

set on this level. A plumb line was also hung from surface to the 3rd level and satisfactory check obtained with the 3rd level surveys, as carried East from the main shaft. Contracts Nos. 10 and 24 holed during the month of June. The surveys tied in by  $00^{\circ}00'30''$  for course and 0.20 and 0.05 for coordinates. Previous to the holing, lines were given about twice a month in these contracts. As the development of the Section 6 ore body proceeded, lines were given for five crosscuts on the 3rd level East and the raises going up from these contracts were lined in. The 1060' sub-level was opened up 100' above the 3rd level East by crosscutting from the top of each raise. Lines were given for connecting drifts holing these crosscuts and also to the contract which holed into the ventilation and timber shaft. All of the raises were offset at this sub-level and new lines given for continuing the raises to the next sub, 100' above the 1060' sub. The stripping of the area overlying this ore body required almost daily attention during the months of September, October and November. The area comprising the proposed pit and approach was first laid out in 27' squares and contoured. As the stripping proceeded and the ledge was uncovered, elevations were taken in order to accurately determine the position of the top of the ledge. Slope stakes were set, ditches laid out to take the surface water away from the pit, grades given the contractor and monthly estimates made of the yardage removed. These estimates were checked by Mr. A. L. Myers, the Engineer representing the contracting firm, who worked jointly with Mr. Hayden. The engine house and hoist foundations and transmission line running from the main Lloyd shaft were staked out. Monthly and mid-monthly surveys were made at regular intervals and assistance given on the geological surveys.

#### MAAS MINE.

At this property, development work only was carried on during the first eight months of the year. This consisting of the sinking of the winze from the 3rd level and the opening up of the drift on the 4th level. Line plugs were set and after the winze reached the bottom the rails for the two skip roads were carefully lined in because of the small clearance between them. All of the raises started during the last four months have

ENGINEERING DEPARTMENT.

been spotted and line plugs set in the back of the raise. As the new sub-levels are being developed, the crosscuts have been systematically laid out so as to leave uniform sized rectangular shaped pillars for slicing. A lay out of the proposed drifts on the 4th level was planned and lines given for the contracts drifting East and West from the bottom of the Winze. On the 2nd level, a check survey was also run from the plugs in the rock drift along the East footwall drift to the boundary line between the Maas and Negaunee mines.

MORRIS MINE.

The monthly and mid-monthly surveys of the 1st and 2nd levels and sub-levels took but little time, but the 4th level required lines at least twice a month. The winze from the 2nd to the 4th level was plumbed three times. The coordinates of the 4th level plugs agreed within 0.01 in both latitude and departure.

NEGAUNEE MINE.

At this property, the routine surveying has greatly increased during the year. Line plugs were set in the majority of the raises, giving both direction and dip. Line plugs were also established on both the 9th and 10th levels in the new development drifts. A trip was made through the entire mine at least once a week in order to give lines to the contracts on the sub-levels. Whenever possible, transit lines were set, but the Brunton compass was used on sub-levels that were caving and crushing due to the impossibility of keeping permanent survey stations in caving ground. A drawing showing the method of timbering and lay out of the pockets was made for the 10th level vertical winze. The timber sets were also lined in by the Engineering department. The hoist foundation was looked after and the turn sheaves set in position. Some of the drifts and raises on the 10th level were sampled in order to find the limits of the Bessemer ore area. An estimate was made of the Negaunee stockpiles at the beginning and end of the shipping ~~ix~~ season in order to determine a factor for the number of cubic feet to the ton of ore.

REPUBLIC MINE.

The Ishpeming office discontinued making monthly surveys after January 1st, this now being done by the resident engineer. All of the annual report work is handled by this office, which consists of posting the tracings, photographing and coloring in the white prints. The question of the division of the mineral rights under Smith's Bay was taken up and drawings made showing several different schemes.

SALISBURY MINE.

The opening up of the South deposit required the only surveying of importance at this mine. Line plugs were set on the 14th level whenever necessary and surveys carried up the raises as the new sub-levels were opened up. On the 14th level, a check survey was run from plugs near No.5 shaft to the breast of the rock drift. The old and the new surveys checked exactly for course and very closely for coordinates. Elevations were also carried to the end of the drift and checked back to the shaft.

SURFACE SURVEYS.

NORTH LAKE EXPLORATIONS.

Locations for new drill holes were given on Sections 2 and 3, 47-28 and Section 6, 47-27 when requested by the Geological department. After the holes were drilled, the exact locations were surveyed, calculated and plotted.

SPIES LEASE, IRON RIVER DISTRICT.

Diamond drilling was resumed late in the year and locations given for drill holes about once a week. An area about 1800' long and 500' wide, embracing the ore body, shaft site, mine location, stockpile grounds, railway tracks, etc, was contoured and a lay out planned for the mine equipment.

REPUBLIC DISTRICT.

The 200' to the inch mounted map of Section 7, 46-29 was made by transferring the information from the 50' to the inch maps photographed down to 200' to the inch. This map was traced and photographed. The

Forty mounted maps of Sections 7 and 18, 46-29 were inked in and lettered. The elevations of bench marks established along the Michigamme river from the town of Republic to Lake Michigamme were recorded in the permanent record books.

AU TRAIN WATER POWER.

Maps were prepared showing outline of the storage basin, lands acquired and to be acquired, and the progress of the lumbering and clearing operations.

CARP RIVER WATER POWER.

A map and profile of a portion of the city of Negaunee were made showing the Partridge Brook project for the proposed diversion of this brook into the Carp river.

DEAD RIVER WATER POWER.

The section line between Sections 9 and 16 was run out for a half mile, beginning at the Southwest corner of Section 9 and running East to the South quarter corner. The random line which was run from the iron pin at the Southwest corner of Section 9 was offset only 2.25 from the South quarter corner and therefore only a slight correction was necessary to establish a true line across the falls themselves, which are situated only a short distance from the West line of Section 9. Three iron pins were put in on this true section line, one being placed on each bank and one on the island in the river. Elevations were carried from the bench mark previously established by the Lake Superior Iron Company and a cross-section made of the river on the section line. Elevations were also taken on the ledge above and below the dam and on the timber of the dam itself. The Dead river transmission line was staked out, beginning at the Meas-Carp high tension line in Section 32 and thence running in a Northerly direction to the proposed power station at the foot of the falls. This line was profiled by carrying elevations East from the Meas mine and thence North along the line, tying in at the dam site for the Carp river No.1 storage basin by 0.19. A preliminary survey for the pipe line was carried from a point East of the present dam to the power house site. The power house was staked out and a second survey made for the pipe line.

CITY OF ISHPEMING.

SECTION 2, 47-27.

Outcrops and changes in fences and buildings were surveyed and plotted. Tracings were then posted and photographed.

SECTION 3, 47-27.

Outcrops and changes in culture were mapped and plotted on the Forty maps and then traced and photographed.

SECTION 4, 47-27.

The outlines of the outcrops were surveyed and mapped.

SECTIONS 9 & 10, 47-27.

The new buildings and changes in the old ones were noted and the mounted maps brought up to date.

SECTION 11, 47-27.

The entire South half of this section was resurveyed. All of the old survey stations were replaced with iron pins. The outcrops on the North half of the section were surveyed and plotted 50' to the inch. The information secured on the South half of the section was only plotted 200' to the inch.

NORTH LAKE DISTRICT.

SECTION 5, 47-27.

The Forty contour maps were finished, traced and photographed for the 1914 annual report.

SECTION 6, 47-27.

The surveys on a portion of this section were described under the caption "Lloyd mine". In the mine location, the position of the houses moved from the Chase mine were staked out Southeast of the present location. The houses to be moved from the Angeline mine were also staked out.

CITY OF NEGAUNEE.

The city of Negaunee maps were carefully gone over and all changes in buildings, fences, railways, etc, surveyed in the major portion of the town. On the Jackson property, the outcrops, dikes, faults and contacts were mapped and certain areas contoured that had been previously omitted. The Section 12, 47-27 maps were finished, traced and photo-

graphed. The field work on this section was done during October and November 1914, but the notes were not plotted until the spring of 1915. A few additional notes were also taken on Sections 17 and 18, 47-26, near the Bellevue farm.

TILDEN DISTRICT.

SECTION 13, 47-27.

The Forty maps of the Southwest quarter of this section were completed as regards topography, but some geological data still remains to be done.

SECTION 14, 47-27.

Lake Ogden lies partly in this section and partly in Section 13. The division of the mineral rights under this lake was finally settled by using the central thread method.

SECTION 22, 47-27.

Elevations were carried along the East-West 192 and 200 coordinate lines and contours and geology surveyed near the South line of the section.

SECTION 23, 47-27.

Elevations were taken on the stations on the East-West 192 and 200 lines and the topography, culture and geology mapped from the South line of the section to the diorite hills along the North limit of the iron formation.

SECTION 24, 47-27.

This section is traversed by coordinate lines running every 800'. Levels were carried to all stations on these lines and the area within the Cliffs field in the Southwest quarter of the section was contoured.

SECTION 26, 47-27.

The 232 East-West line was run from station 232 x 104 to 232 x 152. Levels were carried along the 216, 224 and 232 East-West lines and topography and geology mapped on the area lying between the South limit of the iron formation and the North line of this section.

SECTION 27. 47-27.

The contours and geology were mapped along the East-West 216 and 208 lines and bench marks for levels established on the 216 line.

SPECIAL WORK.

ABSTRACT MAPS.

The Maas-Negaunee abstract maps were gone over and the new transfers posted. The Race Track boundaries were calculated and submitted to the Oliver Iron Mining Company for approval. Mr. Brewer was assisted by two members of the Engineering department during the months of March and April on various abstract maps. All the maps turned out by his department were photographed and printed.

CARBON REPORTS.

A monthly report is turned in to the Auditing department and special reports made at various times. An inventory of the diamond drill equipment was made in the fall of the year. Tables were prepared comparing the results obtained by the Cleveland-Cliffs Iron Company and outside drill contractors in the Ishpeming, North Lake and Gwinn districts. Comparisons were made as to the difference in cost when using large or small bits in the same kind of ground. The underground drilling was also contrasted with the surface drilling.

MINERAL RIGHTS.

Maps of Lake Ogden and Smith's Bay were prepared showing the mineral rights of the abutting property owners.

ESTIMATES.

Coal pile estimates are made yearly on about May 1st. Stockpile estimates were also made at the Salisbury and Negaunee mines. The yearly ore estimate for the State Tax Commission were made by the engineers in conjunction with the superintendents.

STATE TAX COMMISSION MAPS.

Blue print copies of the maps of all the mines operated during the previous year were furnished the Commission. On them were shown the

boundaries of the ore by colors, the dikes, the character of the foot and hanging, and the ore area upon which the estimates were based.

PERMANENT SURVEY STATIONS.

In order to insure the permanency of the survey stations which cost the department so much time and money, it was decided to concrete as many iron pins as possible. The old pins were replaced by new ones 30" long,  $1\frac{1}{4}$ " in diameter and pierced with two half inch holes for crossbars placed at right angles to each other and near the bottom end of the pin. An excavation about 18" in diameter and 30" deep was made around each pin as a center and filled with concrete. The replacing of the old pins with new ones was begun at the Athens property. The Negaunee and Maas mines were taken next and the city of Negaunee gone over in turn. Sections 1, 2, 3, 10 and 11, 47-27 were then gone over one by one. All of the survey stations on these sections have not been replaced with concreted pins, but the object was to get a few in each area permanently fixed because it will take a crew three or four years to change all the pins. So far about 190 pins have been imbedded in concrete.



REPORT OF THE MINE ABSTRACT DEPARTMENT FOR YEAR 1915, BY CARL BREWER.

The following have been employed in this department during the year:

Carl Brewer has been employed regularly throughout the year. The majority of his time was occupied in completing the abstracts and maps of the Company's lands. The current work of the office occupied about 30% of the time and is taken up in detail under the various subjects. He spent 45 days in Marquette at the Register of Deeds office on abstract work. Visits to the Land department were made to complete information for the files and abstracts. He was absent 38 days on vacations.

Mrs. Dunn has copied a few abstracts and several documents during the year. She listed and indexed all the documents filed under "Deeds during May and June.

Miss Powers, during Mrs. Dunn's absence, July 12th to 31st, copied 24 abstracts.

William Kellow, of the Sociological department, has been occupied for about 26 days during October, November and December copying all the rest of the abstracts and documents necessary.

Messrs. Hayden, Derby and Osborne, of the Engineering department, have spent more or less time on abstracts maps during the year.

ABSTRACTS.

The system of filing the Abstracts of Title to Company lands, as mentioned in the Annual Report for 1914, was the grouping of the lands under three divisions as follows:

1. Lands held by the Cleveland-Cliffs Iron Company on the iron bearing formation.
2. Lands held by affiliated companies on the iron bearing formation.
3. Lands for water power.

The abstracts under Nos.1 and 2 were to be filed under the names of the various companies. As the work progressed, it was decided, in order to prevent duplication, to include all abstracts coming under these two divisions under the title "Cleveland-Cliffs Iron Company Abstracts", the two abstract books already completed, namely, Maas-Negaunee Abstracts and Athens Mining Company Abstracts, to be kept separate. The system as finally adopted divides the abstracts as follows:

1. Cleveland-Cliffs Iron Company Abstracts.
2. Maas-Negaunee Abstracts.
3. Athens Mining Company Abstracts.
4. Hydro-Electric Abstracts.

What has been done during the year on these divisions will be taken up under the headings.

In Vault No.1 in two document files are Abstract of Titles of various lands. Some refer to lands formerly held under option, some to lands owned by the Company not on the iron formation, and some are Company lands which should be typewritten and filed under Hydro-Electric Abstracts. A list of these abstracts, according to township and range, is filed in Cleveland-Cliffs Iron Company Abstracts and Hydro-Electric Abstracts. The abstracts in these files are numbered 1 to 159 inclusive.

The original notes of all abstracts which have been copied and filed under the above divisions are filed in letter files in Vault No.2. Also all duplicate copies of the abstracts in the document files are in these letter files.

1. CLEVELAND-CLIFFS IRON COMPANY ABSTRACTS.

Abstracts of Title of all the Company lands on the iron formation have been completed and with the necessary maps have been filed in this book. These cover all the lands it was decided should be included among the mineral lands. Many of the abstracts were made by Mr. Primeau and only needed to be brought up to date. Some of those left by him had to be entirely re-

written, but most of the abstracts had to be written completely. In the Annual Report for 1914, certain lands in the Gwinn district were listed as having been completed and filed. Later it was found that some of the abstracts were incomplete and were rewritten. Clouds were found on several descriptions and were reported to the Legal department. Several other parcels had clouds upon the title but they have all been cleared up. Mr. Brewer's letter to Mr. Jopling of September 29th, 1915, states all the clouds upon title that exist on Company lands included in this book. Two copies of this book are handed you herewith, one for the Cleveland office and one for the Land department. A third copy is filed in this office.

The lands covered by this book are listed below, except those purchased from the Republic Iron Company which were listed in the 1914 Annual Report:

LIST OF ABSTRACTS COMPLETED DURING 1915.

TOWN.	RANGE.	SECTION.	DESCRIPTION.
44	25	2	NW $\frac{1}{4}$ of NE $\frac{1}{4}$ .
45	25	16	E $\frac{1}{2}$ and E $\frac{1}{2}$ of W $\frac{1}{2}$ .
		18	SE $\frac{1}{4}$ .
		19	NE $\frac{1}{4}$ of NE $\frac{1}{4}$ .
		20	Lots 1, 2, 3, 4, 5 and 6, W $\frac{1}{2}$ , W $\frac{1}{2}$ of SE $\frac{1}{4}$ and SE $\frac{1}{4}$ of SE $\frac{1}{4}$ .
		21	NW $\frac{1}{4}$ of NE $\frac{1}{4}$ , S $\frac{1}{2}$ of NE $\frac{1}{4}$ , NE $\frac{1}{4}$ of NW $\frac{1}{4}$ , S $\frac{1}{2}$ of NW $\frac{1}{4}$ , NE $\frac{1}{4}$ of SW $\frac{1}{4}$ , Lots 1 and 2 and SE $\frac{1}{4}$ .
		22	S $\frac{1}{2}$ of N $\frac{1}{2}$ .
		26	SW $\frac{1}{4}$ of SW $\frac{1}{4}$ .
		27	SW $\frac{1}{4}$ of NE $\frac{1}{4}$ , S $\frac{1}{2}$ of NW $\frac{1}{4}$ , SW $\frac{1}{4}$ , W $\frac{1}{2}$ of SE $\frac{1}{4}$ and SE $\frac{1}{4}$ of SE $\frac{1}{4}$ .
		28	W $\frac{1}{2}$ of NE $\frac{1}{4}$ , SE $\frac{1}{4}$ of NE $\frac{1}{4}$ , NE $\frac{1}{4}$ of NW $\frac{1}{4}$ , Lots 1, 2, 3, 4 and 8 and NE $\frac{1}{4}$ of SE $\frac{1}{4}$ .
		29	N $\frac{1}{2}$ of NW $\frac{1}{4}$ .
		34	NE $\frac{1}{4}$ , NE $\frac{1}{4}$ of NW $\frac{1}{4}$ and NE $\frac{1}{4}$ of SE $\frac{1}{4}$ .
		35	N $\frac{1}{2}$ of NE $\frac{1}{4}$ , NW $\frac{1}{4}$ and SE $\frac{1}{4}$ .
45	26	36	Lots 1, 2, 3, 7, 8, 9 and 11.
		2	NE $\frac{1}{4}$ and N $\frac{1}{2}$ of NW $\frac{1}{4}$ .
		12	Lots 4, 5, 6, 9 and 12 and SE $\frac{1}{4}$ of NW $\frac{1}{4}$ .
46	26	20	SW $\frac{1}{4}$ of NE $\frac{1}{4}$ , SE $\frac{1}{4}$ of NW $\frac{1}{4}$ and NW $\frac{1}{4}$ of SE $\frac{1}{4}$ .
47	26	4	Entire.
		5	Entire, except part in Maas-Negaumee Abstracts.
		6	Entire, except parts in Maas-Negaumee Abstracts, Athens Mining Company Abstracts and parts owned by Breitung-Kaufman interests.
		7	NW $\frac{1}{4}$ of NW $\frac{1}{4}$ .
		9	N $\frac{1}{2}$ of NE $\frac{1}{4}$ and NW $\frac{1}{4}$ .
		12	Entire.
		13	E $\frac{1}{2}$ and SW $\frac{1}{4}$ .
		14	Entire.
		15	Entire.
		17	Entire.
		18	Entire.

