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McDERMITT MINE, McDERMITT, NEVADA

DESCRIPTION OF OPERATIONS

LOCATION, ACCESS AND CLIMATE

McDermitt Mine is located in Humboldt County, Nevada, 11 paved-road miles southwest of the small town of McDermitt, which straddles the Nevada-Oregon border. McDermitt is served by U.S. Highway 95, a major thoroughfare connecting Boise, Idaho, 193 miles to the north, with Reno, Nevada, 242 miles to the south. Winnemucca, Nevada is located 74 miles to the south and is served by two major railroads and a small airport.

The McDermitt Mine area has a high plateau desert climate, typical of northern Nevada. The mine is at an elevation of 4,600 feet above sea level on the western edge of the Quinn River Valley.

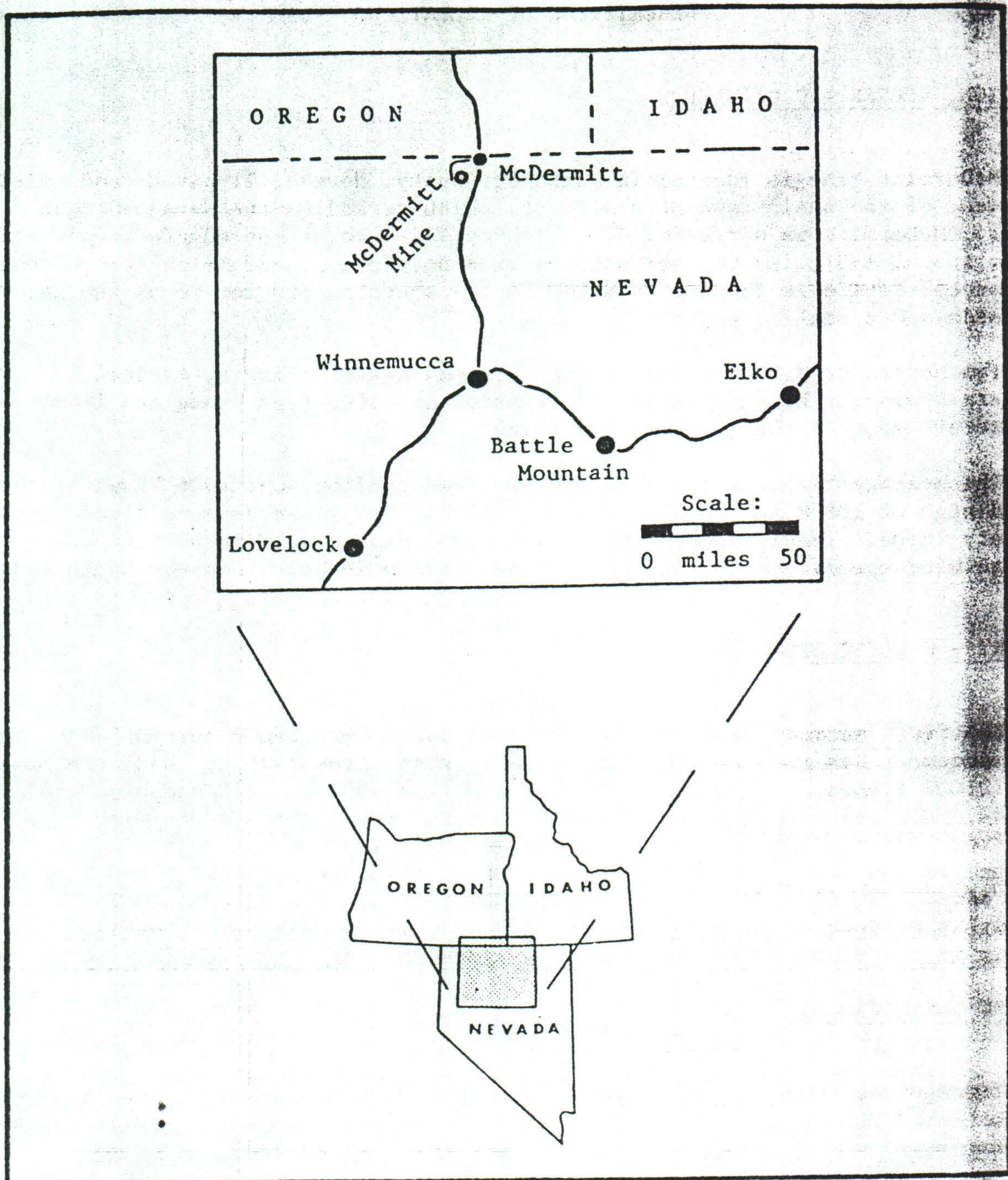
The average temperature range for the area is from 30°F to 65°F with a record high of 106°F and a record low of -34°F. Daily temperature fluctuations are very large. Yearly precipitation averages less than 10 inches per year. Average wind speeds are approximately 8 mph, predominantly from the south and west.

