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Reopening an abandoned Tri-State Zinc Mine - Waco, Missouri

Edgar Carroll Long

REOPENING AN ABANDONED TRI-STATE

ZINC MINE - WACO, MISSOURI

BY

EDGAR CARROLL LONG

A

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Professor of Mining Engineering

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INTRODUCTION.

Early in the year of 1937, the company employing the writer decided to reopen an old mining property located in Kansas, one and one-quarter miles west of Waco, Missouri. This property is known as the Grasselli No. 1, the lease of which had been acquired a short time prior to the depression of 1930.

This property had been extensively mined on upper levels (195-foot, 176-foot, and 150-foot) by former operators and was a noteworthy producer of sphalerite. It was worked from the time of the beginning of the World War until about 1928. The lowest level, 285-foot, had hardly been well opened when, for reasons of the operators, the mine was shut down. It is upon this level that future mining is to be done. (See map of 285-foot level, page 16.)

It suffices to say that this mine has been exploited in typical Tri-State breast stoping practice. The ore-bearing strata are in approximately horizontal planes.

Five other shafts on adjacent tracts and properties are to be mined in conjunction with the Grasselli No. 1, but as repairs made to them and preparatory construction were of a similar nature, but far less extensive, no further reference will be made thereto, except in the case of Shaft No. 19.

SURFACE PLANT.

The old surface equipment at the Grasselli Mine was either wrecked or had been removed from the property, so an entirely new plant was required.

A concentrating plant was built just south of Grasselli No. 1 mine, to which ores from all of the shafts will be trucked. This plant is of modern design and has a capacity of 50 tons of ore per hour. It was constructed under supervision of company engineers, as was all the rest of the plant. A detailed report on this mill would constitute a lengthy paper and will not be included in this review. It is expected to operate the mill on a 24-hour basis, although the mining will be performed on one shift.

A central compressing plant and shop was constructed near the mill. From this compressing plant, air is conducted to the various shafts by means of 6-inch and 4-inch pipe with welded joints. Forty-foot lengths of pipe were purchased to minimize welding costs. The maximum distance for the piping of air is one-half mile.

Two compressors were installed in the plant--one a Chicago Pneumatic, 20 inches x 12 inches x 14 inches, and the other a Sullivan Class WJ3,17 inches x 10½ inches x 12 inches. The combined capacity of these machines will be in the neighborhood of 2100 cubic feet free air per minute, or enough to operate 18 or 19 rock drills in the normal procedure of mining.

The shop is equipped with a general blacksmithing forge, drill press, emery wheel, bit grinder, rod threader, power hack saw, anvil, vise, and accessory tools common to mine shops.

UNWATERING GRASSELLI SHAFT NO. 1 TO 278-FOOT LEVEL.

Water stood in this shaft to within 100 feet of the surface, and, since the shaft was known to be in bad condition, it was decided unwise to attempt a dewatering program by means of pumps in the shaft. The alternative chosen was that of installing a turbine-type well pump in a hole to be drilled to tap the lowest mine workings.

The most desirable place for such a drill hole was close to the shaft, in order to draw the water to the lowest possible level. Also, the pump had to be so located that a reservoir might be formed out of that portion of the workings. In this particular instance, it was desired that the pump drill hole should not penetrate the upper levels where they were mined, as this ground is exceptionally prone to caving, and the opening could cause a crooked hole.

With the above features taken into consideration, the location was chosen and a large hole was put down with a Keystone churn drill, penetrating the back of the mine workings at about -250 feet. This hole was cased with 14-inch pipe, welded at the joints. Great care was taken by the driller to secure a straight hole.

The pump purchased for the unwatering was a 9-stage Peerless well pump with a "Belturbo Head." The diameter of the bowls is $11\frac{1}{2}$ inches, and the diameter of the discharge column is 9 inches O.D. The rated capacity of this pump is 800 gallons per minute against a 285-foot head and at 1360 revolutions per minute.

A flat concrete base for the pump was poured around the cased drill hole, and a motor base was located as per pump manufacturer's specifications (also of concrete). In order to handle the pump, a four-post derrick 24 feet high was built of timber directly over the hole. Now this pump was installed to a depth of 281.8 feet, or within 6 inches of the bottom of the mine. A powered winch mounted on a Ford truck was used for the setting, total weight of pump and column being about 8 tons.

