

ELECTRICAL DEPARTMENT (Cont'd)

Several cases of high tension line trouble occurred during storm periods due either to high wind or lightning. No serious delays, occurred, however, and only a nominal amount of damage was done.

Electrolytic lightning arresters have been provided for all distributing lines, and improved types are to be installed without delay on the high tension lines.

One high tension transformer burned out at the Maas Substation and has been replaced.

Additional precautions have been taken to provide against fire hazard near all electrical installations.

The repair work done at the General Shops seems to be very good, as we have practically eliminated delay due to burn outs in our underground haulage locomotives.

An automatic electrically operated overwind safety device has been developed and this seems to be very reliable. The operation of this is such that in the event of an overwind, or if brakeman brings load up and loses control, or should electric current supply fail, the circuit breaker is tripped and air brake set automatically.

Through the application of educational work among our mine electricians there has now been developed a fairly good and reliable force of men. During the summer this work was carried on through monthly meetings, with class work in the afternoon and a talk on timely subjects in the evening. During the winter we have had two classes per week, both at Gwinn and Ishpeming, and systematic study has been carried on. The results have been very gratifying and noticeable in the work of the men.

PRIMARY LINES - 3 phase, 2300 volt circuits -

Maas Substation to Athens Mine -	300,000 C.M.	6,436 ft.
Athens Mine to South Jackson -	#2 copper	5,156 ft.
Total added during year,		11,592 ft.

Total miles High Tension Three Phase Line -	34.
" " " " Wires -	204.
" No. " " Towers -	377.
" miles Three Phase Primary Line -	30.
" " " " " Wire -	90.
" " Primary Pole Lines -	26.

ELECTRICAL DEPARTMENT

(Cont'd)

The following motors are installed and operating as needed:-

	INSTALLED TO JAN. 1 1913	INSTALLED IN 1913	TOTALS
MAAS MINE -			
(Circulating Pump	40 H.P.		
Turbine Auxiliaries (Injection "	25		
(Exciter	33		
Underground Haulage Set	215✓		
Shop	<u>10</u>		
			323 H.P.
PRINCETON CENTRAL POWER PLANT -			
(Circulating Pump	40		
Turbine Auxiliaries (Injection "	25		
(Exciter	33		
Underground Haulage Set	215✓		
Shop	25		
Fan (See list of motors on hand)			
+ Air Compressor		<u>625 H.P.✓</u>	
			963
CARP RIVER POWER HOUSE -			
Auxiliaries - 2 - 15 H.P. Pump Motors	30		
Water Supply Pump		<u>1</u>	
			31
NEGAUNEE MINE -			
Underground Haulage Set	215✓		
"Ilgner" Hoisting Set	350✓		
Top Tram - 2 - 50 H.P. motors	100✓		
Laboratory Crusher	3		
Reserve Air Compressor (for hoist brakes)	3		
Underground Plunger Pump		300✓	
" " "		300✓	
" Centrifugal "		350✓	
Suction Pumps - 2 - 15 H.P. motors		30	
Cooling Tower Pump		5	
+ Air Compressor		325✓	
Shop (from Morris Mine) * (1)		<u>15</u>	
			1,996
LAKE MINE -			
Underground Haulage Set	215✓		
Lake Drainage Pumps - 2 - 30 H.P. motors	60		
Underground Plunger Pump		75✓	
" Centrifugal "		<u>125✓</u>	
			475
HARD ORE -			
Machine Shop	25		
Carpenter Shop	<u>25</u>		
			50
CLIFFS SHAFT MINE -			
Shop	25		
No. 8 Crusher	125✓		
No. 5 Crushers - 2 - 25 H.P. motors	50✓		
Screens	15		
Top Tram	50✓		
Lower Tram	20		
Underground Haulage Set	100✓		
Hoist		<u>500✓</u>	
			885
fwd.	<u>2,072</u>	<u>2,651</u>	<u>4,723</u>

ELECTRICAL DEPARTMENT

(Cont'd)

	brt. fwd.	INSTALLED TO JAN. 1 1913	INSTALLED IN 1913	TOTALS
MORRIS MINE -		2,072 H.P.	2,651 H.P.	4,723 H.P.
Cage Hoist		400 ✓		
Skip "		400 ✓		
Shop		25		
Water Supply Pump		40		
" " "		50		
Compressor (Ingersoll-Rand) -		250 ✓		
Underground Plunger Pump		350 ✓		
" " "		350 ✓		
Laboratory Crusher		3		
Top Tram - 2 - 25 H.P. motors		50		
Blower - 15 H.P. (Sent to Neg. Mine Shop) *				
Underground Haulage Set			150 ✓	
+ Compressor (Nordberg) -			325 ✓	
				2,393
LLOYD MINE -				
Skip Hoist		400 ✓		
Cage "		400 ✓		
Mine Pumps - 2 - 50 H.P. motors		100 ✓		
Top Tram - 2 - 25 " "		50		
				950
CHASE MINE -				
Compressor		175		
Hoist		200		
Underground Centrifugal Pump		50		
Top Tram		25		
Underground Plunger Pump			50	
Water Supply Pump			5	
				505
SALISBURY MINE -				
Hoist		400 ✓		
Underground Centrifugal Pump		400 ✓		
+ Compressor (from Princeton #2) * (2)			150 ✓	
				950
PRINCETON MINE NO. 1 -				
Hoist		75		
Mine Pumps - 2 - 50 H.P. motors		100		
				175
PRINCETON MINE NO. 2 -				
Hoist (150 H.P. motor sent to Salisbury) *			200	
Top Tram		50		
				250
GWINN MINE -				
Cage Hoist		400 ✓		
Rock Crusher		25		
Skip Hoist			400 ✓	
Underground Centrifugal Pump			400 ✓	
				1,225
AUSTIN MINE -				
Hoist		150 ✓		
Top Tram		25		
Laboratory Crusher		5		
				180
STEPHENSON MINE -				
Underground Plunger Pump			250 ✓	
" Centrifugal "			275 ✓	
				525
	fwd.	7,020 HP	4,856 HP	11,876 HP

ELECTRICAL DEPARTMENT

(Cont'd)

		INSTALLED TO JAN. 1 1913	INSTALLED IN 1913	TOTALS
	brt. fwd.	7,020 HP	4,856 HP	11,876 HP
GARDNER MINE -	Hoist		<u>400</u>	400
MACKINAW MINE -	Hoist		<u>400</u>	400
	Totals,	<u>7,020 HP</u>	<u>5,656 HP</u>	<u>12,676 HP</u>
Pioneer Furnace -	Motor-generator Set (connected to our system)	750 ✓		750
	GRAND TOTALS,	<u>7,770 HP</u>	<u>5,656 HP</u>	<u>13,426 HP</u>

Note:-

- * (1) 15 H.P. motor used on blower at Morris Mine transferred to Negaunee Mine Shop.
- (2) 200 H.P. motor bought for Salisbury Mine compressor exchanged with Princeton #2 for 150 H.P. hoist motor.

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

ATHENS MINE -		
Hoist - cage	400 H.P. ✓	
Compressor	325 ✓	
MAAS MINE -		
Plunger Pump	325	
Centrifugal Pump	350	
CLIFFS SHAFT MINE -		
Plunger Pump	180	
Centrifugal Pump	250	
MORRIS MINE -		
Pump	50	
GWINN MINE -		
Top Tram - ore	37	
" " "	37	
" " - rock	10	
Plunger Pump	350 ✓	
MACKINAW MINE -		
Compressor	325	
SOUTH JACKSON -		
Hoist	75	
Crusher	150	
Compressor	50	
PRINCETON CENTRAL POWER PLANT -		
Fan	25	
Spare (to be sent to Gardner- Mackinaw Shop)	<u>25</u>	
	Total, 2,964	
Motors connected to Dec. 31, 1913, (including Furnace)	13,426 H.P.	
" on hand " " " (not installed)	<u>2,964</u>	
	GRAND TOTAL, 16,390 H.P.	

ELECTRICAL DEPARTMENT (Cont'd)

K.W.H. PER 1000 TON FEET HOIST

MINE	TONS	AVERAGE HOIST	K. W. H.	K. W. H. PER 1000 TON FT.
Austin	67,494	325'	67,520	3.07
Chase	50,936	250	23,760	1.90
Gwinn	14,376	940	29,580	2.15
Lloyd	146,362	400	140,240	2.56
Morris	63,305	800	129,270	2.55
Negaunee	368,956	950	1,003,825	2.86
Princeton	74,297	357	59,800	2.21
Salisbury	126,901	435	264,140	2.58

Average K. W. H. per 1000 ton ft. hoist - 2.48.

AU TRAIN HYDRO-ELECTRIC PLANT

This plant operated satisfactorily throughout the year, with shut-downs amounting to 181½ hrs., 115 hours due to transmission line trouble, 126 hours due to trouble at generating station, and remainder due to mill being idle.

The record for the year is as follows:-

Total current generated at switchboard,	2,889,600 K.W.H.
" " delivered at Paper Mill switchboard,	<u>2,751,500 K.W.H.</u>
" " lost in transmission,	138,100 "
Current sold - 2,751,500 K.W.H. @ \$.005 =	\$ 13,757.50
Operating expense, maintenance and taxes,	4,345.23
Depreciation,	<u>5,503.00</u>
Net profit,	\$ <u>9,848.23</u> \$ 3,909.27
Total investment, (Jan. 1st, 1914)	\$ 86,888.22

This plant ran light for a total of 94 days; 52 Sundays, 36 days, including holidays, on which the Paper Mill did not want the power, and 6 days due to transmission line and plant trouble. The loss of output due

AU TRAIN HYDRO-ELECTRIC PLANT

(Cont'd)

to these light days tabulates as follows:-

Output lost on Sundays	467,600 K.W.H.
" " " account of Paper Mill	261,100 "
" " " " " transmission line and plant	<u>39,500 "</u>
Total,	768,200 "

By deducting 39,500 K.W.H., the loss due to transmission line trouble, etc., from 768,200 K.W.H., we have 728,700 K.W.H. which represents the additional output the plant could have shown by operating, at all times, to the capacity of the stream.

This loss does not take into account any waste water at flood times when the plant was running at capacity and still losing water over the dam.

SUMMARY OF OPERATIONS - 1913.

Month	K.W.H. Generated	K.W.H. Sold	Transmission Loss		Cost per K.W.H. (Incl. Depreciation)
Jan.	210,000	205,100	4,900	2.3%	\$.0039117
Feb.	120 900	113 400	7 500	6.2	.0051666
March	174 900	166 900	8 000	4.5	.0041912
April	386 300	366 400	19 900	5.1	.0029671
May	479 200	452 500	26 700	5.5	.0027811
June	243 100	232 300	10 800	4.4	.0035061
July	179 500	167 600	11 900	6.6	.0044125
August	109 300	98 500	10 800	9.8	.0054554
Sept.	167 800	157 500	10 300	6.1	.0045079
Oct.	242 200	240 100	2 100	0.08	.0038910
Nov.	322 100	307 100	15 000	4.6	.0034768
Dec.	<u>254 300</u>	<u>244 100</u>	<u>10 200</u>	<u>4.0</u>	<u>.0025058</u>
12 Mo's.	2,889,600	2,751,500	138,100	4.8%	\$.0035792

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CARP RIVER HYDRO-ELECTRIC SYSTEM

This system as a whole operated very satisfactorily throughout the year.

STORAGE DAM:-

The spring of the year saw this dam full for the first time since completion. The masonry construction proved to be satisfactory and practically water tight. The water started to raise on April 1st and reached the top of the flashboards on April 24th, making a run-off from the drainage area of 372,000,000 cu. ft. in 24 days.

INTAKE DAM:-

Nothing unsatisfactory concerning this dam developed during the year. Flashboards were placed on the spillway in June, thus raising the overflow line one ft.

PIPE LINE & SURGE TANK:-

The pipe line as a whole operated satisfactorily throughout the year with the exception of considerable trouble being experienced during the early part of the year with the surge tank and riser line freezing. A fire under the riser line at its entrance to the surge tank proved to be the best solution of the trouble. During the year all the air valves were gone over and insulated by surrounding them with about 6" of mineral wool to prevent their freezing. To all appearances this has proved successful.

POWER HOUSE:-

The grounds immediately surrounding the power house and operator's dwelling were worked over during the summer in accordance with the landscape gardener's plans which consisted of cleaning, grading, the planting of shrubs and trees, also the making of paths and a road.

CARP RIVER HYDRO-ELECTRIC SYSTEM (Cont'd)

SUMMARY OF OPERATING CONDITIONS

Month	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Precip. .8	3.0	2.44	1.61	2.01	3.65	3.05	1.8	4.53	5.21	1.75	.26	
Total precipitations for 1913 -							30.11 inches.					
Average " " 5 years -							35.98 "					
Drainage area above Intake Dam -												66.66 sq. mi.
Cu. ft. Precipitation for 1913 -												4,662,660,727
K. W. Hrs. sold in 1913 -												11,451,253
110 cu. ft. of water will deliver 1 K.W.Hr., therefore												
Cu. ft. of water utilized -												1,259,637,830 cu. ft.
" " " " stored -												203,894,000 " "
" " " " wasted -												720,791,800 " "
Total run-off for year -												2,184,323,630 " "
Run-off per sq. mile of drainage area -												32,768,000 " "
Estimated capacity of #1 Storage Basin -												700,000,000 " "
Capacity of #2 " " -												435,000,000 ✓ " "

During 1913 the drainage area of the Carp River above the intake dam produced a run-off of 2,184,323,630 cu. ft. with a precipitation of 30.11 inches; 58% of this run-off was utilized for producing power, 9% was stored and the remaining 33% was wasted over the intake dam. This waste, amounting to 720,791,800 cu. ft., exceeds the estimated capacity of the No. 1 Storage Basin by 20,000,000 cu. ft. Considering that 110 cu. ft. of water is the equivalent of 1 K.W.Hr. delivered at the mines, this waste could be made to produce 6,552,650 K.W.Hrs. by the building of No. 1 Storage Dam.

With such conditions as above existing during a year in which the precipitation falls considerable below the average, the filling of both storage basins would be a certainty with the resulting addition to the power sales of 6,552,650 K.W.Hrs.

Should be obtained by following same as given for an intake

STEAM-ELECTRIC PLANTS & CARP RIVER HYDRO-ELECTRIC PLANT

SUMMARY OF OPERATIONS - 1913

Month	K. W. H. GENERATED				Used By Auxiliaries	Transmission Losses	K.W.H. Sold	Cost per K. W. H. (Incl. Depr.)
	Maas	Princtn	Carp	Total				
Jan.	40	0	708,600	708,640	7,055	16.6%	585,381	\$.005477
Feb.	190	0	895 700	895 890	6 765	17.0	737 711	.004572
Mar.	12,635	6,750	767 000	786 385	8 762	12.0	686 277	.004940
Apr.	205	0	1,044,500	1,044 705	7 075	20.4	826 333	.004443
May	170	0	1 074 300	1 074 470	7 060	12.0	939 000	.004026
June	50	4 351	1 228 900	1 233 301	6 456	16.7	1,022 340	.004867
July	120	0	1 163 800	1 163 920	5 277	23.0	89892 117	.004836
Aug.	155	0	1 365 100	1 365 255	6 617	21.0	1 073 692	.005411
Sept.	170	0	1 312 100	1 312 270	7 545	19.7	1 047 543	.004828
Oct.	290	0	1 510 700	1 510 990	7 485	18.2	1 230 030	.007059
Nov.	305	13 349	1 429 200	1 442 854	9 307	19.3	1 156 184	.006355
Dec.	145	0	1 477 200	1 477 345	7 473	17.8	1 208 236	.005865
	<u>14,475</u>	<u>24,450</u>	<u>13,977,100</u>	<u>14,016,025</u>	<u>86,877</u>	<u>17.8%</u>	<u>11,404,844</u>	<u>\$.005302</u>
					<u>+3,500</u>		<u>*(1) + 50,000</u>	
					<u>90,377</u>		<u>11,454,844</u>	
							<u>*(2) - 3,591</u>	
							<u>11,451,253</u>	

Note:-

- *(1) Adjustment of charge to Cliffs Shaft Mine.
- (2) Adjustment of 3500 K.W.H charged to Carp Station lights, added to "Used by Auxiliaries".
Adjustment of overcharge of 91 K.W.H. to Church at Gwinn.

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REPORT OF TESTS ON ELECTRICALLY OPERATED MINE PUMPS

METHOD OF MAKING TESTS:-

A portable box 8 ft. long by 5 ft. wide by 4 ft. deep, fitted with a standard "V notch" weir, was used to measure the discharge from the pumps. The head on the weir was measured by a hook gauge, and the discharge for each head in gallons per minute was taken from a curve plotted with Thomson's formula found in the proceedings of the American Society of Mechanical Engineers for 1912.

$$\text{Cubic ft. per minute} = .305 \times H^2 \times \sqrt{H} \quad \text{in which}$$

H = Head on weir in inches.

The discharge pressure and pipe friction were measured by a pressure gauge placed in the water column near the pump. The vertical distance from this pressure gauge to the mean water level in the sump during each test was taken as the suction lift. The sum of these two expressed in ft. gives the total operating head.

The power delivered at the switchboard on surface was measured by a recording meter and checked by a standard integrating wattmeter.

The voltmeter and ammeter on the circuit were read at regular intervals.

The power loss in the cable from the switchboard to the pump was computed as a loss due to the resistance of the wire. By Ohm's law the voltage required to force a given current through any conductor is expressed by: $E = I \times R$ in which

E = Voltage

I = Current in amperes at switchboard..

R = Resistance of conductor.

This gives the drop in voltage due to the resistance of the conductor and when expressed as a percentage of the switchboard voltage gives the percent of power loss in the cable.

TEST OF AN 8" 6-STAGE CENTRIFUGAL PUMP

18th LEVEL - SALISBURY MINE

Pump:- Fred M. Prescott Steam Pump Co.
8" Suction - 8" Discharge - 6 Stages.
1000 Gallons per minute capacity against
1000 ft. head including suction lift, discharge lift and
pipe friction.
68% Guaranteed efficiency.
2,215 ft. of 8" discharge piping.

Motor:- General Electric Company.
Type I - Form P - 400 H.P. - 1200 R.P.M.
2200 volts, 3 phase, 60 cycles.
90% Guaranteed efficiency.
1100 ft. #2 Okonite wire.
400 ft. #2 Hard drawn copper, bare.

Test No. 1 - 30 minutes - August 1st, 1913.

Average water pumped -	987.8 G.P.M.
Total operating head -	933.0 ft.
Average K.W. at switchboard -	329.9
Line loss -	1.07%
K. W. delivered to motor -	326.4
H. P. " " " -	437.5
Water horse power = $\frac{987.8 \times 8.33 \times 933}{33000}$ =	232.6
Combined pump and motor efficiency = $232.6 \div 437.5$ =	53.2%
Pump efficiency = $232.6 \div (437.5 \times .90)$ =	59.08%

Test No. 2 - 2 Hours - August 2nd, 1913.

Average water pumped -	973.8 G.P.M.
Total operating head -	933.0 ft.
Average K. W. at switchboard -	319.2 K.W.
Line loss -	1.07%
K. W. delivered to motor -	315.8
H. P. " " " -	423.3
Water horse power = $\frac{973.8 \times 8.33 \times 933}{33000}$ =	229.4.
Combined pump and motor efficiency = $229.4 \div 423.3$ =	54.1%.
Pump efficiency = $229.4 \div (423.3 \times .90)$ =	60.2%.

TEST OF TWO 6½" x 36" PLUNGER PUMPS

2nd LEVEL - MORRIS MINE

Pump:- Fred M. Prescott Steam Pump Co.
1000 Gallons per minute capacity against
1000 ft. head including suction lift, discharge lift and pipe friction.
Duplex, Geared, Pot Form Pump.
6½" Plungers - 36" Stroke.
48.5 to 50 R.P.M. - 10" Suction - 10" Discharge.
12 Suction valves - 12 Discharge valves.
25.12 sq. in. net area in each valve.
90% Guaranteed efficiency with Gears.
40 ft. - 10" Discharge piping No. 1.
80 ft. - 10" " " " No. 2.
1000 ft. 8" " " " No's 1 & 2.

