

FOWLER MINE

AVERAGE MINE ANALYSIS OF OUTPUT FOR YEAR-1917

GRADE	IRON	PHOS.	SILICA	MANG.
Fowler,	56.33	.048	11.86	.99

ORE STATEMENT AND SHIPMENTS FOR YEAR-1917.

	FOWLER	TOTAL LAST YEAR
On Hand Jan. 1st, 1917,	2,725	686
Output for Year,	10,306	2,039
Stockpile Overrun,	981	
Total,	14,012	2,725
Shipments,	11,137	0
Balance on Hand,	2,875	2,725

1917 - 2-8 Hr. Shifts Jan. 1st to Feb. 1st.

No Ore produced Feb. 1st to April 24th.

Hoisted through Meadow shaft - April 24th to Dec. 31st.

1916 -Began operating Dec. 1st - 2-8 Hr. Shifts.



FOWLER MINE.

MINING COSTS FOR YEAR 1916.

	1 9 1 7.	1 9 1 6.	INCREASE.	DECREASE.
<u>PRODUCT</u>	2,395	2,725		330
General Expense	.079	.013	.056	
Maintenance	.053	.045	.008	
Mining Expense	.846	1.168		.322
<u>Cost of Production</u>	.978	1.226		.248
Equipment	.021		.021	
Taxes	.076		.076	
Sundry Expense	.005	.018		.013
Supply Inv.	.003			.003
<u>Cost on Stockpile</u>	1.077	1.244		.167
Loading & Shipping	.068		.068	
<u>Cost on Cars</u>	1.145	1.244		.099
No. Days Operating		25		
No. Shifts and Hours		2-8hr		
Avg. Daily Product		109		

Discontinued hoisting through Fowler Shaft Jan. 22, 1917.  
Now hoisted through Meadow.



REPORT OF THE ENGINEERING FORCE EMPLOYED DURING THE YEAR 1917,  
AND A BRIEF OUTLINE OF THEIR WORK,  
BY CARL BREWER, ASSISTANT ENGINEER.

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THE FORCE.

There has been a considerable change in the personal of the Engineering department at the Ishpeming office during 1917 due to departure of three engineers into military service and the employment of new men to fill their places; also more helpers.

The following list comprises all those in the department during the year, arranged in order to entrance:

NAME.	POSITION.	ENTERED.	LEFT.	SUBSEQUENT POSITION.
C. Brewer	Asst. Eng.	Entire year		
J. F. Hanst	Engineer		March 27	Engineer with Andes Copper Mining Co.
R. J. Chenneour	"	Entire year		
H. O. Moulton	"	" "		
J. K. Osborne	"	" "		
J. E. Hayden	"		May 11	U. S. Army Officers Training Camp.
A. Rock	Helper	Entire year		
J. Trosvig	Engineer	" "		
T. A. Miller	"	" "		
J. Heilala	Helper	" "		
S. Malmgren	"	" "		
C.W.Nicolson	Engineer		March 15	Engineer with British Columbia Copper Co.
		June 21	August 22	U. S. Army Officers Training Camp.
C.S.Stevenson	Engineer	January 5	August 21	U. S. Army Officers Training Camp.
W.F.H.Janzen	"	March 21		
C. Nichols	Draftsman & Chauffeur	March 26	October 3	Michigan Agricultural College.
A. Alanen	Draftsman	April 23		
A. Minnear	Helper	June 15		
M.C.Connolly	"	Sept. 10		
H. Perttula	Chauffeur	Oct. 3	Dec. 13	None.

All the above except S. Malmgren were on salary basis.

Besides the above, the following were employed during the summer for the field work in connection with the McClure plant. With the exception of G. Latrell, who left when school opened, all were transferred to the construction gang at the McClure dam when the field work was finished on August 20th:

NAME.	POSITION.	ENTERED.	LEFT.
Ernest E. Eman	Chopper	June 25	August 20
Joseph Fortier	"	June 25	August 20
Cyrille Fortier	"	June 26	August 20
Henry Pierault	"	June 26	August 5
John F. Thompson	Helper	June 26	August 11
Rudolph Johnson	"	June 26	June 30
E. B. Raymond	Cook	June 26	August 20
Chas. Beaulieu	Cook	June 28	August 20
George Latrell	Helper	July 2	August 27
Leo Fortier	Chopper	August 11	August 20

The following table shows days worked, days lost, percentage, etc., of all salaried men. The vacation column shows time granted for regular vacations, while the absence column gives time lost for other reasons, except sickness. Eight hours constitute a day and over time is credited against absence, except vacations. Saturday afternoons were given throughout the year:

NAME.	DAYS WORKED.	DAYS VACATION.	DAYS ABSENT.	DAYS ILLNESS.	TOTAL DAYS.	PERCENTAGE DAYS WORKED.
C. Brewer	275 $\frac{3}{4}$	0	1 $\frac{3}{4}$	0	277 $\frac{1}{2}$	99.4
J. F. Hanst	58 $\frac{1}{2}$	0	0	9 $\frac{1}{2}$	69	84.8
R.J.Chenneour	250 $\frac{1}{2}$	6 $\frac{1}{2}$	20	$\frac{1}{2}$	277 $\frac{1}{2}$	90.0
H.O.Moulton	254	21	2 $\frac{1}{2}$	0	277 $\frac{1}{2}$	91.5
J.K.Osborne	262 $\frac{1}{2}$	0	0	15x	277 $\frac{1}{2}$	94.6
J. E. Hayden	96 $\frac{1}{2}$	0	1 $\frac{1}{2}$	1	99	96.6
A. Rock	251 $\frac{1}{2}$	0	20	6	277 $\frac{1}{2}$	90.6
J. Trosvig	271 $\frac{1}{2}$	0	6	0	277 $\frac{1}{2}$	97.9
T. A. Miller	268	10	0	1	277 $\frac{1}{2}$	96.5
J. Hellala	253	11 $\frac{1}{2}$	4 $\frac{1}{2}$	8 $\frac{1}{2}$	277 $\frac{1}{2}$	91.2
C.W.Nicolson	106 $\frac{1}{2}$	0	0	$\frac{1}{2}$	107	99.5
G.S.Stevenson	163	0	1 $\frac{1}{2}$	2	166 $\frac{1}{2}$	97.9
W.F.H.Janzen	217	0	0	0	217	100.0
C. Nichols	149	0	0	0	149	100.0
A. Alanen	188	0	5 $\frac{1}{2}$	0	193 $\frac{1}{2}$	97.2
A. Minnear	151	0	1	0	151	100.0
M. C. Connolly	81	0	5 $\frac{1}{2}$	$\frac{1}{2}$	87	93.1
H. Pertula	47 $\frac{1}{2}$	0	0	0	47 $\frac{1}{2}$	100.0

x Days absent because of injury while at work.



The table below shows the number of working days lost on account of illness or absence by those now in the department, during the last five years:

	1913.		1914.		1915.		1916.		1917.	
	VACA- TION.	SICK. TION.	VACA- TION.	SICK. TION.	VACA- TION.	SICK. TION.	VACA- TION.	SICK. TION.	VACA- TION.	SICK. TION.
G. Brewer							0	0	$1\frac{3}{4}$	0
R.J.Chenneour	15	0	16	2	15	$2\frac{1}{2}$	$2\frac{1}{4}$	2	$26\frac{1}{2}$	$\frac{1}{2}$
H.O.Moulton	$11\frac{1}{2}$	0	$14\frac{1}{2}$	3	0	0	0	1	$23\frac{1}{2}$	0
J.K.Osborne	$2\frac{1}{2}$	$2\frac{1}{2}$	$25\frac{1}{2}$	3	$1\frac{1}{2}$	2	0	$4\frac{1}{2}$	0	15
A. Rock	10	4	2	$6\frac{1}{2}$	12	$6\frac{1}{2}$	12	1	20	6
J. Trosvig	$8\frac{1}{2}$	$4\frac{1}{2}$	6	$5\frac{1}{2}$	0	0	0	0	6	0
T.A.Miller							7	0	10	1
J. Heilala									16	$8\frac{1}{2}$
W.F.H.Janzen									0	0
A. Alanen									$5\frac{1}{2}$	0
A. Minnear									1	0
M.C.Connolly									$5\frac{1}{2}$	$\frac{1}{2}$

The following table shows those employed in the office during the last five years, arranged in order of entrance, the months worked, and the average number employed per month:

	1913. MONTHS.	1914. MONTHS.	1915. MONTHS.	1916. MONTHS.	1917. MONTHS.
C. J. Stakel	12	12	12	4	
C. Brewer				8	12
J. F. Hanst	12	12	12	12	3
R.J.Chenneour	12	12	12	12	12
H.O.Moulton	12	12	12	12	12
J.K.Osborne	12	12	12	12	12
W.L.Scanlan	9				
Arthur Aas	12	$9\frac{1}{2}$			
A. Rock	12	12	12	12	12
F.G.Rockwell		7	8		
J. Trosvig	12	$9\frac{1}{2}$	1	12	12
E. L. Derby	12	12	12	8	
M.F.LaCroix	12	9	1		
J. E. Hayden	12	12	12	12	$4\frac{1}{2}$
Edward Ham	7	8			
T.A.Miller				$11\frac{1}{2}$	12
J. Heilala				11	12
S.Malmgren				8	12
C.W.Nicolson				6	$4\frac{1}{2}$
C.S.Stevenson					$7\frac{1}{2}$
W.F.H.Janzen					$9\frac{1}{2}$
C. Nichols					6
A. Alanen					8
A. Minnear					$6\frac{1}{2}$
M.C.Connolly					$3\frac{1}{2}$
Average number of men	14 $5/12$	12 $1/3$	11 $7/12$	8 $5/6$	13 $5/12$



Each man's share of the work of the department is described below:

Carl Brewer has had charge of the work in the office the entire year.

The preparation of the Annual Report Books occupied most of his time during the first two months of the year. He assisted in the measuring in the clearance between shaft runners at the Cliffs Shaft, Lake, Maas and Holmes mines. He ran the check surveys on the 3rd and 4th levels Maas mine and 10th and 12th levels Negaunee mine for raising the shafts. At all of the mines he has assisted on one or more monthly surveys, as well as keeping in touch with the other engineering work. He took charge of the surveys for the McClure plant on the Dead river and was in the field from the start to the finish of the preliminary surveys. Nearly all of the office work in connection with the plans and profiles of the pipe line and dam and the maps were made by him. He ran the survey from the Hoist to the McClure dam and for the limits of proposed intake basin. With Mr. Nicolson, he ran the stadia survey of the Dead river from the dam to Forestville. After the construction work started, he did all of the field work in connection therewith. On the surveys of the South Jackson, Maas and Athens mines surface and the monthly estimates at the Angeline mine stripping he took his share. He drew up a preliminary surface lay out for the equipment at the Barnes & Hecker shaft after spending several days contouring the  $N\frac{1}{2}$  of the  $NW\frac{1}{4}$  of Section 2, 47-28. At the new hospital in Ishpeming, he staked out the building after the excavations were finished. Two of the quarterly surveys and tonnage estimates of the Boston mine were made by him. At the Barnes & Hecker shaft he lined in the first two sets after the excavation had reached ledge. In the office he started filing maps, plates, etc, in the new fixtures in No.2 Vault. He has looked after the ordering of supplies and has spent considerable time in going over the mounted maps and records to see that information has been properly recorded. He drew up blanks for recording shaft data for the different mines and in general has attempted to systematize the recording of miscellaneous information acquired.



J. Faber Hanst was with the Company until March 27th. His health for several months previous had not been good and toward the last became much worse. The doctors advised him to go to a different climate and he accepted a position as mining engineer with the Andes Copper Mining Company in Chile. Until his departure, he spent nearly all his time at the Athens mine. He lined in the shaft sets, took measurements for the runners and laid out the level plats. Considerable time was occupied in designing a standard pocket to be built at the various levels. He also drew up plans for the location of buildings, roads, etc, on surface. Several days were spent on the geological maps of the Ishpeming-Negaunee districts, prepared during 1916, to post all his notes, but sickness prevented the completion of this work.

Reginald J. Cheneour until October spent all of his time in connection with the Negaunee mine. Since then he has looked after the engineering at the South Jackson mine. The proportion of his time at the two properties has been divided as follows:

Negaunee mine	95%
South Jackson mine	5%.

He made all the monthly surveys of the Negaunee mine and also made weekly visits to the sub-levels under development for geological information. He watched the underground work closely, was always on the look out for possible ore extensions and gave lines for raises, drifts, etc, as necessary. He ran several surveys from the 10th to the 12th level for raising No.3 shaft. After holing, he plumbed down from above and set the bearers for the new lift. On the 11th level he gave lines for cutting the pocket and looked after the concreting of the pocket. He drew plans for concreting the 11th level plat and changed the pocket design to suit conditions. In the mining operations in the American Mining Company strip, he gave lines for raises and drifts and carefully watched the boundary lines. Considerable time was spent going over old maps for information regarding ore possibilities above the 9th level in the vicinity of No.1 shaft. He drew cross-sections through No.2 shaft pillar in connection with its development. On surface, he staked out



and looked after the concreting of the foundations of the new top tram engines. In the office, he spent all of January making a new estimate of the ore reserves of the Maas-Negaunee basin, working with Messrs. Derby and Moulton. He also made many new mounted maps of various sub-levels. At the request of Mr. Jackson, he was put in charge of the engineering at the South Jackson. He made a survey of the open pit and a series of cross-sections from which he devised and submitted several plans for development. He staked out and surveyed the drill holes. His only outside work was to check the location of the shaft raise on the 4th level Maas mine during the absence of Mr. Moulton.

Henry O. Moulton spent 80% of his time on the engineering work at the Maas mine. He made all the monthly surveys and under the direction of Mr. Jackson laid out the development work on new sub-levels. The rock drifts on the 1st, 2nd and 4th levels were driven under his direction. He ran check surveys and successfully holed the shaft raise from the 4th to the 3rd level. He designed the shaft timbering in the new lift to adjust the present shaft to the standard shape and set the bearers with regard to the concrete portion of surface. He made the estimate of the Maas mine ore reserves for the Tax Commission, working with Messrs. Derby and Chenneour on the new estimate of the Maas-Negaunee basin. He also helped Mr. Stevenson with the Cliffs Shaft ore estimate. He assisted at the plumbings of the Holmes shaft and in the measuring of the distances between the shaft runners at several mines.

At the new crusher plant, he laid out the foundations for the Mechanical department and during construction gave lines as necessary. In the spring he staked out and allotted the 350 half acre garden lots on Company land in the Negaunee district. He ran the survey and made the deed descriptions for the conveyance of the land in the vicinity of the Carp river storage basin No.2 to Mr. Cowling. At the Athens mine, he ran a check survey to the concreted iron pins. He surveyed and made new mounted maps of the SW $\frac{1}{2}$  of Section 31, 48-26. He ran a check survey from the Hoist to the McClure dam and along the pipe line to the original pipe



line survey. He assisted in giving lines and grades at both the dam and power house of the McClure plant and grade stakes along the pipe line. He prepared the Annual Report maps of the Maas mine. All the coal estimates of the Negaunee district were made by him early in April. During the absence of Mr. Brewer, he was in charge of the work in the office.

John K. Osborne has divided his time between the Lake, Salisbury, Holmes and Cliffs Shaft mines. He made the monthly surveys of the Salisbury and Lake mines until May and October respectively and of the Holmes and Cliffs Shaft mines since April and September. His time spent on these mines is divided as follows:

Lake	28%
Salisbury	11%
Holmes	32%
Cliffs Shaft	12%

At the Lake mine, he made frequent surveys necessitated by crushing of the sub-levels. He gave lines for drifting on the 935' sub-level to the Lake Superior workings to drain the water.

His work at the Salisbury mine was confined mostly to sketching the monthly advances, but several surveys were run into the upper sub-levels in the South Side deposit as the development work extended up to the top of the deposit. Also, in the main deposit he watched carefully the work in the vicinity of the old open room between the 5th and 8th levels. He took charge of the engineering work at the Holmes mine as the development of the hard ore stopes on the 2nd level progressed and he was constantly called upon for lines. When the 1st level was opened, he gave lines for holing to the various parts and also for the drift to the shaft. He looked after the development work along the boundary and reported on the trespasses by the Lake Superior Iron Company. On surface, he staked out stocking trestles and assisted in setting the corners of the timber yard lease.

Since September he has made the monthly surveys at the Cliffs Shaft mine. He has also staked out stocking trestles and made an estimate of lump ore in stock. Until October, he located and surveyed the churn drill

holes at the South Jackson mine and also the drill holes in the Bellevue district. He assisted measuring the shaft runners at the Lake and Cliffs Shaft mines. At the Republic mine, he assisted on the outcrop survey in June. During the year, he has continued the monthly carbon report and he has also reported on all the carbon purchases. He made the diamond drill inventory in November. On February 6th, he was struck on the shoulder by a motor in the Lake mine and was out of the office for three weeks.

J. Ellsey Hayden looked after the engineering work in the North Lake district until he left the Company's employ. He made the monthly surveys at the Morris-Lloyd mines and gave lines, etc, as called for. He assisted Mr. Bush in laying out exploration work and development. He made the ore estimate for the North Lake district and prepared the maps for the Tax Commission. An East-West vertical projection of the Morris-Lloyd ore bodies for Mr. Bush was made by him. He plotted the contours of part of Section 2, 47-28 and made a tracing. He laid out some of the garden lots for the district and gave floor grades for the new club house. In February, he made a check estimate of the stripping at the Side Hill deposit at the Angeline mine. During the same month he made a trip to the Boston mine and prepared an estimate of ore removed since 1913 and made a set of maps. He finished the calculations and plotted the survey of the road to the Hoist on Dead river. When the measurements of shaft runners were made, he managed the machine at the Maas and Negaunee shafts. From March 12th to the 29th he looked after the work at the Athens, making sketches for the proposed plats at 2200' and 2300' levels and laying out shaft runners. He left the Company on May 11th to enter the Reserved Officers Training Camp at Fort Sheridan, Illinois.

Albert Rock has been employed as a helper all the year. He has assisted in the monthly surveys at most of the mines, especially at the Maas and Cliffs Shaft. He did all the printing for the 1916 Annual Report and has done a great deal of blue printing throughout the year. He was on the surveys for the McClure plant from start to finish. He was also on the Round lake survey at the Erickson lease and ran a rod



during the contouring on Section 2, 47-28. At the Holmes mine, he foresighted on the survey to the boundary corners. In the office besides blue printing he has mounted maps, repaired tapes, etc.

John Trosvig has been in charge of the engineering work at the Angeline and Holmes mines and in the North Lake district. His time at the various properties has been divided as follows:

Angeline mine	-	-	18%
Holmes mine	-	-	17%
Morris-Lloyd mines	-	-	43%
Barnes & Hecker	-	-	16%

At the Angeline mine he made the monthly estimates of stripping at both the Side Hill and East End deposits and reported directly to Mr. Eaton. At the East End deposit he made cross-sections and located drill holes. He also surveyed the outcrops around the East end of the Angeline basin. He made the monthly surveys at the Holmes mine since July. He geologized and sampled the 2nd level, lined in trolley supports and designed track frogs. He prepared the Tax Commission maps of the Holmes and Angeline mines. In the shaft he assisted in the plumbing and lined in the last three sets. On surface he ran a survey to the boundary corners and prepared a map showing the location and courses of the boundary lines referred to both Cleveland-Cliffs Iron Company and Lake Superior Iron Company surveys. Since the departure of Mr. Hayden, he has been in charge of the surveys in the North Lake district. He made the monthly surveys, gave lines for drills and raises as necessary, geologized, laid out plan of development and located drill holes, etc, in both the Lloyd and Morris mines. He plumbed the winze in the Morris mine, taking off lines on both the 5th and 6th levels and gave lines for the shaft raise. After hoisting he lined in the bearers beneath the pentice. He estimated and reported the rock excavation in the approach to Section 6 open pit. At the location he staked out the store and new fences for the reconstructed Angeline houses. He assisted in the contouring at the Barnes & Hecker, located the shaft site and estimated the proposed stripping. He ran the line and gave grade stakes for the drainage ditch. He staked out the mine buildings and

the houses in the new location. He set the bearers for sinking the shaft and later lined in the sets preparatory to concreting.

