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4. ESTIMATE OF ORE RESERVES: (Continued)

c. Estimated Analysis:

Lease: Grade	Tons	Iron	Phos.	Silica
Hill:				
Bessemer Direct,	33,671	59.11	.037	10.94
Non-Bessemer Direct,	348,746	60.24	.064	9.09
Bessemer Concentrates,	1,019,106	60.62	.031	9.82
Non-Bessemer Concentrates,	907,479	59.34	.054	7.90
Trumbull:				
Bessemer Concentrates,	1,053,113	58.22	.037	8.70
Non-Bessemer Concentrates,	2,549,940	59.26	.053	7.40
Total Bessemer Direct,	33,671	59.11	.037	10.94
Total Non-Bessemer Direct,	348,746	60.24	.064	9.09
TOTAL DIRECT, -	382,417	60.14	.062	9.25
Total Bessemer Concentrates,	2,072,219	59.40	.034	9.25
Total Non-Bessemer Concentrates,	3,457,419	59.28	.053	7.53
TOTAL CONCENTRATES,	5,529,638	59.32	.046	8.17
Total Bessemer,	2,105,890	59.40	.034	9.28
Total Non-Bessemer,	3,806,165	59.37	.054	7.67
GRAND TOTAL HILL-TRUMBULL MINE,	5,912,055	59.38	.047	8.25

In the above figures the concentrates include 921,072 tons of jig and 4,608,566 tons of wash ore concentrates. Attention is called to the fact that there are only 382,417 tons of direct ore available and that it will be entirely mined out in the next two or three years. The mining in the bottom of the West Trumbull during the 1941 season developed the fact that there had been some concentration in the structure drilling in this area and the material here, which was formerly carried as direct shipping, would merely be a high grade wash ore. All but one thin layer of this material was cut and partially mined during the 1941 season, definitely establishing the concentration in drilling. This resulted in the change in classification of 154,460 tons of Trumbull ore from direct shipping to concentrates.

5. LABOR & WAGES:

a. Comments:

(1) Labor:

The supply of all classes of labor was adequate for the maintenance of full crews in every department during the year. In the early spring there was considerable activity by the S.W.O.C., in an attempt to organize the Mesaba-Cliffs employees and in May a request was made for a meeting to enter into negotiations for an agreement with a local chapter of the C.I.O. Several meetings were held with their representatives and labor organizers during the next few months,

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5. LABOR & WAGES:
(Continued)

a. Comments:

(1) Labor: (Continued)

but no agreement could be reached and early in August they requested a meeting in the office of the Federal Labor Conciliator in Duluth. At the latter meeting there was again a distinct lack of agreement and, following the same, a strike notice was served on the State Department of Labor. In accordance with the State Labor Laws the matter was then referred to a fact-finding commission appointed by the Governor. Three meetings were held in the Village Hall at Taconite, Minnesota and the Governor's Commission made their report to the State, with findings distinctly in favor of The Mesaba-Cliffs Mining Company. A meeting with the Governor developed the fact that no agreement could be reached and the C.I.O. then threatened to strike, following the 30-day cooling-off period embodied in the State law. The strike was called off, however, following a meeting in which it developed that the majority of the employees were absolutely opposed to any strike. The Local Union, No. 2073, Steel Workers' Organizing Committee, then filed a petition with the National Labor Relations Board for a determination on representation and the case was set for December 3rd. However, it was then postponed until December 11th and again continued until some time during the early part of the year 1942.

b. Comparative Statement of Wages & Product:

PRODUCT, ----------	1,285,681 Tons.
Number of Shifts and Hours, ----------	3 - 8-hour
Average Number of Men Working,----------	166
Average Wages Per Day, ----------	$ 6.31
Product Per Man Per Day, ----------	39.29
Labor Cost Per Ton, ----------	$.185
Total Number of Days, ----------	177
Amount Paid for Labor, ----------	$ 238,608.25

6. SURFACE:

a. Buildings, Repairs:

A pit service garage was constructed near the loading pocket for use in the truck operations. Only minor necessary repairs were given to the dwellings in Marble.

c. Tracks, Roads, Transmission Lines, etc:

The usual maintenance work on the tracks and transmission lines was carried on throughout the year. The grading for the new truck road into the pit and for the tracks to serve the new pit conveyor system was started early in November. The track grading consisted of a cut 1,400 feet long with an average depth of 15 feet and a fill for tail track approximately 600 feet long. A total of 90,000 cubic yards of surface material was moved with one 4-yard electric shovel and five Euclid dump trucks. The material not needed for the fill was hauled to a stripping dump immediately East of the shop site,

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6. SURFACE:
(Continued)

c. Tracks, Roads, Transmission Lines, etc: (Continued)
this dumping space having been recently acquired from the Oliver Iron Mining Company.

The grading work was completed early in November and the equipment was then shifted to the road project. The latter consisted of a cut on a 5% grade, extending along the south side of the Trumbull lease from a point immediately west of the approach tracks to the west end of the pit. Approximately 80,000 cubic yards of surface material were removed from this cut and taken to the surface dump east of the shop site. The roadway hit the top of ore near the west end of the Trumbull and was then carried downward along the track benches on the north side of the pit to the pit bottom, near the present ramp site. The grading work was completed during the early part of January, 1942.

7. OPEN PIT:

a. Stripping:

A small stripping program was undertaken immediately following the ore season. This involved the removal of 12,000 cubic yards of sloughed surface material which had been washed into the pit bottom at the east end of the Hill lease. It was necessary to load this material into trucks and haul it to the ramp, where it could be transferred into dump cars and taken to the stripping dumps near the washing plant. The operation was started on November 3rd, using the #34 electric shovel and five 15-yard rear-dump trucks. However, after one shift the work was suspended, due to the fact that it was necessary to use this equipment for the construction of track grades which would serve the new conveyor system and of a road into the pit. The actual stripping operations will be resumed in the early spring.

d. Timbering:

	QUANTITY	AMOUNT
Standard Ties,	3,390	$ 2,542.50
Fir Timber (On Ramps)	12,787'	754.93
Fir Timber (In Tunnel)	110,932'	6,296.87

f. Explosives, Drilling & Blasting:

	QUANTITY	AMOUNT
No.4 Bag Blasting Powder,	14,750#	1,475.00
25%- 3 x 10 Gelatin,	15,600#	1,568.13
25%- 5 x 14 Gelatin, R.C.	24,200#	2,450.00
25%- 5 x 16 Special Gelatin,	3,650#	413.55
60%- 5 x 16 Special Gelatin,	2,550#	300.25
60%- 1-1/8" x 8" Special Gelatin,	1,300#	148.95
40%- 1-1/8" x 8" Red Cross Powder,	2,100#	209.05
No. 6 Blasting Caps,	1,200	14.60
8-ft. Electric Exploders,	300	19.97
16-ft. Electric Exploders,	550	46.70
40-ft. Electric Exploders,	680	118.52
Clover Fuse,	2,200'	13.20
Lead Wire,	500'	7.50
Connecting Wire,	142 Spools	67.25
Tamping Bags,	1,000	7.12

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7. OPEN PIT:

g. Open Pit Mining and Loading:

The 1941 ore season was started on April 18th, on a 3-shift, 5-days per week basis and the production of concentrates was carried forward through October 31st. A total of 1,006,651 tons of concentrates were secured in the mining and washing of 1,639,779 tons of crude ore. 975,546 tons (railroad weights) of the concentrates were shipped during the year, leaving 31,105 tons in stock. Direct ore was loaded intermittently throughout the season, the loading being confined to week-ends and to such times when trucks were available. The output of the latter during the season amounted to 279,030 tons, making a total of 1,285,681 tons produced and 1,254,576 tons shipped.

Mining activities were carried on in five distinct parts of the pit during the 1941 season: - first, the high bank extending along the south side of the Hill pit from the center line of Section 17, eastward to the direct ore area; second, the so-called direct ore area in the southeast corner of the Hill pit; third, the rocky wash area in the north central part of the Hill pit, immediately east of the truck-loading pocket; fourth, the East Trumbull area in the pit bottom, immediately east of the main approach tracks and - fifth, the pit bottom in the West Trumbull.

The mining along the high bank on the south side of the Hill pit was conducted intermittently with the 350-B Marion steam shovel, loading directly into dump cars and utilizing steam haulage to the washing plant. The ore material along the high bank was combed with the big steam shovel, leaving a four-tenths to one slope in the South ore bank. Starting at the Trumbull line at the center of Section 17, the shovel moved Eastward approximately 700 feet, when it encountered a high rock horse extending approximately one-third the distance up the bank. This prevented any further mining with the 350-B shovel in this area. The operation was discontinued on August 8th and the tracks leading around the East end of the pit to the South side were dismantled, making the ore in the track benches available for mining by truck. A total of 133,812 tons of concentrates were mined from the South bank. The material handled was a high grade wash ore, with a good weight recovery.

In the direct ore area in the southeast corner of the pit the mining during the first part of the season was confined to direct ore only. A small tonnage of ore adjacent to the tracks leading into the South side was loaded directly into the cars. Thereafter, the material was loaded into trucks and hauled to the ramp for transfer into ore cars. The operation, as a whole, was more or less a scram, for it consisted in cleaning off the various horses of rock and mining the narrow veins of ore in between the rock formations. The work was conducted with the 2-yard Marion electric shovel and the necessary number of trucks. The scramming and other operations used a bull dozer and a "Carrimor" scraper as much as possible. After loading operations were discontinued with the 350-B shovel on the South side, the tracks around the East end of the pit and along the

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7. OPEN PIT:

g. Open Pit Mining and Loading: (Continued)

South bank were removed and these benches were released for mining. This had tied up a large tonnage of wash ore immediately overlying the direct ore in the extreme southeast part of the area. This material was then mined with a 4-yard electric shovel and five to six trucks, the material being hauled to the pit ramp for transfer to the washing plant. Mining in this area was continued throughout the season. The wash ore was completely mined, leaving a small tonnage of direct ore in the bottom in the southeast corner and a small tonnage of direct ore to be scrammed and cleaned up. A total of 277,270 tons of direct ore and 172,881 tons of concentrates were removed from this area. The usual high grade product was secured from the Hill area during the season.

In the rocky wash area, immediately East of the ramp, operations were conducted intermittently during the first three months, but were discontinued during the latter part of July. Due to the fact that a large amount of rock had to be moved in connection with this mining, it was thought much more advisable to postpone the clean-up in this area until the screening plant, which is being built in connection with the pit conveyor, would be in operation. This will eliminate part of the re-casting and re-handling of the rock by the shovel during mining operations and will give a much cleaner and more satisfactory separation. There were only 25,079 tons of ore removed from this area during the season, but the present plans contemplate cleaning up the area during the 1942 season. A very good resultant concentrate was secured after the rock elimination.

In the East Trumbull the mining operations covered a small area lying between the approach and the property line, immediately East of the approach. The area was approximately 500 feet long, East and West and 300 feet wide, North and South. A series of cuts, running East and West along the area, carried the mining downward to the South practically mining out the entire wash ore product. The material was loaded with a 4-yard shovel and hauled by truck to the pit ramp for transfer to the washing plant. The operations in this area were pushed continuously during the first few months in order to make this shovel available for mining in the West Trumbull. The work in this area was discontinued late in July, when the mining had gotten to such a depth that wet conditions made it practically impossible to continue. An intervening rock horse apparently separated this area from the deep-well pump and water was encountered early in the operations. It was necessary, during the mining to maintain a separate pumping unit in the area carrying the sump downward as the mining progressed. The small remaining tonnage in this area will be cleaned up during the 1942 season, along with the underlying jig ore. A total of 269,438 tons of concentrates were secured from this area during the 1941 season. The crude material handled in this section of the pit was very lean and painty and its weight recovery was low. However, it produced a good concentrate.

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7. OPEN PIT:
(Continued)

g. Open pit Mining and Loading: (Continued)

In the West Trumbull the mining operations were carried to the South by a series of East and West cuts, using a 4-yard electric shovel and loading the ore directly into dump cars. Starting the latter part of July, the mining in this area was conducted rather consistently throughout the balance of the season. A series of cuts and numerous switchbacks carried the mining down to a depth which will prohibit any further mining by this method. The remaining ore in the West Trumbull will all have to be moved by truck and with this in view, a conveyor system is being installed for the 1942 season. Several attempts were made to mine the direct shipping ore which was indicated by the drilling in this area, but the actual mining operations proved that there had been some concentration in this drilling and that the material was merely a very high grade wash product. A total of 1,760 tons of direct and 405,615 tons of high grade wash concentrates were secured from this end of the pit.

With a combination of mining by truck and loading directly into dump cars and with the necessity of moving practically all of the direct ore by truck, the operations through the entire season were rather complicated and rather unsatisfactory as to the disposition of crews. No set plan could be carried forward due to grading requirements, so throughout the entire season there was the confusion of either calling out, or laying off the extra train crews and truck drivers, or there was the problem of trying to take care of these men with some other form of work. This will all be eliminated with the installation of the new conveyor system when all of the ore will be hauled by truck and the train crews will be cut to but two for each shift.

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8. COST OF OPERATION:

a. Comparative Mining Costs:

	1941 BUDGET	1941 COST PER TON	1940 COST PER TON
PRODUCT:			
Direct Shipping Ore, Tons	252,525	279,030	289,980
Concentrates, Tons	858,586	1,006,651	765,330
Total Production, Tons	1,111,111	1,285,681	1,055,310
Average Daily Product, "	-	7,264	8,580
Tons Per Man Per Day,	-	39.29	44.78
Days Operated,	-	177	123
COST:			
Open Pit Direct Shipping Ore,	$.087	$.118	$.060
Open Pit Crude Ore,	.161	.149	.134
General Pit Expense,	.023	.020	.034
Concentrating,	.124	.130	.125
Stocking Concentrates,	.004	.003	.018
General Mine Expense,	.054	.054	.051
Winter and Idle Expense,	.090	.084	.098
Adj.Labor (10¢ per hr. Incr.)	.029	-	-
Cost of Production,	$.444	$.405	$.400
Depreciation - Plant and Equipment,	-	.150	.200
Depreciation-Motorized Equipment	-	.012	-
Amortization, Stripping,	-	.150	.200
Taxes - Ad Valorem,	-	.089	.121
Taxes - Occupational,	-	.113	.124
Taxes - Royalty,	-	.091	.048
Total Cost at Mine,		$ 1.010	$ 1.093
Administrative Expense,	-	.100	.100
Miscellaneous Expense and Income,	-	.007	.001
Grand Total,		$ 1.117	$ 1.192

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8. COST OF OPERATION: (Continued)

a. Comparative Mining Costs: (Continued)

The 1941 figures were taken from the December cost sheet which was prepared before the final figures were received from the Cleveland office. Any changes that are made will be small and will not materially effect the cost per ton as shown in the above statement.

d. Detailed Cost Comparison:

(1) Product:

The original operating schedule for 1941 of 1,111,111 tons was exceeded by 174,570 tons, when it was decided to continue to produce throughout the month of October, after the estimated requirements had been made. In view of a peak demand in 1942, the operations were pushed through the entire month and concentrates, which could not be shipped, were placed in stockpiles. The 1,285,681-ton output for 1941 consisted of 279,030 tons of direct shipping ore and 1,006,651 tons of concentrated ore. This compares with the budget estimate of 1,111,111 tons, made up of 252,525 tons of direct and 858,586 tons of concentrates, and with the 1940 production of 1,055,310 tons, which consisted of 289,980 tons of direct and 765,330 tons of concentrates.

A mixed pit operation in which a part of the ore was loaded directly into cars and the remainder hauled by truck to a pit ramp for transfer cars, resulted in a higher labor cost and a lesser tonnage per man than in 1940. Both the direct shipping and the crude ore were thus effected and the tonnage necessary to be handled by truck was much larger than had been anticipated in the budget estimate. The cost of production was $.041 under the budget and $.005 above that for 1940. The increase over the latter was due, mainly, to a higher labor cost both in the number of men employed and in the higher hourly rate of pay occasioned by the $.10 per hour increase which went into effect on April 1st.

(2) - Open Pit Mining:

The cost of producing direct shipping ore in 1941 was $.031 above the budget estimate and $.058 above the 1940 cost. The latter was reflected entirely in the cost of truck operations. This amounted to $.025 for Trucks Operating; $.017 for Truck Maintenance and $.018 for the Maintenance of Roads and Ramps, totaling $.060, which more than offset a lesser expense for Track Maintenance. This was due to the fact that practically the entire output of direct ore was loaded into trucks and transported to the ramp for transfer into direct shipping cars. There was a small increase in Drilling and Blasting, Power Shovels Operating and Power Shovels Maintenance over the past season, but these were more than offset in a lesser track expense due to the fact that little, or no track work was necessary in the truck operation. In the case of the increase of $.031 over the budget estimate the higher cost was reflected entirely in Trucks Operating and Maintenance and in Truck Roads and Ramps, due to the fact that it was necessary to handle a larger percentage of the direct ore by truck than had been anticipated. The original

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8. COST OF OPERATION: (Continued)

d. Detailed Cost Comparison: (Continued)

(2) - Open Pit Mining: (Continued)

operating plans contemplated moving a large tonnage of direct ore from the south ore bank with the 350-B shovel, but an intervening rock horse, which was encountered, prevented this operation and left this ore to be mined by some other method.

The wash ore costs per ton of concentrates were but $.005 per ton above the 1940 costs and $.002 under the budget estimate. Drilling and Blasting was $.008 under the 1940 costs and the budget estimate, due to the fact that a smaller amount of rocky wash ore was moved than had been anticipated and also to the fact that the large block of ore moved from the West Trumbull areas required no blasting. Power Shovels Operating was also $.006 under the other figures as a result of using the electric shovels for the greater part of the operation, whereas in the original plan and the 1940 operations a large tonnage of ore was to be mined with the 350-B shovel, entailing an increased shovel cost. Locomotives and Cars Operating and Maintenance and Track Expense were the same as in 1940. However, they were $.007, $.001 and $.008, respectively, higher than the budget estimate. The increase over the latter was due, almost entirely, to the added haul and the additional track work occasioned by carrying the mining in the West Trumbull to a greater depth than had been originally planned. Trucks Operating and Maintenance and Pit Roads and Ramps were $.009, $.009 and $.006, respectively, over the 1940 operating costs, due to the fact that there was little or no trucking in the Hill operations during the 1940 season. These same three items were slightly above the budget estimate due to the fact that a larger tonnage than had been anticipated was handled by truck.

(3) - General Pit Expense:

The total cost per ton under this caption was $.013 below that for the 1940 season and $.003 under the budget estimate. All of the items were the same as the budget estimate and the 1940 costs, with the exception of Pumping and Drainage and Exploratory Drilling. In the case of the latter there was a saving of $.016 over 1940, due to a smaller drilling program and $.005 under the budget estimate, due to the fact that the program outlined had not been completed at the end of the year. This saving was partially offset, however, by an increased cost in Pumping and Drainage, due to the fact that it was necessary to maintain and operate extra pumps in the East Trumbull operations during the first half of the 1941 season. An intervening rock horse shut the water from this area off from the main pit pumps and the additional pumping here had not been anticipated.

(4) - Concentrating:

The costs for 1941 were very close to both that for 1940 and the budget estimate. There was an increase of $.006 over the

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8. COST OF OPERATION: (Continued)

d. Detailed Cost Comparison: (Continued)

(4) - Concentrating: (Continued)

latter and $.005 over the 1940 figures. The increase was reflected entirely in the cost of washing in each case, due to a higher labor cost and a larger amount of overtime than had been anticipated. All of the other items under this caption were practically the same as both the budget estimate and the 1940 costs.

(5)-General Mine Expenses:

The cost per ton under this caption was the same as the budget estimate and $.003 above the 1940 costs. The increase over the latter was found in the items Employees' Vacation Pay and Social Security Taxes. The increased cost of Employees' Vacation Pay was occasioned by the new ruling entitling men with over fifteen years experience to two weeks vacation, with pay. The Social Security tax rate was increased during 1941.

(6) - Winter and Idle Expense:

The saving of $.014 over the 1940 figures and $.006 over the budget estimate was due to a larger production and to the fact that the winter repair program at the shops, following the ore season, was much smaller than had been anticipated, due to extensive construction work.

9. EXPLORATIONS:

A comprehensive drilling program was undertaken at the Hill-Trumbull Mine during the year 1941, with a total of 93 holes and 5,009 feet of drilling. Three main areas were drilled - the Hill pit bottom, the Southeast corner of the Trumbull lease and the area north of the pit on the West Trumbull forty. In the Hill pit bottom, 83 holes were drilled, with a total depth of 3,200 feet, the average depth of the holes being 38½ feet. This drilling completely outlined the ore and the rock areas in the pit bottom and the information obtained will be of great value in grading. The work was all done by Company drills. In the Southeast Trumbull a number of holes are being drilled to check the possible extension of the ore body East of the approach. The program, to date, is only partially complete and there was not sufficient information obtained by the end of the year to make any changes in the existing ore body. During the year 1940, six holes, with a total depth of 1,473 feet and an average depth of 245 feet, were completed under contract with the Schultze Drilling Company of Grand Rapids. The work will be completed during the fore part of 1942 and a new estimate will be made of the ore in this area. In the West Trumbull, the NE¼ of the SE¼ of Section 18, 56-23, four drill holes were put down by the Schultze Drilling Company north and west of the West end of the pit in order to prove up a site which could be used for a stripping dump. The area was

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9. EXPLORATIONS: (Continued)

found entirely barren and dumping rights in this section were exchanged for an area adjacent to our shops with the Oliver Iron Mining Company.

10. TAXES:

The following statement shows the taxes and the average rate at the Hill-Trumbull Mine for the years 1941 and 1940:

	1941	1940	Increase	Decrease
Hill Mine,	$49,044.77	56,314.60		7,269.83
Trumbull Mine,	60,145.33	63,963.97		3,818.64
Hill-Trumbull Shops,	901.99	833.10	68.89	-
Hill-Trumbull W.P.Lands,	3,396.60	3,126.99	269.61	-
Personal Property,	4,386.25	3,857.92	528.33	
TOTAL, ----------	$117,874.94	128,096.58	-	10,221.64
Village Lots,	542.91	501.44	41.47	-
GRAND TOTAL, ---------	$118,417.85	128,598.02	-	10,180.17
Average Tax Rate,	97.61	90.05	7.56	-

The decrease in 1941 taxes over the year 1940 was accounted for, mainly in depletion. The small increases in the shops, washing plant lands and Personal Property were due to an increased tax rate. The increased rate of taxation was due to a general increase of State, County, Township, Village and School taxes in both the Village of Calumet and the Village of Marble.

11. ACCIDENTS AND PERSONAL INJURY:

There was but one lost-time accident at the Hill-Trumbull Mine during 1941, which is described as follows:

NAME: Mike Shipka DATE: November 12,1941.
CAUSE: While unloading two rolls of tractor links, the crow bar slipped and one roll of tractor links rolled back and wedged his left arm between the links and the wall of the car, breaking the fore arm.
NATURE: Broken fore arm.
TIME LOST: November 12, 1941. (Still incapacitated at end of year)

12. NEW CONSTRUCTION AND PROPOSED NEW CONSTRUCTION:

A truck ramp and a pit service garage were erected early in the

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12. NEW CONSTRUCTION AND PROPOSED NEW CONSTRUCTION: (Continued)

1941 season in connection with the pit truck operations.

