
Total pounds of copper produced	53,324,969
Dry tons of ore milled daily	12,000
Tons of concentrates produced monthly	6,000
Ratio of concentration	59 to 1
Average Assays of Mill Feed:	
Total copper, per cent	0.743
Oxide copper, per cent	0.029
Sulphide copper, per cent	0.714
Concentrate Analysis:	
Copper, per cent	38.53
Iron, per cent	19.5
Insoluble, per cent	7.9
Average Assay of Tailings:	
Total copper, per cent	0.087
Oxide copper, per cent	0.026
Sulphide copper, per cent	0.061
Extraction of Values	
Total copper, per cent	88.29
Sulphide copper, per cent	91.46
Plus 48-mesh material in tailings, per cent	11.8
Steel Consumption, lbs. per ton of ore:	
Primary crushing	0.023
Secondary crushing	0.069
Total crushing	0.092
Fine grinding:	
Manganese liners	0.017
Cast iron liners	0.218
Grates	0.011
Molychrome balls	1.45

Metallurgical Data - 1945 (Cont.)

Power Consumption, kw.-h. per ton of ore:

Primary crushing	0.182
Primary product conveying	0.281
Secondary crushing	1.052
Secondary product conveying	0.128
Fine grinding	7.161
Concentration	2.223
Reclaimed water	1.285
Concentrate disposal	0.140
Tailings dam	0.004
Sampling	0.012
General mill	0.114
Subtotal	12.582
Fresh water	1.836
Total	14.418

Reagent Consumption, lbs. per ton of ore

Sodium Aerofloat	0.04
Pine Oil	0.08
Lime	6.