HISTORY - OPALITE DISTRICT

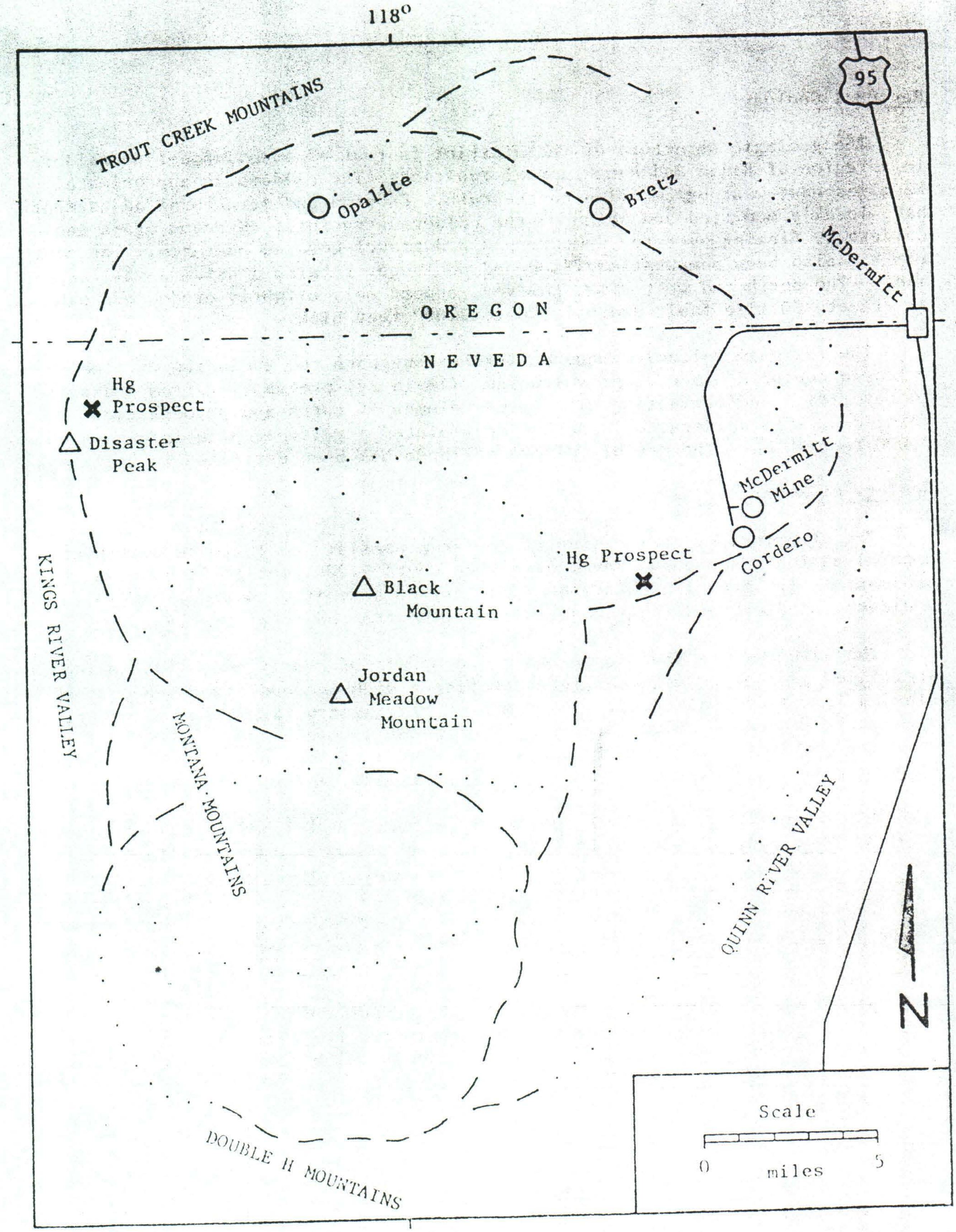
The first mercury discovery in the area was by William Bretz in 1917. The first producer was the Opalite Mine in 1926 which, from 1926 to 1943, produced over 12,000 flasks. The Bretz Mine operated from 1930 to 1965 and produced over 14,000 flasks. The largest producer in the area, the Cordero Mine, operated from 1935 to 1970 and produced over 100,000 flasks. The Ruja Mine, adjacent to the Cordero, operated from 1968 to 1970 and produced 6,000 flasks. Total production of the district was 139,000 flasks. The McDermitt Mine orebody is estimated to contain almost 400,000 flasks, making it the largest orebody in the district and almost three times the total area production to 1970.

HISTORY - CORDERO MINE

Outcropping cinnabar ore was discovered in 1929 by Tomas Alcorta, a Basque sheepherder.* The first claims were staked in 1931 by Alcorta, J. Ondarza and E. Aznarez. The property was leased in 1933 to the Bradley Mining Company which produced about 45 flasks before giving up their lease. In 1939, Horse Heaven Mines acquired a lease on the property, naming it Cordero, the Basque word for lamb. The Cordero Mining Company operated surface and underground workings until 1967 when the property was sold to the Fred H. Lenway Co. which operated the property until 1970. In the fall of 1970, Sierra Mineral Management acquired the property and began exploration drilling. Placer Amex, in a joint venture with Sierra, began drilling in 1972. By 1974, the new orebody had been outlined and a feasibility study completed. Construction and stripping began in April of 1974 and the mine/plant complex was officially opened in June of 1975.



Index map showing location of McDermitt Mine.



Map indicating approximate caldera perimeter and mercury deposits within the Opalite Mining District.

GEOLOGY

Regional Geology

The geologic structure of the district is that of a collapse-type caldera in a region of Basin and Range normal faulting. The caldera is approximately 22 miles east-west by 20 miles north-south. Erosion and structural adjustments have locally modified and obscured the caldera structure. Streams drain the caldera by flowing over the downdropped and gravel-covered east rim. The south rim has also been somewhat modified and no longer retains a caldera-wall appearance. The north and west rims, however, appear only slightly eroded and exhibit an arcuate 30 mile fault scarp 1,000 to 2,000 feet high.

The regional volcanic sequence further suggests the evolution of a major volcanic center. Miocene age volcanism (18-16 my) progressing from andesitic to rhyolitic and terminating with large volumes of tuffs and pyroclastics coincident with caldera collapse has accumulated a volcanic pile in excess of 7,000 feet thick. The age of caldera collapse has been estimated to be 16 my.

Geology of McDermitt Mine

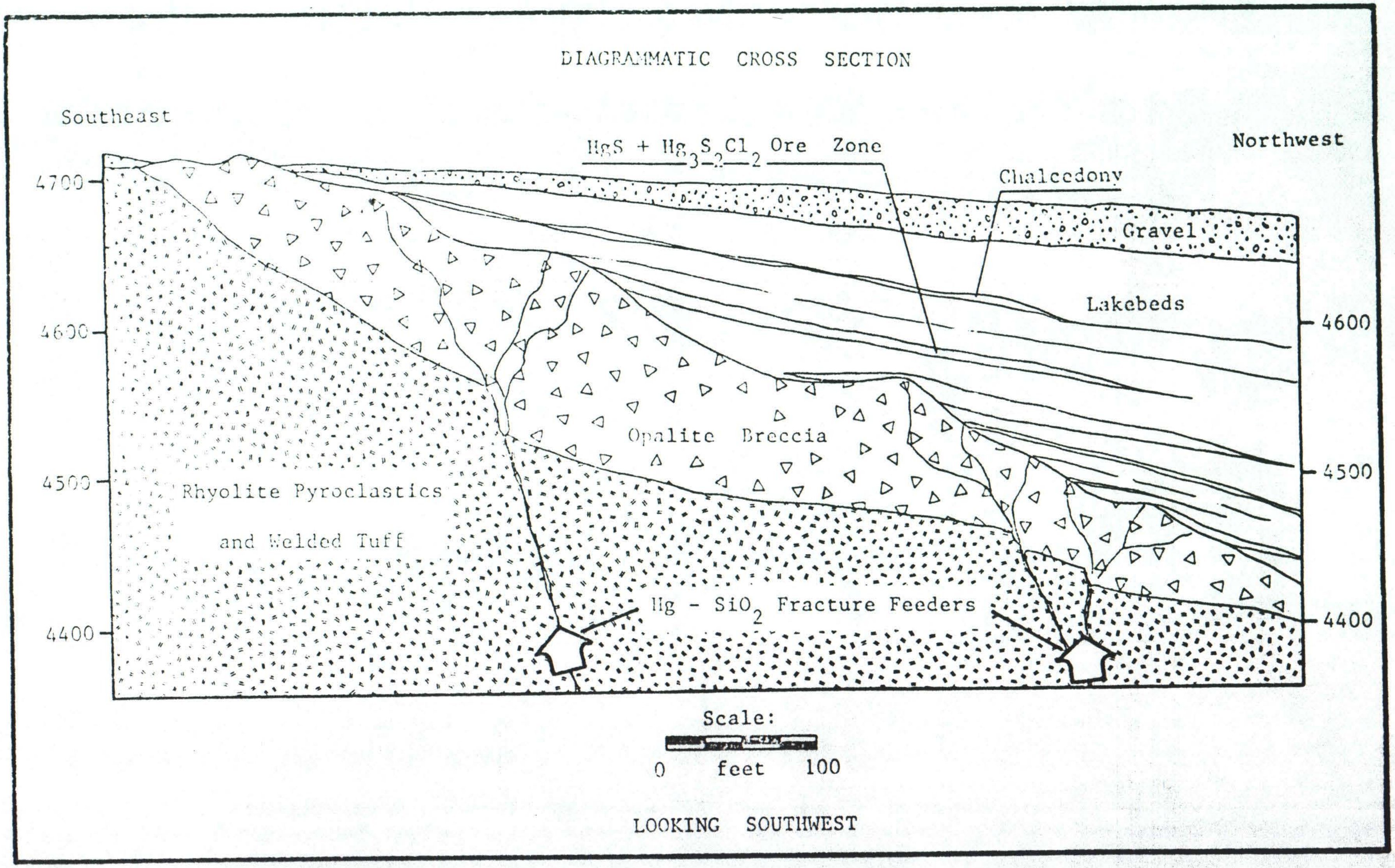
The stratigraphy of the mineralized area consists of 10 to 40 feet post-mineralization Quaternary gravel overlying up to 2,000 feet of lacustrine sediments. The gravel consists of a variety of andesitic to rhyolitic volcanic boulders, cobbles, and finer materials derived from adjacent highlands.