TOWN.	RANGE.	SECTION.	DESCRIPTION.		
47	26	19	NE $\frac{1}{4}$ and SW $\frac{1}{4}$ .		
		21	Entire.		
		22	N $\frac{1}{2}$ and SE $\frac{1}{4}$ .		
		23	Entire.		
		24	Lots 1 and 3, W $\frac{1}{2}$ of SW $\frac{1}{4}$ , SE $\frac{1}{4}$ of SW $\frac{1}{4}$ and SE $\frac{1}{4}$ .		
		26	NW $\frac{1}{4}$ of NE $\frac{1}{4}$ and NE $\frac{1}{4}$ of NW $\frac{1}{4}$ .		
		27	E $\frac{1}{2}$ and NW $\frac{1}{4}$ .		
		28	N $\frac{1}{2}$ .		
		32	S $\frac{1}{2}$ .		
		33	E $\frac{1}{2}$ of NE $\frac{1}{4}$ , SW $\frac{1}{4}$ of NE $\frac{1}{4}$ and S $\frac{1}{2}$ .		
		34	NW $\frac{1}{4}$ .		
		48	26	31	W $\frac{1}{2}$ of E $\frac{1}{2}$ of SW $\frac{1}{4}$ and SW $\frac{1}{4}$ of SW $\frac{1}{4}$ .
		47	27	1	Entire.
				2	Entire.
				3	SW $\frac{1}{4}$ of NE $\frac{1}{4}$ , NW $\frac{1}{4}$ of NW $\frac{1}{4}$ , SE $\frac{1}{4}$ of NW $\frac{1}{4}$ , Lot 1, NE $\frac{1}{4}$ of SW $\frac{1}{4}$ and SE $\frac{1}{4}$ .
				4	Entire.
				5	S $\frac{1}{2}$ of N $\frac{1}{2}$ and S $\frac{1}{2}$ .
				6	Entire.
				7	Entire.
				8	N $\frac{1}{2}$ , N $\frac{1}{2}$ of S $\frac{1}{2}$ , SE $\frac{1}{4}$ of SW $\frac{1}{4}$ and SW $\frac{1}{4}$ of SE $\frac{1}{4}$ .
				9	N $\frac{1}{2}$ , NW $\frac{1}{4}$ of SW $\frac{1}{4}$ and SW $\frac{1}{4}$ of SE $\frac{1}{4}$ .
				10	E $\frac{1}{2}$ , N $\frac{1}{2}$ of NW $\frac{1}{4}$ and fractional parts.
				11	Entire.
				12	Entire.
				13	Entire.
				14	Lots 1, 2 and 3 and NE $\frac{1}{4}$ of NE $\frac{1}{4}$ .
				15	Entire.
				17	NW $\frac{1}{4}$ of NE $\frac{1}{4}$ , NW $\frac{1}{4}$ and N $\frac{1}{2}$ of SW $\frac{1}{4}$ .
				18	N $\frac{1}{2}$ and SW $\frac{1}{4}$ .
				19	E $\frac{1}{2}$ of SE $\frac{1}{4}$ .
				20	S $\frac{1}{2}$ of NW $\frac{1}{4}$ and SW $\frac{1}{4}$ .
				21	N $\frac{1}{2}$ of NW $\frac{1}{4}$ and E $\frac{1}{2}$ of E $\frac{1}{2}$ .
				22	N $\frac{1}{2}$ , N $\frac{1}{2}$ of SW $\frac{1}{4}$ , SE $\frac{1}{4}$ of SW $\frac{1}{4}$ and SE $\frac{1}{4}$ .
				23	Entire.
		24	Entire.		
		25	NW $\frac{1}{4}$ .		
		26	N $\frac{1}{2}$ .		
		27	NE $\frac{1}{4}$ and E $\frac{1}{2}$ of NW $\frac{1}{4}$ .		
47	28	1	Entire.		
		2	N $\frac{1}{2}$ , NE $\frac{1}{4}$ of SW $\frac{1}{4}$ and SE $\frac{1}{4}$ .		
		3	N $\frac{1}{2}$ .		
		12	NE $\frac{1}{4}$ and NW $\frac{1}{4}$ of SE $\frac{1}{4}$ .		
		13	E $\frac{1}{2}$ and SW $\frac{1}{4}$ .		
46	29	7	E $\frac{1}{2}$ of E $\frac{1}{2}$ , SW $\frac{1}{4}$ of SE $\frac{1}{4}$ , Lots 1, 2, 3, 4, 5, 6 and 8.		
		18	N $\frac{1}{2}$ of NE $\frac{1}{4}$ , SW $\frac{1}{4}$ of NE $\frac{1}{4}$ , NW $\frac{1}{4}$ of SW $\frac{1}{4}$ , Lots 1, 2, 6, 7 and 8.		
42	32	12	N $\frac{1}{2}$ of NE $\frac{1}{4}$ and NE $\frac{1}{4}$ of NW $\frac{1}{4}$ .		
43	34	21	SW $\frac{1}{4}$ .		
		22	S $\frac{1}{2}$ .		
43	35	24	E $\frac{1}{2}$ of NW $\frac{1}{4}$ .		
<u>Minnesota.</u>					
58	15	3	SW $\frac{1}{4}$ of NE $\frac{1}{4}$ , SE $\frac{1}{4}$ of NW $\frac{1}{4}$ , Lots 3 and 4.		
57	22	31	NE $\frac{1}{4}$ of NE $\frac{1}{4}$ .		
		32	NW $\frac{1}{4}$ of NW $\frac{1}{4}$ .		

These abstracts are numbered 160 to 399 inclusive.

## 2. MAAS-NEGAUNEE ABSTRACTS.

These abstracts have been written up to date. Abstracts of Title of the lots in the various additions to City of Negaunee have all been rewritten. The books sent to the Cleveland office and Land department in 1912 were recalled to have the additional information entered. Mr. Derby has revised the maps and also assisted in writing the abstracts.

## 3. ATHENS MINING COMPANY ABSTRACTS.

Nothing has been done on these abstracts during the year.

## 4. HYDRO-ELECTRIC ABSTRACTS.

Very little time was spent on these abstracts during 1915. The abstracts on large sheets which were left by Mr. Primeau were arranged in order of township and range to facilitate the reference. The uncopied abstracts are filed in Vault No.1 in the document files marked "Abstracts".

Several new abstracts on some of the lands included in this heading were made or bought during the year but they have not been copied into final form. No new maps have been made.

A definite plan for completing these abstracts has been decided upon and the work will be started immediately.

## CURRENT WORK.

The various documents, papers, information, etc, passing through the office are filed, recorded and listed in the various books in the office under the following divisions:

### REGISTER OF DOCUMENTS.

All documents affecting ownership of or rights upon lands, except surface leases, or conveyed to or by the Company, in which the Mining department is concerned, are listed in this book when they first come into the office. Most of these documents are sent for approval before being executed. After execution the copies are filed under their respective heads. Twenty seven documents were entered during 1915.

OPTIONS FOR MINING LEASES.

No options were acquired during the year.

The following options were relinquished:

No.99 Peterson Farm, covering  $W\frac{1}{2}$  of  $SW\frac{1}{4}$  and  $SE\frac{1}{4}$  of  $SW\frac{1}{4}$  of Section 2, 47-28; dated January 11, 1913, was assigned to George J. Maas on May 12, 1915.

No.105 Lake Superior Land Company, covering  $N\frac{1}{2}$  of  $S\frac{1}{2}$  of Section 3, 47-28; dated June 12, 1914, relinquished April 12, 1915.

There are three options in force. One is perpetual and the other two expire during 1916, viz:

No.98 Spies Mineral Land Company, covering  $N\frac{1}{2}$  of  $NE\frac{1}{4}$ ,  $SE\frac{1}{4}$  of  $NE\frac{1}{4}$ ,  $NW\frac{1}{4}$  of  $NW\frac{1}{4}$ ,  $NE\frac{1}{4}$  of  $SW\frac{1}{4}$  and  $SE\frac{1}{4}$  of Section 24, 43-35; expires July 1, 1916.

No.98A Spies Mineral Land Company, covering  $SW\frac{1}{4}$  of  $NE\frac{1}{4}$  of Section 24, 43-35; expires July 1, 1916.

The following table shows the number of options acquired and relinquished for the last five years:

	<u>1911.</u>	<u>1912.</u>	<u>1913.</u>	<u>1914.</u>	<u>1915.</u>	<u>1916.</u>
Options in force January 1st	21	8	14*	15	5*	3*
Options acquired during year	3	10	4	1	0	-
Options relinquished during year	16	5*	3*	12*	2	-

\* Indicates part of an option has expired.

MINING LEASES.

The following mining leases were acquired during 1915:

No.42 Crosby Washing Plant, covering surface on  $NE\frac{1}{4}$ ,  $S\frac{1}{2}$  of  $NW\frac{1}{4}$ ,  $N\frac{1}{2}$  of  $SE\frac{1}{4}$  of Section 30, 57-22, Minnesota, and a right of way across  $S\frac{1}{2}$  of  $SE\frac{1}{4}$  of Section 30, 57-22; dated March 18, 1915, expires January 25, 1957.

No.43 Meadow Mine, covering Lots 3 and 4 ( $N\frac{1}{2}$  of  $NW\frac{1}{4}$ ),  $SE\frac{1}{4}$  of  $NW\frac{1}{4}$  and mineral rights on  $SW\frac{1}{4}$  of  $NE\frac{1}{4}$  of Section 3, 58-15, Minnesota; dated December 9, 1915, expires December 9, 1964.

The following mining lease was surrendered:

No.32 Barnes Land Company, covering  $N\frac{1}{2}$  of Section 3, 47-28; dated December 1, 1910, was surrendered September 27, 1915.

The following table shows the leases acquired and surrendered during the last five years:

	<u>1911.</u>	<u>1912.</u>	<u>1913.</u>	<u>1914.</u>	<u>1915.</u>	<u>1916.</u>
Lease in force January 1st	34	34	34	32	33	34
Leases acquired during year	3	2	0	2	2	-
Leases surrendered during year	3	2	2	1	1	-

SYNOPSIS OF OPTIONS AND LEASES.

Synopses of the various options and leases are very convenient for quick reference. Early in the year, an attempt was made to revise the synopses of the leases and options then in force to satisfy the needs of both this office and the Cleveland office. Several weeks were occupied in writing about eighteen synopses. Further work was abandoned because of the uncertainty as to what was desired in Cleveland and the questionable value to this office of the revised synopses. It was finally decided to merely note the date, term, lands covered, date of expiration, parties interested and taxation data.

LAND OFFERS.

The record of land offers has been kept during the year in the same way as usual. A new binder for the township plats of "Land Offer Plat Book" was received during November and the former bulky book was divided into two parts. The small township plats have been continued and copies sent to the Cleveland office monthly.

During the fall, Mr. J. F. Hanst, of the Engineering department, went over all the land offers for the purpose of making a map, or a series of maps, showing the location of the land offers with respect to the districts in which the offers were located. The increase of work in the Engineering department put a stop to the work after the offers had been checked.

During the year, 80 land offers were received. No attempt has been made to ascertain the acreage of these lands.

OUTSIDE EXPLORATIONS.

The information in the Geological department filed under this head is entered in Land Offer Plat Book from time to time. Outside Exploration No. 880 is the latest information posted.

AUTHORIZATIONS.

Under this head is filed the authorizations for exploring, either under options or leases or on Company lands. These now have a separate

file. Formerly they only referred to options and were filed with the options. During 1915, there were five authorizations listed. The list of authorizations is filed in "Synopsis of Options and Leases" and the documents are filed under "Miscellaneous" in Vault No.1.

#### DEEDS.

All documents conveying ownership of lands, and a few miscellaneous leases surface, in which the Engineering department is interested, of which copies are held in this office, are filed under this head. In May 1915, a new "Register of Deeds" was secured and all the documents were entered and indexed by Mrs. Dunn. The old book was only an index. The new book gives details and is indexed under grantors and grantees. About 65 deeds were filed during the year.

#### PURCHASES.

Formerly deeds conveying lands to the Company were listed under "Purchases" and filed under "Deeds". During the year this book was discontinued and the papers filed as before. This book was unnecessary and was evidently originally started because the Land department has a similar division. The filing system of the two offices differ widely and the purchases filed in this office are not numerous enough to prevent ready reference when filed in "Deeds".

#### EASEMENTS.

Two transmission line easements were acquired during the year. They were in connection with the line to the "Hoist" on the Dead river. Two other easements are awaiting signature.

#### WATER RIGHTS.

Formerly these documents were filed under "Deeds". During the year all the documents in the office coming under this head were collected and a separate division was made for these rights. Two rights were received during the year.



SURFACE LEASES.

Leases covering the surface of Company lands are issued by both the Mining and Land departments. Copies of all these leases upon lands on the iron formation are sent to this office for approval. After being initialed they are returned. No copies of the leases are kept in this office. A list of those issued by the Land department is kept in book "Record of Sales". During the year 90 leases were entered; also many renewals.

APPLICATIONS FOR SALE.

Until this year, no record was kept in this office of the applications for sale of lands sent by the Land department for the approval of the Mining department. The applications are referred to this department to prevent sale of lands considered valuable for mining purposes. They are listed under this head in book "Record of Sales". Ten applications were received during the year.

SALES.

Previous to 1915, no record of land sales made by the Land department was kept in this office. Only sales of land in which the Mining department might be interested are sent to the department for approval. The description of land and reservations contained in the deed are carefully considered before the approval of the department is given. The documents are listed in book "Record of Sales" and consist of the following:

Farm land contracts	11
Quit claim deeds	4
Warranty deeds	12
Easement	<u>1</u>
Total	28.

TAX HISTORIES.

Four tax histories were placed in the files during the year.

LEGAL OPINIONS.

Legal opinions Nos.96 to 109 were entered on the records during the year.

The following list of documents is a summary of those placed on the records or in the files during 1915:

	Number <u>Received.</u>	Last File <u>Number.</u>
Land offers	80	940
Authorizations	5	110
Deeds	65	598
Easements	2	84
Water rights	2	7
Surface leases	90	934
Applications for sale	10	10
Sales	28	28
Tax histories	4	471
Legal opinions	13	109.

MISCELLANEOUS.

There are several other books in the department for recording information. These are mentioned below with a statement of what has been done during the year.

INDEX PLAT BOOK.

Herein are listed the numbers of all documents in the files on the lands affected. This book has been brought up to date. The following list shows what documents have been entered:

Abstracts	1 to 304 inclusive.
Tax histories	1 to 471
Mining options	1 to 107
Mining leases	1 to 43
Easements	1 to 84
Water rights	1 to 7
Deeds	1 to 598.

LAND OWNERSHIP PLAT BOOK.

Only such information as came into the office has been entered. No attempt has been made to bring it up to date.

U. S. GOVERNMENT PLAT BOOK.

No additional maps have been received during the year.

CITY & VILLAGE PLAT BOOK.

During the year, the Land department has been remaking the maps of the additions to various cities and villages to include the dedications, etc. These maps have been photographed. The former large book under this title has been discontinued and a smaller binder containing photograph prints has been substituted. This book contains maps of all the

plats of the following: Ishpeming, Negaunee, Munising, Republic and Gwinn, several plats of Marquette; also plats of Fayette and Michigamme.

LAND OFFER PLAT BOOK.

This was referred to under Land Offers. It has been kept up to date.

TAXES.

During the spring of 1915, the tax list of Company lands upon which the mining department pays the taxes was completely revised. A set of maps was made showing all the lands covered in the list. Several conferences were held with the Land and Legal departments during the revision and some of the descriptions on the tax rolls of Ishpeming, Negaunee and Marquette were corrected.

ITEMS BY J. E. JOPLING.

WATER POWER.

DEAD RIVER.

Surveys were made for the developments on the Dead river at what is known as the "Hoist Falls" in Section 9, 48-26 and a transmission line right of way was run due South to connect with the main line of towers.

MICHIGAMME RIVER.

Surveys were made at the Village of Michigamme to determine the area flooded by the outlet dam which had been repaired previously. Settlements were made with certain squatters who had built houses within the flowage lines.

PYRITES.

Instructions were received from the President under date of April 14th, 1915, that no further expenses were to be incurred in the search for pyrites.

During the year, the following five offers were received:

No.112, Mrs. Therese C. Schmidt, New York; lands at Graham, Ontario.

No.113, Mr. E. G. Collins, Duluth, Minnesota; property at Trinidad, Cuba.

No.114, Mr. J. A. Hughes, Haileybury, Ontario; two miles from T. & N. O. Railway; description not known.

No.115, Mr. Walpole Roland, Detroit, Michigan; property in Clay County, Alabama.

No.116, Mr. Charles G. Turner, Grand Rapids, Michigan; same as offer No.86,

LAKE SUPERIOR IRON COMPANY.

Captain J. H. Rough and I made an examination of the Hematite mine at the time it was closed last spring. At intervals throughout the year we went down the Section 16 shaft for the purpose of watching the developments on the 1080' level across the Cleveland-Cliffs Iron Company's line and on what is now known as the Holmes mine property. In December, we

made the annual inspection of the Section 16 mine and reported the effect of the caving.

REGENT IRON COMPANY.

Captain Rough and I made our annual inspection of the Prince of Wales mine, which is the only one of the Regent Group now being worked.

ANGELINE MINE.

Previous to the purchase on September 15th of the Angeline mine, which belonged to the Pittsburg & Lake Angeline Iron Company, Captain Rough and I made an examination and report. Subsequent to the purchase, we again visited the mine workings and gave our recommendations for development.

KENNEDY MINE.

On November 26th and 27th, Mr. White and I examined the Kennedy mine on the Cuyuna Range in order to report on this Company's interests.

MEADOW MINE.

On December 6th, Messrs. Belden, Barber and I were in Duluth making arrangements for the leasing of the Meadow mine. From the 16th to the 18th, Captain Rough and I were on the Mesabi Range for the purpose of inspecting the Meadow mine at Aurora.

THE CLEVELAND CLIFFS IRON COMPANY.

REPORT OF THE CHIEF GEOLOGIST FOR YEAR ENDING DECEMBER 31ST, 1915.

STAFF.

The staff of the Geological department during 1915 is given in Table I. Mr. F. G. Rockwell gave one half of his time to the Geological department in January and after that gave all his time to the Engineering department. Beginning February 1st, Mr. M. F. LaCroix was transferred from the Engineering to the Geological department.

TABLE I.

MEN ON PERMANENT STAFF OF GEOLOGICAL DEPARTMENT IN 1915.

<u>NAME.</u>	<u>OCCUPATION.</u>	<u>LENGTH OF SERVICE.</u>	<u>DAYS LOST.</u>		<u>% OF WORKING DAYS WORKED.</u>
			<u>SICKNESS.</u>	<u>VACATIONS.</u>	
F.G.Rockwell	Asst.Geologist in Ishpeming.	15 d.	0	0	100.00
M.F.LaCroix	Asst.Geologist in Ishpeming	11 mo.	9	36	85.85
G.Afuhs	Draftsman	1 yr.	0	21	92.42
E.Allen	Collecting core, testing drill holes,labeling core,visiting explorations of other companies, etc.	1 yr.	8	2	96.39
Total		2 yr.11 mo.15 d.	8 d.	59 d.	91.82

NOTE: 277 days of eight hours worked, 52 Sundays, 10 holidays, 52 Saturday afternoons.

Table II shows days lost by men working permanently for the department during the last four years, with the names arranged in order of the percentage of time worked:

TABLE II.

TIME WORKED 1912 TO 1915 INCLUSIVE.

NAME.	LENGTH OF SERVICE.	DAYS LOST.			AVERAGE PER YEAR.	DAYS WORKED.	% OF WORKING DAYS WORKED.
		SICKNESS.	VACATIONS.	TOTAL.			
E.A.Allen	4 years	8	19	27	6.75	1077½	97.56
Harry Bennett	1 yr.4 mo.	1	8½	9½	7.1	360	97.43
Gustaf Afuhs	4 years	7	25½	32½	8.12	1072	97.06
G.E.Burton	2 yr.9 mo.20 d.	0	23	23	8.2	751½	97.03
R.R.Freeman, Jr.	2 yr.9 mo.15 d.	2	32½	34½	12.4	736½	95.52
F.G.Rockwell	3 yr.15 d.	4½	44	48½	15.93	790	94.22
M.F.LaCroix	(3 yr.9 mo.9 d.	14½	90¾	105¼	27.90	936¾	89.90
leave of absence	( 2 mo.22 d.			(62½)			

NOTE: F.G.Rockwell's time includes time worked for Engineering department in 1914.