Motor:- Allis-Chalmers Co.
Wound rotor - Induction motor.
350 H.P. - 450 R.P.M.
2200 volts - 3 phase - 60 cycles.
92% Guaranteed efficiency at full load with 90% power factor.
No. 1 - 1100 ft. of #00 three conductor cable.
No. 2 - 1200 ft. " " " " "

Test No. 1 - Pump No. 1 - 2 Hours - August 7th, 1913.

Average water pumped -	991.8 G.P.M.
Total operating head -	833.0 ft.
Average K.W. at switchboard -	184.1
Line loss -	.43%
K. W. delivered to motor -	183.3
H. P. " " " -	245.7
Water horse power = $\frac{991.8 \times 8.33 \times 833}{33000}$ =	208.7
Combined pump, gear and motor efficiency = $208.7 \div 245.7$ =	84.9%
Assuming motor to be 91½% efficient at present load	
Pump and gear efficiency = $208.7 \div (245.7 \times .915)$ =	92.8%

Test No. 2 - Pump No. 1 - 1 Hour - August 14th, 1913.

Average water pumped -	995.8 G.P.M.
Total operating head -	832.0 ft.
K.W. at switchboard by standard meter -	186.4
Line loss -	.44%
K.W. delivered to motor -	187.6
H.P. " " " -	251.5

TEST OF PLUNGER PUMPS - MORRIS MINE (Cont'd)

Test No. 2 - Pump No. 1. (Cont'd)

$$\text{Water horse power} = \frac{995.7 \times 8.33 \times 832}{33000} = 209.1.$$

$$\text{Combined pump, gear and motor efficiency} = 209.1 \div 251.5 = 83.1\%.$$

Assuming motor to be $91\frac{1}{2}\%$ efficient at present load

$$\text{Pump and gear efficiency} = 209.1 \div (251.5 \times .915) = 90.8\%.$$

Test No. 3 - Pump No. 2 - 6 1/2 Hours - August 18, 1913.

Average water pumped - 995 G.P.M.

Total operating head - 834 ft.

Average K.W. at switchboard by meters - 188.6

Line loss - .45%

K.W. delivered to motor- 187.7

H.P. " " " - 251.6

$$\text{Water horse power} = \frac{995 \times 8.33 \times 834}{33000} = 209.4.$$

$$\text{Combined pump, gear and motor efficiency} = 209.4 \div 251.6 = 83.2\%.$$

Assuming motor to be $91\frac{1}{2}\%$ efficient at present load

$$\text{Pump and gear efficiency} = 209.4 \div (251.6 \times .915) = 90.9\%.$$

Test No. 4 - Pump No. 2 - 5 Hours - August 19, 1913.

Average water pumped - 978.4 G.P.M.

Total operating head - 833.0 ft.

K.W. at switchboard by meter - 191.0

Line loss - .45%

K.W. delivered to motor - 190.1

H.P. " " " - 254.8

$$\text{Water horse power} = \frac{978.4 \times 8.33 \times 833}{33000} = 205.7.$$

$$\text{Combined pump, gear and motor efficiency} = 205.7 \div 254.8 = 80.7\%.$$

Assuming motor to be $91\frac{1}{2}\%$ efficient at present load

$$\text{Pump and gear efficiency} = 205.7 \div (254.8 \times .915) = 88.2\%.$$

G. P. M. was decreased by a broken valve in the suction side of pump.

TEST OF PLUNGER PUMPS - MORRIS MINE (Cont'd)

Test No. 5 - Pump No. 2 - 2 Hours - August 19, 1913.

Average water pumped - 989.2 G.P.M.

Total operating head - 835 ft.

K.W. at switchboard by meter - 190.0

Line loss - .45%

K.W. delivered to motor - 189.1

H. P. " " " - 253.4

Water horse power = $\frac{989.2 \times 8.33 \times 835}{33000} = 208.2$.

Combined pump, gear and motor efficiency = $208.2 \div 253.4 = 82.1\%$.

Assuming motor to be $91\frac{1}{2}\%$ efficient at present load

Pump and gear efficiency = $208.2 \div (253.4 \times .915) = 89.8\%$.

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TEST OF 8" x 12" PLUNGER PUMP

2nd LEVEL - LLOYD MINE

Pump:- The Goulds Manfg. Co.
7" Suction - 6" Discharge.
Triplex - Single acting - Vertical Type - Outside packed.
8" Plungers - 12" Stroke.
38 to 40 R. P. M.
300 G.P.M. against 400 ft. head including suction lift, discharge head and pipe friction.
45 ft. - 4" pipe.
354 ft. - 8" "
300 ft. - 6" "
No efficiency guaranteed in contract.

Motor:- General Electric Co.
Induction motor.
50 H.P. - 2200 volts - 3 phase - 60 cycles - 500 R.P.M.
Full load efficiency 89%.
3/4 " " " 88%.
600 ft. #4 Okonite wire.

Test No. 1 - 30 Minutes - August 29, 1913.

Average water pumped - 302.3 G.P.M.
Total operating head - 409.0 ft.
Actual K.W. at switchboard - 29.46
Line loss - .11%
K.W. delivered to motor - 29.43
H.P. " " " - 39.4

$$\text{Water Horse Power} = \frac{302.3 \times 8.33 \times 409}{33000} = 31.2.$$

$$\text{Combined pump, gear and motor efficiency} = 31.2 \div 39.4 = 79.2\%.$$

$$\text{Motor 88\% efficient at present load}$$

$$\text{Pump and gear efficiency} = 31.2 \div (39.4 \times .88) = 90.1\%.$$

Test No. 2 - 30 Minutes - August 29, 1913.

Average water pumped - 303.8 G.P.M.
Total operating head - 409.0 ft.
Actual K.W. at switchboard - 28.63
Line loss - .11%
K.W. delivered to motor - 28.60
H.P. " " " - 38.3

$$\text{Water horse power} = \frac{303.8 \times 8.33 \times 409}{33000} = 31.3$$

$$\text{Combined pump, gear and motor efficiency} = 31.3 \div 38.3 = 81.7\%.$$

$$\text{Motor 88\% efficient at present load}$$

$$\text{Pump and gear efficiency} = 31.3 \div (38.3 \times .88) = 92.8\%.$$

- 0 -

TEST OF 4" 4-STAGE CENTRIFUGAL PUMP

2nd LEVEL - LLOYD MINE

Pump:- Alberger Pump Co.
4" 4-stage centrifugal.
300 G.P.M. against 400 ft. head including suction lift, discharge
lift and pipe friction.
1740 R.P.M. approx.
63% Guaranteed efficiency.

Motor:- General Electric Co.
50 H.P. - Induction motor.
3 Phase - 60 cycles - 2200 volts.

Test No. 1 - 30 Minutes - August 29, 1913.

Average water pumped -	288 G.P.M.
Total operating head -	409 ft.
Actual K.W. at switchboard -	43.24
Line loss -	.11%
K.W. delivered to motor -	43.2
H.P. " " " -	57.9

Water horse power = $\frac{288 \times 8.33 \times 409}{33000} = 29.7$
Combined pump and motor efficiency = $29.7 \div 57.9 = 51.3\%$.
Assuming motor to be 88% efficient
Pump efficiency = $29.7 \div (57.9 \times .88) = 58.3\%$.

Test No. 2 - 30 Minutes - August 29, 1913.

Average water pumped -	288 G.P.M.
Total operating head -	409 ft.
Actual K.W. at switchboard -	44.1
Line loss -	.11%
K.W. delivered to motor -	44.05
H.P. " " " -	59.0

Water horse power = $\frac{288 \times 8.33 \times 409}{33000} = 29.7$
Combined pump and motor efficiency = $29.7 \div 59.0 = 50.3\%$.
Assuming motor to be 88% efficient
Pump efficiency = $29.7 \div (59.0 \times .88) = 57.2\%$.

TEST OF AN 8 3/4" x 36" PLUNGER PUMP

5th LEVEL - STEPHENSON MINE

Pump:- Fred M. Prescott Steam Pump Co.
1500 Gallons per minute capacity against
500 ft. head including suction lift, discharge lift and pipe friction.
Duplex - Geared - Missabe Pattern Pump.
8 3/4" Plungers - 36" Strokes.
47 R.P.M. - 15" Suction - 12" Discharge.
12 Suction valve - 12 Discharge valves.
35.4 sq. in. net area in each valve.
85% Efficiency with gears.
60 ft. - 12" pipe from 5th to 4th level.
420 ft. - 10" " " 4th level to surface.
420 ft. - 8" " " " " " "

Motor:- General Electric Co.
Type I - Form K.
2200 volts - 3 phase - 60 cycles.
250 H.P. - 600 R.P.M.
91% Efficient.

Test No. 1 - Plunger Pump - 2 Hours - October 22, 1913.

Average water pumped - 1407 G.P.M.
Total operating head - 509 ft.
Average K.W. at switchboard - 164.7
Switchboard at pump - No line loss
H. P. delivered to motor - 220.7

$$\text{Water horse power} = \frac{1407 \times 8.33 \times 509}{33000} = 180.7.$$

Combined pump, gear and motor efficiency = $180.7 \div 220.7 = 81.8\%$.
Assuming motor to be 91% efficient at present load
Pump and gear efficiency = $180.7 \div (220.7 \times .91) = 89.4\%$.

Test No. 2 - Plunger Pump - 1 Hour - October 22, 1913.

Average water pumped - 1406 G.P.M.
Total operating head - 509 ft.
Average K.W. at switchboard - 164.8
No line loss -
H. P. delivered to motor - 220.8

$$\text{Water horse power} = \frac{1406 \times 8.33 \times 509}{33000} = 180.6$$

Combined pump, gear and motor efficiency = $180.6 \div 220.8 = 81.7\%$.
Motor is 91% efficient
Pump and gear efficiency = $180.6 \div (220.8 \times .91) = 89.8\%$.

TEST OF PLUNGER PUMP - STEPHENSON MINE (Cont'd)

Test No. 3 - Plunger Pump - 1 Hour - October 23, 1913.

Average water pumped - 1426 G.P.M.

Total operating head - 509 ft.

Average K.W. at switchboard - 168

No line loss -

H.P. delivered to motor - 225.1

Water horse power = $\frac{1426 \times 8.33 \times 509}{33000} = 183.2$

Combined pump, gear and motor efficiency = $183.2 \div 225.1 = 81.3\%$.

Motor is 91% efficient

Pump and gear efficiency = $183.2 \div (225.1 \times .91) = 89.4\%$.

- 0 -

TEST OF AN 8" 4-STAGE CENTRIFUGAL PUMP

5th LEVEL - STEPHENSON MINE

Pump:- Allis-Chalmers Co.
8" Suction - 8" Discharge.
1500 Gallons per minute discharge against
500 ft. head including suction lift, discharge lift and pipe friction.
70% Guaranteed efficiency.
60 ft. - 12" Pipe - 5th to 4th level.
420 ft. - 10" " - 4th level to collar.
" " - 8" " - " " " "

Motor:- General Electric Co.
Type I - Form K.
275 H.P. - 1200 R.P.M.
2200 volts - 3 phase - 60 cycles.
91% Efficiency.

Test No. 1 - Centrifugal Pump - 1 Hour - October 23, 1913.

Average water pumped - 1085 G.P.M.
Total operating head - 498 ft.
Average K.W. at switchboard - 188
No line loss.
H.P. delivered to motor - 251.9

$$\text{Water horse power} = \frac{1085 \times 8.33 \times 498}{33000} = 136.38$$

$$\text{Combined pump and motor efficiency} = \frac{136.38}{251.9} = 54.1\%$$

Motor is 91% efficient

$$\text{Pump efficiency} = \frac{136.38}{(251.9 \times .91)} = 59.5\%$$

Test No. 2 - Centrifugal Pump - 1 Hour - October 23, 1913

Average water pumped - 1153 G.P.M.
Total operating head - 498 ft.
Average K.W. at switchboard - 192.7
No line loss.
H.P. delivered to motor- 258.2

$$\text{Water horse power} = \frac{1153 \times 8.33 \times 498}{33000} = 146.9$$

$$\text{Combined pump and motor efficiency} = \frac{146.9}{258.2} = 56.9\%$$

Motor is 91% efficient

$$\text{Pump efficiency} = \frac{146.9}{(258.2 \times .91)} = 62.5\%$$

- 0 -

SUMMARY OF PUMP TESTS

No. of Test		MINE	PUMP										MOTOR					RESULTS					No. of Test	
1	2		KIND	MANU - FACTURER	SIZE	CAPACITY IN G.P.M.	HEAD IN FEET	SUCTION	DISCHARGE	GUARANTEED EFFICIENCY	LENGTH OF TIME IN SERVICE	KIND	MANU - FACTURER	HORSE POWER	R.P.M.	GUARANTEED EFFICIENCY	AVER. WATER PUMPED G. P. M.	TOTAL OPERATING HEAD	AVER. H. P. DELIVERED TO MOTOR	WATER HORSE POWER	OVERALL EFFICIENCY	PUMP EFFICIENCY		
STEPHENSON		CENTRI-FUGAL	DUPLEX PLUNGER	F. H. PRESOTT PUMP CO.	8" X 36	1500	500	15"	12"	85%	2 Years	Type I Form K 2200 V. 3 Phase 60 Cycle	GENERAL ELECTRIC CO.	250	600	91%	1407.0	509	220.7	180.7	81.8	69.4	1	
1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
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COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	TONS HOISTED PER TON COAL	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>CLIFFS SHAFT MINE</u>						
1900	7,969	221,857	359,115,086	35.4	1,410	345,630,130
1901	8 412	283 088	447 136 140	32.5	1 580	353 314 205
1902	9 381	278 756	401 970 520	33.2	1 442	377 910 450
1903	8 150	268 568	322 753 874	34.1	1 200	374 292 985
1904	6 287	169 651	191 094 862	27.0	1 127	372 046 285
1905	7 421	204 645	271 587 404	27.6	1 355	353 087 800
1906	9 204	272 735	451 440 636	28.3	1 794	--- --- ---
1907	8 880	302 924	692 018 970	34.0	2 239	242 599 222
1908	7 991	228 886	541 729 740	28.5	2 367	240 000 000
1909	7 328	242 573	680 932 960	33.3	2 796	166 079 249
1910	8 895	252 793	904 379 312	28.4	3 577	156 948 550
1911	8 095	246 334	898 424 112	30.4	3 647	165 101 640
1912	8 047	276 211	810 020 228	34.3	2 932	218 555 480
1913	8 027	295 105	833 987 419	36.7	2 826	276 582 240
<u>SALISBURY MINE</u>						
1900	3,513	177,258	193,430,796	50.5	1,090	65,724,195
1901	3 621	190 816	184 878 547	49.6	970	71,466,792
1902	3 800	175 782	191 100 362	46.1	1 090	71 962 803
1903	4 167	194 781	264 830 023	46.7	1 360	88 636 312
1904	3 540	159 878	216 911 720	45.2	1 358	77 897 201
1905	3 750	154 017	219 765 211	40.5	1 423	76 346 425
1906	3 909	152 034	219 345 241	39.7	1 461	77 100 543
1907	3 892	139 986	215 971 327	35.9	1 551	86 056 044
1908	3 606	116 724	218 591 828	32.3	1 895	66 957 839
1909	3 537	99 140	218 841 412	27.9	2 228	61 699 506
1910	3 308	113 574	162 828 098	34.3	1 433	63 430 079
1911	3 158	111 272	148 067 843	35.2	1 330	61 654 458
1912	2 788	118 635	154 493 210	42.5	1 301	55 855 799
1913	848	125 178	120 039 019	----	958	51 358 400

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	TONS	CUBIC	GALLONS OF WATER PUMPED
				HOISTED PER TON COAL	FT. AIR PER TON HOISTED	
<u>LAKE MINE</u>						
1900	8,218	510,132	376,482,932	62.0	740	-- --- ---
1901	9,117	472,730	393,632,563	51.7	640	62,998,188
1902	8,400	470,728	440,196,332	51.8	952	64,188,597
1903	8,502	468,277	441,329,198	50.0	993	70,848,359
1904	6,983	281,399	355,084,057	40.3	1,368	78,662,195
1905	10,346	505,321	885,737,363	48.8	1,753	77,492,105
1906	11,072	559,877	784,511,853	51.8	1,247	80,626,208
1907	10,934	549,449	773,662,287	50.7	1,410	90,105,988
1908	9,222	357,628	575,642,546	38.6	1,671	76,896,881
1909	9,640	381,060	826,433,227	39.4	2,245	81,268,184
1910	9,892	559,438	820,568,713	56.5	1,466	85,118,000
1911	7,558	309,519	583,930,820	40.9	1,886	93,643,210
1912	7,824	329,344	656,627,987	42.0	1,993	109,576,544
1913	8,059	473,848	962,459,483	----	2,031	95,007,553
<u>HARD ORE MINE</u>						
1900	3,359	80,577	156,642,514	23.9	1,875	127,301,055
1901	3,537	83,321	198,187,706	23.5	2,375	123,434,439
1902	3,749	79,329	209,140,586	21.3	2,550	124,952,502
1903	3,778	75,458	202,735,698	18.8	2,660	139,284,403
1905	2,549	73,228	387,509,010	28.8	5,278	101,183,553
1906	3,007	81,019	360,850,200	26.3	4,508	115,163,803
1907	3,049	84,201	390,108,500	27.6	4,721	123,765,784
1908	3,202	89,699	407,910,000	27.7	4,584	131,586,740
1909	3,079	94,436	266,175,000	30.9	2,833	126,217,920
1910	3,052	100,820	302,510,000	33.0	3,000	132,000,000
1911	3,195	82,685	264,875,000	25.8	3,203	110,000,000
1912	1,148	19,416	46,930,000	----	2,417	---- --- ---
1913	729	-- ---	-- --- ---	----	-- ---	---- --- ---

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	TONS HOISTED PER TON COAL	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>NEGAUNEE MINE</u>						
1904	8,182	166,781	233,721,669	20.4	1,401	476,056,512
1905	7,386	245,422	211,667,755	33.2	861	345,967,009
1906	10,465	258,354	235,730,810	25.5	921	---
1907	11,216	315,069	250,046,615	28.4	795	707,070,097
1908	10,294	300,007	210,799,982	29.3	696	638,486,540
1909	9,088	316,072	263,322,702	32.0	911	623,789,512
1910	7,913	364,111	361,923,373	46.0	993	610,209,058
1911	7,805	368,352	599,630,043	47.1	1,627	634,100,040
1912	8,003	298,308	825,468,516	37.2	2,767	696,210,397
1913	7,647	368,956	741,224,169	----	2,008	789,153,091
<u>MAAS MINE</u>						
1905	4,066	---	139,268,772	----	-----	311,792,458
1906	4,170	---	260,733,698	----	-----	---
1907	5,861	29,690	---	8.6	-----	337,084,264
1908	6,671	83,075	---	12.4	-----	242,151,139
1909	6,494	141,510	291,338,833	22.1	2,095	231,101,590
1910	8,219	196,052	541,169,843	23.8	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	32.3	3,182	---
<u>PRINCETON MINE</u>						
1909	3,104	143,620	181,915,352	47.8	1,265	144,540,000
1910	2,582	126,047	226,054,113	48.8	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

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	TONS HOISTED PER TON COAL	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>AUSTIN MINE</u>						
1905	1,867	61,878	51,808,300	33.8	837	---
1906	-	165,445	56,931,414	53.4	374	---
1907	3,863	194,571	58,452,975	54.0	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	---	---	---	---
<u>STEPHENSON MINE</u>						
1909	2,396	140,683	181,915,347	63.4	1,313	191,342,376
1910	2,867	217,096	294,935,118	75.7	1,358	383,590,401
1911	4,182	239,991	384,041,898	57.3	1,600	625,253,183
1912	4,856	241,931	460,478,796	49.8	1,903	886,471,232
1913	3,420	283,146	---	---	---	1,028,287,849
<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	-	---	---	---	---	---
1913	1,583	14,376	---	---	---	---
<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

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	TONS HOISTED PER TON COAL	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	---	---	----	- ---	---
<u>GROSBY MINE</u>						
1909	1,735	119,410	---	71.6	- ---	---
1910	2,157	204,588	---	94.8	- ---	---
1911	1,493	80,976	---	69.3	- ---	---
1912	1,515	116,818	---	---	- ---	---
1913	3,305	207,728	---	62.8	- ---	---
<u>IMPERIAL MINE</u>						
1909	2,592	82,135	---	31.8	- ---	---
1910	3,665	137,527	---	37.5	- ---	---
1911	2,744	102,831	---	37.4	- ---	---
1912	- ---	---	---	---	- ---	---
1913	- ---	---	---	---	- ---	---
<u>LUCY MINE</u>						
1910	2,718	66,660	---	24.5	- ---	---
1911	1,440	31,481	48,965,305	21.8	1,505	43,712,842
1912	- ---	---	---	---	- ---	---
1913	- ---	---	---	---	- ---	---
<u>MORRIS MINE</u>						
1911	- ---	1,556	---	---	- ---	---
1912	- ---	41,140	---	---	- ---	---
1913	676	{ Morris-Lloyd 209,667 }	---	---	- ---	---

COMPARATIVE TABLES

YEAR	TONS COAL BURNED	TONS ORE & ROCK HOISTED	CU. FT. AIR USED	TONS HOISTED PER TON COAL	CUBIC FT. AIR PER TON HOISTED	GALLONS OF WATER PUMPED
<u>LLOYD MINE</u>						
1911	-	87,236	---	---	---	---
1912	-	140,404	---	---	---	---
1913	50	(See Morris)	---	---	---	68,591,636
<u>CHASE MINE</u>						
1911	-	3,575	---	---	---	---
1912	-	5,433	---	---	---	---
1913	250	50,936	---	---	---	---
<u>SOUTH JACKSON MINE & CRUSHER PLANT</u>						
1912	381	42,790	---	---	---	---
1913	483	1,940	---	---	---	---

Note:-

- Cliffs Shaft Mine - Hoist operated electrically from Sept. 22nd, to Oct. 23rd.
- Salisbury " - Steam compressor shut down in February. Steam pump operated in February.
- Lake " - Electric pumps started May 27th. Single shift Dec. 1st.
- Hard Ore - Heating only.
- Maas Mine - Furnishes air to Negaunee Mine.
- Princeton Mine - Steam compressor operated in April and May. Mine shut down August 30th.
- Austin Mine - Water drains to Stephenson Mine.
- Stephenson Mine - Electric pumps started April 3rd.
- Gwinn Mine - Mine re-opened. Electric pump started November 30th.
- Prin. C. P. Plant - Compressor wrecked April 21st. Operating electrically May 31st.
- Crosby Mine - Stopped hoisting ore November 30th.
- Imperial Mine - Idle entire year.
- Lucy Mine - " " "

MECHANICAL DEPARTMENT

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O. S. McClure
M. M.