The lakebeds are Miocene in age and composed of poorly consolidated locally argillized tuffaceous material interstratified with bedded layers and discontinuous lenses of chalcedony. The dominant clay mineral is montmorillonite, apparently formed by diagenetic argillization of volcanic ash. Tuffaceous material within the lakebeds includes glass shards in various stages of devitrification, poorly consolidated lapilli tuff, cinders, and silicious ash.

Mercury sulfide ore occurs dominantly within the lakebeds localized above an apron-like body of opalite breccia, but some ore occurs in breccia as well. The field term "opalite" breccia is here used to describe a silicious sinter-silicified lakebed breccia apparently formed by hot spring silicification and associated brecciation of lakebed sediments. The rhyolite welded tuff beneath the opalite breccia is underlain by dacite and andesite flows.

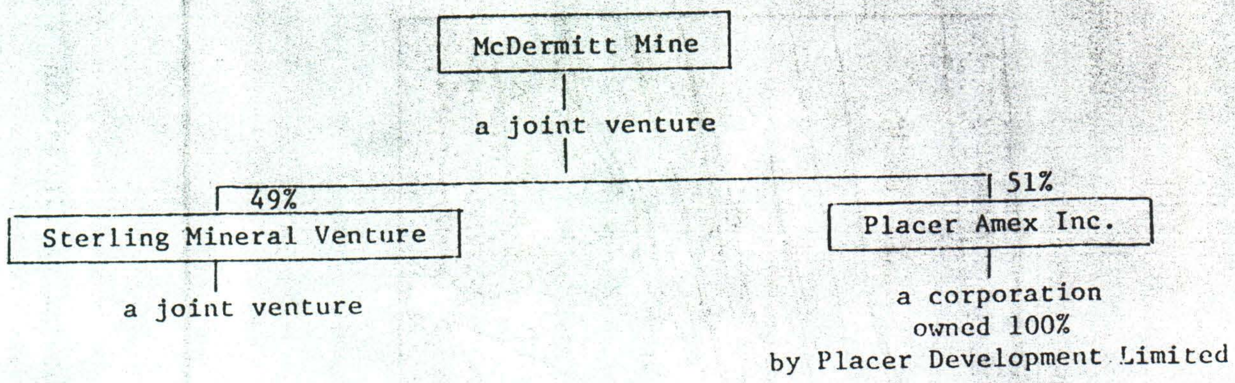
Mercury minerals within the McDermitt orebody include cinnabar (70%) and corderoite (30%), with traces of metacinnabar and mercury oxychlorides, and rare native mercury. Ore minerals occur within the argillized tuffaceous lakebeds and less commonly in the opalite breccia. The variety of textures and relationships with which cinnabar and corderoite are found suggest intermittent, alternate hot spring deposition of mercury sulfides and silica contemporaneous with tuffaceous lacustrine sedimentation, with subsequent alteration and local remobilization of mercury minerals.

Corderoite, a recently discovered photosensitive mercury mineral is ubiquitous to the lakebed orebody, occuring in varying proportion with cinnabar. The corderoite occurs as fine-grained replacement masses (apparently after cinnabar) and as alteration rims and coatings on cinnabar.



Diagrammatic cross section through the McDermitt orebody showing configuration of ore zones and their relationship to lithologic units.