A galvanized steel shed was constructed over the pump and motor base, and a 100-H.P. electrical motor was immediately placed on the base and belted to the pump.

Pumping was begun May 10, 1937, and was continued in this manner until January 4, 1938. Reference to the graph (page 17) shows the rate of the lowering of the water. A flume constructed of lumber conducted the water to a nearby creek. Volume of discharge could be only approximated, since conditions did not warrant the construction of a weir or other measuring device. No attendance was required by this pump other than one daily inspection and oiling by the resident watchman.

GRASSELLI DERRICK AND HOPPER.

Company executives selected and purchased an all-steel derrick (headframe) and 500-ton hopper to be placed over the shaft. This equipment is similar in design to all such structures in the Tri-State mining field. The steel work was contracted to a firm in that business, and erection was performed upon foundations provided by the company. A concrete floor in the hoist room of the derrick was an item in which considerable saving was made by application of a not too common method of forming. By use of corrugated galvanized steel sheets, bent transversely (0.1 of span rise) into place between the floor members, the tedious and costly framing, placing, and removal of wooden forms was eliminated. The galvanized steel was left in place and presented a neat appearance from the lower side. (See sketch, page 18.)

After completion of the hopper and derrick, a United Iron Works Red Giant hoist was installed and equipped with the customary 5/8-inch steel non-spinning hoisting rope of proper length.

REPAIRING SHAFT.

With preliminary work completed and the water in the shaft falling, work was begun on reconditioning the shaft.

Sunk about 20 years previously, this shaft is 5 feet by 7 feet, and was "close cribbed" with 2-inch by 6-inch pine lumber to a depth of 190 feet. The strata penetrated were treacherous to handle and were largely shale, soapstone, and a crumbly dolomitic lime which was partially mineralized. All of the cribbing was extremely rotten and in some places had collapsed so as to almost entirely block the shaft. To complicate matters, there were two 6-inch pump discharge columns and three other 2-inch pipe lines suspended in the shaft. The old mine workings adjacent to the shaft had caved to the surface, and these disturbances may have shaken the ground rather violently. From the bottom of the cribbing to the bottom of the shaft, the ground stands well and is untimbered.

A "raft" was constructed with two 4-inch by 6-inch pine sills, 5 feet long, and a deck of 2-inch by 12-inch oak plank 4 feet long. To each end of each sill, a ½-inch steel hoisting cable 200 feet long was secured. (See sketch, page 18.) The raft was provided with a hook in the center by means of which it was lowered into the shaft with the hoist. At any desired depth the raft was secured to the steel derrick legs by means of the four cables, thus providing a working platform.

Cleats on the four corners were extended to the shaft walls and nailed to the deck to make the platform steady. The cracks around the edges of this raft were closed with boards to keep as much debris from falling down the shaft as was possible.

Beginning at the top, about three feet at a time of old cribbing was removed and replaced with new, until down 36 feet. The new cribbing (2-inch by 6-inch) was laced in the corners with 2-inch by 6-inch and fastened to long bearing timbers which rested across the edges of the shaft collar upon the derrick foundation. At about 36 feet, the shaly ground was firm enough to provide some support for timbers which were hitched into the walls. From this depth on, timbers were hitched into the walls at from ten- to 15-foot intervals. Since the suspended pipe lines were anchored at the bottom, and they seemed to be helping support the old cribbing in places, it was not deemed wise to remove them until a depth of 120 feet was reached with the new cribbing. From this point on, the old cribbing was not decayed so badly, and it was safe to cut off and remove the pipes.

All of the hitch timbers were plumbed and leveled, guide strings being placed in shaft corners for alignment of cribbing. In some places, the shaft had sluffed out so large that it was impossible to insert the hitch timbers without removing a large section of the old cribbing. To obviate this situation, instead of using long timbers, they were prepared in halves, the splice bolted after each end had been placed in its hitch. At one place the shaft section measured 16 feet by 25 feet. All openings back of the cribbing were lagged and filled with sawmill slabs.

The new cribbing is of 2-inch by 6-inch pine and is thoroughly spiked with 20d common nails. As has been mentioned, the original shaft cribbing was of the closed type all of the way down, a measure taken to help hold back ground water during the sinking operations. In the new work, open cribbing was used below 40 feet, as the shaft is now reasonably dry. (See sketch, page 19.)

