720 N., 1950 W. Sp. Wt. 1.008. Cl strong, SO_4 strong. A. T. 620. Depth to rock 140 feet, total depth 300 feet. Geo. Hofmeister. The water rose more than 10 feet above ground until the coal mines began to work. Good water was found at 180 to 200 feet, then became salty.

500 N., 1460 W. Cl low, SO_4 low. A. T. 620. Depth to rock 128 feet, total depth 266 feet. A. Armbruster, owner. This well was cased for 128 feet. Some coal was found in it but mostly hard rock or sandstone.

420 N., 50 W. Cl low, SO_4 low. A. T. 620. This well was cased for 67 feet and is 80 feet deep.

740 N., 50 W. Cl tr., SO_4 trace. A. T. 620. This well is 136 feet deep and a trace of coal was found in the sandstone.

1500 N., 50 W. Cl low +, SO_4 med. A. T. 620. Depth to rock 70 feet, total depth 105 feet.. This well "showed coal."

Section 30.

750 N., 150 W. A. T. 620. Owner, H. Irion; Chas. J. Hofmeister, Jr., driller. This well cost 50c a foot (5% off for cash), and 35c for casing.

The water is quite hard and can be lowered, by pumping, to 23 ft. below surface. It rose at first to 14 feet below surface, and is used for house and cattle.

RECORD FROM SAMPLES OF DRILLINGS.

	Feet.
Struck quicksand at	23
Blue clay	32 to 50
Quicksand and gravel	50 to 150
Rock at	150
Mainly sand (this is doubtless sand and the next is dolomite)	160 to 164
Impure sand, angular, dolomitic	164 to 166
Arenaceous dolomite, pyritiferous with speck of feldspar	166 to 180
Clean gray quartz, sandstone	188 to 191

350 N., 1000 W. Sp. Wt. 1.003. Cl med. +, SO_4 strong. Depth to rock 95 feet, total depth 202 feet. This well used to flow.

Section 31.

300 N., 1950 W. No. 1, Brackish, SO_4 strong, Sp. Wt. 1.007. Depth about 200 feet. No. 2, said to have been not salty originally. It is now stopped up. Depth about 150 feet.

Section 32.

640 N., 1950 W. Cl tr., SO_4 low. A. T. 620. Depth 150 feet. This well is cased for 120 feet.

1460 W., 1950 W. Cl low, SO_4 low. A. T. 620. Depth 165 to 175 feet, cased for 140 feet. The rock is said to be mainly hard stuff, probably limestone.

1400 N., 50 W. A. T. 620. Depth 125 feet.

1600 N., 50 W. A. T. 620. Depth to rock 64 feet, total depth 135 feet. This is a flowing well. T. 51½° F.

140 W., 50 N. Depth to rock 73 feet, total depth 118 feet. Strong flow five feet above ground.

Section 33.

1800 N., 880 W. Cl tr. SO_4 low. A. T. about 625. Depth to rock 73+ feet, total depth 105 feet. This well was at first drilled to 81 to 85 feet and afterwards deepened 20 feet. It was 8 feet in sandstone at first. Flowing well, T. 50½°.

1950 N., 1320 W. Cl low, SO_4 trace. Depth 105 feet. The temperature of flow is 52° F.

1780 N., 50 W. Depth 72 feet. A. T. 627 feet. This well is drilled and used to flow.

50 N., 200 W. Depth 72 feet. Water rose to within three feet of surface.

50 N., 720 W. Depth 64 feet. Water rose 4 feet above surface.

600 N., 1950 W. Depth 96 feet, cased 61 feet. Water tastes free from mineral.

800 N., 1950 W. Depth 126 feet.

Section 34.

50 N., 1160 W. Cl 0, SO_4. Fred Sting, owner. A. T. 629. This well was sunk 59 to 60 feet in quicksand, and the water rose 2 feet above ground. T. 54° F.

760 N., 50 W. Cl low, SO_4 med. Depth to rock 88 feet, total depth 205 feet. A. T. 632.

1120 N., 50 W. Cl low,— SO_4 med.+ Depth 280 feet (?).

1720 N., 50 W. Cl trace, SO_4 trace. Depth to rock about 64 feet, total depth 188.

1900 N., 50 W. Cl trace, SO_4 trace. This well is 132 feet deep, cased to 58 feet. Water rose to 10 feet below surface. A. T. 632 feet.