Plans were drawn and construction started on a pit conveyor system which would eliminate train haul within the Hill-Trumbull pit. Mining with the use of locomotives and cars reached the absolute limit during the season and some new method of mining was necessary. The use of a conveyor was found to be preferable to two independent truck operations, one in the Hill and one in the Trumbull, due to a large saving in mining expense and to the fact that the conveyor system would make available a large tonnage of ore which was tied up in the main track approach through the center of the pit. A road into the pit and the track grading necessary in connection with the conveyor system have been completed. Work was started on a 900-foot tunnel for the conveyor system, and fair progress had been made at the end of the year. The tunnel will be completed and ready for the installation of the conveyor equipment during the first part of March, 1942.

Under an agreement with the fee owners, plans were completed for a heavy density, or cone treating plant, to treat the so-called jig ore. After a careful investigation, the heavy density process was recommended over treatment by jigging. The former process is not only more economical, both as to original cost and operation, but it is quite simple and has greater flexibility. The excavations and foundations for the plant were completed during the year 1941 and the plant proper should be completed early in June, 1942.

13. EQUIPMENT AND PROPOSED EQUIPMENT:

Three additional Euclid trucks and one RD-8 "caterpillar" tractor were added to the pit equipment. At the washing plant, two new Akins classifiers were installed, a Koehring dumptor truck was purchased for rock disposal and a 5/8-yard second-hand 16-B Bucyrus-Erie dragline replaced the old Austin-Western Machinery Company machine.

The new conveyor system will include a screening and crushing plant, 1,500 feet of 36" belt conveyor, made up of three sections and two transfer houses, and a loading pocket at the upper end. The screening and crushing plant will contain a 5' x 12' heavy duty scalping screen and two Ross feeders which will be purchased new. The 40 x 42 jaw crusher will be moved from the present crushing plant at the mill to the new plant in the pit.

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13. EQUIPMENT AND PROPOSED EQUIPMENT:

The heavy density plant, in addition to the cone, the screens, thickeners and pumps, will include a 24" belt conveyor for the crude feed and a 24" belt conveyor for the finished product. The crude material for the plant will be fed on to the conveyor by use of a triple-drum hoist and scraper.

18. NATIONALITY OF EMPLOYEES:

Nationality:

	NO. OF MEN 1941	NO. OF MEN 1940
English,	14	16
Jugo-Slav,	16	33
Swedish,	26	28
German,	24	19
Finnish,	31	29
Croation,	9	0
Irish,	6	9
Norwegian,	10	7
French,	11	4
Italian,	5	5
Bulgarian,	4	4
Welch,	4	1
Bohemian,	3	0
Polish,	3	0
TOTAL,	166	155

19. WASHING PLANT OPERATIONS:

Washing operations were started on April 18th and completed for the season on October 31st. The working schedule was conducted on three 8-hour shifts, five days per week throughout the season. Generally speaking, the operations were quite satisfactory throughout the year and an average daily production of 7,190 tons was secured. This compares with 7,152 tons during the season of 1940, which, at that time, had been the highest average to date at the Hill-Trumbull plant.

With peak operations and a car shortage it was necessary to stock concentrates very frequently during the entire season and a total of 168,501 tons of concentrates were placed in the Hill and Trumbull stockpiles at the plant. During the month of November, 137,396 tons of this material was loaded out with the 2-yard electric shovel which had been moved out from the pit. During the 1941 season, 1,639,779 tons of crude ore were treated, producing 1,006,651 tons of concentrates. The rejects from the

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19. WASHING PLANT OPERATIONS: (Continued)

mill amounted to 34,688 tons, averaging 27.90% in Iron.

The complete washing plant data for the year was as follows:

	TONNAGE	% OF TOTAL MINED	% IRON DRIED	TONNAGE RECOVERY	IRON UNIT RECOVERY
Crude Ore and Rock Mined,	1,675,493	100.00	43.84		
Less: Rock Removed in Mining	6,547	.39	35.34		
Crude Ore Transported to Mill	1,668,946	99.61	43.84		
Less: Rock Rejects in Crusher House,	29,167	1.74	28.22		
Crude Ore Entering Mill,	1,639,779	97.87	44.13		
Concentrates Produced,	1,006,651	60.08	59.20	61.39	82.35
Rock Rejects on Mill Picking Belt	5,521	.33	26.21		
Tailings (By Deduction)	627,607	37.46	20.12		
Total Heads - (As Above)	1,639,779	97.87	44.13		

The analysis of the product from the various machines for 1941 was as follows:

Hill Mill Machines:

	Iron	Phos.	Silica
Logs, ----------	60.84	.046	6.77
Dorr Classifiers, ----------	55.75	.039	14.25
Akins Classifiers, ----------	58.66	.043	10.12
Dorr Tailings, ----------	17.61		
Akins Tailings, ----------	18.78		

Trumbull Mill Machines:

Logs, ----------	59.83	.047	5.13
Dorr Classifiers, ----------	55.09	.042	12.61
Akins Classifiers, ----------	58.08	.045	8.12
Dorr Tailings, ----------	14.45		
Akins Tailings, ----------	15.11		

HILL-TRUMBULL MINE
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19. WASHING PLANT OPERATIONS: (Continued)

The analysis of the plant rejects for the year 1941 was as follows:

	TONS	IRON	PHOS.	SILICA
Hill, ----------	19,701	29.45	.029	51.20
Trumbull, ----------	14,987	25.87	.033	56.16
TOTAL, ----------	34,688	27.90	.031	53.34

The rock removed from the pit and placed on the dumps during the year 1941 was as follows:

	TONS	IRON
Hill, ----------	6,547	35.34
Trumbull, ----------	-	-
TOTAL, ----------	6,547	35.34

The weight recovery realized during 1941 was 61.39%, as compared with 58.96% in 1940. This increase was due to a larger percentage of high grade wash ore being moved from the West Trumbull.

The average Iron content of the crude ore was 2.15% higher than in 1940.

The Iron Unit Recovery for 1941 was 82.35%. The decrease of 1.15% from that in 1940 was due to the lean porous ore which was loaded from the Trumbull area, immediately East of the approach.

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Year 1941

11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents

Fatal accidents occurred at the Holman-Cliffs, Maas, Negaunee, and Lloyd mines and one was sustained by the Cliffs Power & Light Company.

Description of Fatal Accidents

Fatal Accident No. I

Oscar Tenhunen, a fireman on a crude-ore train, was killed at the Holman-Cliffs Mine May 16.

On the night shift the crew of locomotive No. 104 brought two empty 30-yard dump cars from the washing plant and set them out on the run-around track at the coal dock. The cars were attached to one 30-yard car, already standing there. A safety clamp, with a pin which goes under the rail, was set at the head or lower car of this train of three cars. Later on, another train of four empty cars was spotted a little less than half a car from the other cars. A safety clamp was also placed against the wheels of the lower car of the second train.

Shortly after 6:00 A.M., the crew of locomotive No. 106 came down from the washing plant and went in on the upper end of the run-around track to pick up two empty cars. This train bumped the train of three empty cars to make a coupling. The coupling pin failed to hold and the cars moved forward over the intervening space and bumped the lower four cars with sufficient force to start them over the clamp on the rail. All the sixteen wheels on one side of the train of four cars jumped over the clamp without derailment and entered the main line track, through a switch, and continued down grade into the pit, on the track leading to the ramp. The run-a-way train crashed headon into the front end of a locomotive which was spotting cars at the ramp, instantly killing the fireman.

The danger of cars moving when set on a down grade had been reported and an up-to-date derailing device had been recommended. There was unnecessary delay in installing one, and hence the accident was classified failure to provide proper safety device.

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Year 1941

11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents (Continued)

Tenhunen was a single man, 33 years old, and had worked at the mine since April 19, 1941.

Fatal Accident No. II

George Newman, a miner, was instantly killed by a fall of ground at the Maas Mine July 14.

This fatality occurred in a sub-level stope above the 4th level. Three miners worked together on each shift in this stope, and Newman's partners were George Aho and Alfred Beauchaine. On starting the shift, the three men inspected the place together. Newman was the leader and it was decided to start a new bench on the south side of the drift at the 240-foot elevation. This was a small drift, commonly called a "dog drift." Beauchaine went down to the transfer drift to assist the scraper operator in breaking chunks of ore. Aho drilled two 6-foot horizontal holes on one side of the sub-drift to start a new bench, and when these were finished, Newman suggested that they drill an upper hole to blast down the ore over the entrance of the sub-drift to the stope. Before drilling this hole the back was thoroughly tested by bar and pick. Aho testified that they were positive the back was solid. Newman started the drill hole with a stoper machine, inclining it toward the stope at an angle of about 65 degrees. When the hole was drilled about four feet, Aho left the place to go to the sub above for a six-foot drill. Meanwhile, Beauchaine returned from the transfer drift, and after talking with Newman, started searching for a six-foot drill alongside of the sub-level drift, when he heard a fall of ground. The fall occurred over the place where Newman was standing, $2\frac{1}{2}$ feet back from the brow of the stope. The main mass of falling ore fell into the stope but a portion of it caught Newman. His two partners were able in a short time to extricate him, but there was no possible chance of his escape from fatal injury as he was standing directly under the falling ground.

An inspection of the place indicated that a piece of ground approximately 7 feet by 7 feet and 3 feet thick came off from a slip. The slip was not evident before the fall and the amount of ore that gave way was too large to be detected by sounding. The accident was classified a trade risk.

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11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents (Continued)

Newman was 38 years of age, and lived in Negaunee with his wife and three children. He was an able miner and had considerable experience in sub-level stoping.

Fatal Accident No. III

An unusual accident occurred at the Negaunee Mine August 17, which resulted in the death of Otto Romo and minor injuries to two other men. Romo died in the Ishpeming Hospital the following day as a result of a basal skull fracture.

The shaft crew came to the mine on August 17, ready to start work as the afternoon shift men went off work at 12 midnight. The crew consisted of Otto Romo, Selmi Jarvi, Wesley Leece and Arthur Johnson, and it was their work to repair the north skip road between the 13th and 14th levels. The timber foreman, David Pynnonen, had been assigned to shift bossing, and Romo, who had many years' experience in shaft work and was a member of the shaft crew, was in charge of the crew.

The men attached a bonnet to the skip rope, placed a platform within the skip and went below the 13th level in the shaft. The work proceeded along satisfactorily until about 5:35 A.M. Romo, Jarvi and Leece were in the skip above the 14th level and Johnson was at the 13th level giving the signals. They had one more strip to attach on a runner and in a very few minutes their job would have been completed. At this time the door of the measuring pocket on the 12th level apparently opened and several tons of ore went down the shaft. It fell on the bonnet, forced it downward until the clamp that held it to the rope reached the dead end of the rope, 6 feet and 8 inches above the top of the skip. The bonnet plates bent downward, hitting the three men and knocking them down to the platform in the skip in which they stood.

Johnson heard the falling ore and in a short time he was told by Leece to hoist the skip up slowly. It was rung up to the 13th level and then to the station where there is an opening to the cage. The three men were taken immediately to the Ishpeming Hospital. Jarvi and Leece returned to their homes the same day.

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Year 1941

11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents (Continued)

The Manager called in a brain specialist who reached the hospital the next morning. He reported that everything possible in the treatment of the fractured skull had been done but Romo's condition became worse and he died a few hours later.

On investigation it was found that the pocket door had opened several times of its own accord but it had not been reported to the captain or superintendent. The timber foreman knew of it and had given the skip tenders instructions to always leave the measuring pocket empty. In case no one worked on the previous shift he or one of his crew made an inspection and when ore was found in the pocket a prop was inserted under the door. On this occasion, the regular skip tender was home and another man who had had some experience acted as skip tender. According to his evidence, Romo did not inquire about the pocket having ore when the shaft crew came on duty, and Jarvi and Leece stated that they made no inspection of it before starting to work in the shaft. The accident was classified preventable, as Romo should have made a personal inspection of all the stations before working in the shaft.

Romo was 57 years of age and is survived by his wife and five adult children. He had worked at the Negaunee Mine 37 years and for the past 25 years had been a member of the timber crew.

Fatal Accident No. IV

Untio Keskimaki, a Cliffs Power & Light Company lineman, was electrocuted at 1:40 P.M., August 25, in the course of duty near the village of Rumely in Alger County.

Shortly after noon of the day this fatality occurred, Matt Holmi, service man operating out of Chatham, received a trouble call. Service was interrupted on a 2300-volt line which was fed from a 6600-volt transformer located just south of the Rumely store. Holmi and Keskimaki went to Rumely to restore service on the 2300-volt line. Keskimaki climbed the pole and found a fuse blown. He replaced the fuse, closed the cutout with a fuse stick and

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Year 1941

11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents (Continued)

proceeded to climb down. On reaching close to the ground he stepped off the pole and then slumped downward. Holmi went at once to disengage Keskimaki who was then across a fence with his belt still fastened to the pole. Disengaging the belt Holmi pulled Keskimaki from contact with the pole and fence and dragged him about 15 feet from the bottom of the pole. In doing this he experienced only a slight shock which caused no injury.

Holmi attempted artificial respiration by an approved method in which he had been trained. After working a few minutes he decided that he had best leave the victim and go for help. He went to the country store, which was about 600 feet away, and obtained help. The body was removed to the store and another attempt was made to revive the unfortunate man but it was too late.

The ground was wet when the accident occurred. The installation was not in accordance with that now currently erected, and therefore the accident was classified as failure to provide a safe place to work.

Keskimaki was 28 years old and is survived by his wife and three children. He had worked continuously for the Cliffs Power & Light Company since August, 1938.

Fatal Accident No. V

Emil E. Maki, a miner, was drawn into a raise by a pile of ore subsiding at the Lloyd Mine November 26 and was almost instantly killed. It required six hours of strenuous labor to recover his body.

On the 22nd of the month three sets of timber had been erected over the top of raise No. 605 and at the end of the shift a blast was put off opposite the dirt compartment. Before blasting the miners covered the top of the raise with a grizzley, in conformity with the usual safety standard for the protection of the tops of raises. The following day was Sunday, during which time a run of ore from the back occurred and filled the working place up to the cap.

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11. ACCIDENTS AND PERSONAL INJURY

a. Fatal Accidents (Continued)

The next two days were spent trying to overcome the run but it failed. Instruction was then given to put in a "false cap" and spiling poles. The afternoon shift crew of the 25th cut the joggles for the cap but were unable to put in the cap due to the recurrence of another run of ore. In drawing the pile of ore into the raise the miners blasted a large chunk that was held up by the grizzley. It developed later that this blast broke one of the poles of the grizzley and provided an opportunity for the sudden subsidence of the ore pile which brought about Maki's death.

The night shift crew, on reaching the place, found it was again too full of ore to put in the false cap. They sent word to the level for the trammers to draw off some of the ore. The shift boss was there and saw the pile of ore drop down a short distance. He instructed the miners to place long poles across the pile for a covering upon which they could stand in safety. He then proceeded on his inspection tour.

The trammers loaded eight cars but the dirt in the raise hung up. On their next trip they went to the raise on the opposite side of the drift, 50 feet distant from raise No. 605. They had to blast several large chunks of ore which blocked together as they loaded the train of cars. The concussion of the blast jarred the tied-up ore in the other raise just as Maki was cleaning away the top of the ore pile at the top of the raise in order to make room for the cap. Maki's partner was about to call upon miners working close by for their help to lift the cap when the pile of ore dropped away. The surge upset Maki and he was drawn downward with the run. It was necessary to empty the raise to recover his body.

Maki was 45 years of age and had been employed less than one year. His wife and four children survive him. His accidental death was classified due to a failure to coordinate the work on the part of the miners and bosses on the afternoon and night shifts.

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11. ACCIDENTS AND PERSONAL INJURY

TABLE I

FATAL ACCIDENT RECORD
Cleveland-Cliffs Iron Co. and Cliffs Power & Light Co.
1898--1941, inclusive

YEAR	NO. MEN EMPLOYED	NUMBER FATALITIES	FATALITY RATE
1898	1065	6	5.63
1899	1174	4	3.41
1900	1427	4	2.80
	3,666	14	3.79
1901	1317	9	6.83
1902	1485	8	5.38
1903	1551	8	5.15
1904	1338	4	2.97
1905	2038	12	6.54
	7,729	41	5.30
1906	2418	10	4.13
1907	2843	17	6.00
1908	2340	6	2.52
1909	2520	13	5.15
1910	2907	20	6.88
	13,028	66	5.06
1898 - 1910		121	4.99
1911	2633	5	1.90
1912	2335	4	1.71
1913	2621	11	4.19
1914	2435	10	4.10
1915	3308	5	1.51
	13,332	35	2.70
1916	3063	8	2.61
1917	3457	6	1.73
1918	3765	13	3.45
1919	3938	11	2.79
1920	4125	5	1.21
	18,348	43	2.36

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11. ACCIDENTS AND PERSONAL INJURY

TABLE I (Continued)

YEAR	NO. MEN EMPLOYED	NUMBER FATALITIES	FATALITY RATE
1921	2309	6	2.60
1922	2301	1	.43
1923	2728	6	2.20
1924	2472	5	2.02
1925	2472	2	.81
	12,282	20	1.61
1926	2119	4*	1.88
1927	1969	4	2.03
1928	1784	4	2.25
1929	2000	4	2.00
1930	2566	5	1.95
	10,438	21	2.02
1931	1651	3	1.82
1932	630	0	0.00
1933	631	2	3.17
1934	1073	4	3.74
1935	1313	2	1.53
	5,298	11	2.05
1936	2125	2	.94
1937	2763	1	.36
1938	2590	3	1.17
1939	2457	1	.41
1940	2756	5	1.88
	12,691	12	.94
1941	3570**	5	1.40
1911 - 1941		147	1.93
Including deaths in Barnes-Hecker Accident		198	2.60

* Not including loss of lives in Barnes-Hecker Mine Accident.

** Approximate number.

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11. ACCIDENTS AND PERSONAL INJURY

TABLE II

Classification of Causes of Fatal Accidents
From December 1, 1898 to December 31, 1941

A.	Fall of Ground	101	
	Run of Mud or Sand	60	
	Fall of Chunk of Ore from Chute	2	
	Stray Chunk or Stick down Raise or Stope	3	166
B.	Shaft Accidents:		
	Falling down Shaft	14	
	Rock or Timber Falling down Shaft	3	
	Struck or Caught by Cage, Skip, Bucket, Tool	8	
	Falling from Cage, Skip, or Bucket	11	
	Falling from Ladder in Shaft	5	
	Carried or Pushed into Shaft by Car	3	
	Jumping on or Off Cage, Skip, or Bucket	3	
	Struck by Crosshead	5	52
C.	Use of Explosives:		
	Explosion of Powder	16	
	Premature Blast	3	
	Fall of Ground or Timber Due to a Blast	4	
	Overcome by Gas	3	
	Miscellaneous Causes	1	27
D.	Mine and Railroad Cars:		
	Caught by Haulage Cars	13	
	Riding or Attempting to Ride Cars	6	
	Falling with Car from Trestle	4	
	Run over by Railroad Car	8	
	Miscellaneous Causes	1	32
E.	Miscellaneous Causes:		
	Falling in Raise, Stope or Pocket	9	
	Electric Shock	10	
	Falling from Ladder, Stage, Trestle, etc	8	
	By Moving Machinery	6	
	Mine Fires	3	
	Stockpile Slide	3	
	Miscellaneous Causes	3	42
	Total		319

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11. ACCIDENTS AND PERSONAL INJURY

TABLE III

Classification of Fatal Accidents 1911 to 1941, inclusive, by the Central Safety Committee

I	Trade Risks.....		112
II	Negligence of the Company:		
	Violation of Rules.....	4	
	Failure to Provide Safety Devices.....	6	
	Improper Method of Doing Work.....	12	
	Failure to Provide Tools or Safe Place to Work...	5	
	Failure to Instruct Men.....	4	31
III	Negligence of Workmen:		
A	Injured Men:		
	Improper Method of Work.....	20	
	Violation of Rules.....	9	
	Failure to Use Tools or Appliances Provided.....	4	
	Failure to Use Safety Devices.....	3	36
B	Other Workmen:		
	Improper Method of Doing Work.....	14	
	Violation of Rules.....	4	
	Failure to Use Tools or Appliances Provided.....	1	19
	Total.....		198

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11. ACCIDENTS AND PERSONAL INJURY

TABLE IV

NUMBER OF MAN-SHIFTS WORKED
AND TONS OF ORE PRODUCED PER FATALITY

Year	Number of Fatalities	Number of man-days Worked per fatality	Number of tons of Ore mined per fatality
1931	3	165,137	529,680
1932	0	189,000*	486,750**
1933	2	94,689	398,357
1934	4	80,477	451,046
1935	2	196,883	1,136,215
1936	2	283,945	1,850,898
1937	1	765,702	5,216,879
1938	3	163,434	385,954
1939	1	564,433	3,713,389
1940	5	142,878	1,156,387
1941	5	182,340	1,456,528
Average	2.5	194,810	1,237,883

* Man-shifts worked

** Amount of ore mined

Safety Department

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Year 1941

11. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents

Mining abounds in accidents of a minor and serious nature which are due to causes that are less influenced than other causes by preventive efforts because they cannot be entirely eliminated by any device or art known to man. Accidents by falls of ground, falls of men, haulage and the use of high electric current fall into this group when least expected and in places where working conditions are normal to mining. The human element is always present and very frequently it is the principal factor for the occurrence of many accidents which are charged to these hazards.

Accidents are more common among miners because they outnumber the number of men working at any other occupation and also because their work is more hazardous. As to the comparative hazards of day and night work, we have been told that some factors are thought to operate in one direction and some in the other. Fewer men work at night but there is less handling and transportation of timber than on the day shift. Emphasis has been placed on the fact that there is not the same illumination by night as by day but this factor does not enter underground work. Probably the most important differences are the unsatisfactory physical and mental condition of the worker and the fact that he receives less supervision. Our statistical data do not warrant reaching positive conclusion in reviewing this subject, nor do they indicate that fatigue contributes to the occurrence of more accidents during the closing hours of a shift's work than in the early hours of work.

Accidents caused 727 injuries which were treated by physicians but resulted in no lost working time, other than that required to visit a hospital in the cases of a certain proportion of them. There were 19 that were charged with a loss of 6 days or less each, and 79 resulted in a loss of more than 6 days each and thereby were compensable accidents. The most serious injury of this group was the loss of a thumb and two fingers by a Maas Mine miner in a blasting accident. Including the five fatalities, a total of 830 accidents occurred.