Three men were used in the shaft and two men in the surface besides the hoistman. The surface men landed the debris and muck as it was sent out of the shaft and loaded it on a truck for disposal elsewhere. Cribbing and timbers were framed by the surface men in advance of needs.

Six weeks' time was required to recrib the shaft to the 185-foot level (average of 5 feet per day). This hazardous job was completed with no caving and no lost-time accidents. Lessors who had worked the 176-foot level just before this property was acquired by the present lessor had fortunately left a bulkhead in the shaft at this point which had caught all of the material which had fallen down the shaft in late years.

COMPLETION OF UNWATERING.

By the time the shaft repair was completed, the rate of unwatering had become so slow that it was decided to install a larger motor and speed up the pump from 1440 revolutions per minute to 1660 revolutions per minute. This change (effected on January 4, 1938) increased the discharge volume from 1380 gallons per minute to approximately 1600 gallons per minute. As may be seen from the graph (page 17) the water level was speedily dropped, and on February 4, 1938, the pump went on air with the water at -278.4 feet.

The pump was started again after one hour and run until on air, which practice was followed for several days to drain the ground before work underground was begun.

An ingenious but inexpensive device was arranged by the company electrician to automatically stop the pump motor the moment water ceased flowing from the discharge when the pump went on air. A wooden door was hinged with a piece of belting at the end of the horizontal pipe which discharges into the flume so that the discharging water holds it open. Attached to one side of this door is a small Jefferson Metal-Clad mercury switch (costing $1.50) set so that, with the door in the uptilted position, contact is made and the no-voltage release coil in the starting compensator is energized. If for any reason the water ceases to flow, the door drops down, contact in the mercury switch is broken, and the main switch is opened.

When the pump had lowered the water as far as it would, there still remained 5½ feet of water at the shaft. The old pump seat in the north side of the shaft 14 feet from the bottom was found to be in excellent condition, and there proved to be 6½ feet of head room above the water in the drifts leading east and west from the shaft.

Since the Peerless pump was on the east side of the shaft, it was planned to dam the drift leading east and form a reservoir of that portion of the mine. To accomplish this, a scaffold was built just above the low water mark in the shaft with a narrow run-way extending into the drift. From this platform and run-way, bags of earth, loose earth, horse manure, and rock sent from the surface were placed to form a dam. The shaft side of the dam was built up of bags of earth, and is 10 feet from the shaft. An 8-inch pipe was laid through the dam at low water mark to maintain equilibrium of water levels until the dam was complete. Another pipe was put in about 3 feet higher up to keep the water from washing over the top of the dam if the water rose too high for any cause. The dam was built to within $2\frac{1}{2}$ feet of the back of the drift, and is approximately 12 feet wide and 16 feet thick.

To unwater the west portion of the mine, a single-stage open impeller centrifugal pump, direct-connected to a 7.5 H.P. motor, was installed in the pump seat. This pump was piped to discharge to the east side of the dam. By using a flexible rubber suction, the water on the west side of the dam was "boosted" over and the shallow sump at the shaft was cleaned out. A permanent suction was installed, and a positive priming system (which uses an old oil drum for a tank) was provided. The pump is provided with a switch controlled by a float which automatically starts or stops the motor, keeping the water level between predetermined limits.

STEPS TAKEN TO PLACE MINE IN POSITION FOR IMMEDIATE PRODUCTION.

When the mine water had been pumped out, a thorough inspection of the roof was made, any loose slabs or boulders being barred down. Generally speaking, the roof was in very good condition. The faces were examined, and it was decided to re-lay a track from the shaft to one heading in order to take out some ore for experimental purposes.

Quite a large amount of mud, shovelers' boards, old ties, and other trash had to be removed before actual mining could be started.

It was found that the highest and best headings lay on the east, or reservoir side of the shaft. To mine any of this area, it was necessary to drive a small drift from west to east on the north side of the shaft, and hole through above the water level. Now a fill built out to the east faces makes them accessible for mining. A chute at the west end of this drift will be used to transfer the ore to the shaft level. This procedure will sacrifice a few feet of mineable ore in the lower part of the east side, but since the headings are 40 to 50 feet in height, a large tonnage of cheap ore is obtainable. Furthermore, a permanent pumping set-up, which will do away with the necessity for the dam and lower the water in the entire area, will permit complete extraction.