ANNUAL REPORT FOR THE YEAR ENDING DECEMBER 31ST, 1913.

Ishpeming, Michigan, February 19, 1914.

ENGINEERING DEPARTMENT.

Mr. M. M. Duncan, Agent,

City.

Dear Sir:-

The accompanying report of the Engineering department is herewith handed to you. The maps which form part of this report are bound and the books have been labeled as follows:

LIST OF ANNUAL REPORT BOOKS FOR 1913.

Cleveland Iron Mining Company.

Iron Cliffs Company.

Cleveland-Cliffs Iron Company.
(Marquette and Mesabi ranges, etc.).

Cleveland-Cliffs Iron Company.
(Gwinn District).

Cleveland-Cliffs Iron Company.
(General Explorations).

The Cleveland-Cliffs Iron Company's book covering the Marquette and Mesabi ranges includes a few maps of the hydro-electric systems of Au Train and Carp.

Two sets of these books of maps have been prepared, one for the Cleveland office, which I hand you, and the other to be kept in the vault in this building. Mr. Jackson has received a copy of the Gwinn district book.

A special book has been prepared for the Lackawanna Steel Company, containing the views and maps of the Negaunee mine. This is also handed you.

Mr. Stakel has written the statement as to the staff in this department and also described the surveys. Mr. Primeau gave me the information as to the Abstract department.

Yours very truly,

J. E. Jopling
Chief Engineer.

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REPORT OF THE ENGINEERING FORCE EMPLOYED DURING THE YEAR 1913,
AND A BRIEF OUTLINE OF THEIR WORK,
BY C. J. STAKEL, ASSISTANT ENGINEER.

THE FORCE.

At the end of the year, the following men were employed in the department as engineers: C. J. Stakel, J. F. Hanst, H. O. Moulton, R. J. Chennecur, J. K. Osborne, J. E. Hayden, M. F. LaCroix and E. L. Derby. At the beginning of the year there was one additional engineer, namely, W. L. Scanlan, who left the employ of the Company about October 10th. Four additional men were employed as helpers, namely, John Trosvig, Albert Rock, Arthur Aas and Edward Ham. Mr. Ham was taken on the force on June 2nd. Walter Sterne was employed for three and one half months during the summer. In addition from two to four axemen were steadily employed from May 14th to November 1st.

The following is a table showing the number of days each man worked, the days lost through illness, vacations, etc, and the percentage of time put in by each man:

NAME.	EIGHT HOUR DAYS WORKED.	DAYS VACATION.	DAYS LOST THROUGH ILLNESS.	TOTAL DAYS EIGHT HOURS.	PERCENTAGE OF DAYS WORKED.
C.J.Stakel	267	9		276	96.7%
J.F.Hanst	252	24		276	91.3%
H.O.Moulton	264 $\frac{1}{2}$	11 $\frac{1}{2}$		276	95.6%
R.J.Chennecur	261	15		276	94.7%
J.K.Osborne	271	2 $\frac{1}{2}$	2 $\frac{1}{2}$	276	98.2%
W.L.Scanlan	203	3 $\frac{1}{2}$		206 $\frac{1}{2}$	98.2%
J.E.Hayden	261	14 $\frac{1}{2}$	$\frac{1}{2}$	276	94.7%
M.F.LaCroix	241	20 $\frac{1}{2}$	14 $\frac{1}{2}$	276	87.3%
E.L.Derby	273	1 $\frac{1}{2}$	1 $\frac{1}{2}$	276	98.9%
John Trosvig	263	8 $\frac{1}{2}$	4 $\frac{1}{2}$	276	95.3%
Albert Rock	262	10	4	276	95.0%
Arthur Aas	270	4	2	276	97.8%

In compiling the above table, credit was given each man for Sunday work done at the mines, such as shaft plumbing, special surveys, etc.

The following table shows the percentage of time worked by each man for the years 1912 and 1913 arranged in proper sequence:

1912.			1913.		
NAME.	DAYS WORKED.	PERCENTAGE OF TIME WORKED.	NAME.	DAYS WORKED.	PERCENTAGE OF TIME WORKED.
J. F. Hanst	275 $\frac{1}{2}$	100%	E. L. Derby	273	98.9%
R. D. Skelley	60 $\frac{1}{2}$	100%	J. K. Osborne	271	98.2%
W. L. Scanlan	182 $\frac{1}{2}$	98.8%	W. L. Scanlan	203	98.2%
J. K. Osborne	272	98.7%	Arthur Aas	270	97.8%
Albert Rock	271	98.4%	C. J. Stakel	267	96.7%
E. C. Sterling	271	98.4%	H. O. Moulton	264 $\frac{1}{2}$	95.6%
Fred Flink	107	98.2%	John Trosvig	263	95.3%
John Trosvig	269 $\frac{1}{4}$	97.7%	Albert Rock	262	95.0%
H. O. Moulton	267	96.9%	J. E. Hayden	261	94.7%
J. E. Hayden	265	96.2%	R. J. Chemneour	261	94.7%
Arthur Aas	264 $\frac{1}{2}$	96.1%	J. F. Hanst	252	91.3%
R. J. Chemneour	262 $\frac{1}{2}$	95.2%	M. F. LaCroix	241	87.3%
C. J. Stakel	256 $\frac{1}{2}$	93.1%			
M. F. LaCroix	256	92.9%			
E. C. Weinsheimer	117	85.5%			
E. L. Derby	243 $\frac{1}{2}$	88.4%			
C. T. Kriebel	31	22.6%			

E. L. Derby and C. T. Kriebel have low percentages of time worked on account of illness.

M. F. LaCroix lost some time because of illness.

The following table shows the number of working days in the past year and the distribution of the department's time at the various properties:

MINES, WATER POWERS, EXPLORATIONS, ETC.	TOTAL DAYS.	% OF TOTAL DAYS.
Maas mine	301	10.02
Ashland mine	1	- - -
Gwinn District mines	11 $\frac{1}{2}$	0.39
Crosby mine	2 $\frac{1}{2}$	0.09
Shores mine	2	0.06
Detroit mine	3	0.10
Imperial mine	3	0.10
Morris mine	110 $\frac{1}{2}$	3.68
Lloyd mine	104	3.47
North Lake explorations	2	0.06
Chase mine	62 $\frac{3}{4}$	2.09
Lucy mine	42 $\frac{1}{2}$	1.38
Au Train water power	182 $\frac{1}{2}$	6.09
Dead river water power	5 $\frac{1}{2}$	0.19
Carp river water power	33 $\frac{1}{2}$	1.11
Iron River explorations	74 $\frac{1}{2}$	2.49
Crystal Falls explorations	60 $\frac{1}{2}$	2.01
Aitkin County explorations	1	- - -
Seager-Smith explorations	6 $\frac{3}{4}$	0.22
Steam electric plant	7	0.23
Athens mine	190 $\frac{3}{4}$	6.36

MINES, WATER POWERS, EXPLORATIONS, ETC. TOTAL DAYS. % OF TOTAL
DAYS.

East New York mine	34	1.12
Canadian lands	7	0.23
Michigamme Company lands	$1\frac{1}{2}$	0.05
Michigan Mineral Land Company lands	$1\frac{1}{2}$	0.05
American Iron Mining Company lands	1	---
Carbon reports	33	1.09
Bunker Hill mine	$21\frac{1}{4}$	0.71
Lake mine	153	5.10
Cleveland Iron Mining Company lands	$235\frac{3}{4}$	7.86
Cliffs Shaft mine	$272\frac{1}{2}$	9.04
Salisbury mine	126	4.22
Iron Cliffs Company lands	$373\frac{3}{4}$	12.45
Negaunee mine	426	14.22
Jackson mine	$107\frac{1}{4}$	3.59
Boston mine	$4\frac{1}{4}$	0.13

It will be noted that the Maas, Cliffs Shaft, Negaunee and Athens mines and Iron Cliffs Company and Cleveland Iron Mining Company lands and Au Train water power sub-divisions account for two thirds of the department's time. The reason for the large number of days at the Negaunee mine is that in addition to the regular mine work a special engineer was stationed there for five and a half months to oversee the pump house and sump construction work. The Maas mine and Cliffs Shaft property required a great deal of attention because of the large number of surveys made underground, practically no sketching being done at either mine, and also because of the large number of maps required to show the work being done. Thirty six separate maps are now in use for the Maas mine and twenty one for the Cliffs Shaft mine. The Iron Cliffs and Cleveland Iron Mining companies lands accounts cover the contour surveys on Sections 2, 3, 4, 9 and 11, 47-27 and the Iron Cliffs drive territory and lands near the Fitch and Saginaw mines. The Au Train account covers the summer's work at the proposed storage reservoir and dam sites.

The following is a detailed description of the work of the various men:

C. J. Stakel had general supervision over the office force. The greater portion of the month of January was devoted to the annual report, the report being completed on the 28th. He and Mr. Hanst spent

over two weeks going over all the surveys that had been made in the past in the cities of Ishpeming and Negaunee and vicinity, a special report on which is included in this report. The Morris mine shaft was plumbed on three separate occasions and check surveys run both on surface and underground. The Lake mine air tests required attention. He assisted Mr. Scanlan on a number of the Maas mine surveys. Two trips were made to the Iron River and Crystal Falls districts in order to map the Shelden, Neely, Kimberly, Carpenter and Spies options. The Athens mine construction work was looked after. On June 25th, the Au Train water power surveys were started and as a general rule two visits a month were made to note the progress of the work. During the months of September and October a great deal of attention was directed to the surveys South of Ishpeming and the North Lake district on the Iron Cliffs Company lands. The annual report work was then taken up and kept at until the close of the year.

J. F. Hanst had charge of the Cliffs Shaft mine surveys until August when he was stationed at the Athens mine. The annual report maps kept him busy until the middle of January. He then started to map the contours on Section 1, 47-27, which were finished by the 1st of April. In the meantime he also assisted Mr. Stakel for two weeks while the surveys in Ishpeming, Negaunee and vicinity were being recompiled, and later made a copy for the Land department. All of the underground survey stations at the Cliffs Shaft mine were tagged. He made a resurvey of Section 4, 47-27 during the month of May. He assisted on two of the Morris mine plumbings and also gave the lines for the Cliffs Shaft raise in "A" shaft, which has since holed as mentioned later. He was absent from the office during the entire month of June on his vacation. During July he spent a great deal of time on the Cliffs Shaft estimate maps. An accurate contour map of the area between the Cliffs Shaft engine house, general office, Spruce street and the store yards South of "A" shaft was made for Mr. Manning. On the 1st of August, he was transferred to the Athens mine, where he had charge of the construction work for the remainder of the year.

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ENGINEERING DEPARTMENT.

H. O. Moulton had charge of the North Lake district surveys until about February 1st. He assisted Mr. Graff in making the annual estimates. He assisted on the three plumbings of the Morris shaft and twice at the Lloyd shaft. He attended to the North Lake district surveys while Mr. Hayden was absent in April and also did the Lake mine work during Mr. LaCroix's absence in June. During the month of May he also contoured the South half of Section 15, 47-27. He finished up the 50' to the inch contour maps of Section 2, 47-27 and also spent considerable time on the Section 3 maps. During the month of July he assisted Mr. Hanst at the Cliffs Shaft mine and on August 1st he was put in charge, Mr. Hanst going to the Athens mine. Mr. Moulton and Mr. Scanlan contoured the North half of Section 11, 47-27. Mr. Moulton also ran elevations over all the iron pin stations in Section 11 and then ran a line of levels around the Cliffs drive. From bench marks established along the drive, elevations were carried over some of the coordinate lines established by Mr. Hayden. The regular and annual report work in connection with the Cliffs Shaft mine kept him busy the rest of the year.

R. J. Chennecour was stationed at the Negaunee mine until about June 15th. He had charge of the construction^{work} at the 10th level pump chambers and sump. On June 25th, he and a crew of five men were sent to the Au Train river to make the water power surveys, a separate account of which work follows later in this report. This field work was finished on September 11th. He then spent a week on the Iron-River-Crystal Falls surveys, after which he took a two weeks vacation. On his return he was put in charge of the Maas mine surveys. In addition to the regular mine work of this property, he finished up all the Au Train water power maps before the close of the year.

W. L. Scanlan was employed until about October 10th. He had charge of the Maas mine surveys previous to this time. He also spent considerable time on the Maas-Negaunee geological surveys. Every other month the extensions in these mines were geologized and the cross-sections posted. He also gave considerable time to the maps

and surveys of the Erickson lease on Section 21 at Iron River. He made a special survey to get the contours on the South half of the lease and then made a layout of the proposed equipment, both surface and underground. The maps and tracings of Sections 1, 6 and 12 near Crystal Falls were finished. He assisted on the Spies option surveys and also on all the Section 11, 47-27 contour surveys.

J. K. Osborne has had charge of the Salisbury mine work during the entire year. He has also spent more or less time in connection with the diamond drill carbons. He makes monthly reports and at certain intervals of time makes an inventory of all the carbon in use and in stock. Point maps of Sections 2, 10 and 15 were made and he plotted all the notes taken on Section 15 and also some taken on Section 11, 47-27. He mapped the contours on the three Pendill forties which embrace the Lucy mine property. He also ran a line of levels from the Salisbury to the Saginaw mine.

J. E. Hayden has been attending to the North Lake district mines since February 1st. In addition to the regular mine surveys, frequent trips were made to the Morris and Lloyd shafts to give lines on the main level. The Lloyd shaft raise holed as planned and in connection with this work he made a number of check surveys as mentioned later. He spent three weeks on the Au Train river surveys. He mapped the contours of Section 9, 47-27 and portions of Section 2, 47-27. He had charge of the crews that put in the coordinate lines South of Ishpeming and Negaunee and on Section 5, 47-27. He also looked after repairs made to the new Dead river road in the spring of the year.

M. F. LaCroix made the Lake mine surveys during the year. In addition to the customary monthly and mid-monthly surveys the air tests, air shaft and new pump house on the 5th level took up considerable time. He finished the abstract maps of the Athens mine. He assisted at two of the Morris shaft plumbings and on the survey of the South half of the Erickson lease. He mapped the contours of Section 4, 47-27 and assisted on all the survey work in Section 9. He spent considerable time with Mr. Hayden in the North Lake district and Iron Cliffs drive territory. He was given nearly a month's vaca-

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ENGINEERING DEPARTMENT.

tion and in addition lost two weeks by illness.

E. L. Derby, who has charge of the surveys at the Negaunee mine, has also put in considerable time on the Negaunee-Maas boundary line calculations. With the exception of the Race Track boundaries, the work is completed. He started a set of detailed plans of the Negaunee top tram stocking car. The 10th level development drifts, the sump and pump house required considerable attention. The new county road across the Maas field was laid out and also a line for the new Maas mine launder was surveyed. He spent a few days at the Athens mine while Mr. Hanst was on his vacation and two weeks at the Au Train river with Mr. Chenneour. The contours within the Bunker Hill mine area were mapped.

John Trosvig has been employed largely as a helper in the Negaunee district, assisting Messrs. Hanst, Chenneour and Derby. In addition he has made a number of tracings, such as Section 3 and Section 4 Ishpeming, point maps of the City of Negaunee and all the 50' to the inch Jackson mine tracings. He ran a line of levels over all the survey stations on Section 4, 47-27, establishing over sixty bench marks. He made the Negaunee mine monthly survey while Mr. Derby was on the Au Train water power surveys and also ran a check survey in the 10th level drifts that are intended to hole. He also made a complete new set of annual report tracings for the Maas mine.

Albert Rock and Arthur Aas have acted as assistants in the field and office. Mr. Rock has been making all the annual report prints. He also satisfactorily ran the majority of the levels in the Crystal Falls district on the Neely, Kimberly and Sheldon options.

Walter Sterne was given employment during the summer and Edward Ham has been in the department since June 2nd. Mr. Ham has been kept busy making tracings of various kinds for the last two months.

Two axemen and a cook were used on the Au Train surveys in addition to the three men from the office and two other axemen were needed on the coordinate lines established South and West of Ishpeming.

UNDERGROUND WORK.

A brief description of the mine work will now be taken up under the separate mine headings:

MAAS MINE.

Fifteen new sub-levels, ranging from the 746' sub-level above the 1st level to the 315' sub-level above the 3rd level, were opened up during the year. The surveys required to map these subs, the new maps and separate tracings for the Agent, Superintendent and Captain, account for a great deal of the time spent at this property. The 3rd level received most attention. Nine curves were started off on the South side of the main drift and lines given at the ends of these curves for due South crosscuts. Two check surveys were run from the end of the North-South drift leading from the shaft Easterly to the end of the level. These surveys tied in by 0.20 in the latitude and 0.03 in the departure. Three separate surveys at various times were made in the new pump house. Accurate elevations of the floor and back were determined. A large scale map was then drawn up and cross-sections drawn through the pump house. From these drawings the Mechanical and Engineering departments and Superintendent Elliott jointly agreed upon the location of the pumps and sump. Lines were given for raises that are being carried from the 2nd level up to the 1st. All the survey stations on the 1st, 2nd and 3rd levels were tagged with aluminum markers. The only surveying of any importance on surface was the laying out of a line for the new proposed launder to carry the mine water across the Maas-Lonstorff-Mitchell land North of the Maas mine.

GWINN DISTRICT MINES.

The only work in this office for these mines was in connection with the annual report.

CROSBY MINE.

This property receives attention only at the close of the year by the Engineering office when the annual report maps are printed and colored for the report.

LAKE MINE.