M.F.LaCroix's " " " " " " " " in 1912-15 inclusive.

No men were engaged temporarily on geological surveys during 1915, since no surveys of this kind were made, except the work in the Ishpeming and Negaunee districts in connection with the topographic mapping by the Engineering department.

DIVISION OF WORK AMONG THE MEMBERS OF THE DEPARTMENT.

H. L. Smyth. The work of the Geological department continued under the direction of Mr.H.L.Smyth, Consulting Geologist for the Company.

E. E. White. My work during the year has consisted chiefly of general oversight of the work of the department, which has included diamond drilling explorations in the Negaunee, Ishpeming, North Lake and Iron River districts and in the Cliffs Shaft, Section 16, Morris, Lloyd, Dexter, Republic and Gwinn mines; retesting Breitung-Hematite hole K close to the Athens property; underground geological surveys in the Cliffs Shaft, Salisbury, Lake, Lloyd, Morris, Chase, Maas, Negaunee, Stephenson and Gwinn mines; surface geological work in the Ishpeming-Negaunee district, and visiting and reporting on the explorations of other companies on the Lake

Superior iron ranges. In June, I assisted in obtaining reductions on the valuations of our mines by the State Tax Commission and attended the Hearing at Crystal Falls for that purpose. In August, I made a trip to Missouri to examine a manganese property which was offered this Company. In November, I accompanied Mr. Jopling in an examination of the Kennedy mine on the Guyana Range in connection with a possible exchange of interests in the Kennedy and Meacham mines. I made several examinations of lands offered in Marquette County during the year and also examined certain Company lands to determine whether it was advisable to sell the surface. During the summer and fall, I spent as much time as possible in the field tracing the faults in the Ishpeming-Negaunee district and working up the geology of the Lake Angeline basin, preparatory to diamond drilling. During the early part of the year, I spent considerable time underground on regular monthly geological surveys of the mines, but during the latter part of the year have been too busy with diamond drilling and other matters to spend much time underground. I also prepared a complete report on the history and exploration of the Athens property with a set of maps and cross-sections showing all the Athens, Lucky Star and Breitung-Hematite drilling plotted according to tests of direction in the drill holes. I was in Chicago on personal business for five days early in November but took no other vacation.

F. G. Rockwell. During January, 1915, Mr. Rockwell spent about one half of his time assisting with the underground geological surveys and routine work in the Geological department. At the end of the month, it became advisable to transfer him back to the Engineering department.

M. F. LaCroix. Mr. LaCroix was transferred from the Engineering to the Geological department on February 1, 1915, and worked regularly for this department the remainder of the year. He has done most of the



underground geological work, with the exception of the Cliffs Shaft mine. He has kept the geological maps up to date and has done considerable work on the cross-sections in the Lake, Lloyd, Morris, Maas, Negaunee, Stephenson and Gwinn mines. He has also assisted in the routine work of the Geological department, making and checking sections of drilling, monthly reports, ore estimates, geological maps, etc. During the summer and fall, Mr. LaCroix spent considerable time on geological field work in the vicinity of Ishpeming and Negaunee in connection with the topographic surveys of the Engineering department. Mr. LaCroix took a month's vacation in May and June and also three weeks vacation at Christmas, being delayed in his return to the office by sickness. He also took several days and half days during the year, so that as shown by Table I his percentage of days worked is rather low.

Gustaf Afuhs. Mr. Afuhs continued with us as draftsman during the year and in addition to his regular work of preparing cross-sections of drilling, monthly reports, geological maps, etc, has at times helped in collecting and labeling core during the absence of Ernest Allen. Mr. Afuhs took a four weeks vacation in February and March. This was the first vacation of more than a few days which he has had since he came with the Company in December 1910.

Ernest A. Allen. Mr. Allen has spent most of his time during the yearx collecting core from the various explorations at North Lake, Angeline, Junction Forty, etc; testing drill holes at these explorations, and labeling and filing core and sludge in the core room. He has visited the explorations of other companies on the Michigan iron ranges from time to time, but very little drilling was done by other companies in 1915. Mr. Allen took only a few days vacation in 1915 but lost several days on account of sickness.

### SURFACE GEOLOGICAL SURVEYS.

The only surface geological work done during the year was the work by Mr. LaCroix in the vicinity of Ishpeming and Negaunee. He did this work in connection with the topographic mapping of the Engineering department and we found it best to have him do the field work at the same time the engineers did theirs. In this way the outcrops are located more accurately. The cost of the geological part of this work was included in the general expense of the Geological department.

In the report of the Geological department for 1914, a statement was made of the territory covered by our geological maps on the 50' scale. In 1915, the geological work was completed and plotted on a 50' scale on the  $W\frac{1}{2}$  of Section 4, the  $S\frac{1}{2}$  of the  $N\frac{1}{2}$  and the  $N\frac{1}{2}$  of the  $S\frac{1}{2}$  of Section 5 and the  $N\frac{1}{2}$  of Section 9, all in 47-27. The field work was also completed but the geological maps had not been plotted at the end of the year of the  $N\frac{1}{2}$  of Section 12, the  $S\frac{1}{2}$  of the  $S\frac{1}{2}$  of Section 22, the  $S\frac{1}{2}$  of Section 23, the  $SW\frac{1}{4}$  of the  $SW\frac{1}{4}$  of Section 24, the  $NW\frac{1}{4}$  of the  $NW\frac{1}{4}$  of Section 25, the  $N\frac{1}{2}$  of Section 26 and the  $N\frac{1}{2}$  of the  $N\frac{1}{2}$  of Section 27, all in 47-27. A considerable area has also been mapped by the engineers, upon which no geological work has yet been done.

### UNDERGROUND GEOLOGICAL WORK.

The underground geological maps of the Salisbury, Lake, Lloyd, Morris, Maas, Negaunee, Stephenson and Gwinn mines were kept up to date by members of this department and the geological maps of the Cliffs Shaft mine were posted by Mr. Hanst, of the Engineering department, assisted by Messrs. H. O. Moulton and M. F. LaCroix. Mr. LaCroix kept the geological sections up to date as well as he could in the time available.

### CLIFFS SHAFT MINE.

Mr. J. F. Hanst, assisted by Mr. H. O. Moulton, who now has charge of the surveying in the Cliffs Shaft mine, has kept the geological work pretty well up to date. Since Mr. Hanst has had charge of the engineering at the Athens mine, he has not been able to post the

geology at the Cliffs Shaft mine so often, but since the workings in the hard ore mines stay open, I believe that it will still be satisfactory to have him continue with the geology. The geology in this mine is so complex that it will take another man a long time to become familiar enough with it to do accurate work.

LAKE MINE.

Mr. LaCroix kept the geological maps in this mine up to date and brought the geological sections up to date in December.

SALISBURY MINE.

During the greater part of the year, nothing was done at the Salisbury mine, except driving towards the ore which was found by drilling further South in 1914. This ore was encountered late in the year and it is now being developed. I mapped the geology in this drift but we have done little with the geology of the ore body as yet. No work was done in the old mine until late in the year and no geological work in the old mine was done in 1915.

MORRIS-LLOYD MINE.

These mines have been worked continuously during the year, including the new ore body at the East end of the Lloyd. Mr. Rockwell posted the geology in January in connection with his monthly engineering survey and since then Mr. LaCroix has posted the geology regularly every month. The cross-sections at the East end of the Lloyd have been kept pretty well up to date but the other sections should have considerable work done upon them. A duplicate set of geological maps and cross-sections has been made of the new ore body at the East end of the Lloyd and these are given to the mine superintendent and posted as occasion requires.

CHASE MINE.

The Chase mine was so nearly worked out at the beginning of the year that no geological work has been done since January 1st. The mine was abandoned early in the year.

MAAS MINE.

The Maas mine was closed down until September 1st. Mr. LaCroix has posted the geology since the mine was opened.

NEGAUNEE MINE.

This mine was worked continuously in 1915 and Mr. LaCroix and myself have kept the geological maps and cross-sections up to date.

STEPHENSON MINE.

This mine was worked continuously in 1915 and Mr. LaCroix and myself have kept the geological maps and sections up to date.

GWINN MINE.

This mine was worked continuously in 1915 and Mr. LaCroix and myself kept the maps and sections up to date. A duplicate set of geological maps and cross-sections was made and this set is kept at Princeton. It is returned to this office and posted each month.

DEXTER MINE.

The drilling in the Dexter mine was completed early in 1915 and it was not necessary to do any further geological work.

EXPLORATIONS.

During the year, we continued diamond drilling explorations in the Ishpeming, Negaunee, North Lake and Iron River districts and in the Cliffs Shaft, Morris-Lloyd, Chase and Dexter mines. Drilling was also begun at the Republic, Gwinn and Section 16 mines.

No new options for exploration were executed in 1915, nor were any leases taken on lands which we have recently been exploring. The Lake Superior Land Company option, on the  $N\frac{1}{2}$  of the  $S\frac{1}{2}$  of Section 3, 47-28 in the North Lake district, was relinquished on April 12th, and the Peterson option, on the  $W\frac{1}{2}$  of the  $SW\frac{1}{4}$  and the  $SE\frac{1}{4}$  of the  $SW\frac{1}{4}$  of Section 2, 47-28, was assigned to George J. Maas on May 12th. The Kimberly option, on the  $E\frac{1}{2}$  of the  $NE\frac{1}{4}$  of Section 1, 42-33, expired January 1st, 1915. Lease No. 32, on the Barnes lands, the  $N\frac{1}{2}$  of Section 3, 47-28, was surrendered on September 27th, 1915.

Instead of giving the footage drilled and cost of drilling in the description of each exploration this year, I give them in Table III, which is more complete than the figures given in previous years. It will be noted that the average cost of surface drilling was \$2.90 per foot, excluding certain items which would have to be added to the price of contract drilling. The average price of underground drilling in the same way was \$1.94 per foot.

MARQUETTE RANGE.

ISHPEMING DISTRICT.

SECTION 9, 47-27, HOLMES MINE SURFACE.

In November, 1915, work was started with two drills to find a safe location for a shaft on the Junction Forty. One drill was started close to the North line in the center of the forty, where the shaft was probably to be located, to determine the depth of ledge and be sure that there was no ore at that point. The second drill was started further South to locate the fault which was known to cross the forty, as we wished to keep the shaft well to the North of the fault. Three holes were drilled along the North line and two holes were completed standpiping for the fault. Two more holes were standpiping for the fault at the end of the year but had not at that time determined its position. The drilling served to show, however, that the fault was further North than we had supposed and it was determined to locate the shaft as close as possible to the North line and as far East as could

TABLE III.

## SUMMARY OF DIAMOND DRILLING FOR 1915.

PROPERTY.	SECTION.	STANDPIPING. FT.	DIAMOND DRILLING.FT.	TOTAL.			LEAN ORE. FT.	TOTAL COST. A.	COST PER FT.A.	COST. B.	COST PER FT.B.
				FT.	ORE.FT.	ORE.FT.					
<u>Surface Drilling.</u>											
Jackson	1,47-27		1521	1521	59	48	55	\$8020.73	\$5.27	\$6542.49	\$4.30
Lloyd mine	6, "	427	648	1075	458	57	38	2066.91	1.93	2046.84	1.90
Holmes mine	9, "	282	150	432	0	0	0	1560.99	3.61	1452.57	3.36
Angeline mine	14, "	41	25	66	0	0	0	) 3025.50	2.28	2967.53	2.23
Angeline mine	15, "	595	670	1265	205	0	3				
Barnes & Hecker	2,47-28	125	1265	1390	10	35	125	4504.44	3.24	4034.81	2.91
Moore & Chase	2, "	1739	770	2509	0	0	0	8732.27	3.48	7591.71	3.03
Peterson option	2, "	0	228	228	0	0	0	629.07	2.76	558.50	2.45
Lake Superior Land Co.option	2, "	0	228	228	0	0	0	628.08	2.76	558.47	2.45
Chase mine	3, "	542	300	842	0	0	0	3224.96	3.83	3136.75	3.72
Barnes-Dexter	3, "	708	1357	2065	29	41.5	13	7581.60	3.67	5750.66	2.79
Spies lease	24,43-35	744	378	1122	171.5	20	51	2324.86	2.07	2257.75	2.01
Total surface drilling		5203	7540	12743	932.5	201.5	285	\$42299.41	\$3.32	\$36898.08	\$2.90
<u>Underground Drilling.</u>											
Gwinn mine	28,45-25	0	4382	4382	294	108	100	8338.23	1.90	8213.04	1.87
Morris-Lloyd mine	(6,47-27)	0									
	(1,47-28)	0	405	405	94	25	32	499.28	1.23	497.08	1.23
Section 16 mine (Holmes)	9,47-27	0	1412	1412	654	72	24	3691.93	2.61	2463.03	1.75
Cliffs Shaft mine	(9, "										
	(10, "	0	2961	2961	415	285	150	5253.65	1.77	5096.17	1.72
Dexter mine	3,47-28	0	65	65	0	0	0	405.88	6.25	405.58	6.23
Chase mine	3, "	0	266	266	0	0	18	669.49	2.52	662.27	2.49
Republic mine	7,46-29	0	2155	2155	39.6	11.8	0	5232.40	2.43	5232.40	2.43
Total underground drilling			11646	11646	1496.6	501.8	324	\$24090.86	\$2.07	\$22569.57	\$1.94
Total drilling		5203	19186	24389	2429.1	703.3	609	\$66390.27	\$2.72	\$59467.65	\$2.44
Testing Breitung drill holes 6,47-26								183.70			
Grand total cost of exploring								\$66573.97			

NOTE: Cost A includes taxes, office expense, engineering, analysis, and legal, (where included on monthly statements).  
 Cost B excludes " " " " " " (to compare with contract prices).  
 Cost B also excludes cost of starting branch hole at Jackson, cost of test pitting at Angeline, and cost of drifting in Section 16 mine (all included in Cost A).  
 All Cleveland-Cliffs drilling except Spies lease (Cole & McDonald by contract) and Section 16 mine underground (Lake Superior Iron Company at cost).

be done considering railroad connections. All except the two Northeastern holes encountered slate and it is possible that there may be ore beneath the slate. The two Northeastern holes encountered greenstone at shallow depth and showed that that vicinity would be a favorable location for the shaft.

SECTION 9, 47-27, SECTION 16 MINE UNDERGROUND.(TESTING HOLMES MINE).

In June, 1915, the Lake Superior Iron Company started a drill for us in the Section 16 mine on the 955' level, at the same time starting a crosscut to establish a drill station in the hanging on the 1080' level. The hole on the 955' level was drilled from the Lake Superior workings Northwest under the Junction Forty to determine the extent of the ore body. It was successful in finding more ore than we had expected, both hard and soft, and was stopped in hard ore at 247' because the drilling was expensive and we seemed to be drilling parallel to the strike of the ore.

The drill was next moved to the drill station in the hanging on the 1080' level and three holes were drilled, one approximately East, one dipping Northeast and one approximately South to determine the thickness of the ore body beneath the level. All three holes were successful in finding a considerable thickness of ore. The hard ore was much thicker than the average in the Section 16 mine, but the Hematite ore was thinner and considerably mixed with paintrock, except in hole No.4. Altogether these four holes exceeded our expectations and showed that there is a very considerable ore body on the Junction Forty on the 955' level and extending down 200' or more beneath the 1080' level.

One more hole was drilled horizontally Northwest from the extremity of the main drift which was being driven on the Junction Forty by the Lake Superior Iron Company. This hole was started to determine the position of the main fault, to determine the thickness of ore North of the drift, and it was also intended to drill the hole North to the location of our Holmes shaft and be sure that there was no ore beneath the shaft. This hole showed a good thickness of rich hard ore just

North of the drift and also found a body of hematite ore about 100' North of the drift on the South side of the main fault. We do not know that this ore connects up with the other ore body and it may mean another lens of considerable extent. The fault and greenstone contact were encountered North of this ore and the hole was drilling in greenstone at the end of the year.

This work was done at cost for us by the Lake Superior Iron Company and the cost compared very favorably with work done by our own drills.

SECTIONS 9 & 10, 47-27, CLIFFS SHAFT MINE.

Drilling at the Cliffs Shaft mine continued under the charge of Superintendent Eaton with the advice of Mr. Smyth. Drilling was discontinued from June 2nd to July 9th, since the drill was needed in the Lloyd mine. Drilling was also discontinued on December 20th and the outfit was moved to the 4th level Morris mine.

Twenty one holes were drilled during the year. The locations and reasons of drilling these holes have been given in full in my monthly reports and I presume Mr. Eaton will mention them in his annual report.

SECTION 14, 47-27, ANGELINE EXPLORATION.

In the course of testing the extreme East end of the Angeline basin, one hole was drilled just across the line on Section 14. It encountered the massive crystalline dike which outcrops several hundred feet further East.

SECTION 15, 47-27, ANGELINE EXPLORATION.

In November, 1915, we started two drills on the recently purchased Angeline property. A geological reconnaissance showed that there were several possibilities for finding ore and one drill was started among the houses in "Happy Hollow" high up on the South side of the basin and another in the swamp a short distance East of the old East end pit. The first hole drilled in "Happy Hollow" found 17' of ore under 24' of surface and this was followed up by five other holes, three of which encountered ore. One of these holes was still drill-



ing at the end of the year. Our estimate of this ore body for the State Tax Commission as of January 1st, 1916, was 34,600 tons, averaging 59.24% iron natural and .039% phosphorus. Since this ore undoubtedly connects up with the small ore body mined by Jones & Laughlin a short distance further Northwest, it is very likely that a somewhat larger tonnage will be found.

The first hole in the swamp East of the open pit encountered jasper with a seam of ore and the drill was then moved 100' South. This hole encountered 31' of high grade Bessemer ore and was followed up by six other holes in the immediate vicinity, of which three encountered the same high grade ore. Our estimate for the Tax Commission as of January 1st, 1916, was 36,600 tons, averaging 61.18% iron natural and .028% phosphorus. This estimate was made by taking an area 25' outside of drill holes in ore and multiplying by the average thickness of ore in the drill holes. It is not probable that this tonnage will be greatly exceeded, although at the end of the year the limits of the ore had not been determined.

A third drill was started early in December at the extreme East end of the property to test more thoroughly the small trough of iron formation East of the railroad grade from which a small amount of ore had been mined and which had been partially explored by the union shaft sunk by the Pittsburg & Lake Angeline Company and the Cleveland Iron Mining Company. This hole encountered a little jasper but showed that the trough was smaller than we had supposed. This drill was then moved a little further East to Section 14 but had not quite completed testing this vicinity at the end of the year.

#### NORTH LAKE DISTRICT.

#### SECTION 6, 47-27, LLOYD MINE SURFACE.

In July, 1915, drilling was started at the extreme East end of the East Lloyd ore body to determine the amount of ore which could be stripped and mined by open pit methods; also to determine the amount

of stripping necessary. In August, a second drill was started to hurry up the work and the drilling was completed early in September. In all, 13 holes were drilled, of which seven encountered good ore. They showed that the ore area which could be stripped was somewhat larger than we had figured and the work of stripping was started at once.

SECTION 6, 47-27)

SECTION 1, 47-28) MORRIS-LLOYD MINE.

In June, the underground drill was borrowed from the Cliffs Shaft mine and four holes were drilled in the Lloyd mine. The first three holes were drilled on the 1305' level of the timber shaft in the East Lloyd ore body. They were drilled to check up the ore found by vertical drilling from surface several years previous and were quite encouraging as they showed a considerable thickness of clean ore. The fourth hole was drilled on the 3rd level to look for a continuation to the West of the fault crotch between the slate footwall and the Westward extension of the main fault which bounds the old Lloyd ore body on the East. This hole was drilled 225' in the slate and it was then stopped as it was evident that the bottom of the crotch must be above the 3rd level at this point.