With the mine in the condition as described, it is now in a position to produce 300 tons per shift. With eventual and permanent pumping arrangements, some 50 tons may be added to production, and costs will be less when all of the ore is handled on the one level.

MACHINERY UNDERGROUND.

Two new Ingersoll Rand DA 35 drifters were purchased to do the development at Grasselli Shaft No. 1. Jackbits were used and proved very satisfactory in this type of dolomitic ground.

REPAIR OF SHAFT NO. 19.

In May, 1938, a contract was let on the recribbing of No. 19 shaft. It had been recribbed from the 45-foot level down to the

170-foot level, and then from the surface to the 30-foot level, when a cave-in at this point caused the contractor to abandon the shaft. This cave-in caused that portion of the cribbing above the 30-foot level to drop, fall over sidewise, and partially collapse, as is illustrated in the sketch on page 20. A hoisting can and other large objects were thrown down the shaft with the hope of wedging them at 45 feet to stop further caving, which they did. At this time, an enlarged ($8\frac{1}{2}$ feet by $8\frac{1}{2}$ feet in the clear) shaft was begun from the surface, the pole cribbing of which circumscribed the original shaft opening. The poles were put in down to 11 feet before work was stopped in June, 1938 (spring rains having started).

On August 4, 1938, work was resumed, employing strictly company workmen. The shaft was by this time full of mud and debris up to the 11-foot level. The pole cribbing was suspended by an improvised system of suspension cables and the shaftmen were tied to an independent life-line by means of ropes.

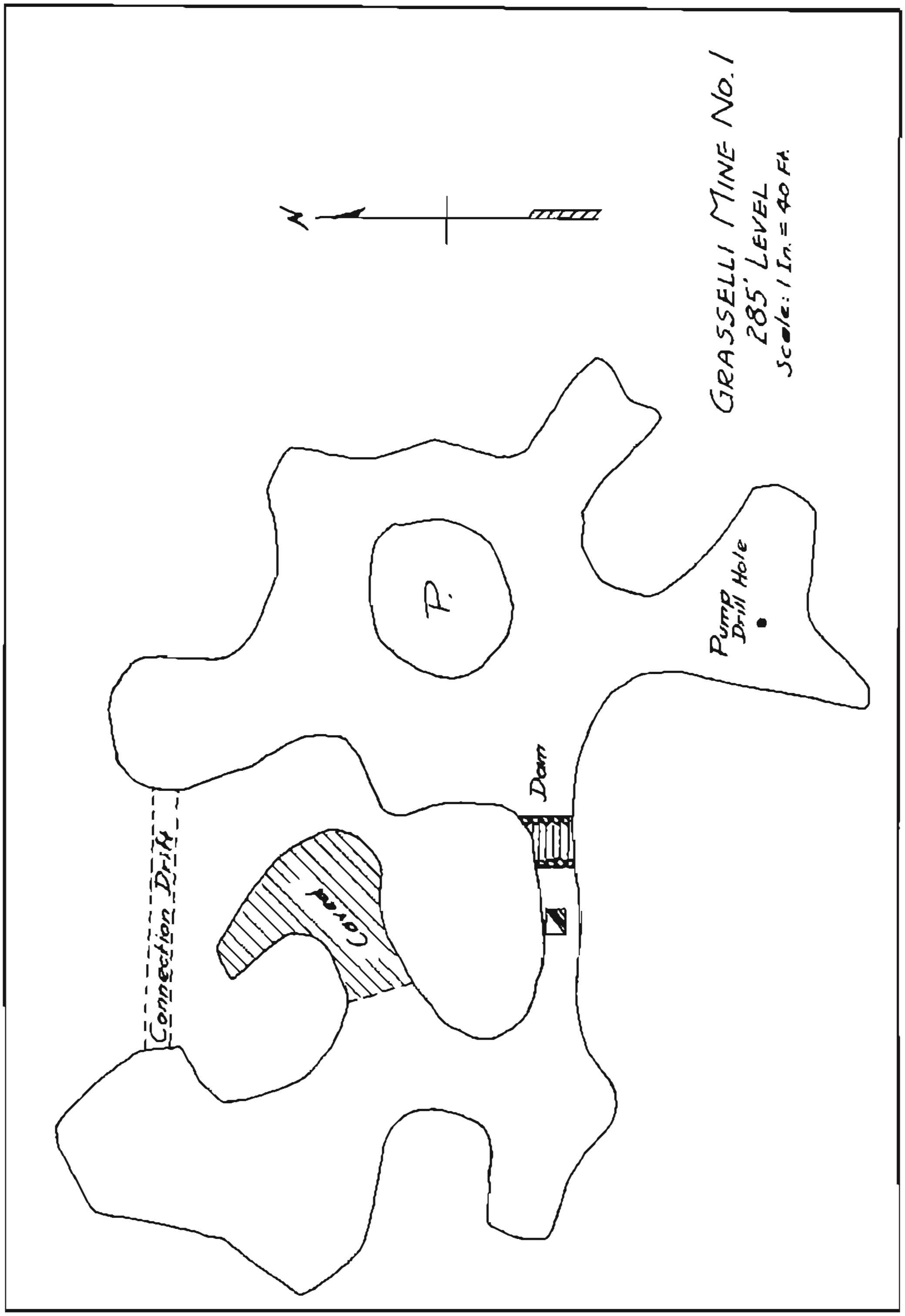
The $8\frac{1}{2}$-foot shaft was sunk through the mud, old cribbing, etc., with great difficulty until reaching the 43-foot level, where the remaining plug fell through.