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents (Continued)

TABLE V

SHOWING NUMBER OF ACCIDENTS OF ALL KINDS

Mine or Plant	Slight	Lost-time: Less than 7 days	Lost-time: 7 days or more	Fatal	Total
Athens	85	3	14	0	102
Canisteo	43	3	6	0	52
Cliffs Shaft	86	5	9	0	100
C. P. & L. Company	9	1	2	1	13
Hill-Trumbull	39	1	1	0	41
Holman-Cliffs	61	3	2	1	67
Lloyd	91	0	6	1	98
Maas	124	2	19	1	146
Mather	26	0	1	0	27
Negaunee	110	0	14	1	125
Spies-Virgil	18	0	2	0	20
Shops & Storehouse	20	0	1	0	21
Tilden	7	1	0	0	8
Miscellaneous	8	0	2	0	10
	727	19	79	5	830

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents (Continued)

TABLE VI

CAUSES OF THE 84 COMPENSABLE ACCIDENTS, INCLUDING FATALITIES

UNDERGROUND

Cause	Athens	C.S.	Lloyd	Maas	Mather	Negaunee	Spies	Total
Falls of ground	3	1	3	3		4	1	15
Chunks rolling down pile, etc.	1	2		1				4
Handling timber or other objects	4	1	1					6
Loading at chutes	1	1		1				3
Falling in raise			1	1				2
Haulage	1			2		1	1	5
Blasting				2				2
Hand tools	1	2		1		1		5
Slipping or stumbling		1		2		2		5
Struck by objects moved by hoists			1	3		3		7
Stepping on projecting nail	1			1				2
Other causes	1			2		2		5
Total underground	13	8	6	19		13	2	61

Safety Department

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11. ACCIDENT AND PERSONAL INJURY

b. Non-Fatal Accidents (Continued)

TABLE VI (Continued)

SHAFT ACCIDENTS

Cause	Athens	C.S.	Lloyd	Maas	Mather	Negaunee	Spies	Total
Struck by falling ore						2		2
Falling persons					1			1
Caught between skip and runner			1					1
Total shaft			1		1	2		4

SURFACE

Handling material	1			1				2
Caught in sheave when oiling		1						1
Total surface	1	1		1				3
Total underground mines	14	9	7	20	1	15	2	68

OPEN-PIT MINES

	Canisteo	Hill-Trumbull	Holman-Cliffs	Tilden	Total
Truck operation	2				2
Machinery	1				1
Handling material	2	1	1		4
Railroad Cars			1		1
Slipping			1		1
Struck by chunk of ore off dipper	1				1
Total Open Pits	6	1	3		10

Safety Department

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Year 1941

11. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents (Continued)

TABLE VI (Continued

OTHER OPERATIONS

Causes	C.P.& L. Co.	Princeton	Gen.Sthse.	Hospital	Total
Handling material			1		1
Slipping & falling	1			1	2
Contact with high voltage current	2				2
Cranking car		1			1
Total	3	1	1	1	6

TABLE VII

FREQUENCY RATES*

All Compensable Accidents

Year	Total Man Days Worked	Number of Compensable Accidents Non-fatal	Fatal	Frequency Rate
1935	393,967	35	2	.094
1936	567,891	33	2	.062
1937	765,701	58	1	.077
1938	491,303	46	3	.099
1939	564,542	44	1**	.078
1940	714,391	59	5	.089
1941	918,300***	79	5**	.092

* Based on number of accidents per 1000 man-days worked.
** C. P. & L. Company fatality included.
*** Approximately correct.

Safety Department

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Year 1941

11. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents (Continued)

TABLE VIII

Severity Rates
All Compensable Accidents

Year	Non-Fatal Days Lost	Rate	Fatal Days Lost	All Accidents Days Lost	Rate
1935	3,225	7.93	3,600	6,825	17.70
1936	3,509	6.16	3,600	7,109	12.67
1937	7,881	10.29	1,800	9,681	12.64
1938	6,290	12.80	5,400	11,690	23.66
1939	3,264	5.79	1,800	5,064	8.97
1940	3,442	4.82	9,000	12,442	17.52
1941	5,403	5.81	9,000	14,403	15.75

TABLE IX

SHOWING GROUP AGES OF INJURED WORKERS
(Compensable Accidents)

Age	Number injured
20 to 25 years of age	10
25 to 30 years of age	9
30 to 35 years of age	8
35 to 40 years of age	10
40 to 45 years of age	2
45 to 50 years of age	14
50 to 55 years of age	10
55 to 60 years of age	13
60 to 65 years of age	8
	84

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Year 1941

11. ACCIDENTS AND PERSONAL INJURY

b. Non-Fatal Accidents (Continued)

TABLE X

SHOWING TIME PERIODS WHEN COMPENSABLE ACCIDENTS OCCURRED

Time	Number	Working Period
8:00 to 12:00 A.M.	30	First half of day shift
12:00 to 4:00 P.M.	15	Second half of day shift
4:00 to 8:00 P.M.	17	First half of afternoon shift
8:00 to 12:00 P.M.	7	Second half of afternoon shift
12:00 to 4:00 A.M.	8	First half of night shift
4:00 to 8:00 A.M.	7	Second half of night shift
	84	

TABLE XI

SHOWING OCCUPATION OF INJURED WORKERS
(Compensable Accidents)

Miner	39	Trammer	2
Timberman	4	Locomotive runner	2
Surface laborer	4	U.G. laborer	1
Chuteman	4	Truck driver helper	1
Foreman or boss	3	Electrician	1
Scraper man	3	Skip tender	1
Mechanic	3	Fireman	1
Truck driver	3	Timber framer	1
Miner's helper	2	Trackman	1
Oiler	2	Blacksmith helper	1
Sampler	2	Nurse	1
Lineman	2		84

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection

Safety in industry is dependent to a very large extent upon a continuing activity on the part of the supervisors and workers alike in every phase of accident prevention work. This is particularly true of mining, for there are no automatic and permanent influences that safeguard the miners from some of the hazards that are common and incidental to their work. The Company has never been sparing in effort or money in utilizing every preventable agency available in order to maintain the interest of the workers in safety, but experience has proven that the rigid enforcement of safety rules and regulations has been the most effective cure for the control of accidents.

One of the principal functions of the Safety Department is to inspect the mines and plants in the capacity of cooperating with the supervisory force for enforcing the Company's safety standards. H. F. Rogers, safety inspector, and the writer spent most of their time the past year in work of this kind. Mr. Rogers made his inspection tours accompanied by the shift bosses and the writer went along with the captains or foreman. The former makes a written report of each of his inspections, three copies of which are sent to the Superintendent of the mine inspected. A copy of his reports is returned to the Safety Department with the Superintendent's notations attached and is transmitted to the Manager as a part of the monthly report of the Department. The writer's suggestions and recommendations have been acted upon when given orally at the time of inspection but those of unusual importance were called to the attention of the superintendents.

The following table gives the number of safety suggestions and recommendations that were submitted during the year by Mr. Rogers.

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

Mr. Whittington submitted a total of 102 safety recommendations and 72 suggestions during the course of the year. He also inspected and replenished the fire extinguishers, in compliance with the regulations with respect to time-period stipulations.

A. J. Stromquist became a member of the Safety Department December 1. He is unusually qualified in natural ability, training and experience to promote safety activities in the mining field. After completing his education, he worked as a miner and foreman in mines at Ironwood and during the past fifteen years was with the U. S. Bureau of Mines in the capacity of mine rescue and first aid instructor. His duties as instructor also brought the responsibility of fighting mine fires, and as his work extended to metal mining districts in other sections of the country, his association with our Company will give it the benefit of his varied experiences. Since 1930, our first aid training has not reached the development necessary for our requirements but this deficiency will be corrected within a comparatively brief time under his able leadership.

Idle and Abandoned Mines and Explorations

The protection around pits and shafts on these properties was inspected early after snow disappeared and again late in the fall. Many repairs were needed, as is the usual condition existing after the lapse of a few months. The destructive forces are snow drifts and the wanton action of men and boys. Work of this description took in pits and shafts on the Angeline, Salisbury, Lake, Cleveland, Hard Ore, North and South Jackson, Lucy, Prince of Wales, Empire, Princeton, Fitch, and Republic mines and numerous explorations.

Inspection Reports

To improve the enforcement of our rules for the safe ignition of explosives, shift bosses are required to report weekly on blasting practices of the miners. A shift boss must inspect every contract of miners at blasting time at least once every two months. The report on this inspection has 12 questions which cover the most

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

TABLE XII

Mine or Plant	Violation of Standards	Safety Suggestions	Recommendations	Total
Athens Mine	29	8	3	40
Cliffs Shaft Mine	9	15	4	28
Lloyd Mine	31	15	10	56
Maas Mine	48	25	9	82
Mather Mine	1	0	2	3
Negaunee Mine	38	15	1	54
Spies-Virgil Mine	1	3	5	9
Tilden Mine	1	1	0	2
Shops	2	3	3	8
C. P. & L. Co.	1	1	1	3
Miscellaneous	3	3	10	16
Totals	164	89	48	301

G. R. Whittington, safety inspector for our mines in Minnesota, made the number of inspections listed in the next table.

TABLE XIII

Mine	Pit	Shops	Washing Plant	Surface	Total
Canisteo	25	14	21	12	72
Hill-Trumbull	29	13	22	9	74
Holman-Cliffs	26	16	20	11	73
	80	43	63	32	219

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

hazardous details involved in blasting. How extensive this inspection has become is apparent by the number of reports submitted to the superintendents during the last nine months in the year. This procedure should go far in stopping unsafe and improper blasting practices, which in the past have caused many costly accidents.

TABLE XIV

NUMBER OF BLASTING INSPECTION REPORTS

Mine	Number
Athens	205
Cliffs Shaft	521
Lloyd	119
Maas	341
Negaunee	449
Spies-Virgil	60
Total	1695

The following tables show the kind and number of safety inspection reports made by the mine and plant foremen, which were received and checked by this Department.

TABLE XV

Hoisting Ropes	Daily Report	2124
Skip Roads	Weekly Report	334
Ladder Roads	" "	362
Skip and Cage Hoists	Monthly Report	140
Cage Safety Catches	" "	91
Slack Rope Alarm	" "	67
Underground Fire Doors	" "	24
Mine Rescue Apparatus	" "	23
Fire Extinguishers	Semi-Annual Report	33
Fire Hose	" "	29
Fire Prevention	Annual Report	188
	Total	3415

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

TABLE XVI

NUMBER OF FIRE EXTINGUISHERS INSPECTED

	2½ Gallon Soda Acid Type	3 Gallon Carbon Tetrachloride	1 Quart Carbon Tetrachloride	Other Types
Athens Mine	5	4	28	0
Canisteo Mine	6	0	32	0
Cliffs Shaft Mine	9	4	48	2
Central Office	6	0	12	1
Gardner-Mackinaw	0	0	0	0
Gwinn District	0	0	0	0
Hill-Trumbull	0	2	30	0
Holman-Cliffs	5	0	20	0
Hibbing Office	0	0	0	0
Ishpeming Hospital	9	0	20	0
Ishpeming Residences	0	0	36	0
Lloyd Mine	3	6	26	0
Maas Mine	5	10	36	0
Mather Mine	4	0	14	0
Negaunee Mine	5	6	30	0
Negaunee Hospital	3	0	0	0
North Lake Residences	2	0	20	0
Spies-Virgil	3	8	42	0
Spies Location	0	0	34	0
Shops, Storehouse, & C. P. & L. Co.	14	26	80	18
Tilden Mine	1	2	56	3
Totals	80	68	558	24

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

Rules and Regulations

The number of rule books distributed at our Michigan mines was considerably less than in 1940, being limited to newly-appointed foremen and men assigned to locomotive haulage and the handling and distribution of explosives.

A set of safety rules for the Cliffs Power & Light Company was formulated and will be ready for distribution to all its employees early in 1942.

The Company's standards relative to employment, safety, supplies, etc. were combined together and copies were given to Messrs. Moulton, Allen, Marjamaa, Haller, and Whittington.

TABLE XVII

RULE BOOKS DISTRIBUTED AT MICHIGAN MINES

Mine or Plant	Foremen	Haulage	Explosives	Top Slicing	Total
Athens	2	7	0	0	9
Cliffs Shaft	2	25	0	0	27
Lloyd	2	2	5	1	10
Maas	2	11	6	7	26
Mather Mine	2	0	0	0	2
Negaunee	2	8	0	0	10
Spies-Virgil	3	7	0	0	10
Tilden	2	0	0	0	2
Totals	17	60	11	8	96

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

There were 57 men suspended one or more days each for not complying with rules or regulations and three discharged for smoking underground. Other men were let out of employment for permitting drinking to interfere too frequently with their work.

TABLE XVIII

CAUSES AND NUMBER OF DISCIPLINARY ACTION

Cause	Athens	Cliffs Shaft	Lloyd	Maas	Mather	Negaunee	Spies-Virgil	Total
Losing time	7		4	9				20
Infraction of rules			1	10				11
Not conforming to safe practices		1		2		5		8
Disregarding instruction		1		4	1	2		8
Reporting to work under influence of liquor	1	1				4	1	7
Carelessness						3		3
Smoking underground	3							3
Total	11	3	5	25	1	14	1	60

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

Central Safety Committee

This committee met only twice; in June and in December. There has not been the demand these later years for frequent meetings as there was years ago when it was necessary for it to act upon subjects of safety which were more or less in dispute. The superintendents have been very busy the past two years in the production of ore and it has not been advisable to demand too much of their time attending conferences of various kinds. It has been found more advantageous to discuss accident causes and their prevention at safety conferences attended not only by the superintendents but also the captains, foremen, and bosses, which have been held after working hours.

Foremen Conferences

There were four general safety conferences during the year, each being attended by the superintendents, captains, and the foremen and bosses who were not working at the time of the meetings. There were 67 men present at one conference and the others also had large attendances. The captains and foremen were requested to give the circumstances pertaining to the occurrence of each serious or fatal accident; different methods of performing hazardous jobs were discussed; and subjects dealing with efficiency were included in the programs. A "smoker" followed each conference, which added to the interest of the gathering together of these men who fill the various supervisory positions in our Company. Minutes were recorded and copies were sent to the superintendents.

The foremen at our Minnesota mines met in conference four times with W. A. Sterling presiding and G. R. Whittington as secretary. The attendance varied from 11 to 25 men per conference. All the safety recommendations submitted by Mr. Whittington were discussed and the accidents that occurred at the Minnesota mines were classified.

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

Mining Club

The annual meeting of this club was held December 6 with 148 men present. A banquet was served and was followed by a discussion of the subject of present-day safety activities at our mines and plants by the writer. Mr. Elliott commented on what was said and then requested a united cooperation for safety and pleaded for the loyalty of every foreman.

Lake Superior Safety Conference

This conference was held in Duluth on June 26 and 27. Employees of the Company present were: W. A. Sterling, H. C. Bolthouse, G. E. Tucker, J. J. Foucault, J. A. Wivell, and M. E. Gaffney from our Minnesota mines, and H. F. Rogers, L. C. Moore, and Richard Cattran from this district.

National Safety Council

Membership in this organization was retained for the year at a cost of $180.00. The mining companies in the Lake Superior District, with few exceptions, are members and it is fitting that our Company continues its support.

We received from the Council the same amount of safety literature as in 1940 and made the same use of it as in previous years.

The annual meeting was held in Chicago during the first week in October. The writer was present at two of the meetings of the mining section and presented in writing a report on a dust-laying substance which has the commercial name of Compound "M". (See subject of ventilation in this report).

Safety Flags

The national safety flag was flown under the Stars and Stripes at the mines and plants. The Cliffs Shaft, Tilden, and Shops had the honor of flying the banner safety flag for the best safety records in 1940.

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

Miners' Safety Bulletin

The first Bulletin was printed in July, 1937 and since then 45 issues have been distributed to employees. Due to the time required in fighting the Athens Mine fire one issue failed to appear in 1941. A total of 2,700 copies of each Bulletin is now being printed and distributed.

Bonus For Foremen

The cost of awarding safety bonuses to foremen and bosses amounted to $5,770.56, as compared to $4,658.99 in 1940. This expenditure was distributed to 92 men.

TABLE XIX

SAFETY BONUSES PAID TO FOREMEN

Mine or Plant	Amount	Men Participating
Athens	$ 1,004.91	14
Cliffs Shaft Mine	1,205.75	14
Lloyd Mine	845.73	13
Maas Mine	1,098.04	16
Mather Mine	6.60	3
Negaunee Mine	1,088.26	17
Spies-Virgil Mine	202.78	6
General Storehouse	181.07	5
C. P. & L. Company	137.42	4
Total	$ 5,770.56	92

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11. ACCIDENTS AND PERSONAL INJURY

c. Safety Inspection (Continued)

TABLE XX

OCCUPATIONS OF MEN PARTICIPATING IN BONUS

Title	Athens	Cliffs Shaft	Lloyd	Maas	Mather	Neg.	Spies-Virgil	Gen. Sthse.	C.P.& L.	Total
Shift Boss	10	9	8	11	3	13	4	-	-	58
Mech. Foreman	1	1	1	1	-	1	-	2	-	7
Elect. Foreman	1	1	1	1	-	1	1	1	-	7
Surface Foreman	1	1	1	1	-	1	-	-	-	5
Timber Foreman	1	1	1	1	-	1	1	-	-	6
Blacksmith Foreman	-	-	-	-	-	-	-	1	-	1
Garage Foreman	-	-	-	-	-	-	-	1	-	1
Scraper Foreman	-	1	-	-	-	-	-	-	-	1
Track Foreman	-	-	1	-	-	-	-	-	-	1
Machy. Helper	-	-	-	1	-	-	-	-	-	1
District Foreman	-	-	-	-	-	-	-	-	3	3
Mech. Engineer	-	-	-	-	-	-	-	-	1	1
Total	14	14	13	16	3	17	6	5	4	92

d. Ventilation

Ventilation work for the year can be summarized under the following headings:

1. Collecting air samples and counting the dust particles contained in them.

2. Measuring the volume of air passing through each mine and checking its distribution.

3. Testing the efficiency of ventilation equipment.

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11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

4. Inspecting and checking efficiency of dust-preventive appliances.

5. Submitting reports on these subjects to the superintendents.

T. W. Hill continued in his capacity as investigator of dust conditions in and about the mines. He assisted E. C. Urban, local field representative of the Trudeau Foundation, in testing our ventilation equipment, such as main and auxiliary fans and ventube and the installation of the same. He also accompanied the mine engineer of each mine in measuring air currents, which is done twice a year. Maps of the air circuits are kept on file in the Engineering Department.

A total of 379 air samples were collected and counted in 1941. As has been the procedure since the beginning of this investigation, dust samples were taken frequently at all rock headings and less often elsewhere, such as loading cars at chutes and unloading them at shaft stations, crushing ore, etc. The various cycles of work in mining ore were completed at all the local mines in 1940, with the exception of the Cliffs Shaft Mine, which was done early in 1941. This work will be repeated at all of our underground mines during the second half of 1942.

The principal objective in our mine air analyses is to ascertain whether we are successful in keeping silica dust particles below what has been fixed as a safe border line, namely a count of 5,000,000 particles. When this cannot be done by dust preventive methods, the workers must be protected by providing them with clean air piped directly to them from its source. This is accomplished by wearing respirators which are connected with hose to the compressed-air line, or by air delivered in a like manner from a clean-air blower, which sucks the air where it is installed, cleans it of dust particles and then forces it to the respirators worn by the miners.

Very few of the air samples analyzed during the year contained silica particles in excess of the permissible limit. When too high silica counts were found it was apparent they were due to failure to use an ample amount of water when starting to drill bore holes, or when scraping rock piles not saturated with water.

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11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

Free silica particles in mine atmospheres have been recognized as the most injurious dust to the health of the workers, and the permissible limitation is supposed to apply only to such particles. We have aimed to keep our rock work records on the safe side of the border line by including the combined silica particles with the free silica particles. Rock samples are collected and analyzed for both silicate and free silica contents and their combined proportion has been accepted as the amount of silica dust in the air at the time work is in progress and the air samples taken. It would be laborious and an almost incomplete undertaking to make microscopic slides of the rock every time the air is sampled in order to separate free silica from the silicates. There are mining companies that have adopted this method but their number of microscopic counts have been very few and therefore far from being sufficient to guarantee conclusive proof of accuracy.

The superintendents received in April reports from this Department, which were compiled by Mr. Urban, upon our investigation of air blowers. These reports gave the volume of air delivered by each blower in comparison to its rated capacity and defects in the installation and maintenance were pointed out. The data submitted included a sketch of every blower set-up and the formula that determined the amount of air it delivered when inspected. These reports were very instructive and the superintendents lost no time in correcting defects to which attention was invited.

We cooperated with a request of the U. S. Bureau of Mines in affording its representative from the experimental station at Pittsburgh to test in our mines what is commercially called "Compound M". It is a fluid that is similar to soap which is forced into the water line at a working face for the purpose of settling dust. It has a higher affinity for dust particles than water and is used in a number of coal mines. It is manufactured by the Johnson-Marsh Corporation of New York. We carried out investigations in the shaft sinking at the Mather Mine with representatives of the Bureau and the manufacturer. Messrs. Urban and Hill actually did the work with our equipment, which was more efficient than that of the representatives.

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11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

Later on, Urban and Hill in consultation with the writer, made more comprehensive tests with the Compound in the Negaunee Mine. The dust counts obtained proved to us that the liquid was yet in an experimental stage. It is effective in laying dust in an atmosphere where the supply of water for damping is limited but as our water facilities are large it is of little or no advantage to add it to the water. It is expensive when consideration is given to the extra labor involved in its application. Other mining companies in this district reached the same conclusion after experimenting with it.

TABLE XXI

NUMBER OF DUST SAMPLES COLLECTED

Mine	In Rock	In Ore	Total 1941	Total 1936-1941
Athens	12	14	26	311
Cliffs Shaft	48	61	109	1041
Lloyd	27	9	36	327
Maas	33	9	42	289
Mather	61	-	61	61
Negaunee	79	19	98	521
Spies-Virgil	4	-	4	34
Tilden	-	3	3	21
Miscellaneous	-	-	-	94
Total	264	115	379	2699

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11. ACCIDENTS AND PERSONAL INJURY

d. Ventilation (Continued)

TABLE XXII

VARIOUS OCCUPATIONS WHERE DUST SAMPLES WERE COLLECTED

	Athens	Cliffs Shaft	Lloyd	Maas	Mather	Neg.	Spies-Virgil	Tilden	Totals
Drilling	8	65	13	22	27	50	2	-	187
Scraping	2	20	4	2	-	3	2	-	33
Blasting	-	4	-	2	2	2	-	-	10
Timbering	-	-	2	2	-	2	-	-	6
Hand shoveling	2	3	7	2	30	-	-	-	44
Barring back	-	1	1	2	-	-	-	-	4
Blowing cars	6	-	3	3	-	7	-	-	19
Blowing pocket	2	-	-	-	-	-	-	-	2
Crushing ore	-	7	-	-	-	-	-	3	10
Loading cars from chute	4	7	4	5	-	6	-	-	26
Changing clothes in dry	2	2	2	2	2	7	-	-	17
Using compressed air loader to fill cars	-	-	-	-	-	21	-	-	21
Total	26	109	36	42	61	98	4	3	379

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11. ACCIDENTS AND PERSONAL INJURY

e. Mine Rescue and First Aid Work and Training

Fire was discovered in the timber gob of a working place on the 600-foot sub-level of the Athens Mine on June 20. It was attacked immediately with a stream of water and was thought to be extinguished. Later on it was apparent that it had extended up into the gob to an unknown height. It was then decided by the men who were in the mine at the time to seal off the drifts in the vicinity of the fire in the expectation that it would thus be smothered.

A few days later it was evident that this method was a failure and steps were taken to approach the fire zone and to fight it directly. This involved suspending operations of the mine and the wearing of oxygen breathing apparatus. Ten of these machines were taken to the vicinity of the fire and crews of trained fighters were organized. The work had not been in progress long before it became evident that the task was not a simple one. The smoke was heavy and the heat very oppressive and it was not possible to get water into the fire area except at the bottom of the gob where it was first discovered. As our ten machines were being used continuously throughout the 24 hours of each day it was decided to request the U. S. Bureau of Mines to bring additional equipment. The local representatives of the Bureau, Messrs. Frank Cash and A. J. Stromquist, responded immediately. With this additional equipment thus provided and the guiding assistance these officials gave, the fire fighting tactics were carried on until the fire was extinguished. Mining operations were resumed July 18.