The drill was again being moved to the Morris mine at the end of December but drilling was not started until after the first of the year.

SECTION 2, 47-28, W $\frac{1}{2}$  of SW $\frac{1}{4}$  & SE $\frac{1}{4}$  of SW $\frac{1}{4}$ , PETERSON OPTION.

Very little drilling was done on this option during the year. Hole No.70 was completed, from 262' to 717', and drilling was then stopped. This hole encountered only lean jasper conglomerate and hard ore ~~jasper~~ beneath the slate and quartzite and there was no indication of any continuation in depth of the small amount of ore found in 1914 in holes Nos.59 and 65. It will be remembered that No.70 was drilled because No.66 had deflected so much to the West that it did not strike the hard ore horizon at the point intended. No.70 kept its direction as intended but found the same lean formation as No.66. The option was later relinquished.

SECTION 2, 47-28, N $\frac{1}{2}$ , BARNES & HECKER LEASE.

Work continued in 1915 to determine whether there was enough ore close to the West end of North Lake to warrant development. The two holes which were drilling at the beginning of the year were completed in January and February and the results were so discouraging that work was stopped. The six holes which we drilled in 1914 and 1915 showed conclusively that the ore which we encountered previously in holes Nos. 25, 48 and 51 must have been in bunches and did not lie in a continuous ore body.

In March, it was decided to do some more drilling to see if the ore encountered in the holes mentioned above did not run down into a larger ore body in depth. We knew that there was a fault running Northeast through North Lake and it was hoped that there might be a good ore body in the trough formed by this fault and the footwall slate. Holes drilled previously had been laid out with a view of following up the ore already discovered and had not been so placed as to prospect the crotch of the fault. A platform was accordingly built on the ice on North Lake and was supported by piles and guy ropes so that drilling could be continued during the summer. Hole No. 75 was started early in April to prospect the upper end of the trough. It found no ore at all and passed into the slate footwall at 660'. In accordance with our plan, we wished to drill two deep holes to test the fault crotch further West, but these could not be located accurately until the fault was more definitely located by standpiping on the Moore & Chase lease. This standpiping continued for the rest of the year but no more drilling was done on the Barnes & Hecker lease.

SECTION 2, 47-28, NE $\frac{1}{2}$  OF SW $\frac{1}{2}$ , MOORE & CHASE LEASE NO. 28.

Early in January when it became evident that the drilling for ore West of North Lake was going to prove unsuccessful, we started standpiping on the Moore & Chase lease to determine the position of the fault. We felt that if we could find the fault and determine

its dip, we would have a better chance of finding ore on the Barnes & Hecker lease, as these ore bodies in the North Lake district are governed largely by the big faults which displace the footwall and form a trough between the fault and the footwall slate. At first we thought we could locate the fault by finding the Westward continuation of the dike which lies in the fault zone at the East end of North Lake. Standpipes Nos.71, 72 and 73 were drilled with this in view without finding the dike. No.73 had a seam of dike, however, and it was thought that this hole might have been just on the edge of the dike. No.74 was therefore started South of No.73 and dipping North at an angle so as to cut the dike and determine its position and dip. This hole found no dike at all and as our standpipes, taken in connection with holes already drilled, made a complete cross-section, it was evident that the dike had pinched out and that there was no hope of locating the fault by this means.

It was next determined to try and locate the point where the fault crosses the quartzite-jasper contact further West and holes Nos. 76 to 81 inclusive were drilled with this in view. The first four holes were unsuccessful in locating the fault, although the material encountered indicated that the fault was probably located about as we expected. Hole No.80 finally struck the fault and as this hole passed from quartzite into soft ore jasper, it was proof that such a fault existed. No.81 was located at a short distance from No.80 and dipping under it so as to strike the fault at a lower horizon and determine its exact dip. This hole was standpiping in surface at the end of the year.

All of the drilling done on this lease during the year was for the purpose of locating the fault. Since the fault was finally located, it is probable that this considerable expense will be justified.

SECTION 3, 47-28, NE $\frac{1}{4}$ , CHASE MINE SURFACE.

A little more work was done nearly in 1915 to complete testing the hard ore contact across the NE $\frac{1}{4}$  of Section 3. Hole No.63, one of the holes to test the contact at intervals of 400', was completed in February and encountered only lean jasper conglomerate and hard ore jasper. Two other holes were drilled to try and find a continuation of the ore in No.61 but were unsuccessful. No.61 was the only hole which found any ore along the stretch of hard ore contact and we therefore decided that no further drilling was warranted.

SECTION 3, 47-28, NW $\frac{1}{4}$ , BARNES-DEXTER DRILLING ON BARNES LEASE.

It was decided to test the hard ore contact West of the Dexter mine before relinquishing the Barnes lease and a drill was started about a quarter of a mile West of the Dexter shaft in February. The second hole found the hard ore contact and a little second class ore and the third hole found 22' of first class ore and 11' of second class ore. These two holes were close together and we hoped that this ore might lead to a merchantable ore body. Two other holes were drilled close by, however, of which one was blank and the other only encountered 5' of ore and a little lean and second class ore. These holes showed that there could be no considerable extension to the ore found in the third hole, although there might be a slight extension of shallow ore to the East. It did not seem possible that there could be enough ore to mine and the drill was therefore moved West to test the hard ore contact across the rest of the lease. Two more holes were drilled but both were blank and drilling was stopped in July. This completed the drilling on the hard ore contact and the Barnes lease was relinquished.

SECTION 3, 47-28, N $\frac{1}{2}$  OF S $\frac{1}{2}$ , LAKE SUPERIOR LAND CO. OPTION.

Hole No.70, on the East line of this option, was completed in 1915. The conditions which led to the drilling of this hole and the results of this drilling were described under the heading "Peterson Option" Section 2, 47-28. No ore was encountered and the option was relinquished.

SECTION 3, 47-28, N $\frac{1}{2}$ , DEXTER MINE.

Hole No.8, which was drilling in quartzite at the beginning of the year, encountered hard ore jasper at 294' and was stopped at 319'. This hole was drilled vertically to test the hard ore contact beneath the quartzite, and as it encountered only lean hard ore jasper, the hole was stopped and it was decided to discontinue the Dexter mine exploration. The results of this drilling were considered more fully in the report of the Geological department for 1914.

SECTION 3, 47-28, NE $\frac{1}{2}$ , CHASE MINE.

In January, 1915, a drill was started in the Chase mine to make sure that there was no ore at a certain point on the 2nd level, preparatory to giving up the lease. Four short holes were drilled and the work was completed early in February.

NEGAUNEE DISTRICT.

SECTION 1, 47-27, JACKSON.

Drilling was continued in hole No.68 at the Jackson. The hole was 1167' at the beginning of the year and was continued without any trouble until ore was encountered at 2326'. Drilling was then stopped for over a month while we obtained special casing and while concrete foundations were being put in under the drill. We raised the drill about 6' so that we could allow the casing to work down with the bit by ~~its~~ its own weight. When drilling was started again, this plan worked very well and as the casing went down, new lengths of 5' each were coupled on. The drill being raised up 6' permitted the 5' lengths of casing to be put on with little trouble and at all times kept the top of the casing above the collar of the hole. At the same time, tests were made on the drill water for sulphur.

When we struck the ore at 2326', we had every reason to believe that we had struck the main ore body and that we would have at least 100' of ore. To our disappointment, the ore only went to 2345' and the hole then passed into lean ore and jasper. What ore there was was very good, averaging 61.70% iron and .037% phosphorus.

The hole was then continued with no trouble and another bunch of ore was encountered from 2510' to 2530' and another from 2605' to 2659'. The last bunch of ore was thickest. Thirty one feet of this averaged 60.87% iron and .141 phosphorus and the 23' above this averaged 52.42% iron and .180% phosphorus. Dike was encountered below this bunch of ore at 2659' and slate at 2670'. These small bunches of ore have little value at such great depth and the hole was a great disappointment.

No appreciable amount of sulphur was found by tests on the drill water in any of these bunches of ore.

Drilling was finished at 2688' on October 1st and work was stopped for a few days until it was decided what to do. It was finally determined to wedge off the hole to the South to see if we could not strike the main ore body. There were several considerations which led us to believe that this hole might have struck a fault and did not get down to the main footwall. We at first attempted to plug the hole and put in a wedge at a depth of 2330', but the hole caved so badly that this was impossible. This attempt took from the middle of October to the middle of December. It was then determined to put the wedge at a depth of 1570' in the big dike at that point. There should be no difficulty in wedging off the hole in this dike, although it will entail considerably more drilling after the hole is wedged off before reaching the ore. The operation of plugging the hole and cementing, preparatory to placing a wedge at this depth, was proceeding at the end of the year.

SECTION 6, 47-26, TESTING BREITUNG HEMATITE DRILL HOLES.

The tests on hole K were completed early in January and as it did not seem necessary to retest any of the other Breitung-Hematite holes, the drill was moved back to Ishpeming. This hole was tested in connection with the exchange of information between the C.C.I. Company and E. N. Breitung Company concerning the Athens, Pioneer and Breitung-Hematite properties. Hole L was tested in 1914.

REPUBLIC DISTRICT.

SECTION 7, 46-29, REPUBLIC MINE.

In January, a drill was started on the 1935' level of No.9 shaft to look for the downward continuation of the ore body above. Two holes were drilled without finding any extension of the ore body and the drill was then laid off for over a month while a crosscut was driven into the hanging. From the extremity of this crosscut, six holes were drilled at various angles to test the ground below the 1935' level and these holes were also disappointing. The only ore that was encountered was in thin seams mixed with rock. The drilling was all very discouraging and work was stopped in July. The drill holes were laid out by Mr. Bush after consultation with Mr. Smyth.

GWINN DISTRICT.

SECTION 28, 45-25, GWINN MINE.

Early in 1915, it was decided that the East end of the Gwinn mine and the territory below the bottom level could be more economically explored by diamond drilling than by drifting. In February, a drill was started and work was still continuing at the end of the year. Fifteen holes were drilled and of these, three were successful in finding considerable amounts of ore. All of this ore was below the bottom level and probably constitutes a separate small ore body in another roll in the footwall, similar to the flat roll on the 8th level. The drill holes on the 5th and 7th levels, to prospect the fold, at the East end, were all blank. Mr. Jackson has probably described this drilling more in detail in his report on the Gwinn mine. The drill holes were laid out by Mr. Jackson after consultation with Mr. Smyth.



MENOMINEE RANGE.

IRON RIVER DISTRICT.

SECTION 24, 43-35, E $\frac{1}{2}$  OF NW $\frac{1}{4}$ , SPIES LEASE.

In November, 1915, two drills were started to determine the best location for a shaft on the Spies property. The first hole drilled encountered 8' of ore and following this up, three other holes encountered a considerable quantity of ore further North. It had been intended to locate the shaft about where this ore was found and it therefore became necessary to move the shaft further East on to the slate footwall. Several standpipes were sunk to determine the contact between the slate and iron formation and by the first of the year we had practically determined the safest position for the shaft and buildings, although one or two holes remained to be drilled.

In December, a third drill was started to drill a hole further South and determine whether the ore at ledge was wide enough to warrant an open pit. This hole, No. 43, encountered 43 $\frac{1}{2}$ ' of ore, but Mr. Duncan decided that there was no use considering an open pit. In all, 13 drill holes and standpipes were sunk, but of these, three were still continuing at the end of the year.

EXPLORATIONS OF OTHER COMPANIES.

Ernest Allen continued to visit the explorations of other companies in Michigan and Wisconsin. The maps of these explorations were kept up to date and we also brought up to date the index of these explorations in the form suggested by Mr. S. L. Mather. Mr. Allen has made written reports regularly of information thus acquired and these reports have been submitted to Mr. Duncan and Mr. Smyth.

So little was going on in the Lake Superior district in 1915 that Mr. Allen was able to keep track of it in addition to his duties of collecting cores at our several explorations and labeling samples in the core room. This work cost only \$226.88 in 1915, of which \$80.06 was Allen's salary while engaged in this work and the balance was traveling expenses.

TABLE IV.

COMPARATIVE STATEMENT OF CHARGES TO GEOLOGICAL DEPARTMENT.

	<u>1913.</u>	<u>1914.</u>	<u>1915.</u>
Salaries - - - -	\$15,443.54	\$15,448.80	\$13,778.60
Travel - - - -	100.43	188.42	124.15
Supplies - - - -	1,344.31	762.17	511.75
Miscellaneous - - -	95.71	15.11	23.97
Visiting outside explorations	<u>1,160.21</u>	<u>312.16</u>	<u>226.88</u>
	\$18,144.20	\$16,726.67	\$14,665.35
Expenses of H.L.Smyth, i.e. travel, supplies and mis- cellaneous - - -	1,016.80	922.85	749.33
Geological surveys -	<u>3,206.06</u>	0	0
Grand total	<u>\$22,367.06</u>	<u>\$17,649.52</u>	<u>\$15,414.68.</u>

The 10% reduction in salaries and the cut in the staff of the Geological department in October, 1914, are reflected in the figures for 1915. The 10% reduction in salaries was restored in September, 1915. Supplies were also lower in 1915 on account of the smaller number of men working, and the smaller proportion charged the Geological department. The small cost of visiting outside explorations was due to the few explorations now going on in the Lake Superior district.

### CLIFFS SHAFT MINE

On March the 20th the electric pumps installed on the 15th level were started up and have been in continuous operation since that time. The plunger pump has operated without any delays or breakdowns. Considerable trouble was experienced with the centrifugal pump, however, due to breaking of heads in both sections. The manufacturers in each case replaced the heads free of charge. A great deal of water in this mine comes from the ledge and it might be possible to reduce the current consumption for pumping by installing a separate pump to take care of the ledge water.

During the month of July one of the old Rand compressors was removed from the engine house and sold as scrap. The Allis-Chalmers electric driven compressor formerly used at the Chase Mine was installed in the space formerly occupied by the old Rand compressor. It was placed in operation in September. This compressor and the steam driven Nordberg machine now furnish all the air needed at this mine.

The crushing plant and tram plants operated without any trouble. New concaves were put in the #8 McCully crusher during the fall.

All machinery at this mine is in first class repair.

### HARD ORE

Up to October the Hard Ore Shops worked only five days a week. Very little new work was done, repair jobs constituting practically all of the work for the year.

In May the drawing class organized and instructed by the Mechanical Department finished the prescribed course. The members of the class did very good work. Some of the men are now able to make very creditable drawings. It was found that most of the men in the class had not even completed a grammar school course and some had never attended

HARD ORE

(Cont'd)

school at all. The class work also increased the mutual good feeling between the men and the Department. The Sociological Department gave a banquet for the class in May. This was very much enjoyed and appreciated by the members of the class.

LAKE MINE

One of the #6 McCully gyratory crushers was moved from the Imperial Mine to this mine during the month of May and installed north of the shaft house near the loading pocket.

No other new machine was installed at this mine. All machinery operated without delay during the year.

SALISBURY MINE

No new machinery was installed at this mine during the year. All of the mechanical equipment operated without trouble during the year.

The flow of water in this mine has increased materially and is now approximately 200 gallons per minute. A new electric driven plunger pump has been purchased and will be installed on the 14th level. After this is placed in operation the centrifugal pump will be used as a spare.

ATHENS MINE

The machinery at this mine operated without delays during the year.

In May a 35 gallon per minute, 500 ft. head, Aldrich triplex pump, driven by a  $7\frac{1}{2}$  H.P. General Electric motor, was installed in the skip compartment about 480 ft. from surface.

During the same month the hoist used for pulling the rock car up the dump was moved to a new location, a new house built for it and the hoist electrified. This hoist is now driven by a 25 H.P. Westinghouse, 1200 R.P.M.,

ATHENS MINE

(Cont'd)

induction motor through a D. O. James Manfg. Co. 20 H.P. Speed Reducing Transmission.

The 300 cu. ft. electric driven Ingersoll-Rand compressor was moved from the South Jackson Crusher Plant in December and installed at this mine.

LUCY MINE

In December the 125 H.P. Burt boiler and the smoke stack were moved to the Holmes Mine. The only equipment left at this mine is a worn out duplex double drum geared hoist, a serviceable feed water heater and a small air receiver.

MAAS MINE

This mine was entirely idle during the month of January. On February 15th hoisting was started from the third level winze. About August 1st mining operations were resumed throughout the mine.

The mechanical equipment at this mine has been completely overhauled and is now in good shape throughout, with the exception of some of the boiler brickwork which should be repaired during the summer. The feed water heater was completely rebuilt and practically all feed water piping was renewed. The economizer was overhauled and new scraper mechanisms installed which operate perfectly.

The cylinders of the cage hoist were rebored and new pistons put in. A new Wuest herringbone gear and pinion were put on October 31st. This improved operating conditions very much.

A bad overwind occurred on the skip hoist in September, causing a delay of three days. An overwind safety device has been ordered from the Sullivan Machinery Company to be installed on this hoist so that similar accidents will not occur in the future. During the same month another accident occurred to this hoist, causing a delay of two days. This was

MAAS MINE (Cont'd)

caused by a cap screw in the follower plate dropping out and bending the piston rod.

All other machinery operated without delay during the year.

The interior of the engine house and boiler house was painted. This was very much needed as no paint had ever been applied to the interior. The machinery and piping was also painted.

The 5 $\frac{3}{4}$ " x 36" duplex, geared, electric driven plunger pump was installed on the third level during July and August. It was placed in operation in September and handles nearly all of the water from this mine. This pump was manufactured by the Fred. M. Prescott Steam Pump Company and has a capacity of 800 gallons per minute against 1150 ft. head. It is driven by a 320 H.P. General Electric motor. The sump has never been completed for this pump station and the pumps are pumping very dirty water. The concrete floor and the pipe supports remain to be put in. The flow of water increased on July 3rd from 75 gallons per minute to about 600 gallons per minute.

NEGAUNEE MINE

The only serious delay at this mine was caused by the burning out of the induction motor driving the flywheel set. This occurred in September and caused a delay of 1 $\frac{1}{2}$  days. All other machinery operated without serious trouble.

Extensive tests were run on June 22nd and 30th on the compressor and motor by the C. A. Chapman Company of Chicago and Prof. C. M. Allen of the Worcester Polytechnic Institute, who afterwards made a report on the efficiencies of the machines.

New Wuest herringbone gears and pinions were put on the top tram plants in May to replace the spur gears and pinions. This improves operating conditions very much.

One of the #6 McCully gyratory crushers was taken from the

NEGAUNEE MINE

(Cont'd)

Imperial Mine and installed at this mine in May. It is located north of the shaft house near the loading pocket and is arranged so that the skips can dump directly into it. The ore goes direct from the crusher into the cars.

The steam pumps in #2 Shaft were operated in March and April on account of shortage of electric power due to low water at the Carp River Water Power Plant. The #2 Boiler Plant was shut down entirely on April 9th.

The two triple expansion Prescott steam pumps on the 6½ level of #2 Shaft have been dismantled and some of the parts removed to the Hard Ore Yard for storage. The work of taking these to the surface had to be discontinued on account of ice forming in the shaft and preventing the crosshead from running up and down. It is also planned to remove the compound pump on the 4th level.

The electric pumps operated throughout the year without delay. Great improvement was made in the condition of the water by providing catch basins for the sand and ore, which can now be removed from the sump at any time without draining it. The building of board walks along the motor drifts facilitates their cleaning and prevents the dirt from getting into the ditches.