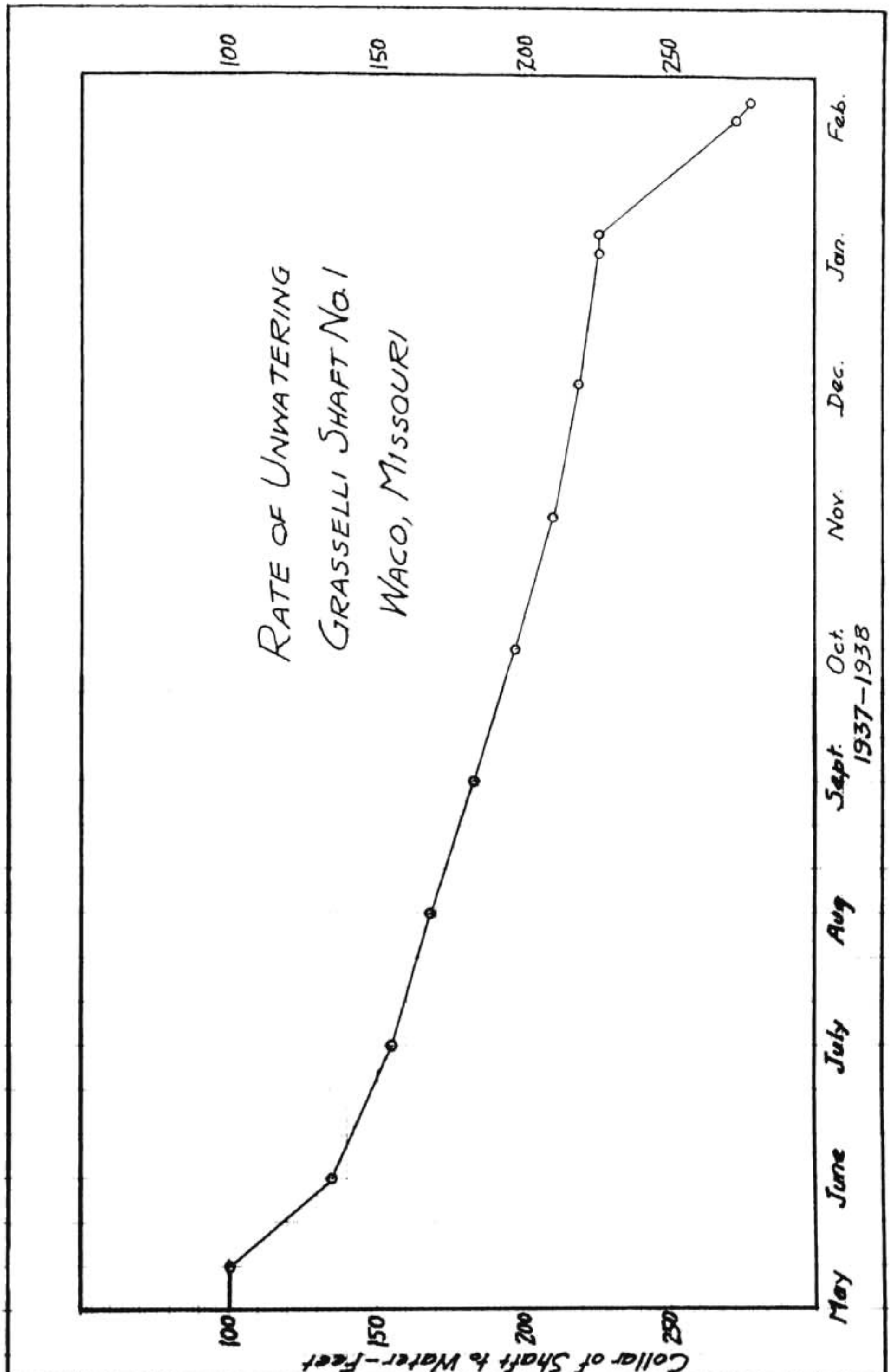
Now, cribbing was started on the original shaft (5 1/3 feet by 5 1/3 feet) and brought on up to the surface. Two-inch by 4-inch lumber was used in this work. After each six feet was cribbed, the space between the two sets of cribbing was filled with concrete and boulders. This method provided approximately an 18-inch wall of concrete around the shaft proper. The shaft was finished, and accessory equipment removed from the premises by August 26.