50 N., 260 W. Cl trace, SO_4 low. A. T. 631. This well is more than 100 feet deep.

1700 N., 1950 W. A. T. 627. Depth of well 75 feet. This well used to flow.

The wells of this section are divided into two groups, one (a) drawing water from the subcarboniferous limestone at from 58 to 100 feet, the other (b) from the

Napoleon or Upper Marshall sandstone from 150 to 200 feet down. The latter pass through dolomitic shales of the Michigan Salt Group and these not being cased off give a somewhat gypsiferous water.

Section 35.

400 N., 1950 W. Depth to rock 80 feet, total depth 202 feet. A. T. 632. C. J. Hofmeister, driller, for Christ Deeg, owner.

900 N., 1950 W. A. T. 632. Depth to rock 62 feet, total depth 192 feet. Jacob Sting, owner. Cased two feet in rock and one foot above ground.

RECORD FROM SAMPLES.

Pleistocene	0 to 18	Hardpan.
	18 to 60	Blue clay.
	60 to 62	Gravel.
Upper Grand Rapids	62 to 66	Yellow dolomite.
	66 to 72	Greenish grey shale.
	72 to 80	Grey micaceous sandstone.
	80 to 85	
Michigan series or Lower Grand Rapids	85 to 90	Dolomitic. Shales somewhat pyritiferous and arenaceous, dull grey.
	96 to 100	
	100 to 105	
	112 to 120	
	120 to 125	Impure grey sandstone with some pyrite and calcareous matter.
	126 to 128	
	129 to 130	
Napoleon sandstone	130 to 132	White sandstone, clearest at 150-160 (glass sand).
	132 to 136	
	136 to 140	
	140 to 145	
	150 to 160	
	160 to 167	
	191 to 192	Somewhat impure calcareous sandstone.

Brookfield township (T. 15 N., R. 10 E. L.).

Section 1.

50 N., 540 W. Cl low, SO_4 med. A. T. 649. Total depth 62 feet.

Section 2.

1950 N., 660 W. A. T. 648. Total depth 185 feet.

Section 3.

1950 N., 1320 W. SO_4 low, Cl low. A. T. 645. Depth to rock 135 feet, total depth 235 feet. Fritz Matz, owner; driller, W. Smith. Mainly blue clay (sample taken), chips came from the boring at 130 feet.

Section 5.

1050 N., 1900 W. Cl low, SO_4 trace. A. T. 632. Frank Smith, owner. Depth 138 feet.

940 N., 1950 W. Cl low, SO_4 mod. Depth 122 feet. L. Wisner, owner; J. P. Russell, driller. Sept. 13, '95.

	Thickness.	Depth.	
Red clay	13	.....	Pleistocene.
Blue clay	52	65	
Hardpan and boulders	8	73	
Sand and gravel	2	75	Grand Rapids group.
Shell slate	2	77	
Hard slate	12	89	
Soap rock	3	92	
Hard slate rock	6	98	
Dark sandrock	2	106	
Soap rock	2	108	
Hard dark sandrock	2	110	
Soft white rock (gypsum?)	5	115	
Very hard sand rock	2'6"	117'6"	
Water sand rock	12'6"	130	

Section 6.

1000 N. W., along diagonal road, i. e., 707 N., 707 W. Trace SO_4, Ca low, Cl med., strong Fe taste. Depth to rock 64, total depth 165 feet.

Depth 127 feet. George Kundinger's well, Kilmanagh, P. O. drilled by J. Russell. July 15th, 1896.

DRILLER'S RECORD.

	Thickness.	Total.
Clay	55	55
Hardpan	3	58
Loose dark rock	4	62
Hard clay rock	4	62
Hard dark rock	5	67
Hard dark rock	6	73
Dark lime rock	25	98
Sandy fire clay..	4	102
Hard sand rock	4	106
Soft sand rock	21	127

1000 N., 1120 W. SO_4 medium, Ca medium, Cl strong trace. A. T. 632. Total depth 65 feet, a few feet in rock.

50 N., 1280 W. Cl low, SO_4 med. Depth to rock 65 feet, total depth 65 feet. Few feet in rock.

950 N., 1220 W. Cl trace, SO_4 strong. Total depth 65 to 70 feet.

Section 7.