A third motion electric driven hoist was installed during the latter part of the year on the 10th level to be used in sinking the winze to the 11th level. This hoist was manufactured by the Lake Shore Engine Works and has a drum 36" in diameter by 36" long. It is driven by a 35 H.P. General Electric motor. This hoist has not yet been placed in operation.

SOUTH JACKSON CRUSHER PLANT

The crusher plant was in operation from May to November. Very few breakdowns and delays occurred. The most serious delays were caused by the failure of the hoist. On two different occasions both the secondary and drum shaft were bent and twisted and the gear teeth broken. New shafts

SOUTH JACKSON CRUSHER PLANT

(Cont'd)

and gear were put on and arranged so that further trouble is not anticipated. A new solenoid brake has been ordered for this hoist to be placed on the motor coupling to prevent the dropping of the skip when the circuit is suddenly opened.

The other equipment at this plant operated without trouble.

CHASE MINE

This mine operated with practically no trouble. It was shut down entirely in July. All of the equipment was removed and disposed of as follows:

The Allis-Chalmers compressor and motor was shipped to the Cliffs Shaft Mine and installed in the engine house.

The hoist and motor was transferred to the Morris Mine and used underground.

The heating boiler and the air receiver were stored at the Hard Ore Yard.

Top tram equipment was sent to the Lloyd Mine. The engine itself was stored in the engine house basement, while the motor was installed to drive the Lloyd Mine crusher.

The shaft house was taken down in sections by a structural steel gang and stored at the Morris Mine.

The Blacksmith Shop equipment was separated. The drill heating furnace was sold to T. L. Durocher, a contractor at Marquette. The drill sharpener was stored in the Hard Ore Yard. The forge, anvil and tools were shipped to the Spies Mine at Iron River.

The 3-pole Gould electric driven underground pump was stored in the engine house basement at the Lloyd Mine. The 5" 2-stage and the 4" 4-stage Alberger centrifugal pumps used at the Dexter Mine were sent to the Gwinn District. The small centrifugal water supply pump was sent to the Dead River Water Power Plant.



CHASE MINE

(Cont'd)

The remaining equipment of pipe, valves, fittings, etc., was absorbed by the Morris and Lloyd Mines.

LLOYD MINE

The air brakes on both hoists were overhauled. The grids for the skip hoist motor were removed from the basement and set on balcony above secondary panel. Electric safety overspeed governors were installed on both hoists as a safety precaution. A new shell was placed in the outboard bearing of the skip hoist.

A #6 McCully gyratory crusher was purchased for this mine and installed during the month of September near the shaft house. This is driven by the 25 H.P. Allis-Chalmers motor formerly used on the Chase Mine top tram. The crusher is set on a concrete foundation 20 ft. high. The necessary grizzly bars, steel chutes and pocket were constructed. This plant was placed in operation early in October. During December the plant was housed in and a heating system, consisting of a small vertical diamond drill boiler and four radiators, was installed. The entire equipment has operated with satisfaction.

The top tram system gives trouble in cold weather. The 25 H.P. motors driving the tram engines are not powerful enough when the trams are set at maximum length. A new 40 H.P., 2200 volt, Westinghouse motor has been ordered for one side.

A #10 blower, driven by a 15 H.P. D.C. motor, was installed on the 600 ft. level and operated until the drift to Sec. 6 Shaft was completed. It was then moved to the winze on the 800 ft. level of Morris Mine.

The portable loader was rebuilt. It was used in driving the 600 ft. level drift and assisted in establishing a record for fast drifting. The loader is now idle on the 600 ft. level. It will have to be overhauled before being put into service again.

One skip caught in the shaft in March and caused a delay of two days. Four sets of timber were partly torn out and the skip rope was broken.

LLOYD MINE

(Cont'd)

The 300 gallon per minute, 3 pole, Gould electric driven pump on the second level was removed and will be used on the 200 ft. level of the Morris Mine.

Six new tram cars, equipped with roller bearing wheels, were added to the equipment on the 600 ft. level.

MORRIS MINE

Very little new equipment was installed at this mine.

The hoist from the Chase Mine was installed on the 800 ft. level to serve the winze sunk to the 1200 ft. level. A skip and dump plate were put in at this winze and the 1200 ft. level rock is hoisted into the 800 ft. level storage pocket. This equipment, aside from one burned motor connection, has given no trouble.

The operation of the two 1000 gallon per minute underground Prescott pumps was improved by inserting side thrust collars between the pinion and the bearings, reversing direction of gear rotation and making solid couplings out of the flexible couplings between the motor and pump. The motor bearings of both pumps were re-babbitted. The big sump was cleaned out in the spring and again in the fall.

Considerable trouble was experienced with the starting transformers on the Westinghouse motor driving the Nordberg compressor. Four of these, two air and two oil cooled, burned out, but the fifth, installed in July, has given no trouble. This starting transformer will be replaced by the Westinghouse Company free of charge.

Speed governors were installed on both hoists. These set the brakes when the hoists are run at an excessive speed.

A few minor repairs were required on the Nordberg compressor. The Ingersoll-Rand compressor has been operated very little. The only repair it required was one new clearance control piston.

The ventilating fan from the 800 ft. level was stored on surface and later sold to the Athens Mine.

The ventilating fan from the 600 ft. level of the Lloyd Mine was

MORRIS MINE (Cont'd)

shifted to the collar of the winze in the Morris Mine and now removes the smoke from the 1200 ft. drifts.

Besides taking care of the regular mine work the Shops made a dump plate and skip for winze, built a safety crosshead, made up the structural steel for the Lloyd Mine crusher plant, split the hoist drum from the Chase Mine and overhauled the underground pumps from the Chase Mine.

SEC. 6 MINE

Sinking at this shaft was started in the spring with a derrick, a bucket and an air driven hoist with a 4 ft. dia. drum secured from the Lucy Mine. This operated during the summer.

The permanent equipment was installed during September, October and November. A wooden head frame, 30 ft. high, was constructed and this carries an 8 ft. head sheave for the cage rope and a 6 ft. sheave for counterbalance rope. A brick engine house, 24' x 28', was built approximately 150 ft. from the shaft. In this engine house was installed an Ottumwa Iron Works hoist and auxiliary equipment. This hoist has a 6 ft. dia. by 8 ft. face drum controlled by two sets of post brakes, one lever and one solenoid operated. It is driven by a 200 H.P. Westinghouse motor through one set of Wuest herringbone gears. The cage was taken from the Chase Mine. The counterbalance is a shaft  $11\frac{1}{8}$ " in diameter, weighing 5900 lbs., and running in a 12" pipe. This equipment was placed in operation on December the 11th and is giving satisfaction.

A pole line carrying #6 wire was constructed from the Lloyd Mine to this shaft.

Air is secured by tapping with a 4" line the 6" line between the Morris Mine and the Cliffs Shaft Mine.

The mechanical equipment for this mine is now practically completed.

AUSTIN MINE

This mine was not operated during the year.

FRANCIS MINE

The shaft was unwatered and sinking started during the year.

A temporary steam hoist was installed for use while sinking.

One of the boilers from Princeton No2 was installed. A 900 cu. ft. Sullivan straight line compressor, which was taken from the Gwinn Mine, was also installed. Two Prescott sinking pumps of 500 gallons capacity each were installed in a pump station at the 400 ft. level.

An electric driven compressor of 600 cu. ft. capacity had been installed previously.

The boiler plant consists of two boilers of 125 H.P. each.

Shops and Dry were built and equipped.

Permanent equipment consisting of a 1000 gallon per minute centrifugal pump and a 2000 cu. ft. electric driven compressor have been purchased for this mine and will be installed early in 1916.

GARDNER-MACKINAW MINES

No work was done at these mines during the year.

GWINN MINE

The hoisting plant operated satisfactorily, only a few minor cases of trouble occurring.

The electric driven top tram plant operated without any trouble, the only serious delay being from the tramming system which was caused by a car going off the trestle.

The mine pumping equipment operated satisfactorily throughout the year.

Electric underground haulage was installed at this mine in the fall. The plant consists of a 100 K.W. General Electric motor-generator

GWINN MINE

(Cont'd)

set located in the engine house and two General Electric locomotives. The locomotives were taken from the Stephenson Mine. Electric haulage is in operation on the 5th level at present and will be installed on both the 4th and 7th levels in the near future.

The Machine Shop was equipped with power driven pipe cutter and drill press. All shop equipment and building were destroyed in a fire in September. The boiler house and temporary engine house were also destroyed in this fire. The old boiler plant has been dismantled.

JOPLING MINE

No work was done at this mine during the year.

PRINCETON MINE

No new installations were made during the year.

All mechanical equipment operated satisfactorily and no trouble occurred from breakdowns.

PRINCETON CENTRAL POWER PLANT

The equipment at this plant operated satisfactorily during the year. The steam turbine was in operation until May and again in September and October.

The compressor was changed from electric to steam drive in May and has operated satisfactorily.

The only new equipment installed was a new double stoker engine in the boiler room.

Very little trouble occurred on transmission lines during the year.

PRINCETON CENTRAL PUMPING STATION

Station equipment operated satisfactorily throughout the year. Efforts were made to find a more satisfactory water supply than

PRINCETON CENTRAL PUMPING STATION

(Cont'd)

the river, as the water in the river contains a large amount of iron ore. Test pits and pipes were put down across the river from the Pump Station, but a sufficient supply of water could not be found.

Plans for moving the Pump Station to the Gwinn Mine and pumping from wells are under consideration.

STEPHENSON MINE

The hoisting plant gave little trouble during the year, only one breakdown occurring that delayed the mine.

The top tram plant was the cause of a few delays. These were caused mostly by the cars jumping the track.

The underground tramping system operated very satisfactorily. Two new General Electric locomotives of the latest type were added to the equipment, replacing two locomotives which were taken to the Gwinn Mine.

The steam mine pumps were in operation about a month in the spring while repairs were being made to the electric driven plunger pump on the 5th level. The repairs consisted of installing a sole plate under the motor end of the pump.

A Cameron pump of 1000 gallons per minute capacity was also installed in the pump house on the 5th level to throw water up to the steam pump on the 4th level. Pumping can be handled entirely by steam if necessary.

All locomotives and cars were equipped with automatic couplers.

Electric driven tram plants have been bought to replace the present steam driven plant. One of these plants has been installed for handling the Section 29 ore.

Two similar plants will be installed for handling Stephenson ore.

#### GROSBY MINE

The Washing Plant was completed and is ready for operation.

The mine has been completely electrified.

The hoist was furnished by the Ottumwa Iron Works, has a 6 ft. drum and is geared to a 75 H.P. Westinghouse motor.

A motor-generator set of 100 K.W. capacity, furnished by the General Electric Company, is in place to take care of underground haulage.

The mill supply pumps, which receive water from the storage dam, are placed in the engine room at the mine. One is a Prescott plunger pump of 600 gallons per minute capacity, and the other is an Allis-Chalmers centrifugal of same rating. It is expected that either of these pumps will supply sufficient water for the mill.

Two pumps duplicating the above two pumps are on hand to be used underground when the mine is unwatered and pump station provided for them.

Connection has been made to the lines of the Great Northern Power Company and everything is in readiness for immediate operation.

#### MEADOW MINE

Report on the Meadow Mine is not possible as I have not yet been to the property.

#### IMPERIAL MINE

This mine was idle the entire year.

#### REPUBLIC MINE

Few changes worthy of note have been made at this property.

The Water Power Plant, which was rebuilt in 1914, has operated without interruption during the year. The flow of water has been unusually good and this plant has furnished nearly all the air needed at this mine.

I am still of the opinion that it is advisable to electrify this plant and connect it to our general system at Ishpeming. The new water

REPUBLIC MINE

(Cont'd)

wheel which was installed is suitable for direct connection to a 500 K.W. generator. This was the subject of special reports dated May 29th, 1914, June 25th, 1914, and July 2nd, 1915. This would insure the maximum benefit from the water power and close down the present steam generating unit and at the same time give this mine unlimited electric service. The mine is now short of current and the generating plant unreliable.

This arrangement would make it necessary to operate the steam compressor the greater part of the time, but this is a compound condensing unit and a very efficient machine.

The complicated flat rope compound drum counterweight system at #9 Shaft had to be discarded and the ordinary system put in its place.

ELECTRICAL DEPARTMENT

The year 1915 has been one of routine operation with very few changes or additions.

An effort has been made to increase the efficiency and reliability of all electrical applications. The results have been very satisfactory.

By a careful analysis and study of our transmission losses we have, by regulation, adjustment and suitable changes in distributing potential, made very marked reduction in the total transmission losses. In the years 1913 and 1914 our average transmission losses were slightly more than 14%, while during the year 1915 our losses were only 11.2%. This is a direct saving of 3% in usable current, and for the year 1915 amounts to 569,000 K.W.Hrs., which increased our net earnings by \$5,690.00.

The total current cost is slightly higher in 1915 than in 1914 due to carrying into the year 1916 a large amount of stored water to carry the heavy load through the winter months. On January 1st, 1915, we had very little water in storage due to the very dry fall of 1914. A comparison of the tables will make this clear.

The most serious trouble on our electric system occurred in April,



ELECTRICAL DEPARTMENT

(Cont'd)

causing a delay of several hours. This was caused by a severe electrical storm which shattered line insulators on practically all our high tension circuits. Several minor line troubles occurred from various causes, but no delays resulted which in any way affected our mining output.

The only serious accident to any apparatus, other than routine operating trouble, was the burning up of one of the main generator switches at the Carp River Power House on June 6th. This was evidently caused by lightning entering the station and setting the switch oil on fire. A new switch was installed.

The usual work of a general nature in connection with the operation of the mines was carried on. The most important work, aside from general inspections, was the systematic testing and calibration of all meters.

A detailed and careful test of underground haulage systems was made to locate and correct electrolysis. This resulted in the recommendation and adoption of a new style of rail bond which seems to be much more efficient and reliable than the older form of bonding.

A new style of ringer switch box for use in mine signal systems has been perfected and is now being made in our Hard Ore Shops. This box is being gradually introduced at the various mines. These have not heretofore been available in this country, and the only ones that have been entirely satisfactory were imported from Germany at great expense and trouble.

The educational work has been continued, not only by winter classes, but also at the mines with the men whenever opportunity permitted. We now have a small force of very efficient and reliable electrical workers, with an organization that can be readily expanded or filled as the occasion may require.

The distributing lines to the Chase and Dexter Mines were dismantled. A new line was constructed from the Lloyd Mine to Sec. 6 Shaft.

The transmission line from the Dead River Power Plant to the Maas Substation was nearly completed. This is a single circuit, three phase,

ELECTRICAL DEPARTMENT

(Cont'd)

15,000 volt line on 30 to 40 ft. cedar poles, with stranded guard wire on bayonets and an iron telephone line on brackets below. No. 2 copper wire is used. Contracts have been placed for all generating and transformer equipment for this development.

New switching apparatus has been ordered for the Maas Substation to enable us to carry the increased load which has followed the expansion in the Negaunee district.

An order has been placed for outdoor substation to be erected near the Cliffs Shaft Mine. This will serve the Cliffs Shaft and Holmes Mines and was necessitated by the opening up of the Holmes Mine.

GROSBY MINE - ELECTRICAL

The Crosby Mine was completely electrified during the year. The electrical equipment for the Washing Plant was also installed. This installation, as a whole, is very creditable, having been designed and installed as a complete system at one time. Current is purchased from the Great Northern Power Company under a very satisfactory contract and delivered to the mine at 22,000 volts, 3 phase. An outdoor Substation was erected on a pole structure, with complete lightning arrester and transformer equipment, and from this current is carried into the power house at 2,200 volts. In the power house is located the slate switchboard for controlling the various apparatus. This contains 10 feeder switches, with all necessary meters and other apparatus. From the Power House to the Washing Plant a three phase circuit is carried on cedar poles. This circuit is protected at each end by an electrolytic lightning arrester.

There are nine 440 volt motors in the Washing Plant, all furnished by the Allis-Chalmers Manfg. Co., and each served by separate switch and cable so that any trouble on one will not affect the operation of the others.

In the Power House are located two pumps for supplying water to the Washing Plant. These are driven by General Electric motors. The two underground pumps are also driven by General Electric motors. Current for

*Dammann*  
~~Electrical Department~~ *Bond*  
ELECTRICAL DEPARTMENT (Cont'd)

GROSBY MINE - ELECTRICAL

underground haulage is furnished by a 100 K.W. motor-generator set furnished by the General Electric Company. The hoist is driven by a 75 H.P. General Electric induction motor with primary contactor control.

A detail list of all motors is shown below.

Hoist	General Electric	Induction	75 H.P.	514 R.P.M.
Motor-Generator Set	" "	Synchronous	125 "	900 "
Plunger Pump	Allis-Chalmers	Induction	50 "	580 "
Centrifugal Pump	" "	"	85 "	1750 "
U. G. Plunger Pump	" "	"	50 "	580 "
" Centrifugal Pump	" "	"	85 "	1750 "
Shop	" "	"	5 "	1200 "
Conveyor	" "	"	40 "	580 "
Apron Feeder	" "	"	20 "	575 "
Large Screen	" "	"	20 "	575 "
Picking Belt	" "	"	5 "	1130 "
Chip Screen	" "	"	3 "	1130 "
Crusher	" "	"	20 "	575 "
Tables	" "	"	20 "	575 "
25 ft. Log Washer	" "	"	20 "	575 "
18 ft. " "	" "	"	20 "	575 "
		Total,	<u>643</u> H.P.	

REPUBLIC MINE - ELECTRICAL

A new exciter and a Tirrill voltage regulator were installed in No. 5 Engine House.

A new 5 H.P. General Electric motor was installed to drive the picking belt at No. 9 Shaft. The motor formerly used on No. 6 hoist was transferred to No. 9 Shaft to drive the top tram plant.

A 10 H.P. General Electric motor was installed to drive the screen at the crusher plant.

ELECTRICAL DEPARTMENT (Cont'd)

REPUBLIC MINE - ELECTRICAL

A new three phase standard pump cable was placed in No. 9 Shaft.

All outside lines were overhauled and mine lighting changed to 220 volts.

Several hundred pounds of copper wire and about sixteen service transformers were recovered by intelligent changing of circuits.

DEAD RIVER WATER POWER

Orders were placed for nearly all the material and equipment for this development.

Work on transmission line was started and about 50% of it completed.

A camp was built and about 20 men started on preliminary work the middle of December. While work on this project is at a great disadvantage in the winter time, it is advisable as it will hasten its completion materially.