The origin of the fire was not determined. A possible cause may have been a discarded lighted cigarette in spite of the prohibition of smoking in this mine, as in all the Company's mines. It was very fortunate the fire did not penetrate to the direct air circuit, otherwise it would have spread beyond control in a very short time. The apparatus stood the test without failure and the fighters rendered valuable service.

Oxidation of sulphur in the slate formation in the Spies-Virgil mine continues and in its wake sulphur dioxide fumes must be confined to restricted areas within the mine. When bratticed

Safety Department

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11. ACCIDENTS AND PERSONAL INJURY

e. Mine Rescue and First Aid Work and Training

off the fumes and gases become too hot and deadly for human endurance. The use of our oxygen-breathing apparatus in the construction of brattices for this purpose has demonstrated the value of these machines as a necessary equipment at our mines.

We had to purchase many replacement parts for this apparatus after the fire in the Athens mine was extinguished. We have a first-rate room at the Negaunee Mine for keeping our equipment for fighting mine fires, but our station at the Cliffs Shaft Mine was taken from us several years ago and we are badly in need of a new one, which the superintendent has delayed in providing.

Mr. Rogers trained 30 men in wearing the oxygen-breathing machines at regular intervals during the year. In September 22 inexperienced employees were given the U. S. Bureau of Mines training course under the supervision of A. J. Stromquist.

A course in artificial respiration for the officials, foremen, and linemen of the Cliffs Power & Light Company was rendered by Mr. Stromquist in September. This instruction was given at Ishpeming and Forest Lake and 52 men participated in it.

Mr. Rogers delivered first aid material weekly at all the mines and plants. The number of articles listed in the following table is indicative of the amount of first aid treatment rendered in taking care of injuries. Most of the first aid articles are used in taking care of slight injuries, such as cuts and bruises, which are not reported in our accident records. Their total cost amounted to $216.72.

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11. ACCIDENTS AND PERSONAL INJURY

e. Mine Rescue and First Aid Work and Training (Continued)

TABLE XXIII

FIRST AID SUPPLIES DISTRIBUTED

Material	Number Distributed
Mercurochrome Pads	22,005
Ounces of Merthiolate	230
One-inch Roller Bandage	510
Three-inch Roller Bandage	310
Rolls of Adhesive Tape	67
Pads of Picric Acid Gauze	182
Pads of Plain Gauze	546
Leather Finger Cots	224
Antiseptic Applicators	1140
Tubes of Unguentine	18
Ounces of Aromatic Spirits of Ammonia	22
Pairs of Scissors	1
Ounces of Absorbent Cotton	92
Triangular Bandages	32
Total items	25,379

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11. ACCIDENTS AND PERSONAL INJURY

f. **Department Expenses**

TABLE XXIV

Salaries	$ 8,056.00
Auto Expense	360.20
Furniture & Fixtures	--
Heat, Light & Power	1.32
Insurance	5.46
Postage	3.34
Repairs	-
Stationery & Printing	161.22
Supplies	296.78
Taxes	--
Traveling & Entertainment	428.03
Telephone & Telegraph	51.39
Personal Injury Expense	12.00
Unemployment Insurance Tax	237.15
General - Unclassified	238.90
Old Age Benefit Tax	71.86
Depreciation	199.84
Equipment	--
Total	10,123.49

Respectfully submitted,

William Courtney

Assistant Superintendent

22. REPORT OF THE GEOLOGIST FOR THE YEAR ENDING DECEMBER 31, 1941

A. STAFF

The staff of the Geological Department for the year 1941 is shown in Table I below. The Department experienced two changes in its personnel during the year.

Mr. Burton H. Boyum was engaged as an Assistant Geologist and joined the Department on June 2nd. He received his training at the University of Minnesota and a degree of Bachelor of Science in Geological Engineering on June 14th.

Mr. Stanley W. Sundeen, who joined the Department on June 15th, 1936 as an Assistant Geologist and has served in such a capacity since, left the Department on December 1st, to become Assistant Superintendent of the Cliffs-Shaft Mine.

TABLE I.

Name	Occupation	Hours Lost		Hours Overtime	Net % Hours Worked
		Sickness	Absence		
E. L. Derby, Jr.	Chief Geologist	11	267¾	179	95.1
Stanley W. Sundeen	Asst. Geologist	25½	50	9	96.4
Burton H. Boyum	Asst. Geologist	-	14¼	20¼	100.5
Archie Minnear	Draftsman	-	90¼	4	95.7
E. A. Allen	Assistant	-	3½	-	99.8

The year 1941 was divided into the factors shown in Table II, below:-

TABLE II

Total Working Days	280½ days (2,027 hours)
Sundays	52 "
Full days resulting from Saturday afternoons	26 "
Holidays	6½ "
	365 days

Table III, below, shows the average number of men regularly employed on a full time basis on the staff of the Geological Department during the past five years.

TABLE III

Year	Average Number of Men
1937	4.0
1938	4.0
1939	4.0
1940	3.9
1941	4.5

B. GENERAL DESCRIPTION OF THE WORK OF THE DEPARTMENT

The work of the Geological Department was divided between the various mines, explorations and miscellaneous items shown in Table IV, below:-

TABLE IV.

ITEMS	HOURS WORKED	PERCENT
MINES		
Athens	60 3/4	0.7
Canisteo	68 3/4	0.8
Cliffs-Shaft	762 1/2	8.6
Hill-Trumbull	336 1/2	3.8
Holman-Cliffs	90 1/2	1.0
Jackson Lease	111 1/2	1.3
Lloyd	386 3/4	4.4
Maas	340 1/2	3.8
Mather	274 1/2	3.1
Morris Lease	19 1/2	.2
Negaunee	455	5.1
Pontiac	74½	.8
Princeton	4	.1
Ravenna-Prickett Lease	1/2	-
Tilden	71 3/4	.8
Virgil	83 3/4	.9
Webster	56	.6
Total Mines	3,197 1/4	36.0
EXPLORATIONS		
Cliffs-Shaft Surface (Section 9)	97 1/4	1.1
Cliffs-Shaft Mine	351 3/4	4.0
Lloyd Mine	453 1/4	5.1
Maas Mine	166 1/2	1.9
Mather Mine Surface	492.3/4	5.6
Negaunee Mine Surface	287	3.2
Section 5, 47-27	547 1/2	6.2
Virgil Mine	58 1/4	.7
Total Explorations	2,454 1/4	27.8
MISCELLANEOUS ITEMS		
Annual Report	41 1/2	0.5
Beneficiation of Iron Ores (General)	2	-
Carbon Selecting	64 1/4	0.7
Engineering Department	597 1/2	6.7
Geological Surveys on Company's Mineral Estate	326	3.7
Gold Leases on Company's Mineral Estate	8 3/4	0.1
Investigating Mineral Land Offers	220 1/2	2.5
Investigating Outside Explorations	198 3/4	2.2
Michigan Mineral Land Company	2	-
Miscellaneous Geological Expense	1,678 3/4	18.9
Missouri-Cliffs Mining Company	71 3/4	0.8
Tax Commission Estimates	3	0.1
Total Miscellaneous	3,214 3/4	36.2
GRAND TOTAL	8,866 1/4	100.0

B-1. DESCRIPTION OF WORK BY THE STAFF MEMBERS

E. L. DERBY, JR. Approximately 51% of my time during the year was spent in connection with the geological work in the Company's active mines. About 12% of my time was spent in planning and supervising diamond drill explorations in the Cliffs-Shaft, Lloyd, Maas and Virgil Mines; from the surface of the Cliffs-Shaft, Mather and Negaunee Mines; and on Section 5, 47-27 in the North Lake District. The balance of my time, or approximately 37%, was taken up with the routine work of the office and the numerous miscellaneous duties peculiar to the Geological Department. The geological surveys and explorations are treated separately and in more or less detail later in the report. My other activities, in addition to the strictly routine work of the office, may be summarized as follows:

In FEBRUARY, I spent one day at the Mines Experiment Station, University of Minnesota, at Minneapolis, in connection with the experimental tests and the progress being made on the concentration of manganese from Cuyuna Range black manganiferous ores for Butler Brothers. This was followed by three days spent on the Mesaba Range with headquarters at Hibbing going over the plans of the proposed drilling and operating programs for the 1941 ore season at the Canisteo, Hill-Trumbull and Holman-Cliffs Mines. I was absent the entire month of March on vacation.

In APRIL, I spent two days on the Mesaba Range and two days in St. Paul and Minneapolis. While on the Range, I visited the drilling which was being done on the Remer Reserve at the West end of the Range, covered by our Land Offer No. 2141, in company with Mr. Barber. In St. Paul, I consulted with Mr. Holt, then of Butler Brothers, in regard to progress and improvements being made at the Butler Bros. plants, using the heavy density medium process of concentration and made some political contacts. In Minneapolis, I conferred with Mr. E. W. Davis, Director of the Mines Experiment Station, on proposed legislation by the State and the general manganese situation being considered in Washington as a war measure. I also interviewed and offered a position of Second Assistant Geologist in the Department to Burton H. Boyum, then a Senior student in the Mining Engineering and Geological Departments of the University of Minnesota. I accompanied Mr. Elliott in attendance at a meeting in Duluth on April 12th at the Oliver office, of representatives from all the Lake Superior iron companies to discuss the new Wage and Hour regulations of mining labor. I accompanied Messrs. Barber, Geffine, Jackson and Adams on the Annual conference with the State Appraiser of Mines for the State Tax Commission in Lansing, held on April 24th. At this conference we discussed and considered the first tentative valuations placed by the Appraiser on all the Company's activities in Michigan.

In MAY, I attended the Annual Occupational Tax hearing on our Minnesota properties in company with Messrs. Barber, Geffine, Walter Sterling, Donovan and MacPherran at the Minnesota State office building. Mr. Barber and I went from this meeting to the Mesaba Range and visited all of the Company's properties. In particular, I went over the current drilling at the Hill-Trumbull and Holman-Cliffs properties. Messrs. Barber, Walter Sterling, Hugh M. Roberts of Duluth, and I visited the property of the Steep Rock Iron Mines Ltd., of Steep Rock, Ontario. With Messrs. W. D. Neeland, Geologist at that time in charge of the property, and Mr. W. Samuel, Consulting Engineer, we examined all of the records of exploration work to date on the two principal deposits of iron ore discovered beneath

the lake bottom. Mr. Roberts who, as an independent consulting mining geologist, had reported on this property to Mr. Errington, President of the Steep Rock Company, was engaged to prepare a supplemental report for the Company. I again went to Minneapolis where I consulted with Messrs. Davis and Wade at the Experiment Station on the preliminary work just being started by them on a carload sample of high sulphur ore from the Maas Mine for the removal of this sulphur. I went to Duluth for a conference with Mr. MacPherran in preparation of a protest on the findings by the State Tax Commission on our Occupational Tax reports and then attended a conference in St. Paul with the Commission with Messrs. Geffine and MacPherran.

In June, I had a conference in Duluth with Messrs. Hugh M. Roberts and W. H. Crago on several phases of the Steep Rock ore deposit in connection with a consideration by the Company as a possible operator of this property, controller of sales of ore, or both. I went to Hibbing and went over the reserves of "jig" ore and the possibility of future production of this type of material from the Hill-Trumbull Mine leading up to the final selection of a process and plant design to concentrate this type of ore. In this connection I spent one day in St. Paul with Mr. Grover Holt, then of Butler Brothers, who, because of his experience in this work was engaged to advise with us as a Consultant.

In July, I was in New York City to attend a regular meeting of the Board of Directors of Consolidated Coppermines Corporation, of which I am a member. While there I conferred with Mr. R. W. Hyde, Vice President of the Dwight & Lloyd Sintering Company in connection with the possible sintering of Maas high sulphur ore for the removal of this sulphur. On my return, I stopped in Cleveland and conferred with Messrs. Greene, Brown, Barber and Cyrus Eaton on matters relating to the Steep Rock iron deposit in Ontario. In passing through Chicago, I conferred with Mr. E. W. Shallock, Chief Engineer of the American Ore Reclamation Company, also in connection with the possible sintering of Maas high sulphur ore. I arranged to have a sample of this ore shipped to the Reclamation Company's testing laboratories at Buffalo, New York. As a result of this, I have received a valuable report from Mr. Shallock covering the possibilities of removing the sulphur from this ore by sintering.

I made the usual periodic trip to the Mesaba Range. In passing through Duluth, I conferred with Mr. Guy Diehl, Vice President of the Oliver Iron Mining Company to get first hand information on the old Champion iron mine on the Marquette Range for future reference. In Hibbing, I had a conference with Mr. R. C. Fish, General Minnesota Superintendent of the M. A. Hanna Company in connection with their desire for us to make them an offer to dispose of our Pontiac Mine. We finally decided to make no such offer.

While on the Range, Messrs. Walter Sterling, Bolthouse, James Wivell, Moore, Youngberg and I made an inspection of the modern jig plants at the Danube and Majorca properties of Pickands Mather and the heavy density cone plant at the Harrison Mine of Butler Bros. Following this examination, and after careful consideration of the many tests made during the last few years on Trumbull "jig" ores, we were unanimous in recommending a heavy density cone plant for treatment of Hill-Trumbull "jig" ores. Mr. Sterling and I prepared a joint report and formal recommendation on this subject. We also conferred with Mr. C. J. Calvin, Chief Engineer of

the Great Northern Iron Ore Properties. We had a general discussion with him of proposed flow sheets for the treatment of these ores, using jigs on the one hand and the heavy density cone process on the other. Mr. Calvin agreed with us that either of these two methods would be satisfactory, assuming the use of an elastic flow sheet in each case, and also was satisfied to have us finally decide on the use of the heavy density cone process. On my way home, I conferred in St. Paul with Mr. Holt on this flow sheet and also conferred with Messrs. Davis and Wade at the Mines Experiment Station in Minneapolis on both the tests being made on the Maas high sulphur ore and the developments by the Government and others toward a large scale production of manganese from the black manganiferous iron ores on the Cuyuna Range.

In AUGUST, I attended the Lake Superior Regional meeting of the American Institute of Mining and Metallurgical Engineers, which was held in Duluth and on the Mesaba Range. While on the Range, I went over the current explorations at the Canisteo, Hill-Trumbull and Holman-Cliffs Mines. I conferred with Messrs. Brown, Barber, Raymond, Elliott, Jackson and Walter Sterling, all of whom were in Hibbing, on the flow sheet to be used at the proposed plant for the treatment of Hill-Trumbull "jig" ores. Mr. Barber authorized me to proceed with the preparation of design and estimates of cost of construction of such a plant, using the heavy density cone method of concentration and to engage Mr. Holt, then of Butler Bros., as consultant in this work. I conferred with Mr. Calvin to keep him posted to date on the progress being made in the selection of the heavy density cone process and plans to go ahead on plant construction. It was important to advise Mr. Calvin of each step in our progress in the treatment of these jig ores and have his approval of the final plant design to facilitate any future negotiations with the Great Northern, not to mention eliminating any possible future controversy over the selection of such a plant. A party of Company directors, composed of Messrs. W. G. Mather, Greene, Williamson, Brainerd, Graves and Russell, came to Ishpeming on their annual visit and I addressed them on the problems and progress of iron ore beneficiation in general as well as on our own specific beneficiation problems. I also discussed the development at Steep Rock Lake in Ontario and the lean magnetites of the Adirondack Region in New York State.

In SEPTEMBER, I had several conferences, both in St. Paul and on the Mesaba Range, with Messrs. Holt, Jones and Palmer. The Chemical Construction Corporation of New York, a fully owned subsidiary of the American Cyanamid Company, was engaged to design and prepare working plans for the proposed heavy density cone plant to treat Hill-Trumbull "jig" ores and Messrs. Jones and Palmer were the engineers designated for the work. I conferred in Duluth with Messrs. MacPherran and Walter Sterling on the form of the proposed License Agreement for the use of the heavy density cone process from the American Zinc, Lead and Smelting Company, who controls the patents protecting this process. I spent a week at the Cleveland office principally in connection with the re-writing of the proposed License Agreement.

From Cleveland I went to Northern New York State where I spent several days visiting all of the mining activities in the magnetite ore belt of the Adirondacks. I went underground at Mineville and Lyon Mountain, both operations of the Republic Steel Corporation, and visited the Benson

Mine property of the Jones & Laughlin Steel Company and the Clifton Mines property of the M. A. Hanna Company. When Messrs. Jacobs and Bourlier of the Bethlehem Steel Company were on the Marquette Range for their inspections of the Mather and Negaunee Mines, I gave a talk to these gentlemen and to Messrs. Greene, Brown and Barber on several phases of the Company's mineral estate and also accompanied them on their inspection trip.

In OCTOBER, I had conferences with Mr. Holt in St. Paul, with the staff of the Mines Experiment Station in Minneapolis, and with members of the faculty of the Geological Department at the University of Minnesota on various current problems. With Messrs. Barber, Geffine, Walter Sterling and Donovan, I conferred on tax matters relating to our Mesaba Range operating mines and with them attended the annual Ad Valorem tax hearing before the Commissioner of Taxation at the State Office Building in St. Paul. I also conferred with Messrs. Holt and Palmer in St. Paul on the progress of the heavy density cone plant design.

I accompanied Mr. C. W. Nicholson, Assistant General Manager of the North Range Mining Company, and Mr. Lee Ives, Sales Agent for the latter company, on a trip to Southeastern Missouri. We spent three days examining the limonite ore district with Messrs. Chapman and Doane, with headquarters at Poplar Bluff, Missouri, visiting some 15 mines and explorations pertinent to a potential future interest in the operations in this District. In returning to St. Louis, Messrs. Nicholson and I stopped and visited the large iron mine at Iron Mountain, Missouri. The property was idle at the time, but is under lease to the M. A. Hanna Co., who owns 50% of the fee. On my return home, I went to the Gogebic Range and joined Messrs. Geffine and Adams at a public hearing before the Committee on Taxation recently appointed by the Governor of Michigan to investigate the valuations of iron mines in Michigan. This hearing was held at the Courthouse in Bessemer.

In NOVEMBER, I had a conference with Mr. Grover Holt at his office in St. Paul on the proposed heavy density cone plant at the Hill-Trumbull Mine and also a conference with Messrs. Davis and Wade at the Mines Experiment Station in preparation for test work to be done at the Station on fines from Cliffs-Shaft crushed ore. A carload of this material was shipped to the Station for tests during the winter ahead. I spent three days on the Mesaba Range with headquarters at Hibbing, going over data on the Steep Rock Iron Mines Limited of Ontario for a report by Mr. Walter Sterling and in connection with revaluations then being considered by the Cleveland office on the merger, ten years ago, forming the present Mesaba-Cliffs Mining Company. These anticipated revaluations were the outgrowth of a controversy with the Internal Revenue Department. I held a conference in Duluth for the purpose of going over all the details of construction and equipment for the proposed heavy density cone plant and arranged for the ordering of all materials. At my request, Messrs. W. A. Sterling, Bolthouse, Moore, Jaedecke, James Wivell, Youngberg and Young of our organization, and Mr. Holt, our consulting engineer on this project, attended and had a part in the conference.

In DECEMBER, I went to the Cleveland office and assisted in drawing up the proposed License Agreement for the use of the heavy density or M.B.I. process. This resulted in a conference, also in Cleveland, later in the month with Messrs. Brown, Barber and Jaynes of the Company and Messrs.

Young and Seymour of the American Zinc, Lead & Smelting Company, who control this License. I went to Toronto, Ontario, with Messrs. Barber, Raymond, McClure and W. A. Sterling for a conference there with Messrs. Errington, Hogarth, McCrea, Acres, Roberts and Crago on the Steep Rock Iron Mines Ltd. iron ore property in Ontario.

While in New York to attend a regular Directors meeting of the Consolidated Coppermines Corporation, I conferred with Mr. Frederick Laist, Executive Metallurgist of the Anaconda Copper Mining Company on the proposed concentrating plant to be built by the Government on the Cuyuna Range for the extraction of manganese from the black ores, of which the Pontiac Mine would be a potential producer. From New York, I went to Altavista, Virginia, and spent parts of two days examining manganese ore lands in the District with Messrs. Maginnis and Hardy. Mr. Maginnis is the prime mover in a group which holds title and lease to a large tract of these lands. This is our Land Offer No. 2175. On my return, I stopped in Pittsburgh and spent one day at the Mellon Institute where a fellowship has been set up to study the possibilities of making certain alloy steels by a revolutionary electric process from extremely pure iron ore.

I held a conference in my office with Messrs. Barber, Nicolson and Robert Archibald on matters connected with the formation of the Missouri-Cliffs Mining Company for the operation of iron ore properties in Southeastern Missouri. Messrs. Barber and I conferred, later in the month, in Duluth with Messrs. Salsich and Diehl, President and Vice President of the Oliver Iron Mining Company, on the possiblity of acquiring a lease on the Oliver property in Section 10, 47-27 at Ishpeming adjacent to the Cliffs-Shaft Mine on the South, and the old Champion Mine property at Champion, Michigan.

STANLEY W. SUNDEEN. Mr. Sundeen continued as Assistant Geologist for eleven months of the year. On December 1st he was made Assistant Superintendent of the Cliffs-Shaft Mine. During the eleven months with the Department, he spent about 51% of his time on the geological surveys and maps of our operating mines; 14% on the drilling explorations; and 35% on the miscellaneous duties comprising the routine work of the Department. Although he made periodic underground geological surveys and posted this information on the geological maps of all the new development work in the operating mines, the Cliffs-Shaft Mine continued to take the largest share of his time on such work,— a total of nearly 31%. This property is by far our largest and most important underground geological problem.

Mr. Sundeen made all of the calculations to determine the sulphur content of the drill water which had to be sampled whenever the drills encountered ore in drilling on the Mather Mine surface, Section 2, 47-27 and in the Maas Mine. He visited the old lean ore stockpiles at the Jackpot Mine on the Gogebic Range and made an estimate of this ore in connection with an offer made by Mr. William Trebilcock, present owner, to have the Company purchase it. He also spent two half days making an examination and geological survey of the surface at the old Webster Mine in Baraga County, preliminary to a report which I prepared for the Cleveland office for a possible drilling campaign. He continued to work on the general surface geological map of the Marquette Range filling in as many gaps as the time and information at hand would allow. This involved numerous short field examinations. On account of my increased

absence from the office on special assignments, he was called upon to direct the explorations and work of the Department progressively more throughout the year under my general supervision.

BURTON H. BOYUM. Mr. Boyum joined the Department as Junior Assistant Geologist on June 2nd. He came to us following his graduation, as Mining and Geological Engineer, from the University of Minnesota. I had known for some time that Mr. Sundeen was to be transferred to the Cliffs-Shaft Mine as soon as I could break in an Assistant to take his place. For this reason Mr. Boyum was at once subjected to an intensive training in all phases of the work of the Department, chiefly by working directly with Mr. Sundeen until the latter left the Department. Mr. Boyum spent about 44% of his time on the geological surveys and maps of our operating mines; 11% on the drilling explorations; and 45% on miscellaneous duties included in the routine work of the Department. Further detail of his work until December 1st, would be essentially a repetition of what I have said in discussing Mr. Sundeen.