1950 N., 1950 W. Cl trace, SO_4 med. A. T. 630. Total depth 76 feet.

1825 N., 1950 W. Total depth 100 feet.

N. W. of N. W. Total depth 140 feet. Cl low, SO_4 trace. Much less hard than the dug well, water came at 95 feet. 69 feet of casing, well extends about 20 feet in grey sandstone. Owner, A. Dreher.

680 N., 1700 W. Cl low, SO_4 trace. At about 80 feet first water was struck, it was cloudy and rose to five feet below surface and was very abundant. Owner, Carl Jahnke.

350 N., 1950 W. Cl trace, SO_4 med. Water at 80 feet. Total depth 99 feet. This well does not reach sand rock, but is in blue soap rock.

Section 8.

1000 N., 900 W., 1480 W. on diagonal road, trace SO_4, trace Ca, at Cole's saw mill. Cl low, Fe present. A. T. 640. This well has about 83 to 85 feet casing and is 160 to 165 feet deep.

Section 10.

SO_4 strong, Ca med., Cl low. A. T. 650. Owner, J. D. Durand. Depth to rock 41 feet, total 51. This well had a slight flow.

Section 11.

SO_4, light trace D. Ca trace, Cl low. A. T. 651. This well is at Owen's farm house and is 180 feet deep.

Section 13.

220 N., 50 W. Cl 0, SO_4 0 D. A. T. 676. Depth about 30 feet to rock, total 102½. The well passed through flintrock first and then mainly sandrock. There was about two feet of rock before striking water.

210 N., 40 E. A. T. 676. Depth about 64 feet. This well went about 64 feet in surface material before it came to sandrock. The wells are near by and belong to the same owner.

Section 14.

About 1900 N., 1400 W. Ca low, Cl low, SO_4 tr. A. T. 650. Depth 170 feet. Temperature 48°. This is a flowing well at saw mill, Owendale, but the pump is not working. Same data also apply to another well at saw mill.

2000 N., 1060 W. SO_4 trace, Ca low, Cl medium. A. T. 650. Well at hotel.

660 N., 950 W. Depth 45 feet. This well once flowed, and had 4 foot head.

280 N., 1050 W. Depth to rock 56 feet, total depth 70 feet. Owner, Mrs. Carver. This well is in hard and soft blue rock, and water rose close to the surface.

800 N., 950 W. A. T. 655. Depth to rock 38 feet, total depth 53 feet, McArthur's well.

700 N., 1050 W. A. T. 655. Depth to rock 40 feet, total depth 43 feet. Owner, S. Good. This well is in soft rock, chips were struck at about 15 ft. in boring well. The water is good for washing.

T. Davis' well has total depth of 107 ft. Water was struck at 70 feet.

Section 15.

200 N., 1050 W. Depth to rock 54 feet. Owner, J. Ross. This well flows, and has a five foot head.

50 N., 520 W. Depth 33 feet. A. T. 644. This well used to flow and had 1½ foot head at first but stood just at the surface in the fall of 1897. The water is hard. Owner, F. Carson.

N. W. part Shufeldt's. Flowing well.

800 N., 900 W. Total depth 60 feet. Flow with one foot head. T. Welch. Struck in gravel.

Section 21.

J. Finkel's well 60 feet deep, struck in gravel the water.

Section 22.

1950 N., 260 W. A. McKenzie's well. Dug 10 and bored 40 more feet, flows. Ca medium.

Section 23.

1250 N., 1900 W. Total depth 60 feet. Taylor's well, flows, in drilling were black lumps like coal.

1160 N., 1000 W. Depth to rock 47 feet, total depth 51 feet. Sandstone water. This is a drilled well. A. T. 613.

Section 24.

0 N., 120 W., Sandstone water. This is a drilled well.

Section 26.