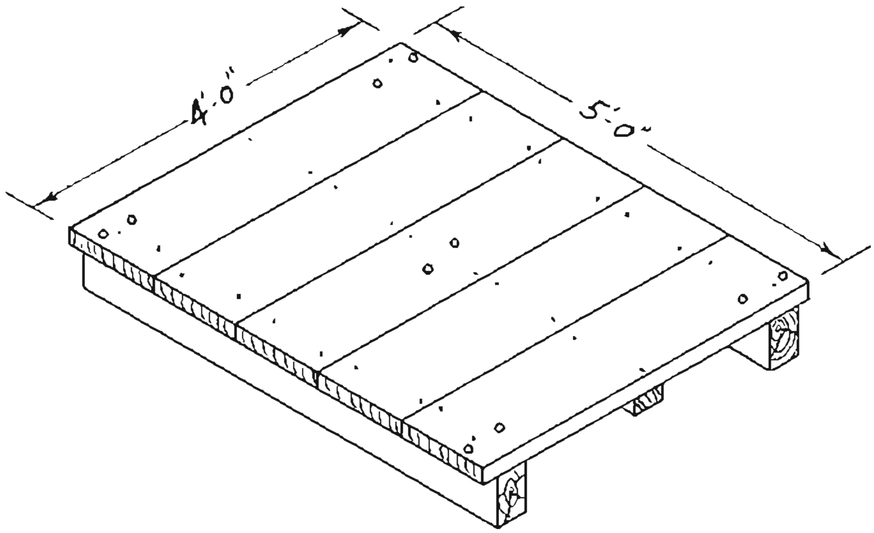
Access to concrete aggregate and water made for very low costs. Two hundred and fifty yards of concrete were poured at a cost of $3.25 per yard. Only 106 sacks of cement were used.

The 25-foot crater at shaft collar was filled with tamped earth to provide support for derrick and hopper.

Six men were employed in this work; one hoistman, three shaftmen, and two surface laborers.

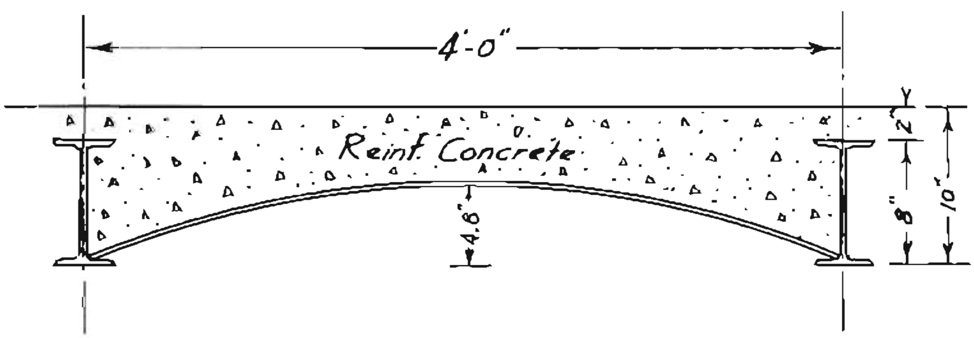

GRASSELLI MINE No. 1
285' LEVEL
Scale: 1 In. = 40 Ft.
N
P.
Pump Drill Hole
Dam
Caved
Connection Drift