Tom A. Miller has looked after the engineering at the Republic and Spies mines all the year and at the Lake mine since September. His time spent on these mines is as follows:

Republic mine	40%
Spies mine	16%
Lake mine	12%

At the Republic mine he made all the monthly surveys and located all the underground drill holes. He made special stope surveys for Mr. Stakel. In both No.9 shaft and Pascoe shaft he gave lines for timbering the new lifts and carried surveys and elevations down to the 2170', 2270' and 2220' levels. He assisted Mr. Derby with the underground geology. On surface he made an estimate of ore in stock and had charge of the party surveying outcrops. He made a profile and mapped the contours for the proposed new engine house and pulley stands for No.9 shaft. In March and August he surveyed the underground workings at the Spies mine. All the rest of the monthly reports maps of the Spies mine have been posted from the maps of Mr. Meyers. In August he ran a survey around Section 24, 43-35 to locate section corners, preparatory to sub-dividing the NW $\frac{1}{4}$  of the section and establish the Spies mine boundaries. He prepared analysis maps and cross-sections for Mr. Elliott.

His time at the Lake mine has been taken up with making the monthly reports and an occasional sub-level survey. He gave lines for the drift on the 930' sub-level into Lake Superior Iron Company workings to tap the water. Early in the year he assisted on the surveys at the Maas and Negaunee mines. He had charge of the soundings of Round lake. He calculated and plotted the contour surveys of Section 2, 47-28. He estimated the ore in stock at the Moro mine and assisted in measuring down the Athens shaft. He located and mapped the drilling on Sections 2, 3 and 4, 47-27.

John Heilala has been a helper and since May has made the monthly surveys at the Salisbury mine. He assisted on the surveys at all the mines,



both surface and underground, but more especially in those in the Ishpeming district. In the office he has looked after the maps of the Salisbury mine and made captains and superintendents maps and other tracings. He helped in survey calculations and blue printing.

Sixtus Malmgren has been employed as a helper. He has assisted at all the mines and in all the surface work except the McClure plant surveys. In the office he has blue printed, cleaned tapes, etc.

Clyde W. Nicolson until March assisted in the North Lake surveys. He made the February monthly survey of the Lake and Salisbury mines. He plotted and traced contours on Section 2, 47-28 and assisted in plumbing the Holmes shaft. In March he ran the survey for the proposed drainage of Round lake. On March 15th, he left the Company and took a position with the British Columbia Company. On June 21st he returned to the department and until his second departure was on the McClure plant survey. He ran preliminary lines and all the levels over the pipe line. He made cross-sections at the dam. He also ran levels from Forestville to the Hoist and on the intake basin survey. He assisted in the calculations and plotting of the pipe line plan and profile. On August 22nd he left the Company to enter the U. S. Army Officers Training Camp at Fort Sheridan, Illinois.

Carl S. Stevenson entered the department on January 5th after the Educational department had closed. He had charge of the engineering work at the Cliffs Shaft mine, over 66% of his time being spent in connection therewith. He made all the monthly surveys and located drill holes. On the 15th level, he set pump foundations and in the engine house bolts for new gearing and motor. He ran check surveys on the 6th, 7th, 8th and 9th levels "B" shaft. He made new mounted maps for the Negaunee mine and assisted in setting bearers in No.3 shaft below the 10th level. At the Angeline he assisted in the monthly stripping estimate. He was on nearly all the shaft runner measuring jobs. He assisted Mr. Moulton on the Cowling farm survey and Mr. Miller on the Section 24, 43-35 survey. He left the Company on August 21st to enter the U. S. Army Engineer Officers Training Camp at Fort Leavenworth, Kansas.

William F. H. Janzen entered the department on March 21st. He took charge of the engineering work at the Athens mine after Mr. Hanst left and continued to look after it the remainder of the year. In the shaft he lined in sets, measured runners, etc, until it was finished in May and when the levels were opened up he gave lines for drifting. He revised the underground pocket designs and supervised their construction. On surface he staked out the various new buildings, gave grades for grading, lines and elevations for trestles, and designed the timber and road tunnels. He supervised the construction work and made monthly reports to Mr. Jackson regarding progress of construction and development work. The laying of sewer and water pipes was done under his direction, as was also the moving of the houses from the office site. Since September he has made the monthly estimates of the stripping at the Angeline mine.

Gleland Nichols was employed as a draftsman from March 26th to the latter part of April when he was made chauffeur for the department. When not busy with the car, he continued drafting, making superintendets and captains tracings. He left October 3rd to enter the Michigan Agricultural College.

Arvid Alanen has been employed as a draftsman since April 23rd. He assisted in making the new set of mounted maps for the Morris-Lloyd mines and the accompanying tracings. He has also made maps and tracings for all mines and has laid out surface maps. Most of the new Annual Report maps were made by him, as well as all the various notices and signs the department was called upon to make. He has assisted in survey calculations and in making blue prints.

Archie Minnear entered the department as a helper on June 15th. He has assisted on surveys at all the mines and since September has been regularly helping in the North Lake district. He ran surveys and gave lines under the direction of Mr. Trosvig. In the office he made tracings, mounted maps, posted surveys, etc.

Michael C. Connolly has been employed as a helper for the Negaunee district since September 10th. He has assisted in making maps, etc, in



the office and on the underground work at the Maas, Negaunee and Jackson mines. Under the supervision of Messrs. Moulton and Chenneour he has run surveys at these mines.

Valmer Perttula was employed as chauffeur from October 3rd to December 13th.

OFFICE EXPENSES.

The following table shows the office expenses for 1917:

Travelling expenses and livery	- -	\$553.89
Supplies	- - - - -	4146.79
Office expenses	- - - - -	230.73
Insurance	- - - - -	22.08
Taxes	- - - - -	37.53
Operating automobile	- - - - -	931.37
Total		<u>\$5922.36.</u>
Total salaries	- -	\$21443.89
Total office expense	-	<u>5922.36</u>
		\$27366.25.

No attempt has been made to compare the office expense with previous years.

The extraordinary expenses in supplies are as follows:

Tracing cloth, blue print paper, etc.	- -	\$735.51
Annual report negatives	- - - - -	306.32
Mining transit	- - - - -	328.50
1 Tcerring Type Electric Lamp and Globe for		
Blue Print Machine	- - - - -	42.50
Proportion of building partition	- - - - -	69.19
Vault fixtures for No.2 value	- - - - -	1391.50
Total		<u>\$2873.52.</u>

This year for the first time the department used an automobile in place of horses for transportation to and from the mines, etc. The Company's Overland car was used from the middle of April to the first of November, when a broken clutch put it out of commission. A Ford touring car was delivered and used on November 16th and a Ford truck on December 8th. Both the Ford cars were put up for the season on December 10th. The automobile was also used by the Geological department for collecting core, etc. The time saved by the use of a car in place of horses is uncalculable. Upwards of three hours a day per man was saved on long trips. Livery hire was greatly reduced and trips made possible that otherwise would not have been taken. Below is a statement of the comparative cost of livery and auth expense for 1916 and 1917:

ENGINEERING DEPARTMENT.

COMPARATIVE STATEMENT OF LIVERY AND AUTO EXPENSE.

	COMPANY HORSES.	LIVERY HIRE.	AUTO HIRE.	OPT. COMPANY Salaries.	AUTO. COMPANY AUTO. Expenses.	TOTAL.
1917	\$436.94	\$11.00	\$21.00	\$220.05	\$711.32	\$1400.31
1916	901.54	130.50	45.50			1085.54.

In May, October and November 1916 three horses were charged to Mining Engineering.

Cost of repairing and painting vehicles in 1916 was \$105.00.

Two horses charged to Mining Engineering in 1917.

STATEMENT OF COST OF OPERATING AUTOMOBILE FOR YEAR 1917.

Salary of chauffeur	-	-	\$276.72
Gasoline, oils, etc	-	-	201.76
Tires and tools	-	-	208.75
Repairs	-	-	99.63
Building garage (##)	-	-	187.03
Miscellaneous	-	-	28.97
Depreciation	-	-	215.00
Total			<u>\$1217.86</u>

(##). One third proportion of cost of converting horse shed near general shops into a garage.

DIVISION OF ABOVE EXPENSE.

Proportion charged to Mining Engr.	\$931.37	-	76.5%
" " " Geological Dept.	286.49	-	23.5%
	<u>\$1217.86.</u>		

The rising prices and scarcity of tracing cloth made it advisable to procure a year's supply in advance. The mining transit was necessary to take care of the increasing number of mines and it is necessary to keep two transits in the Negaunee district. The old lamp of the blue print frame needed repairs and owing to the probable delay in having the work done, a new lamp was purchased. A partition was built across the hall on the first floor of the building to shut off the offices of the Chief and Assistant Engineers from the stairs. The vault fixtures were necessary to give room in No.1 vault, which was very much over crowded. The annual increase in number of glass negatives made it imperative to secure additional room. Under the new plan of keeping the last plate of each map, the new fittings will take care of the natural increase for many years.



DISTRIBUTION OF TIME.

The next table shows the distribution of time for the year compared with that of 1915 and 1916, together with the labor cost for 1917:

	<u>1917.</u>			<u>1916.</u>		<u>1915.</u>	
	LABOR.	TIME.	%.	TIME.	%.	TIME.	%.
Angeline mine	\$693.48	125.5	3.04	61.0	1.76	65.0	2.78
Athens mine	2268.47	309.5	7.50	156.0	4.53	130.5	5.60
Barnes & Hecker mine	402.16	82.5	2.00				
Boston mine	81.14	115.0	2.79	6.0	0.17		
Cliffs Shaft mine	2360.40	385.0	9.34	311.0	8.98	219.0	9.41
Holmes mine	1269.67	212.0	5.14	298.0	8.53	54.0	2.31
Jackson mine	387.78	61.0	1.48	18.0	0.52	77.25	3.31
Lake mine	1218.29	220.5	5.33	275.0	7.94	147.75	6.34
Lloyd mine (with Morris)	346.5	8.40		285.0	8.23	200.75	8.62
Maas mine	2686.28	382.5	9.28	331.0	9.56	128.0	5.49
Moro mine	30.78	6.0	0.14				
Morris-Lloyd mines	2676.82	227.5	5.51	132.0	3.82	98.75	4.24
Negaunee mine	3006.94	460.5	11.17	472.0	13.59	243.0	10.44
Republic mine	810.80	172.5	4.18	129.0	3.72	23.0	0.98
Salisbury mine	734.80	134.5	3.26			47.75	2.52
Spies mine	367.54	72.5	1.74	82.0	2.36	12.25	0.52
Erickson lease	71.38	20.5	0.50				
Hospital	64.69	9.0	0.22				
Maas crusher	37.80	6.5	0.13				
Miscellaneous	461.64						
Carbon & drill inventory		15.0	0.36	22.0	.64	40.75	1.73
Sections 17 & 18, 47-26		8.0	0.20	15.0	.43		
" 1,2,3,4, 47-27		70.55	1.69			58.75	2.51
Shaft runners							
Tax Commission							
Annual Report							
Gwinn district		6.0	0.14	16.0	.77	8.25	.34
Mesabi Range		6.5	0.16	3.0	0.09	6.5	.27
Water Power							
Carp river	45.08	6.5	0.16	7.0	.20	16.0	0.67
Dead river	68.57	9.0	0.22	83.0	2.39	57.25	2.44
McGlure plant	11798.38	528.0	12.80				
Automobile		12.90	3.12				
Second Addition sewer	21.64	5.0	.01				
Total	\$21443.89	4132.00	100.00				

The proportion of office and field work is difficult to ascertain. It varies from all office to all field work, but the former predominates.

A brief description of the field and office work is given below:

ANGELINE MINE.

Monthly estimates have been made of the stripping at the Side Hill and East End deposits. At the former the monthly reports of excavations were checked in February and when the Contractor finished in November. At the East End deposit drill holes were located and the outcrops around the East end of the basin were mapped.

#### ATHENS MINE.

The construction of the permanent buildings and equipment was carried on all summer. The office, laboratory, crusher, warehouse, shops and dry buildings were all staked out and the road and timber tunnels designed and located. Rock, coal and stocking trestles were designed and erected. Grade stakes for timber yard, roadways and stocking grounds were given and also for drainage water and sewer pipes. Underground the shaft sets were lined in and measurements taken for runners until the shaft was bottomed. The pockets were designed and installed and lines given for drifting on the 8th and 10th levels for the pump room and sump and raises into sump and to 7th level.

#### BARNES & HECKER MINE.

In May part of the  $E\frac{1}{2}$  of the  $NW\frac{1}{4}$  of Section 2, 47-28, lying South of the L. S. & I. Railway, was contoured and later a proposed surface lay out was submitted. Estimates for stripping around the shaft site were made and grades and limits given after work started. Location and grades were run for the change in drainage for the creek running past the shaft site. Buildings were staked out for the mine equipment and houses in the new location. Bearers were set in in November for sinking the shaft and sets were lined in when ledge was reached, preparatory to concreting.

#### BOSTON MINE.

Quarterly surveys were made and maps posted and sent to the Cleveland office, ~~gals~~ together with estimates of ore removed.

#### CLIFFS SHAFT MINE.

Monthly surveys have been made throughout the year. Check surveys and elevations were run on the 6th, 7th, 8th, 9th and 10th levels "B" shaft in June and July; also the diamond drill holes were located and surveyed. On the 15th level, "A" shaft lines for pump foundations were given and also in the engine house for new hoisting engine gears.

#### HOLMES MINE.

The shaft was bottomed on January 16th and on the 21st the shaft was plumbed from surface to the 2nd level. The 2nd level drift holed to the



shaft on the 30th, there being a difference of 8.80' in elevation due to error in calculations. The surveys from Section 16 mine were connected with the lines from the plumbing and checked by 2.74' and 2.63' for coordinates. Using a line between two plugs, No.1 near Section 16 shaft and No.2 near Holmes shaft, as a base line, the entire 2nd level surveys were recalculated and the results used as a base for the mine surveys. Trolley wire supports were lined in and track frogs designed. The development of the mine required considerable time in giving lines for raises, drifting, etc. The extension of the 1st level towards the shaft required most attention. Boundary drifts were carefully watched and trespasses encountered were surveyed and reported. On surface a survey was run to the corners of the property for the establishment of boundary lines with the Lake Superior Iron Company. The Northwest corner was not found and the contemplated agreement was not made. The Northeast and Southeast corners of the timber yard lease were set and concreted. Stocking trestles were staked out in October.

#### JACKSON MINE.

All the work was done at the South Jackson <sup>open</sup> pit. The drill holes were located and surveyed as necessary. In November the diorite outcrops South of the pit were mapped and cross-sections at 50' intervals made of the pit. Profiles and lines for the steam shovel cut were run. Considerable time was spent preparing ore estimates and planning a mining method.

#### LAKE MINE.

The monthly surveys have been made as usual during the year. The rapidity of development and mining on the various sub-levels below the 4th level has necessitated frequent surveys and the heavy ground made it impossible to keep survey points near the working places. On the 945' and 930' sub-levels, lines were given for the water drift near the West boundary line.

#### LLOYD MINE.

The development of sub-levels under the hanging and the raising to the top of the ore chutes required constant attention. Considerable office

time was occupied in making an entire new set of mounted maps and tracings of all sub-levels and main levels. Estimates for proposed deepening of the approach to Section 6 pit and available ore were made. The monthly surveys were made as usual and the geology kept up to date.

#### MAAS MINE.

Check surveys were run between the 3rd and 4th levels and lines given for raising, preparatory to deepening the shaft to the 4th level. The raise holed on November 13th. Lines were given on the 2nd level for the rock drift. The development of sub-levels has been laid out and lines given. The geology of the sub-levels and the cross-sections have been posted with the help of the Geological department. Weekly surveys of the sub-levels where most of the mining operations were located have been made throughout the year but were only reported in the monthly map report. A new survey was made of the Maas surface and crusher and new mounted maps of the S $\frac{1}{2}$  of the SW $\frac{1}{2}$  and the N $\frac{1}{2}$  of the SW $\frac{1}{4}$  of Section 31, 48-26 were made and traced.

#### MAAS MINE CRUSHER.

The foundations of the crushing plant were staked out and lines given for the erection as necessary.

#### MORO MINE.

Estimates were made early in December of the ore in stock for the Shipping department.

#### MORRIS MINE.

The monthly surveys were made as usual. The 6th level development was carefully watched, being surveyed, geologized and sampled as necessary. Preparatory to deepening the shaft to the 6th level, the winze was plumbed and lines taken off on the 6th and 5th levels. Lines were given for raising from both levels. When the raises holed into the bottom of the shaft, the bearers were set below the pentice. A new set of mounted maps and tracings were made for all sub-levels below the 3rd level.

#### NEGAUNEE MINE.

The engineering work has required the constant attention of one engineer and about one half the time of a helper. The systematic development of the sub-level requires lines in every crosscut. Considerable time was spent

ENGINEERING DEPARTMENT.



laying out the proposed development on the 11th and 12th levels with reference to the probable ore outline. Surveys were run and checked from the 10th to the 12th level and lines given for the shaft raise. After holing to the bottom of the shaft, the bearers were set below the pentice. At the elevation of the 11th level, lines were given for cutting out the pocket plans of the pocket, together with those for concreting both pocket and plat. On the 10th level, lines were given for raises. Weekly trips were taken through the mine to keep the sub-level advance and geology posted to date. The development of the American Mining Company strip was watched and lines given as necessary. In the office, considerable time was occupied in making cross-sections N. 45° E. through No.2 shaft pillar to assist in the development. Old records were also searched for information regarding the territory above the 9th level in No.1 shaft pillar. Fifteen mounted maps were made to replace old ones too small to show all the workings. On surface, the foundations for the top tram engines were set.

#### REPUBLIC MINE.

Besides the monthly surveys, frequent trips were necessary for special surveys into stopes. Lines were given in the Pascoe shaft for sinking, laying rails and plat timbering, and in No.9 shaft for timbering. Drill holes were located and surveyed. Surveys were extended into new workings for lines as necessary and levels were run and checked from the 1935' level No.9 shaft to the 2170' and 2270' levels Pascoe shaft and 2220' level No.9 shaft. The survey stations were marked underground and level plats numbered. Several days were spent geologizing underground. On surface, profiles and contours were taken in connection with the proposed new engine house for No.9 shaft. The survey of outcrops was continued along the open pits to the Kloman property. Stockpile estimates were made early in the season.

#### SALISBURY MINE.

Very little work besides the monthly surveys was done underground. In the office, new mounted maps were made to concentrate information regarding underground workings.

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#### SPIES MINE.

In January and August, trips were made to check up the underground surveys. The monthly reports were made from maps posted by Mr. Meyers. Analyses maps and cross-sections were posted also upon information sent in to the office. In August, a survey was run on surface to the East quarter corner and South quarter corner for the purpose of sub-dividing the Northwest quarter section.

#### ERICKSON LEASE.

In March, a stadia survey was run from iron pins on the Erickson property across Round lake. From there two lines, one South and the other Southwest, over possible lines of drainage across Section 28, 43-34. Soundings were taken in Round lake for depth of water and mud.

#### NEW HOSPITAL.

Lines were given for excavation for foundations and an estimate of yardage removed reported. Stakes for line and grade were given for building.

#### CARBON & DIAMOND DRILL INVENTORY.

Monthly reports of the carbon used in diamond drilling have been made, and before purchasing, the carbon was examined and tested. The annual inventory of drill outfits was made.

#### SECTIONS 17 & 18, 48-26.

#### SECTIONS 1, 2, 3, & 4, 47-27.

Locating and surveying of drill holes on these sections constituted the work of the year.

#### SHAFT RUNNERS.

Early in the year the distance between runners in both ship and cage compartments of the Morris, Lloyd, Holmes, Lake, Maas and Negaumee shafts was measured with the instrument devised by Mr. Elliott. These records were tabulated and reported to the various superintendents and the Safety department.