After Mr. Sundeen left, Mr. Boyum was given much of the responsibility during my absence that previously had been assumed by the former. He made a geological survey of the surface outcrops and augmented this by a number of trenches and test pits in the N½ of the S½ of Section 5, 47-27 and in the vicinity of the North-South center line. This was preliminary to our explorations in Section 5 that resulted in the discovery of a structural crotch in which high grade ore since has been discovered, by our drilling.

ARCHIE MINNEAR. Mr. Minnear continued as a draftsman and office assistant with the Department throughout the year. During the year, however, he spent about 20% of his time assisting in the Engineering Department due to the shortage of help and emergencies that arose. About 38% of his time was spent in drafting work associated with the geological surveys and maps of our operating mines; 6% on similar work for the drilling explorations; and 36% on miscellaneous duties included in the routine work of the Department. He assisted in taking drill water samples when ore was encountered at the Mather Mine and Negaunee Mine Surface explorations, the drilling in Section 5, 47-27 and in the Lloyd and Maas Mines. He also checked the calculations made from these drill water samples to determine the soluble sulphur encountered. He spent a considerable time on the reclassification and refiling of old maps, cross-sections and other data in our vaults which was necessary to make room for current mapping and other data.

E. A. ALLEN. Mr. Allen spent 85% of his time during the year collecting, labeling, sampling and filing diamond drill core and sludge samples from the current explorations and in making tests for the dip and bearing of all current drill holes with the Maas Compass whereever this data was required. He made thin sections of rock samples and drill core whenever necessary for microscopic study by Messrs. Sundeen, Boyum and myself. About 10% of his time was charged to the Engineering Department for the weekly observations he made during the year of the water levels in the various deep well holes on the surface of the Maas and Negaunee Mines. These wells were drilled for the purpose of observing and platting the activities and drainage of surface water over the ore bodies in these mines. The rest of his time was spent on routine office duties.

C. SURFACE GEOLOGICAL SURVEYS

The surface geological surveying during the year was confined chiefly to Section 5, 47-27 and the old Webster Mine property in Section 26, 48-31.

A detailed study of the outcrops was made in the N½ of the S½ of Section 5, 47-27 near the North-South center line of the section and augmented by numerous trenches and test pits where the ledge was relatively shallow. From this work a dike or dike system was found and traced sufficiently in a Northwest trend to indicate its intersection with the Siamo slate footwall to the North and thus form a structural crotch favorable to the concentration of high grade ore. Drill holes located and completed as a result of this work have led to the discovery of high grade merchantable ore. This will be discussed in more detail under Explorations.

The work done at the Webster property did not add materially to the geological information we already had on this property. Nothing has been done here for many years and the chief object was to determine the general surface conditions at the property with the possible idea of conducting a limited drilling campaign in the area between the old pit operations and the Portland Mine located about 600' to the West. Mr. S. L. Mather thought that in times like these, when we are shipping a large tonnage of standard grade ores, we might be able to mix with them enough Webster ore to bring the iron content above 50% iron natural in the combined mixture. This would eliminate the double penalty on Webster ore which it would suffer if it had to be sold and shipped by itself and the Company would begin to realize some return on this long held investment. A decision to do this drilling has not yet been reached.

D. MINE GEOLOGICAL SURVEYS AND OPERATIONS

Underground geological surveys of the current mining extensions and development work were made during the year in all of our operating mines. This included periodic inspections of the Mather Mine shaft in mapping the geology of the formations passed through and also occasional underground geological surveys of the current extensions in the Jackson Lease being operated by the Republic Steel Corporation in connection with its Cambria Mine.

From January 1st, 1941, all underground mines, excepting the Cliffs-Shaft and Virgil, were operated on a five day per week basis, working 3 - 8 hour shifts per day. The Cliffs-Shaft and Virgil Mines operated on a five day per week 2 - 8 hour shifts per day basis. Effective January 11th, the Cliffs-Shaft Mine increased its operation to six days per week and on January 25th all mines increased their working schedules by 1 - 8 hr. shift, on the sixth day. On September 1st, these mines increased their working schedule by 2 - 8 hr. shifts on the sixth day, except the Virgil which remained on the five day per week 2 - 8 hr. shifts per day. Overtime was paid for over eight hours in one day and over forty hours in one week.

The Tilden open pit operations began April 19th and continued quite steadily to and including November 29th. Operations were geared to the schedule of boat shipments.

D-1. - ATHENS MINE

Most of the production from the Athens Mine came from Block 3 above the 7th Level, both North and South of the fault dike. Mining was resumed during the year above the 4th Level which produced a considerable tonnage. The remaining production came from Block 2 above the 9th Level and a small amount of it from blocks of ore between the 4th and 6th Levels South of the fault dike.

Two new cross-cuts, Nos. 400 and 410, were opened on the 4th Level. Four raises were put up to the hanging wall from the 400 cross-cut and three raises from the 410. These raises tapped the area from which mining is being carried on. One new drift was driven Southwesterly on the 6th main level elevation connecting the main South drift from the shaft with the Easternmost cross-cut. This drift was necessary to replace the main Southwest drift which had been driven in ore and has since crushed. During the year approximately 491,000 tons of additional ore, not previously included in our reserve estimate, was developed in sub-level operations above the 4th Level and between the 4th and 6th Levels.

D-2. - CLIFFS-SHAFT MINE

In "A" Shaft, the production for the year continued to come chiefly from the Bancroft Lease on the North; the main deposit, in both the central part and areas adjacent to the old Incline and No. 3 Mines on the East; and from the Southeast deposit. Approximately 62% of the total mine production was mined from "A" Shaft deposits but only about 50% of the mine product was hoisted through "A" Shaft, the balance was hoisted through "B" Shaft along with ore from the "B" Shaft deposits.

On the Bancroft Lease, the strong ore body which has been followed up by stoping from the 10th Level all the way to the 5th Level, has continued to be followed with most of the development work being done on the 5th Level elevation. It appears now that the ore body on the 5th Level is taking the shape of a large synclinal fold pitching Easterly. A large stope has been opened up along the West and South limb of this syncline on the 5th Level. Stoping continues in comparatively large volume on the fee property to the East of the Bancroft Lease at several elevations.

"B" Shaft deposits produced about 38% of the total mine production but, as mentioned above, approximately 50% of the total mine production was hoisted through "B" Shaft. The ore tributary to this shaft continued to come mainly from the floors, raises and stopes in the ore areas already developed on the main levels. The development work on the South side of the 1st Level continues to open up to the West the ore encountered in Drill Hole No. 467, West of the Lake Superior Iron Company's forty. Two inclined raises have been put up in this ore above the level a distance of 135'. These will be connected and stoping in this deposit begun during the current year.

In Section 9 Deposit at the extreme West end of the 10th Level, "B" Shaft, a drift was driven on this level and encountered the ore cut in Drill Hole No. 472. Two inclined raises have been put up a distance of

approximately 80' where the ore apparently pinched out. Development work for stoping is now going on from these raises. On the East end of this deposit, a stope raise has been carried up some 200' above the 9th Level elevation in order to reach the hanging wall contact. This raise is in rock but it is hoped that by following the hanging contact ore again will be encountered, which may connect with the ore encountered at a still higher elevation in old drill holes put down from the surface.

D-3. - JACKSON LEASE

Operations in the Jackson Lease were carried on continuously during the year on a full time basis from the Cambria Mine by the Republic Steel Corporation. Production from the lease during the year amounted to 123,698 tons, all Cambria (non-Bessemer) grade. This compares with 92,669 tons produced in 1940. The production came entirely from above the 6th Level.

A large additional tonnage of high grade ore was developed in the Jackson Lease during the year, principally from diamond drilling on the 6th Level, drifting on the 7th Level and exploration work above both the 6th and 7th Levels. Five diamond drill holes were drilled on the 6th Level with a total of 499'. It now has been fairly well established that the ore in the East and Center deposits joins just below the 6th Level to form one large ore body and, further, that the top of this ore below the level, flattens out to the South and again rises to a considerable height above the level. From present developments we know, at one point, that this riser extends over 300' above the 6th Level.

One unfavorable factor noted during the past year is that the lower portion of this ore body is high in sulphur. The transition point seems to be about 55' above the 7th Level elevation. From our experience and observations, it appears that the concentration of Sulphur usually forms a roughly horizontal zone of variable vertical thickness. It is reasonable to assume, therefore, that all of the ore in the zone from 55' down to the 7th Level and for an unknown distance below it, will be high in Sulphur. The average analysis of this ore so far encountered will run somewhere between .200% and .300% in Sulphur.

The main drift on the 7th Level was advanced 140' to the Southwest in high sulphur ore and stopped in an East-West dike which, at the present time, is thought to be the Southern limit of this ore body. What conditions exist to the South of it we, as yet, do not know. The two raises, which were started from this level in 1940, were holed through to the 6th Level. The bottom contact of ore in the Easterly raise was encountered 95' above the level and ore continued to within 18' of the 6th Level. In the West raise, this contact was cut 120' above the level and the ore continued to the 6th Level.

There remains a large area of promising un-explored ground on this lease. The eventual exploring of this area together with developments in depth will be watched with increased interest.

D-4. - LLOYD MINE

Most of the production from the Lloyd Mine came from three areas in the Lloyd East ore body,--namely, from the extreme East end above the 4th Level; the central area between the 525' and 625' Sub-Levels; and the extreme West area which extended from the 6th Level upward along the North-east face of the NW-SE fault which forms the West limit of known ore in the property. A small production also came from exhausting the last remaining ore in the old Lloyd ore body just below the 3rd Level.

The principal main level development occurred on the 6th Level and comprised the extension of the 680 cross-cut Southwesterly and thence Southeast to encounter and particularly out line the ore cut in Diamond Drill Hole No. 117, which was drilled horizontally at this elevation. Two raises were put up in this ore and development work carried on above the level. Sinking the main Lloyd shaft was resumed from the 7th Level elevation and had reached a depth of 70' on the last of the year. The 8th main level will be opened at a depth of 150' below the 7th. Unless additional ore is found by diamond drilling, the 8th Level will be deep enough to extract all of the known ore in the property.

D-5. - MAAS MINE

Production from the Maas Mine came principally from two areas,-- namely, from the East and West footwall pillars above the 3rd Level, and the main deposit between the 4th and 5th Levels on the Race Course lease and to the South and Southwest of it. A small production continued to come from the main deposit above the 4th Level just East of the Race Course. The amount of Bessemer ore produced continued to be very small,-- probably not amounting to more than 2 or 3%, and is confined almost entirely to the horizon immediately below the hanging wall jasper.

On the 4th Level, new development work was confined to an East-West footwall drift and a cross-cut, No. 4100, driven to the Southeast from this drift. Two raises were put up from the footwall drift and four from the cross-cut to develop and mine the third block of ore East of the Race Course.

On the 5th Level, the No. 5800 or Westernmost cross-cut, was extended South 100' and three raises put up from it. Also, a drift was turned off to the West from this cross-cut a distance of 125' to locate the hanging wall contact of the mian ore body. All of this work is some 400' West of the Race Course lease. Three raises were put up from the North footwall drift into the footwall ore body North of the North dike. A cross-cut was started to the North from the North footwall drift from which a winze will be sunk 104' to the proposed 6th Level elevation. It is planned to develop the new level from this winze and as the development warrants, a connection will be made directly with the shaft through a long drift driven to the North. It will be remembered that all of the known ore below the 5th Level is high in sulphur and it is a question of mixing with other ores as to how much of it can be extracted or at what rate extraction can be maintained.

D-6. - MATHER MINE

Ground was broken to start sinking the Mather Mine shaft by Mr. S. R. Elliott, Manager, on January 6th, 1941. Diorite ledge dipping steeply to the South was encountered on the North side of the shaft at a depth of about 43' and on the South side of the shaft at a depth of about 53'. Sinking was continuous on a six day, 17 shift per week basis throughout the year and the shaft had reached a depth of approximately 1036 feet at the end of the year.

D-7. - MORRIS MINE LEASE

The Morris Mine continued to be operated under lease by the Inland Steel Company. Mining was on a basis of five double shifts per week throughout the year. While he was still a member of the Department, Mr. Sundeen made one geological inspection of the underground development work. I have gone over the geological maps of the year's work in some detail with Mr. F. A. Olson, Superintendent, Mr. Robert Braund, Geologist, and Mr. Peter Ribotto, Engineer.

The production during 1941 amounted to 350,765 tons and was made up of 267,899 tons of standard grade ore and 82,866 tons of Siliceous ore. This production came principally from leases 9 and 24. A small production continued to come from the Cleveland-Cliffs Iron Company's fee land to the East and South of Lease No. 9. Approximately 85% of this production came from top slicing operations and 15% from stoping. The topmost workings were on the +120' Sub-Level elevation in No. 75 Deposit which is 40' above the 7th Level, the lowest workings on the -110' elevation in No. 33 or main deposit, which is 15' above the 8th Level.

One of the most important developments during the year was the extension of No. 75 Deposit on the +20' Sub-Level. Ore in this deposit has been followed from No. 9 lease on to No. 24 lease to the West, a distance of some 400' West of the boundary line between these leases. A drift in jasper on the 8th Level was extended to the West a distance of 450', all on Lease 24 below this ore and two raises started from it to be put up into the ore.

On the 9th Level elevation, two cross-cuts were driven due South on No. 9 lease cutting the No. 33 or main deposit. Also, in the East cross-cut, ore was encountered which is believed to be the downward extension of No. 75 deposit and separated on this elevation from No. 33 deposit by only a narrow (about 4') dike. Drifts also were driven longitudinally in a general East-West direction along the ore body. The No. 33 deposit was also developed by drifting and cross-cutting on the -220' Sub-Level elevation which is 100' above the 9th Level and half way between the 8th and 9th Levels. At this elevation the ore body appears to be about 700' long and with a maximum width of 150'. The size of this ore body at these lower elevations has exceeded expectations and is very encouraging.

Four horizontal diamond drill holes were drilled during the year. Three of these holes, Nos. 4, 5 and 6, were drilled from the 8th Level. Hole No. 4 was drilled Southwesterly on Lease No. 24 and encountered no ore. Hole No. 5 was drilled South on No. 9 Lease near the East boundary of the lease and extended on to Cleveland-Cliffs Iron Company fee land to the South.

It was carried to a depth of 1263' to and into the quartzite hanging, but encountered no ore. Hole No. 6 was drilled Southeasterly on fee land and encountered 24' of high grade ore between the depths of 433' and 457'. This represents an entirely new ore body. Early in the current year, an additional hole farther to the East has been drilled from this elevation. This hole cut more than 100' of ore and is a most encouraging discovery. One drill hole, No. 7, was drilled Southwesterly from the Southwest end of the 9th Level on Lease 24. It encountered 41' of good ore extending from 204' to 245'. This also represents a new ore body but unfortunately it is rather high in sulphur, averaging approximately .250%. Development work will be carried on during the current year to open up this ore and determine its grade. No additional high sulphur ore, however, was encountered during the year in the No. 33 and No. 79 deposits.

D-8. - NEGAUNEE MINE

The principal production from the Negaunee Mine in 1941 came from the main deposit between the 12th and 13th Levels. Production also continued from the footwall pillar above the 12th Level, the area between the two South dikes above the 12th Level, and from shaft pillars above the 9th Level around old No. 1 and No. 2 shafts. In addition to these operations, the development of the area leased from the Maas Mine was started and some production came from the 260' Sub-Level above the 13th main level.

Main level development during the year was confined to the 13th and 14th levels and raises put up from them. On the 13th Level, the 1330 cross-cut was extended Northwest to the Maas-Negaunee boundary and three raises put up. This cross-cut replaces a portion of the Southwest main drift parallel to the boundary which crushed during the year. The 1380 cross-cut was extended Northwest nearly to the Maas-Negaunee boundary and one raise put up to the top of the ore in the area North of the North dike. A footwall drift and cross-cut were driven into the Maas area and four raises put up from which the ore in this area is being developed for extraction through the Negaunee shaft. The development of the 14th Level was nearly completed during the year. A total of 2,700 ft. of drifts and cross-cuts were opened, including three cross-cuts into the Maas area. Nine raises were put up from these openings. A drift was started at the end of the year near the shaft plat from which a new sump area will be developed.

D-9. - PRINCETON MINE

The Princeton Mine was closed in 1921 and eventually filled with water. Pumping to dewater the mine in preparation to resume production was commenced in October, 1941, and continued the balance of the year.

D-10. - TILDEN MINE

The 1941 production from the Tilden continued to come from the East and West Pit areas. The total production amounted to 302,943 tons, of which 109,399 tons were mined from the East Pit and 193,544 tons from the West Pit. Of the East Pit production, 12,926 tons were of Special Low Phosphorus grade, averaging .015% Phos. A total of 6,873 cubic yards of surfade stripping were removed from the North and East sides of the East Pit in preparation for the coming season's production.

The stockpiling facilities at this property, which were provided during 1940 for the creation of a surge pile, became an important part of the operation during 1941 and made possible a steady production in spite of the intermittent shipments which must be geared to the demand and boat supply. A total of 51,702 tons were stocked during the year and 41,202 tons were loaded out at the beginning and end of the shipping season. There remained in stock at the end of the year a total of 52,483 tons.

D-11. - VIRGIL MINE

At the Virgil Mine, the production came about equally from the Southwest area between the 6th and 8th Levels and from the Northwest area between these same elevations. A small amount of ore, however, continued to be drawn from the old stope above the 6th Level in the Southwest deposit as well as from the high sulphur ore areas East of the Northwest stope. The knownreserves in the Virgil Mine are being rapidly depleted.

The footwall drift on the 6th Level was extended 100' Southwest and two raises put up to mine ore from the footwall side of the Southwest deposit. These raises were carried up to the 145' Sub-Level,--80' above the 6th main level. Draining of water was continued from the old Virgil workings above the 2nd Level elevation to reduce the water hazard to a minimum. Current workings in the mine are directly below this area.

E. OPTIONS AND LEASES

No new options to explore, nor mining leases, were taken by the Company during the year.

The lease on the Stephenson Mine, comprising the $S\frac{1}{2}$ of $SW\frac{1}{4}$ of Section 20, 45-25, was surrendered as of September 30th, 1941.

The lease on the Gardner Mine, comprising the $NW\frac{1}{4}$ of $NE\frac{1}{4}$ of Section 2, 44-25, the $NE\frac{1}{4}$ of $SW\frac{1}{4}$ and the $SE\frac{1}{4}$ of $SE\frac{1}{4}$ of Section 35, 45-25, was surrendered as of December 31st, 1941.

The mineral estate of the Spies Mine, comprising the $E\frac{1}{2}$ of the $NW\frac{1}{4}$ of Section 24, 43-35, was purchased from the Spies Mineral Land Company in December, 1941. Also, the fee interest of six forties and the mineral interest of four other forties, all in Section 24, 43-35, were purchased from the Spies Mineral Land Company at the same time.

The mineral estate of the $SW\frac{1}{4}$ of Section 2, 47-27, held under the Iron Duke mining lease, was purchased during December, 1941. This is a part of the Mather Mine property.

F. EXPLORATIONS AND COSTS

Drilling explorations were carried on in 1941 in the following districts and mines:

F-1. - FROM SURFACE

DISTRICT	RANGE	PROPERTY
Coleraine	Mesaba	Canisteo Mine
Marble	Mesaba	Hill-Trumbull Mine
Taconite	Mesaba	Holman-Cliffs Mine
Ishpeming	Marquette	Cliffs-Shaft Mine
Ishpeming	Marquette	Mather Mine
Negaunee	Marquette	Negaunee Mine
North Lake	Marquette	Section 5 Exploration.

F-2. - FROM UNDERGROUND

Ishpeming	Marquette	Cliffs-Shaft Mine
North Lake	Marquette	Lloyd Mine
Negaunee	Marquette	Maas Mine
Iron River	Menominee	Virgil Mine

Table V, which follows, gives the footage drilled, the ore encountered, and the cost per foot of drilling for both surface and underground explorations. It will be noted that the average cost of surface drilling was $4.52, excluding certain items, not actual drilling expense but which customarily are charged to the explorations. By including these items, the average cost of the surface drilling was $5.40 per foot. The cost of underground drilling, in the same way, was $2.91 per foot and $3.54 per foot, respectively. By comparison with 1940, the cost of drilling from surface increased by $0.47. This was due to much harder ground encountered in the drilling at the Hill-Trumbull and Holman-Cliffs Mines, and the advancing cost of both labor and supplies. Strangely enough, however, the cost of drilling underground was $0.51 less in 1941. The principal decrease was in the Cliffs-Shaft and Maas Mines were drilling conditions were much improved over 1940. Drilling costs as a whole in 1941 showed an increase over 1940 of only $0.28.

Table VI, also shown below, gives a comparative cost of total drilling for the past five years.

TABLE V.

SUMMARY OF DRILLING FOR 1941.

PROPERTY	SEC.	T.	R.	STAND-PIPING FT.	CHURN DRILLING FT.	DIAMOND DRILLING FT.	TOTAL DRILLING FT.	FIRST CLASS ORE FT.	SECOND CLASS ORE FT.	LEAN ORE FT.	TOTAL COST "A"	COST PER FT. "A"	TOTAL COST "B"	COST PER FT. "B"
SURFACE DRILLING														
Canisteo Mine	29, 30, 31 & 32	56	24 Minn.	609	4,594	-	5,203	-	-	* 2,325	$ 20,590.94	$3.96	$ 13,756.68	$2.64
Hill-Trumbull Mine	17	56	23 "	575	4,206	-	4,781	-	-	* 2,220	22,511.30	4.71	16,796.01	3.51
Holman-Cliffs Mine	21	56	24 "	455	11,934	-	12,389	-	-	* 7,195	57,878.28	4.67	47,165.87	3.81
Cliffs-Shaft Surface	9	47	27 Mich.	227	3	828	1,058	-	8	-	4,486.69	4.24	4,080.86	3.86
Mather Mine Surface	2	47	27 "	70	-	3,523	3,593	69	13	49	30,209.97	8.41	28,421.97	7.91
Negaunee Mine Surface	5	47	26 "	248	21	2,082	2,351	-	20	197	12,365.55	5.26	11,144.81	4.74
Section 5 Exploration	5	47	27 "	48	8	3,679	3,735	-	-	27	30,812.72	8.25	28,158.55	7.54
TOTAL SURFACE DRILLING				2,232	20,766	10,112	33,110	69	41	12,013	$178,855.45	$5.40	$149,524.75	$4.52
UNDERGROUND DRILLING														
Cliffs-Shaft Mine	3 & 10	47	27 Mich.	-	-	3,781	3,781	175	239	304	$10,461.00	$2.77	$ 9,340.96	$2.47
Lloyd Mine	6	47	27 "	-	-	3,679	3,679	260	113	109	14,179.89	3.85	12,424.48	3.38
Maas Mine	6	47	26 "	-	-	766	766	440	111	39	3,354.22	4.38	2,082.31	2.72
Virgil Mine	24	43	35 "	-	-	887	887	10	30	15	4,244.05	4.78	2,675.75	3.02
TOTAL UNDERGROUND DRILLING				-	-	9,113	9,113	885	493	467	$32,239.16	$3.54	$26,523.50	$2.91
GRAND TOTAL DRILLING				2,232	20,766	19,225	42,223	954	534	12,480	$211,094.61	$5.00	$176,048.25	$4.17

* This is Crude Ore, which, when concentrated, becomes First Class Ore.