RATE OF UNWATERING
GRASSELLI SHAFT NO. 1
WACO, MISSOURI
Collar of Shaft to Water – Feet
100
150
200
250
May
June
July
Aug
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
1937–1938

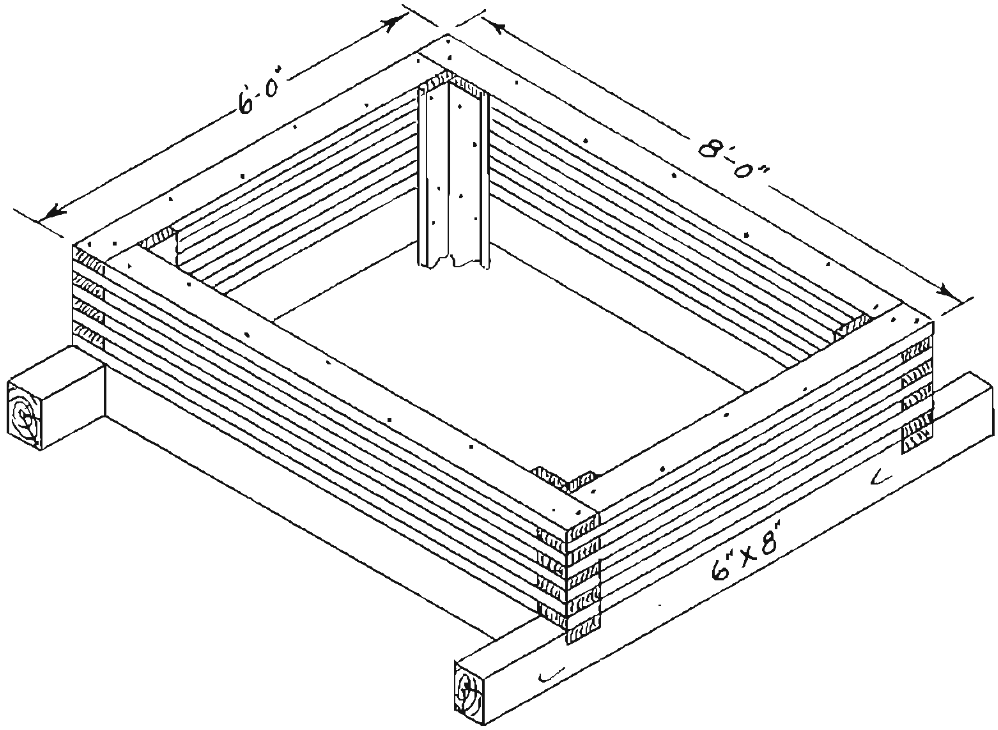


RAFT

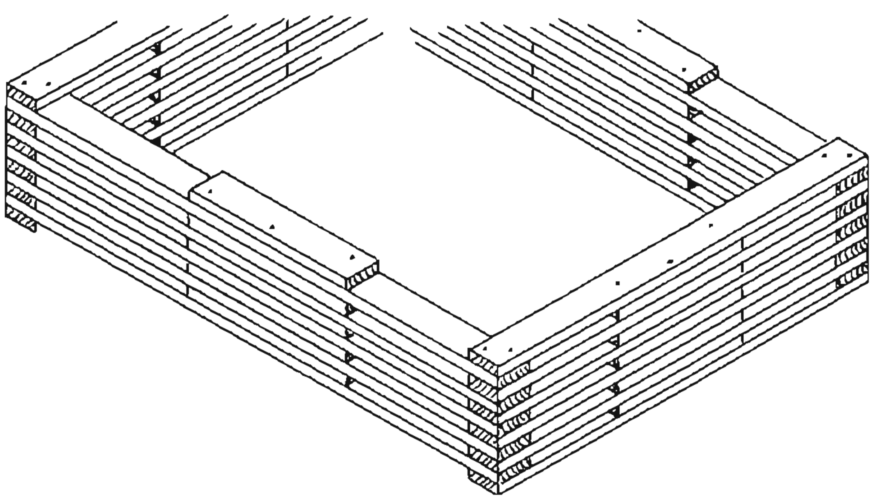
Cables are fastened thru holes & around sills at corners.
Cable loop is fastened in Ctr. thru deck & around 2" X 4".