ELECTRICAL DEPARTMENT

(Cont'd)

The following alternating current motors are installed and operating as needed:

	INSTALLED TO JAN. 1, 1915	INSTALLED IN 1915	TAKEN OUT IN 1915	TOTALS
<b>CARP RIVER POWER HOUSE</b>				
Auxiliaries - 2 - 15 H.P. pump motors	30 HP			
Water Supply Pump	<u>1</u>			31 HP
<b>CLIFFS SHAFT MINE</b>				
Shop	25			
No. 8 Crusher	125			
No. 5 Crushers - 2 - 25 H.P. motors	50			
Screens	15			
Top Tram	50			
Lower Tram	20			
Underground Haulage Set	100			
Hoist	500			
Underground Plunger Pump	180			
" Centrifugal "	250			
Compressor (From Chase Mine)		<u>175 HP</u>		1,490
<b>HARD ORE</b>				
Machine Shop (Sent to Lake for crusher)			25 HP	
" " (From Republic Mine)		<u>7½</u>		
Carpenter "	25			32½
<b>LAKE MINE</b>				
Underground Haulage Set	215			
Surface Drainage Pumps - 2 - 30 HP motors	60			
Underground Plunger Pump	75			
" Centrifugal Pump	125			
" Fan (From Presque Isle)		40		
Crusher (From H.O. Machine Shop)		<u>25</u>		540
<b>SALISBURY MINE</b>				
Hoist	400			
Underground Centrifugal Pump	400			
Compressor	150			
Underground Fan (Sent to Negaunee Lab.)			5	
" "		<u>7½</u>		
Compressor Circulating Pump		<u>5</u>		962½
<b>ATHENS MINE</b>				
Cage Hoist	400			
Compressor	325			
" Circulating Pump	3			
Auxiliary Compressor (for hoist brakes)	5			
Rock Hoist (From Mackinaw Shop)		25		
Sinking Pump		<u>7½</u>		
Underground Ventilating Fan		<u>7½</u>		773
<b>MAAS MINE</b>				
(Circulating Pump)	40			
Turbine Auxiliaries (Injection " (Exciter)	25			
	33			
Underground Haulage Set	215			
Shop	10			
Underground Centrifugal Pump	350			
" Hoist	50			
" Plunger Pump		<u>320</u>		
Fwd.,	<u>4,252 HP</u>	<u>620 HP</u>	( 30 )	<u>1,043</u> 4,872 HP

ELECTRICAL DEPARTMENT

(Cont'd)

	INSTALLED TO JAN. 1, 1915	INSTALLED IN 1915	TAKEN OUT IN 1915	TOTALS
brt. fwd.,	4,252 HP	620 HP	30 HP	4,872 HP
<b>MEGAUNEE MINE</b>				
Underground Haulage Set	215			
"Ilgner" Hoist Set	350			
Top Tram - 2 - 50 HP motors	100			
Laboratory Crusher (Sent to Gen'l Storehouse)			3	
" " (From Salisbury Mine)		5		
Auxiliary Compressor (for hoist brakes)	3			
Underground Plunger Pumps - 2-300 HP motors	600			
" Centrifugal Pump	350			
" Suction Pumps - 2- 15 " "	30			
Cooling Tower Pump	5			
Air Compressor	325			
Shop	15			
Underground Sump Pump	5			
" Hoist		35		
Crusher		<u>25</u>		
				2,063
<b>SOUTH JACKSON CRUSHER PLANT</b>				
Hoist	75			
Compressor	50			
Crusher	<u>150</u>			
				275
<b>CHASE MINE</b>				
Hoist (Sent to Morris for U.G.)			200	
Compressor ( " " Cliffs Shaft)			175	
Top Tram ( " " Lloyd for crusher)			25	
Underground Plunger Pump (Stored at Lloyd)			50	
Water Supply Pump ( " " Morris)			5	
<b>DEXTER MINE</b>				
Underground Centrifugal Pump (Sent to Francis)			50	
" " " " " "			50	
" " " (Stored at Morris)			50	
<b>LLOYD MINE</b>				
Skip Hoist	400			
Cage "	400			
Underground Plunger Pump (Sent to Morris)			50	
Top Tram - 2 - 25 H.P. motors	50			
Crusher (From Chase Mine)		<u>25</u>		
				875
<b>MORRIS MINE</b>				
Skip Hoist	400			
Cage "	400			
Shop	25			
Water Supply Pump	40			
" " "	50			
Air Compressor (Ingersoll-Rand)	250			
Underground Plunger Pumps - 2 - 350 H.P.	700			
Laboratory Crusher	3			
Top Tram - 2 - 25 H.P. motors	50			
Underground Haulage Set	150			
Air Compressor (Nordberg)	325			
" " Circulating Pump	5			
Winze Hoist (From Chase Mine)		200		
" Pump ( " Lloyd " )		<u>50</u>		
				2,648
<b>SEC. 6 SHAFT</b>				
Hoist		200		200
fwd.,	<u>9,773 HP</u>	<u>1,160 HP</u>	( 688 )	<u>10,933 HP</u>

ELECTRICAL DEPARTMENT

(Cont'd)

	INSTALLED		INSTALLED TAKEN OUT		TOTALS
	TO JAN. 1, 1915	IN 1915	IN 1915	IN 1915	
brt. fwd.,	9,773 HP	1,160 HP	688 HP	10,933 HP	
<b>PRINCETON CENTRAL POWER PLANT</b>					
(Circulating Pump	40				
Turbine Auxiliaries (Injection "	25				
(Exciter	33				
Underground Haulage Set	215				
Shop	25				
Compressor	625				
Boiler Room Fan	25				
					988
<b>AUSTIN MINE</b>					
Hoist	150				
Top Tram	25				
Laboratory Crusher	5				
					180
<b>FRANCIS MINE</b>					
Compressor		100			
U.G. Centrifugal Pumps 2-50 HP (From Dexter)		100			
Underground Fan (From Gwinn Mine)		7			
					207
<b>GWINN MINE</b>					
Skip Hoist	400				
Cage "	400				
Rock Crusher	25				
Underground Centrifugal Pump	400				
" Plunger "	350				
Ore Tram - 2 - 37 HP motors	74				
Rock Tram	10				
Auxiliary Compressor (for hoist brakes)	3				
Underground Fan (Sent to Francis Mine)			7		
" Haulage Set		150			
Shop		5			
					1,817
<b>GARDNER MINE</b>					
Hoist	400				
Sinking Pump	35				
					435
<b>MACKINAW MINE</b>					
Hoist	400				
Shop (Sent to Athens Mine)			25		
Sinking Pump	35				
Compressor	325				
					760
<b>PRINCETON MINE NO. 1</b>					
Hoist	75				
Underground Pumps - 2 - 50 HP motors	100				
					175
<b>PRINCETON MINE NO. 2</b>					
Hoist	200				
Top Tram	50				
					250
<b>STEPHENSON MINE</b>					
Underground Plunger Pump	250				
" Centrifugal Pump	275				
					525
Totals,	14,748 HP	1,522 HP	(720HP)	16,270 HP	
<b>PIONEER FURNACE</b>					
Motor-generator Set (connected to system)	750				750
GRAND TOTALS,	15,498 HP	1,522 HP		17,020 HP	

ELECTRICAL DEPARTMENT (Cont'd)

The following motors are on hand, but are not installed:

Morris Mine (storage)		
Underground Pump Motors	2 - 50 HP	100 H.P.
Water Supply Pump Motor		5
General Storhouse (Storage)		
Motor from Negaunee Laboratory		3
Francis Mine (Storage)		
Compressor Circulating Pump Motor		3
(Bought for Mackinaw)		
Total		111 H.P.

Motors connected to Dec. 31, 1915,	(including Furnace)	17,020 H.P.
" on hand	" " " (not installed)	111 "
	GRAND TOTAL,	17,131 H.P.

Note:-

New motors installed during 1915,	802 H.P.
Motors taken out and transferred or stored,	720 H.P.

During the year the pole line from the Morris Mine to the Chase Mine was dismantled. This line was about 10,500 ft. long. A pole line was built from the Lloyd Mine to Sec. 6 Shaft, the length being 2,850 ft.

Total miles High Tension Three Phase Line	- 36.
" " " " Wire	- 216.
" number " " Towers	- 377.
" miles Three Phase Primary Line	- 28 $\frac{1}{2}$
" " " " " Wire	- 85 $\frac{1}{2}$
" " Primary Pole Line	- 24 $\frac{1}{2}$



AU TRAIN HYDRO-ELECTRIC PLANT

The Au Train Hydro-Electric Plant operated throughout the year without serious trouble and with the usual efficiency. The plant was idle  $80\frac{3}{4}$  hours during the year, the greater part being due to line trouble, but some of it being due to Paper Mill not taking any current.

The only change of consequence made at this plant was a power factor connection which was made in June in order to relieve the machines at the Paper Mill. This change, while it caused a doubling of line losses, undoubtedly saved the apparatus at the Paper Mill from disaster.

The record for the year is as follows:-

Total current generated at switchboard,	3,844,000 K.W.H.
" " delivered at Paper Mill switchboard,	<u>3 453 300</u> "
" " lost in transmission,	390,700 = 10.2%
Current sold - 3,453,300 K.W.H.	‡ 17,842.00
Operating expense, maintenance & taxes,	\$5,058.89
Depreciation,	<u>10,359.90</u>
	15,418.79
Net gain,	‡ 2,423.21 = 2.2%
Plant account not charged off, (Dec. 31, 1915)	‡ 107,327.37

The plant ran light a total of 66 days; 50 Sundays and 16 other days, on which the Paper Mill did not take all the current the Au Train Plant could have furnished.

Output lost on Sundays,	506,450 K.W.H.
" " " account of Paper Mill,	109,950 "
" " " " " line trouble,	<u>11,000</u> "
Total,	627,400 K.W.H.

By deducting 11,000 K.W.H., the loss due to line trouble, from 627,400 K.W.H., we have 616,400 K.W.H., which is the additional output the plant could have shown had it operated at capacity all the time when no trouble prevented.

AU TRAIN HYDRO-ELECTRIC PLANT

(Cont'd)

SUMMARY OF OPERATIONS - 1915.

Month	K. W. H. Generated	K. W. H. Sold	Transmission Loss		Cost per K. W. H. (Incl. Depreciation)
January	105,800	98,200	7,600 =	7.1%	\$.0068254
February	115,000	108 500	6 500	5.6	.0065507
March	144 700	131 900	12 800	8.8	.0063341
April	406 000	382 500	23 500	5.8	.0039974
May	467 400	432 400	35 000	7.4	.0038924
June	438 000	384 800	53 200	12.1	.0040031
July	336 400	298 900	37 500	11.1	.0042429
August	361 700	319 800	41 900	11.5	.0043137
September	291 900	256 800	35 100	12.0	.0046158
October	400 800	353 700	47 100	11.7	.0041970
November	419 700	366 100	51 600	12.2	.0041304
December	<u>356 600</u>	<u>317 700</u>	<u>38 900</u>	<u>10.9</u>	<u>.0050413</u>
Totals,	3,844,000	3,453,300	390,700	10.2	\$.0044649

CARP RIVER HYDRO-ELECTRIC PLANTSUMMARY OF OPERATING CONDITIONS

Month	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Precipitation	1.45	1.44	0.29	1.88	4.48	5.97	2.80	3.30	7.27	3.76	4.24	1.53	
Total precipitation for 1915 (Ishpeming) - 38.41 inches.													
Average Marquette records - 46 years - 32.8 "													
Drainage area above Intake Dam -											66.66 sq. mi.		
Cubic feet Precipitation in 1915 -									5,941,785,600				
K. W. Hrs. generated at Carp River Plant in 1915 -											17,470,300		
Cubic feet water utilized (90 cu. ft. = 1 K.W.H.) -									1,572,327,000				
"	"	"	in storage basin Jan 1st, 1915						- 69,842,000				
"	"	"	"	"	"	Dec. 31st, "						- 410,402,400	
"	"	"	"	"	"	Jan. 1st, 1916 in excess of that in storage Jan. 1, 1915						- 340,560,400	
"	"	"	wasted over Intake Dam in 1915						- 48,410,000				
Total run-off for the year 1915									- 1,961,297,400				
Run-off per sq. mile of drainage area									- 29,422,403				

GARP RIVER HYDRO-ELECTRIC SYSTEM (Cont'd)

During the year 1915 the drainage area produced a run-off of 1,961,297,400 cubic feet of water with a precipitation of 38.41 inches, 2% of this being wasted over intake dam and the remainder utilized for producing power. About 4% of the power produced was made by water in storage January 1st. About 20% of the total power produced during the year was made by steam, the greater part of this being generated in the first four months. The operation of the steam plants was necessitated by the small amount of water in storage.

GARP RIVER HYDRO-ELECTRIC PLANT & STEAM-ELECTRIC PLANTS

SUMMARY OF OPERATIONS - 1915

Month	K. W. H. GENERATED			Total	Used by Auxiliaries	Transmission Losses	K.W.H. Sold	Cost Per K. W. H. (Incl.Depr.)
	Carp	Maas	Princeton					
Jan.	751,800	598,375	392,400	1,742,575	90,780	10.1%	1,484,419	\$.00888
Feb.	616 800	600 900	458 250	1 675 950	106 635	7.5	1 451 599	.00879
March	719 000	544 650	386 600	1 650 250	92 285	10.6	1 389 035	.00855
April	1,381 000	69 375	193 000	1 643 375	31 835	11.3	1 429 461	.00825
May	1 797 200	0	0	1 797 200	7 000	10.9	1 594 348	.00414
June	1 623 900	0	0	1 623 900	5 445	11.5	1 432 592	.00396
July	1 763 400	0	0	1 763 400	5 165	13.4	1 522 326	.00403
Aug.	1 971 100	2 000	24 900	1 998 000	8 340	12.9	1 732 938	.00387
Sept.	1 243 500	389 675	352 250	1 985 425	60 311	11.2	1 709 147	.00764
Oct.	1 568 800	122 075	218 200	1 909 075	44 154	9.8	1 681 961	.00607
Nov.	1 955 800	0	22 100	1 977 900	8 470	13.1	1 711 661	.00538
Dec.	2 078 000	0	0	2 078 000	6 020	11.6	1 831 200	.00315
Totals	17,470,300	2,327,050	2,047,700	21,845,050	466,440	11.2	18,970,687	\$.00592

Note:-

Cost for April is high on account of settlement of Hemmila Personal Injury Case.

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>CLIFFS SHAFT MINE</u>					
1902	9,381	278,756	401,970,520	1,442	377,910,450
1903	8 150	268 568	322 753 874	1 200	374 292 985
1904	6 287	169 651	191 094 862	1 127	372 046 285
1905	7 421	204 645	271 587 404	1 355	353 087 800
1906	9 204	272 735	451 440 636	1 794	--- --- ---
1907	8 880	302 924	692 018 970	2 239	242 599 222
1908	7 991	228 886	541 729 740	2 367	240 000 000
1909	7 328	242 573	680 932 960	2 796	166 079 249
1910	8 895	252 793	904 379 312	3 577	156 948 550
1911	8 095	246 334	898 424 112	3 647	165 101 640
1912	8 047	276 211	810 020 228	2 932	218 555 480
1913	8 027	295 105	833 987 419	2 826	276 582 240
1914	7 496	316 986	1 054 320 348	3 326	281 392 090
1915	5 181	347 955	889 280 382	2 555	283 489 900
<u>SALISBURY MINE</u>					
1902	3,800	175,782	191,100,362	1,090	71,962,803
1903	4 167	194 781	264 830 023	1 360	88 636 312
1904	3 540	159 878	216 911 720	1 358	77 897 201
1905	3 750	154 017	219 765 211	1 423	76 346 425
1906	3 909	152 034	219 345 241	1 461	77 100 543
1907	3 892	139 986	215 971 327	1 551	86 056 044
1908	3 606	116 724	218 591 828	1 895	66 957 839
1909	3 537	99 140	218 841 412	2 228	61 699 506
1910	3 308	113 574	162 828 098	1 433	63 430 079
1911	3 158	111 272	148 067 843	1 330	61 654 458
1912	2 788	118 635	154 493 210	1 301	55 855 799
1913	848	125 178	120 039 019	958	51 358 400
1914	583	97 318	94 530 000	971	56 786 400
1915	522	27 150	134 776 200	---	53 503 200

COMPARATIVE TABLES

YEAR	TONS GOAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>LAKE MINE</u>					
1900	8,218	510,132	376,482,932	740	-- --- ---
1901	9 117	472 730	393 632 563	840	62,998,188
1902	8 400	470 728	440 196 332	952	64 188 597
1903	8 502	468 277	441 329 198	993	70 848 359
1904	6 983	281 399	355 084 057	1,368	78 662 195
1905	10 346	505 321	885 737 363	1 753	77 492 105
1906	11 072	559 877	784 511 853	1 247	80 626 208
1907	10 934	549 449	773 662 287	1 410	90 105 988
1908	9 222	357 628	575 642 546	1 671	76 896 881
1909	9 640	381 060	826 433 227	2 245	81 268 184
1910	9 892	559 438	820 568 713	1 466	85 118 000
1911	7 558	309 519	583 930 820	1 886	93 643 210
1912	7 824	329 344	656 627 987	1 993	109 576 544
1913	8 059	473 848	962 459 483	2 031	95 007 553
1914	5 733	324 251	596 066 577	1 838	45 925 949
1915	6 019	359 185	586 965 354	1 634	96 375 565

H. O. #3 HEATING PLANT

1913	729
1914	810
1915	883

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>MEGAUNEE MINE</u>					
1904	8,182	166,781	233,721,669	1,401	476,056,512
1905	7 386	245 422	211 667 755	861	345 967 009
1906	10 465	258 354	235 730 810	921	--- --- ---
1907	11 216	315 069	250 046 615	795	707 070 097
1908	10 294	300 007	210 799 982	696	638 488 540
1909	9 088	316 072	263 322 702	911	623 789 512
1910	7 913	364 111	361 923 373	993	610 209 058
1911	7 805	368 352	599 630 043	1 627	634 100 040
1912	8 003	298 308	825 468 516	2 767	696 210 397
1913	7 647	368 956	741 224 169	2 008	789 153 091
1914	5 269	337 792	613 144 000	1 798	(#2 Shaft) 395 877 353
1915	1 703	404 020	363 242 060	933	--- --- ---
<u>MAAS MINE</u>					
1905	4,066	--- ---	139,268,772	---	311,792,458
1906	4 170	--- ---	260 733 698	---	--- --- ---
1907	5 861	29,690	---	---	337 084 264
1908	6 671	83 075	---	---	242 151 139
1909	6 494	141 510	291 338 833	2,095	231 101 590
1910	8 219	196 052	541 169 843	2 760	209 688 862
1911	7 252	---	646 245 479	---	---
1912	6 502	55 603	355 459 673	---	---
1913	8 903	287 784	915 881 473	3 182	---
1914	6 819	213 423	720 319 949	---	(3 months) 8 336 357
1915	4 325	85 150	486 626 678	---	190 534 750

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>AUSTIN MINE</u>					
1905	1,867	61,878	51,808,300	837	---
1906	-	165 445	56 931 414	374	---
1907	3 863	194 571	58 452 975	300	---
1908	-	204 769	---	---	---
1909	-	186 064	181 915 343	985	---
1910	-	69 500	33 411 030	480	---
1911	-	145 360	128 013 967	880	---
1912	-	121 191	153 118 878	1,263	---
1913	-	67 494	---	---	---
1914	(Mine idle entire year)				
1915	" " " "				
<u>PRINCETON MINE</u>					
1909	3,104	143,620	181,915,352	1,265	144,540,000
1910	2 582	126 047	226 054 113	1 793	138 556 000
1911	570	100 150	171 032 509	1 707	---
1912	184	22 639	48 083 876	2 123	107 537 270
1913	467	74 297	---	---	108 366 555
1914	64	772	---	---	99 939 295
1915	87	2 833	---	---	94 629 250
<u>STEPHENSON MINE</u>					
1909	2,396	140,683	181,915,347	1,313	191,342,376
1910	2 867	217 096	294 935 118	1 358	383 590 401
1911	4 182	239 991	384 041 898	1 600	625 253 183
1912	4 856	241 931	460 478 796	1 903	886 471 232
1913	3 420	283 146	---	---	1 028 287 849
1914	2 281	238 739	---	---	772 327 870
1915	2 220	230 575	---	---	763 683 450
		+ 4 395			
		234 970			