McDERMITT MINE OWNERSHIP



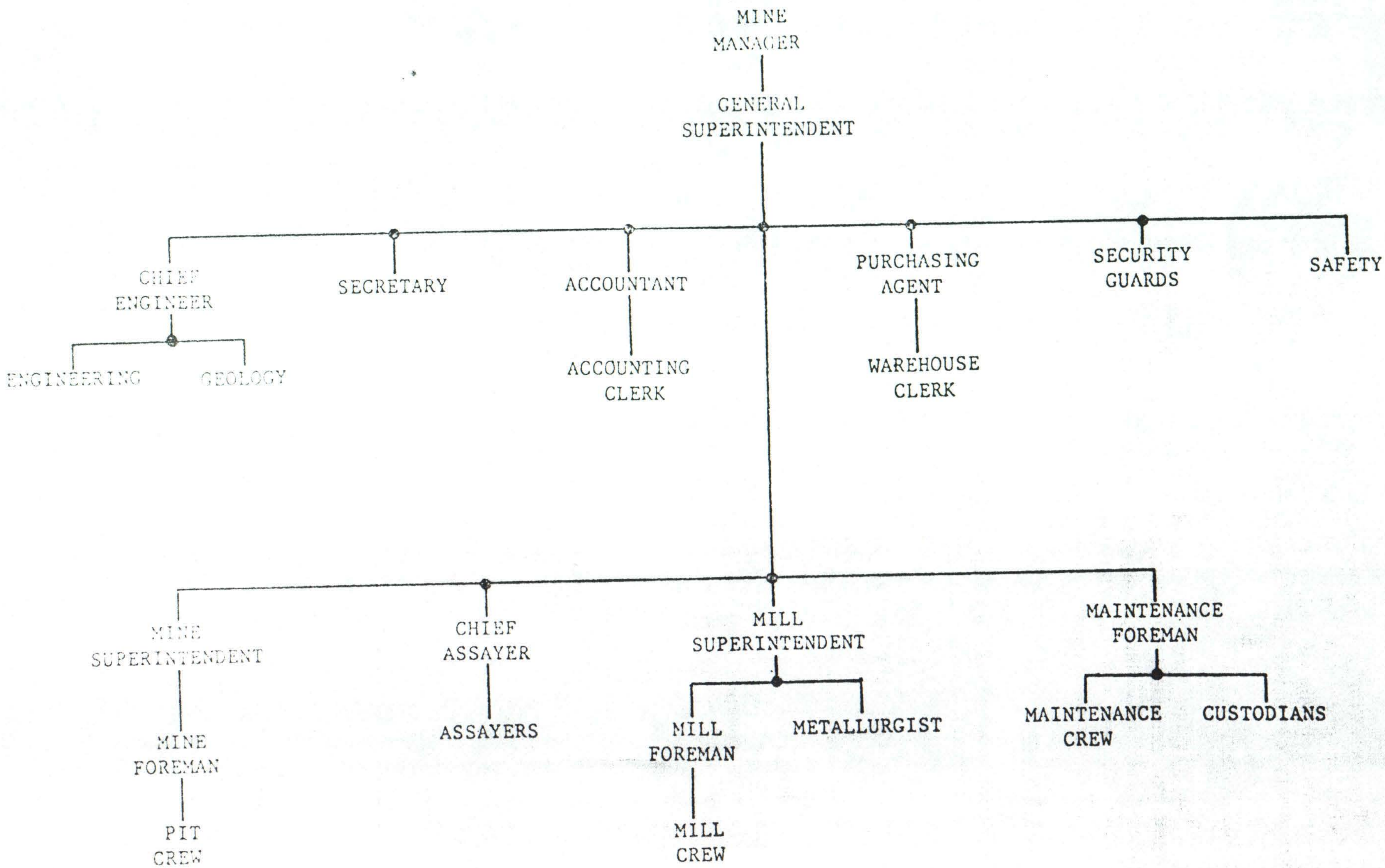
PROPERTY OPERATION

The property operates with eight basic departments under the administration of a resident Mine Manager and a General Superintendent. As of July 1, 1981 the total operating crew strength was distributed as follows:

Administration (includes Security)	8
Engineering (includes Geology)	5
Purchasing	2
Mine	13
Mill	13
Maintenance (includes Custodians)	16
Assaying	3
Safety	1
TOTAL	61

(Above does not include summer students or part-time employees.)

ORGANIZATIONAL CHART
McDERMITT MINE-1981



OPEN PIT OPERATIONS

The existing pit excavation encompasses an area of approximately 140 acres and will extend to a depth of 165 feet below the original surface elevation. The overall slope of the pit is $1\frac{1}{2}$:1 or approximately 34°. The walls are predominately clay and no slope stability problems have been encountered.

Design Sequence

The pit has been divided into seven distinct areas or "stages". These stages are designed to optimize stripping by balancing contained ore versus waste, based upon budgeted milling requirements. Current budget calls for milling 302,400 tpy (25,200 tpm) and waste stripping of 2,640,000 tpy (220,000 tpm). The overall waste-to-ore ratio for the orebody is 4.7:1.

Mining Sequence

Grade control is accomplished by taking 3-pound samples from a grid with 25-foot centers on the pit floor. The grid is surveyed to locate it within the pit. The assay values are plotted and the grid is then Kriged.

Due to the very spotty and erratic nature of the ore mineralization within the clays, selectivity in mining is important to maintain projected grades. After a scraper makes a cut in the ore zone, the cut is grab sampled and the sample is then panned. This panning allows for instant discrimination between waste, low grade and ore, and enables the panner to make a surprisingly accurate estimate of the overall grade mined in that area. The panner uses hand signals to tell the scraper operator whether his load should go to waste, the low-grade stockpile or to the ore stockpile.

Rock Production

The semi-autogenous design of the mill requires 10-12% of the mill feed be a hard, tough, silicious material locally called "opalite breccia" and found at the base of the clay. A quarry for the breccia has been established in a mined-out area of the pit. The breccia is drilled with air track and compressor on six-foot centers with a six-foot burden, using $2\frac{1}{2}$" button bits and ten-foot benches. The holes are bottom primed using a $\frac{1}{3}$-pound cast booster capped with an 8 millisecond Nonel delay to eliminate cutoffs in the trunkline. The hole is then charged with AN/FO to within two feet of the collar and stemmed with cuttings to the collar. The individual trunklines are made up of "E-Cord" and connected with 25 ms Nonel surface delays between each trunkline. An average shot consists of approximately 250 holes.

Pit Equipment

4 ea.	Caterpillar	631C	Scrapers
1 ea.	Caterpillar	631D	Scraper
2 ea.	Caterpillar	D8-H	Tractors
1 ea.	Caterpillar	D8-K	Tractor
1 ea.	Caterpillar	14-G	Road Grader
1 ea.	Caterpillar	631B	10,000-Gallon Water Wagon
1 ea.	Caterpillar	966C	Front-End Loader (4-yd^3 bucket)
1 ea.	Terex	3322-A	16-yd^3 End-Dump Truck
3 ea.	Ford	F-100	Pickup Trucks
1 ea.	Bucyrus-Erie	30-R	Rotary Drill (exploration drilling)
1 ea.	Gardner-Denver	SP-900	Compressor
1 ea.	Gardner-Denver	ATD-3200	Air-Track Drill

Pit Statistics 07/01/81

Total Ore Mined to Date	967,017 BCY
Total Low Grade Mined to Date	72,159 BCY
Total Waste Mined to Date	3,813,561 BCY
TOTAL	4,852,737 BCY