#### TAX COMMISSION MAPS.

In January, sets of blue prints were prepared of all the mines for the Tax Commission. Considerable time was spent with the superintendents on the ore estimates. Especially in the Maas, Negaumee district new estimates were made for these mines.

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#### ANNUAL REPORT MAPS.

The maps for the Annual Report were photographed, printed and colored in. The book of surface maps was completed and a copy made for Mr. Smyth.

#### GWINN DISTRICT.

The only work done by this department for the district was in connection with the Annual Report.

#### MESABI RANGE.

The time spent on the Annual Report constituted the work done during the year.

#### WATER POWER.

##### CARP RIVER.

The final survey for fencing in the land in Sections 28, 37 and 33, 48-27 deeded to Mr. Cowling was run and descriptions for the deeds prepared.

##### DEAD RIVER.

The maps of the road to the Hoist were finished and traced.

##### MCCLURE PLANT.

During May, several trips were made to the dam site and along the proposed pipe line. At the lower end a preliminary survey was run from Rainey creek to Beaver dam and elevations from Forestville. On June 25th, camp was started at Van Iderstine's Crossing on the L. S. & I. Railway. A trail was cut from camp to the dam. Preliminary pipe lines were run from the power house end and after final location was decided, the pipe line survey was run from the lower end to the dam. Profile and plans were made. Elevations were run from Forestville to the dam via both pipe line and L. S. & I. Railway and were continued to the Hoist. Changes were made in the pipe line to give better location. At the dam site, contours were taken and cross-sections along the face. A survey was run from the Hoist to the dam and along both North and South limits of the intake basin. Stadia surveys were run from the dam down Dead river and up from Forestville to power house. On August 2nd, camp was moved to the construction camp at the dam and on August 20th, the party returned to the office. Lines and elevations have been given at both dam and power house as necessary for construction.

In October, another survey was run from the Hoist to the dam and along the pipe line and tied into the iron pin survey on the first proposed pipe line. Grades were set for excavating the pipe line near the power house.



REPORT ON THE ABSTRACTS FILED IN THE MINE DEPARTMENT FOR THE  
YEAR 1917, BY C. H. EICHLER.

Mr. C. H. Eichler took charge of the books in the Abstract department on October 4, 1917. No regular work had been done except occasional posting since Mr. Brewer became assistant engineer on March 20, 1916. The office records were somewhat behind and the following books were posted and brought up to date:

REGISTER OF DOCUMENTS.

In this book have been listed the documents originating from this department, including leases and renewals of options and also easements, rights of way, etc. Twelve documents were entered during the year.

OPTIONS FOR MINING LEASES.

There still remains in force three options, two of these being on the Spies land, on which a renewal was secured during the year, and a perpetual option with the Michigan Mineral Land Company. No options were acquired or relinquished during the year.

MINING LEASES.

No leases were surrendered during the year. The following lease was granted:

No.46 Iron County, Michigan Mineral Land Company to Hollister Mining Company, dated November 1, 1917. Term of 50 years, 80 acres, description, SE $\frac{1}{4}$  of NE $\frac{1}{4}$  and NE $\frac{1}{4}$  of SE $\frac{1}{4}$  of Section 24, 43-33.

The following table shows the leases in force during the past seven years:

	<u>1911.</u>	<u>1912.</u>	<u>1913.</u>	<u>1914.</u>	<u>1915.</u>	<u>1916.</u>	<u>1917.</u>
Leases in force January 1st,	54	54	54	52	53	55?	56
" acquired during year,	3	2	0	2	2	1	0
" surrendered " "	3	2	2	1	1	0	0

LAND OFFERS & LAND OFFER PLAT BOOK.

The land offers received during the year embrace Nos.1040 to 1105 inclusive. These offers have been recorded in the loose-leaf books entitled, "Land Offer Plat Books".

Township plats showing these offers have been sent monthly to the Cleveland office.

OUTSIDE EXPLORATIONS.

A new register for outside explorations has been started but has not been posted beyond No.880.

AUTHORIZATIONS.

During the year four authorizations for drilling were placed on record, the last number being 115.

DEEDS & MISCELLANEOUS DOCUMENTS.

During the year ten documents were filed in this book, the last number being 631.

These documents include deeds, rights of way (not affecting the Cleveland-Cliffs Iron Company's Estate), leases, land contracts, etc.

EASEMENTS.

The following easements were secured by the Company during the year:

- No.93, May 10, Martin Ramile, Au Train Transmission Line Easement.
- No.94, Oct.25, D. H. Ball, Dead River-McClure Transmission Line.
- No.95, Oct.16, C. & N. W. Ry., AuTrain-Gwinn Line, License.
- No.96, Nov. 2, Michael Guelff, Dead River-McClure Transmission Line.
- No.97, Nov.14, Anton A. Fassbender, " " " "
- No.98, July 1916, M. M. & S. E. Ry., AuTrain-Gwinn Line.

RIGHT OF WAY DEEDS.

During the year four right of way deeds have been listed in this book, the last number being No.162.

WATER RIGHTS.

The following water right was granted during the year:

- No.9 Permit from Marquette County to construct a dam on the SW $\frac{1}{4}$  of SE $\frac{1}{4}$  of Section 14, 48-26.

FARM & LOT LEASES.

During the year 109 farm and lot leases were entered in the "Record of Sales" book, the last number being 1235. Several renewals were also posted. These leases, which are sent to this office from the Land department, for initials, embrace parcels of land on the iron formation.



APPLICATIONS FOR SALE.

During the year there were recorded nine applications for sale, the last one being No.23.

These applications for sale are sent from the Land department to this office to be initialed in order to prevent the sale of lands considered valuable for mining purposes. These documents are posted in the "Record of Sales" book.

SALES.

There were 47 sales of Company lands entered in the "Record of Sales" book during the year, the last number being No.101. The descriptions of land and reservations contained in these deeds and land contracts are carefully considered before being approved by the Mining department.

TAX HISTORIES.

One tax history was filed during the year, the last number being 472.

LEGAL OPINIONS.

During the year seven legal opinions were placed in the files, the last number being 118.

The following list of documents is a summary of those placed on the records or in the files during 1917:

	<u>NUMBER</u> <u>RECEIVED.</u>	<u>LAST FILE</u> <u>NUMBER.</u>
Land offers	65	1105
Authorizations	4	115
Deeds	10	631
Easements	6	98
Water rights	1	9
Surface leases	109	1235
Applications for sale	9	23
Sales	47	101
Tax histories	1	472
Legal opinions	7	118.

INDEX PLAT BOOK.

In the index plat book the following documents are entered: abstracts, tax histories, options, leases, easements, water rights and deeds.

This plat book has been brought up to date.

LAND OWNERSHIP PLAT BOOKS.

No work has been done on these books for a few years back.

U. S. GOVERNMENT PLAT BOOK.

The U. S. township plats are filed in two large post binders. No new maps have been added this year.

MISCELLANEOUS.

In vertical file marked "Miscellaneous" there have been added a few old leases and some Bills of Sale. In this file are a number of documents for which a place could not be found in the regular files.

C. C. I. CO. ABSTRACTS.

Considerable time has been spent in making additional entries to several of the above abstracts, bringing them up to date by means of the documents which we have on file in this office. These documents had not been entered on the abstracts for some time back. Four new abstracts were made but have not been typewritten. This additional information to the C. C. I. Company abstracts will be entered in the abstract books which are on file in the Cleveland office and the Land department.

HYDRO-ELECTRIC ABSTRACTS.

Work has been started on these abstracts on the transmission line from the power plant to the Pioneer Furnace and will be completed within a short time. The abstracts covering the land embraced in the Ayer & Longyear lease will also be typewritten and placed in this book and a copy of the Hydro-Electric book will then be sent to both the Cleveland office and the Land department.

MAAS-NEGAUNEE ABSTRACTS.

No new work has been done on these abstracts during the year.

ATHENS MINING COMPANY ABSTRACTS.

No new work has been done on these abstracts during the year.



SUNDRY ITEMS BY J. E. JOPLING.

WATER POWER.

During 1917 surveys were made for the development of the Longyear & Ayer water power on Dead river. On June 19th, I started this work by going over the line. I was in the field more or less until July 7th. Later I made only occasional trips.

For the Dead river storage basins, surveys were made by Mr. Charles Cummings at various times during the summer to determine certain features in connection with the purchase of land. I went with Mr. Cummings to inspect the dam sites on September 11th. Later a diamond drill was employed to determine the ledge under proposed dam site No.1 at the Holyoke.

A number of visits were paid to the office of Mr. Longyear in Marquette to consult with him and Mr. Sherman relative to certain features in the developments.

On August 1st, Mr. A. B. Eldredge came to my office to consult with regard to purchase of South Shore Land Company's land needed for water power.

On October 12th, Mr. McClure and I met Mr. A. E. Miller and Mr. E. S. Bice regarding the purchase of the Reichel land.

PYRITES.

The following offers of pyrites properties were received during the year:

- No.127, J. E. Marks, Port Arthur, Ontario. Property on Grand Trunk Ry., North of Port Arthur.
- No.128, Frank G. Stevens, 36 Oakmount Road, Toronto, Ont. Property near Porcupine, Ont.
- No.129, Dr. Strandgard's Medicine Co., Toronto, Ont. Property in Rainy Lake district, Ont.
- No.130, A. D. Mackay, 130 Pearl St., New York City. Property at Marietta, Ga.
- No.131, C. H. Ruggles, 71 Ascot Ave., Toronto, Ont. Property in Ontario.
- No.132, H. W. Fesing, Houghton, Mich. Property in Ontario, 190 miles from a Lake Superior port.
- No.133, R. S. Archibald & W. B. Pattison, Negaunee, Mich. Property in Michipicoten.
- No.134, Golden Reward Cons. Gold Mining & Milling Co., Deadwood, S. Dak. Property in South Dakota.

No.135, American Smelting & Refining Co., Creede, Colo. Property  
in Leadville, Colo.

According to instructions from Cleveland, no money was expended  
in examination, consequently the only work done was to keep posted as  
to the lands offered and new developments.

LAKE SUPERIOR IRON COMPANY.

No examination was made by me of the workings in Section 16 mine,  
which is the only property of the Lake Superior Iron Company at work,  
during the year.

REGENT IRON COMPANY.

The Regent Iron Company stopped work at the Prince of Wales mine  
on May 31, 1917. This was the last operation on these lands by the  
company. The lease was surrendered to the fee owners. No examination  
of the mine was made during the year.

MICHIGAN MINERAL LAND COMPANY.

On September 7th, I accompanied Mr. Walter S. Prickett to Crystal  
Falls, where we visited the drills of M. A. Hanna & Company which had  
found the ore on Michigan Mineral Land Company's lease.

MICHIGAN STATE TAX COMMISSION.

The estimates of ore tonnage in the C. C. I. Company's mines and  
lands were made in January. Mr. Hamilton, the engineer for the Tax  
Commission, visited this office in that month. The entire information,  
together with the maps, was completed by March 1st.

MARBLE.

On June 8th, I went over the line of the proposed railway to the  
Michigan Verde Antique Marble Company's quarry and inspected the out-  
crops on the Company's lands. Later a survey was begun by Mr. Charles  
Cummings in order to show the position of the outcrops. This work was  
not completed when the snow came.



COUNTY ROAD COMMISSION.

On November 13th, Mr. K. I. Sawyer, Superintendent of the County Road Commission, consulted me with reference to the position of proposed roads leading North from Ishpeming and Negaunee.

DRILLING.

A No.5 Keystone drill was purchased early in the year and has demonstrated its use in drilling through the hard jasper of the Marquette Range at low cost.

THE CLEVELAND-CLIFFS IRON COMPANY.

REPORT OF THE GEOLOGIST FOR YEAR ENDING DECEMBER 31, 1917.

STAFF.

The staff of the Geological department during 1917 is given in Table I. Mr. F. R. Mitchell was engaged as an assistant geologist on October 15th. Mr. Fred Royce, also engaged as an assistant geologist, began work on November 12th. Messrs. Afuhs and Allen continued with the department throughout the year.

TABLE I.

STAFF OF GEOLOGICAL DEPARTMENT IN 1917.

<u>NAME.</u>	<u>OCCUPATION.</u>	<u>LENGTH OF SERVICE IN 1917.</u>	<u>DAYS LOST. SICKNESS.</u>	<u>VACATIONS.</u>	<u>% OF WORKING DAYS WORKED.</u>
E. L. Derby, Jr.	Geologist in charge of department.	Entire year	0	12 $\frac{1}{2}$	95.5
Fred Royce	Assistant Geologist.	1 2/3 mo.	0	2	93.1
F. R. Mitchell	Assistant Geologist.	2 $\frac{1}{2}$ mo.	0	5	90.6
Gustaf Afuhs	Draftsman	Entire year	11 $\frac{3}{4}$	2 $\frac{3}{4}$	94.7
E. A. Allen	Collecting & labelling core, testing drill holes, visiting outside explorations, etc.	Entire year	0	1/2	99.7

The year was divided into the factors shown in Table II.

TABLE II.

Total days of eight hours worked	- - -	276 $\frac{1}{2}$ days.
Sundays	- - -	52 "
Days resulting from 52 Saturday afternoons	-	26 "
Holidays	- - -	10 $\frac{1}{2}$ "
<b>Total</b>		<b>365 days.</b>



The following table, No.III, shows the average number of men regularly employed on the staff of the Geological department during the last five years:

TABLE III.

<u>YEAR.</u>	<u>AVERAGE NUMBER OF MEN.</u>
1913	6.54
1914	5.74
1915	3.96
1916	3.17
1917	3.35

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.

E. L. Derby, Jr. My work during the year has consisted chiefly of general oversight and supervision of the work of the department. This has included surface drilling explorations in the Negaunee, Ishpeming, North Lake and Republic districts; underground drilling in the Cliffs Shaft, Morris, Republic and Francis mines; surface geological surveys in the Negaunee, Ishpeming and Republic districts; underground geological surveys in the Maas, Negaunee, Holmes, Morris, Republic, Gwinn, Jopling, Francis and Stephenson mines; and in visiting and reporting on the explorations of other companies on the Lake Superior iron ranges.

The time not taken up with these duties was spent chiefly as follows:

In January, I revised the estimate of ore on the Barnes & Hecker lease, both for ourself and the Tax Commission, to conform with the most recent drilling; and checked over the Tax Commission estimate of the Holmes and Angeline mines.

In February, I made an estimate of the ore remaining in the Negaunee mine, being assisted by Mr. Cheneour of the Engineering department.

With Mr. Jopling, I made an estimate of the ore on the Pederson property in Section 1, 46-29, Minnesota, Guyana Range, land offer No.1045. I also made an underground geological survey of the extensions of development work at the Gwinn mine.

In March, I accompanied the Lake Superior Mining Institute on its visit to the Birmingham iron and coal districts.

In April, I made a geological survey of the 2nd level Holmes mine.

In May, I geologized all new developments on the main levels of the Maas and Negaunee mines and spent several days on underground geological surveys at the Republic mine. The latter was practically the first underground geological work done at the Republic since the mine was taken over by the Company in 1914.

In June, I made a joint examination with Mr. Jopling of the Company's land crossed by the proposed location of the C. & N. W. Railway spur from North Lake to Mr. Carter's Michigan Verde Antique Marble Quarry in the vicinity of the Ropes gold mine, North of Ishpeming. This examination is covered by a separate report. During the month, I also visited the Suneson-Levine exploration in the SW $\frac{1}{4}$  of Section 8, 46-29, East of the Republic mine, and this is covered by a separate report. I continued the underground geological work at the Republic mine whenever it was possible. The small amount of surface geology at the latter mine necessary to complete the work started in the fall of 1916 was done this month by the engineers under my supervision. Due to press of work in the Engineering department, however, these results have not as yet been mapped.

In August, I brought the underground geology of all accessible levels of the Republic mine practically up to date.

During the month of September, I made special trips underground with Mr. Smyth in the Maas and Morris mines in connection with the new development work and anticipated explorations. I also mapped some of the more important geological features in the latter mine.



In November, I spent considerable time looking up the records of the old diamond drill holes in Sections 1, 4, 5, 6, 9, 10 and 21, 47-27, and in getting them into shape preparatory to correlating all the information on a detailed geological map of the territory covering the central part of the Marquette Range, namely the Negaunee, Ishpeming and North Lake districts. I also visited the SE $\frac{1}{4}$  of Section 15, 47-27 with Mr. Walter Vickary in a vain search for his professed ore find. This is covered by a special report.

In December, I made an underground geological survey of the Holmes mine with Mr. Royce of the department and prepared a detailed estimate of the available ore remaining in the Maas mine, East of the Race Course.

Fred Royce. To Mr. Royce, who was added to the department as an assistant geologist in the middle of November, I assigned the geological work connected with the mines in the Gwinn and North Lake districts, as well as the Holmes mine in Ishpeming. He spent his time posting the maps and cross-sections of these properties, making the necessary new maps and sections, and in assisting with the routine work of the department. He also made one underground geological survey at the Holmes mine.

F. R. Mitchell. To Mr. Mitchell, who was added to the department as an assistant geologist in the middle of October, I assigned the geological work connected with the mines in the Ishpeming and Negaunee districts. He spent his time posting the maps and cross-sections of these properties, making the necessary new maps and sections, and in assisting with the routine work of the department.

Gustaf Afuhs. Mr. Afuhs continued as draftsman throughout the year. In addition to his regular work of preparing cross-sections of drilling, monthly reports, geological maps, etc, he has at times helped in collecting and labelling core during the absence of Mr. Allen. He has also ably assisted in the various ore estimates prepared by the department.

E. A. Allen. Mr. Allen has spent the major part of his time during the year collecting and labelling core and sludge from all the various current explorations, filing samples of these in the core room, and

surveying of holes over 200' or 300' in depth. He has become very proficient in the art of slide making used in connection with the microscopic study of rocks in thin sections and now makes all the slides used in the department. During the last half of the year, he prepared the regular monthly carbon statement for the Accounting department, which was formerly handled by Mr. Osborne of the Engineering department. He has also visited several explorations of other companies on the Michigan iron ranges from time to time and embodied the data in special reports.

#### SURFACE GEOLOGICAL SURVEYS.

Very little surface geological work was done during the year because of the impossibility of getting the necessary assistance. The work done was as follows:

##### ISHPEMING-NEGAUNEE DISTRICT.

Mr. Smyth and I made several trips into the field in Sections 1, 2, 3, and 4, 47-27 in connection with the drilling campaign started on these sections the past summer. On these occasions we corrected some of the work mapped by Mr. Hanst in the summer of 1916 and added considerable detail to the rest. I also added a small amount of detail to our geological maps of the Bellevue Farm, Section 18, 47-26, and the Angeline basin in Section 15, 47-27.

Members of the Engineering department mapped the outcrops immediately South of the South Jackson pit in Sections 1 and 12, 47-27.

##### REPUBLIC DISTRICT.

In the fall of 1916 the surface outcrops in the  $S\frac{1}{2}$  of Section 7, 46-29, at the Republic mine, were mapped by the engineers and geologized by Mr. Hanst and myself. Last June the work was continued. The outcrops on the East side of the Republic trough, as far Northwest as the Kloman mine boundary, were located by the engineers and I made the geological survey of them. The engineers unfortunately have been too pressed with



their mine work to plot their notes of this work, consequently the geology could not be mapped. It is expected that this work will be done, however, during the present winter.

#### UNDERGROUND GEOLOGICAL WORK.

It has been impossible to keep the underground geology up to date during the past year. Following drastic cut in the force in October 1914, it was planned to place the major part of this work, at least the making of underground notes, in the hands of the engineers of the several properties. The geology from these notes was to be plotted and all maps kept up to date by the Geological department. The engineers did the best they could with their reduced members and the time at their disposal, but the work accomplished was not sufficient to keep the geology posted up to date. Now that the Geological department has two assistants, however, it should be possible to steadily catch up this work.