720 N., 720 W. This well was hand drilled and used to flow

1180 N., 1000 W. Depth to rock 50 feet, total depth 65 feet. A. T. 670.

This well is in sandstone, the pipe was cut three feet below level to get flow.

680 N., 1000 W. A. T. 675. Trace SO_4, tr + Ca and Cl Depth to rock 58 feet, total 62 feet.

This well is on the west side of the road. It used to flow but stopped in 1894.

Section 27.

900 N., 1000 W. A. T. 650. Total depth about 60 feet. This is sandstone water. T. 51° F., the pipe is exposed to the sun for 4 feet.

Section 33.

50 N., 50 W. A. T. 656. Baird and Prestage's sawmill. There are three wells on this farm and they all flow. (1.)Depth to rock 40 feet, total depth 90 feet. (2.) Depth to rock 40 feet, total depth 44 feet. (3.) Depth to rock 40 feet, total depth 48 feet.

Section 34.

50 N., 400 W. A. T. 655. Depth to rock about 30 feet, total depth about 60 feet. This well used to flow.

50 N., 1780 W. Depth to rock 40 feet, total depth 60 feet. This well used to flow with a six foot head but was checked.

2000 N., 1000 W. A. T. 658. This is sandstone water and has traces of Ca, Cl and SO_4. T. 50° F.

Section 35.

260 N., 1000 W. A. T. 692. This well was drilled in sandstone, the depth is unknown. The water has traces of Ca, Cl and SO_4.

Section 36.

1000 N., 860 W. A. T. 710. This well is in sandstone water. This is a drilled well on top of gravel beach.

1950 N., 1300 W. A. T. 693. This well was drilled near the front of a dissected terrace of gravel and sand and had only a little oily water.

Grant Township (T. 15 N., R. 11 E.).

Section 1.

1200 N., 2000 W. Total depth 13 feet. This is a surface well and there is plenty of water in the hollow. A. T. 782 feet.

S. W. of S. E. Total depth about 45 feet.

10 N., 50 W. Cl low, Ca low, SO_4 0. Depth to rock 85½ feet, total depth 86½ feet. A. T. 697. There is ½ foot of bluish rock at the bottom. The water rose to five feet from surface.

Section 6.

50 N., 50 W. Total depth 46 feet. A. T. 660 feet. This well was bored.

50 N., 1280 W. Total depth 11 feet. A. T. 660.

Near N. E. corner. A. T. 650.

Lead is said to have been found at 65 feet, but I doubt it. Cf. Henning's explorations there later. This shows the rumor on which he probably went. Chas. Henning's explorations were on E. ½ of N. E. ¼, first in slate.

1400 N., 1950 W. These are surface wells.

80 N., 1950 W. A. T. 650. Total depth 20 feet. This is a surface well.

Section 7.

220 N., 1950 W. A. T. 660. Depth to rock 35 feet, total depth 36½ feet. This well is in sandstone. The water contains traces of SO_4, Ca and Cl George Zimiker, owner.

A. T. 608. Jay M. Burgess, owner. Depth to rock 42 to 52 feet, total depth about 70 feet. Water was struck in this well at about 45 to 50 feet and flowed eight gallons an hour, but has since decreased and nearly stops flowing during northerly or northeasterly winds.

Shodwell and others say this well has not reached rock.

Section 8.

50 N., 1300 W. Depth to rock 60 feet, total depth 70 feet. A. T. 710. This well is in white sandstone. J. King, owner.

Section 11.

50 N., 860 W. Depth to rock 59 to 60 feet, total depth 120 feet. A. T. 730.

Aaron Endersby, owner. The water in this well stands about 15 feet below ground. The well is cased 43 feet 3 inches through quicksand, then 16 feet 2 inches more casing and below this is a bluish whetstone.

Around the N. W. corner of this section wells are about 8 to 11 feet deep.

Section 13.

N. E. ¼. Total depth 35 feet. A. T. 762. This well is probably not to rock. D. McPhail, owner.

Section 16.

300 N., 50 W. SO_4 low, Ca low, Cl none. Depth to rock 60 feet (40 or 100 feet ?) total, 210 feet. A. T. 647. The water rose to 4 feet below surface, and is sometimes muddy. The following record is from memory by J. H. Hare:

60 feet surface.
At 60 feet, fine flow of water, but in quicksand.
40 feet, sandstone.
40 feet, limestone hard and disturbed. The balance is grey grindstone with last ten feet in a soft sandstone holding a fine second vein of water.