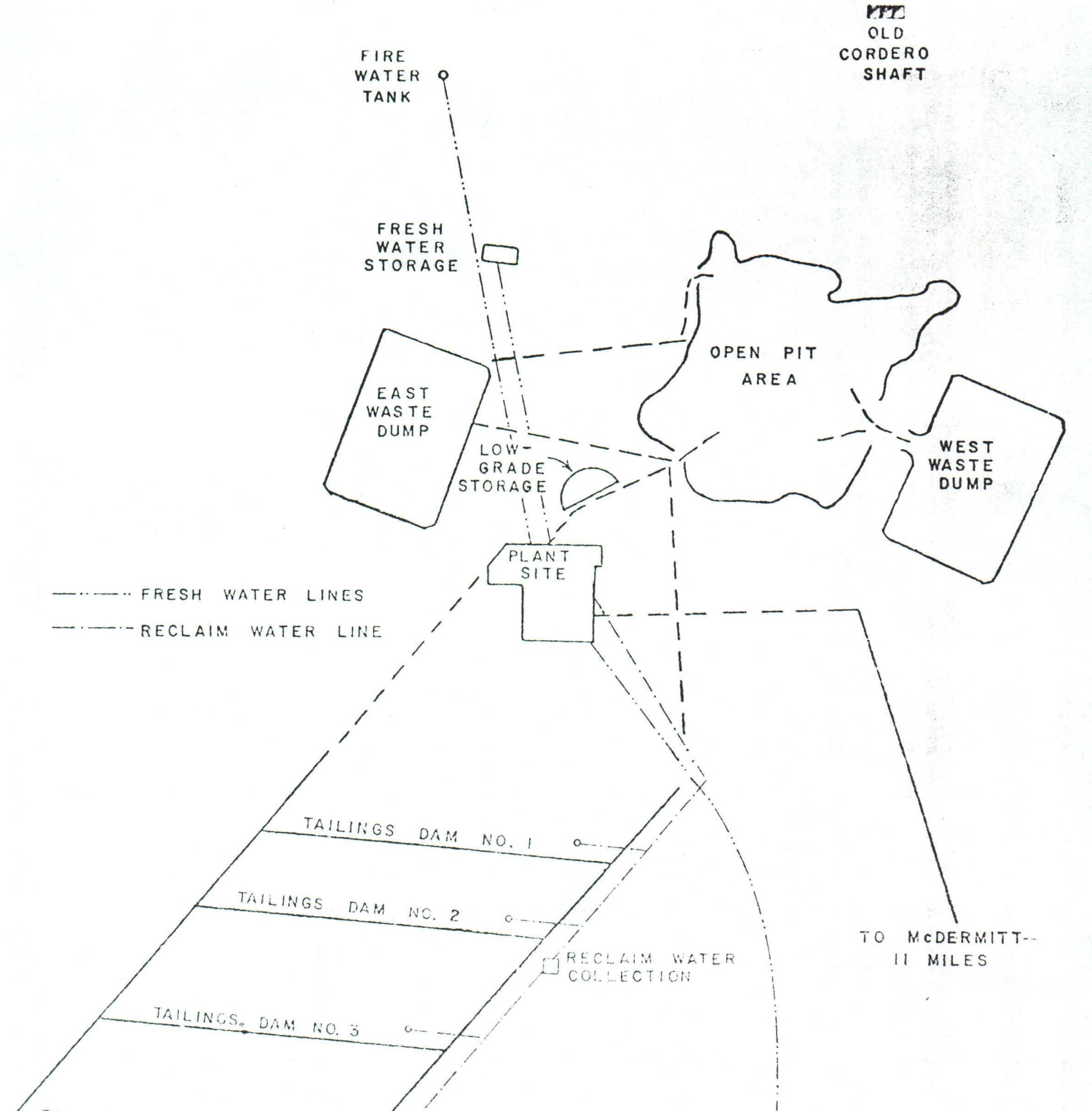
McDermitt Mine statistics and most production records use "bank cubic yards" as the production unit due to the different densities of the materials moved. The gravels that represent the overburden have a density of 1.47 tons per bank cubic yard, the rock (breccia) has a density of 2.09 tons per bank cubic yard and the clay has a density of 1.39 tons per bank cubic yard.

Scraper load factors used are as follows:

Caterpillar	631C	= 20.0 BCY/Load Gravel (heaped)
Caterpillar	631C	= 17.0 BCY/Load Clay (heaped)
Caterpillar	631D	= 23.5 BCY/Load Gravel (heaped)
Caterpillar	631D	= 20.0 BCY/Load Clay (heaped)