Note: Cost "A" includes office expense, engineering, analysis, legal, personal injury, etc.
Cost "B" excludes " " " " " " " (to compare with contract prices)

At the Canisteo Mine, 1696'6" were drilled on contract for $3.516 per foot by J. S. Schultze of Grand Rapids, Minnesota.
At the Hill-Trumbull Mine 1580'8" were drilled on contract for $3.500 per foot by J. S. Schultze of Grand Rapids, Minnesota.
At the Holman-Cliffs Mine 6793'9" " " " " " 3.357 " " " " " " " " "
At the Virgil Mine 887' were drilled on contract for $3.020 per foot by E. J. Longyear, Minneapolis, Minnesota.

TABLE VI.

SUMMARY OF FOOTAGE DRILLED AND COST PER FOOT OF DRILLING FOR THE PAST FIVE YEARS

YEAR	TOTAL FEET DRILLED	COST PER FOOT "A"	COST PER FOOT "B"
1937	21,008	$ 5.32	$ 4.69
1938	15,774	6.16	5.38
1939	19,926	4.70	3.96
1940	19,514	4.66	3.89
1941	42,223	5.00	4.17

ELD:DWC
5-27-42
-3-

F-3. - DIAMOND DRILL CARBON

We had on hand, January 1st, 1941, a total of 433.25 carats of diamond drill carbon, which inventoried at $43,056.69. We purchased, during the year, a total of 228 stones, having a weight of 995.97 carats, at a cost of $78,037.08. We consumed during the year a total of 272.04 carats, having a value of $23,920.42. This left on hand, December 31st, 1941, a total of 1,157.18 carats, which inventoried at $97,173.35. In addition to this carbon we used 2.22 carats of Bortz at a cost of $7.21, leaving a balance on hand, December 31st, 1941, of 9.00 carats, having a value of $29.25. Bortz is used in the place of chipped carbon when we encounter soft ore, or real soft ground, in our surface drilling. It is carried separately and not inventoried with the carbon.

F-4. - DRILL SECTIONS

Cross-section tracings of all drilling, showing analyses and classification of material encountered during the year, have been made up. Photographic copies, showing the work done during the year on the Marquette Range, in colors, will be found in the Annual Report books of maps of the Michigan Ranges which are submitted as a part of the Annual Report of the Engineering and Geological Departments.

G. SURFACE EXPLORATIONS

G-1. - EXPLORATIONS ON CLIFFS-SHAFT MINE SURFACE, SECTION 9, 47-27, MICHIGAN

Drilling from surface near the Northeast corner of the SE¼ of NE¼ of Section 9, 47-27 was started in November, 1940, to explore for the downward extension of a strong ore body being mined on the South side of the 1st Level, "B" Shaft. The second and last hole of this program, No. 53, a vertical hole, was drilling in hanging wall slate at a depth of 402' on the first of the year. The hole passed from the Goodrich or hanging wall series into the Negaunee iron formation at a depth of 462', where hard ore jasper was encountered. This jasper continued, except for two narrow dikes, to a depth of 526'. It was conglomeritic and somewhat brecciated in places and, from 509' to 526', was very lean and cherty. Footwall dike was cut at 526' and the hole bottomed in it without further change, at 547'. It seemed apparent from this work that the ore body on the 1st Level does not extend down to the elevation of the 5th Level (a tramming level) as had been hoped.

Two vertical holes, Nos. 54 and 55, were drilled in the Southeast part of the NW¼ of NE¼ in order to test the hanging wall contact of the hard ore formation along its Westerly strike and in an area which cannot be reached conveniently from any present underground opening. Both holes were drilled through the hard ore horizon into dike footwall but found the horizon to be very thin and to contain no high grade ore. Hole 55, however, did encounter an 8' seam, from 380' to 388', of 53% conglomeritic second class ore. Exploring in Section 9 was discontinued on the completion of Hole No. 55 on April 1st, 1941.

G-2. - MATHER MINE SURFACE, SECTION 2, 47-27, MICHIGAN

Diamond drilling on the Mather Mine property, which had been discontinued with the completion of Hole 48 at the shaft location in November,

1940, was resumed with Hole 49 on July 18th, 1941. It was planned to drill several vertical holes to further explore for the upward and Westerly extension of the thin but persistent ore body located at the contact with the Negaunee Iron Formation and the Siamo slate footwall.

Hole No. 49 was drilled on the 12000 W. meridian which passes through Holes 16, 27A and 40, and approximately 800' North of Hole No. 16. The hole had reached a depth of 1,778' at the end of the year and was in 47% lean ore in the ore zone at the slate contact at this point. No high grade ore had been encountered in this horizon. Two narrow seams of high grade ore were encountered from 665' to 675' and from 685' to 690', respectively. High grade ore also was encountered from 1565' to 1605'. This is an important thickness and averaged 63.36% Iron, .059% Phos. and .017% Sulphur. This ore was quite different in appearance from the ore bodies lying near or on the footwall slate, being quite hard, somewhat brecciated and vuggy. For this reason and because it apparently has no connection with the main ore bodies thus far encountered on the property, we suspect that it owes its existence to mineralizing activities along a fault plane and we cannot connect it with any important proven tonnage of ore.

A second drill rig was employed on Hole 50, which was drilled on the 12650 W. meridian, about 800' North of Hole No. 38. This hole was started on July 23rd, 1941, and had reached a depth of 1815' at the end of the year. No high grade ore nor important enrichment of the Negaunee Iron Formation, was encountered in this footage. The objective ore horizon of this hole is some 200' below the point reached at the end of the year.

G-3. - NEGAUNEE MINE SURFACE, SECTION 5, 47-26, MICHIGAN

Early in the year it was decided to drill several holes from surface near the South boundary of the Negaunee Mine property to explore for a continuation of the ore encountered in surface Hole No. 17, drilled in 1906. The latter hole was reported to have encountered 67' of high grade ore from 650' to 717'. Several other holes drilled in the vicinity during the same period indicated that a fault of major proportions with a general East-West strike, passed to the North of Hole 17, forming a structure similar to that formed by an East-West fault passing through No. 3 shaft in which ore was encountered at the 13th Level elevation. This latter ore, however, was high in sulphur. Development by a flat inclined raise from the 13th Level indicated the ore had a strike in the general direction of Hole No. 17. Unfortunately, when Hole 17 was drilled, no sulphur determinations were made on the samples of ore or drill water.

A total of four holes, Nos. 26 to 29, inclusive, were drilled in this present campaign. All of them were carried down to and into the Siamo slate footwall. Hole No. 26 was located 400' East of No. 17 and drilled vertically. Hole No. 27 was located 450' West and a little North of Hole 17, about half way between the latter hole and the brest of the incline raise from the 13th Level and drilled vertically. Hole No. 28 was drilled from the same location as Hole No. 17 but with an initial dip of 84° to the South which flattened to 75°. Hole No. 29 was drilled from a point 145' North of Hole 17. It is being drilled with a dip of 87° to the South in order to encounter the ore cut in Hole 17 at approximately 75' North of a point vertically below the collar of Hole 17. Hole 17 itself was not surveyed so we do not have the exact location of the ore cut in the hole. The standpipe

was being sunk through surface material at a depth of 25' on the last of the year. Thus far no high grade ore has been encountered in any of this drilling and the exploration has been a disappointment.

G-4. - EXPLORATIONS IN SECTION 5, 47-27, MICHIGAN

Diamond drilling was resumed in the N½ of the S½ of Section 5, 47-27 on March 24th, 1941 with Hole No. 5. Four holes were drilled along the North limit of this area, which is underlain by the North rim of the Negaunee Iron Formation, in 1918 and 1919. Although no first class ore was found, considerable enrichment was encountered and three out of the four holes cut material averaging as high as 54.90% Iron. These holes were located on the East side of the section.

In resuming drilling, Hole No. 5, which was drilled vertically, was located near the West line of the section at approximately S. 3350 and 5400 E. This location is about 600' North of the East end of the old Excelsior Pit which lies just West of the boundary line in Section 6. There is a major fault striking a little North of West and South of East which passes through this pit and cuts across the iron formation at an acute angle. It is thought probable that this has produced a structural deformation in the slate footwall to form a crotch favorable for the concentration of a body of high grade ore.

The dip of the iron formation and slate across Section 5 is very steep, being nearly vertical in places. Hole No. 5 encountered the slate footwall at a depth of 2,146' and was bottomed in it at a depth of 2183'. Several narrow seams of enrichment were encountered but no high grade ore.

In order to speed up the exploration of this area, a second drill rig was added in May and Hole No. 6 drilled with a dip of -69° to the North from a location 60' North of the collar of Hole No. 5. With this dip, the hole would test the footwall of the iron formation at a considerably higher elevation and also make it possible, after reaching the footwall in Hole 5, to outline this contact. The footwall was encountered at a depth of 681' and the hole bottomed in it at 702'. Here again several seams of lean ore were cut but no high grade ore. In spite of there being no ore in either of these holes, there still remains an excellent possibility that an ore body exists in this crotch to the South. If there is ore, however, it may be at a considerable depth, possibly between 3,000 and 4,000 feet, on account of the very steep dip of the formation and slate footwall on this meridian. As our main object in this drilling was to find any possible ore that might be reached conveniently from the present levels of the Lloyd Mine or within a reasonable distance below them, it was decided to drill no additional deeper holes on this meridian for the present.

In connection with the explorations in this section, we made a detailed study of the outcrops along the North-South center line to find, if possible, a cross dike that might extend to the footwall and, by its intersection with it, form another favorable structure for ore concentration. After trenching and test-pitting, and as mentioned under Surface Geological Surveys, such a dike was found with an indicated strike to the Northwest and Southeast. Two incline holes, Nos. 7 and 8, with dips of 44° and 41° due North, respectively, were drilled along the center line of the section about

150 ft. apart in order to intersect this dike in depth and determine its dip. Hole No. 7 was drilled to a depth of 304' and No. 8 to a depth of 528'. Instead of encountering a single dike, each hole encountered a series of dikes dipping steeply to the North forming an acute angle with the dip of the iron formation. The results of these holes, together with the trend of the dike outcrop, indicated a crotch favorable for ore concentration formed by the intersection of these dikes with the slate footwall.

Before drilling a vertical hole into the crotch just mentioned, Hole No. 9 was planned with a dip of -35° due North on a meridian 600' West of the North-South center line of the section in order to cut both the dikes and slate footwall. This hole ledged in soft ore jasper at a depth of 8' and was drilling in it at a depth of 18' at the end of the year.

G-5. - CANISTEO MINE, SECTIONS 29, 30, 31 & 32, 56-24, MINNESOTA.

A total of 50 structure drill holes were drilled in the Canisteo Pit and around its perimeter during 1941. Twenty holes were drilled on the South Bovey leases. Two of these holes were drilled on the NW¼ of SE¼ of Section 30, 56-24; 17 holes on the NE¼ of NE¼ of Section 31; and one hole on the NW¼ of NW¼ of Section 32. Twenty-nine holes were drilled on the Snyder leases. Of these, six holes were drilled on the East Snyder, the SE¼ of SE¼ of Section 30, 56-24; five holes on the Middle Snyder, the SW¼ of SE¼ of Section 30; and eighteen holes on the West Snyder, the SE¼ of SW¼ of Section 30, 56-24. Only one hole was drilled on the Hemmens Lease, the SW¼ of SW¼ of Section 29, 56-24. The total footage drilled amounted to 5,203 ft. A total of 1,696'6" was drilled under contract by J. S. Schultze of Grand Rapids, Minnesota, and the balance, or 3,506'6", by Company rigs. In this drilling, 2,325' of crude wash ore and jig material was encountered.

G-6. - HILL-TRUMBULL MINE, SECTION 17, 56-23, MINNESOTA

A total of 113 structure drill holes were drilled in the Hill-Trumbull Pit and around its perimeter during 1941. The total footage drilled was 4781' and 2,220' of crude wash ore and jig material were encountered. One hundred and four of these holes were drilled on Hill property; 69 holes on the SE¼ of NE¼ of Section 17, 56-23, and 35 holes on the SW¼ of NE¼ of Section 17. Nine holes were drilled on Trumbull property, five holes on the NE¼ of SW¼ of Section 17, 56-23 and four holes on the NE¼ of SE¼ of Section 17. A total of 1,580'8" was drilled on contract by J. S. Schultze of Grand Rapids, Minnesota, and the balance, or 3,200'4", was drilled by Company rigs.

G-7. - HOLMAN-CLIFFS MINE, SECTIONS 21 & 22, 56-24, MINNESOTA

A total of 108 structure drill holes were drilled in the Holman-Cliffs Pit and around its perimeter in 1941. The total footage drilled was 12,389 ft. and 7,195' of crude wash ore and jig material were encountered. Ninety-three holes were drilled on the Holman lease, the SE¼ of NE¼ of Section 21, 56-24. Nine holes were drilled on the Brown No. 1 Lease, the SW¼ of NE¼ of Section 21, 56-24, six holes were drilled on the Brown No. 2 leases. Five of these holes were drilled on the SW¼ of NW¼ of Section 22, 56-24 and one hole on the SE¼ of NW¼ of Section 22. A total of 6,793'9" was drilled under contract by J. S. Schultze of Grand Rapids, Minnesota, and the balance, or 5,595'3" by Company rigs.

H. UNDERGROUND EXPLORATIONS

H-1. - CLIFFS-SHAFT MINE

One diamond drill operated continuously in the Cliffs-Shaft Mine throughout the year. During this time, 17 holes were completed and the 18th started, for a total of 3,781'. These holes were numbered from 479 to 496, inclusive.

Hole No. 479, which was drilled horizontally and due North from the East side of the 15th Level, "A" Shaft, was drilling in hanging wall slate at a depth of 170' on the first of the year. Thirteen feet of second class ore were cut between 187' and 200', averaging 55.35% Iron and .143% Phos. This is only slightly leaner than a shipping grade ore and can be mined and mixed with the richer material. The ore was followed by 5' of hard ore jasper and, at 205', by footwall dike in which the hole was bottomed without change at a depth of 256'. This was the second of two horizontal holes from the East drift on the 15th Level to explore for the downward continuation, in an Easterly pitch, of the strong ore body on the 10th Level elevation and above, and both were drilled on the Bancroft Lease. Narrow runs of first and second class ore were encountered in Hole 479 at shallower depths in December, 1940.

Two additional horizontal holes, Nos. 480 and 481, were drilled from the West end of the West drift on the 15th Level, "A" Shaft, also on the Bancroft Lease. Hole No. 480, which was drilled due South encountered a 3' seam of second class ore at the start which averaged 53.05% Iron and .082% Phos. and then went into footwall dike where it was stopped at a depth of 60'. Hole No. 481 was drilled due North on the same meridian from the opposite side of the drift and encountered 1' of ore at the start averaging 57.50% Iron and .067% Phos. It then entered footwall dike and was bottomed in it without change at a depth of 97'. These two seams of ore added to the width of the drift which was in ore on this meridian and the cut-out for the drill station, also in ore, making a total width of the ore body on this meridian of about 12'. This completed drilling on the 15th Level, "A" Shaft for the year.

A series of four holes, Nos. 482 to 485, inclusive, was drilled from the 3rd Level, "A" Shaft. Hole No. 482 was drilled horizontally and due North from the East side of the level to explore a large synclinal fold between operating stopes to the East and West. A nice run of ore from 115' to 133', which averaged 58.46% Iron and .090% Phos. was encountered. In addition to this ore, several narrower seams were cut which may be recovered in mining. Hole No. 483 was drilled vertically from the floor of an operating stope in order to determine the depth and quality of ore below this elevation. Although no high grade ore was cut, second class ore, averaging from 53.71% Iron to 54.35% Iron, was cut to a depth of 70', interrupted by narrow seams of leaner material. All of this footage undoubtedly will be recovered in stoping and mixed with the richer ore for a satisfactory grade.

Holes 484 and 485 were drilled to the Southwest and Northeast of the same stope, with dips of -11° and -21°, respectively, to further outline the limits of the ore in this stope. In Hole 484, the ore was considerably mixed with jasper to a depth of 94' before encountering the footwall. In Hole 485', a nice seam of ore was cut from 6' to 23' which averaged 59.21% Iron and .059% Phos. Mineable ground, however, was encountered to a depth of 40' but will require sweetening.

Three holes, Nos. 486, 487 and 488, were drilled from the 5th Level, "A" Shaft, all of them horizontally, and on the Bancroft Lease. The object of this drilling was to explore the ground North of an East-West fault which has dropped the block to the North of this fault down. Hole 486 was all in footwall greenstone with occasional interbedded bands of siderite and hard ore jasper. Hole 487 encountered 11' of second class ore from 26' to 37', averaging 54.59% Iron and .129% Phos. and 12' of high grade ore from 285' to 297' averaging 58.82% Iron and .060% Phos. The balance of the hole was in footwall greenstone. Hole No. 488 which was drilled toward the hanging wall, encountered 3' of ore at the start of the hole, averaging 58.25% Iron and .078% Phos. and 5', from 22' to 27', averaging 62.68% Iron and .114% Phos.

Hole No. 489 was drilled horizontally and due North from the North side of the 4th Level, "A" Shaft, East end workings, in order to explore a synclinal fold along the slate-hanging contact which, in this part of the mine, pitches to the West and is a downward extension of the Westerly pitching synclinorium along which ore was encountered in the Incline and No. 3 Mines to the East. Ten feet of high grade ore was encountered at the start of the hole averaging 57.76% Iron and .102% Phos. Several other seams of second class and lean ore were cut which were interbedded in the hanging wall slate, but are not considered of economic importance.

A series of four holes, Nos. 490 to 493, inclusive, were drilled from the 6th Level, "A" Shaft. They were all drilled from the Northeast workings on Cleveland-Cliffs property, lying between the Bancroft Lease on the West and the old New York property on the East, in order to explore the ore zone along the slate-hanging wall contact. Holes 490, 491 and 492 were drilled horizontally, Hole 490 to the East and 491 and 492 Northeasterly. All three holes encountered important footages of high grade ore which very likely connect to form an important ore body. This is one of the most encouraging results of the years' drilling. Hole 493 was drilled due North on a dip of -20° several hundred feet to the West of the first three holes to get under the hanging contact. Although no high grade ore was encountered, an important footage of second class ore was cut averaging from 51% Iron to 53.40% Iron. This material occupied the conglomerate zone between the more or less flat hanging and the iron formation below. It is quite likely that the analysis of this material was contaminated by the hole running in and out of slate along the contact and that an important body of high grade ore lies directly beneath it. Further explorations will be conducted in this area to determine this possibility.

Three holes, Nos. 494, 495 and 496, were drilled from the Northwest end of the 8th Level, "A" Shaft, all of them horizontally and on the Bancroft Lease. The object here was to test the footwall side of the iron formation for possible ore droppers from the stopes above. Hole 494, drilled N. 16° W. encountered no high grade ore. Hole 495, drilled N. 40° W. and Hole 496, due West, both encountered important footages of high grade ore. Hole 496 was still drilling in high grade ore at a depth of 105' at the end of the year. Tabulated below are the analyses of the ore encountered in Holes 495 and 496:

Hole No.	From	To	Amount	Iron	Phos.
495	61	64½	3½'	64.07	.130
	78	96	18'	54.13	.104
	96	108	12'	61.68	.175
496	5	17½	12½'	63.25	.426
	97	105	8'	58.19	.186

H-2. - LLOYD MINE

One diamond drill operated continuously in the Lloyd Mine throughout the year. During this time, ten holes were completed for a total of 3,679'. These holes were numbered from 115 to 124, inclusive.

Holes 115 to 119, inclusive, and Hole No.124 were drilled from the 6th Level. No. 115 was drilled with a dip of -50° S. 5° E. from near the South end of the 640 cross-cut to further explore a structural crotch formed by an East-West fault displacing the footwall slate in a manner similar to the numerous fault crotches which carry the principal ore bodies in the North Lake District. Incline holes on the same meridian, both above and below this hole, had been drilled during 1940. No high grade ore was encountered on this meridian.

Hole No. 116 was drilled horizontally and S. 4° E. from the second cross-cut to explore the North contact of the main Northwest-Southeast dike, along which ore was found to the Northwest, and also to explore the iron formation to the South of this dike. The formation both North and South of the dike was extremely rich with considerable footage of material averaging from 46% to 52% Iron. Unfortunately no high grade ore was encountered. The next hole, No. 117 was drilled due South about 200' farther to the West into the same territory. We were more fortunate here in that we encountered mineable ore from 330' to 409' as follows:

From	To	Amount	Iron	Phos.
330	360	30'	58.12	.050
360	377	17'	56.12	.079
377	391	14'	58.29	.080
391	409	18'	54.72	.077

A drift and cross-cut were driven into this ore, as mentioned under Mine Geological Surveys previously in this report, and two raises put up from the level to develop it. The ore body is not large but has helped to keep up the production from the mine. Considerable difficulty was experienced in drilling Hole #117 on account of encountering a heavy flow of water in the ore zone which resulted in the ground caving badly while drilling. Much time was spent reaming the hole to case off the water.

Holes 118 and 119 were drilled horizontally to the Southeast from the 4th cross-cut in order to explore for possible ore along a dike having a general East-West trend against which some enriched ground had been encountered in Hole No. 112 drilled during 1940. Ore averaging 57.50% Iron and .099% Phos. was encountered in Hole 118 from 230 to 235'

and ore averaging 61.50% Iron and .044% Phos. from 265' to 276' in the same hole. Hole 119 encountered only 3' of ore from 270 to 273' which averaged 58.10% Iron and .126% Phos. None of this ore is wide enough to be of economic importance at this elevation.

Holes 120 to 123, inclusive, were drilled from the 7th Level. Hole No. 120 was drilled vertically from the first South cross-cut to aid in getting a fairly accurate cross-section of the downward extension of the main Lloyd East ore body below the 7th Level through its deepest point in order that plans might be completed for deepening the main hoisting shaft and opening a new level from which most of the ore remaining in this deposit may be mined. High grade ore was encountered from 35' to 135', averaging 65.53% Iron and .063% Phos. The hole then encountered footwall slate and was bottomed in it at a depth of 165' without further change.

Hole No. 121 was drilled horizontally to the South from the same cross-cut as No. 120 in order to locate another point on the Northerly dipping fault contact which controls the Lloyd-East ore body and assist in constructing the shape and size of the fault crotch on this meridian. A second object of this hole was to explore for the downward continuation of the good ore encountered in Hole No. 117 which was drilled on approximately the same meridian on the 6th Level, 135' above. The first 40' of hole drilled averaged 62.84% Iron and .050% Phos. This was followed by 3' of 51% Second Class ore, after which the hole encountered footwall slate. The dike representing the objective fault zone was cut between 93' and 129', after which the hole again entered the footwall slate which represented the South block that had been faulted up. The hole was finally bottomed in slate without further change at a depth of 387'. Finding this great thickness of faulted slate below the ore in Hole 117 demonstrated that the ore bearing crotch had a Northerly dipping South fault plane limit too flat to carry the ore in Hole 117 down as far as the 7th Level elevation on this meridian. This crotch very likely pitches to the West and may carry ore to the 7th Level elevation on its pitch.