The customary monthly and mid-monthly surveys were made with occasionally an extra day required to carry a survey from one of the main levels into a new sub-level. The new pump house on the 5th level was finished and lines were given as required while the construction work was in progress. Two series of air tests were made in order to find out the temperature, barometric pressure and percentage of oxygen and carbon dioxide in the air in every working place and also at various points on the main levels and on surface. A profile was drawn through the air shaft from the cave North of this shaft to the cave South of the shaft. From the data secured from the profile, a drift was planned to run from the bottom of the South cave in a Northerly direction until it intersected the air shaft. This tunnel has since holed as planned. In order to insure the permanency of the surveys on surface, three iron pins were established and concreted near No.4 shaft which were tied in satisfactorily for course, coordinates and elevation from the old survey points.

CLIFFS SHAFT MINE.

This property received considerable attention during the past year. In addition to the regular mine work trips were made underground to give lines for diamond drill holes. A few check surveys were made on the "B" shaft levels and it took about a week to tag the underground survey stations. A geological survey of the mine was made at least every three months. Air tests similar to those made at the Lake mine were secured in every contract. The most important survey, however, was done in connection with the "A" shaft raise. Lines were given for this raise in March. It holed shortly before Christmas. Before giving these lines it was necessary to first accurately locate the shaft corners on the 10th level. After this was done the shaft was found to be twisted slightly at this point and not exactly standard size, which in this case was 10' X 14' inside of timbers. When the corners were established on the 15th level the shaft was spotted so that the South side was vertically underneath the South side on the 10th level. After the shaft holed

the timbering on the South and West sides was found to be in exact alignment with the old timbering. The other two sides did not agree exactly as was clearly impossible due to the twisted shape of the old shaft. A surface map showing the contours of a portion of the property, as mentioned before, was made for Mr. Manning.

SALISBURY MINE.

With the exception of air tests made at this mine no work other than the usual mine surveys was accomplished underground. On the surface a number of iron pins were set, some of them in concrete.

MEGAUNEE MINE.

Monthly and mid-monthly surveys were required here to show the areas mined as the drifts caved very soon after being opened up. The 10th level received a great deal of attention. Lines were given for every raise put up and all the drifts are carried forward on lines. Check elevations and a check survey were carried from the breast of No.38 contract to the breast of No.36 contract. These two drifts should hole in a short time. During February the main footwall drift being driven Southerly from the winze holed into the drift being carried Northerly from the shaft. When the surveys were tied in it was found that they disagreed only a half minute for course and 0.06 for elevations. The pump house and sump also required a great deal of attention. A special cross and longitudinal section showing the relation of the mined out areas to the caves on surface was made for the Lackawanna Steel Company. The only work of importance on surface was in connection with the air compressor foundations and the new coal dock and coal tram.

IMPERIAL MINE.

This property was not operated during the year.

MORRIS-LLOYD MINE.

With the exception of the shaft work, the 4th level Lloyd and the 1st and 2nd levels Morris required most attention. The majority of the gangs on these levels are drifting ahead on lines and consequently these lines were accurately lined in about once a month. As the 2nd level Morris approached the Lloyd shaft and as it was first proposed to raise the Lloyd shaft full size for a distance of 370', it was necessary to accurately locate the shaft corners on the 2nd level Lloyd and also to have accurate surveys on the 2nd level Morris, which is the same elevation as the 4th level Lloyd. Therefore accurate surveys were carried from a common base line to the collars of both the Lloyd and Morris shafts. On these surveys all angles were read four times and the distances between points split up into short intervals so that there was not much sag in the tapes when measuring. We worked on the theory that the closer the line stakes were placed together the less difference there would be in the results secured by different men. The surveys to the Lloyd shaft finally agreed by $00^{\circ}00'12''$ for course and 0.01 and 0.01 for coordinates. The surveys to the Morris shaft finally checked so that the average course disagreed only by $00^{\circ}00'12''$ from one survey and $00^{\circ}00'18''$ from another survey. The coordinates only disagreed 0.01 in both latitude and departure. Wires were then hung in the Lloyd shaft and the shaft corners on the 2nd level carefully read into twice. The Morris shaft was plumbed on three separate occasions and after a great deal of difficulty we finally decided on a definite course for the underground surveys. Previous to Good Friday we had six plumbings that gave courses varying from $S.00^{\circ}14'30''$ East to $S.00^{\circ}20'00''$ East between two points on the 2nd level. The average of these six plumbings was $S.00^{\circ}17'30''$ East. On Good Friday we secured two plumbings that gave us $S.00^{\circ}17'5''$ East and $S.00^{\circ}17'55''$ East. The average coordinates secured from the two latter plumbings for one of these plugs is S. 2562.51 and 680.135 W. The average of the coordinates for this same plug

from the six previous plumbings was S. 2562.52 and 680.13 W. From these results it was evident that the correct course and coordinates had been secured but to further insure the correctness of the results the shaft was plumbed again on May 4th. This time we obtained a course of S.00°17'35" E. which differs only by 00°00'5" from the average of the first six plumbings and also only 00°00'5" from the average of the Good Friday plumbings, thereby absolutely proving the accuracy of the work. From this data the shaft corners were spotted on the 4th level Lloyd and the shaft carried up full size for two sets and then raised the rest of the distance by a smaller opening. The raise holed as planned.

CHASE MINE.

Very little except routine mine surveys were made at this property, the only exception being the raise that was holed from the 1st level into the bottom of a winze sunk from surface Northeast of the shaft in order to provide a second outlet from the mine.

SURFACE SURVEYS.

AU TRAIN WATER POWER.

The surveys were started on June 24th and finished on September 9th and consisted of running out and blazing the 788' contour about ten miles in length, running accurate levels from the North to the South end of the basin and making cross-sections for the upper and lower dam sites.

PREVIOUS SURVEYS.

During the winter of 1911, Mr. Adams ran out the East-West cross-section lines from a quarter of a mile from the North line of Section 6, 45-20 to the South line of Section 31, 45-20. He established a bench mark at the intersection of these cross-section lines and the county road and usually set a bench mark at the end of each line. During the summer of 1911, Mr. Chas. Cummings ran out a portion of the high water contour.

C.C.I.CO.SURVEYS.

LEVELS.

It was deemed advisable to first check Mr. Adams' elevations before attempting to run out the high water flowage line. For that reason we first ran a line of levels from the present dam to the bench mark Mr. Adams based all his work on. We checked by 0.03. His bench mark "Y" on the South line of Section 36, 45-21 was checked by 0.06. Good permanent bench marks now exist every quarter mile along the North-South county road, six bench marks are established along the North-South section line between Section 36, 45-21 and Section 31, 45-20 and a number of them exist along the M.M.& S.E.Ry. at the North end of the basin.

788' CONTOUR.

The 788' contour was run out by a survey line across Sections 1, 12, 13, 25 and 26, 45-21 and Sections 31 and 32, 45-20. This line was tied into Adams' cross-section lines whenever his stakes could be found and elevations checked on his bench marks. At intervals of say 25' the trees along this line were blazed.

CROSS-SECTIONS AT PROPOSED DAM SITES.

PROPOSED DAM SITE AT SOUTH END OF BASIN.

Starting at the Southeast corner of Section 36, 45-21 a line was run North to the East quarter corner of Section 36. At intervals of 400' East-West lines were run out, stakes set every 100' and elevations taken. On the West side of the basin these lines were carried to an elevation of 795' and on the East side to an elevation of 850'. In addition to the 400' lines the East-West township line, the 16th line and the quarter line North of the township line were put in. All of these lines averaged 5000' in length.

PROPOSED DAM SITE AT THE M.M.& S.E.RY.TRACKS.

Stations 50' apart were set over an area 300' wide and about 3000' long on the South side of the track. The contour lines were

carried up to an elevation of 800' sea level. North of the railway tracks stakes were set every 100' from the tracks to the present dam for a distance of 500' East and 300' West from the river. This area was contoured to find the most suitable position for the proposed intake pipe.

TIMBER.

Section 1, 45-21. The area within the flowage line is mostly low swampy ground with very little merchantable timber to be cut. On the East side of the area between the Slapneck creek and the flowage line there are a few hardwood trees.

Section 12, 45-21. The area that will be flooded West of the Slapneck creek is low swampy ground with the exception of a hardwood ridge a little over a half mile long and 500' wide. This ridge has some merchantable timber. East of the Slapneck creek the timber has already been cut.

Section 13, 45-21. There is a belt of good hardwood timber between the high water contour line and the North-South 1/16 line in the East half of the section.

Section 25, 45-21. The 788' contour is on cut-over ground, the entire section having been logged.

Section 36, 45-21. The entire Northeast quarter of the Northeast quarter is cleared land but a little timber exists on the other three forties within the storage basin.

Section 31, 45-20. The 788' contour is at the foot of a ridge through old slashings. Between the contour line and the West boundary of the section there are two large swampy areas, separated by a hardwood ridge about 600' wide, which contains a few scattered trees. The swamps contain no timber of any value.

Section 30, 45-20. The high water flowage line is at the foot of a ridge upon which there is some timber.

ROADS, RAILWAYS, ETC.

The Buckeye spur No.2 of the Rapid River branch of the Soo line runs East and West along the North line of Section 36, 45-21 and then turns North towards the center of Section 30, 45-20. This provides railway facilities within a half mile of the proposed dam site at the South end of the basin. The other dam site is served by the main line of the M.M. & S.E. Ry. A fair road traverses approximately North and South along the West side of the storage basin. This road will be submerged for about two miles South of camp No.2 near the West quarter corner of Section 7, 45-20. There is also a road branching East from camp No.2 that runs to Joe's creek Northeast of Mud lake. The greater portion of this road will also be flooded. The number of people using this latter road I cannot state. Another road runs West along the South line of Section 25, 45-21 which furnishes an outlet for the farmers in Sections 25 and 36 and in the area South of the storage basin.

CHARACTER OF SOIL, LEDGE, ETC.

At the proposed dam site at South end of the basin, no ledge outcrops were found. No test pits were dug to ascertain the character of the soil but the two large swamp areas appear to have sandy bottom. From Adams' soundings made in 1911 along the South line of Sections 31 and 36, the soil appears to be sand and gravel to a depth of about four feet underlaid by a limestone ledge. Adjacent to the high sandy plateau in Section 31 for a length of about 800' the sand and gravel are replaced by muck underlaid by limestone.

At the proposed dam site at the North end of the basin, no rock outcrops were seen with the exception of those in the river bottom at the railway bridge. North of the railway tracks and East of the river the ground is low and appears to be soft and swampy for quite a distance back from the river. On the West bank, however, the ground is high, dry and firm and for that reason I would judge that the intake pipe from the new dam ought to be located on the West bank of the river.

BURROW PITS FOR SAND FILLS.

It is proposed to construct both dams largely of earth. At the South dam there is a plateau 50' high ^{er} than the top of the proposed dam running along the East flowage line from which large quantities of material can be borrowed. At the North dam site a burrow pit could be established in the cut along the main line of the M.M. & S.E. Railway, a short distance West of the Au Train river, or the material could be borrowed from the high hill Southeast of the dam site.

SPRINGS.

There are quite a number of springs in Section 31 along the flowage line and near the South line of the section and also South of the storage basin, especially in the vicinity of Trout lake. The question naturally arises as to where these springs are fed from. Along the Eastern side of the storage basin there is a steep bank and on top of this bank is a plateau reported to be four miles wide, twenty miles long and elevated from 50' to 75' above the general level of the ground in the storage basin. The 788' contour line runs along this steep bank and numerous springs occur along the line, which of course is above the general elevation of the ground in the storage basin. A large spring was also found on the South line of Section 31, 45-20 near a creek that flows into Trout lake. The water in this spring bubbles forth with considerable force and its elevation is only one foot below the level of Mud lake. Its source is probably not in the storage basin but undoubtedly in the high plateau to the East. It is also very probable that the springs in Trout lake and vicinity are fed from the ground waters in this same large flat plateau and not from the North through underground channels in the limestone.

CRYSTAL FALLS DISTRICT.

Surveys on Sections 1, 6 and 12 were made to map general topography and drill holes on lands under option. The NE $\frac{1}{4}$ of Section 1, 42-33 was used as an origin and a polaris observation was made here upon which to base the surveys. A line was run entirely around the NE $\frac{1}{4}$ of Section 1, which includes the Kimberly option, and around

the SE $\frac{1}{4}$ and a portion of the SW $\frac{1}{4}$ of the section. A due North and South line running South a half mile from the origin divides the Kimberly and Carpenter options. An East-West coordinate line was run across the three Neely forties under option in Section 12 and surveys from this also ran far enough South to take in the explorations on the Shelden lands in Section 12. Elevations were run over all these stations and the loops satisfactorily tied in.

IRON RIVER DISTRICT.

A survey of a portion of the Spies option on Section 24, 43-35 was made in September. The Northwest corner of this section was used for an origin and a polaris observation was made for course. A line was then run completely around the NW $\frac{1}{4}$ and general topography surveyed within the quarter section. We attempted to run levels from Section 24 to a bench mark at the C. & N.W. depot but stormy weather interfered and the work was postponed. At present we have only relative elevations on the drill holes.

CLIFFS DRIVE TERRITORY.

Coordinate lines were run out on Sections 22, 23 and 24, 47-27. A due North and South line was established near the center line of Section 24. Another North and South line divides Sections 22 and 23 and a third line divides Sections 21 and 22. An East-West line connecting the ends of these three lines runs along the South side of the above sections. Elevations have also been carried completely around the Cliffs Drive and bench marks established at frequent intervals. The elevations were carried from one of these bench marks South along the East line of Section 21, thence East to the South quarter corner of Section 24, and thence North to the Ogden mine. Practically all the exterior corners of Sections 11, 12, 13, 14, 15, 22, 23 and 24, 47-27 have been surveyed and some of the interior corners of Sections 11, 13, 14, 15 and 24, 47-27. In addition the exterior corners of Sections 21, 25, 26 and 27, 47-27 have been partially located. The shore lines of lakes Ogden and Sally have been surveyed.

FITCH AND SAGINAW MINES DISTRICT.

The line running due South from the North Lake origin was extended to the East quarter corner of Section 24, 47-28. From this point we ran West a half mile, thence North a half mile, thence looping back to the North-South base line, thereby entirely surrounding the Fitch mine. A line was also carried due East from the East quarter corner of Section 24 to the East quarter corner of Section 19, 47-27, thence North a quarter mile to the road, looping back along the road to the base line. Elevations were also carried from the Salisbury mine to the iron pins on the East-West line in Section 19 and checked back by 0.03.

NORTH LAKE DISTRICT.

Three East-West lines were carried across Section 5 on the 1600 South, 3200 South and 4000 South meridian lines. Wooden stakes were put in every 200' and iron pins every 800'. All the sight stations were also iron pins. We now have parallel lines established 800' apart and lines half way between those blazed out for contour surveys on this section.

CONTOUR SURVEYS.

Section 3, 47-27. The surveys on the $N\frac{1}{2}$ of the section started last year were finished.

Section 4, 47-27. An entire new survey was made of this section. Survey loops consisting of iron pin stations were first run around and across the cleared areas. An East-West line was then put in along the center line and a North-South line parallels the other center line. Elevations were then carried over all the iron pins and the contours mapped.

Section 9, 47-27. The contours on the $N\frac{1}{2}$ of this section were mapped from the existing survey stations.

Section 11, 47-27. As nearly all the old survey points on the $N\frac{1}{2}$ of this section had been stakes and consequently destroyed, an entirely new set of iron pins was established. Elevations were then carried to these stations and data taken for the topographical maps.

Lucy mine surface. Contour maps of the three forties embracing the Pendill property have been finished.

Bunker Hill surface. The data necessary to complete the contour maps of this property has been secured.

Section 15, 47-27. The $S\frac{1}{2}$ of this section was contoured early in the spring. An East-West line was run from the South quarter post of the section to the Southwest corner and thence North to the swampy area. A line was then carried completely around this swampy area and tied into the old Salisbury mine surveys. The location of the city water pipe was staked out by Superintendent Devine of the Board of Public Works and then surveyed by the Engineering department.

SPECIAL SURVEYS.

BOSTON MINE.

This department continued to make the surveys of the Boston mine for the Pickands, Mather Company.

CITY OF NEGAUNEE.

A few days were spent at the Maas and Negaunee properties reading into fence corners in connection with the calculations made to determine the boundary lines. The Northeast corner of the Negaunee property had never been accurately located and discrepancies existed at the Race Track property which had to be resurveyed.

SPECIAL WORK.

AIR TESTS.

These were made in the Lake, Cliffs Shaft and Salisbury mines to determine the percentage of oxygen, carbon dioxide and the temperature in every working place. At the Lake mine the tests were repeated. These tests were made usually by a party consisting of one engineer, a chemist and a man from the Safety department.

ABSTRACT MAPS.

The maps of the Athens property were finished and photographed. These maps show the complete chain of title for both the surface and mineral ownership. The maps of the Bunker Hill property, Lucy mine and Gwinn district were started.

INSURANCE MAPS.

The insurance maps of Ishpeming and Negaunee were secured from a local insurance agency and all our 50' to the inch mounted maps were colored in to correspond to the same scheme; that is, all wooden buildings were tinted yellow, all brick buildings red, all stone buildings blue, etc.

ESTIMATES.

Coal estimates are made once a year about May 1st at every mine. At various times during the year the stockpiles were estimated at the Lake, Salisbury and Cliffs Shaft mines.

WITNESSING SURVEY STATIONS.

Aluminum tags about 1" wide and $1\frac{1}{2}$ " long, upon which the name of the stations and their elevations are stamped, have been placed underground at most of the mines on the main levels near the various survey points. In the hard ore mines where points and plugs are driven in the back the stations have been circumscribed with circles of white paint. Rail points are witnessed by a long white line on the rib opposite the point.

RECAPITULATION OF SURVEYS AND INDEX MAP.

The loose-leaf record books, although generally complete as regards mine surveys, had never been worked up to contain all our surface surveys. After trying for a time to get a set of coordinates to check closely for all points within the Ishpeming-Negaunee area, it was finally decided to split the entire section into three districts, namely, the City of Negaunee district, the City of Ishpeming district and the Iron Cliffs district. A set of coordinates was finally derived for every point so that if a survey is started from any point in the City of Negaunee district and run to some other point in the City of Negaunee district the resultant check is invariably within a foot each way for coordinates and within two minutes for course. If a survey is run from some point in the City of Negaunee district and carried to some point in the City of Ishpeming district the resultant

check will not be within a foot for coordinates because the two districts do not exactly agree with each other and it is impossible to make them agree unless the old coordinates of every section corner and iron pin within the city of Ishpeming area is changed. It was not deemed practical to make this change because it would affect all the plotting that had previously been done on the 50' to the inch maps in the City of Ishpeming. By dividing the above area into three districts and using one given point within each district from which all surveys radiate, we were enabled to make last summer's surveys check fairly close with the surveys run in previous years. For instance, all surveys in the City of Negaunee district radiate North, South, East and West from points 13G and 13H near the origin in the old Roman Catholic cemetery. The surveys within this area run approximately North one mile, South one mile, East three miles and West three miles. In the City of Ishpeming district all surveys now radiate from triangular station "B" shaft, which is an iron pin at the Cliffs Shaft mine. Surveys from this point run North one mile, Northeast one mile, West one mile, Southwest one mile and Southeast a half mile. All surveys in the Iron Cliffs district are based upon our coordinate lines within that area. In each case the origin for the district is as near as possible to the center. All coordinates for the three districts are on the Maas system. An index map has been prepared to show this situation.

ANNUAL REPORT.

The annual report of 1912 kept the department busy until well along in February. This year we started the report in October. Views were taken of the various properties during the latter part of that month. The December monthly surveys of the Ishpeming and North Lake mines were made about the 15th of the month, which enabled us to post up all the tracings and photograph them before the end of the year.

EQUIPMENT, BUILDING & SUPPLIES.

Practically no change was made in the equipment or building for the Engineering department. The customary supplies were bought to replace used up stock. Four new tripods and two new instrument boxes were order to replace old ones used underground. One underground transit and one surface level were sent to the makers for minor repairs. In addition four new leveling screws were fitted to surface transits and a new set of stadia wires were inserted within the North Lake transit.

MINE ABSTRACT DEPARTMENT.

INFORMATION FURNISHED BY A. E. PRIMEAU.