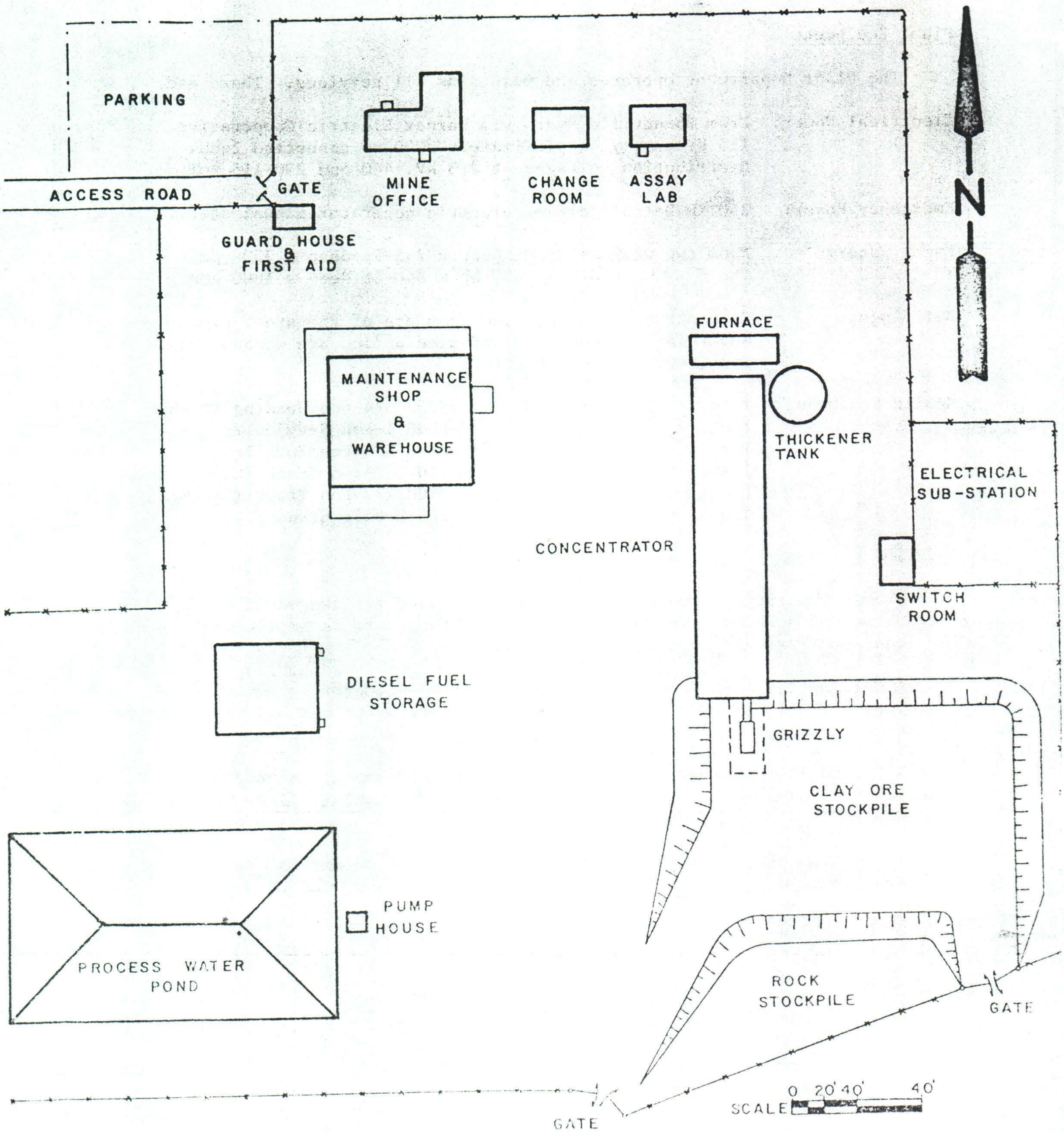
PLANT SERVICES

The Plant Services Department is responsible for repairs and maintenance of buildings, concentrator and furnace, water systems, mobile equipment and electrical systems. Maintenance scheduling, planning and parts ordering are all done internally, and a work order system is used for maintenance and construction projects other than routine. These work orders are initiated or approved by department heads. The vast majority of Plant Services' responsibility is divided between the mobile equipment and the concentrator/furnace complex.



GENERALIZED PLAN OF McDERMITT MINE AREA

SCALE: 500' 0' 500' 1000'



McDERMITT MINE SITE PLAN

Plant Equipment

The Plant Department operates and maintains all services. These are:

Electrical Power:	From Bonneville Hydro via Harney Electric Cooperative 115 KV supply, approximately 3000 hp connected load. Distribution voltages at 2.3 KV, 440 and 230-115 volts.
Emergency Power:	250 KW Detroit diesel electric generator-manual start.
Fresh Water:	From two wells - 1) 150-hp x 745-ft deep x 750 gpm 2) 150-hp x 840-ft deep x 1000 gpm
Buildings:	Concentrator, furnace and shop are of the steel type. Assay lab, change room and mine office are wooden frame-type, constructed on site.

Mobile Equipment:	1 ea.	Ford	F250 3/4-ton Welding Truck
	1 ea.	Ford	F350 1-ton Service Truck
	1 ea.	Ford	F250 3/4-ton Fuel Truck
	1 ea.	Chev.	C10 1/2-ton Truck (Leadman's)
	1 ea.	Ford	F100 1/2-ton Truck (Foreman's)
	1 ea.	Galion	125 Mobile Crane

ASSAYING

Atomic absorption techniques are currently used for assaying, although fire assaying capability for gold and silver is hoped to be implemented soon for local and regional exploration efforts.

A Perkin-Elmer 360 Atomic Absorption Spectrophotometer is employed for flameless mercury analysis in liquids only. Blood, water and urine are assayed for mercury content on this unit.

A Perkin-Elmer 560 Atomic Absorption Spectrophotometer is used for all other assays. The lab routinely assays for antimony, gold, silver, copper, zinc, sulfur and mercury with this unit.

As currently staffed, the lab can perform approximately 250 mercury determinations per day.

MINERAL PROCESSING

Grinding

Clay ore is delivered to the concentrator by the scrapers which discharge onto a low stockpile near the grizzly. The rock is delivered via the Terex truck and dumped into a stockpile below the clay stockpile. (Oversize rock is sorted out in the pit with the loader and stockpiled for a secondary blasting, usually concurrent with a production blast.) A front-end loader (Caterpillar 966C) then moves the clay through the grizzly (11-in openings) into a 50-ton hopper. Rock for grinding media is also added this way, the ratio of rock-to-clay being determined by the concentrator operator. From the hopper the ore feeder discharges into a Koppers "Hardinge" 18-ft x 9-ft long semi-autogenous mill driven by a 2300 v/1000 hp synchronous motor turning 200 rpm. A small charge of 3½-in balls are added to the mill once daily at the rate of 1.1-1.2 lbs/T. Also added to the mill feed is .08 lbs/Ton of dry $KMnO_4$ to act as a mercury vapor depressant. Mill discharge is maintained at 55-60% solids, as higher densities tend to restrict flow through the grates. Currently under test are rubber discharge grates. The shell liner configuration is currently a low lift (2½") plate and bar configuration. The mill speed is 71% of critical.

Classification of the mill discharge is performed by two-three Krebs 20-in cyclones in parallel (one extra cyclone acts as a spare). Inlet pressure is held to 9-11 psi. The cyclone underflow flows by gravity back to the mill with the addition of American Cyanamid A-242* at 600 cc/min (.15 lbs/T) which acts as the flotation collector. The cyclone overflow reports to the flotation section at 60-65% minus 200 mesh. Manual grind control is done by the operator via hourly wet screenings to hold 15 wt % +65 mesh.

Flotation

The rougher flotation of the cyclone overflow is carried out by six 600-ft^3 Denver cells in series with six scavenger cells of the same capacity. Added to the rougher feed is MIBC (Methyl Isobutyl Carbinol) at the rate of 50 cc/minute to act as the frother. Added to the scavenger cells is MIBC at the rate of 8 cc/minute. Concentrate from both the roughers and the scavengers goes to a cleaner circuit of six 200-ft^3 Denver cells, then on to the recleaners -- four 50-ft^3 Denver cells. Tails from the cleaners are recycled back to the roughers, and tails from the recleaners are recirculated through the cleaners. Eventually all tails end up in the scavengers and transit from there to one of the four tailings ponds. The rougher flotation circuit operates at a density of 20-25% solids and with a total retention time of 48 minutes (assuming 100 tph throughput). Final concentrate sizing is 83% minus 200 mesh.

The final concentrate, assaying approximately 1500 lbs mercury per ton, is pumped to a 40-ft diameter Denver thickener, where it is dewatered to 60% solids and is then pumped to an 18-ft diameter x 18-ft high storage or stock tank. Added to the thickener is Hydrated Lime to act as a flocculant. Thickener overflow is pumped back to the rougher cells. Some storage space can be utilized in the thickener, although the amount is quite density-dependent.

Storage

Thickened concentrate is slurried and pumped to a Denver 6-ft diameter, two disc multileaf filter. The filter dewaters the concentrate to about 10% moisture and feed it to a 1-ft diameter x 25-ft long enclosed screw conveyor which transports it to the top of the furnace. Reagents added to the screw are CaO at the rate of 50 lb/hr and Na_2S at the rate of 30 lbs/hour (dry). The CaO acts primarily as a flux, and the Na_2S aids in the reduction of the corderoite and other mercury oxy-chlorides found in the ore.

The tailings settle to a maximum of 30-35% solids due to the ore being hosted in clay. Consequently, the tailings scheme incorporates four successive ponds, each approximately 50 acres in area, constructed of impervious 20-ft high, clay core/gravel shell dams with side slopes at 2½:1. The 18-in layer of impervious desert floor serves as the common floor for the ponds. The four ponds are successively filled with tails to a depth of 3 to 4 ft. The filling period per pond is three months. When the fourth pond is filled, the first pond has evaporated from about 4 ft of 36% solids to 1-ft of almost dry clay. The drying process thus takes nine months.