#### ANGELINE MINE.

The Happy Hollow and East End pits were worked steadily during the summer months. Mining was entirely by steam shovel. Practically all the ore thus obtainable from the former pit was removed but there still remains several thousand tons that will be recovered by milling. Hardly more than one fourth of the ore has been removed from the East End pit. Messrs. Tresvig and Janzen, engineers, posted the geology of both pits.

Lake

No work was done in the old Angeline mine but geological cross-sections of the Middle deposit were made. Mr. Smyth submitted a special report on the probable ore remaining in the mine which may be recovered.

#### ATHENS MINE.

The Athens shaft was bottomed at 2489' below the collar on May 10th. Flats and pockets were then cut on the 1800', 2000' and 2400' levels, known as the 4th, 8th and 10th levels, respectively. During the latter part of the year, the work of developing these levels progressed steadily.

GEOLOGICAL DEPARTMENT.

Although no detailed geological survey has yet been made, the essential features are being mapped as the work advances by Mr. Janzen, engineer at this property.

AUSTIN MINE.

This mine was worked in a small way during the summer months. Mining was confined to robbing some of the remaining pillars and necessitated no geological work.

CLIFFS SHAFT MINE.

Although the Cliffs Shaft mine has worked continually during the year, no geological surveys have been made since December 1916. The workings, however, stay open almost indefinitely so that all this work can be caught up satisfactorily at the first opportunity.

FRANCIS MINE.

Development of this mine was commenced in the latter part of the year and so far has been confined to the 4th and 5th levels. Mr. A. H. Tillsen, Jr., engineer at the property, has mapped the geology thus far but the work will be taken over by this department early in the coming year. We have already prepared a set of tracings.

GWINN MINE.

The Gwinn mine has worked continuously throughout the year. I posted the geology of the development work twice during that time and Mr. Wallace, formerly engineer at the property, and Mr. Sterling, who succeeded him, have kept the sub-level geology fairly well posted. All necessary new maps and cross-sections were made by this department and kept posted to date.

HOLMES MINE.

Development work progressed steadily in this mine during the year and actual mining started in the early spring. I kept the geology posted up to date until Mr. Royce came with us and since then he has done this work. Both Mr. Afuhs and Mr. Royce have worked on the cross-sections and they are posted to date.

GEOLOGICAL DEPARTMENT.



JOPLING MINE.

The work at this mine consisted in extending the 7th level Gwinn mine to the proposed shaft location, raising about 100' on the line of the shaft and cutting out a sub-level, primarily to drain the fissured ground immediately adjacent to the shaft raise at an elevation of 85' above the main level. I have posted the geology and geological maps of this development. A small seam of second class ore was encountered on the sub-level in a small Southeasterly pitching local synclinal fold.

LAKE MINE.

The Lake mine was operated continuously throughout the year. The geology was posted by Messrs. Osborne and Miller of the Engineering department and the maps and cross-sections kept up to date by the Geological department.

LLOYD MINE.

Mr. Trosvig, engineer at this property, succeeded in posting the major part of the geology in this mine during the year, but considerable additional work remains to be done. His work was posted on the maps and cross-sections by Mr. Afuhs. A great many new cross-sections of this mine were made during the year.

MAAS MINE.

For the greater part of the year, I was able to keep the geology of the new main level development work at the Maas up to date and Mr. Moulton, engineer, did the sub-level work. The geological maps and cross-sections were posted by the Geological department and Mr. Mitchell has posted all the geology since his advent into the department.

MACKINAW-GARDNER MINES.

The work at these properties during the year consisted in sinking at the Gardner shaft and drifting from the Mackinaw to the Gardner on the 4th level Mackinaw, preparatory to raising the remainder of the Gardner shaft. No geological work has as yet been done.

MORRIS MINE.

This mine was worked continuously during the year. I mapped the geology of the new main level development work and Mr. Royce posted all the cross-sections. The extension of the 6th level to the West has necessitated a large number of new sections. Mr. Royce also spent considerable time on the Morris maps, posting on them a large number of drill holes which had been omitted in past years.

NEGAUNEE MINE.

Mr. Cheneour, engineer at this property, has kept the geology fairly well up to date and the maps and sections were posted by the Geological department. I mapped the geology of the extensions on the 6 $\frac{1}{2}$ , 10th and 12th levels in May and posted the maps.

REPUBLIC MINE.

I made a geological survey of all the accessible levels and stopes in this mine during the year and posted the complete set of new geological maps. I also transferred to the latter all the geology obtainable from old maps and miscellaneous sources of information of those parts of the mine now inaccessible. This information is probably not infallible but is the best we can get.

SALISBURY MINE.

Mining in the South Side deposit of the Salisbury mine has continued throughout the year. Mr. Osborne, of the Engineering department, has kept the geology fairly well up to date and Messrs. Afuhs and Mitchell have posted the maps and cross-sections. A few pillars were robbed in the old mine but no geological work was necessary.

SOUTH JACKSON PIT.

This mine was worked steadily during the summer months. Mr. Cheneour, of the Engineering department, prepared a complete set of geological cross-sections through the pit, including all the drill holes of the recent exploration.

SPIES MINE.

The Spies mine worked continuously throughout the year and Mr. Miller, the engineer, posted the small amount of geology obtainable.

GEOLOGICAL DEPARTMENT.



STEPHENSON MINE.

The Stephenson mine was operated continuously during the year until it was flooded on December 8th by a sudden in-rush of water through the cracked capping in Section 29. Mr. Barabe, the engineer at the property, kept the geology fairly well mapped, but considerable work is necessary to bring our set of maps and cross-sections up to date.

EXPLORATIONS.

Diamond drilling explorations were carried on during the year in the Ishpeming, Negaunee, North Lake, Republic and Aurora districts; and in the Cliffs Shaft, Francis, Morris, Republic mines and the South Jackson pit.

No options for exploration were executed or relinquished in 1917 and no leases were taken or surrendered on lands explored or being explored. The only option in force is from the Spies Mineral Land Company and comprises the E $\frac{1}{2}$ , the NW $\frac{1}{4}$  of the NW $\frac{1}{4}$ , the NE $\frac{1}{4}$  of the SW $\frac{1}{4}$  and the SE $\frac{1}{4}$  of Section 24, 43-35. This is option No.98.

Table IV gives the footage drilled, the ore encountered and the cost per foot of drilling for both the surface and underground explorations. It will be noted that the average cost of surface drilling was \$2.84 per foot, excluding certain items from the drilling done by the Company in order to compare these results with the contract drilling costs and thus get a fair net result. By including these items, the average cost was \$3.01. The average cost of underground drilling in the same way was \$2.76 per foot and \$2.85 per foot, respectively. The average cost of all the drilling was \$2.82 per foot and \$2.97 per foot, respectively.

Surprising as it may seem, considering the gradual increased cost of labor and of drill supplies, the cost of surface drilling for 1917 is over 18% less than for 1916. The underground drilling cost increased about 13% over 1916 but the average cost of surface and underground drilling combined is over 10% less in 1917 than in 1916.

TABLE IV.

## SUMMARY OF DRILLING FOR 1917.

EXPLORATION.	DESCRIPTION. SEC. T. & R.	STANDPIPING. FT.	DRILLING. FT.	TOTAL. FT.	FIRST CLASS ORE. FT.	SECOND CLASS ORE. FT.	LEAN ORE. FT.	TOTAL COST. "A".	COST PER FT. "A".	TOTAL COST "B".	COST PER FT. "B".
<u>SURFACE DRILLING.</u>											
Angeline	15, 47-27	181	182	363	61	2	0	\$1,462.33	\$4.03	\$1,434.25	\$3.95
Barnes & Hecker	2, 47-28	454	571	1025	10	0	11	4,421.66	4.31	4,223.61	4.12
Bellevue	17 & 18, 47-26	696	5000	5696	77	85	340	14,410.15	2.53	13,148.47	2.31
Dead River Storage	2, 48-27	168	42	210	0	0	0	1,571.41	7.48	1,293.58	6.16
East New York	SW $\frac{1}{4}$ -2, 47-27	429	250	679	0	0	10	1,821.67	2.68	1,744.00	2.57
Golf Club	N $\frac{1}{2}$ - 2, 47-27	396	955	1351	0	0	25	6,973.83	5.16	6,607.57	4.89
Ishpeming Sec. 3	3, 47-27	690	978	1668	0	10	65	5,185.51	3.11	4,946.78	2.97
Ishpeming Sec. 4	4, 47-27	896	624	1520	0	0	25	5,468.11	3.60	5,209.70	3.43
Meadow mine	3, 58-15	118	479	597	5	20	15	2,230.97	3.74	2,223.24	3.72
Republic	7, 46-29	42	950	992	0	0	0	3,417.69	3.44	3,379.00	3.41
Salisbury	15, 47-27	409	2781	3190	0	0	10	7,868.46	2.47	7,686.87	2.41
South Jackson Pit	(1 & 12, 47-27 (6 & 7, 47-26	230	2827	3057	10	50	1284	5,767.49	1.89	5,289.38	1.73
Jackson	1, 47-27	79	1015	1094	0	0	0	3,571.24	3.26	3,401.16	3.11
Union Park	SE $\frac{1}{4}$ - 2, 47-27	53	1069	1122	30	0	5	3,779.47	3.37	3,583.69	3.19
Total surface drilling		4841	17723	22564	193	167	1790	\$67,949.99	\$3.01	\$64,171.30	\$2.84
<u>UNDERGROUND DRILLING.</u>											
Cliffs Shaft	9 & 10, 47-27	0	2220	2220	385	245	136	\$5,483.59	\$2.47	\$5,231.65	\$2.36
Francis	27, 45-25	0	587	587	10	45	0	1,094.19	1.86	1,059.97	1.81
Morris	1, 47-28	0	2086	2086	10	80	167	6,531.26	3.13	6,349.05	3.04
Republic	7, 46-29	0	3826	3826	153	1121.5	236.5	11,755.54	3.07	11,446.25	2.99
Total underground drilling		0	8719	8719	558	491.5	539.5	\$24,864.58	\$2.85	\$24,086.92	\$2.76
Grand total drilling		4841	26442	31283	751	658.5	2329.5	\$92,814.57	\$2.97	\$88,258.22	\$2.82

NOTE: Cost "A" includes taxes, office expense, engineering, analysis, legal, and personal injury.  
 Cost "B" excludes " " " " " " " " (to compare with contract prices).  
 The contract drilling for the year comprises the surface drilling at the Meadow and Republic mines and 500 ft. of the  
 Barnes & Hecker drilling. This was all done by Cole & McDonald.



SURFACE EXPLORATIONS.

MARQUETTE RANGE.

ISHPEMING DISTRICT.

EAST NEW YORK, SW $\frac{1}{4}$ , SECTION 2, 47-27.

Exploring on the East New York property was commenced early in August with one drill. Drilling was confined to that part of the property lying North of the main East-West fault zone which about corresponds to the location of the Street Railway track and between the two large greenstone outcrops to the East and West. The object here was to explore the iron formation lying on this greenstone and against the fault. A number of standpipes were sunk in this area fifteen or twenty years ago by Captain Platto for the old East New York Company. It was reported that iron formation was encountered at ledge at each location. If this were true, it showed that the formation had a considerable extent and the chance of an appreciable thickness with a fair prospect for concentration. On the strength of this evidence, six holes were drilled. Nos.14, 17, 18 and 19 encountered greenstone at ledge and Nos.20 and 21 encountered iron formation lying on the greenstone, but it was hardly more than 50' thick and only slightly enriched. This completed the exploration and eliminated this area from the promising list, at least as far as shallow ore is concerned.

GOLF CLUB, N $\frac{1}{2}$ , SECTION 2, 47-27.

The work of exploring the Golf Club area was commenced early in August with one drill and will be confined to the iron formation lying on the old greenstone sheet which extends across the North part of the section. Considerable drilling was necessary at first to determine the structure of the basin. So far all holes have been drilled approximately on the 12000 Meridian, which is several hundred feet East of the Golf Club house.

Holes Nos.15 and 16 located the North contact of the iron formation with the old greenstone footwall and determined its dip. No.16 passed

through a higher horizon of diorite or greenstone and No.22, located 200' South of No.16, was drilled into this to give some idea of its thickness and dip.

Holes Nos.24, 25 and 26, all shallow, succeeded in locating the faulted contact of the jasper and Southern greenstone sheet. The first two holes encountered greenstone and No.26 the jasper North of the fault. No.27 was then located 200' North of No.26 with the object of exploring the entire thickness of jasper North of the fault down to the old greenstone footwall. Lean ore was encountered from 81' to 86' and from 360' to 380'. At 404' the drill passed into greenstone, evidently a dike or upper sheet, and was still in it at 475' at the end of the year.

UNION PARK, SE<sup>1</sup>. SECTION 2, 47-27.

This exploration comprises a triangular shaped area immediately Southeast of Cleveland Park and North of the main East-West fault zone above referred to as passing through the center of the East New York property on the West and through the North Jackson on the East. Old holes 7c, 7d, 7e, 50 and 51, all of which were on or close to the boundary line between Sections 1 and 2 and drilled as union holes by the Jackson Iron Company and The Cleveland Iron Mining Company, are located in this area. These holes are comparatively shallow, however, and their records very indefinite.

The present exploration was commenced the last of September with a drill just previously employed on the East New York. The first hole, No.23, had reached a depth of 1122' at the end of the year. It was located just West of the East line of Section 2 and about 200' North of the South side of the fault zone. The entire hole thus far has been in typical brecciated fault zone material, mainly soft ore jasper cut here and there by ferruginous dike material. Thirty feet of good Bess-emer ore was encountered from 885' to 915'. It averaged 62.42% iron, .036% phosphorus and .43% manganese. This was followed by 5' of lean ore, but no other concentration has thus far been found.



SECTION 3, 47-27.

One drill started exploring in Section 3 early in August at the West end of the Westward extension of the basin passing through the Golf Club area. The old greenstone on the North and the greenstone sheet forming the Southern boundary of this area apparently come together in a faulted and folded complex on the West side of Section 3. A series of holes, Nos. 2 to 7 inclusive, were laid out on a North-South line to cross-section the basin on the 19400 Meridian. The Southern greenstone was found to be wider than expected at this point; consequently the jasper was comparatively narrow and thin. Only a small amount of concentration was found. This consisted of 25' of 46% material in No. 6 and 10' of 47.40% and 10' of 51% material in No. 7.

Holes Nos. 8 and 9 were then drilled on nearly an East-West line, East of the first holes and at 300' intervals. The formation continued to be comparatively thin and without any appreciable concentration. We are hopeful of more favorable conditions a little farther East.

SECTION 4, 47-27.

The work of exploring the favorable areas in Section 4 was also commenced early in August. The contact between the jasper and footwall slate has been quite accurately traced across the  $W\frac{1}{2}$  of the section from surface outcrops and test pits. The  $E\frac{1}{2}$  is quite deeply covered with surface, consequently the first thing necessary was to locate this contact at one quarter mile intervals by standpiping. The work was started about on the North-South center line and was carried East. Three standpipes at 100' intervals North and South, holes Nos. 12, 13 and 14, were necessary to locate this contact on the center line and the same number, holes Nos. 15, 16 and 17, one quarter mile East.

It required five standpipes to locate the contact on the East line of the section, holes Nos. 18 to 22 inclusive, thus indicating a rather sudden set back in the footwall of from 300' to 400'. This may be due to a fault on the West, or possibly merely to folding. It at least offers a favorable condition for concentration and the locality should be carefully explored during the present drilling campaign. Hole No. 19

was drilled to the slate to get the dip of the contact and explore the formation on the footwall at this point. Slate and transition material were encountered at 467' and the hole bottomed in it at 502'. Lean ore was cut from 215' to 225' and again from 350' to 360'. The drill was then moved about 400' East to the NW $\frac{1}{4}$  of the NW $\frac{1}{4}$  of Section 3, 47-27 and a hole located to encounter the footwall at about 500'. It was standpiping at the end of the year. It is planned to explore the footwall on this forty at intervals of 400' along the strike before returning the drill to Section 4.

ANGELINE SURFACE, SECTION 15, 47-27.

In January, one standpipe, No.55, was sunk in the center of a small swampy depression on the side hill and in the main greenstone mass East of Happy Hollow and South of the East End deposit. Mr. Eaton thought it advisable to test the ledge here in case there might be a small residual concentration of ore similar to that in Happy Hollow. The hole ledged in greenstone and the drill was moved back to the Salisbury surface, from whence it had been taken.

In March, the drill was again moved from the Salisbury work to the Angeline; this time to the East End deposit. Stripping operations were just commencing and Mr. Eaton was desirous of getting a more definite idea of the outline of the ore body to insure the dumps of stripping material being at a safe distance from the edge of the pit. The first hole, No.58, was located about half way between holes Nos.8 and 9 and encountered 37' of ore averaging 67.15% iron and .022% phosphorus. No.59, located 100' Northwest of No.58 and 100' North of No.24, was blank, thus demonstrating that the ore terminates in a Westerly direction to the East of this and No.24 holes. Hole No.60 was located about 80' Southwesterly from No.18 and encountered 24' of ore averaging 65.94% iron and .062% phosphorus. No.61, 75' Southeasterly from No.60 and the last one drilled on this property, was blank, thus limiting the Easterly extent of ore. These two runs of ore increased the previous estimate only slightly. The outfit was again returned to the Salisbury surface.



SALISBURY MINE SURFACE, SECTION 15, 47-27.

Drilling in the SW $\frac{1}{4}$  of Section 15 at the Salisbury, which began in May 1916, continued into September of the present year with several interruptions when the drill was moved to the Angeline for short periods.

Hole No.54 was drilling in one of the upper greenstone sheets at 36' at the beginning of the year. It passed out of this at 143' and was finally bottomed in the foot greenstone of the district at 827', after having passed through two zones of siderite and jasper, separated by another sheet of greenstone. No concentration was encountered and another hole, 200' farther South, was drilled with the same disappointing results.

Several holes were also drilled to the North and one hole one quarter mile Northeast of this exploration to explore apparent depressions in the diorite but none of them found enriched formation. One standpipe, No.67, was then sunk in the greenstone basin immediately East of the East Salisbury deposit with the hope of finding a residual concentration of ore similar to those East of the Lake and old Lake Angeline mines. The surface conditions are very similar but greenstone was encountered at ledge in No.67. This completed the exploring at the Salisbury for the year.

NEGAUNEE DISTRICT.

SOUTH JACKSON PIT, SECTIONS 1 & 12, 47-27.  
SECTIONS 6 & 7, 47-26.

A greater part of the South Jackson pit is covered by 10' of more of loose rock which has been picked out of the ore in the past and used to fill in the pit to a level that would facilitate tramping from the ore faces to the railroad cars. Mr. Elliott decided in June to have the ground tested for 40' or 50' below this fill to determine whether the ground is of sufficient grade to warrant the removal of the loose rock and start mining.

The Keystone churn drill, purchased early in the spring, was used for this work and so far has given very satisfactory results at a much lower cost than possible with the regular diamond drill equipment.

Twenty four churn drill holes were drilled in the main pit Section 1. Some lean jasper was encountered in scattered places but the majority of the holes demonstrated that most of the ground for a distance of 50' below the present pit bottom will produce a manganiferous ore of the South Jackson grade, averaging about 40% combined iron and manganese, if properly mixed. This could be accomplished by a milling method of mining.

Three nearly horizontal diamond drill holes were drilled Southwesterly from South face of the pit, two in Section 1 and one in Section 12. All encountered practically a South Jackson grade ore but the strata was found folded from a vertical to nearly a horizontal position so that the holes did not get a sample across the formation. In order to crosscut this flat formation, four vertical churn drill holes were then drilled a short distance South of the pit, two in Section 12 and two in Section 7, but the results were somewhat disappointing.

One nearly horizontal diamond drill hole was drilled Northeasterly from the North face of the old Lucy pit, ~~xxxx~~ now connected with the main Jackson pit. The first 35' was South Jackson grade ore but the remaining 65' lean jasper. It is planned to mine this material with the steam shovel during the coming summer.

The churn drill was moved in October to a point West of the main South Jackson pit and just North of the old so-called Manganese pit. Seven holes had been completed and the eighth started at the end of the year. They averaged 88' in depth and all showed a good grade of South Jackson ore. There is approximately 4,000 cu. yds. of surface over this material but it will probably be removed and mining commenced in this area during the coming summer.