The information on record in the Mine Abstract department is confined to that of the lands on which are situated the Company's mines, explorations, hydro-electric developments, etc. During the year better progress has been made in acquiring and systematizing this information; in fact, most of the abstracts have been collected, but there still remains much copying and also maps have to be made to illustrate these abstracts. It is hoped that early in the coming year the information will have been completed on the Company's mining property and water powers.

The following remarks on the information recorded in the various books are in the order in which this information coming to the department is treated:

REGISTER OF DOCUMENTS.

This book was started in 1912 and has proved to be valuable, showing when instruments are received, from whom, date, and to whom delivered, number of copies, etc.

GENERAL INDEX PLAT BOOK.

This is a plat book 14" X 17" comprising nine sections on a page, showing forty acre tracts on a scale of one square inch, all ruled about six lines to the inch. On each forty acre tract are entered any or all of the following instruments or documents, if any affect said forty, by letters as follows: A - Abstract; T.H. - Tax History; O - Option; L - Lease; P - Purchase; F.L. - Farm lease; T.T. - Tax Titles; E. - Easement; R.W. - Right of Way; W.R. - Water Rights; the number of document being placed after letter corresponding to instrument affected and to be indexed. It is a quick way to get information as to what we have on file affecting any lands or parcels of land, etc.

GOVERNMENT PLAT BOOKS.

These books are 24" X 19" and include the following United States Township Plats:

Book 1 includes the following: 48-13; 49-13; 48-14; 49-14; 48-15; 49-15; 41-16 to 49-16; 39-17 to 48-17; 38-18 to 49-18; 38-19 to 48-19; 39-20 to 47-20; 38-21 to 48-21; 38-22 to 48-22; 38-23 to 47-23; 36-24 to 47-24; 34-25 to 49-25, ranges East of range 26 West.

Book 2 includes the following: 32-26 to 51-26; 32-27 to 52-27; 34-28 to 52-28; 34-29 to 52-29; 39-30 to 52-30, ranges 26 to 30 West inclusive.

Book 3 includes the following: 31-23 to 33-23 E; 31-22 to 33-22 E; 31-21 to 38-21 E; 31-20 to 38-20 E; 38-19 to 40-19 E; 39-18 E; 40-18 E; 39-17 E; 40-17 E; 40-16 E; 41-31 to 52-31 W; 41-32 to 52-32 W; 42-33 to 51-33 W; 42-34 to 50-34 W; 42-35 to 50-35 W; 42-36 to 50-36 W; 42-37 to 49-37 W; 43-38 to 45-38 W; 43-39 to 45-39 W; 47-42 W; 47-43 W; 47-44 W; 47-45 W; 47-46 W; 47-47 W; 45-1 E; 46-1 E; 45-2 E; 46-2 E; 44-1 W; 45-1 W; 45-2 W.

CITY AND VILLAGE PLAT BOOK.

This book, 18" X 24", is for plats. The following plats are now on file in this book:

MISCELLANEOUS.

The Village of Cornwall.

MEGAUNEE.

Corbits Addition.
Collins' " No.1.
Edward Lobb's Addition.
Mary Gaffney's "
Map of Harvey's "
Harris' Addition.
Iron Plat) these plats are
Iron Plat) different.
Block 2 Johnson Plat.
Jackson Iron Co. Addition Plat.
Kirkwood & Kellan's Addition) these plats are
Kirkwood & Kellan's Addition) different.
MacKenzie's Addition.
Meas, Lonstorf & Mitchell Addition.

MEGAUNEE CONTINUED.

Maitland's Addition.
Map of Negaunee Village - Pioneer Iron Co. Plat.
Map of City of Negaunee - Pioneer Iron Co. Second Addition.
Read & Winter Addition.
Sterling's Addition.
Sterling & MacKenzie Addition.

ISHPEMING.

Original Plat.
Excelsior Iron Co. Second Addition.
Excelsior Iron Co. Addition - two plats.
Lake Superior Iron Co. sub-division.
Mildon's Addition.
Nelson's Addition.
Nelson's Plat.
The Cleveland Iron Mining Co. Addition.
The Cleveland Iron Mining Co. Second Addition.
The Cleveland Iron Mining Co. Third Addition.
The Cleveland Iron Mining Co. Fourth Addition.

LAND OFFERS.

The land offers to January 1st, 1914, numbered 762, there being 116 land offers received during the year.

Land offers are entered numerically in Land Offer Register and alphabetically indexed in same book; then same are entered on township plats in duplicate, one copy retained in this office and one copy forwarded to the Cleveland office the first of each month. Copies retained in this office are filed numerically in a loose-leaf book 8½" X 11". Once a month same are posted in Land Offer Plat Book, 25½" X 19".

EXPLORATIONS.

The Geological department keeps records of its outside explorations, numbering them numerically, and same are posted in Land Offer Plat Book in green ink, same being a great help in determining the value of a land offer.

ABSTRACTS.

Abstracts of the Athens Mining Company's property at Negaunee, Michigan, are now completed, comprising in all 432 entries, and as soon as abstract maps are photographed same will be in shape for Cleveland office.

The following abstracts are now completed, except as to maps and abstracts of platted portions from respective date of plats:

Lucy mine property.
Jackson Iron Company property.
Pioneer & Arctic lands.
Bunker Hill Mining Company property.
Lobb field.

Also various lease-hold interests in the Gwinn district as well as abstracts covering Carp river water power lands and rights acquired by the Mine department the past year.

The above abstracts are copied in triplicate on our regular form abstract sheets, 14" X 17", and enclosed in a loose-leaf folder with the title on the cover. Original copy is for Mine department, one copy for the Cleveland office and one copy for Land department. All of the above were made the past year and there are over 4500 entries in same.

There are on file 287 abstracts, not including those above mentioned.

TAX HISTORIES.

There are on file 390 tax histories to January 1st, 1914. These are filed numerically and posted in Plat Index Book.

LAND & MINERAL OWNERSHIP PLATS.

The addition during the year was certain ownership plats in Marquette County, Michigan; also in Aitkin County, Minnesota. Only a few additions and corrections were made in any of the plats. It will be necessary to have this book corrected to date.

The monthly information of the Reception Book of Deeds from Marquette and Iron counties was discontinued.

LEGAL OPINIONS.

The Record Book of Legal Opinions shows 85, entered, indexed and filed. As fast as opinions are acquired or found in correspondence files copies are made for this office.

OPTIONS FOR MINING LEASES.

The following options were taken out in 1913:

- No.99. Peterson et al, dated January 11, 1913; expires January 11, 1914. Covers $W\frac{1}{2}$ of $SW\frac{1}{4}$ and $SE\frac{1}{4}$ of $SW\frac{1}{4}$ of Section 2, 47-28. In force while work is being done on same.
- No.100. Kimberly Iron Co., dated September 23, 1912; expires April 1, 1913. Covers $E\frac{1}{2}$ of $NE\frac{1}{4}$ of Section 1, 42-33. This option was only accepted after the lapse of considerable time.
- No.101. F. I. Carpenter et al, dated April 28, 1913; expires April 28, 1914; right of renewal for one year. Covers $SE\frac{1}{4}$ of $SW\frac{1}{4}$, $SW\frac{1}{4}$ of $SE\frac{1}{4}$ of Section 31, 43-32; $NW\frac{1}{4}$ and $NW\frac{1}{4}$ of $NE\frac{1}{4}$ of Section 6, 42-32.
- No.102. Seager-Smith Land Co. Ltd. et al, dated August 11, 1913; expires August 11, 1914 with right of renewal for one year. Covers $SE\frac{1}{4}$ of $NE\frac{1}{4}$ of Section 19 and $NE\frac{1}{4}$ of $NE\frac{1}{4}$ of Section 28, 47-27.
- No.103. S. P. Snider. Minnesota State Leases, dated August 27, 1913, perpetual. Covers state leases and miscellaneous lands in which Mr. Snider of Minneapolis has a one third interest.

The following extensions were acquired the past year:

- No.89. Thomas Estate - in force.
- No.95. Benjamin C. Neely et al, dated December 27, 1912; expires December 27, 1913. Note: Lease demanded December 1913.
- No.96. (W. D. Calverly et al, dated August 20, 1913; expires
96A. (
96B. (August 20, 1914.
- No.97. (
97A. (Sheldon Estate Company et al, dated August 20, 1913; ex-
97B. (pires August 20, 1914.
97C. (
- No.98. Spies Mineral Land Company, dated October 31, 1913; expires November 21, 1914.
- No.98A. Spies Mineral Land Company et al, dated October 13, 1913; expires December 13, 1914.
- No.99. Peterson et al, in force while work is being continued.
- No.100. Kimberly Iron Company, dated March 8, 1913, expires July 1, 1913.
" July 1, 1913, " Jan. 1, 1914.
" Dec.18 , 1913, " July 1, 1914.

The following is the only option that was relinquished during the year:

- No.101. F. I. Carpenter et al, Crystal Falls, relinquished September 4, 1913.

At the end of the year the following options were in force;

- No.89. Thomas Estate , expires indefinite.
- No.95. Neely, expired December 27, 1913 - lease demanded.
- No.96.)
 - 96A.) Galverly, expires August 20, 1914.
 - 96B.)
- No.97.)
 - 97A.) Sheldon Estate Company, expires August 20, 1914.
 - 97B.)
 - 97C.)
- No.98. Spies Mineral Land Company, expires November 21, 1914.
- No.98A. Spies Mineral Land Company et al, expires December 13, 1914.
- No.99. Peterson farm - in force while work is continued.
- No.100. Kimberly Iron Company, expires July 1, 1914.
- No.102. Seager-Smith Land Company, Ltd, expires August 11, 1914.
- No.103. S. P. Snider. Minnesota State Leases, perpetual.

In connection with option No.98, Spies Mineral Land Company, an option was obtained from that company dated December 2, 1913, to purchase their 1/16 interest in the surface of the SE $\frac{1}{4}$ of the NW $\frac{1}{4}$ of Section 24, 43-35. This expires with the mineral option November 21, 1914.

Also from Finlay A. Morrison of Iron River, Michigan, an option was obtained covering his 15/16th interest in the surface of the above description. This expires June 1, 1914.

LEASES.

No leases were taken out during 1913.

An application for a lease on option No.95 was made in December.

Lease No.35, Hanson, Iron River, was surrendered September 12, 1913.

DEEDS.

During 1913 there were 398 deeds numbered, filed and indexed, bringing the total number to 556. There are numerous deeds yet to be filed.

In numbering deeds all purchases and any and all instruments are given a deed number.

An Alphabetical Index Book is kept for deeds and same is posted to date.

RECORD OF PURCHASES.

There were 158 purchases entered to January 1, 1914, comprising deeds of Maas and Negaunee mines, Gwinn district, Carp river water power, etc. These are all indexed alphabetically and copied filed.

Deeds and purchases are not at this date posted in Index Plat Book.

TAX TITLES.

The tax deeds are given a purchase number.

TRANSMISSION LINE.

In the Record of Transmission Line Easements, I have entered to January 1, 1914, 79 easements, all indexed, numbered and properly filed.

There were 11 easements acquired in 1913 as follows:

	Dated.	
No.42, Pioneer & Arctic,	July 22, 1913.	
No.48, Wm. Ward Heirs (Deed)	Aug. 25, 1913.	
No.67, Munising Company	June 2, 1913.	
No.72, C. & N.W.Ry.Co.	July 1, 1913.	
No.73, D.S.S. & A.Ry.Co.	Aug. 4, 1913.	
No.74, Iron Cliffs Co.	July 18, 1913.	
No.75, Pioneer Iron Co.	Nov. 26, 1913.	
No.76, Athens Mining Co.	Nov. 26, 1913.	
No.77, Bunker Hill Mng.Co.	Dec. 20, 1913.	
No.78, Michigan Railroad Commission	Aug. 12, 1913.	C. & N.W.
No.79, Michigan Railroad Commission	Aug. 12, 1913.	D.S.S. & A.

The easements to be acquired are as follows:

No. 3, Pittsburg & Lake Angeline Co.
No.32, Escanaba River Land & Iron Co.

RIGHTS OF WAY.

This subject is being handled by the Land department, therefore nothing was done in this department.

WATER RIGHTS.

No information other than that acquired for transmission line easements and purchases of land for Carp river water power has been made by this department.

SALES & LEASE BOOK.

This book has two divisions, one for sales and the other for farm and lot leases.

Nothing to date has been done with sales. No sales have been made by the Mine department the past year.

All lot and farm leases are entered in this book and given a number irrespective of that given by the Land department. In posting leases in book our number is given, then the Land department number, date lease begins, date of expiration, parties in lease, rental per year, description, term of years and form number. Only those are entered which affect the mineral interests or water power. The Land department issues no leases on iron formation without the Mine department initials.

To January 1, 1914, there were entered 714 lot and farm leases and same indexed.

No record copies of leases are kept but space has been provided for extension on our records.

All lot and farm leases are to be posted in Index Plat Book.

MISCELLANEOUS.

During 1913 there was started a miscellaneous file for all instruments, etc, which cannot be filed under other headings in the Mine Abstract department.

GENERAL OFFICE WORK.

A. E. Primeau spent sixty two days at the Court House in Marquette in 1913 copying records.

The following helped to copy information for this office:

Richard Pryor worked 16 days in March for this department.

Miss Gill worked as follows: 6 days in April, all of May, 13 days in June, leaving on the 18th. Miss Gill resumed work for this department on November 12, 1913, and is now in the employ of this department.

Miss Ryan worked 19 days in September and October.

Mrs. Dunn also helped 5 days in November.

Current work took about one third of the time in the office.

Copies of records and documents were made for the Land department as directed.

ITEMS BY J. E. JOPLING.

WATER POWER.

AU TRAIN.

As above described by Mr. Stakel, surveys of the proposed storage basin on the Au Train have been completed. These are in compliance with the request of Mr. F. O. Blackwell, but as the development of this storage basin is not contemplated at the present time the information remains in this office. No test pits or drill holes were put down as recommended by him to test the dam sites. The necessary land has not yet all been purchased by the Land department. The timber has not yet all been removed by the Lumbering department and there is still some timber on lands which have not been acquired.

CARP RIVER.

For the development of storage basin No.1 to the North of Negaunee, the lands have not yet all been purchased by the Land department. In this case it was thought best not to carry on the survey to determine the proposed flowage line.

The balance of the Carp River Furnace Company lands at the mouth of Carp river, Marquette, were purchased during the year by the Cleveland-Cliffs Iron Company.

DEAD RIVER.

On May 12th, Mr. O. D. McClure accompanied me to see the falls on Dead river upon the land formerly occupied by the powder works North of Marquette, and a report was made of the same. This proposition would be worth developing when a complete or nearly complete storage has been accomplished on the Dead river.

A report was also written by Mr. McClure and myself showing the additional power that could be developed on the Dead river at the Hoist.

PYRITES.

A special report covering all the pyrites properties was made during the beginning of last year. This report will be extended to date.

Examinations of pyrites properties offered were made during the year, the principal one being in January when Messrs. Smyth, McClure and I examined the Delyea mine in Hastings County, Ontario. From May 18th to the 31st I examined explorations offered in the Rainy Lake, Port Arthur and Michipicoten districts. From June 15th to the 27th I again visited Hastings County and also the Cobalt, Porcupine and Sudbury districts. Since that time a number of offers have been received, principally from the same districts. Up to date the Company has not acquired a pyrites property. The only recommendation that can now be made is to examine a few of the recent offers and if none of them are suitable then to start explorations, preferably in Hastings County. Mr. J. E. Marks continues to make examinations for the Company in the Port Arthur district upon request.

LAKE SUPERIOR IRON CO. & REGENT IRON CO. MINES.

Captain J. H. Rough and I made examinations of the Lake Superior and Regent mines at the end of the year and reported on the same.

CUYUNA RANGE.

In compliance with the contract with Mr. S. P. Snider of Minneapolis and as modified by a supplemental agreement made this year, the Company has started to explore the lands in Aitkin County in which Mr. Snider is interested with it.

No trip was made by me to the Cuyuna Range last year.

MICHIGAN MINERAL LAND CO.

As agreed at a meeting of the Company's officers, I furnished Mr. Prickett certain maps and information regarding explorations in the neighborhood of and upon the lands of the Michigan Mineral Land Company in three districts, namely, the Atkinson, the district from

Crystal Falls to Amasa and that North of Amasa. These maps were accompanied by the regular diagrams showing the result of explorations by sections and also a brief report upon the result of these explorations.

OLIVER IRON MINING CO.

Information in the form of maps of the Marquette Range was furnished to Mr. M. W. Merriam, Chief Geologist of the Oliver Iron Mining Company. Mr. Merriam is about to get out a new map of the geology of the Marquette Range and will furnish this Company with copies.

VARIOUS TRIPS.

On June 10th in company with Messrs. Bush and Rough, I made an examination of the Youngs mine, Iron River, and on July 1st we made an examination of the Ashland mine. In October I was at the Crosby mine and also with Mr. E. E. White on the East end of the Gogebic Range.

During the year some time was spent in investigating the subject of drying ores, also a washing plant at the Crosby mine.

While at Sault Ste. Marie, Ontario, examining pyrites claims, I visited an iron formation at Bellevue, 23 miles up the Algoma Central Railway, which should be investigated further. Among the land offers was the old Detroit mine property at Ishpeming, which I looked over at different times with Mr. Smyth and also Captain Collick.

THE CLEVELAND-CLIFFS IRON COMPANY.

REPORT OF THE CHIEF GEOLOGIST FOR YEAR ENDING DECEMBER 31ST, 1913.

DIVISION OF WORK AMONG THE PERMANENT MEMBERS OF THE DEPARTMENT.

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

E. E. WHITE. My work during the year has consisted chiefly of general oversight of the work of the department, which has included geological surveys in the Crystal Falls, Amasa and Michigamme districts, test pitting in the Crystal Falls district; diamond drilling explorations in the Negaunee, Ishpeming, North Lake, Gwinn, Iron River, Crystal Falls and Aitkin County districts and in the Cliffs Shaft, Morris, Chase and Negaunee mines; redrilling old holes on the Athens property to determine if sulphur is present; underground geological surveys in the Cliffs Shaft, Salisbury, Lake, Lloyd, Morris, Chase, Maas, Negaunee and Gwinn district mines, and visiting and reporting on the explorations of other companies on the Michigan iron ranges. The geological map of the Gwinn district was completed during the year; also new tracings of all drilling in that district, according to the corrected records made by looking over the core and reaveraging the ore analyses. I have made several examinations of land offers in Iron County and on the Gogebic Range and have prepared figures and papers dealing with mine valuation and taxation.

F. G. ROCKWELL. Mr. Rockwell continued looking after our drilling in the Iron River district until Mr. Bush became superintendent of explorations during the latter part of February. He then returned to Ishpeming and assisted in the general work of the Geological department until the middle of May when he took charge of a geological survey for us in the Amasa district. While in Ishpeming, he spent some time going over the records of the old Jackson drilling and preparing an index of outside explorations in the form suggested by Mr. S. L. Mather. Mr. Rockwell continued the geological survey Northwest of Amasa from the point where it was left by Mr. Burton in 1911. In September it became necessary to make a geological survey of lands of the American Iron Mining Company in the Michigamme district and Mr. Rockwell with his party started this work about the middle of the month. When this survey was

completed early in November, Mr. Rockwell returned to Ishpeming and since then has been busy with the underground geological work and with routine work in the department.

R.R. FREEMAN, JR. Mr. Freeman continued looking after drilling explorations in the Crystal Falls district until he left for his vacation early in April. Upon his return a month later he started immediately upon a continuation of his geological and magnetic work in the Crystal Falls district. His survey this year was particularly directed to the Mastodon district Southwest of Crystal Falls. He completed the work which we wished done about the middle of October and since the weather was getting bad, he returned to Ishpeming and since that time has been assisting in the underground geological work, in the general work of the department and in preparing a report on his summer's field work.

GEORGE E. BURTON. Mr. Burton continued at Ishpeming during the greater part of the year, keeping the geological maps of the mines up to date, preparing ore estimates, averaging analyses, and assisting in the general work of the department. During the summer he gave as much time as possible to mapping the geology between Ishpeming and Negaunee but was not able to cover much ground on account of the little time which he could give to it. Late in October he left for Minnesota to look after our drilling in Aitkin County on the Snider lands. This work will not be finished until well into 1914.