Hole No. 122 was drilled horizontally and due South on the 1400 E. meridian or about 320' West of Hole No. 121. Likewise, the object of this hole is twofold. In the first place, it was valuable in developing and locating the fault crotch cut in Holes 117 and 121 and, in the second place, it was a second attempt to explore for the ore encountered in Hole No. 117 in its downward pitch to the West. Unfortunately the hole did not encounter high grade ore. Another attempt was made to continue exploring this crotch in its pitch to the West at this elevation in Hole 123. This likewise was drilled horizontally to the South and about 400' West of Hole 122. A little enrichment of the iron formation was found averaging 50% Iron but no high grade ore. Additional drilling will be done in a further attempt to find high grade ore in this crotch in its downward pitch to the West.

Before exploring further the crotch just mentioned, the drill was moved back to the 6th Level and Hole No. 124, drilled with a dip of -38° N. 65° W. from a stub drift near the South end of the first cross-cut. The object of this hole was to follow down on the pitch the ore encountered in Hole No. 117 and developed by this cross-cut with the hope that it might later be located on the 7th Level elevation. The hole encountered 10'

of ore at the start averaging 59.62% Iron and .128% Phos. After passing through two 5' seams of second class and lean ore, good ore again was encountered from 20 to 65', averaging 59.46% Iron and .066% Phos. The hole was bottomed in soft ore jasper at a depth of 214' on the last of the year.

H-3. - MAAS MINE

Diamond drilling in the Maas Mine was resumed on January 3rd, 1941. A series of three holes, Nos. 34, 35 and 36, were drilled from the 5th Level. The first two of these holes were drilled vertically and the last horizontally, all of them to determine the bottom or footwall limit of ore and its grade, especially its sulphur content.

Hole No. 34 was drilled from near the South end of the Westernmost North-South cross-cut and No. 35 from a stub on the North side of the North or footwall drift and approximately on the same North-South meridian. Hole No. 36 was drilled N. 27° W. from the same location as No. 35. All of the holes were carried to and into the Siamo slate footwall. They encountered the following footages and grades of ore:

Hole No.	From	To	Amount	Iron	Phos.	Sul.
34	0	110	110'	61.59	.073	.136
	110	135	25'	52.58	.423	.161
35	0	5	5'	51.97	.051	2.318
	10	15	5'	51.81	.048	3.321
	20	195	175'	61.78	.058	.958
	195	272	77'	54.35	.102	.145
36	5	10	5'	59.90	.048	1.864
	20	170	150'	60.89	.094	.853

The sulphur content in this ore is largely in the form of calcium sulphate, the mineral gypsum. Therefore, it was necessary to keep casing in the holes close to the drilling and sample the drill water for soluble sulphur dissolved by it during drilling operations. Hole No. 36 was completed on March 25th, 1941 and no additional drilling was done during the balance of the year.

H-4. - VIRGIL MINE

A study of the geology on the old 1st Level, Virgil Mine, located about 175' below the collar of the old Virgil shaft, which was made some years ago, indicated the possibility of a major synclinal fold at this elevation which might contain commercial ore not connected with either the main Virgil ore body, or the Spies ore body which was exhausted some time ago. It was decided to do enough drilling from the old 1st Level to determine definitely whether such a fold does exist and if it contained commercial ore. A series of four holes were drilled, Numbers 120 to 123, inclusive. The first three holes were drilled horizontally, two of them due South and one due East, and the last hole with a dip of -45° due South. The work was done under contract by the E. J. Longyear Company of Minneapolis, Minnesota, and was started on September 18th.

The drilling did demonstrate a synclinal fold but much more protracted in area than we had hoped. The first two holes encountered no enrichment in the formation. Hole No. 122 encountered 10' of 50% second class ore. For this reason, Hole 123 was drilled inclined below it to find out whether the concentration increased in size and richness as it dipped into the fold below the level. Four 5' seams of second class ore were found averaging from 50% to 54.70% Iron and one 10' run of first class ore averaging 57.08% Iron, .476% Phos. and .280% Sulphur.

On account of the protracted size of the fold developed, the small amount of ore encountered, and the fact that all the ore that was found was high in sulphur, it was decided to discontinue further exploring in the old section of the Virgil Mine. This drilling was completed on October 29th, 1941.

I. EXPLORATIONS AND NEW DEVELOPMENTS BY OTHER COMPANIES

Because of the tremendously accelerated production of iron ore in the Lake Superior District, it is only natural that most of the companies have increased their activities in explorations, acquiring and opening new properties, investigating methods of concentration, etc. Many of these have come to my attention but due to the demands on my time throughout the year because of our own increased activities, I have not be able to collect and correlate sufficient information to make my usual chapter on this subject of particular value or add much to what I included in my Annual Report for 1940. Because of this and the delay in preparing this report, I am forced to omit further comments at this time.

J. EXAMINATION OF MINERAL LAND OFFERS

A total of 53 land offers were received by this office during the year 1941. Forty-three of these were mineral land offers. The remaining ten offers were of real estate in the City of Negaunee. The offers and their numbers are as follows:

Offer No.	Description	Remarks
2132	Lot 8, Block 18, Pioneer Iron Co. Plat, Negaunee	Pending
2133	330 acres of mineral land on Cuyuna Range, Minnesota	Declined
2134	1/7th interest in Lots 4 and 5, Block 10, Jackson Iron Co. Addition, Negaunee	"
2135	Iron lands North of Hibbing, Minnesota	" "
2136	80 acres in SE¼ of Section 9, 47-26, Marquette County	"
2137	Lot 1, property of John R. Collins, Negaunee	"
2138	Iron and coal lands North of Birmingham, Alabama	"
2139	SW¼ of SE¼ and SE¼ of SW¼, Section 8, 46-26, Marquette County	"
2140	Iron, nickel and chromium claims, State of Washington	"
2141	Lands in Section 2, 55-25, Itasca County, Minnesota	"
2142	House at SW corner, Main Street & Brown Avenue, Negaunee	"
2143	Ten iron ore claims in Perry Sound District, Ontario, Canada	"
2144	Iron lands in Atikokan District, Ontario, Canada	"
2145	One-Half mineral interest, lands in Itasca County, Minnesota	"
2146	Mineral lands in Vilas and Price Counties, Wisconsin	"
2147	Iron ore lands in Meagher County, Montana	"

Offer No.	Description	Remarks
2148	SW¼ of SW¼ of Section 22, and NW¼ of NW¼ of Section 27, 47-27 Marquette County	Pending
2149	Louis Corbitt estate on Main Street, Negaunee	Declined
2150	Adelphi Rink property, Lincoln Street, Negaunee	"
2151	Lean ore stockpiles at Mastodan and Commonwealth Mines	"
2152	Minerals only in Section 19, 40-30, Dickinson County	"
2153	Lot 13, Block 2, Maitland Addition, Negaunee	Pending
2154	Lean iron ore in Gunflint District, Minnesota	Declined
2155	Mineral rights in Crow Wing County, Minnesota	"
2156	NE¼ of Section 36, 43-35, Iron County, Michigan	"
2157	House on Lot 22, Block 2, Corbit's Add. Negaunee	"
2158	One-Fourth Interest in W½ and SE¼ of Sec. 8, 45-25, Marquette County	"
2159	Hard iron ore lands in Ontario	Pending
2160	W½ of NW¼ and NW¼ of SW¼ of Sec. 17, 46-29, Cuyuna Range, Minnesota	"
2161	Manganese property, State of Virginia	Declined
2162	Minerals only in N½ of N½, Sec. 7, 47-28, Marquette County	"
2163	Iron ore lands on Cuyuna Range, Minnesota	"
2164	Mineral rights on Western part of Marquette Range	"
2165	Mineral rights in Morrison County, Minnesota	"
2166	Surface of the Morissette Parcel, Negaunee	"
2167	1/8 interest in NW¼ of SW¼ and SW¼ of NW¼, Section 36, 43-35, Iron County, Michigan	"
2168	House on lands leased from Jones & Laughlin, Sec. 5, 47-26, Negaunee	"
2169	Fee and mineral rights, Spies Mineral Land Company, Section 24, 43-35, Iron River	Purchased
2170	Various mineral lands in Dickinson and Marquette Counties	Declined
2171	Molybdenum lands, location not given	"
2172	Iron ore lands in Southeastern Missouri	Leased
2173	Lands in Sections 23 and 24, 48-30, Marquette County	Declined
2174	Manganese property in Page County, Virginia	"
2175	Manganese property in Campbell County, Virginia	"
2176	Steep Rock Iron Mine, Ontario, Canada	Pending
2177	Foley and Klondike properties on Cuy. Range, Minnesota.	Declined
2178	Iron lands near Altoona, Pennsylvania	"
2179	Mathisen property, Cuyuna Range, Minnesota	"
2180	Miscellaneous lands in Sections 26 and 35, 47-28, Marquette County	"
2181	Miscellaneous lands in Sections 33 and 34, 59-18, St. Louis County, Minnesota	"
2182	Manganese Deposit in North Dakota	"
2183	S½ of NW¼ of Section 10, 47-27, Ishpeming	Pending
2184	Champion Mine, S½ of SW¼, Sec. 31, 48-29, Marquette County	"

K. RESEARCH AND EXPERIMENTS

Samples of Maas Special (high sulphur) ore were sent to the Mines Experiment Station, University of Minnesota, Minneapolis, Minnesota, and to the Buffalo Sintering Corporation, Buffalo, N. Y. These samples, in the crude, had a sulphur content of over .700%. We purposely selected the

highest sulphur ore we could find conveniently. At the Mines Experiment Station, experimental work was conducted to reduce the sulphur content of the ore to a merchantable grade by leaching with water, roasting, and by sintering. At Buffalo, the sample sent there was treated by sintering. The sulphur in the Maas ore is practically all in the form of gypsum (calcium sulphate) which is soluble in water under certain conditions.

Leaching reduced the sulphur to a satisfactory content on -4 mesh material but was ineffective on sizes coarser than this. In crushing to -4 mesh, however, the normal structure of the ore was pretty well destroyed. The roasting tests were quite unsatisfactory. Sintering this material with crushing to -.371" was satisfactory. The results, however, on -4 mesh material were much more so. We assumed, on advice from Mr. Raymond, a maximum sulphur content in the finished product of .040%. The sulphur in the sintered product of crude ore crushed to -371" was .044% which, for all practical purposes, would be acceptable. On the -4 mesh feed, sulphur was reduced to from .021% to as low as .008% with only a 30% return of sinter to the feed. On the basis of cost of equipment, fuel, labor, etc. at the time of these tests, the estimated cost of producing this sinter would be about $1.00 per ton. With the present demand for ore we can dispose of our Maas Special grade by mixing with standard grade ores. If the time comes when this is no longer possible, it may be necessary to install a sintering plant to handle this material.

Late in the year, approximately 50 tons of crushed Cliffs-Shaft ore were sent to the Mines Experiment Station at Minneapolis for experimental work during the winter and current spring. The material selected was the -¾" to 0 size, so-called "pills". This material results,after screening out the coarser sizes. The Silica content of this finer ore is too high to be sold as a separate grade and is also undesirable in mixing because of this fact. Consequently, up to the present time it has been wasted. It is our thought that it may be possible, by some simple concentrating flow sheet, to reduce this silica a few points so that it can be mixed with standard grade ores without raising the Silica in the mixed product to an objectionable point. The results of these tests have not yet been received but will be included in my report for the year 1942.

In the fall of 1941, and as a result of numerous large scale experimental tests, it was decided to construct an auxiliary beneficiation plant in conjunction with the Hill-Trumbull washing plant on the Mesaba Range to treat so-called "jig" ores. The flow sheet adopted will make use of cone separation on the coarse sizes (-1½" +4 mesh) and "double classification" on the material -4 mesh +0. The cone will use a heavy density medium composed of ferro-silicon and water. The double classification makes use of two Akins spiral classifiers run in tandem. The first unit operates with a high pulp density which results in hindered settling and separates the coarser gangue and ore particles. The second unit is operated as a straight classifier and separates the finer particles of ore and gangue. This complete process, known as the M.B.I. process, is covered by patents and controlled by the American Zinc, Lead & Smelting Company. A license to use the process has been granted by the latter at a cost of 5¢ per ton of product. The plant is being constructed at present and it is expected to start operating early in August.

Mr. George H. Beasley has continued to make laboratory tests at our Hill-Trumbull research laboratory on all "jig" material from our structure drilling on our various Mesaba Range properties as well as hand washed tests on all wash ore material from this drilling. We have now adopted the use of ferro-silicon as a heavy density medium to make float and sink tests on the coarser sizes of the jig material. The finer sizes are treated as before in the glass classifier and on a small laboratory size concentrating table. It is my plan to construct a new experimental and testing laboratory on the Range with completely redesigned concentrating units. When this is done we will be able to run all of our structure drill hole samples through a miniature flow sheet which will exactly duplicate treatment that our crude ores received in our commerical plants. In that way we will get the best possible results from all our drilling and exactuly comparable to what may be expected from this material as it is mined. In such a plant also we will be able to make a large variety of tests on all types of ores and keep in the van of such activities. With the rapid depletion of high grade ores, the leaner ores, first on the Mesaba Range and later on the other Ranges, will become of increasing importance and the concentration of progressively leaner ores necessary.

L. EXPENSE STATEMENTS

Tables VII and VIII, which follow, show a detailed statement of charges to Geological expense for the year 1941 and a comparative statement of these charges for the last three years. They are self-explanatory.

TABLE VII

STATEMENT OF CHARGES TO GEOLOGICAL EXPENSE FOR THE YEAR 1941

Salaries	$ 14,439.59
Travel and Entertainment	1,911.11
Operating Automobiles	691.00
Supplies and Office Expense	1,749.11
Personal Injury	22.50
Unemployment Insurance Tax	357.85
Old Age Benefit Tax	108.44
Unclassified	163.60
TOTAL	$ 19,443.20

TABLE VIII

COMPARATIVE STATEMENT OF CHARGES TO GEOLOGICAL DEPARTMENT FOR LAST THREE YEARS

	1941	1940	1939
Salaries	$14,439.59	$ 12,609.09	$ 13,068.50
Travel and Entertainment	1,911.11	1,793.92	1,882.88
Operating Automobiles	691.00	854.21	683.81
Supplies and Office Expense	1,749.11	1,187.10	1,235.07
Personal Injury	22.50	251.14	262.16
Unemployment Insurance Tax	357.85	310.52	337.87
Old Age Benefit Tax	108.44	94.11	99.32
Unclassified	163.60	12.76	7.18
TOTALS	$19,443.20	$17,112.85	$17,576.79

Respectfully submitted,

E. L. Derby, Jr.

Geologist

ELD:DWC
7-10-42

ANNUAL REPORT OF THE MINING ENGINEERING DEPARTMENT FOR THE YEAR ENDING DECEMBER 31, 1941

The regular books of photographic maps, scale 1" = 200', showing the areas mined on the various sub-levels and levels in the operating mines during 1941, accompany this report. These books contain views of some of the properties and cross-sections of the open pit mines. The maps show in red the areas mined and development work since last year's report. The sections show in color the geological structure adjacent to the open pits. Books have been prepared for the different companies interested in the various mines, the following list showing the companies for which books have been prepared and the mines included therein:

Company	Mines
The Cleveland-Cliffs Iron Company	Athens, Canisteo, Champion, Cliffs-Shaft, Hill-Trumbull, Holman-Cliffs, Jackson Lease-Cambria, Lloyd, Maas, Mather, Morris, Negaunee, Princeton, Spies-Virgil and Tilden.
Bethlehem Steel Company	Mather and Negaunee.
Canisteo Mining Company	Canisteo.
Hanna Ore Mining Company	Hill-Trumbull and Holman-Cliffs.
Inland Steel Company	Hill-Trumbull and Holman-Cliffs.
Jones & Laughlin Steel Corporation	Hill-Trumbull and Holman-Cliffs.
Otis Steel Company	Hill-Trumbull and Holman-Cliffs.
Pickands, Mather & Company	Athens.
Pittsburgh Steel Corporation	Hill-Trumbull and Holman-Cliffs.
Republic Steel Corporation	Hill-Trumbull and Holman-Cliffs.
Wheeling Steel Corporation	Hill-Trumbull and Holman-Cliffs.

There were two bound volumes made of The Cleveland-Cliffs Iron Company book, one for the Cleveland office and one for the Engineering Department at Ishpeming. Six loose-leaf books were made of the Canisteo Mine for the Canisteo Mining Company. One loose-leaf book was prepared for each of the partners in the Mesaba-Cliffs Mining Company except for the Republic Steel Corporation for which two books were prepared. One copy of the other books were made in loose-leaf form.

There were similar books prepared for the fee owners and superintendents. Those for the Mesaba Range were bound, while the others were in loose leaf form.

Person	Mines
Arthur Iron Mining Company	Hill-Trumbull and North Star-Bingham Lease of Holman-Cliffs.
W.A.Sterling, District Supt.	Canisteo, Hill-Trumbull and Holman-Cliffs.
H.C.Bolthouse, Superintendent	Hill-Trumbull and Holman-Cliffs.
G.E.Tucker, Superintendent,	Canisteo.
W.W.Graff, Superintendent	Athens and Negaunee.
H.O.Moulton, Superintendent	Maas.
F.J.Haller, Superintendent	Lloyd and Spies-Virgil Mines.
C.J.Stakel, Superintendent,	Cliff-Shaft.
C.W.Allen, Superintendent	Mather.

B. MAP REPORTS

At the end of each month, two sets of blueprints of mine maps for the Michigan Mines, scale 1" = 50', were prepared, showing in red the areas mined during that month. One of these sets was made for the General Superintendent, and the other for the Mine Superintendent. The sets for the General Superintendent are boxed and preserved for future reference. Maps of the Cliffs-Shaft Mine are made quarterly.

Besides the above map reports, other sets of maps for Michigan Mines were prepared as follows:

ATHENS MINE

Two sets of monthly blueprints of the Athens Mine, showing in red the work done during that month, were sent to the Cleveland office for Pickands, Mather & Company.

CLIFFS-SHAFT MINE

Two sets of blueprints of the geological maps of the Bancroft Lease, scale 1" = 50', were prepared after each quarterly survey of the mine, one for the Ishpeming office of the Oliver Iron Mining Company and the other for our Cleveland office. These maps showed, in red, the work done since the previous report. At the end of the year, two sets of these geological maps were prepared showing the work done for the year, one for the Duluth office of the Oliver Iron Mining Company and one to our Cleveland office. Also, two copies of the estimate of ore reserves in the Bancroft Lease as of December 31st, 1941, as prepared for the Michigan State Tax Commission, were sent, one to the Duluth office of the Oliver Iron Mining Company and one to our Cleveland office, together with a set of maps, scale 1" = 200', showing the location of the estimated reserves.

MAAS MINE

Blueprints of those portions of the Maas Mine workings, scale 1" = 50', in the Roman Catholic Cemetery Lease are sent monthly to Mr. R. S. Archibald, Negaunee, Michigan, showing in red the areas mined during the month.

During the early part of the year, Mr. R. C. Miller of Negaunee, Michigan, became engineer for some of the fee-owners of the Maas Mine lease. Since and including March, 1941, sets of blueprints, scale 1" = 50', of the Maas Mine have been sent to Mr. Miller, showing in red the workings in the Maas Mine lease during that month.

NEGAUNEE MINE

Mr. R. C. Miller was appointed Engineer by some of the fee-owners of the Negaunee Mine lease early in the year. Since and including March, blueprints of the Negaunee Mine maps, scale 1" = 50' have been sent to Mr. Miller, showing in red the areas mined during the previous month.

At the end of the year, sets of the Annual Report maps of the 4th, 6½, 9th, 11th, 12th, 13th and 14th Levels of the Negaunee Mine were forwarded to eleven of the fee owners.

A set of blueprints, scale 1" = 50', of the North-South cross-sections of the Negaunee Mine were sent to Mr. W. L. Cumings, Geologist of the Bethlehem Steel Company, Bethlehem, Pennsylvania. Only those sections that were affected by mining in 1941 were sent.

SPIES-VIRGIL MINE

Five sets of blueprints, scale 1" = 50', of the Virgil Mine workings were sent quarterly to the fee-owners of the Virgil property, showing in red the areas mined during the previous three months.

MICHIGAN STATE TAX COMMISSION

Estimates of ore reserves at the Athens, Cliffs-Shaft, Lloyd, Maas, Negaunee and Spies-Virgil Mines were made as of December 31st, 1941. These estimates were accompanied by a set of Annual Report Maps, showing in color the areas included in compiling these estimates and also the general geological structure. One of these books was sent to the Michigan State Tax Commission through the Cleveland office in January, 1942, the other book remaining on file in the Engineering Department at Ishpeming.

C. REMARKS ON MISCELLANEOUS DOCUMENTS AND ABSTRACTS

All documents affecting lands and rights held by the Company or its subsidiaries passed through the Engineering Department for recording and approval irrespective of the Department in which they originate. These documents received the approval of both the Engineering and Geological Departments and are entered on the records and initialed by Mr. Brewer and also by Mr. Derby if necessary. Careful consideration of these documents are given from the standpoint of the Mining Department especially where the mineral or economic value is concerned. Copies of those documents which affect the mineral lands are kept on file in the Engineering Department.

The following table shows the number and classification of such documents as have passed through the Department during the year:

Classification	Number Received	Last File Number
Mining Leases	0	72
Miscellaneous Documents	38	1,411
Easements	2	416
Rights of Way	2	224
Water Rights	7	66
Surface Leases	124	5,121
Applications for Sale	2	179
Sales	288	2,243
Tax Histories	0	702
Legal Opinions	0	195

The following comments cover the above classifications and the documents that were entered on the Department records during 1941:

MINING LEASES

There were no mining leases received during the year.

The lease of the Stephenson Mine, comprising the S½ of the SW¼ of Section 20, 45-25, was surrendered as of September 30th, 1941.

The lease of the Gardner Mine, comprising the NW¼ of NE¼ of Section 2, 44-25, the NE¼ of SW¼ and the SE¼ of SE¼ of Section 35, 45-25, was surrendered as of December 31st, 1941.

Notices for the surrender of the Mackinaw Mine lease, comprising the S½ of SW¼, N½ of SE¼ and SW¼ of SE¼ of Section 35, 45-25, were mailed in December and will be effective in February, 1942.

The mineral estate of the Spies Mine, comprising the E½ of NW¼ of Section 24, 43-35, was purchased in December, 1941. The fee interests of six other forties and the mineral interest of four forties, all in Section 24, 43-35, were purchased at the same time.

The mineral estate of the SW¼ of Section 2, 47-27, held under the Iron Duke Mining Lease was purchased during December, 1941.

MISCELLANEOUS DOCUMENTS

This classification covers all documents involving the transfer of rights on mineral lands. Of those received during the year, there were sixteen purchases or transfers of land on the mineral formation, sixteen easements, three mining lease surrenders, and the balance other miscellaneous rights.

EASEMENTS

This file covers rights of way acquired by the Cliffs Power & Light Company. These two documents cover a new line to the Mather Mine and a county permit for the rebuilding of the Carp River Storage Basin No. 2 dam.

RIGHTS OF WAY

This file covers railway and highway rights of way. Two copies of former documents were received as a matter of record.

WATER RIGHTS

These are permits regarding the discharge of mine water across lands adjacent to mines. The water rights received during the year were for the new line from the Athens Mine to the Carp River.

SURFACE LEASES

These leases cover all sorts of permits for use of Company lands and originate in the Land Department. These consist of sites for residences, camps, farms, gardens, etc.

APPLICATIONS FOR SALE

These also originate in the Land Department and are preliminary reports covering lands to be sold and are issued for the properties lying off the mineral formation.