Pond design was approved by the State Bureau of Environmental Health, with the proviso that McDermitt maintain two monitoring wells to detect the presence of any dissolved mercury that may have seeped through the impervious pond bottoms. These wells are assayed once per month.

Storage

Thickened concentrate is slurried and pumped to a Denver 6-ft diameter, two disc multileaf filter. Frequently only one disc is required to provide adequate furnace feed. The filter dewaters the concentrate to about 15% moisture and feeds it by gravity to a 1-ft diameter x 18-ft long enclosed screw conveyor which transports it to the top of the furnace. Reagents added to the screw are $Ca(OH)_2$ at the rate of 50 lb/hr and Na_2S at the rate of 300 cc/min (dry). The $Ca(OH)_2$ acts primarily as a flux, and the Na_2S aids in the reduction of the corderoite and other mercury oxy-chlorides found in the ore.

Furnace

The furnace plant consists of an Envirotech 10-ft diameter, six-hearth diesel-fired furnace with propane pilots, condensing system and off-gas scrubbing system. The concentrate is fed to the furnace at a rate of 1000 lbs/hr, although the rate will vary with concentrate grade and purity. Furnace temperatures vary between 1200 to 1600°F. Two fans, one located immediately above the furnace and one just before the SO_2 scrubber, keep the entire system under a negative pressure to ensure that no mercury vapor leaves the plant. The draft is controlled by two dampers located downstream of No. 1 fan and upstream from No. 2 fan. The furnace discharges dust, mercury vapor, water vapor, sulfur dioxide, some chlorine compounds, plus the products of combustion and excess air. Dust is removed from the off-gas discharge by a dry cyclone handling 1800 cfm and is mixed with scrubber water and sent to tailings.

The gas stream passes through two parallel towers, each consisting of twelve condensing tubes in series. The mercury condenses and is collected under water in fiberglass launders. The gas stream then passes through a venturi and impinger tower to remove any particulates and then through an SO_2 scrubber and cooling tower, exhausting to atmosphere at ambient temperature with negligible SO_2 or mercury vapor content. (E.P.A. regulations limit the emission of mercury vapor from the stack to 2300 gm per day.) Scrubber and impinger water is pumped to tailings. This addition to the tailings depresses the pH. However, the concentrator tailings are slightly basic due to the addition of the hydrated lime and consequently neutralize the pond water so that it may be reclaimed as necessary.

The condenser tubes located near the furnace discharge are 10-in diameter and are mild steel. Those tubes in the cooler portion (below 300°F) of the system are 8-in diameter and fabricated from fiberglass. The presence of corderoite and other oxy-chlorides in the concentrate contribute chlorine which.

forms very corrosive acids and salts of mercury that tend to inhibit the condensation of metallic mercury. The addition of $Ca(OH)_2$ and Na_2S to the concentrate before furnacing helps alleviate this problem.

The launder sludge is processed through a spiral classifier to separate the liquid mercury. The remaining residue is then pumped into the thickener. The mercury is routed back to the mercury leaving the launders.

All mercury flows to a cleaning bath in the concentrator. From there it is placed in bulk storage tanks. Prior to flasking, it is double filtered and then bottled in 40-lb plastic bottles, conventional 76-lb metal flasks or metric-ton containers. These metric receptacles, 20-in in diameter and 18-in high, hold the equivalent of 29 conventional flasks and make bottling and handling easier for mine personnel and customers.

MERCURY EXPOSURE AND MONITORING

Mercury emits an odorless, tasteless, invisible vapor which has been recognized for centuries as a toxic substance. As with all liquids, mercury vapor emission is related to heat, increasing temperatures resulting in higher vapor pressures. Because of the peculiarities of mercury, McDermitt Mine has adhered to rigid safety standards to protect the health of personnel engaged in production.

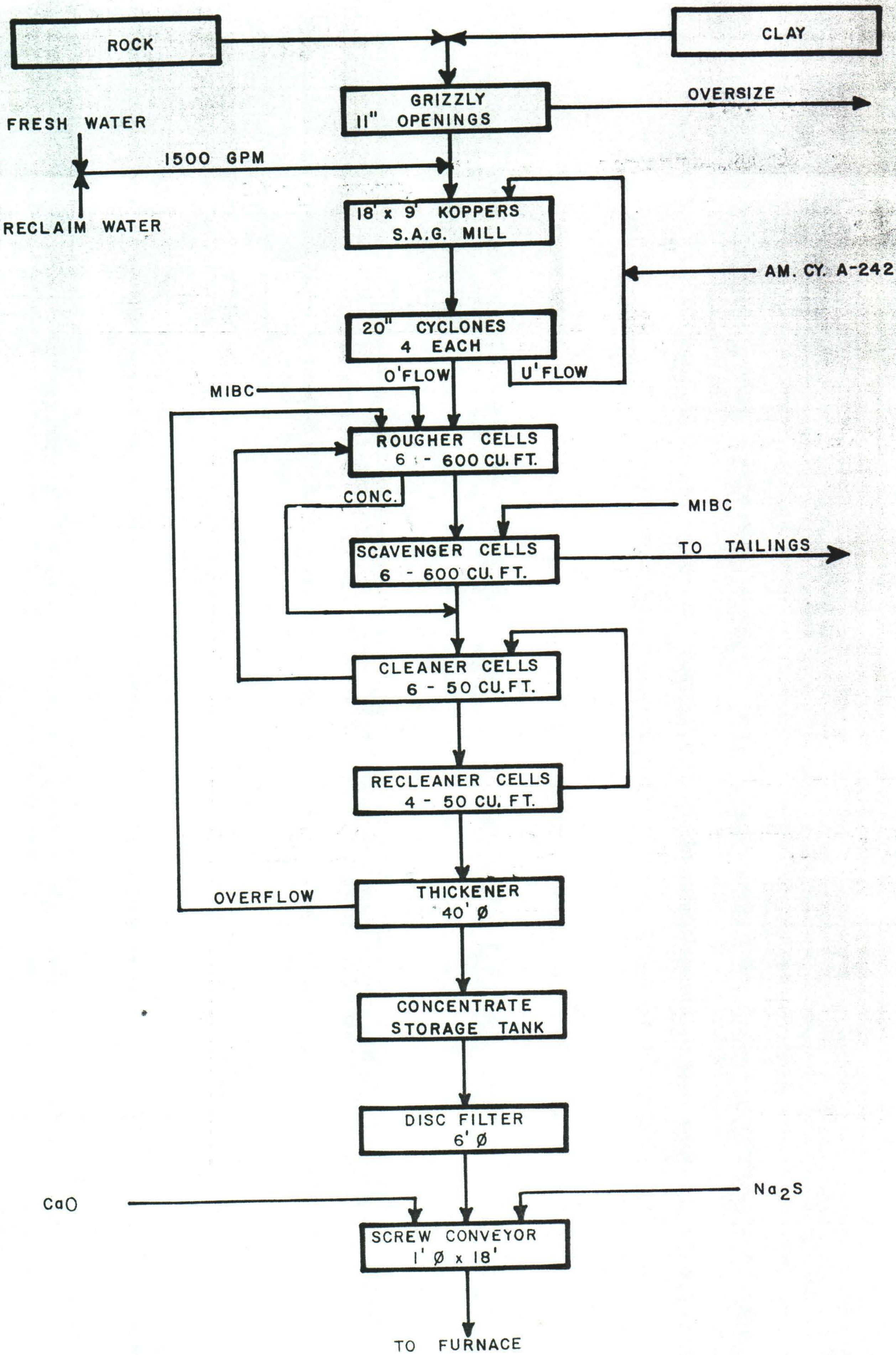
The possibility of occupational mercury poisoning (mercurialism) has resulted in development and implementation of a comprehensive program which consists of air monitoring, and employee education concerning personal hygiene, special facilities, and protective equipment. Air monitoring for mercury vapor is conducted regularly at set stations throughout the plantsite. The detection instrument is a direct sampling atomic absorption spectrophotometer which reads out directly in micrograms per cubic meter (ug/m^3).