GUSTAV AFUHS. Mr. Afuhs continued with us as draftsman during the year and frequently assisted Mr. Burton in his underground geological surveys of the several mines. During the early part of the year before we engaged Harry Bennett to look after the core, Mr. Afuhs spent considerable time labeling and filing the samples of core and sludge.

ERNEST A. ALLEN. Mr. Allen spent most of his time during the year visiting the explorations of other companies in Michigan. He has also tested drill holes for us in the Ishpeming, and Negaunee districts and has assisted in the special tests for sulphur at the Athens and Jackson properties.

HARRY T. BENNETT. In June our explorations expanded so that it became necessary to have somebody regularly in the core room to label and file the core and sludge samples. Mr. Bennett was engaged about the middle of the month and since then has continued at this during the year.

SURFACE GEOLOGICAL SURVEYS.

TABLE III.

SUMMER OF 1913.

	<u>CRYSTAL FALLS DISTRICT.</u>	<u>AMASA DISTRICT.</u>	<u>AMERICAN IRON MINING CO. LANDS.</u>
Salaries	\$820.96	\$1060.38	\$475.92
Provisions		240.00	97.14
Board & lodging	308.67		34.75
Traveling expenses	29.57	51.07	15.90
Livery		15.00	8.60
Equipment & misc.	17.51	4.67	25.92
Total	\$1176.71	\$1381.12	\$648.23
Party days in field	150	124	57
Man days in camp	313	473	196
Square mi. surveyed	14	15.5	7.25
Total per day	\$7.85	\$11.13	\$11.36
	(no helper)	(with helper)	(with helper)
Sq. mi. per day	0.093	0.125	0.127
Total per sq. mi.	\$84.05	\$89.10	\$89.40
Total per acre	\$0.131	\$0.139	\$0.139
Provisions per man per day in camp.		\$0.508	\$0.495
Number of men	2	4	4

During the summer of 1913 we continued our geological and magnetic surveys in the Crystal Falls and Amasa districts and also made a survey of the American Iron Mining Company lands in the Michigan district. Table III gives a statement of the cost of these surveys for 1913, exclusive of overhead charges, that is, general office expenses and superintendence. Mr. Freeman's work was much more economical this year than last because he and his compassman boarded in Crystal Falls, thus avoiding the necessity of engaging a cook. The rather more favorable weather this year allowed Mr. Freeman to cover on an average over 10% more territory per day. This, with the very considerably lower cost for the party per day, gave a cost of only \$84.05 per square mile as against \$134.55 and \$122.40 per square mile in 1911 and 1912 respectively.

The character of the work done was practically the same and the difference in the cost per square mile was due almost entirely to his boarding instead of living in camp.

In Mr. Rockwell's work in the Amasa and Michigamme districts it was not possible to board so that he had to have a camp and a cook. The nature of the country made it necessary to have a helper, which made the total cost of his party per day over \$11.00. Mr. Rockwell's cost of provisions per man per day was the best of which we have any record in this department, however, only averaging 50¢ per day, so that the total cost of his survey per square mile does not compare unfavorably with our previous surveys in the same district.

TABLE IV.

	AMASA SURVEY.	AMERICAN IRON MINING CO. SURVEY.	CRYSTAL FALLS SURVEY.	TOTAL.
Days worked in the field.	45.5 35.8%	16.5 29.5%	62 36.9%	124 36.2%
Days lost correcting time and checking compass.	17.5 13.8%	3.5 6.3%	18.5 11.6%	39.5 11.5%
Days lost by cloudy weather.	46.5 36.6%	33. 58.8%	52. 32.6%	131.5 38.4%
Days lost moving & erecting camp.	7. 5.5%	3. 5.4%	0	10. 2.9%
Sundays & holidays not worked.	10.5 8.3%	0	27 16.9%	37.5 11.0%
Total	127 100%	56 100%	159.5 100%	342.5 100%

Table IV is interesting as it shows the small amount of the time spent in the field which can be spent in actual magnetic work. In ordinary geological work a larger percentage of the time would be available but in magnetic work with a dial compass little can be done on cloudy days. It will be noted that on only from 30% to 39% of the days spent in the field could magnetic work be done. No field work could be done on from 32% to 59% of the days because of bad weather but the geologist in charge could avail himself of the cloudy days to prepare the maps of his work.

CRYSTAL FALLS DISTRICT.

Mr. R. R. Freeman carried his magnetic and geological survey of the previous year East to Crystal Falls and also did considerable careful magnetic work Southwest of Crystal Falls in the Mastodon district. His work showed a marked continuity of structure, and although the magnetic lines which he has worked out do not show us definitely where the ore formation lines, they at least permit us to determine whether or not there is any chance of the iron formation occurring on any given piece of land in the district surveyed. Mr. Freeman's detailed report and maps have already been submitted.

AMASA GEOLOGICAL SURVEY.

In May, Mr. Rockwell started a geological and magnetic survey Northwest of Amasa in Section 18, 46-33 and followed the Western magnetic line about six miles to the Northwest and West. Mr. Burton in 1911 surveyed the Southern end of this line in Section 32, 46-33, but Mr. Burton's work showed that it merged into a wider area of high attraction to the Northwest. Mr. Rockwell's work showed that the line again became definite and continued to the Northwest in the direction except-^{ed}ed. This line is supposed to represent a horizon of magnetic slates, corresponding with the line a few miles further East, which turns to the Northeast. Mr. Rockwell found so few outcrops that he could not determine definitely what the line represented and as he found no outcrops of iron formation he does not know what relation the line has to the iron formation, if such be present.

SURVEY OF AMERICAN IRON MINING CO. LANDS.

At the request of Mr. Mather, this department undertook a survey of these lands in September and Mr. Rockwell transferred his party and equipment from the Amasa to the Michigamme district about the middle of the month. He surveyed all of the lands in the district belonging to the American Iron Mining Company and has already submitted a detailed report and maps. He found that the Imperial iron formation probably passes North of the lands in question and there is little chance for any ore on them.

UNDERGROUND GEOLOGICAL WORK.

The underground geological maps and sections of the Salisbury, Lake, Lloyd, Morris, Chase, Austin, Stephenson and Princeton mines were kept up to date by members of this department and the geological maps of the Cliffs Shaft, Maas and Negaunee mines were posted by the members of the Engineering department who did the engineering in these mines.

CLIFFS SHAFT MINE.

Mr. Hanst, assisted occasionally by Mr. Burton, has kept the geological work up to date and has the geological maps and cross-sections in very good shape. He has also kept up to date the analysis maps, compiled from the biweekly stope samples.

LAKE & SALISBURY MINES.

Mr. Burton kept the geological work in these mines up to date during the greater part of the year and Messrs. Freeman and Rockwell did some work in each while they were in Ishpeming before leaving for their summer's field work and after returning. Mr. Freeman spent considerable time on the maps and sections in December and put them in very good shape.

MORRIS, LLOYD & CHASE MINES.

These mines have been worked continuously during the year and Mr. Burton kept the geological maps and sections up to date during the greater part of the year. Messrs. Rockwell and Freeman did a little work on them in the spring and fall.

MAAS & NEGAUNEE MINES.

Mr. Scanlan, assisted by Messrs. Derby and Chenneour, all of the Engineering department, did the geological work in these mines during the year, but when Mr. Scanlan left in October we found that the maps were not in very good shape. Messrs. Rockwell and Freeman did not have much time for these maps before the first of the year but will bring them up to date in January or February.

GWINN DISTRICT MINES.

Mr. Burton did the geological work in these mines and kept the geological maps and sections posted during the greater part of the year,

with a little work by Mr. Rockwell in the spring. Little work was done at the Gwinn mine and we did no geological work there during the year. The last geological work in the Princeton mine was in August and the mine was closed down shortly afterwards. The Austin and Stephenson mines were brought up to date in October and another survey will be made early in the year.

ASHLAND MINE.

This department never prepared any geological maps of the Ashland mine and now that this mine has been given up the Crosby mine in Minnesota is the only operating mine which we do not survey regularly.

EXPLORATIONS.

During the year we did some test pitting in the Crystal Falls district and continued diamond drill explorations in the Negaunee, Iron River and Crystal Falls districts and in the Cliffs Shaft and Morris mines. Diamond drill explorations were also begun on some lands in the Ishpeming and North Lake districts and on the Snider lands in Aitkin County, Minnesota. Drilling was also begun in the Chase mine and two short holes were drilled in the Negaunee mine to drain off the water and sand from some of the workings. The standpiping in the Gwinn district to determine whether water from the Escanaba river was running into the Stephenson mine was continued but was completed early in the year. We successfully completed redrilling a second hole on the Athens property to determine if there is sulphur in the ore.

During the year we took options at Crystal Falls upon the $E\frac{1}{2}$ of the $NW\frac{1}{4}$ of Section 1, 42-33 owned by the Kimberly Iron Company and upon the $NW\frac{1}{4}$ and the $NW\frac{1}{4}$ of the $NE\frac{1}{4}$ of Section 6, 42-32 and the $SE\frac{1}{4}$ of the $SW\frac{1}{4}$ and the $SW\frac{1}{4}$ of the $SE\frac{1}{4}$ of Section 31, 43-32 owned by Mr. F. I. Carpenter, Mr. B. C. Neely, Mr. R. F. Goodman, The Merry Land Company, et al. In the Ishpeming district we took an option upon the $SE\frac{1}{4}$ of the $NE\frac{1}{4}$ of Section 19, and the $NE\frac{1}{4}$ of the $NE\frac{1}{4}$ of Section 28, 47-27, owned by the Seager-Smith Land Company, Limited, et al. In the North Lake district we took an option upon the $W\frac{1}{2}$ of the $SW\frac{1}{4}$ and the $SE\frac{1}{4}$ of the $SW\frac{1}{4}$ of Section 2, 47-28 owned by Mrs. Sophia Peterson, et al.

We relinquished the Carpenter option in the Crystal Falls district later in the year and relinquished the Hanson lease at Iron River.

The fee owners of the Neely option on Section 12, 42-33 in the Crystal Falls district demanded in December that we take a lease but this had not been executed at the end of the year.

M A R Q U E T T E R A N G E.

ISHPEMING DISTRICT.

SEC.15, 47-27, SALISBURY MINE SURFACE.

Early in September, a drill was started on this section in the basin of iron formation on the SW $\frac{1}{4}$. This basin is formed by a nearly vertical East and West fault on the South side and by a greenstone footwall on the North side, dipping South at approximately 45° against the fault, conditions similar to those at the Salisbury mine. The first hole encountered a favorable looking iron formation but only 20' of first class ore and a little lean and second class ore. The next two holes were located to test the basin further West but were both too far South and encountered nothing but greenstone. A fourth hole further North was standpiping at the end of the year.

In all, 168' of standpiping and 669' of diamond drilling were done on this section, making a total of 837'. Only 20' of first class ore and 25' of lean and second class ore were encountered. This drilling was done under Mr. Eaton's superintendence and I have no figures as to the cost.

SEC.19, 47-27, SE $\frac{1}{4}$ OF NE $\frac{1}{4}$, SEAGER-SMITH OPTION.

The papers for this option were drawn up in August but they were not executed and returned to us until September and work was started the middle of October. Only one hole was drilled and this was still continuing at the end of the year at a depth of 736'. This hole was located close to the Southeast corner of the option and was designed to test the deep basin on the North side of the Great East-West fault on the South side of the Marquette Range at this point. Since we own

the land to the East, this hole will give us valuable information about our own land, as well as testing the land under option. Of the 736', 26' was standpiping, 10' was drilled in first class ore and 49' in lean and second class ore. This work was done by Cole & McDonald under contract and no payment had been made them up to the end of the year. Costs of engineering, analyses and general expenses for the three months amounted to \$107.97. The contract rate with Cole & McDonald for work on this option is \$3.00 per foot to a depth of 1000' and \$3.50 per foot for 1000' to 2000'.

CLIFFS SHAFT MINE.

The drilling at the Cliffs Shaft mine continued under the charge of Superintendent Eaton and under the direction of Mr. Smyth. Work was practically continuous except for about a month in January and February when the drill was temporarily moved to the Negaunee mine. In all, 2632' of drilling were done, of which 553½' were in first class ore and 511' in second class ore. Of the first class ore, 213' were Bessemer and of the second class and lean ore 397' were below .060% phosphorus. I have no figures on the cost of this work.

The locations and reasons for drilling these holes have been given in full in my monthly reports and I presume a general report will be made upon them by Mr. Eaton in his annual report.

NORTH LAKE DISTRICT.

SEC. 2, 47-28, W½ OF SW¼ & SE¼ OF SW¼, PETERSON OPTION.

In January 1913 an option was taken upon these lands from Mr. George Maas, Mr. P. P. Chase, Mrs. Sophia Peterson, et al and drilling was started early in April. In this case also there was a long delay in getting the papers executed. It was determined to test the hard ore contact across this property since it would give us valuable information as to the chances for ore on our own lands at North Lake as well as testing the land under option. The footwall of the soft ore formation would lie so deep on this property that it was decided not to be advisable to explore for soft ore. Five standpipes were first sunk to locate ~~the~~ accurately the position of the hard ore contact in the middle of the Northern forty and a hole was then drilled across the contact to test

GEOLOGICAL DEPARTMENT.

for hard ore. It started in quartzite and passed into lean hard ore jasper, in which it was drilled 40' without encountering any ore. Another similar inclined hole was started late in November close to the East line of the option but was drilling in quartzite and had not reached the hard ore contact at the end of the year. In all, 1765' of drilling were done on this option, of which 1353' were standpiping and 412' drilling with diamonds. Nothing over 45% iron was encountered. The total cost of this work including engineering, analyses, general expense, etc, was \$6884.05.

MORRIS MINE.

Considerable drilling was done at the Morris mine during the year under the superintendence of Mr. Graff and with the advice of Mr. Smyth and myself. Drilling was started in January, drilling hole No.1 deeper, and continued with other holes after No.1 was completed until early in March. The drill was then laid off for two months but started again early in May and continued for a month. No more work was done until October and this continued until the middle of December. In all, 2426' of drilling were done, of which 150' was in first class ore and 513' in lean and second class ore. Of the 150' of first class ore, 85' was Bessemer and 30' of the second class ore was below .060% phosphorus. I have no figures for the cost of this work and will not go into the location and results of the holes as I have done that in my monthly reports and as Mr. Graff will probably do so in his annual report. In a general way, however, the drilling was discouraging and did not succeed in locating any considerable body of ore which had ^{not} been already found by the drilling from surface several years ago.

CHASE MINE.

Drilling was begun at the Chase mine during the year under the superintendence of Mr. Graff and with the advice of this department. Work was started early in June and continued until late in September when the drill was laid off for the balance of the year. In all, 1356' of drilling were done, of which 30' was in first class ore and 325' in second class and lean ore, all Non-Bessemer. I have no figures for

GEOLOGICAL DEPARTMENT.

the cost of this work and will not go in detail into the location and results of the holes for the same reasons mentioned under the other mines. At this mine, as well as at the Morris, the drilling was discouraging and did not succeed in proving up any new ore.

MEGAUNEE DISTRICT.

SEC.1, 47-27, JACKSON.

Hole No.67, which was started in June 1912, was finally completed in December 1913. It was drilled 96' into the ore body in August 1913 but it took until December to ream and case the hole so that it could be drilled deeper into the ore. Another 110' of ore was finally drilled and the hole was lost because of the ore caving, the greatest depth reached being 2990'. The first 41' of ore averaged 64.23% iron, .057% phosphorus and .031% sulphur and the last 165' averaged 62.57% iron, .111% phosphorus and .033% sulphur. Since the hole was in ore when it was lost, we do not know how much thicker the ore is at this point but it is probable that we drilled almost through the ore body. A little ore was encountered higher up in the hole at a depth of about 1550' but this was very high sulphur. Of the 1234' drilled in 1913, 206' were in first class ore and 36' in lean and second class ore. The cost of this work in 1913 was \$9223.78. The total cost of the hole was \$15,738.44, an average of \$5.26 per foot.

While drilling the ore in this hole we made special tests for sulphur by taking frequent samples of the drill water and taking meter readings to determine how much water was used. These tests showed that there is no more sulphur than is usual in Marquette Range ore. For the greater part of the drilling in ore we settled all the drill water in barrels for several hours so as to collect all the fine particles of sludge which cannot be saved in an ordinary sludge box. These settlings averaged appreciably lower than the regular sludge sample and the weighted average of the two which we used should be a very accurate determination of the percentage iron and phosphorus.

SECTIONS 5 & 6, 47-26, ATHENS PROPERTY.

Work was started in January redrilling hole No.3 at the Athens to make a test for sulphur similar to that at hole No.1 in 1912. We supposed that we had the wedge firmly cemented in the hole at the proper point to deflect the bit into a new hole but while drilling out the cement above the wedge the core barrel and rods were stuck in the hole and the core barrel had to be drilled out, causing considerable delay. This was finally finished about the middle of March but when the depth where the wedge should be was reached no wedge was found. It had dropped into the hole, presumably because the sides of the drill hole below the wedge had caved, carrying with them the wedge and the wooden plug which held it in place. A new wedge was then cemented in the hole a little higher up where the hole had not caved and was held in place by 50' of old rods which were screwed to the wedge and reached down into the mud in the bottom of the hole. The cement was drilled out early in April and most of the month was spent drilling on the wedge and trying to deflect the hole. The jasper was so hard that the bit cut more of the wedge than of the jasper and in May the attempt to wedge the hole off at this point was abandoned. Another wedge was cemented in the hole in a band of dike 500' higher up and in July the hole was successfully deflected and drilling continued in the new hole. The ore was finally reached during the latter part of September and careful tests were made of the drill water to determine whether sulphur was present. The first 15' in the main ore body averaged 46.33% iron, .098% phosphorus and .030% sulphur. The next 115' averaged 60.80% iron, .141% phosphorus and .021% sulphur and the next 10' averaged 52.00% iron, .132% phosphorus and .027% sulphur. Below this there was considerable lean ore but it was much mixed with rock and no sulphur tests were made. Our tests showed that there was no more sulphur than is usual in Marquette Range ore.

In August a union hole with the Breitung was started on the boundary between the Athens and Lucky Star properties. It was a vertical hole located over the center of the ore body and was drilled to make a test for sulphur similar to the ones already made on two of our old drill holes. It was started with a large bit and double length core barrel, the same as our Jackson hole No.67, in order to keep it straight and permit of casing if necessary. Unfortunately caving ground was encountered at about 400' and casing had to be put in and the hole continued with an "A" bit. Below this point the hole deviated considerably from the vertical and a test at 1045' showed it to be dipping $70\frac{1}{2}^{\circ}$ N. 35° E. There was still a chance that the hole would swing enough to the East so that it would strike the ore body and we decided to drill another 100'. The hole was 1083' deep at the end of the year.

In all, 1872' of drilling were done at the Athens during the year, of which 53' was standpiping and 1819' was drilling with diamonds. There were 122' of first class ore and $106\frac{1}{2}$ ' of lean and second class ore encountered. The total cost of the drilling on this property in 1913 was \$9668.14, of which \$4108.46 was chargeable to the union hole, of which the Breitung will pay their half proportion. There was also \$7703.91 charged to this exploration in 1913 for 1912 taxes.

MEGAUNEE MINE.

Starting late in January, Mr. Elliott drilled two holes on the $6\frac{1}{2}$ level MEGAUNEE mine to drain off the water and sand from some old workings above. The holes were drilled in a Southwesterly direction at an angle of about 20° up and to a depth of 155' and 146'. Nothing but soft ore jasper with a few bands of lean ore was encountered. In all, 301' of drilling was done, of which 10' was lean and second class ore. I have no figures as to the cost of this work.

MICHIGAMME DISTRICT.

SEC.20,48-31,AMERICAN IRON MINING CO. LANDS.

In the spring of 1913, Stephen Lowney sent us a specimen of jasper from a test pit in the $SE\frac{1}{4}$ of this section, stating that he thought the

pit reached ledge and that this specimen from the dump was from the ledge. We therefore decided to have this pit reopened, together with one or two others in the vicinity, to try and determine whether there really was a jasper iron formation at this point. Captain Marks had some men do this work and I afterwards examined the pits. Only one of them reached ledge and that was in black slate, so that the specimen of jasper which Mr. Lowney sent in must have been float. The cost of this work including my traveling expense and expenses of Mr. Lowney locating the test pits was \$60.34.