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>GWINN MINE</u>					
1909	2,022	---	60,638,452	---	---
1910	5 116	---	143 309 920	---	---
1911	3 400	2 548	136 216 025	---	---
1912	(Idle entire year)				
1913	1 583	14 376	---	---	---
1914	1 400	95 510	---	---	90,245,720
1915	807	151 474	---	---	131 676 720

PRINCETON PUMPING STATION

1909	598				137,037,480
1910	545				142 284 450
1911	497				153 854 205
1912	569				158 661 990
1913	633				172 438 180
1914	675				184 799 040
1915	794				202 554 240

PRINCETON CENTRAL POWER PLANT

1909	4,630	(output) 606,384,494
1910	6 101	697 710 181
1911	7 493	819 304 399
1912	4 104	661 681 550
1913	2 360	---
1914	5 900	---
1915	7 092	---



COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>GROSBY MINE</u>					
1909	1,735	119,410	---	---	---
1910	2 157	204 588	---	---	---
1911	1 493	80 976	---	---	---
1912	1 515	116 818	---	---	---
1913	3 305	207 728	---	---	---
1914	(10 mo.) 2 151	(8 mo.) 23 221	---	---	---
1915	250	---	---	---	---
<u>IMPERIAL MINE</u>					
1909	2,592	82,135	---	---	---
1910	3 665	137 527	---	---	---
1911	2 744	102 831	---	---	---
1912			(Mine idle entire year)		
1913			" " " "		
1914			" " " "		
1915			" " " "		
<u>LLOYD MORRIS MINE</u> (Includes Sec. 6 Shaft)					
1911	---	88,792	---	---	---
1912	---	181 544	---	---	---
1913	726	209 667	---	---	---
1914	615	242 476	655 119 000	2 701	363 889 057
1915	533	298 816	722 622 750	2 418	322 295 660
<u>CHASE MINE</u>					
1911	---	3,575	---	---	---
1912	---	5 433	---	---	---
1913	250	50 936	---	---	---
1914	138	79 222	202,237,750	2,552	54,206,045
1915 (7 months)	80	36 154	51 347 250	---	34 832 000

COMPARATIVE TABLES

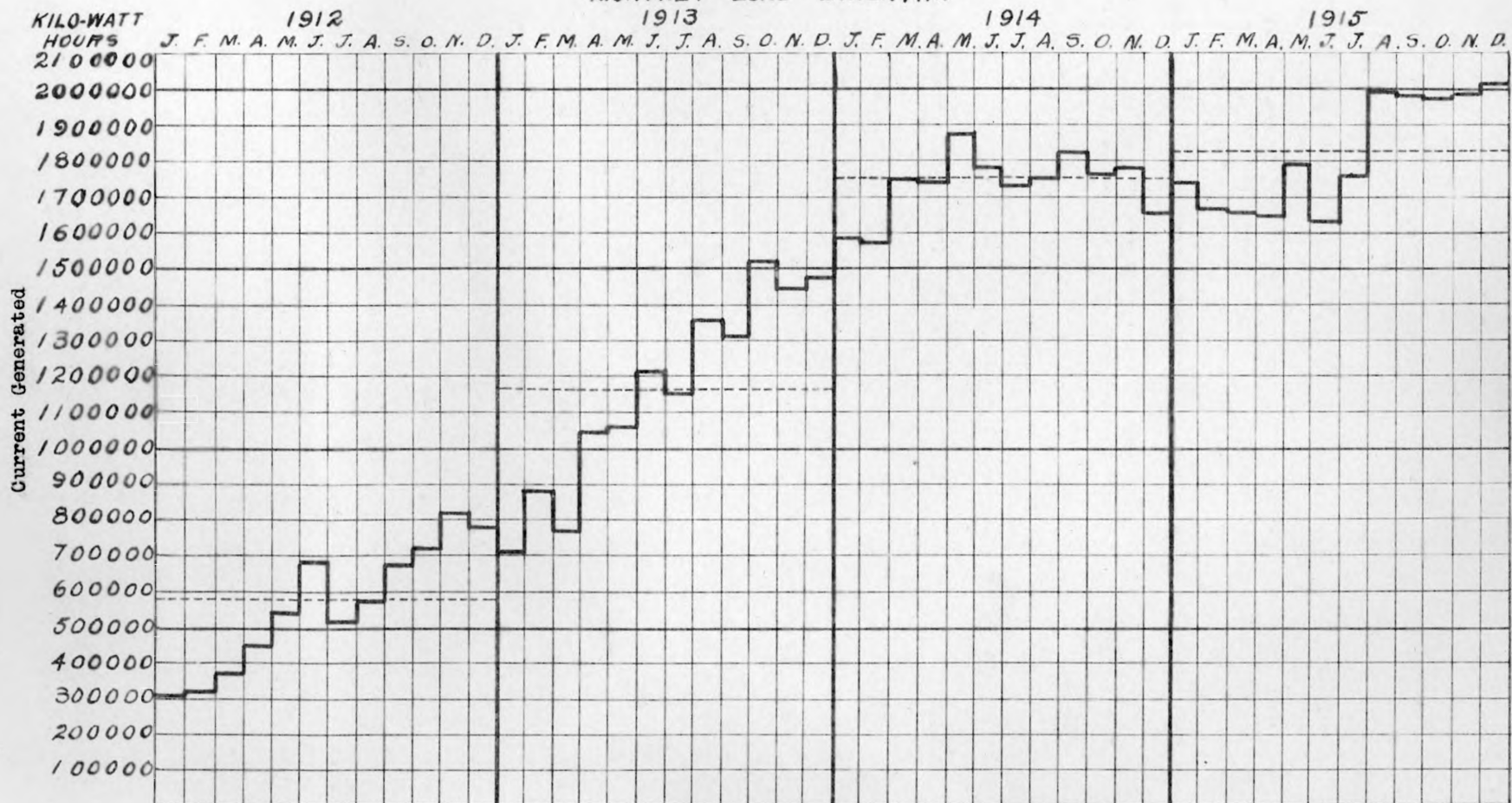
YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>SOUTH JACKSON MINE &amp; CRUSHER PLANT</u>					
1912	381	42,790	---	---	---
1913	483	1 940	---	---	---
1914	0	15 281	-----	---	---
1915	0	56 026	---	---	---
<u>GARDNER &amp; MACKINAV MINES</u>					
1914	303	-- ---	221,355,000	- ---	---
1915		(Idle entire year)			
<u>ATHENS MINE</u>					
1914	231	7,404 <sup>(7 months)</sup>	120,048,750	- ---	---
1915	385	21 245	242 196 750	- ---	---
<u>REPUBLIC MINE</u>					
1914	5,834 <sup>(8 months)</sup>	106,663	---	---	---
1915	7 353	244 697	1,711,333,000	6,993	---
<u>FRANCIS MINE</u>					
1915	603	---	---	---	---

Note:-

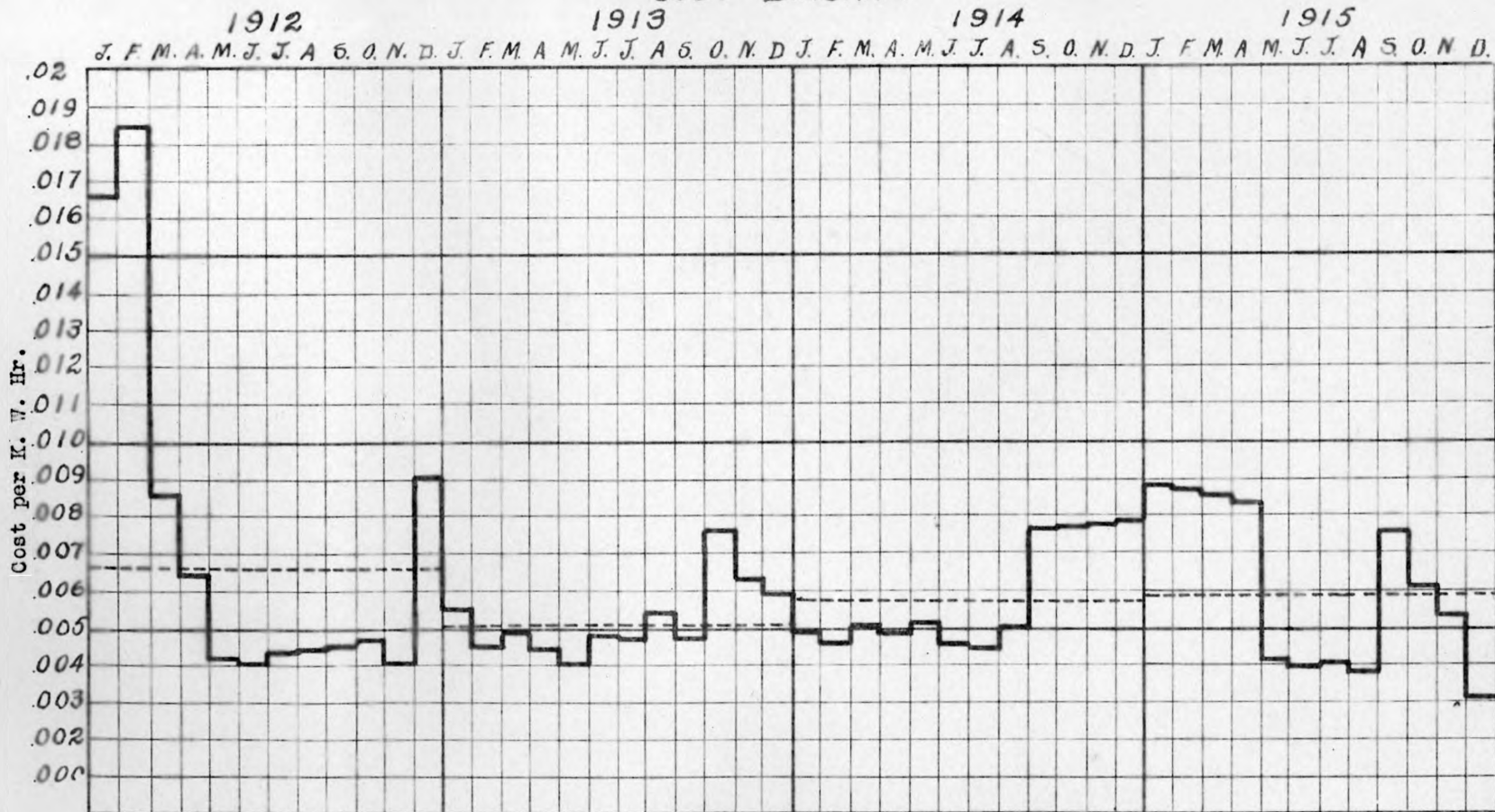
- Cliffs Shaft Mine - Steam pump operated in Jan., Feb. & March. Electric driven compressor started up September 20th.
- Salisbury Mine - Mining resumed in September.
- Negaunee Mine - Steam pumps operated in March & April. #2 Boiler Plant shut down April 9th. Started hoisting night shift in Aug.
- Maas Mine - Hoisting started from 3rd level winze Feb. 15th. Mining resumed in Sept. Increased flow of water July 3rd.
- Stephenson Mine - Steam pumps operated from March 7th to April 12th.
- Prin. C. P. Plant - Compressor changed to steam drive June 1st.
- Crosby Mine - No mining work carried on. Washing Plant built.
- Morris-Lloyd Mine - Furnished air to Cliffs Shaft Mine until Sept. 20th.
- Chase Mine - Shut down and abandoned in July.
- Francis Mine - Resumed sinking operations in March.

- - 0 - -

MONTHLY LOAD DIAGRAM



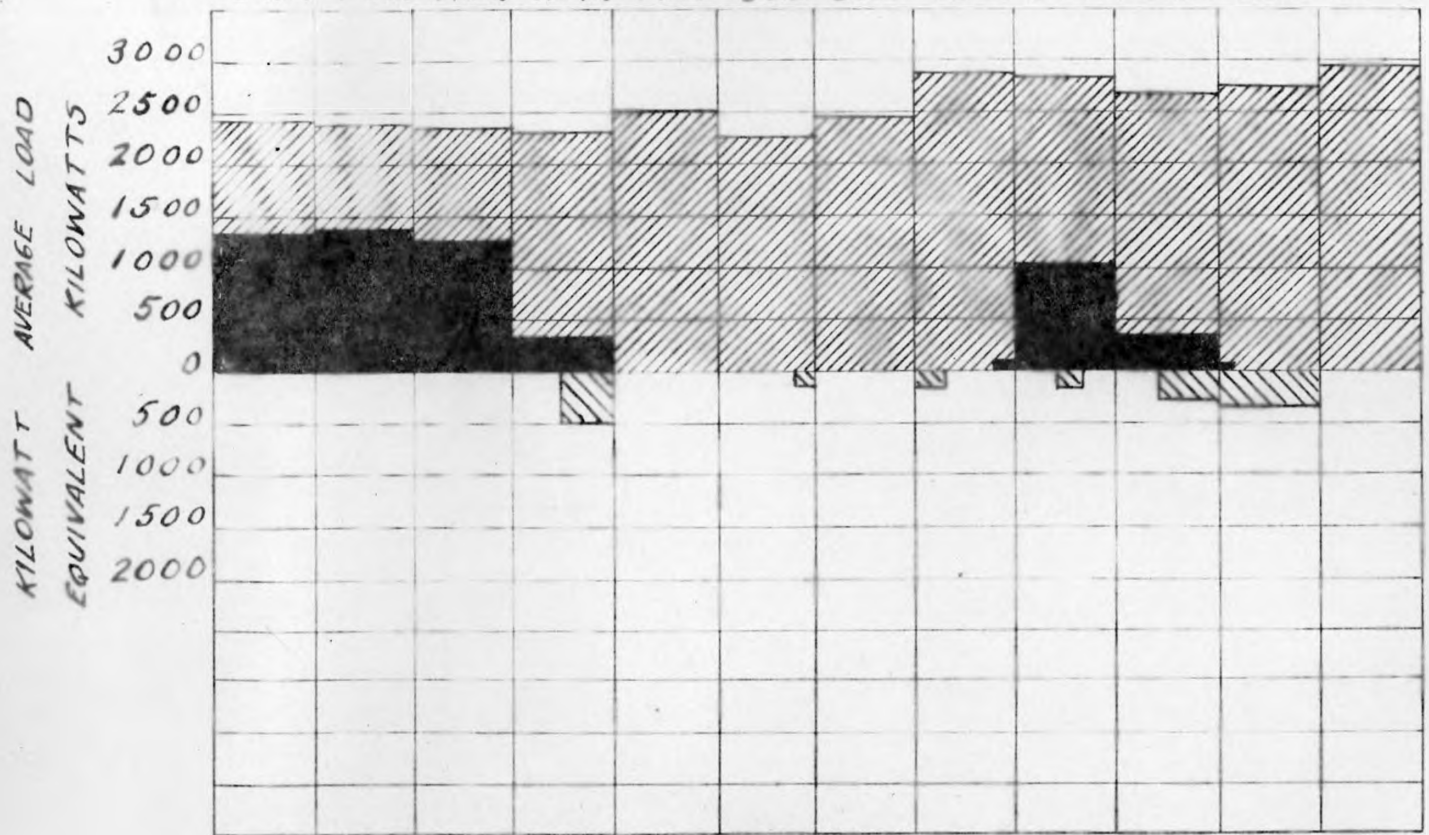
# COST DIAGRAM



10

# 1915

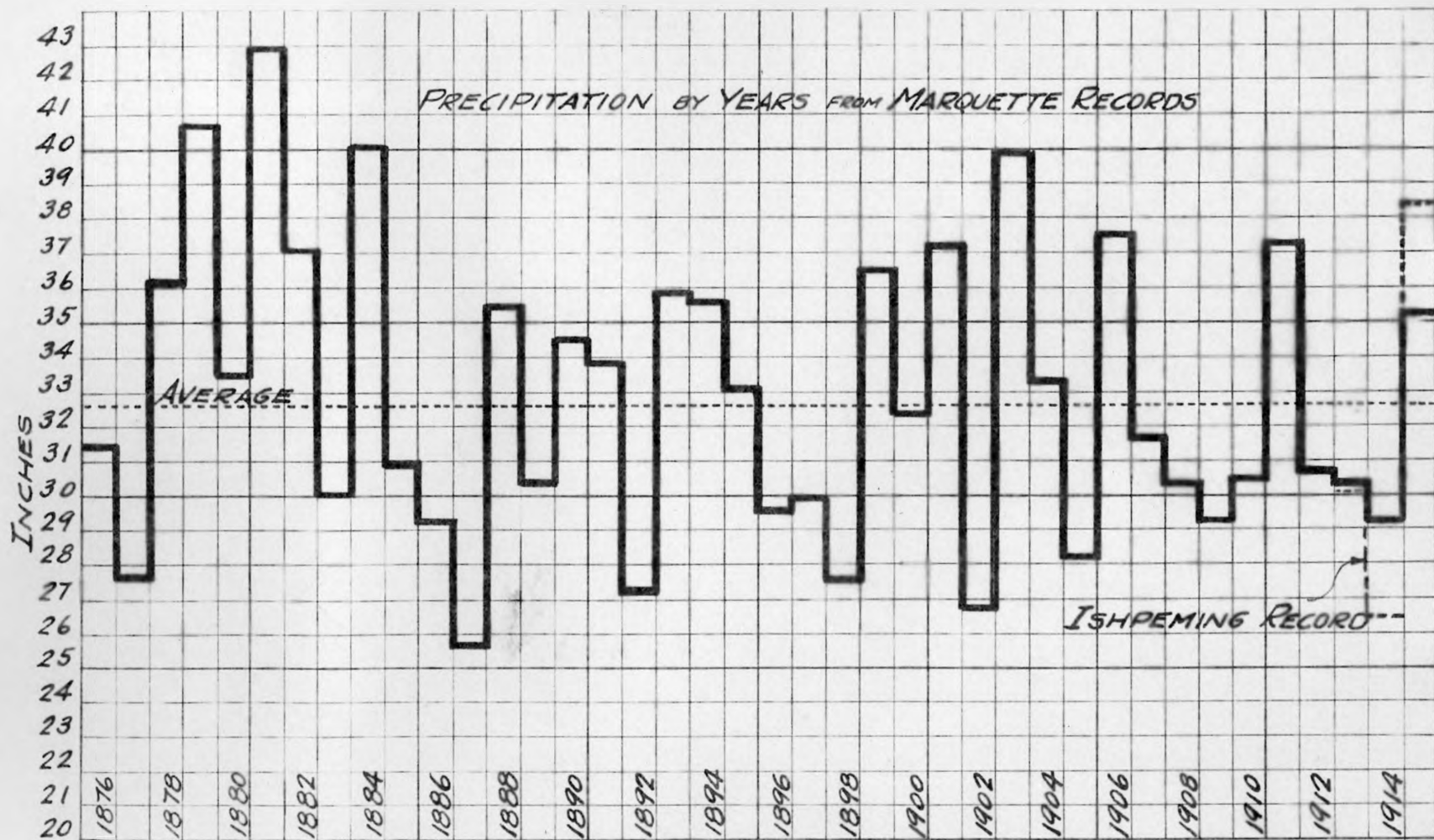
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.



DIAGONAL LINES CURRENT MADE BY WATER POWER

SOLID BLACK CURRENT MADE BY STEAM POWER

CROSS-HATCHED WATER LOST BY OVERFLOW



ANNUAL REPORT  
(1915)  
OF THE  
SAFETY DEPARTMENT.