Physiological monitoring consists of urine and blood mercury determinations on a twice monthly and monthly basis respectively. This is complemented with semi-annual physical examinations for exposed personnel by a qualified physician. Pulmonary induction of mercury vapor results in an estimated 80% immediate absorption into the blood stream. Eventually, all absorbed mercury is removed by the body's scrubbing system, the kidneys, and may be detected in the urine. Some time is required for removal, since the half-life of mercury in the human body ranges from 60 to 90 days, which is compounded by continuous exposure.

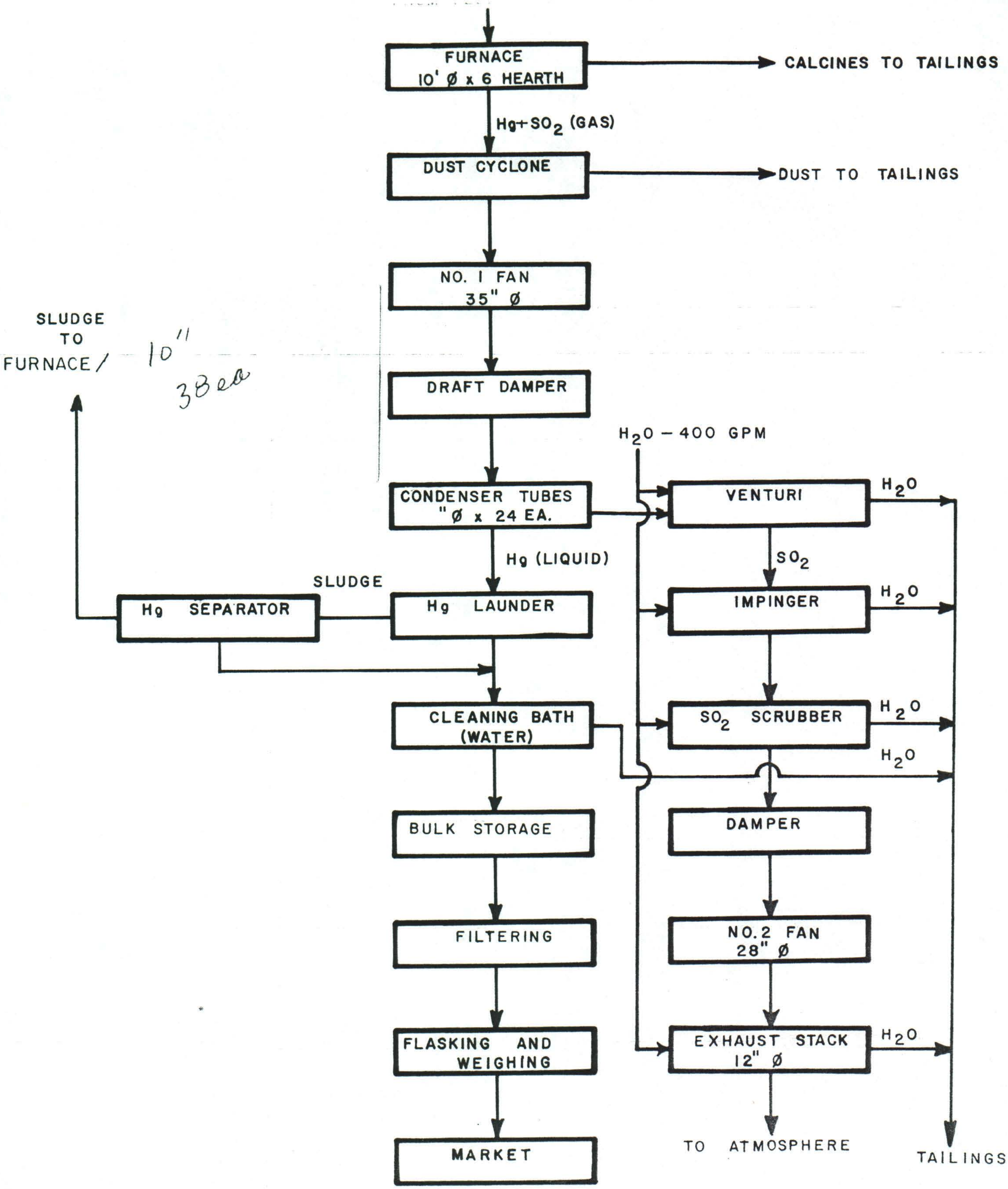
Workers exceeding recommended maximum limits for urine and blood mercury are removed to a low-exposure job assignment until biologic levels decrease to a "normal" range.

Good personal hygiene is paramount when processing mercury in any form. Mercury contamination is easily spread and difficult to eliminate. For example, a worker repairing contaminated components will carry an aura of mercury vapor on clothing, hands and feet. This aura or "mini-environment" may be carried into an uncontaminated area, and expose not only the contaminated worker but co-workers as well. Welding and torch cutting contaminated equipment produces large concentrations of mercury vapor, requiring further precautions. One or more shower and change of clothes is often required during the shift.

Special company issued equipment is required for mill and maintenance personnel in the concentrator/furnace complex. Mercury vapor respirators, coveralls, rubber gloves and boots are issued in addition to safety glasses and hard hats. To prevent the possibility of spreading contamination to the home, a change house is provided where workers shower, change clothes and launder contaminated clothing. A shower is required at the end of each shift and work clothes are laundered daily.



McDERMITT MINE CONCENTRATOR FLOWSHEET



McDERMITT MINE CONCENTRATOR FLOWSHEET