JACKSON EXPLORATION, SECTION 1, 47-27.

The exploring of that part of the Jackson property lying just North of the county road and East from Cornishtown was commenced late in September.



The first hole, No.94, was located just North of the county road and West of the Cornishtown road. It ledged in dike and was bottomed after drilling about 50' in it. Hole No.95, located about 350' farther North, encountered the greenstone footwall at 822'. No ore was found but the jasper was of the manganiferous variety very similar to the South Jackson. The formation is steeply folded, practically conforming to the structure exhibited in the jasper outcropping in the L. S. & I. Railway cut several hundred feet Northwesterly. The next hole, No.102, was located approximately 600' Northeast of No.95. It encountered soft ore jasper ledge at 14' and was drilling in it at 127' at the end of the year. This jasper has also been noticeably manganiferous.

BELLEVUE FARM, SECTIONS 17 & 18, 47-26.

Drilling at the Bellevue, which was resumed late in November 1916, continued until the middle of November 1917.

In January, February and the early part of March, a series of eight holes were drilled on a North-South line just East of the West boundary of Section 17. As the object of this exploration is to discover a body of shallow ore that can be stripped, this series of holes was planned to test the iron formation along its outcrop at the ledge surface. The first hole, No.1, was located about 300' North and 30' East of the West quarter corner of Section 17. This is about 250' East of No.1 Section 18, which encountered good ore from 32' to 53'. This hole ledged in soft ore jasper at 18'; from 124' to 170' the jasper was interbedded with slate and at 170' passed into the typical magnetite grunerite slate of the district. It was bottomed in the latter material at 230' after encountering a dike from 209' to 228'. The remaining seven holes were located at 300' intervals to the North. No.2 encountered slate at 211'; 15' of lean ore, which was cut from 165' to 180', was the only sign of concentration in the jasper passed through. Hole No.3 had 106' of soft ore jasper before reaching slate but no enrichment. The remaining five holes all ledged and were bottomed in slate.

The drill was now moved across the line into Section 18 and hole No.8 located 100' North of No.1 to try and follow up the ore found in the latter. Lean ore was encountered at ledge at 4' and 10' of good ore from 10' to 20', averaging 57.80% iron and .092% phosphorus. The remainder of the hole was in soft ore jasper and bottomed at 240'. No.9, located 100' North of No.8, found this ore at ledge but it was only 4' thick. Although three more holes were drilled to the West and North of No.9, no additional ore was found.

Drilling was now resumed in hole No.4 from a depth of 504'. This hole had reached a depth of 670' in December 1916 when it became necessary to cement the lower part. In attempting to drill this cement out, the drill branched off at 504' and the hole was temporarily discontinued at the end of 1916. The present branch hole encountered no ore in addition to the lean and second class material at the bottom of the old hole, which of course was now again drilled through. The diorite was encountered at 722' and the hole bottomed in it at 760'.

An attempt was next made to follow the ore in No.1 on the dip and pitch. The first hole, No.13, was located 100' Southwesterly from No.1 and encountered 58' of first class ore and some second class ore at a depth of 150'. Although four other holes were drilled, all close together and near holes Nos.1 and 13, no more merchantable ore was located. This was very disappointing and proved without doubt that the ore found was a comparatively narrow seam, even if continuous for an appreciable distance.

One hole was drilled 300' due West of the old open pit near the East quarter corner of Section 18, from which several thousand tons of ore were removed a number of years ago. It was thought an extension of this ore might occur on the dip but the hole, although carried to a depth of 298', was all in unoxidized siderite and magnetite slate.

Four holes were then drilled in a general North-South direction at intervals of 250' on the North part of the farm to explore the ground which had been partially tested by several shallow test pits



sunk some years ago. No merchantable ore and only a small amount of lean ore was encountered. This completed the Bellevue Farm exploration.

DEAD RIVER DISTRICT.

DEAD RIVER STORAGE EXPLORATION, N $\frac{1}{2}$  OF SE $\frac{1}{4}$ , SECTION 2, 48-27.

Work was commenced early in November standpiping for a storage dam site in connection with the hydro-electric developments at the Hoist and McClure plants.

Four holes in all were sunk to ledge and enough drilling done in each to determine its character. They were all located South of the river and arranged on a general East-West line, the most Easterly hole being drilled first. The first two were approximately 100' apart, the interval then being increased to 200'. The ledge in all four holes was a decomposed slate, but No.4, after passing through 14' of slate, encountered and was bottomed in a slightly ferruginous chert or lean iron formation. The depth and character of ledge eliminates this locality from the possible dam sites.

NORTH LAKE DISTRICT.

BARNES & HECKER LEASE NO.31, N $\frac{1}{2}$ , SECTION 2, 47-28.

Hole No.88, located at the West end of the Barnes & Hecker ore body thus far developed, was drilling in soft ore Jasper at 863' on the first of the year. This hole was sunk in a final attempt to find a merchantable ore body at the bottom of the supposed fault crotch in this locality. A 10' seam of ore and a few feet of lean ore was the only concentration found and this was encountered several hundred feet above the dike or approximate position of the fault zone. This completed the attempt to increase the Barnes & Hecker ore reserves by surface drilling.

As it was shortly decided to open up the property, a suitable shaft site was the next consideration. Standpiping ~~was~~ for ledge was started early in March with the Keystone churn drill, which had just arrived from the manufacturers. It did very creditable work. The slate on the North Greenwood road is the nearest outcrop of ledge to this ore body.

As it is about 1800' away, it was hoped by standpiping to find ledge within a reasonable distance from the surface much nearer than this.

The first standpipe was located at S. 1550 and 8000 W., or about 700' due North of the center of the ore. Slate ledge was encountered at 186'. Of course this is much too deep for a sand shaft, but as the churn drill expert demonstrator was here for a limited time and at a large expense to instruct our operating crew, the hole was ledged and chopped 29' into it principally as a demonstration. We then moved 700' farther North to a point within 100' of the main line of the L. S. & I. Railway. The hole was stopped at 80' without encountering ledge. The most feasible course now remaining was to sink a series of standpipes in the vicinity of the above mentioned outcrop to determine how much of this 1800' could be cut down and still reach ledge at a moderate depth. Four standpipes were sunk. The first, about 400' East of the outcrop, encountered ledge at 56'. The second, about 140' nearer the slate, got ledge at 64' but it was gradually rising to the West since the collar of the latter hole was 20' higher than the former. The next hole, 100' farther West, reached ledge at 36', and the last, No.95, which was located another 100' West and only 100' East of the outcrop itself, encountered ledge at only 13'. This information allowed accurate ledge contours to be drawn and the shaft was finally located at approximately the position of No.94, the next to the last standpipe.

#### REPUBLIC DISTRICT.

Drilling from surface in the West Republic area to explore the iron formation immediately below the hanging wall contact was continued until about the middle of February with disappointing results. The third and last hole, which was started at the beginning of the year, was located on the axis of the basin where it should have ~~have~~ reached the quartzite-jasper contact at from 500' to 600'. Like the first two, however, it wandered far from its original vertical position and encountered jasper at 864'. A survey of the hole showed this contact to be on the Western limb of the basin which we previously know to be thin and unfavorable. The inclination of the hole at the bottom was 30°.



Since it proved to be practically impossible to get a hole down from the surface with any degree of assurance as to its ultimate position, at least with the present drill equipment, this exploration was stopped. Later in the year a drift was driven on the 1335' level Pascoe shaft over into this basin, from which it is planned to continue exploring.

MESABI RANGE.

AURORA DISTRICT.

MEADOW MINE, SECTION 3, 58-15, MINNESOTA.

Late in November, Mr. Barber engaged Cole & McDonald to systematically explore the  $\frac{1}{2}$  of the NW $\frac{1}{4}$  of Section 3, West of the Meadow mine workings. Several holes and test pits were sunk in this locality by another company several years ago but the job was not finished. Two diamond drills are being used. Three holes, Nos. 300, 301 and 302, had been bottomed in the Pokegama quartzite, and two others, Nos. 303 and 304, started at the end of the year. No. 300 encountered 5' of ore averaging 60.40% iron and .065% phosphorus at ledge, depth 35', followed by 20' of second class ore averaging 53.27% iron and .067% phosphorus, and 15' of leaner material. No other concentration has been found thus far. All these holes are in the NW $\frac{1}{4}$  of the NW $\frac{1}{4}$  of the section and are laid out on approximately 200' centers, checker-board fashion, according to the customary Mesabi practice.

UNDERGROUND EXPLORATIONS.

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

Drilling continued in this mine until the middle of September and was stopped only because the drill was needed for several holes at the South Jackson pit and the Francis mine.

Eighteen holes, including No.265, which was being drilled at the beginning of the year, were completed during this time. They are pretty well scattered throughout the mine, but their locations, reasons for drilling and ultimate results, are all given in detail in my monthly reports and I presume Mr. Eaton will discuss them again in his annual report.

A total of 385' of first class ore; 245' of second class ore and 136' of lean ore were encountered in this drilling. This is a slight decrease from the 1916 results, proportionally to the total footage drilled, but an increase over the results of 1915.

FRANCIS MINE, SECTION 27, 45-25.

Two horizontal holes were drilled late in the year and each on a course of S. 31° W. from the 5th level of the Francis mine to explore the gently folded footwall for a possible recurrence of ore in a structural basin at this elevation should one be found to exist.

The first hole encountered nothing but zones of arkose and granite until it was bottomed in the latter material at 322'. The second hole passed through 210' of arkose and footwall slate, then encountered 55' of slaty ore. It was stopped in the latter at 265' since it was decided to explore the rest of the area by drifting. From 220' to 230' this ore averaged 58.75% iron and .127% phosphorus but the rest was second class material and is in reality a highly ferruginous slate.

MAAS MINE, SECTION 6, 47-26.

Although no new holes were drilled in this mine during the year, work was begun in December to try and recover the bit lost at the bottom of old hole No.9. This hole was drilled from surface to a depth of 1285' in 1901 and was one of the holes that proved up the Maas ore body.



Eight hundred feet of rods were lost with the bit and were recently encountered on both the 200' and 180' sub-levels of the Maas mine. Following the completion of the Francis drilling, the outfit was moved to the Maas mine and set up on the 180' sub-level to ream around the old rods. This work was progressing satisfactorily on the last of the year.

MORRIS MINE, SECTION 1, 47-28.

On the first of the year, hole No.35 was being drilled horizontally and South from the breast of the South exploratory drift on the 6th level to locate and explore the hard ore jasper-quartzite contact. It was 1318' deep and in dike on January 1st. At 1350' it passed from the latter into hard ore jasper. The jasper was considerably brecciated or conglomeratic and lean. From 1375' to 1431', alternate seams of slate, hard ore jasper, dike and quartzite were passed through but at the latter depth the main hanging quartzite was encountered and the hole finally bottomed in it at 1447'. This is the first time the hard ore jasper-quartzite contact has been explored in depth in this vicinity and it was hoped a concentration might be found.

Hole No.29, a vertical hole from the same drift which had been previously drilled to a depth of 355', was now reopened and deepened to the slate footwall. The latter was reached at 1120' without encountering any first class ore. This completed the drilling at the Morris mine for several months. It was decided to extend this exploratory drift 275' South and put down another vertical hole to the footwall.

Drilling was resumed the last of September and a series of three horizontal holes were drilled very near the West end of the 6th level. Holes Nos.38 and 40 were drilled North to locate the slate foot and explore its off set. No first class ore was encountered. Hole No.39 was drilled Southwesterly from a location nearby to explore for a possible Westerly pitching extension of the ore being mined on the 420' and 390' sub-levels. No merchantable ore was found.

By this time the South exploratory drift had been extended and a drill station cut at the breast so that hole No.41 was located here. It is the intention to carry the hole down to the slate footwall in hopes of encountering a continuation on the dip of the ore found in the upper part of No.29, as well as a possible extension of the ore from Section 6. The hole was drilling in soft ore jasper at 651' on the last of the year and no ore had been encountered.

REPUBLIC MINE, SECTION 7, 46-29.

One diamond drill operated continuously throughout the year in the Republic mine and 31 holes were completed. Although they were pretty well distributed amongst the working levels in both the Pascoe and No.9 shafts, the results were discouraging. No new lenses of any appreciable size were found and the old ones became much smaller and some pinched out altogether in depth. It is significant to bear in mind, however, that, theoretically, lean horizons have been characteristic of this mine ever since it was opened.

The locations, reasons for drilling and ultimate results of all the holes have been given in detail in my monthly reports and I presume Mr. Stakel will discuss them again in his annual report.

A total of 153' of first class ore; 121.5' of second class ore and 236.5' of lean ore were encountered in this drilling. Proportional to the total footage drilled, these results are greater than those of 1916 and a large increase over the results of 1915.

The 1335' level, which was extended Westerly into the West Republic basin during the year, had nearly reached the point on the last of the year from which we plan to continue the exploration of the West Republic area. This is practically virgin territory, having never been explored in depth.



EXPLORATIONS BY OTHER COMPANIES.

Ernest Allen continued to visit the explorations of other companies in Michigan. Owing to the press of work in looking after the core of the large amount of drilling, he was not able to make any long trips during the last half of the year and the amount and character of outside exploring being done did not warrant engaging another man for this special duty.

The maps of these explorations have been made by Mr. Allen. He has also written special reports covering each visit and the information thus acquired.

This entire work cost \$105.49 in 1917, of which \$55.26 was Mr. Allen's salary while engaged in it, and the balance, \$50.23, his traveling expenses.

Mr. Afuhs has copied for our files all outside exploration results of any importance which have come to this office in the form of land offers, etc. The proportional time required was so small that no separate cost of this work was kept.

TABLE V.

COMPARATIVE STATEMENT OF CHARGES TO THE GEOLOGICAL DEPARTMENT FOR THE  
LAST THREE YEARS.

	<u>1917.</u>	<u>1916.</u>	<u>1915.</u>
Salaries - - - - -	\$13,130.41	\$13,282.44	\$13,778.60
Travel - - - - -	221.55	30.02	124.15
Operating auto - - - - -	286.49	0	0
Supplies - - - - -	1,043.59	961.20	511.75
Miscellaneous - - - - -	12.23	125.36	23.97
Visiting Outside Explorations	105.49	110.55	226.88
Total	\$14,799.76	\$14,509.57	\$14,665.35
Expenses of H. L. Smyth, i.e. travel, supplies and miscella- neous - - - - -	569.05	764.80	749.33
Grand total	\$15,368.81	\$15,274.37	\$15,414.68

Although there were several general salary increases during the year, the total salaries of the Geological department is less than for a good many years. This is of course due to the small force which prevailed for the greater part of the year. This has not been conducive to anything like a maximum geological efficiency in such a period of mining activity but until late in the fall it was impossible to get any new men.

Practically the only unusual item included in supplies is the cost of the drawers for the new core filing cabinet which was built in 1916. This amounted to \$255.20. The Geological department's proportion of the depreciation of the new automobile to take the place of horse hire, etc, in the summer months was \$53.75, but this hereafter will be a regular item under supplies.



#### ANGELINE MINE

Some headway was made in preparing this mine for operation. The old steam compressor was removed from the engine house and sold for scrap. The corliss engine driving the double drum hoist was removed, sold for scrap, and was replaced with the gears removed from the Cliffs Shaft Mine hoist and a motor purchased to drive the underground pump at the Holmes Mine, but which will not be needed there until another duplicate motor can be received. This ~~200~~<sup>250</sup> H.P. motor was built with sub base and outboard bearing for belt drive. It was necessary to remove sub base and outboard bearing and replace pulley with a flange to adapt it for this installation. Equipment is installed with the exception of motor, which will be ready as soon as flange is attached at the Shops.

The locomotive crane was removed from the East End in June and used to strip the overburden from the gravel bed at the Dead River-McClure Plant dam site. A small 5/8 yard dipper Marion "28" revolving shovel was secured from Section 6 Shaft and has operated at the East End since July.

#### CLIFFS SHAFT MINE

##### HOIST

This hoist was made over so that each drum is driven through herringbone gears by a separate motor. "B" Shaft drum equipment was put in from September 1st to 3rd and no product was lost through hoisting delays. "A" Shaft drum was equipped later while "A" Shaft was closed down for three weeks for repairs. Each drum is now driven by a 500 H.P., 600 R.P.M., General Electric motor through a 253 and 14 tooth single reduction herringbone gear bolted to drum shell. A safety brake mechanism is attached to pinion shaft coupling flange which is operated by overwind mechanism. The equipment has been in operation approximately two months and works satisfactorily. The hoisting speed is now 1000 ft. per minute.

CLIFFS SHAFT MINE (Cont'd)

PUMPS

An additional electric driven plunger pump was installed in the pump room on the 1000 ft. level. This pump has a capacity of 600 gallons per minute. The poles are 6 $\frac{1}{4}$ " dia. with 24" stroke and are driven through herringbone gears and flexible coupling by a 200 H.P. , 600 R.P.M., General Electric motor. This pump was furnished by The Prescott Company, Menominee, Mich., and was placed in operation in July. The combined capacity of the pumps on this level is now 1800 gallons per minute. The pumping load at present is between 600 and 700 gallons per minute.

BOILER ROOM

A coal crusher and elevator was installed in the boiler room. This reduces the 3/4 coal to slack size. This equipment was purchased from The Link-Belt Company and has a capacity of 15 tons per hour. Two views of this are shown on Plates 1477/48.

The crank shaft on fan engine broke in November and it was necessary to use natural draft for two weeks while a new shaft was secured and installed.

The Russel steam engine formerly used to drive electric light generator was sold to the Foundation Company in November and shipped to Kansas City, Mo.

A new 70 "C" Bucyrus steam shovel was received in April and was used most of the summer in the lump pile.

A small 5/8 yard dipper air operated revolving shovel was placed underground in May and was used intermittently on the 7th level.

HARD ORE

No additions or changes made in Shops.

The boilers at No. 4 Shaft were removed. One was sent to the Athens Mine and installed in the change house for heating system. The other was hauled to the Barnes-Hecker Mine and bricked in. It will furnish steam for sinking the shaft and will then be used for heating only.



HARD ORE (Cont'd)

The corliss engine at this Shaft, which formerly operated the cornish pump, was removed and sold for scrap.

HOLMES MINE

TEMPORARY EQUIPMENT

This was removed when the permanent hoists started operating during the summer. The boiler was placed in the change house for the permanent heating plant. One hoist was moved to the East End, Angeline Mine, and used to draw cars from the pit, while the other was shipped with remainder of equipment to the Barnes-Hecker Mine.

PERMANENT EQUIPMENT

The hoists have given no trouble since they were placed in commission. It was necessary to raise the air pressure on the air brakes to 80 lbs. in order to make them work freely.

A bad overwind occurred on skip hoist in September.

A new high pressure cylinder was received for the air compressor and the cracked one shipped back to the factory. During October a series of tests were run on this machine, which showed it to be running close to guaranteed efficiency. It has given no trouble during the year.

In the shaft house the two No. 6 crushers were each connected to 40 H.P. motors, while the No. 8 crusher was belted to a 100 H.P. motor. A two drum top tram plant, belted to a 25 H.P. motor, is used for the gravity tram, while the two revolving screens are connected to the same countershaft and driven by a 25 H.P. motor. The ore elevator was installed in June, but has not been needed yet. All other machine<sup>ry</sup> has been in operation and works satisfactorily.

In August a quintuplex belt driven Aldrich pump was received and was stored on surface as it will not be needed for several months. This is a 7" x 12", vertical, single acting, plunger pump of 600 gallons per minute capacity against 1200 ft. head, equipped for belt drive. The motor for this

HOLMES MINE (Cont'd)

pump was received and will be used on Angeline Mine hoist. It is a General Electric, 250 H. P., 600 R.P.M., Form "P" machine.

The 8" water column was installed in the shaft. The 12" counterweight pipe was also installed and counterweight connected to cage hoist.

Underground the electric haulage was put in, pockets installed on 1st and 2nd levels and ventilating doors with remote opening mechanism placed in operation on 2nd level.