SWANZY RANGE - GWINN DISTRICT.

STEPHENSON MINE SURFACE.

Work continued on the standpipes between the Stephenson mine and the Escanaba river, which was started in December 1912 to determine whether it was possible that the great amount of water in the mine came from the river. Two more standpipes were sunk on Sections 20 and 29 during January and the drill was then laid off. This work determined that the water level was higher between the river and the Stephenson mine than at the two points mentioned. It is therefore impossible that there could be any movement of water from the river into the mine.

In all, 217' of drilling was done in 1913, of which 197' was standpiping and 20' was drilling in ledge with diamonds. I have no figures as to the cost of this work.

MENOMINEE RANGE.

IRON RIVER DISTRICT.

We continued explorations during 1913 in the Bates district of Iron River. Most of our work was confined to the Spies option, but we also drilled one hole on the Hanson lease, which was later surrendered. We also did some standpiping on the Erickson lease to determine the best site for a shaft and completed the hole which was started in October 1912 to try to find an Eastward extension of the Erickson ore formation on to the Hanson lease.

SEC.21, 43-34, SW $\frac{1}{2}$, ERICKSON LEASE.

Hole No.36, which was drilling at the end of 1912, at a depth of 386', was completed in February at a depth of 1609'. It encountered a belt of ferruginous slate and chert from 1155' to 1368' but it is doubtful if this was the continuation of the main Erickson iron formation. In any case the material was so unfavorable for ore that we decided it was not worth while to drill any more on the Erickson lease with the idea of finding a continuation of the formation. The drill was therefore laid off.

Standpiping continued on the Erickson lease to determine the most favorable site for a shaft and four more short standpipes were sunk besides the one which was started in December 1912. We succeeded in finding a point where ledge was only from 70' to 75' from surface and fairly level. Although there was a considerable distance from the ore body, it was decided to be the only feasible place for a shaft and developments were planned on this basis.

In all, 1733' of drilling were done on this lease during the year, of which 469' was standpiping and 1264' was drilling with diamonds. None of this drilling was in ore or lean ore. This work was all done by contract at a cost of \$11,129.48, including engineering, general expenses, taxes, etc. The contract price was \$3.50 per foot for standpiping, \$3.00 per foot for drilling in ledge to 1000', \$3.50 per foot from 1000' to 1500', and \$4.00 per foot from 1500' to 2000'.

SEC.21, 43-34, NE $\frac{1}{2}$ OF SE $\frac{1}{2}$ & SW $\frac{1}{2}$ OF SE $\frac{1}{2}$, HANSON LEASE.

After hole No.36 on the Erickson lease was completed, it was decided to drill one more hole on the Hanson lease to see if the ore formation crosses near hole No.23, which encountered a few feet of very good ore at ledge with gray slate below. Since it was 400' from the point where ledge was encountered in No.23 to the point where it was encountered in No.15, the nearest hole to the Northwest, we felt that there was a chance of the iron formation crossing the property at that point. A test pit was started the middle of March, 100' North and 100' West of No.23, but progress was slow, being delayed by surface water running into the pit while the snow was melting and also by hard ground.

A drill was finally started in the test pit early in
GEOLOGICAL DEPARTMENT.

May but the hard ground and many boulders made slow drilling and ledge was not reached until early in July. The material was greywacke and gray slate with no sign of an iron formation or ferruginous material of any kind. This hole, taken in connection with hole No.27, showed that there was no considerable width to the ore encountered in No.23 and it was therefore decided to surrender the Hanson lease and the drill was laid off.

In all, 393' of drilling was done on this lease in 1913, of which 368' was standpiping and 25' was drilling in ledge. The total cost of this exploration in 1913 including royalties, taxes, drilling, etc, was \$8,628.66. The drilling was done by contract at \$3.50 per foot for standpiping and \$3.00 per foot for drilling with diamonds.

SEC.22, 43-34, S $\frac{1}{2}$, THOMAS OPTION.

No work was done on this property during the year but we still hold it under option. When we stopped work in 1912 we obtained permission to do so for one year or until the iron business became active. We offered to relinquish the option after the expiration of the year but the fee owners said they would be glad to have us continue to hold the option and bear the property in mind in connection with developments in the district.

SEC.24, 43-35, E $\frac{1}{2}$, N $\frac{1}{2}$ OF NW $\frac{1}{4}$, SE $\frac{1}{4}$ OF NW $\frac{1}{4}$ & NE $\frac{1}{4}$ OF SW $\frac{1}{4}$, SPIES OPTIONS.

Most of our drilling in the Iron River district in 1913 was done on the Spies lands. Two drills were started in December 1912 and both of these continued work during the greater part of the year with a third drill for a short time. Three holes were drilled upon the Northern run of iron formation in continuation of the James mine but were unsuccessful in locating any merchantable ore and showed the formation to be so shallow and lean that further work was not considered advisable. These three holes totaled 1942', of which all but 58' was done in 1913.

Our drilling further South in search of an Eastward continuation of the Sherwood and Virgil mines formation was more successful. The first hole started in 1912 was drilled to a depth of 710' in gray slate

and unoxidized carbonate and the next hole, 400' to the North, was drilled to 170' in the same material. The third hole, however, about the same distance North of the second, encountered jasper and lean ore at ledge and was drilled to a depth of 880', mostly in iron formation. Thirty five feet of ore averaging 56.84% iron and .372% phosphorus was encountered and this was considered encouraging for the location of an ore body in this iron formation. We drilled several more holes, however, before we found any ore worth mining. Hole No.9 encountered a few bands of ore but holes Nos.8, 11 and 12 were blank. Hole No.13 finally struck a little ore at ledge and this was followed up by holes Nos.14, 15, 16, 17, 18, 20 and 22, all of which encountered ore. The only blank holes drilled in developing this ore body were holes Nos.19, 21, 23 and 24. Hole No.25 had just reached ledge at the end of the year. We estimate that we have developed by drilling 245,000 tons averaging 58.65% iron and .462% phosphorus dried at 212° and 60,000 tons averaging 51.34% iron and .487% phosphorus.

Starting in March we drilled two union holes with the Bates Iron Company on the formation which they had already found on their Johnson option which adjoins our Spies option in the Southeastern part. The first of these holes, No.6, encountered 339' of iron formation and was quite encouraging. The next hole, No.10, however, only cut 26' of iron formation, although it was drilled to a depth of 1000'. The results of these two holes, taken in connection with the work by the Florence Iron Company further East, did not seem to justify any further drilling on this formation and both companies decided to lay off their drills at this point.

In all, 10945' of drilling were done on the Spies options during the year, of which 2083' was standpipng and 8862' was drilling with diamonds. There were 724' of this drilling in first class ore and 528' in second class and lean ore. The total cost of the work including general expenses, taxes, etc, was \$29,980.24. The work was done by

Cole & McDonald under contract at \$2.75 per foot except in a few cases where the price was \$3.00 per foot for standpiping in inclined holes where the pipe was over 100' deep.

CRYSTAL FALLS DISTRICT.

SEC.1, 42-33, W $\frac{1}{2}$ OF SE $\frac{1}{4}$, E $\frac{1}{2}$ OF W $\frac{1}{2}$ & SW $\frac{1}{4}$ OF SW $\frac{1}{4}$,

SEC.2, " SE $\frac{1}{4}$ OF SE $\frac{1}{4}$,

SEC.12, " W $\frac{1}{2}$ OF NW $\frac{1}{4}$, SE $\frac{1}{4}$ OF NW $\frac{1}{4}$, N $\frac{1}{2}$ OF SW $\frac{1}{4}$ & NW $\frac{1}{4}$ OF SE $\frac{1}{4}$, SHELDEN OPTIONS.

The line of test pits which was started in December 1912 running S. 30° W. at 100' intervals from the center of Section 12, was continued during January and ten more pits were sunk on this line. They encountered nothing but chert and ferruginous slate, only partially oxidized, and the last five pits could not be ledged on account of water. Another line of eleven pits was sunk running East at 100' intervals from a point a short distance Southeast of the last pit of the first line mentioned. Several of these pits also encountered water and the others encountered the same chert and sideritic slate, partly oxidized. Our test pitting on the Shelden lands was disappointing as we had hoped to find an iron formation close to surface. In all, 175.5' of test pitting was done on the Shelden lands in 1913.

When the test pitting was completed, it was decided to test these lands by diamond drilling and the first hole, No.1 Section 1, was started dipping East on the section line between the Shelden and Neely options. This hole encountered iron formation but was rather unsatisfactory since it ran nearly parallel to the formation for the greater part of its depth. The results of this hole, taken in connection with magnetic work, indicated that there was a fold at this point and that the SW $\frac{1}{4}$ of the SE $\frac{1}{4}$ of Section 1 was underlaid by a syncline of iron formation. Several other holes were drilled on this forty to test this formation. Holes Nos.2, 3 and 15 were shallow holes located on the Southern limb of the syncline and No.17 was a standpipe looking for the North limb of the syncline but was unsuccessful. Hole No.12 was a deep hole located over the center of the syncline as nearly as we could tell and was drilled to a depth of 1500' without encountering anything but unoxidized gray sideritic slate and chert. The syncline mentioned is undoubtedly present

on this forty but the bottom of the fold lies so deep that we decided it was not worth while to try to explore it for ore and hole No.12 was therefore stopped before reaching the iron formation. It is of course possible that the formation is not oxidized on this forty at such a great depth and we did not think the chances were sufficiently favorable to warrant continuing the hole.

Drilling was done on the Shelden lands in Section 12 and three holes were sunk at the most favorable points indicated by magnetic work without finding anything but unoxidized sideritic slate and chert. This drilling was so discouraging that it was decided to relinquish the Shelden options, although this had not been done at the end of the year.

In all, 4823' of drilling were done on these lands, of which 326' was standpiping and 4497' was drilling with diamonds. In all this drilling no first class ore was encountered and only 14' of lean and second class ore. The total cost of the work on these lands in 1913 including taxes, general expense, etc, was \$15,715.78. The drilling was done by Cole & McDonald under contract for \$2.75 per foot to a depth of 1000' and \$3.25 per foot from 1000' to 1500'. In one case where the standpipe was inclined and over 100' deep the rate was \$3.00 per foot.

SEC.12,42-33,N $\frac{1}{2}$ OF NE $\frac{1}{4}$ & NE $\frac{1}{4}$ OF NW $\frac{1}{4}$, NEELY OPTION.

Option was taken upon these lands in 1912 and drilling was started early in January 1913. We located the first hole with respect to the Oliver Iron Mining Company explorations on the forty South and it was drilled through about 700' of iron formation, although it encountered no ore. The second hole, however, encountered 105' of ore averaging 58.53% iron and .319% phosphorus dried and as this was an inclined hole dipping 60° Northeast across the strike it was very encouraging for finding a merchantable body of ore. The next hole, No.3, missed the ore body and it was then determined to test the syncline of iron formation in the Northeast part of the forty, determined by magnetic work. Holes Nos.4 and 6 were shallow holes to locate the East side of the syncline and holes Nos.7 and 9 were then drilled as nearly as possible to the center of the fold. Both were successful in finding a consider-

able quantity of ore, although neither found ore continuous for any great distance. The core from the upper part of hole No.7 was so much richer than the sludge and there seemed to be so many fine grains of sand in the sludge that Cole & McDonald agreed to redrill the upper 200' with the understanding that we should pay for it if the samples checked the first drilling. This second hole was No.7A and showed that as we suspected the samples from hole No.7 were bad and that there was a considerable thickness of ore above 200'. Cole & McDonald therefore drilled this check hole free of charge.

Since we did not find any considerable body of ore in these holes in the syncline, the next drilling was done in the vicinity of hole No.2, which first found ore on the option. Several vertical holes were sunk and they succeeded in tracing a continuation of the ore body to the Northwest and Southeast but showed that its cross-section was comparatively small. The drill was then moved back again into the syncline and drilled hole No.17 midway between holes Nos.7 and 9. No.17 also encountered a small thickness of ore, not far from surface, and we hope to be able to prove up some tonnage at this point, where the ore body seems to be entirely separate from that encountered by No.2.

We estimate that we have developed by drilling 216,000 tons averaging 59.31% iron and .262% phosphorus dried and 30,000 tons averaging 51.12% iron and .121% phosphorus.

Our option expired in December and we were notified by the fee owners that in view of the amount of ore which we have found they would compel us to take a lease instead of renewing the option. This we agreed to do but the papers had not been executed at the end of the year. We are still continuing work with one drill and hope to be able to prove up considerable additional tonnage.

In all, 8327' of drilling was done on this option in 1913, of which 1256' was standpiping and 7071' was drilling with diamonds. We encountered 579' of first class ore and 1058' of lean and second class ore. The total cost charged to this exploration in 1913 including taxes, general expense, etc, was \$23,417.90. The work was done by Cole & McDonald

under contract at \$2.75 per foot.

SEC. 1, 42-33, E₂ OF NE₂, KIMBERLY OPTION.

In September 1912 we were granted an option upon this property by Mr. J. M. Longyear, Agent for the Kimberly Iron Company. The terms were not very favorable and although we paid the taxes for 1912 we did not decide to accept the option and proceed with explorations until early in April 1913. The very first hole that we sunk, No. 4 Section 1, encountered lean ore and jasper at ledge and was stopped after drilling five feet of ore from 105' to 110'. We wished to get control of the Carpenter lands to the East, upon which we supposed we would find the continuation of this iron formation and so moved the drill from hole No. 4 with the idea of going back later. The next hole, No. 5, a short distance Northeast of No. 4, encountered ferruginous slate and jasper, evidently close to the iron formation, and the water so red that we also left this standpipe and moved to hole No. 6. This hole was a considerable distance East and was an inclined hole dipping South with the idea of determining definitely whether the iron formation continued to the East across the forty and if so its exact position. To our surprise and disappointment it encountered nothing but gray slate, although it was drilled to a depth of 819'. At that depth we decided that it was doubtful if the formation continued East and that it would be cheaper to determine this by standpiping on surface than by continuing this inclined hole. By this time we had obtained option on the Carpenter lands and so moved back to hole No. 4 and continued this to the footwall. It passed immediately out of the ore in which it was stopped but continued in rich iron formation with many bands of lean and second class ore and encountered 110' of ore averaging better than 55% iron dried between 440' and 565'. This was very encouraging and several holes, some shallow and some quite deep, were drilled in this vicinity to try to find an extension of this ore body. This drilling was all unsuccessful, although it found a rich iron formation and much lean and second class ore. Standpiping showed that the formation did not continue East across the forty and it became evident that it was

merely a little pinched in fold branching off from the main formation further North. We therefore decided to do no further work, although we were still holding the option, hoping to turn it over to some other company, and obtained an extension to July 1st, 1914.

There were 3990' of drilling done on this property, of which 994' were standpiping and 2996' drilling with diamonds. There were 135' drilled in first class ore and 489' in lean and second class ore. The total cost of this exploration including general expense, taxes, etc, was \$11,952.87. The drilling was done under contract by Cole & McDonald at \$2.75 per foot.

SEC. 6, 42-32, NW $\frac{1}{2}$ & NW $\frac{1}{2}$ OF NE $\frac{1}{4}$,
SEC. 31, 43-32, SE $\frac{1}{2}$ OF SW $\frac{1}{4}$ & SW $\frac{1}{2}$ OF SE $\frac{1}{4}$, CARPENTER OPTION.

When we struck ore on the Kimberly option we immediately applied for option on the Carpenter lands, which are owned by the same parties as own the fee of our Neely option. There was considerable delay in getting in touch with all the fee owners. The option was dated April 28th but the papers were not finally executed and returned to this office until about the 1st of July. By that time we were fairly sure that the iron formation did not continue East on to these lands on account of further drilling on the Kimberly, but we sunk three shallow standpipes in July and August to make certain. Nothing but gray slate and unoxidized carbonate was encountered and the option was relinquished early in September.

There were 392' of drilling done on this option, of which 317' was standpiping and 75' was drilling with diamonds. No iron formation was encountered. The total cost of this work including general expense, etc, was \$1355.50, the drilling being done by Cole & McDonald at \$2.75 per foot.

CUYUNA RANGE - MINNESOTA.

AITKIN COUNTY DISTRICT.

The State of Minnesota notified us during 1913 that if we wished to continue to hold our state leases in Aitkin County we must conduct explorations according to the terms of the leases. Two drills were therefore started on portions of these leases late in October, the expense of the work being borne by the Cleveland-Cliffs Iron Company two thirds and S. P. Snider one third.

SECTIONS 24 & 36, 50-23.

Starting at the center of the South half of Section 24, three standpipes were sunk on a North-South cross-section to look for the Cuyuna Range iron formation which in general runs a little North of East. These standpipes all encountered a green slate which seems to be the usual country rock in the vicinity. A fourth standpipe Northwest of the first had not reached ledge at the end of the year.

On Section 36, three standpipes were ledged on a cross-section running Southeast from the center of the section and a fourth standpipe was sinking at the end of the year. The first two standpipes on this section encountered soft dark gray or black slate and the third green slate the same as Section 24. The gray slate in the first two holes on this section may not mean anything but we intend to sink a standpipe between holes Nos. 2 and 3 as the iron formation might possibly come at the contact between the gray and green slates.

In all, 1194' of drilling were done on these leases during the year, of which 1066' was standpiping and 128' was drilling. The total cost of this work was \$1998.47, of which our share was \$1325.65. The drilling was done by the Duluth Diamond Drilling Company under contract at \$2.00 per foot for standpiping and \$2.25 per foot for drilling in ledge.

EXPLORATIONS OF OTHER COMPANIES.

Ernest Allen continued to visit all explorations of other companies in Michigan and Wisconsin and the maps were kept up to date in the same way as in 1912. We also started an index of these explorations in the form suggested by Mr. S. L. Mather. The work of visiting outside ex-

plorations in 1913 cost \$1160.21, of which \$658.02 was for Allen's salary while engaged in this work and the balance was traveling expenses.

STATEMENT OF CHARGES TO GEOLOGICAL DEPARTMENT FOR 1913.

Salaries	-	-	-	-	-	-	-	-	-	-	\$15,443.54
Travel	-	-	-	-	-	-	-	-	-	-	100.43
Supplies	-	-	-	-	-	-	-	-	-	-	1,344.31
Miscellaneous	-	-	-	-	-	-	-	-	-	-	95.71
Expenses of H.L.Smyth, i.e. travel, supplies & miscellaneous											1,016.80
Visiting outside explorations	-	-	-	-	-	-	-	-	-	-	1,160.21
Geological surveys Crystal Falls and Amasa districts											2,557.83
Geological survey American Iron Mining Co. lands											648.23
Total											<u>\$22,367.06.</u>

The above item for supplies is too high as it includes many items bought for the Engineering department and charged by mistake to the Geological department. In the future more attention will be paid to this and supplies designed primarily for either department will be charged to that department, supplies used jointly by the two departments being charged one third to the Geological and two thirds to the engineering department. I have not the complete figures for the cost of explorations in 1913 but presume that they will be included in the annual report of the Auditing department.

ANNUAL REPORT
OF THE
SAFETY DEPARTMENT.
(1913)

Organization

Employes and committees. There were employed in the Safety Department in 1913 a clerk, a first aid and mine rescue foreman, and a safety inspector. All of the company's mines in Marquette county were inspected by two foremen committees and two workmen committees, and the surface equipment by a special committee on mechanical appliances. The Central Safety Committee held a meeting each month of the year.

Clerical work. The clerical and stenographic work of the department was performed by J. D. Lundin, who was employed in 1911. He makes copies of all personal injury accidents, filing a copy of each accident with the Pension Department and a copy in the office of the Safety Department. It is his work to examine and file the following reports, which are forwarded from the mines: cage rider's daily report, daily report of inspection of hoisting ropes, weekly report of inspection of ladder ways and shaft stations, monthly report of testing cage safety catches and quarterly report of testing fire hose. Failure to receive a report promptly or the reporting of a violation of a safety rule or unsafe condition is noted and called to the attention of the safety inspector. In addition, Mr. Lundin has done considerable stenographic work for the Educational Department and Superintendent Eaton.