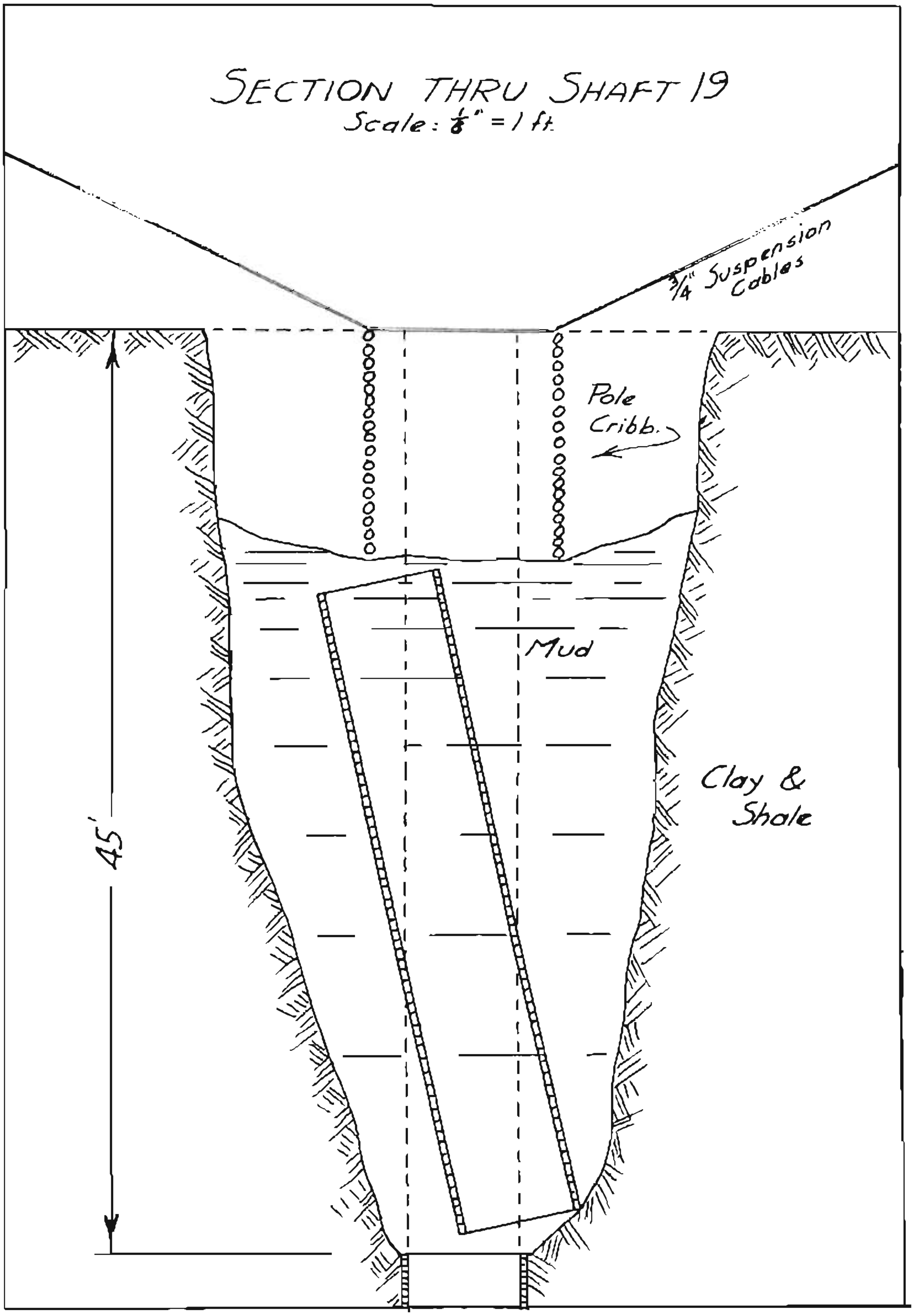


FLOOR SLAB



CLOSED CRIBBING


OPEN CRIBBING


SECTION THRU SHAFT 19
Scale: 1/8" = 1 ft.
3/4" Suspension Cables
Pole Cribb.
Mud
Clay & Shale
45'