LAKE MINE

No changes were made in the boiler house and few repairs were needed.

The cage hoist was partially rebuilt. A new crank shaft middle bearing was added, the spur gear and pinion were replaced with gears of the herringbone type and an overwind mechanism was purchased. The machine is now in good condition.

To allow hoisting from greater depth an 8 ft. diameter drum shell was installed on the skip hoist and the 7'6" diameter shell was sold for scrap. This change was made in April and works satisfactorily.

A Link-Belt coal crusher, driven by a 15 H.P. Western Electric motor, was installed near coal dock and reduces all 3/4 coal to slack size before it goes into coal car.

SALISBURY MINE

As it was necessary to replace the old boiler at the swamp pump station a new pump house was built and equipped with a 2000 gallon per minute, 40 ft. head, Allis-Chalmers motor driven centrifugal pump, which takes care of all surface water in spring and fall. The steam pump was stored in yard and the boiler was sold for scrap.

The old Cornish pump engine and Rand steam compressor located in engine house were removed and sold for scrap. The size of engine room was made smaller, which makes it much easier to heat.



### ATHENS MINE

No changes were made in engine house and only minor repairs were needed to keep machines in first class condition.

A 100 G.P.M., 1400 ft. head, Aldrich pump was installed on the 2400 ft. level. This pumps the water to the 1000 ft. level where it is handled by a 100 G.P.M., 1000 ft. head pump. These operate with automatic float control and give very little trouble.

A Prescott "Menominee" horizontal duplex pump was received and stored on surface until pump house and sump on 2400 ft. level is completed. This pump, of a horizontal duplex type, has  $5\frac{1}{2}$ " x 24" poles driven through herring-bone gears and flexible coupling by a 400 H.P., Westinghouse, 514 R.P.M. motor and has a capacity of 500 gallons per minute against 2400 ft. head.

The small  $3\frac{1}{4}$ " x 5" Aldrich triplex pump, 35 gallons per minute capacity against 500 ft. head, was shipped to the Gardner-Mackinaw Mine.

All of the permanent steel trestle was received and erected during the summer.

The Shops were completed and occupied.

### MAAS MINE

Few changes were made in the engine house. It was necessary to replace one cage hoist drum spider as four spokes were cracked. A steam brake and overwind mechanism were also installed on this hoist.

To increase the condenser capacity on steam turbine a 14" wood pipe line was put in between spray pond and hot well and a 12" H.S. centrifugal pump end bought to replace the old one, which was 10". This equipment gives satisfaction and a 25% continuous overload can now be carried on turbine.

A cooling tower and pump were installed to furnish clear water for compressor, transformers, turbine and water cooled bearings instead of using City water. This equipment saves about \$60.00 per month on water consumption.

The boiler plant gave continuous trouble during the year due to burned out arches, fan engine troubles, economizer leaks and careless firemen.

MAAS MINE

(Cont'd)

The boiler plant was forced so hard to carry the mine and turbine load very little time could be secured for repairs. To relieve the situation the boiler plant from the Imperial Mine was dismantled, brought to this mine and installed in a temporary building between engine house and coal dock. This plant now carries the mine load while the old plant furnishes steam for the turbine, rock tram and heating.

The fan engine broke and was replaced with a 25 H.P. electric motor.

A crushing plant similar to the one installed near the Gwinn Mine was put in during the spring and was operated from July to the end of the shipping season. The only serious accident occurred to conveyor belt, which was ripped close to its entire length. It was patched and is still in commission.

A new electric driven top tram plant was installed and the old plant removed. This new plant is similar to the one shown on Plate 160. It was started in February and has given no trouble.

A small brick addition was added to boiler room for coal crusher. This crusher and conveyor duplicates the one installed at the Cliffs Shaft Mine, with the addition of screw conveyors over the coal bunkers. The equipment is similar to that shown on Plate 147.

NEGAUNEE MINE

The shaft house was enclosed during the fall and a heating system planned for the upper dump and chutes. Hoisting delays and coal will be saved by this change.

As the tram plants located in shaft house gave considerable trouble, a new tram equipment was installed on the ground and the old motors shifted to the new equipment. This equipment is shown on Plate 160.

In May a 450 H.P. motor was installed in flywheel set to replace the 350 H.P. motor, which was too light for the work. This has given no trouble since it was placed in operation.



#### SOUTH JACKSON CRUSHER PLANT

This equipment was shut down in July when the new Maas Crusher Plant was placed in operation. Only the compressor was used to furnish air for mining in the pit.

#### BARNES-HECKER MINE

The 6" air line formerly used between the Cliffs Shaft and Morris mines was taken up and put in between the Morris Mine and this shaft. Air is supplied by the spare Ingersoll-Rand compressor in the Morris Mine engine house.

A 66" x 18' boiler was secured from Hard Ore #4 boiler house and bricked in at the end of the change house. This will supply steam to the temporary hoist equipment used in sinking.

Electric hoists and other equipment has been ordered but not received.

#### LLOYD MINE

New contactor equipment was installed on skip hoist and works satisfactorily.

The tram plant rawhide pinions were received. An accident to the south side plant rendered it useless for two days, but repairs were finally secured from the Lake Shore Engine Works.

#### MORRIS MINE

In February the motor-generator set furnishing current for the underground haulage caused trouble and the Holmes Mine equipment was used until repairs could be made.

During November the inboard bearing on the Nordberg air compressor gave trouble and was removed and repaired, causing a delay of one day.

A bad overwind occurred on skip hoist in October, due to brakeman's carelessness. It was necessary to put in a new rope, head sheave and skip.

A new rawhide pinion was added to Gould triplex pump on 1200 ft. level in June.

### SECTION 6 SHAFT

No trouble was experienced with any of the mechanical equipment during the year.

### AUSTIN MINE

Operations were not started at this mine until April 30th.

On April 27th a tooth in the herringbone pinion on the hoist broke and a new pinion was installed on April 29th. While this was being done the hoisting rope hung slack over the rope stands to the shaft house and in some unknown way a loaded ore car on the switch ran away, fouling the rope and pulling down two of the wooden pulley stands.

On June 14th, and again on July 24th, coils in the hoist motor gave trouble and caused short delays. On November 27th the outboard bearing of the hoist motor broke, causing considerable delay for repairs.

On December 24th the mine was closed down due to the water coming in from the Stephenson and flooding the mine.

In December a Prescott sinking pump of 500 gallons capacity was installed near the first level, and in January a Cameron pump of about 200 gallons capacity was installed on the first level to prevent the water from rising up on this level. These pumps have been running almost continuously since their installation. The water has risen slightly during this period of time.

### FRANCIS MINE

A water tank has been erected and partially piped up to the dry, fire hydrants, boiler house, etc., for providing water for this mine.

The two electric driven Lake Shore Engine Works hoists are erected and one is working the skip and cage in balance. The other is not yet working, as the counterbalance pipe has not yet been installed.

The 10" water column to the 5th level pump house is now in place as far down as the 5th level and the Prescott pole pump is also erected. As the



FRANCIS MINE (Cont'd)

suction and discharge fittings for this pump have not yet been received the motor for driving the pump was left on the surface, as it was not deemed advisable to install it until the pump was ready to run.

A new electric driven tram plant for the stocking trestle was also put in operation at this mine during the year.

GARDNER-MACKINAW MINES

In August the Gardner Mine was unwatered and sinking operations started.

On March 31st a wedge bolt on the crosshead of the Nordberg air compressor broke, allowing the wedge to drop out. Before the compressor could be stopped the connecting rod had been jammed out of shape, requiring a new rod.

A pump house is being cut on the 850 ft. level preparatory to installing a temporary pump to throw the water to the surface until the main pump house can be cut and the permanent pumps installed on this level.

The 10" water column is completed in the shaft down to the 850 ft. level.

GWINN MINE

The operation at the Gwinn Mine has been satisfactory for the year, with only minor trouble to the mechanical equipment to break into the operation.

A puffer for hoisting ore from below the sixth level was installed on this level and a small electric driven Aldrich pump was also installed on the same level for throwing water up to the fifth level pumps. No other additions were made to the mechanical equipment at this mine.

GWINN CRUSHING PLANT

This plant operated very successfully the past year, with practically no delays.

#### GWINN SUBSTATION

During the year a new electric Substation was built near the Gwinn Mine the better to distribute power to the Gwinn, Francis and Gardner-Mackinaw Mines. It also serves as a terminal for the Au Train transmission line.

#### JOPLING MINE

No work has been done at this mine during the year.

#### PRINCETON MINE NO. 1

Idle the entire year with the exception of the pumping plant, which keeps Princeton No. 2 unwatered.

#### PRINCETON MINE NO. 2

When the Stephenson and Austin mines were closed down preparations for starting the Princeton #2 Mine were at once gotten under way.

The hoist motor, which had been removed and installed at the Austin Mine, was returned. A top tram motor from the Stephenson "Northwestern" stocking tram plant was removed and installed at the Princeton Mine.

The mine operated very little during 1917.

#### PRINCETON CENTRAL POWER PLANT

A great deal of trouble has been experienced with the coarse coal breaking the stoker arms, feed tables and other parts of the stokers. On account of sagging front arches and the coarse coal it has been almost impossible to feed the stokers automatically, almost all of the feeding having been done by hand.

The coal crushing plant was just recently put into operation, but it does not seem to crush the coal fine enough to relieve the trouble mentioned above, even though it is set to crush as fine as possible. However, as stated above, a very considerable amount of the trouble is now caused by the sagging arches blocking the feeding spaces in the magazines.



PRINCETON CENTRAL POWER PLANT (Cont'd)

Considerable trouble is experienced with tubes and headers in the Sturtevant economizer failing from time to time. The tubes and headers are deeply pitted and are very much wasted away and deteriorated. It will soon be necessary to make very extensive repairs on the economizer because of this condition.

A new high pressure steam cylinder was installed on the Allis-Chalmers air compressor in the month of July. On July 29th the compressor was changed over to steam operation.

On July 27th a severe electric storm put the transmission line to Ishpeming out of service and only enough electricity could be generated on the turbine to operate the pumping units at the various mines.

PRINCETON PUMP STATION

A new smoke stack for the boilers was put up in July.

The dam in the river at the pump station was raised about a year ago and since that time the water in the river has been cutting away the bank on the side opposite from the pump station, which has necessitated much filling in of rock to keep the water on the suction of the pumps and preserve the river bank. The dam should be very materially lowered in the middle of the river and on the side next the pump station to relieve this trouble.

STEPHENSON MINE

The third and last electric driven tram plant for the stocking trestle was put in operation January 1st, 1917.

During the year a pump house was cut on the 6th level and an Allis-Chalmers centrifugal pump installed to throw water up to the 5th level pump house. The foundation in this pump house for the Aldrich pole pump was also completed, but the pump was not installed.

The 5th level pump house was enlarged and the foundation for the

STEPHENSON MINE

(Cont'd)

large Aldrich pump completed. Installation of this pump was about to be started when the mine was flooded.

In December, due to a large increase in the mine water, which was much more than the pumping equipment could handle, the mine was lost. Since that time bailing, blowing water with an air lift and pumping has been continued. The water at the present time stands 124 ft. below the collar of the shaft.

CROSBY MINE

The mechanical equipment at the Crosby Mine worked quite satisfactorily during the year and no change in equipment was necessary. No accidents of consequence occurred and there are no changes contemplated for the coming year.

MEADOW MINE

The mechanical equipment at the Meadow Mine worked quite satisfactorily during the year, without accidents or delays of consequence.

A gasoline tramping locomotive was purchased for this mine to facilitate tramping and dispensing with the using of mules underground.

IMPERIAL MINE

This mine was idle during the entire year.

REPUBLIC MINE

The Republic Mine operated without serious trouble during the year. Shortage of water at the Water Power Plant necessitated making considerable compressed air by steam.

An electric generator was connected up to the No. 2 wheel at the Water Power Plant and this now furnishes what electricity is needed at the mine. This put the old generator and engine out of service at No. 5 Engine House, which formerly generated current for this district. This equipment



REPUBLIC MINE (Cont'd)

was old and very unreliable and extravagant of steam. We find now that by generating the electricity with this water wheel and making up the deficiency in compressed air with the steam compressor, which is a good machine, considerable saving in fuel is shown.

A new hoist has been bought for #9 Shaft, which will operate electrically. When this is installed the #5 Boiler Plant will be shut down completely. Current to run this electric hoist will have to come from the Ishpeming district. Transmission line will be built during the coming summer so as to be ready to operate this hoist when our new water power installation is completed, which will give us sufficient electric power.

SPIES MINE

A new electric driven air compressor was installed at this mine during the year, taking the place of the old steam machine. The steam machine was not furnishing sufficient air and it was very extravagant of steam. The electric machine proves far more satisfactory and more economical.

No changes are contemplated at this property during the coming year.

DEAD RIVER-McCLURE PLANT

The work at the dam has been continued through the winter. The placing of concrete in the winter time proves far more expensive than in the summer, but in order to hasten the work and get this plant in operation at the earliest possible time this work has been continued. There was placed up to December 31st about 5000 yds. of concrete and stone.

A small force of men have been at work at the Power House continuously, clearing off the site for the power house, putting in foundations, building railroad from the L. S. & I. Ry. to the power house and other preliminary work.

Material for the job has begun to arrive and gives promise of all being here as soon as we will be ready for it.

## ELECTRICAL DEPARTMENT

The past year has been one of continued progress under difficulties.

We have reached considerably more than our water power capacity under normal conditions, and because of an unusually dry season there has been difficulty in carrying the load even with all steam plants working.

Our steam plant costs have been very high. This was on account of necessity of forcing the boilers at times to carry the load, but mostly on account of poor coal. The coal was so poor that at times we were only able to secure 50% capacity on the boilers, and then at the expense of settings and bricking going to pieces due to inability to keep clinkers out and the draft free.

A number of electrical storms occurred which caused a nominal damage and temporary shut down of Gwinn District for one day, but in general practically continuous service has been supplied.

Our plan for railway crossings has not been satisfactory on account of inability to secure suitable strain insulators and it has been necessary to cut off practically all of them and carry circuits straight through.

During the latter part of the year some losses were observed due to low power factor. In order to correct this it is probable we will find it necessary to install synchronous condensers at one or two selected points.

The high tension entrance windows in old Substations have broken down and been largely replaced by porcelain entrance tubes, which are much more rugged and satisfactory.

At the Maas Mine the feeder switches and arrangement of Substation was changed in order to reduce the probability of fire and to give additional capacity at this point.

A new Substation of the outdoor type was installed near the Gwinn Mine. This has a capacity of 1875 K.V.A., 30000 to 2300 volts, with steel and wood supporting structure and sheet iron switch house for feeder switches and meters. This takes care of the Gwinn, Francis and Gardner-Mackinaw Mines. Westinghouse transformers were used and General Electric switches and protective devices.



ELECTRICAL DEPARTMENT

(Cont'd)

The line connecting our Au Train Plant with the general system was completed and put in service in December. This is a single circuit of #6 H.D. copper wire on 30 ft. poles set 38 per mile, and with stranded 1/4" steel guard wire on bayonets. The length of this line is 30 miles. Equipment at Au Train end consists of two generators made by the General Electric Company, 450 K.V.A. each, with direct connected exciters and connected to the old Pelton water wheels which have been in service since the plant was first built. The old 40 cycle, 13,000 volt, generators were sold to the Munising Paper Company and removed by them. One three phase, 1250 K.V.A., 30,000/2300 volt air cooled transformer, electrolytic lightning arresters and air switches in connection therewith were supplied by the General Electric Company. Wooden supporting structure was built on the ground. The Au Train line was connected with our main system through a 30,000 volt oil circuit breaker near the Gwinn Substation and so arranged as to operate under reverse current and clear in case of trouble. Right-of-way for this line was acquired from the M. M. & S. E. Ry. the entire distance.

The old #2 line from Au Train to Munising will be converted to 30,000 volts and used to supply power to Munising during 1918.

Plans are complete and material ordered for connecting Republic Mine with our general system during 1918. We have installed a 150 K.V.A. generator at the Republic Water Power Plant and this will be tied in when line is completed.

A two circuit 30,000 volt, 3 phase, pole line was built from the Morris Mine to the Barnes-Hecker Mine, one circuit to supply Barnes-Hecker Mine and the other to be carried through to Republic.

All 2300 volt lines between the Princeton Central Power Plant and the Gwinn Substation were taken down and replaced by one 30,000 volt circuit.

A temporary 2300 volt circuit was built from the Dead River "Hoist" Plant to the new McClure Plant dam to furnish power for use during construction.

On account of the impossibility of securing lamps for the present Gwinn street lighting it has been necessary to order new equipment for this service, which will be installed as soon as received.

ELECTRICAL DEPARTMENT (Cont'd)

The use of synchronous converters for underground haulage service was first applied during this year and with satisfactory results.

Improvements are now under way to prevent overwinds of electric hoists, being allogical development of the safety devices which we have heretofore used.

More satisfactory signal systems for mines are now under development and will be perfected the coming year.

We found it necessary to run steam plants throughout the year as the load is so large that the water power plants would not carry the peaks.

Our applications are now so numerous and varied that it will be necessary to introduce a more systematic method of inspection and testing during the coming year.

The new applications and developments have been made with our own force and we believe in general reliability and good engineering that the plant as a whole will compare very favorably with any of similar size in existence, and this, we think, at a cost remarkably low.

Plate No: 1574158 show Gwinn Substation and switch house and Plate No: 1554156 show terminal switch tower at Princeton Central Power Plant.

During the year the following changes and additions were made in pole lines and circuits:

<u>NEW LINES BUILT</u>	<u>POLE LINE</u>	<u>CIRCUIT</u>	<u>WIRE</u>
"Hoist" Plant to McClure Plant - #8	18,500 ft.	18,500 ft.	55,500 ft.
Salisbury to Angeline Mine - #6	1,500	1,500	4,500
Morris to Barnes-Hecker Mine - #6	9,400	9,400	28,200
Maas Crushing Plant - #6	1,000	1,000	3,000
Gwinn to Au Train Plant - #6	160,000	160,000	480,000
C.P. Plant to Gwinn Substation - #2		9,770	29,300
Gwinn Substation to Gwinn Mine - #4/0	3,000	3,000	9,000
" " " Gwinn City - #6		4,400	13,200
	<u>193,400 ft.</u>	<u>207,570 ft.</u>	<u>622,700 ft.</u>



ELECTRICAL DEPARTMENT (Cont'd)

	<u>LINES TAKEN DOWN</u>	<u>POLE LINE</u>	<u>CIRCUIT</u>	<u>WIRE</u>
C.P. Plant to Gwinn Substation - #4/0		9,770 ft.	9,770 ft.	29,300 ft.
" " " " " - #2			9,770	29,300
" " " Gwinn City - #4			<u>5,800</u>	<u>17,400</u>
		9,770 ft.	25,340 ft.	76,000 ft.
Total miles High Tension 3 phase line	-	68.		
" " " " " " wire	-	322		
" number " " Towers	-	377		
" miles 3 phase Primary Line	-	37		
" " " " " wire	-	113		
" " Primary Pole Line	-	37		

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

	<u>INSTALLED</u>	<u>INSTALLED</u>	<u>TAKEN OUT</u>	<u>TOTALS</u>
	<u>TO JAN. 1,</u>	<u>IN 1917</u>	<u>IN 1917</u>	
	<u>1917</u>			
<b>CARP RIVER POWER HOUSE</b>				
Auxiliaries - 2 - 15 HP 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 HP. motors	50			
Screens	15			
Top Tram	50			
Lower Tram	20			
Underground Haulage Set	100			
Hoist	500			
Underground Plunger Pump	180			
" Centrifugal Pump	250			
Compressor	175			
No. 2 Hoist		500 HP.		
Underground Plunger Pump #2		200		
Laboratory Crusher		5		
Coal Crusher		<u>15</u>		2,210
<b>HARD ORE</b>				
Machine Shop	7½			
Carpenter "	25			
Blacksmith Shop Punch	<u>3</u>			35½
<b>HOLMES MINE</b>				
Air Compressor	340			
" " Cooling Water Pump	3			
Skip Hoist	400			
Cage "	<u>400</u>			
	fwd. 1143			

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1917	INSTALLED IN 1917	TAKEN OUT IN 1917	TOTALS
brt. fwd.	1,556½ HP.	720 HP.		2,276½ HP.
<b>HOLMES MINE</b> brt. fwd.	1,143			
Underground Haulage Converter		125		
Machine Shop		7½		
Top Tram (From Lloyd Mine)		25		
No. 8 Crusher		100		
No. 6 Crushers (2 motors)		80		
Screens		10		
Laboratory Crusher (From Austin)		3		
				1,493½
<b>LAKE MINE</b>				
Underground Haulage Set	215			
Surface Drainage Pumps - 2 - 30 HP motors	60			
" " Pump (From Francis)	50			
" " "	20			
Underground Plunger Pump	75			
" Centrifugal Pump	125			
" Ventilating Fan	40			
Crusher	25			
Surface Drainage Pump (on hand 1916)		5		
Coal Crusher		15		
				630
<b>SALISBURY MINE</b>				
Hoist	400			
Underground Centrifugal Pump	400			
" Plunger "	100			
Compressor	150			
Underground Ventilating Fan	7½			
Compressor Cooling Water Pump	5			
Surface Drainage Pump		30		
				1,092½
<b>ATHENS MINE</b>				
Cage Hoist	400			
Compressor	325			
" Cooling Water Pump	3			
Auxiliary Compressor (for hoist brakes)	5			
Rock Hoist	25			
Underground Ventilating Fan	7½			
Sinking Pump (1000 ft. station)	35			
" " (2400 " " )		50		
Skip Hoist Set	850			
" " " Oil Pump	1			
Shop		10		
				1,711½
Forward,	6,023½ HP.	1,180½ HP.		7,204 HP.