Mine Rescue and First Aid Work.

Mine rescue and first aid to the injured training was under the direction of the safety inspector during January but since Feb. 1st it has been under the direction of J. H. Williams. Mine rescue training is a very important part of the department and the maintenance of the apparatus in perfect working order for actual operation is absolutely necessary if it is

to be of any value to fight a mine fire. In order to inspect each mine monthly and also give first aid mine rescue training, it was found necessary to ask the rescue men to practice after their day's work at the mine was over. Such practices did not receive the approbation of all the men nor did they give satisfactory training especially when it became generally known that there were mining companies on the range that were allowing a full shift for a two-hour practice. To encourage our crews and to assure competent training, the Company decided to allow one half a shift for a two hour practice, which should be held from one to three o'clock. The crews are required, however, to spend the entire afternoon shift when they over-haul and test their apparatus.

Mine rescue equipment. The breathing apparatus for the mines in the Ishpeming and North Lake districts are kept in a room in the north-east end of the Cliffs Shaft mine warehouse. A hardwood floor was laid in this room and the walls and ceiling were lined with Hemlock flooring. As the rubber parts of the apparatus deteriorate rapidly and the cost of replacement is high, they are stored in a zinc-lined cabinet, from the bottom of which water is permitted to evaporate. The Negaunee equipment is kept in the Negaunee mine ambulance room, and is also stored in a cabinet. These cabinets were made sufficiently large to hold five apparatus, in case the time should come when more apparatus would be maintained. The Gwinn district equipment is kept in the basement of the Central office, where the temperature is such that a cabinet is not required. In Table I is given a list of the supplies, repairs and additional equipment which were purchased in 1913, their valuation and distribution.

Table I.

<u>Supplies</u>	<u>Valuation</u>	<u>Distribution</u>
300 Potash cartridges	\$330.00	All mines.
10 Storage tanks of oxygen	57.00	8 Ishpeming; 2 Gwinn.
Total	387.00	

Table I. (continued)

<u>Repairs</u>	<u>Valuation</u>	<u>Distribution</u>
2 Breathing bags	\$ 34.00	Ishpeming station.
1 Pump valve	4.00	Gwinn "
2 Repairs reducing valves	10.56	Ishpeming and Gwinn stations.
6 Rubber air pumps	11.21	All stations.
3 Cushions for helmets	18.31	" "
1 Measuring bag	4.19	Ishpeming station.
Paint and brushes	1.00	" and Negaunee stations.
Total,	83.27	
<u>New Equipment</u>		
2 Pulmotors	305.00	Maas and Chase mines.
1 Face mask (Adult)	10.13	Ishpeming station.
2 " " (Child)	20.24	" and Gwinn stations.
5 Jaw openers	12.50	All stations.
2 Inhalation bags	1.50	North Lake mines and Gwinn station.
1 Oxygen storage tank	42.00	Ishpeming station
1 Mouth breathing attachment	17.76	" "
1 Electric lamp	4.26	" "
Miscellaneous tools	1.00	" "
Total	414.39	
Grand total,	\$884.66	

Training.

Rescue Teams. A rescue team of three men were ^{trained} throughout the year at each mine. When it was not convenient for a member of a team to participate in a practice, a member of the 1912 team was usually substituted. Monthly practices at the mines were supplemented by training under the auspices of the Bureau of Mines Rescue Car No. 8, which was here in September, spending a week each at Gwinn, Negaunee, Ishpeming and North Lake. There were ten teams organized and all of them continued training the entire year.

First Aid Teams. Ten first aid teams, representing fifty workmen, completed our course in first aid training, and all of them will be given the Company's First Aid Certificate. The teams were trained monthly at the mines, from three to five o'clock, and in addition were trained a half a day for one week by the Bureau of Mines first aid foreman, who received his first training from the Company when he was an employe of the Stephenson mine.

The 1912 first aid teams of the Negaunee, Ishpeming and North

Lake mines gave an exhibition of their work for the benefit of the public at the Ishpeming Y. M. C. A. in January. The Ishpeming teams, by invitation, gave a public exhibition of first aid and mine rescue work during the Fourth of July Home Coming Week. On December 5th a first aid contest, in which all of the 1913 first aid teams participated, was held in the General Office. Drs. Felch and Vandeventer and Mr. C. S. Stevenson were judges. The Maas mine team won first place, Stephenson mine was second, and the Chase and Negaunee mine teams were tied for third place. A neat watch fob, on the face side of which are engraved the Company's "C. C. I. Co." monogram and the words "Safety First", and on the opposite side "Awarded to First Aid and Rescue Men", has been presented to the members of the 1912 and 1913 teams.

Table II.

Showing the number of fire helmet and first aid practices by mines and the total number of men receiving training.

Mine	<u>Fire Helmet</u>		<u>First Aid</u>	
	No. of Practices	No. of men	No. of Practices	No. of men
Austin	14	6	14	7
Chase	14	9	14	7
Cliffs Shaft	14	8	15	5
Gwinn	1	3	0	
Lake	14	9	15	5
Maas	14	8	16	5
Mackinaw	0		2	5
Negaunee	15	9	15	5
Morris-Lloyd	15	9	14	7
Princeton	15	8	15	9
Salisbury	14	9	16	5
Stephenson	15	10	15	5
Total	145	88	151	65

Average attendance per fire helmet practice 3; per first aid practice 4.

There were 34 men who completed the company's first aid course in 1912 and 48 in 1913. Of these men, two have left the company's employment and one was killed, thus leaving 79 first aid men in and about the various mines.

Table III.

Showing occupation and nationality of first aid and mine rescue men now in the company's employment.

<u>Occupation</u>	<u>First Aid</u>	<u>Mine Rescue</u>	<u>Nationality</u>	<u>First Aid</u>	<u>Mine Rescue</u>
Shift Boss	21	15	English	26	13
Miner	21	17	American	16	13
Surface Foreman	5	0	Scandinavian	14	8
Timberman	5	5	French	10	3
Sampleman	5	0	Finnish	7	3
Electrician	3	3	Italian	3	6
Pumpman	3	2	Irish	2	
Clerk	2	0	Austrian	1	
Fireman	2	0			
Trackman	2	3			
Blacksmith	2	0			
Laborer	2	0			
Captain	1	0			
Machinist	1	0			
Motorman	1	0			
Cageman	1	0			
Skip Tender	1	0			
Trammer	1	1			
Total	79	46		79	46

Table IV.

Showing approximate cost of a practice in first aid work and also mine rescue work.

<u>1 - 2 hour First Aid Practice of 5 Men.</u>		<u>1 - 2 hour Mine Rescue Practice of 3 Men.</u>	
5 - 1/4 shifts @ \$.75	- \$3.75	3 - 1/2 shifts @ \$1.50	- \$4.50
1/2 shift training foreman	- 2.00	3/4 shift of training foreman	- 3.00
Total	5.75	3 Potash cartridges @ \$1.20	- 3.60
		3 Cylinders of Oxygen @ \$.35	- 1.05
		Total	\$12.15

Actual Mine Rescue and First Aid work. The mouth breathing apparatus was not used during the year other than for training. There were, however, two underground fires, one in the Princeton mine in July, and one in the Salisbury mine in November. The Princeton mine fire originated in the "motor barn" and was probably caused by an exposed electric wire. It was the practice, when repairing a motor, to use a light, which was attached to a long piece of loose wire and when it was not in use to hang it to a nail driven in a nearby leg. The insulation gradually wore off, and the exposed wire is supposed to have touched the leg, which may have been dry and splintery, as they are frequently found to be. When the fire

was discovered, Capt. Jory immediately investigated and experienced little difficulty in extinguishing it. He encountered considerable smoke which caused him to stumble into the motor pit. Fortunately his injuries were slight, causing him but a few days idleness.

That there was a fire in the Salisbury mine was found by workmen on Monday morning, Nov. 3rd, as they entered the 8th level main drift. It was located in a smoldering condition, at a switch where there were but three sets of timber. Beyond this switch are a number of large stopes which afforded an avenue of escape for most of the smoke and gases. The limited amount of timber and its damp condition undoubtedly prevented a serious fire. As it was, many of the workmen became ill before their day's work was over by the small amount of smoke that was found in their working places. It was the opinion of Capt. Dunstan and his bosses that the fire was started by a workman casting aside a lighted candle stub while enroute to the shaft station late Saturday night and that the fire had smoldered over Sunday.

The pulmator was used effectively several times the past year. It proved valuable in assisting to revive a Stephenson miner who had been recovered in almost an unconscious condition. Victor Erickson, a Negaunee mine first aid man, worked this apparatus forty minutes upon an employe who had been knocked out completely by inhaling gases which were generated by blasting. At the Cliffs Shaft, Chase and North Lake mines it has been found useful on more than one occasion to stimulate workmen who were suffering from powder smoke and gases. On the other hand it proved futile when it was used in efforts to revive Chas. Sackrider, who was electrocuted at the Maas mine, and also when applied to a young lad who was drowned in a nearby pond. In each of these instances, however, a physician had pronounced the victim dead before the pulmator was used.

We have no record of the first aid work that has been rendered by our trained men, but this information is now being received through the revised form of personal injury reports that was adopted recently. We have

not received as much service as should have been rendered, not because of a reluctance by first aid men but rather because many injured men have spurned proffered aid and also because their aid has not always been available. These conditions will be eliminated steadily by the educational effect of the service that is being given and by an increasing number of first aid men at the mines.

SAFETY INSPECTION.

The company's system of safety inspection for the past year was conducted along the same plan as that of the two previous years, namely, inspections of all places where workmen are employed by the inspector and committees and reporting the conditions found in accordance with the report form as adopted in 1911.

Safety Inspector. The office work of the department demanded more attention in 1913 than previously, but as the training of first aid and rescue corps was placed in charge of an assistant, the inspector has been able to devote more time to inspection of mines than was given in 1911 or 1912. There were 112 safety inspection reports made for the year, of which 69 were made by the inspector. He accompanied the foremen and workmen committees on their tours to all mines, with the exception of the last foremen's inspection of the Salisbury and Maas mines, at which time the accident at the Crosby mine, which killed three men, was being investigated. The inspector's reports frequently represented two or three underground trips during a month as special attention has been given to such dangers as motor-tram riding, cage riding, use of explosives, etc.

The inspector investigated and reported on all the fatal accidents of the year; many of the more serious ones were investigated, and also such of the minor ones which might have indicated a laxity of enforcement of the company's rules. He attended all the meetings of the Central Safety Committee, and was appointed a member of several of its committees which demanded investigation of working conditions as found in other mines. By invitation of Mr. C. E. Pettibone, Safety Inspector of Pickands, Mather & Co., he visited the Verona Iron Company's mines at Iron River and spent two

days in inspecting that company's safety methods. Our mines in turn were visited by safety inspectors representing the Bureau of Mines, and the Republic Iron & Steel, M. A. Hanna, Verona and Copper Queen Consolidated companies.

Foremen Committees. The members of the foremen committees were chosen from among the shift bosses who had not already served in this capacity. The first committee was composed of John Freethy of the Lake mine, Wm. Nault of the Morris-Lloyd and Wm. Johns of the Stephenson. Its tour of inspection was made from April 1st to the 14th. Shift bosses R. E. Carlyon of the Chase, Henry Henrickson of the Maas and Chas. Hocking of the Princeton were selected for the second committee, which inspected the mines from Oct. 13th to the 24th.

Workmen Committees. The first inspection by workmen committees was made from June 13th to July 9th, and the second was from December 11th to the 31st. The same mines were inspected by these committees as were inspected by the foremen committees with the exception of the Austin mine, which was closed during the period between the last inspections of the second committees. The workmen committees represent 57 workmen of whom 16 were Finnish, 15 Italian, 14 English and 12 Scandinavians.

Table V.

Showing the number of shift bosses and workmen by mines, who have served on safety committees.

Mine*	Shift Boss	Workman
Austin	1	12
Chase	1	9
Cliffs Shaft	2	15
Lake	2	15
Maas	2	9
Morris-Lloyd	1	15
Negaunee	2	15
Princeton	1	9
Salisbury	2	15
Stephenson	1	15
Gwinn	0	6
Total	<u>15</u>	<u>135</u>

*Operated mines 1913.

Central Safety Committee. This committee met twelve times during the year, with an average attendance of 8 from a membership of 10. All accidents of the year were classified and special consideration was given to such safety matters that were of more than ordinary importance or the expediency of which brought out a difference in opinion. The safety measures which the Central Safety Committee recommended and which were approved by the Agent are outlined under the heading of safety devices but no mention is made of those recommendations of individual members of the committee, the safety inspector, the foremen or workmen committees, which did not receive approbation.

SAFETY DEVICES.

Safety Rules. The company's book of safety rules has been given to each employe that has entered the employment since May 1912 and at the close of 1913 there have been about 6,000 copies given out; English, 2,500 copies, Finnish, 2000 copies and Italian, 1500 copies. It is the usual practice to hand a copy to every man who is given a job regardless of the fact that he may have received a book at some other mine. As there are many workmen who roam from one mine to another they are apt to accept the distribution of the Safety Rules with slight regard and thus by communication with their fellow workmen this custom may not prove as effective in its results as it should be. To guard against this danger the safety inspector suggested that our employes should be examined to test their familiarity with the rules that related to their individual work. The Central Safety Committee recommended that before an examination should be given that a blank form should be given to each employe upon which he should acknowledge receiving a copy of the rules and state whether he had studied and had become familiar with them. A committee was appointed to prepare the form.

Special rules were adopted requiring the testing of fire hose equipment at regular intervals and reporting the tests; the testing of cage safety catches monthly in the presence of either the superintendent

or mining captain; and the daily examination and reporting of the condition of hoisting ropes. The cage rider's daily report and the ladder inspector's weekly report were both revised, which included definite rules governing the operation of cages and the inspection of ladderways.

Safety Admonitions. The Agent instructed the Central Safety Committee to consider the advisability of distributing safety admonitions or warnings to employes, a practice which is in vogue in some parts of the country. The Committee heartily approved of the practice and appointed Mr. Moulton and the safety inspector a committee to carry out this work. It was recommended that at first brief but effective admonitions could be given to each employe, once a month with his due bill, and that later on it might be advisable to issue a small pamphlet, with illustrations, once in three or more months. The committee prepared several cards which would be given to employes beginning with the New Year.

Safety Cigars. As the recommendation of the Central Safety Committee that "Safety Cigars" be distributed each month to the employes of the mine having the lowest accident rate was approved, the accident rates of all mines were computed monthly, charts were published and cigars given to the winners. It was decided by the Central Safety Committee that all accidents should be considered but that no accident should represent a loss of more than 30 working days; in case of a fatal accident, the mine would be eliminated for that month. In order to present a chart that would command attention it was decided to use heavy lines to represent a comparison rather than numbers. By the scale used, a line 2 1/4 inches long represents one quarter of a shift loss during the month by every employe, but the scale is not given on the charts for fear that many workmen may conclude that the loss, which occasionally represents their mine and which eliminates them from winning, is so slight that it is almost useless to endeavor to do better. The winners so far are Salisbury - 5 times, Maas - 2 times, Morris-Lloyd - 2 times, Gwinn - 2 times, Negaunee - 1 time and Chase - 1 time. The cost of distributing cigars is given under the cost

statement which appears in this report.

Surface Openings. The company owns considerable land in the vicinity of Ishpeming and Negaunee, much of which was prospected in the early days by test pits and shafts. Most of these openings were protected but with the lapse of time the fences yield and require repairs. Attention was called to bad conditions at Iron Cliffs, Union Park, Nelson and Dead River, and by order of the Agent these pits were repaired promptly by the Mechanical Department.

At our operative mines there are open pits or caved areas at the Lake, Salisbury, Morris-Lloyd, North and South Jackson, Negaunee, Stephenson and Princeton mines. Fences around these pits and caves were kept in repair last year with the exception of the Negaunee mine caved area, which Supt. Elliott decided was not necessary to maintain. Most of the caves, however, have steep walls which exposed wandering cattle to danger. It is a statute of the State that these openings must be protected and the company has complied with the law so far as the inspection of this department has been able to ascertain.

Roadways. Notices have been placed on the "short-cut" tracks over the hills to the Lake and Salisbury mines, which call to the attention of pedestrians that those tracks are not public highways. Railroad crossing signs have been erected at crossings alongside the Lake mine Transfer Building and the Salisbury shaft, where there are abrupt passageways from alongside of buildings across tracks. At the Stephenson mine it was the practice of workmen to use a "short-cut" over a piece of ground that was undermined but had been fenced off. One morning last spring there was a large cave, which dropped away a few minutes after several men had passed over it. Large notices, warning employes against using this trail, have combined with the effective result of the cave to stop workmen from using this perilous passageway. The main highway into the Lake mine has had a number of electric lights swung along it at reasonable distances apart and at the Salisbury a light has been placed at the top of the stairway

leading into the pit and also one at the rock and Clinton ore pile dumps.

Shops and engine-houses. All of the moving machinery in the new machine shops at the Negaunee mine has been equipped with safety devices of the best design. A number of improvements have been made in protecting fly wheels that are worthy of mention. Prior to 1913 the large fly wheels of the steam-driven air compressors at the Lake, Maas and Cliffs Shaft mines were protected by a single guard rail. The passageways around these wheels are narrow, and in addition the engineer of each plant was exposed to danger when filling the oil cups of the main shafting. These dangers have been eliminated at the Maas and Lake mines by a heavy wire hood which encloses the revolving wheel to a height of six feet. A similar device has been placed around the fly wheel of the new compressors at the Negaunee mine and one has been recommended for the Cliffs Shaft mine compressor. The fly wheels of the transfer engines at the Stephenson, Lake and Maas mines are also equipped with the same safety device. There have been many other guards installed during the year at the various mines in order to have all new equipment up to the standard which has been established by the safety work of 1911 and 1912. The new machinery at the Salisbury, North Lake and Gwinn Central Power Plant has required the most work to safeguard but there has been more or less work and expense involved at all mines.

It was decided by the Agent that when two men are employed in an engine house at the same time they must both be at the hoist when men are handled in the cage but in case only one man is employed it shall not be necessary to provide a second man. It was also decided that no brakeman should be permitted to work more than two consecutive shifts. An overwinding device for electric hoists was made by the Mechanical Department and tested at the Morris shaft. It proved very effective and has been recommended for all of the electric hoists. An oil lamp, which shall be kept lighted during darkness, must be maintained at all hoist indicators so that they will not be in darkness in case the electric lights happen to fail when men are being handled. These precautions have been adopted for the safety of handling employes into and out of the mines.

Pyrene fire extinguishers have been placed in all of the engine house buildings. These extinguishers are highly recommended for fighting electric fires, and on this account they are a valuable adjunct in transformer and other electrical equipped buildings. Since the purchase of these extinguishers two fires have been put out by using them, one in the Hard Ore transformer building and another in the Salisbury mine engine-house.

Boiler Houses and Coal Docks. The passageways at both floors to coal elevator shafts in the Maas, Stephenson and Cliffs Shaft boiler rooms were equipped with gates that work automatically with the elevator. The Lake boiler plant has been provided with safer manway, additional lights and a second ladderway. The tramway between the coal-dock and boiler house at the Salisbury was repaired, making it much safer. The manways on top of all coal-docks have a guard railing to prevent employes from slipping or falling off.

Top Tram. Special attention has been given to the working places between the top tram and sheaves in shaft houses, where they are many openings to shaft compartments. Safer conditions have been made by providing permanent ladderways, platforms with railing, and by closing openings into shaft compartments. At the Negaunee mine top tram, the oiler must first notify the transfer engineer before he goes out upon the trestle to oil and, as an extra safe guard, he is required to place a large sign at the end of the permanent trestle, which is a constant reminder to the engineer that the oiler is on the trestle. Notices have been posted on the Stephenson top tram and in the transfer house instructing oilers to notify engineers before oiling, during which period haulage cars must remain idle. At the Salisbury top tram, where the car runs out by gravity and is pulled in by an air puffer, several accidents have been caused by the workmen projecting their feet so that they struck against the pulleys, which directs the course of the rope. A larger foot board has been provided and special instruction has been given to the workmen to be more careful for the prevention of similar accidents.