\*\*\*\*\*

The Safety Department of the Company had the same organization in 1915 as in 1914 and its work was conducted throughout the year along the same procedure as has been outlined in the annual reports for previous years. A resume' of the work for the past year indicates marked progress in maintaining safety devices in and about the mines and a gradual development of a more favorable disposition on the part of employes in general towards the safety efforts of the Company. It is characteristic of many workmen to look upon any movement to better their working conditions as an innovation that may hide an ulterior motive, but as time passes without any advantage being gained to the employer and efforts are still being put forth to make the movement a success, the confidence of the workmen is gradually won and their cooperation is assured. The attainment of ideal safety conditions accompanied by the occurrence of very few personal injuries depends chiefly upon the sympathetic and active support of all employes, and the general policy of the Company in its safety work has been planned with this object in view. During the past five years there has been an improvement in the deportment of our employes, which is due entirely to the enforcement of the rules and regulations for the prevention of accidents. Violations of rules and disregard for the instructions of foremen are becoming less frequent. Safety first is a slogan that is permeating the atmosphere of our mines and bids fair to grow stronger in favor of our workmen with the lessening of fatal and serious accidents that have already been evident and should be still more apparent as time passes by.

Mine Rescue Work.

The year 1915 passed without a call being made for the mine rescue equipment from our mines or those of outside mining companies. However,

SAFETY DEPARTMENT.

shortly after the first of the year, the Calumet & Hecla Company sent in an urgent call for fire apparatus. We were in a position to grant the request, which proved to be of inestimable value to them as they had a very serious fire in one of their mines and were without adequate fire equipment. This is but an illustration demonstrating how important an up-to-date mine rescue equipment is and the absolute necessity of having it ready always in first class condition.

The danger of fire in our mines has been greatly reduced by the elimination of candles for lighting purposes. Underground workmen have to provide their carbide lamps and consequently there is no light left after shift as was formerly when candles were used. The second cause of mine fires has been due to defective electric wiring but the electrician of each mine has inspected the entire wiring under his care and has made it conform as closely as possible to the National Uniform Code. All danger of underground fire is by no means a past possibility. So long as combustible material, such as dry lagging, waste and oils must be taken underground and there are open lights, men smoking and electric wiring, there will be ever present the possibility of fire and hence the importance of maintaining mine rescue apparatus and men trained to use them.

#### Rescue Equipment.

The major portion of our equipment was purchased in 1914 and that which was in use prior to last year was sent to the factory and overhauled; hence there were few new parts needed last year and comparatively few repairs were made to pieces that easily become out of adjustment. In table I, which follows, is given a list of the new parts, repairs and supplies purchased the past year. Of the total, \$217.12, about one fifth, \$47.80, was spent in the purchase of new parts and repairs and the balance is the amount spent for the purchase of potash cartridges and oxygen, supplies used in practice work. In 1914 we spent \$485.00 purchasing similar supplies and \$116.10 on repairs, exclusive of new equipment and exchange of old.

In order to comply with an inter-state railroad rule, large oxygen cylinders have to be equipped with a fusible air valve as a safety precaution.



Our tanks have been equipped with this device but it has caused considerable inconvenience and loss of oxygen as the safety valves first turned out by the Draeger Oxygen Apparatus Company did not stand the pressure of the confined oxygen but the company has assured us that the difficulty has been overcome and the valves now being supplied are guaranteed to be satisfactory.

It is a rule that a canary bird must be kept at each mine for the purpose of detecting the presence of deadly gases, especially when there is a mine fire. Birds were obtained two years ago but several of them have died, probably on account of draft exposure. The canary songster is an important bird and due to the war local dealers have none for sale. We expect to succeed in obtaining a sufficient number for our present equipment through a dealer at Calumet.

Table I.

Helmet Supplies and Repairs.

100 Potash cartridges	\$100.00
55 Batteries	13.20
14 Refills of oxygen cylinders	56.12
3 Repairs to reducing valves	15.00
10 Diaphragm gaskets	2.50
4 Rubber parts for pulmotor	17.20
2 Litre bags	1.50
4 Rubber tubes	1.00
1 Set pump packing	2.00
1 Flexible bye-pass tube	5.00
1 Moisture trap	2.50
1 Safety disc	.50
6 Screens for injector nozzle	.60
Total,	<u>\$217.12</u>

Rescue Training.

Three to five men were trained monthly to use the rescue apparatus at each operative mine. Training was carried on in the smoke rooms and in the mines. Smoke rooms, which were recommended by the Central Safety Committee, have been provided in all the districts but as yet they have not been completed so as to provide proper places for practice work. The Safety Inspector will submit a report to the Central Safety Committee embodying such recommendations as are necessary to make these buildings adaptable for this work. The reduction in forces last year resulted in changes in the personnel of many of the

rescue teams as well as the first aid teams, but so far as possible the mining captains retained our most valuable men.

The mouth breathing attachment, which replaces the helmet, is being used more now than when first introduced and it will not be long ere its use will be accepted by all of our rescue men. No serious defect in the mechanism of any apparatus was discovered and whenever a wearer was found who claimed his machine was not working satisfactorily, the trouble was found to be in not having it adjusted properly or else the man was not complying with the rules necessary for the proper use of this apparatus.

The apparatus has been kept in the best condition possible under the supervision of Mr. Williams. The writer has made periodic inspections of the several stations, either in company with Mr. Williams or alone, and the entire equipment has always been found fit for immediate use. The reducing valve of the apparatus is apt to become defective without warning, but extra valves are kept in stock and it is but the work of a few minutes to make an exchange. A thorough test of the entire equipment of each station is determined monthly and a report of the same is filed in the office of this department. Mr. Williams makes it a special part of his work to watch with keenness the men who he is training, for knowing as he does that the apparatus is in safe working order, any abnormal symptoms on their part may probably indicate a physical weakness that would disqualify them for this work. Mr. C. S. Stevenson and the writer are agreed in their opinions that Mr. Williams by constant and diligent application during the past three years has qualified himself to handle our mine rescue apparatus and the training of our men so that in time of a fire we should be able to cope with it successfully.

#### First Aid to the Injured.

#### Actual Work.

It is not even yet possible to determine accurately the exact figures as to how many of our injured failed to receive first aid treatment before leaving a mine for home or hospital. From the description of an in-

jury it is not always safe to classify the injury as one that may or may not have required the aid of a first aid man. Then, too, it happens very frequently that a workman will receive a slight injury and continue working throughout the shift and remain home the following day, which means that an accident report must be recorded. The number of injuries that failed to be treated by first aid men last year were very few indeed, and we have no record nor have we heard of a single case where a serious accident was not given proper treatment. There were reported 26 less accidents in 1915 than in 1914 and our accident reports show ~~that~~ 45 more first aid treatments in 1915 than in 1914. Of 427 accidents last year, 236 were reported receiving necessary first aid help. An examination of the causes of accidents shows very clearly that there are many accidents occurring that our first aid men cannot be expected to aid, for instance; 37 cases of straining or wrenching, 27 cases of falls, which usually causes no external injury, and 11 cases of poison or infection, which usually develops slowly after workmen have failed to take proper care of a slight injury. It is a common practice now to send for a first aid man as soon as there is a rumor that a workman has been injured and in fact injured workmen themselves ask for their aid before leaving the mine. That first aid to the injured is worth the money spent in keeping a trainer and instructing workmen is proven by citing some of the work that was rendered last year. Space does not permit recording more than is warranted to prove this statement.

More cases of complete or partial suffocation by powder fumes occurred in 1915 than in any year since the safety department was organized. An explanation for this may be found in the fact that several mines had - extraordinary construction in progress and also to the introduction of dynamite by the manufacturers, which probably resulted in making more fumes than is considered permissible. This probability is discussed later on in this report. In the Lake Mine a rock raise was put up from the third level to surface and in the Salisbury Mine a long drift to the new ore body was completed. In each of these places the rock was extremely hard, demanding

heavy charges of dynamite to break. As there was urgent demand for progress workmen took chances that they would not have taken if they were mining ore. One life was lost and quite a few workmen on different occasions were taken from the mine in a helpless condition. With one exception artificial respiration was used successfully by first aid men. To illustrate the importance of this feature of our work one case will be given. Three miners went to work in the Salisbury drift on the night shift, beginning at 11 o'clock. The miners on leaving the drift on the close of the afternoon shift had blasted. The night crew started to work and very shortly one of them felt himself becoming weak. He told his fellow workmen of his condition and they started to take him towards the shaft. The man became entirely unconscious and the other two workmen began to feel the effects of the gas and with much difficulty succeeded in getting him to fresh air. They were, however, unable to take him out to the shaft and one of the two rescuers crawled out to the shaft station and sent the alarm to surface. Surface employes entered the mine and recovered the three men and in a short time with the aid of oxygen and by artificial respiration revived them before a physician had reached the mine. Miners employed at the Cliffs Shaft and the Morris-Lloyd Mines have been knocked out by gases from time to time but they have been taken in charge by first aid men, compelled to inhale fresh oxygen and were sent home with instructions as to their diet and proper care.

<u>Mine</u>	<u>Name</u>	<u>Occupation</u>	<u>Nature of Injury</u>
Cliffs shaft	John Salson	Trammer	Compound comminuted fracture left thigh, simple fracture both bones left leg and contusions of left hip and back.
Cliffs shaft	Oscar Huhtala	Miner	Multiple scalp wounds, multiple contusions and concussion of brain.
Gwinn	Peter Saurdi	Miner	Burn of right hand and upper part of face.
Gwinn	Chas. Aho	Trammer	Broken left collar bone.
Lake	William Thomas	Coal Trammer	Fracture of left fibula.
Lake	Ed King	Fireman	Compound comminuted fracture of first and second fingers, right hand, with severing of extensive tendons.

<u>Mine</u>	<u>Name</u>	<u>Occupation</u>	<u>Nature of Injury</u>
Lake	Victor Jackson	Miner	Blasted face, eyes, arms, neck and thigh, with particles of dirt.
Lake	Robert Wilcox	Miner	Dislocation of left shoulder.
Morris-Lloyd	Leo Zoppetti	Trammer	Compound fracture of second finger, left hand.
Morris-Lloyd	Arthur Mackie	Trammer	Burns of face and eye.
Morris-Lloyd	John Valimaa	Miner	Broken upper arm.
Maas	Matt Aho	Miner	Bruised and cut about mouth, teeth loosened and bruised over right kidney.
Maas	Andrew Peterson	Surface Laborer	Deep electric burn of right thumb and abrasion of lobe of left ear.
Negaunee	Wm. Pennanen	Miner	Left index finger nearly amputated at first joint.
Negaunee	Edwin Anderson	Surface Laborer	Lacerated wound on right eye about three inches in length.
Negaunee	Angelo Sartori	Miner	Laceration of nose, left side, two inches long through to nasal cavity. Nasal cartilage completely torn loose.
Republic	Jule Van DeCastile	Filler	Contusion of right foot with fracture of little toe.
Republic	Alphonse Tindemans	Pufferman	End of middle finger, left hand, pinched off at middle of nail. Nail all gone.
Salisbury	J. H. Dunstan	Captain	Fracture of collar bone.
Stephenson	Andrew Felezetti	Miner	Fracture tibia and fibula both legs.
Stephenson	Ermon Nocenti	Top Lander	Fracture of left thigh and fracture of 5th and 6th ribs, left side.
Stephenson	Fred Nault	Miner	Fracture of left lower leg.

#### First Aid Equipment.

To maintain a sufficient supply of first aid material where it will be available when needed is a problem because of the habit common to many men to appropriate for personal property anything tangible, providing it be not too bulky and there is no danger of being detected in the act. As we have endeavored to provide such material as has been recommended by the Central Safety Committee it has been found necessary to make a very limited distribution and this only

under lock and key or in the possession of trusted employes. As all underground employes must enter the dry-house before leaving the mine, a Red Cross first aid cabinet is kept in the ambulance room and most of the dry keepers are now qualified to treat injuries. An effort was made by a committee, appointed by the Central Safety Committee, to procure a box for shift bosses to carry on their person but nothing suitable could be found. Metal first aid packages are given to shift bosses and such other first aid men whose work requires them to cover territory where they are apt to come in contact with fellow workmen. Leather finger cots are in great demand, as there are very many minor finger injuries which can be protected by wearing them. One or two cases of prevention of infection, such as we have suffered in the past, will more than pay for all the finger cots that we have bought. A small bottle of iodine is now supplied as a part of each first aid kit. It is made in the company's laboratories and is used to dress wounds to prevent infection.

It has been the aim of this department to furnish first aid supplies wherever there is a liability of a personal injury in the mining department, and to this end small quantities of roller bandages, adhesive tape, spirits of ammonia, etc. have been given to shop foremen, drill foremen and the men in charge of construction work in new territory, such as water power, shaft sinking, etc.

#### First Aid Training.

Six first aid teams completed the regular course as outlined by the Bureau of Mines and the American Red Cross and a demonstration was held before the local officers of the Company. Twenty-three men received first aid certificates and souvenir watch fobs, making a total of 105 men who have completed the work to date.

Nine new teams were organized and are well advanced in training. New mines like the Athens, Francis and Angeline give employment to few men and it would interfere very seriously with mining operations if a full quota were taken to compose a team. It is the custom at these mines to train at

least two men and always with the object of training them when it will not delay or interfere with their usual occupation.

Representatives of the U. S. Bureau of Mines were in Ishpeming several times during the year and inspected our training. They rendered such assistance as they had to offer in showing new methods which have been adopted by the Bureau. In this connection it is worthy to note that while the Bureau no longer keeps the pulmotor for resuscitating an unconscious person it nevertheless has a lungmotor as a part of the equipment with the car that has been designated for the Lake Superior district, although it is not kept here all the time. No definite conclusion has been reached by first aid experts as to rejecting or accepting a mechanical appliance for reviving victims of gas, drowning and electric shock.

It was decided that the Company should be represented in the Second Annual First Aid Contest under the auspices of the Lake Superior Mining Institute, which was held in Ironwood on Labor Day. A Company contest in which picked teams took part was held on the lawn, west of the Engineering building, July 22nd. Special training had been given all these teams for several weeks before the contest and the spirit of rivalry exhibited was very keen but friendly. The judges were local physicians and teams representing the Negaunee and Morris-Lloyd Mines won first and second places. It was decided that participants, having the highest individual markings, should be selected to form the two teams to represent the Company in the contest at Ironwood. After the selection of the personnel of the two teams had been decided upon every effort possible was made training them for the final contest. Mr. C. S. Stevenson assisted Mr. Williams in this work and spared neither time nor labor in his usual characteristic way to produce winning teams. Our boys looked forward to making a very creditable showing but they were doomed to disappointment. The method of artificial respiration used by us was not approved by the head judge and as the full penalty was permitted to stand in every instance where our men used this so-called Howard method, it put them out of the running and they returned home with their trainer very much chagrined and sadly disappointed.

ted. They were greatly encouraged and took a more philosophic view of the affair later on when informed that the Agent of the Company was satisfied so long as they had had a good time otherwise.

Table II.

First Aid Supplies.

Roller bandages	\$45.00
First Aid outfits	36.60
Metal first aid packets	3.00
Spirits of ammonia	8.90
Plain gauze	10.80
Picric gauze	11.80
Absorbent cotton	6.84
Scissors	3.60
Z. O. tape	11.40
Carbolated vaseline	1.20
Finger cots	7.15
Muslin for triangular bandages	19.04
Splints	1.90
Sewing brattice cloth	2.50
Suits for first aid teams	59.60
Turpentine	.95
Vaseline	.20
Total	<u>\$230.48</u>

Table III.

Showing the number of Helmet and First Aid Practices and the number of men receiving training by mines during year.

Mine	First Aid Practices	No. of Men Trained	Helmet Practices	No. of Men Trained
Athens	5	6	0	0
Cliffs Shaft	18	16	9	7
Gwinn	15	13	10	10
Lake	16	16	10	7
Maas	4	5	4	3
Negaunee	18	10	10	13
Morris-Lloyd	18	14	8	7
Republic	14	16	10	10
Stephenson	15	17	10	11
Chase	0	0	2	3
Princeton				1
Engineers	5	9	4	9
Electricians	1	3	0	0
Contest teams	29			
Total	<u>158</u>	<u>125</u>	<u>77</u>	<u>81</u>



Table IV.

Showing Occupation and Nationality of Mine Rescue  
and First Aid Men now in the Company's Employment.

<u>Occupation</u>	<u>Helmet</u>	<u>First-Aid</u>	<u>Nationality</u>	<u>Helmet</u>	<u>First-Aid</u>
Mining Captains	3	3	American	26	36
Shift bosses	20	26	English	39	72
Miners	27	37	Finnish	17	10
Timbermen	13	13	Scandinavian	6	24
Underground Laborers	3	4	French	1	14
Electricians	4	7	Austrian	2	2
Motormen	1	5	Italian	5	7
Pumpmen	3	3	German	0	1
Cage Riders	1	2	Total	96	166
Trackmen	2	2			
Pipemen	3	4			
Drymen	0	2			
Engine House Men	0	3			
Surface Foremen	0	8			
Surface Laborers	0	9			
Samplers	2	6			
Clerks	0	6			
Chemists	0	3			
Blacksmiths	0	4			
Machinists	0	6			
Mining Engineers	10	9			
Miscellaneous	4	4			
<b>Total</b>	<b>96</b>	<b>166</b>			

Table V.

Showing Number of Accidents Reported Receiving  
First Aid Treatment and Not Receiving Treatment.

<u>Mine</u>	<u>Receiving Treatment</u>	<u>No Treatment</u>
Athens	5	2
Chase	3	1
Cliffs Shaft	26	17
Gwinn	36	6
Lake	22	20
Maas	5	4
Morris-Lloyd	28	25
Negaunee	20	13
Republic	42	68
Stephenson	40	16
Salisbury	4	1
Crosby*	0	9
Miscellaneous	5	9
<b>Total</b>	<b>236</b>	<b>191</b>

\*Accident reports gave no information.

SAFETY INSPECTION.

A safety inspection report of each mine was submitted monthly; a total of twelve reports being made; two by foremen committees, two by workmen committees and eight by the inspector. The surface haulage and top tram system of the Stephenson Mine was inspected by the Central Safety Committee. Whenever a dangerous condition was found, which was not in accord with the general policy of the Company, the mine superintendent was asked to inspect the same by the inspector, and this method of procedure always resulted in accomplishing the desired result without creating friction or ill-feeling among employes. The superintendents are anxious to enforce all safety rules but, kept busy as they are with their routine work, they depend largely upon their foremen to enforce them. As a general rule, they dislike to have unfavorable reports turned in to the General Office, and whenever their attention is invited by the inspector to a dangerous practice or slack enforcement of rules they exhibit a gratifying alacrity to eliminate the danger or hold somebody to account for the non-enforcement of the safety rules. The Safety Inspector makes it a point to create a feeling of mutual cooperation on the part of the mining captains but this could not be gained if every minor violation of rules found in the mines was reported. When a violation is an exception and not the condition in general throughout a mine the captain's or shift boss' attention is attracted to it and no report is made of it, unless no immediate action is taken by them to comply with the rules. On the last tour of inspection of one of our mines a stick of dynamite was found by the inspector in a box with detonators. The shift boss in charge of the miner, who had unintentionally been guilty of violating a rule, is very conscientious in the discharge of his duty. If he were taken to task by his mining captain or superintendent for having this reported, he would feel, and justly so, that he was being held to account for a violation which may occur any time and which he could not prevent. Guard rails will be knocked down, gratings found missing and other similar unsafe places found even in the best governed territory and it is up to the inspector to use considerable latitude in reporting