ELECTRICAL DEPARTMENT (Cont'd)

	brt. fwd.	INSTALLED TO JAN. 1, 1917	INSTALLED IN 1917	TAKEN OUT IN 1917	TOTALS
<b>MAAS MINE</b>		6,023½ HP	1,180½ HP.		7,204 HP.
(Circulating Pump)		40			
Turbine Auxiliaries (Injection " (Exciter)		25			
Underground Haulage Set		215			
Shop		10			
Underground Centrifugal Pump		350			
"    Hoist		50			
"    Plunger Pump		320			
Winze Pump (4th Level)		15			
Top Tram (temporary)				50	
Cooling Water Pump			5		
Skip Pit Hoist (From Angeline)			15		
Top Tram - 2 - 50 H.P. motors			100		
Induced Draft Fan (from Cent. Power Plant)			40		
Coal Crushing Plant			15		
					1,233
<b>MAAS CRUSHING PLANT</b>					
Crusher			100		
Pan Conveyor			50		
Belt Conveyor			50		
					200
<b>NEGAUNEE MINE</b>					
Underground Haulage Set		215			
"Ilgner" Hoist Set (on hand)				350	
"    "    "			450		
Top Tram - 2 - 50 HP. motors		100			
Laboratory Crusher		5			
Auxiliary Compressor (for hoist brakes)		3			
Underground Plunger Pumps - 2-300 HP motors		600			
"    Centrifugal Pump		350			
"    Suction Pumps - 2-15 HP motors		30			
Compressor Cooling Water Pump		5			
Air Compressor		325			
Shop		15			
Underground Sump Pump		5			
"    Hoist		35			
Crusher		25			
Underground Ventilating Fan		15			
Timber Hoist - No. 2 Shaft		25			
					2,203
<b>SOUTH JACKSON CRUSHER PLANT</b>					
Hoist		75			
Compressor		50			
Crusher		150			
					275
<b>LLOYD MINE</b>					
Skip Hoist		400			
Cage Hoist		400			
Top Tram		25		25	
"    "		40			
"    "			40		
Crusher		25			
					905
Forward,		19,974½ HP.	2,045½ HP.	(425)	12,020 HP.

ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1917	INSTALLED IN 1917	TAKEN OUT IN 1917	TOTALS
	brt. fwd.,	19,974 $\frac{1}{2}$ HP.	2,045 $\frac{1}{2}$ HP. (425)	12,020 HP.
<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 HP	700			
Laboratory Crusher	5			
Top Tram - 2 - 25 HP motors	50			
Underground Haulage Set	150			
Air Compressor (Nordberg)	325			
" " Cooling Water Pump	5			
Underground Hoist	200			
Winze Pump	50			
Centrifugal Pump		50		
Triplex Pump (on hand 1916)		50		
				2,750
<b>SECTION 6 SHAFT</b>				
Hoist	200			
Water Supply Pump	3			
				203
<b>AUSTIN MINE</b>				
Hoist	150			
Top Tram	25			
Laboratory Crusher	5			
				180
<b>FRANCIS MINE</b>				
Underground Ventilating Fan	7			
Air Compressor	403			
Underground Centrifugal Pump	400			
Skip Hoist		400		
Compressor Cooling Water Pump		3		
Shop		10		
Top Tram (from Stephenson)		50		
				1,273
<b>GWINN MINE</b>				
Skip Hoist	400			
Cage "	400			
Rock Crusher (sent to McClure Plant)			25	
Underground Centrifugal Pump	400			
" Plunger "	350			
Top Tram - Ore	37			
Underground Haulage Set	150			
Rock Tram	10			
Auxiliary Compressor (for hoist brakes)	3			
Shop	5			
9th Level Pump		35		
				1,790
<b>GWINN CRUSHING PLANT</b>				
No. 7 $\frac{1}{2}$ Crusher	85			
Pan Conveyor	50			
Belt "	40			
				175
<b>Forward,</b>	15,747 $\frac{1}{2}$ HP	2,643 $\frac{1}{2}$ HP	(450)	18391 HP.



ELECTRICAL DEPARTMENT (Cont'd)

	INSTALLED TO JAN. 1, 1917	INSTALLED IN 1917	TAKEN OUT IN 1917	TOTALS
	brt. fwd.,	15,747½ HP.	2,643½ HP.	(450) 18,391 HP.
<b>GARDNER MINE</b>				
Hoist	400			
Sinking Pump	<u>35</u>			435
<b>MACKINAW MINE</b>				
Hoist	400			
Sinking Pump	35			
Compressor	325			
Shop	7½			
Sinking Pump (from Athens)		<u>7½</u>		775
<b>PRINCETON MINE NO. 1</b>				
Hoist	75			
Underground Plunger Pump	50			
" Centrifugal Pump	<u>50</u>			175
<b>PRINCETON MINE NO. 2</b>				
Hoist	200			
Top Tram	<u>50</u>			250
<b>STEPHENSON MINE</b>				
Underground Plunger Pump	250			
" Centrifugal Pump	275			
Top Tram	50			
" "	37			
" "			50	
6th Level Centrifugal Pump			<u>50</u>	712
<b>PRINCETON CENTRAL POWER PLANT</b>				
(Circulating Pump (to Maas)			40	
Turbine Auxiliaries ( " " (from G.Storehouse)	50			
(Injection " "	25			
(Exciter	33			
Underground Haulage Set	215			
Compressor	625			
Boiler Room Fan	25			
Coal Crushing Plant			<u>15</u>	988
<b>PRINCETON CENTRAL SHOP</b>				
Shop Motor	25			25
<b>DEAD RIVER-McCLURE PLANT (Construction Work)</b>				
Air Compressor		150		
Pump		10		
Centrifugal Pump (from Francis)		50		
Rock Crusher ( " Gwiffn )		25		
" "		<u>20</u>		
Totals,	<u>18,935</u> HP.	<u>3,071</u> HP.	( 490)	<u>22,006</u> HP.
<b>MARQUETTE FURNACE</b>				
Motor-generator Set (connected to system)	750			
Sawmill - 8 motors ( " " " )	<u>225</u>	445		
GRAND TOTALS,	<u>19,685</u> HP.	<u>3,516</u> HP.		<u>1,195</u> <u>23,201</u> HP.

ELECTRICAL DEPARTMENT (Cont'd)

The following motors are on hand (Dec. 31st, 1917), but are not installed:

<b>GENERAL STOREHOUSE</b>		
Spare		400 HP.
"		50
"		35
"		25
"	(from McClure Plant)	<u>7<math>\frac{1}{2}</math></u>
		517 $\frac{1}{2}$ HP.
<b>HOLMES MINE</b>		
Underground Plunger Pump		250
<b>ATHENS MINE</b>		
Underground Haulage Converter		125
Top Tram		50
Underground Plunger Pump		400
"	Sump Pump	<u>2</u>
		577
<b>NEGAUNEE MINE</b>		
Flywheel Set		350
Underground Plunger Pump		<u>15</u>
		365
<b>FRANCIS MINE</b>		
Cage Hoist		400
Underground Haulage Set		125
Underground Plunger Pump		350
(Loaned to Munising Woodenware Co.)		<u>100</u>
		975
<b>GARDNER-MACKINAW MINES</b>		
Underground Centrifugal Pump		400
"	Plunger "	350
Water Supply Pump		<u>3</u>
		753
<b>STEPHENSON MINE</b>		
Underground Plunger Pump		<u>250</u>
Total on hand 12/31/17,		3,687 $\frac{1}{2}$ HP.

The following motors have been ordered, but not received:

<b>ANGELINE MINE</b>		
Hoist		250 HP.
<b>CLIFFS SHAFT MINE</b>		
Exhaust Fan for Coal Crushing Plant		$\frac{1}{2}$
<b>GENERAL STOREHOUSE</b>		
Spare		150
"		15
"		10
"		<u>5</u>
		180
Forward,		<u>430<math>\frac{1}{2}</math> HP.</u>



ELECTRICAL DEPARTMENT (Cont'd)

	brt. fwd.,	430 $\frac{1}{2}$ HP.
<b>BARNES-HECKER MINE</b>		
Skip Hoist	400	HP.
Cage "	400	
Underground Haulage Converter	100	
Top Tram	50	
" "	50	
Water Supply Pump	10	
Underground Centrifugal Pump	350	
" Plunger Pump	<u>350</u>	
		1,710 HP.
<b>ATHENS MINE</b>		
Top Tram		50
<b>MAAS MINE</b>		
Exhaust Fan for Coal Crushing Plant		$\frac{1}{2}$
<b>AUSTIN MINE</b>		
Hoist		200
<b>GARDNER-MACKINAW MINES</b>		
Top Tram	25	
" "	25	
Underground Pump	100	
" "	75	
" Triplex Pump	<u>75</u>	
		300
<b>PRINCETON CENTRAL POWER PLANT</b>		
Exhaust Fan for Coal Crushing Plant		$\frac{1}{2}$
<b>STEPHENSON MINE</b>		
Underground Plunger Pump	50	
Vertical Shaft Pump	150	
Underground Plunger Pump	250 *	
" Centrifugal Pump	<u>275 *</u>	
		725
* To replace motors lost when mine was flooded in December		
<b>REPUBLIC MINE</b>		
Hoist	400	
"	400	
Underground Haulage	<u>30</u>	
		830
Total HP ordered,		4,246 $\frac{1}{2}$ HP.
Motors connected Dec. 31st, 1917 (including Furnace)		23,201 HP.
" on hand " " " (not installed)		3,687 $\frac{1}{2}$
" ordered " " " (not received)		<u>4,246<math>\frac{1}{2}</math></u>
GRAND TOTAL,		31,135 HP.

AU TRAIN HYDRO-ELECTRIC PLANT

SUMMARY OF OPERATIONS - 1917

<u>Month</u>	<u>K. W. H. Generated</u>	<u>K. W. H. Sold</u>	<u>Transmission Losses</u>	<u>Cost per K.W.H. (Incl. Depreciation)</u>
January	244,200	227,600	16,600 = 6.79%	\$.0052821
February	137,300	122,200	15,100 = 11.00	.0071717
March	154,500	142,900	11,600 7.50	.0065964
April	467,700	419,100	48,600 10.39	.0042351
May	535,100	480,400	54,700 10.22	.0040689
June	464,100	414,800	49,300 10.62	.0042663
July	235,900	211,500	24,400 10.34	.0053845
August	0	0	0	
September	85,200	75,300	9,900 11.61	.0090378
October	251,600	237,400	14,200 5.64	.0058237
November	206,300	212,700	0	.0081916
December (11 months)	<u>Plant taken over by Mining Department</u> 2,781,900	<u>2,543,900</u>	<u>238,000</u> 10.9%	<u>\$.0054799</u>

CARP RIVER HYDRO-ELECTRIC PLANT

SUMMARY OF OPERATION CONDITIONS - 1917

Month	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Precipitation	0.74	0.84	2.26	1.63	1.16	3.35	2.85	3.57	3.22	4.10	0.58	1.16
Total precipitation for 1917 (Ishpeming) - 25.46 inches.												
Average " at Marquette						- 32.8	" (46 years record)					
Drainage area above Intake Dam,												66.66 sq. mi.
Cubic feet Precipitation in 1917,								3,943,000,000				
K. W. Hrs. generated at Carp River Plant in 1917,								18,310,100				
Cubic feet water utilized (90 cu. ft. = 1 KWH)								1,647,900,000				
" " " in Storage Basin Jan. 1, 1917,								337,286,700				
" " " " " Dec. 31, "								155,727,000				
" " " stored in 1916 and used in 1917,								181,559,700				
" " " wasted over Intake Dam in 1917,								20,692,000				
Total run-off for the year 1917,								1,487,032,300	cu. ft.			
Run-off per sq. mile of drainage area,								22,322,000	" "			



## ELECTRIC POWER SYSTEM

## SUMMARY OF OPERATIONS - 1917

Month	KILOWATT HOURS GENERATED						Used by Auxiliaries	K. W. H. Sold	TRANSMISSION Losses	Cost Per K. W. H. (Incl. Depr.)
	Carp	Dead	Au Train	Maas	Princeton	TOTAL				
Jan.	1,590,200	567,675		52,250	440,050	2,650,175	48,925	2,289,029	12.0%	\$ .00605
Feb.	1 520 700	541 825		34 300	595 200	2 692 025	63 480	2 336 650	11.1	.00604
March	1 330 900	540 550		120 825	693 300	2 685 575	68 445	2 332 939	10.85	.00679
April	1 907 900	651 100		0	167 050	2 726 050	29 100	2 332 454	13.51	.00508
May	1 852 400	762 550		0	88 350	2 703 300	26 780	2 307 672	13.78	.00568
June	1 917 800	748 475		0	65 350	2 731 625	26 140	2 407 984	11.00	.00549
July	1 713 900	501 000		272 525	166 600	2 654 025	43 155	2 295 017	12.09	.00768
Aug.	1 340 300	524 035		474 100	269 100	2 607 535	68 975	2 217 560	12.64	.00949
Sept.	1 301 500	527 040		381 500	349 500	2 559 540	73 110	2 172 574	12.62	.01032
Oct.	1 481 400	601 200		355 200	165 100	2 602 900	54 945	2 254 503	11.51	.00959
Nov.	1 292 400	537 100		396 000	418 000	2 643 500	81 110	2 314 714	9.66	.01210
Dec.	1 060 700	442 350	38,500 +92624	380 600	355 300	2 370 074	80 725	2 031 035	11.28	.01366
	18,310,100	6,944,900	131,124	2,467,300	3,772,900	31,626,324	664,890	27,292,131	11.85%	\$ .00808

Note:- Au Train Plant taken over by Mining Department December 1st.  
 " " " discontinued furnishing current to Paper Mill on December 8th.

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>					
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
1916	5 226	388 090	878 041 710	2 262	398 818 855
1917	4 500	377 177	885 993 944	2 349	345 847 725

SALISBURY MINE

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
1916	496	100 803	273 558 000	2,713	126 831 364
1917	445	104 082	188 563 500	1 811	104 560 277



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>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	64 188 598
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
1916	6 708	397 021	637 468 347	1 605	192 033 482
1917	7 181	497 272	782 431 925	1 573	134 142 986

HARD ORE #3 HEATING PLANT

1913	729
1914	810
1915	883
1916	922
1917	1,038

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>NEGAUNEE MINE</u>					
1904	8,122	166,781	233,721,669	1,401	475,056,512
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	--- --- ---
1916	1 223	526 237	474 099 050	900	--- --- ---
1917	1 414	548 083	455 525 250	831	780,000,000 (Est.)
<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
1916	8 062	272 802	763 134 066	2 797	363 273 050
1917	8 656	333 290	879 808 672	2 639	337 467 390



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			" " " "		
1916	-	23 697	---	---	---
1917	-	54 167	---	---	---
<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
1916	105	2 636	---	---	136 569 170
1917	101	734	---	---	109 949 035

COMPARATIVE TABLES

<u>YEAR</u>	<u>TONS COAL BURNED</u>	<u>TONS ORE &amp; ROCK HOISTED</u>	<u>CU. FT. AIR USED</u>	<u>CUBIC FT. AIR PER TON HOISTED</u>	<u>GALLONS OF WATER PUMPED</u>
<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 +4 395	---	---	763 683 450
1916	1 658	327 395	---	---	875 501 510
1917	3 073	256 756	---	---	961 713 000 (11 months)
<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	(Mine idle entire year)				
1913	1 583	14 376	---	---	---
1914	1 400	95 510	---	---	90,245,720
1915	807	151 474	---	---	131 676 720
1916	871	186 839	---	---	131 783 700
1917	976	191 080	---	---	148 022 900
<u>PRINCETON PUMPING STATION</u>					
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
1916	814				224 152 095
1917	986				275 717 100



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>PRINCETON CENTRAL POWER PLANT</u>					
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		---		
1916	5 322		1,375 169 052		
1917	2 121		1 051 739 302		
<u>GROSBY MINE</u>					
1909	1,735	119,410	---	---	---
1910	2 157	204 586	---	---	---
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	--	---	---	---
1916	2 069	127 373	---	---	---
1917	2 504	300 142	---	---	---
<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			" " " "		
1916			" " " "		
1917			" " " "		

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>MORRIS-LLOYD 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
1916	1,004	304 849	- - - - -	- - - -	320 074 400
1917	886	281 749 +14 840	667 908 000	2 370	319 198 700
			<u>SOUTH JACKSON MINE</u>		
1912	381	42,790	- - - - -	- - - -	
1913	483	1 940	- - - - -	- - - -	
1914	0	15 281	- - - - -	- - - -	
1915	0	56 026	- - - - -	- - - -	
1916	0	0	(No ore taken out)		
1917	0	46 994			
			<u>GARDNER &amp; MACKINAW MINES</u>		
1914	303	- - - -	221,355,000	- - - -	- - - - -
1915			(Mine idle entire year)		
1916			" " " "		
1917	443	29,235	323,595,000	- - - -	- - - - -
			<u>ATHENS MINE</u>		
		(7 months)			
1914	231	7,404	120,048,750	- - - -	- - - - -
1915	385	21 245	242 196 750	- - - -	- - - - -
1916	419	26 930	222 840 000	- - - -	- - - - -
1917	277	23 988	211 612 500	- - - -	- - - - -
			<u>REPUBLIC MINE</u>		
		(8 months)			
1914	5,834	106,663	- - - - -	- - - -	- - - - -
1915	7 353	244 697	1,711,333,000	6,993	- - - - -
1916	8 637	226 797	1 841 863 000	8 033	- - - - -
1917	8 755	196 996	1 582 113 000	8 031	- - - - -



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>FRANCIS MINE</u>					
1915	603	-- --	---	---	---
1916	3,513	15,656	---	---	---
1917	1 223	21 420	353,070,000	---	66,723,400
<u>ANGELINE MINE</u>					
1916	---	5,772	6,128,112	1,060	---
1917	---	38 310	23 257 417	607	---
<u>HOLMES MINE</u>					
1916	729	32,951	---	---	---
1917	739	90 225	425,227,500	4,712	---
<u>MEADOW MINE</u>					
1916	3,241	63,501	---	---	---
1917	3 007	102 519	40,658,040	396	---
<u>SPIES MINE</u>					
1916	1,644	20,308	---	---	---
1917	3 657	80 204	186,701,680	2,327	---
<u>FOWLER MINE</u>					
1916		(Dec.) 2,039			
1917		(Jan.) 1 414			

Note:-

- Cliffs Shaft Mine - Received air from Holmes Mine in Jan., Feb., Mar. and April.
- Lake Mine - Furnished air to Hard Ore Shops, Angeline Mine and Hoose & Person.
- Negaunee Mine - Receives considerable amount of air from Meas Mine.
- Austin Mine - Hoisting started in April.
- Princeton Mine - Very little work done.