SALES

This classification covers the transfer of rights of all kinds, most of which originate in the Land Department, and are sent to the Mining Department for approval. There were 63 sales of land off the mineral formation, 31 rights of way, 41 house sales, and the balance miscellaneous permits.

TAX HISTORIES

There were no tax histories added to the Engineering Department files during the year.

LEGAL OPINIONS

This file is for ready reference of legal opinions as to the title of various lands. There were no additions to the Engineering Department files during the year.

ABSTRACTS

There was no work done on abstracts during the year.

D. THE FORCE

There was no change in the engineering personnel of the Department during the year. There was considerable change, however, among the helpers. Mr. F. A. Koski and D. Isaacson were drafted into military service and left the Department at the end of May. Mr. Koski was later released from the Army as being over age and re-entered the Department on October 6th.

Mr. John M. Hill entered the Department on May 26th and C. A. Koski on June 9th. Mr. R. E. Magnuson, Jr., was employed as helper during the summer.

The following table shows the personnel of the Department during the year, their position and period employed during 1941:

Name	Position	Entered	Left	1941 Employment
C. Brewer	Chief Mining Engineer			12 months
J. Trosvig	Engineer			12 "
W. R. Atkins	"			12 "
C. R. Sundeen	"			12 "
J. S. Westwater	"			12 "
G. T. Hollett	"			12 "
W. H. Stannard	Draftsman			12 "
F. A. Koski	Helper	Oct. 6th	May 31st	8 "
D. W. Carlson	Stenographer			12 "
J. M. Hill	Helper	May 26th		7 "
C. A. Koski	"	June 9th		6¾ "
D. Isaacson	"		May 31st	5 "
R. E. Magnuson	"	July 7th	Sept. 20	2½ "

The next table shows the length of service in the Engineering Department of the present personnel:

Name	Date Entered	Length of Service	
C. Brewer	August, 1906	23 years, 3 months	
J. Trosvig	June, 1911	24 " 10 "	(1)
W. R. Atkins	November, 1936	5 " 1½ "	
C. R. Sundeen	February, 1940	1 " 10½ "	
J. S. Westwater	May, 1940	1 " 7½ "	
G. T. Hollett	August, 1940	1 " 4½ "	
W. H. Stannard	November, 1940	1 " 2 "	
F. A. Koski	January, 1936	5 " 8 "	(2)
D. W. Carlson	August, 1936	5 " 4½ "	
J. M. Hill	May, 1941	6 "	
C. A. Koski	June, 1941	6 "	

(1) Not employed by Company from October 15, 1914 to December 1, 1915, also from June 1, 1932 to November 9, 1936.

(2) In U.S. Army (Selective Service) between May 31st and October 6th, 1941.

The above "Length of Service" only covers the period that the men were employed in the Engineering Department and does not necessarily cover the entire length of service with the Company. Several of the men have been in other departments either before or at intervals since first entering this department.

The following table shows the total days worked, days sick and days absent for the year:

Name	Days Worked	Days Sick	Days Absent
C. Brewer	258½	3½	18½
J. Trosvig	267	1½	12
W. R. Atkins	267½		13
C. R. Sundeen	271½		9
J. S. Westwater	274		6½
G. T. Hollett	273		7½
W. H. Stannard	272½	4½	3½
F. A. Koski	179		5
D. W. Carlson	264	2½	14
J. M. Hill	160		8
C. A. Koski	157		
D. Isaacson	118		
R. E. Magnuson	59½		
J. P. Peterson	16		

The distribution of the time spent underground, in the field and in the office during 1941 is shown in the following table, together with the total percentages.

Name	Underground	Field	Office	Total
C. Brewer	2	70½	186	258½
J. Trosvig	54½	35	177½	267
W. R. Atkins	105½	34	128	267½
C. R. Sundeen	121	20½	130	271½
J. S. Westwater	84	54	136	274
G. T. Hollett	70½	92	110½	273
W. H. Stannard	8	27	237½	272½
F. A. Koski	44	61½	73½	179
D. W. Carlson	2	-	262	264
J. M. Hill	51	59	50	160
C. A. Koski	21½	91½	44	157
D. Isaacson	27½	39½	51	118
R. E. Magnuson	½	51½	7½	59½
J. P. Peterson			16	16
TOTAL	592	636	1,609½	2,837½
%	20.9	22.4	56.7	100.0

The following is a resume of the work done by the various men in the Department during the year:

CARL BREWER, Chief Mining Engineer, had charge of the Engineering Department and exercised general supervision over all the work. He handled all the documents that passed through the Department and made such reports as were necessary, initialing them and entering them on the Engineering Department records. He assisted Mr. Preston in acquiring certain lands in Carp River Storage Basin No. 2. He compiled the Annual Report books, estimates of ore

reserves and maps for the Michigan State Tax Commission, Stockpile estimates, etc. He checked the delinquent tax list of the Mining Department and Cliffs Power & Light Company and prepared the 1941 tax lists. He supervised the triangulation surveys and calculations of mineral boundaries. He spent some time in connection with the reopening of the Princeton Mine.

The following table shows the distribution of his time for the month:

Property	Underground	Field	Office	Total	%
General Engineering		27	163½	190½	73.6
Athens Mine		2½		2½	.9
Lloyd Mine		½		½	.2
Maas Mine		1		1	.4
Mather Mine	2	6½	2½	11	4.2
Negaunee Mine		1		1	.4
Spies-Virgil Mine		2		2	.8
Princeton Mine		4	2	6	2.2
Webster Mine		3		3	1.5
Champion Mine		1		1	.4
C. P. & L. Co.		22	18	40	15.4
TOTAL	2	70½	186	258½	
%	.8	27.2	72.0		100.0

JOHN TROSVIG, Engineer, had charge of the engineering work at the Cliffs-Shaft Mine and the Jackson Lease-Cambria Mine throughout the year. He made the quarterly surveys of the Cliffs-Shaft Mine and monthly surveys for the Jackson Lease, preparing the map reports. He made estimates of the ore reserves at the Cliffs-Shaft Mine for the Tax Commission and ore reserve estimates of the Jackson Lease for Company purposes. He made surveys and staked out the screening plant for the Champion stockpile. He also ran a survey in the Carp River Storage Basin No. 2 to tie in our surveys in that region. At the Cliffs-Shaft Mine, he gave lines for trestles and for the new road and grading near the new laboratory and the dry. During May he made an estimate of ore in stock at the plant of the Otis Steel Company in Cleveland. The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
General Engineering		6½	24	30½	11.4
Cliffs-Shaft Mine	43½	8	99	150½	56.3
Jackson Lease	11		47½	58½	21.9
C. P. & L. Co.		8	5	13	5.0
Mather Mine		2	1	3	1.1
Otis Steel Company		7		7	2.6
Champion Mine		3	½	3½	1.3
Princeton Mine			½	½	.2
Lloyd Mine		½		½	.2
TOTAL	54½	35	177½	267	
%	20.4	13.1	66.5		100.0

WILLIAM R. ATKINS, Engineer, had charge of the engineering work at the Maas Mine throughout the year. Considerable time was spent in the planning for the development of the 6th Level. He made preliminary plans for the reopening of the Princeton Mine in connection with stocking areas, etc. He staked out the piers for the headframes at No. 2 and No. 3 shafts and did what other engineering work was required at that property.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
Maas Mine	105½	9½	121½	236½	88.4
Gwinn District		½		½	.2
Princeton Mine		15	4½	15½	7.3
Mackinaw Mine		½	1	1½	.6
C. P. & L. Co.		8½	1	9½	3.5
TOTAL	105½	34	128	267½	
%	39.4	12.7	47.9		100.0

CURTIS R. SUNDEEN, Engineer, had charge of the engineering work at both the Negaunee and Spies-Virgil Mines throughout the year. He made the monthly map reports, estimates of ore reserves and ore in stock for both these properties. With the superintendents he planned development work and gave lines, grades, etc., underground, as required.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
Negaunee Mine	87½	16	89½	193	71.1
Spies-Virgil Mine	33½	3½	38	75	27.6
Athens Mine		1		1	.4
General Engineering			2½	2½	.9
TOTAL	121	20½	130	271½	100.0
%	44.6	7.6	47.8		100.0

JAMES S. WESTWATER, Engineer, took care of the engineering work at the Lloyd and Tilden Mines throughout the year. At the Lloyd Mine he gave lines for the development work, made estimates of ore reserves and ore in stock. He planned the development below the 7th Level. At the Tilden Mine he supervised the various blasts in the pits, located the drilling for the blasts and exploration work. He made estimates for future stripping.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
Lloyd Mine	83	14	89½	186½	68.0
Tilden Mine		37	46½	83½	30.4
Spies-Virgil Mine	1			1	.4
Geological Dept.		1½		1½	.6
Stephenson Mine		½		½	.2
Princeton Mine		½		½	.2
C. P. & L. Co.		½		½	.2
TOTAL	84	54	136	274	
%	30.7	19.7	49.6		100.0

GRANT T. HOLLETT, Engineer, had charge of the engineering work at the Athens and Mather Mines throughout the year. At the Athens he made estimates of ore reserves, ore in stock and took periodic elevations to outline the subsidence areas. Underground he gave lines and planned the development work above the 4th Level. At the Mather Mine he checked the alignment of the bearer sets in the shaft and gave lines and grades for the headframe piers and other structures as required around the shaft. He staked out the original location of the building, but was not called upon for any further work in connection with this structure.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
Athens Mine	63	13	93	169	61.9
Mather Mine	7½	61	14½	83	30.4
C. P. & L. Co.		15	2½	17½	6.4
Cliffs-Shaft Mine		1½	½	2	.7
General Engineering		1		1	.4
Webster Mine		½		½	.2
TOTAL	70½	92	110½	273	
%	25.8	33.7	40.5		100.0

W. HARLOW STANNARD, Draftsman, spent most of his time in the office, making various maps as they were needed. These consisted mostly of mine maps, but there were many others needed during the course of the year. He also assisted in some of the surface and underground surveys.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
General Engineering		3½	30½	34	12.5
Athens Mine	1½	2½	28	32	11.7
Cliffs-Shaft Mine	½	½	½	1½	.5
Canisteo Mine			7	7	2.6
Lloyd Mine	3	4½	6½	14	5.1
Hill-Trumbull Mine			3	3	1.1
Holman-Cliffs Mine			3	3	1.1
Jackson Lease			14½	14½	5.3
Maas Mine	½	1	73½	75	27.5
Mather Mine		3	18	21	7.7
Negaunee Mine	2½		13	15½	5.9
Princeton Mine		4	4½	8½	3.1
Tilden Mine		6	8½	14½	5.3
Bunker Hill Mining Co.			13½	13½	5.0
C. P. & L. Co.		2	9	11	4.0
Geological Department			4½	4½	1.6
TOTAL	8	27	237½	272½	
%	2.9	9.9	87.2		100.0

DONALD W. CARLSON, Stenographer, worked for both the Engineering and Geological Departments throughout the year. He helped occasionally on underground and surface surveys.

The following table shows the distribution of his time for the year:

Property	Underground	Field	Office	Total	%
Stenography			262	262	99.2
Lloyd Mine	2			2	.8
TOTAL	2		262	264	
%	.8		99.2		100.0

F. ALFRED KOSKI, Helper, assisted in underground and surface surveys during the time he was in the Department. He went to Cleveland with Mr. Trosvig in May for the estimate of the Otis Steel Company ore in stock. Between May 31st and October 1st he was in the military service of the country. In the office, he assisted in plotting survey calculations, making blueprints, etc., and miscellaneous other work.

The following table shows the distribution of his time for the period that he was in the Department during the year:

Property	Underground	Field	Office	Total	%
General Engineering		9	44	53	29.6
Athens Mine	2½	5	3½	11	6.1
Cliffs-Shaft Mine	27	4	11½	42½	23.7
Jackson Lease	3		½	3½	2.0
Lloyd Mine	1	1		2	1.1
Maas Mine	4½	6	6½	17	9.5
Mather Mine	2	8		10	5.6
Negaunee Mine	4	2	3½	9½	5.3
Princeton Mine		9½	3	12½	7.0
Champion Mine		2	½	2½	1.4
Webster Mine		2½		2½	1.4
Hill-Trumbull Mine			½	½	.3
Geological Dept.		3½		3½	2.0
C. P. & L. Co.		1		1	.5
Otis Steel Company		8		8	4.5
TOTAL	44	61½	73½	179	
%	24.6	34.4	41.0		100.0

P. DANIEL ISAACSON, Helper, was in the Department until May 31st when he left to enter military service. During the time he was in the Department, he assisted in the surface and underground surveys and, in the office, made blueprints, etc.

The following table shows the distribution of his time for the period that he was in the Department:

Property	Underground	Field	Office	Total	%
General Engineering		7	49½	56½	47.9
Athens Mine	5	6		11	9.3
Cliffs-Shaft Mine	3½	1½	½	5½	4.7
Lloyd Mine	4	½		4½	3.8
Maas Mine	6½	2	½	9	7.6
Mather Mine		8½		8½	7.3
Negaunee Mine	6½	½	½	7½	6.4
Spies-Virgil Mine	2			2	1.7
Tilden Mine		11		11	9.3
Geological Dept.		1		1	.8
Mackinaw Mine		½		½	.4
Champion Mine		1		1	.8
TOTAL	27½	39½	51	118	
%	23.3	33.5	43.2		100.0

JOHN M. HILL, Helper, entered the Department on May 26th. He assisted in the surfade and underground surveys for the balance of the year and made blueprints, etc., in the office.

The following table shows the distribution of his time during the period he was in the Department:

Property	Underground	Field	Office	Total	%
General Engineering		5½	38	43½	27.2
Athens Mine	3	2	1	6	3.8
Cliffs-Shaft Mine	20½	4		24½	15.3
Lloyd Mine	9	2		11	6.9
Maas Mine	7½	7	7½	22	13.8
Negaunee Mine	7	1½	½	9	5.6
Mather Mine		6		6	3.8
Jackson Lease	1½		½	2	1.2
Spies-Virgil Mine	2½	2		4½	2.8
C. P. & L. Co.		13		13	8.1
Princeton Mine		4		4	2.5
Tilden Mine		7½	2½	10	6.3
Webster Mine		2½		2½	1.5
Geological Dept.		2		2	1.2
TOTAL	51	59	50	160	
%	31.9	36.9	31.2		100.0

C. ARTHUR KOSKI, Helper, entered the Department on June 9th. He has assisted in the various surface and underground surveys and in the office made blue-prints, etc.

The following table shows the distribution of his time for the period he was in the Department:

Property	Underground	Field	Office	Total	%
General Engineering		4	43	47	29.9
C. P. & L. Co.		33		33	21.0
Athens Mine	7	1½		8½	5.4
Cliffs-Shaft Mine	1½	3		4½	2.9
Jackson Lease	1		½	1½	1.0
Lloyd Mine	3½	4½		8	5.1
Maas Mine	2	6½		8½	5.4
Mather Mine		10		10	6.3
Negaunee Mine	6½	8½	½	15½	9.9
Tilden Mine		5½		5½	3.5
Spies-Virgil Mine		2		2	1.3
Geological Dept.		1½		1½	1.0
Webster Mine		2		2	1.3
Princeton Mine		9½		9½	6.0
TOTAL	21½	91½	44	157	
%	13.7	58.3	28.0		100.0

RALPH E. MAGNUSON, JR., Helper, was in the Department between July 7th and September 20th. Most of his time was spent as helper in connection with the surveys in the Carp River Storage Basin No. 2. He also assisted in some of the other surface and underground surveys and general work in the office.

The following table shows the distribution of his time during the period he was in the Department:

Property	Underground	Field	Office	Total	%
C. P. & L. Co.		38½	3½	42	70.6
General Engineering			3½	3½	5.9
Cliffs-Shaft Mine		1		1	1.7
Lloyd Mine	½	4½		5	8.4
Maas Mine		2½	½	3	5.0
Mather Mine		3		3	5.0
Tilden Mine		2		2	3.4
TOTAL	½	51½	7½	59½	
%	.8	86.6	12.6		100.0

E. DISTRIBUTION OF TIME

The raising of the Carp River Storage Basin No. 2 required more engineering time than any other one job except for the operating mines. All the time in connection with the various properties has been charged thereto when directly possible. The time of blueprinting, miscellaneous drafting, reports, etc. has been classified under General Engineering. For payroll purposes, the time under General Engineering has been distributed proportionately to the various properties.

The following table shows the distribution of time for the Department divided between underground, field and office, at the various properties:

Property	Underground	Field	Office	Total	%
General Engineering		63½	398½	462	16.3
Athens Mine	82	33½	125½	241	8.5
Cliffs-Shaft Mine	96½	23½	112	232	8.2
Lloyd Mine	106	32	96	234	8.2
Maas Mine	126½	35½	210	372	13.1
Negaunee Mine	114	29½	107½	251	8.8
Mather Mine	11½	108	36	155½	5.5
Spies-Virgil Mine	39	9½	38	86½	3.0
Tilden Mine		69	57½	126½	4.5
Jackson Lease	16½		63½	80	2.8
Princeton Mine		46½	14½	61	2.1
Geological Dept.		9½	4½	14	.5
Mackinaw Mine		1	1	2	.1
Webster Mine		10½		10½	.4
C. P. & L. Co.		141½	39	180½	6.4
Champion Mine		7	1	8	.3
Canisteo Mine			7	7	.3
Hill-Trumbull Mine			3½	3½	.1
Holman-Cliffs Mine			3	3	.1
Bunker Hill Mining Co.			13½	13½	.5
Otis Steel Company		15		15	.5
Stephenson Mine		½		½	.0
Gwinn District		½		½	.0
Stenography			278	278	9.8
TOTALS	592	636	1,609½	2,837½	
%	20.9	22.4	56.7		100.0

F. COSTS

The next table shows a comparison of costs for the Engineering Department for the last three years:

	1939	1940	1941
Salaries	$15,753.16	$20,252.36	$19,486.36
Auto Expense	680.87	934.43	1,143.41
Furniture and Fixtures	5.00	-	236.81
Heat, Light and Power	196.91	571.06	569.41
Insurance	145.85	112.22	81.50
Postage	28.08	30.18	34.29
Repairs	344.72	189.18	118.50
Stationery and Printing	92.27	57.42	116.35
Supplies	1,653.50	1,831.61	1,801.68
Taxes	45.82	45.27	46.40
Travel and Entertainment	60.28	68.10	153.23
Personal Injury Expense	317.52	410.97	53.25
Telephone and Telegraph	91.09	130.68	106.02
Papers and Periodicals	3.83	17.00	-
Unemployment Insurance Tax	521.36	660.47	645.10
General - Unclassified	20.54	32.69	110.09
Old Age Benefit Tax	157.74	204.47	195.50
Depreciation	-	84.96	84.96
TOTAL	$20,118.54	$25,633.07	$24,982.86

H. AUTOMOBILES

The Ford Station-Wagon and Chevrolet Coupe were replaced at the end of January by new cars. A new Ford Station-Wagon owned by the Company was received on January 24th and a Ford four-door sedan, furnished by the Four Wheels, Inc., was received on January 30th. The following table shows the mileage covered in 1941, the total mileage and the date purchased or received:

	Miles		
Car	1941	Total	Date Received
Ford Station Wagon	150	38,370	November 10th, 1930
Ford Station Wagon	6,907	7,320	January 24th, 1941
Chevrolet Coupe	311	27,341	July 1st, 1937.
Ford Sedan	9,318	9,675	January 30th, 1941

I. MINES

The following summary covers some of the special work done by the Department during the year:

GENERAL

The weekly inspections of soft ore mines were continued throughout the year unless prevented by other important work. The engineer accompanied either the mining captain or shift boss and visited practically every working place on these inspections. General geology was noted and special trips made with members of the Geological Department to check up those portions that needed more careful geological study. The engineers have assisted the superintendents with their monthly and annual reports.

ATHENS MINE

When the snow disappeared in the spring, it was found that the surface cave extended much further to the South and East than had been anticipated. The southern part of the property was staked out with iron pins in checkerboard arrangement, and frequent levels were run to determine whether or not the cave was extending South toward the Chicago & North Western Railroad tracks. It was found very early in the spring, except for a slight surface pull, that the limit of cave had practically been reached along the South and would not endanger the railroad. During the summer, however, cracks appeared further to the East and frequent elevations and surveys were made to locate the probable limit of settlement. The extent of caving to the South and East has probably been reached for some time but it is likely that the northern limit will show extension throughout the timber yard.

The ground settlement necessitated the relocation of the mine water discharge. Surveys and estimates were prepared for the new location which now runs Easterly along the L. S. & I. R.R. track and thence Northeasterly on to the Negaunee Mine property and joining in with the Negaunee Mine water going into the Carp River. The settlement also made it necessary to transfer the timber treating plant to the Maas Mine. This was done during the summer and the plant over there is now in operation and the timber treating is done there.

Underground, the development of the 4th Level East of Block 4 required constant attention in giving lines, grades, etc. A new cross-cut on the 6th Level was driven immediately South of the shaft. Plans were drawn for the new fan lay-out on the 10th Level and lines given for the commencing of this work late in the year. A fire in the capping adjacent to the 6th Level closed the mine between July 2nd and 17th.

CHAMPION MINE

The purchase of the stockpiles at the Champion Mine at Beacon did not require any estimates of ore in stock. A survey was made for the best location of the screening plant and lines and grades given for its construction.

CLIFFS-SHAFT MINE

It was decided to crush, screen and wash the crushed ore at the Maas Mine crushing plant in order to secure a better product for this ore. The addition to the crusher was staked out and the new settling pond for the fines

was located and elevations taken for future reference.

Plans were drawn for a parking area adjacent to the dry and the grading and filling for this was supervised. The addition to the laboratory near "A" Shaft necessitated the changing of the roadway. This was staked out and grades were given as required for the new construction.

The underground quarterly surveys were made in February, May, September and November. Lines were given for drill holes and many special surveys were run for development raises throughout the mine.

JACKSON LEASE - CAMBRIA MINE

Regular monthly map reports of the operations on the Jackson Lease by the Republic Steel Corporation were made throughout the year and a monthly written report prepared showing analyses of ore produced by the different contracts. During March, a special study of the off-grade ore was made. During the year, the proposed methods of operation and development were presented to the operators.

LLOYD MINE

The new stocking ground for the silica ore was laid out on surface and grades and lines given for the permanent trestle.

Underground, development of the 6th and 7th Levels required considerable time in planning and supervising. The commencing of sinking operations below the 7th Level was supervised and the shaft timbering checked as work progressed. Plans for diamond drilling were made with the Geological Department and lines for the holes put in underground as required.

MAAS MINE

The timber treating plant from the Athens Mine was planned and staked out in the field. This plant will probably be purchased from the Athens Iron Mining Company and operated by the Maas Mine.

A lot of time was spent planning methods of development for the 6th Level. The final plan provides for sinking the main shaft and putting down a winze near the ore body from which the 6th Level will be developed. Drifting on the 5th Level was commenced in December for this work.

MATHER MINE

Shaft sinking was started on January 6th with an appropriate ceremony. Lines for the bearers and first set had been given previously and these were in place when sinking operations commenced. Such elevations and lines for the erection of the temporary headframe had been given as were required. As sinking progressed, shaft sets were checked. The concreting of the sets above ledge was carefully watched and after completion were checked again for alignment. As sinking progressed in ledge the alignment of each bearer set has been further checked.

In the spring, lines and grades were given as required for the headframe and permanent trestle piers. Construction of the new permanent trestle