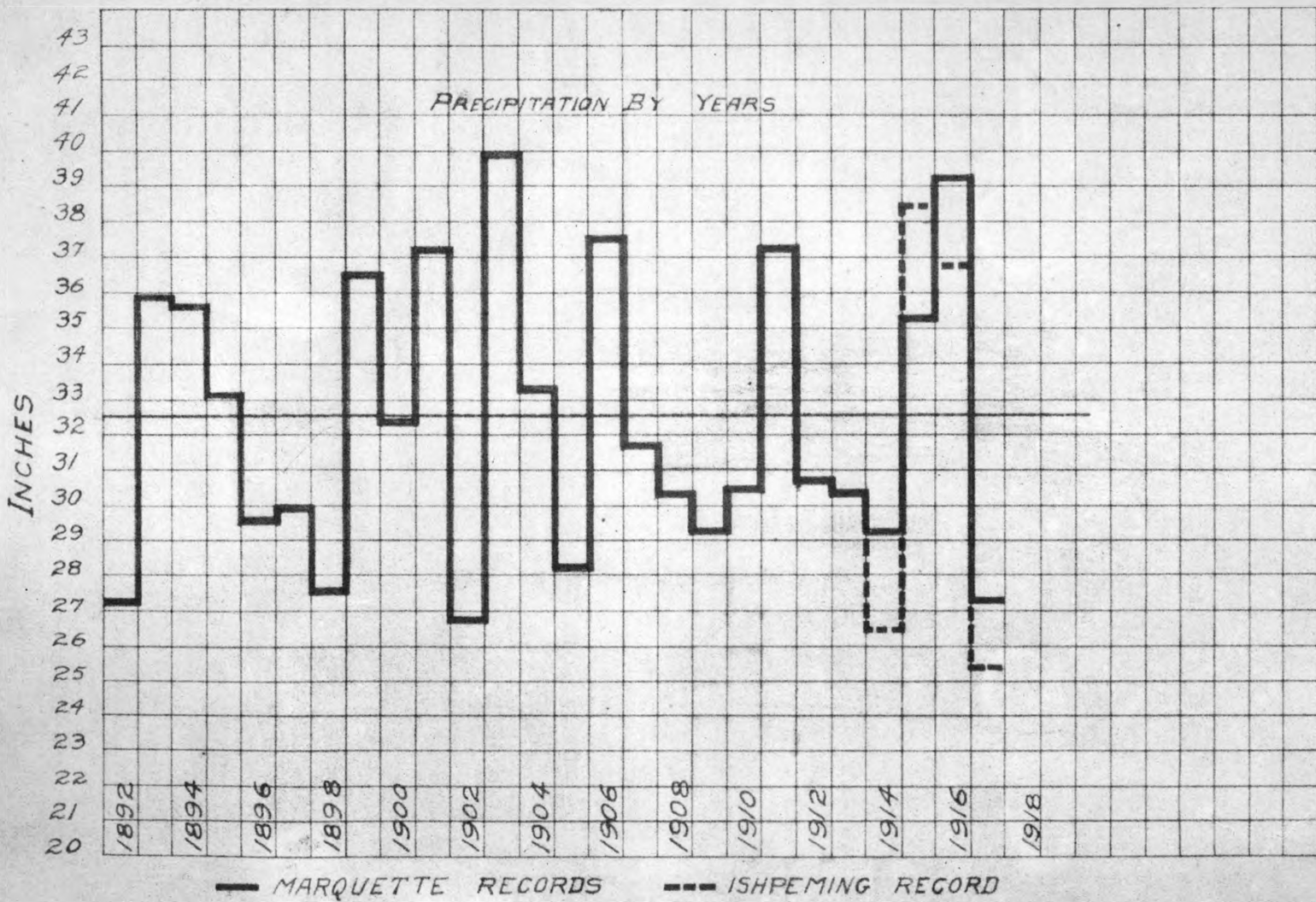
COMPARATIVE TABLES (Cont'd)

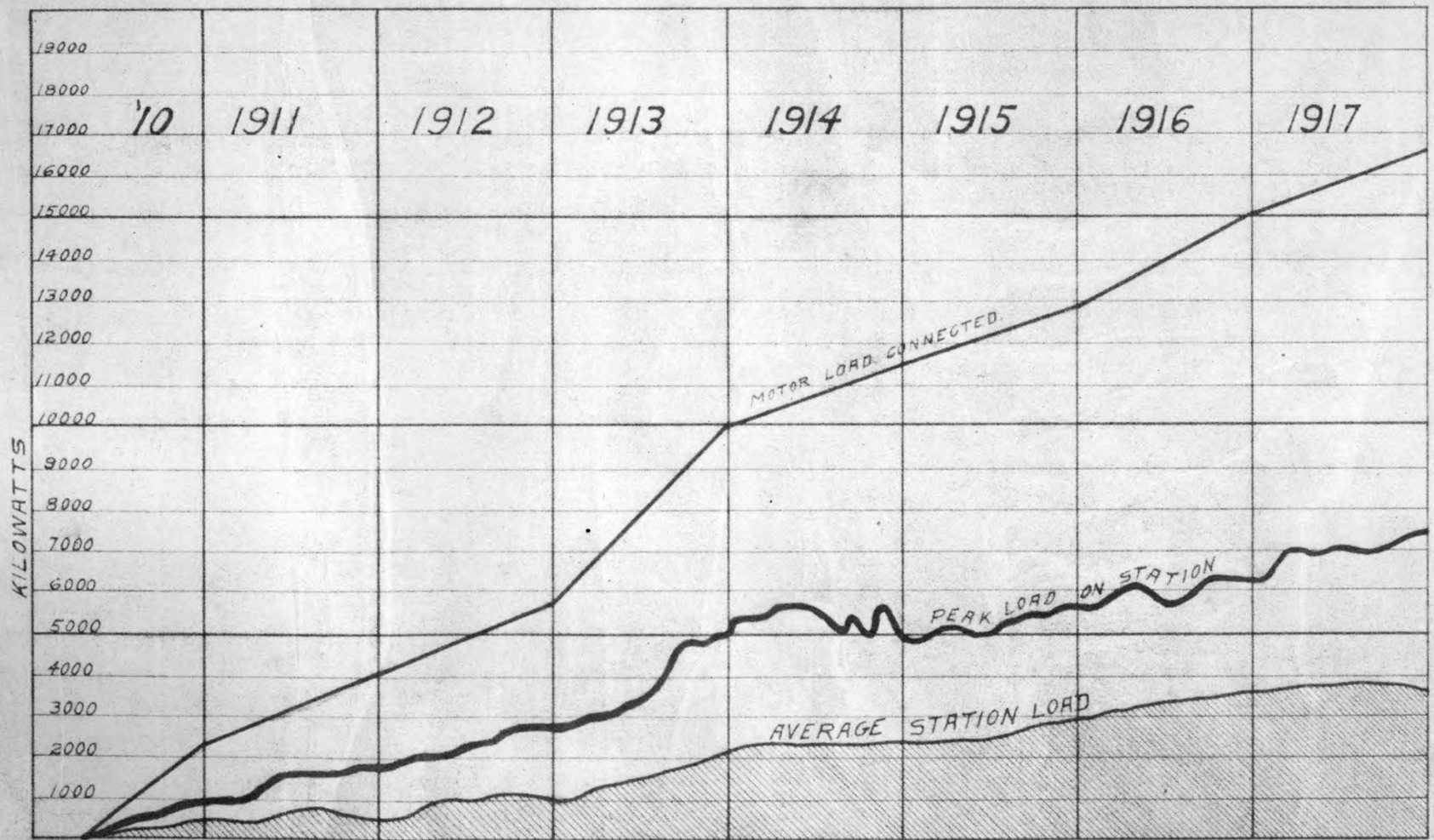
Note:-

- Stephenson Mine - Mine was flooded and lost in December.
- Prin. C. P. Plant - Compressor changed to steam drive on July 29th.
- Francis Mine - Electric hoist started in August.
- Holmes Mine - Furnished air to Cliffs Shaft Mine in Jan., Feb.,  
March and April.  
Electric driven skip hoist started in March.
- Spies Mine - Electric driven compressor started in September.

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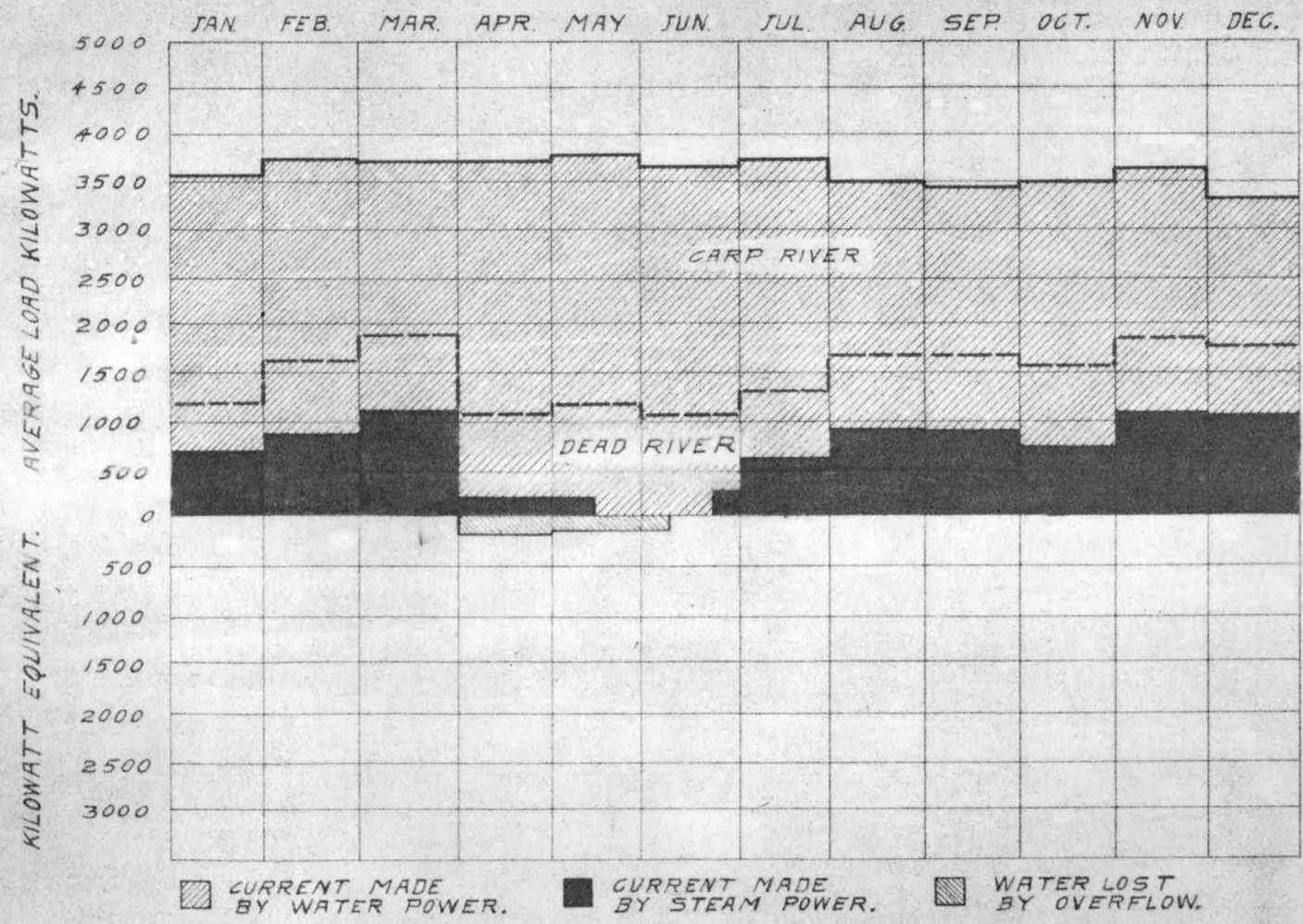




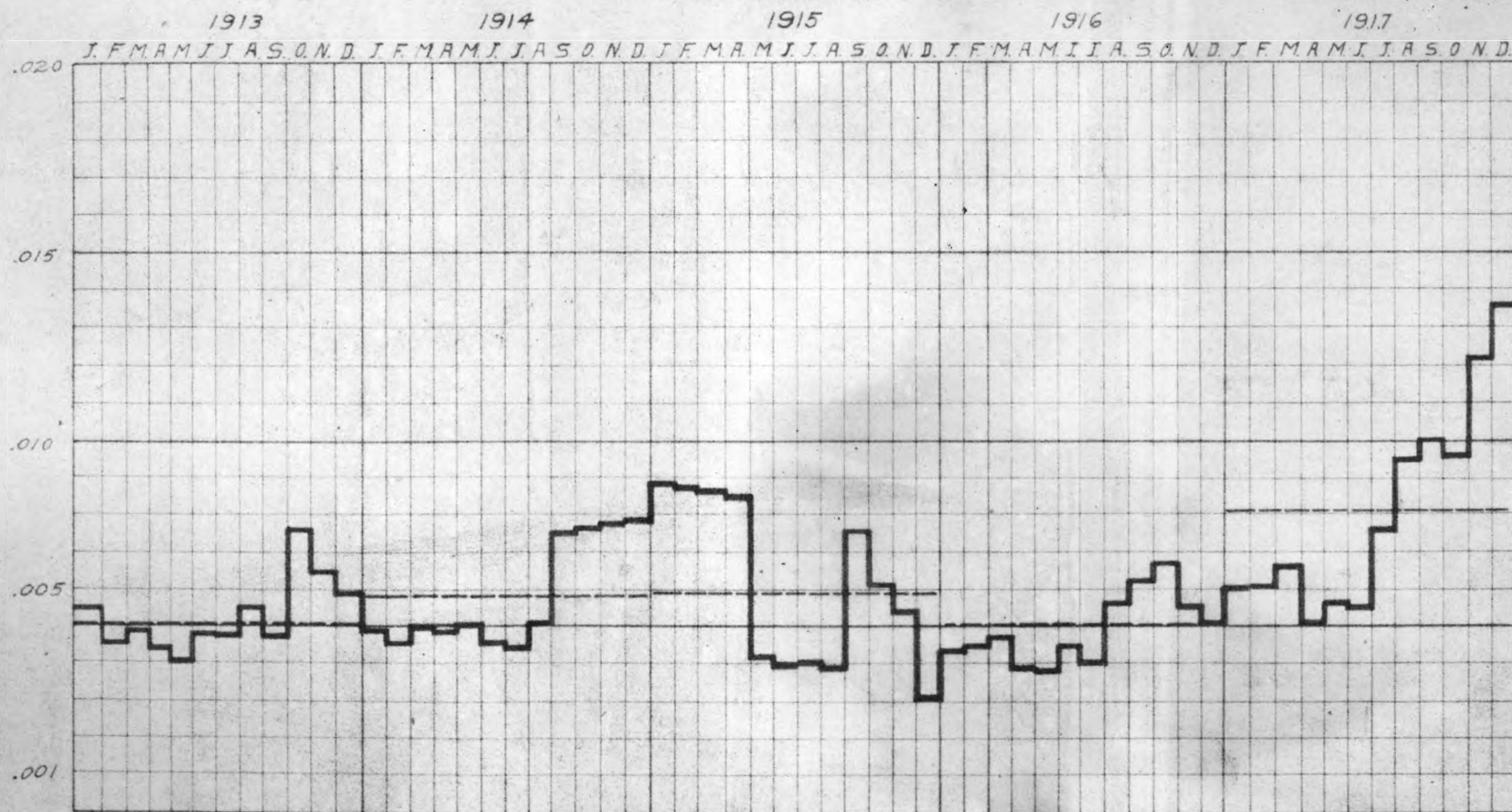




1917



COST DIAGRAM

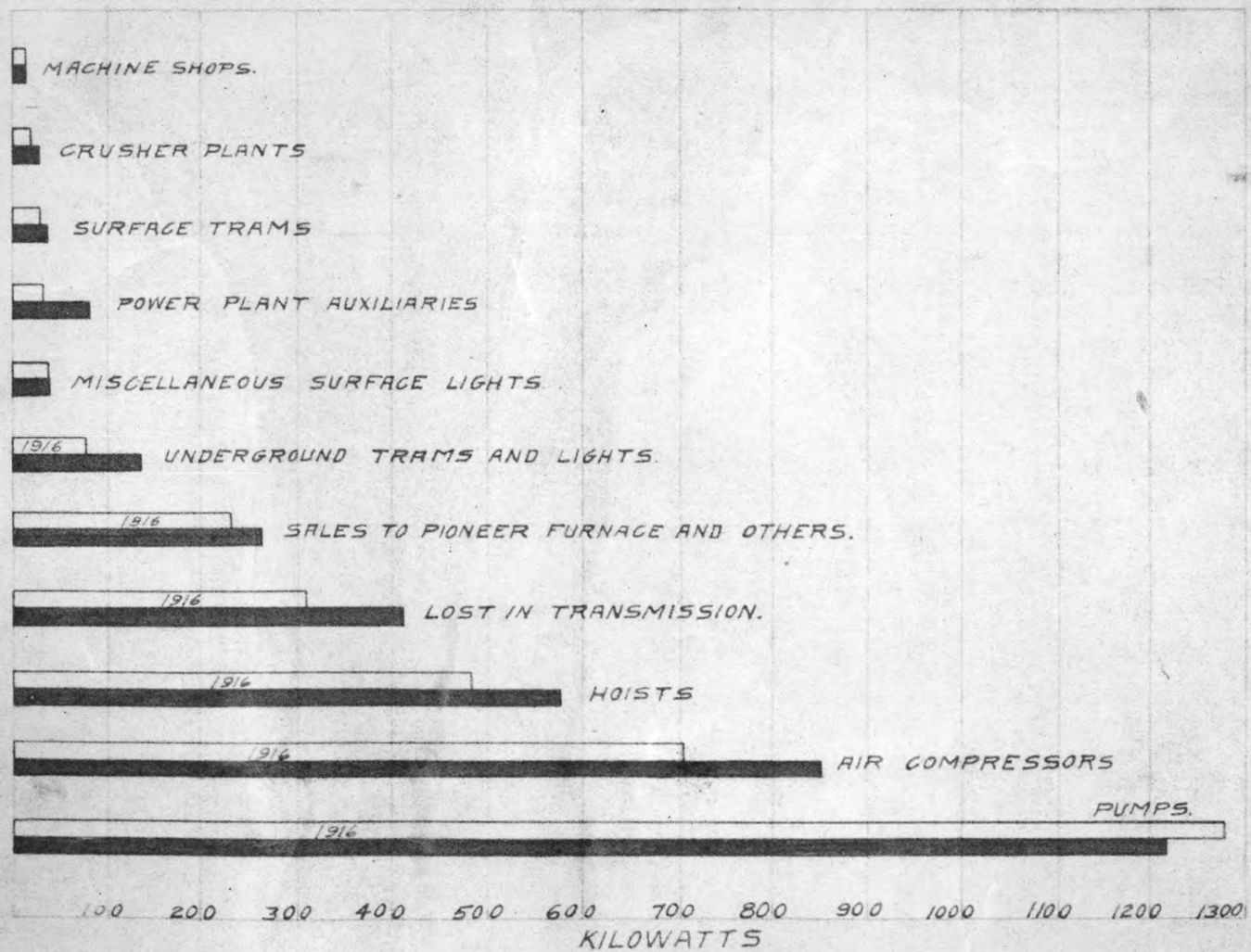


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MECHANICAL DEPARTMENT



DISTRIBUTION OF ELECTRIC POWER IN 1917.



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