Section 17.

1160 N., 50 W. 57 feet to rock, total depth 73 feet. Mrs. P. Walsh, owner. (Put down in Oct., 1897.) Record as follows:

Clay	15	
Quicksand	20	35
Till, "red clay, gravelly clay and hardpan"	22	57
White sand, soft rock	4	61
White flint	1½	62½
"Blue liquid paint rock," i. e, soft clay shale	1½	64
Hardrock	9	73

In some respects this agrees with a section into the Bayport limestone.

Section 18.

320 N., 1950 W. Cl 0, SO_4 0. Depth to rock 62 feet, total depth 126 feet. A. T. 670. This well is mostly through sandrock. There is said to be 3½ feet of "zinc" (?). Miles King of Elmwood, driller.

1950 N., 680 W. Cl 0, SO_4 0. A. T. 670. This well was newly drilled in 1896, apparently all through sandstone.

Section 22.

0 N., 1380 W. Ca. med., Cl low, D. A. T. 722. Total depth 50 feet. This is a clay water and comes up to the surface, through hardpan 3 or 4 feet deep.

Section 35.

2000 N., 940 W. Total depth 60 feet. This is a drilled well, some distance into rock. Wells in this vicinity are bored in several cases to about 35 feet depth in clay and gravel, but not to rock.

Sheridan Township (T. 15 N., R. 12 E.).

In a large part of this township wells are not in rock as there are numerous water-bearing gravels.

Section 1.

1740 N., 50 W. Depth 12 feet. Shallow like all around here. A. T. 762.

Section 3.

300 N., 1950 W. Depth 16 feet, plenty of water. A. T. 762.

Section 6.

550 N., 1800 W. Depth 20 feet through gravel, etc. Abundant water. A. T. 764. Another well was dug 12 feet through gravel and bored 35 feet.

Section 8.

1500 N., 1800 W. A. T. 700. Wells around here are surface wells at 12 to 20 feet deep.

Section 9.

1380 N., 50 W. Depth 24 feet through gravelly clay. A. T. 762.

Section 10.

580 N., 1850 W. Depth 27 feet on sandy ridge 200 feet broad. A. T. 770.

Section 13.

1720 N., 50 W. Depth 200 feet. A. T. 778.

120 N., 50 W. Depth to rock 30 feet. This well was dug 15 feet and drilled 8 feet. It flowed too much and they stopped it up. A. T. 780.

1720 N., 0 W. Depth to rock 24 feet, total depth 54 feet. Ca low, Cl low, SO_4 trace. Rock, blue sandstone. Sandstone varies from surface to 25 feet below surface in this neighborhood. A. T. 770.

Section 24.

540 N., 50 W. Depth 43 feet, 18 feet dug, the rest drilled. A. T. 796.

Section 25.

S. W. ¼. A. T. 780. Depth to rock 102 feet, (?) total depth 102 feet.

Section 35.

0 N., 780 W. Depth to rock less than 73 feet, total depth 73 feet. Ca trace, Cl slight trace. A. T. 791. This well is some distance in rock.

Section 36.

1600 N., 50 W. Total depth 52 feet. Bored but not to rock.

500 N., 150 W. SO_4 none, Ca trace, Cl slight trace. Depth to rock 60 feet, total depth 93 feet. A. T. 761. This well is 24 rods west of road, the rock is very hard for 3 or 4 feet, then very soft for the rest of the way. B. Morrison, owner.

800 W. 0. N., A. T. 843 feet. Depth to rock 90 feet, total depth 144 feet. This well is mostly through sandstone but there is some "soapstone" (shale) at the bottom.

Bingham Township (T. 15 N., R. 13 E.).

"Toward Ubly it is hilly and the wells are 100 feet deep on the hills."

Section 2.

1900 W., 300 N. Depth to rock 86 feet, total depth 91 feet. A. T. 844.

The water rises to 30 feet below the surface and this corresponds to the difference of level between this and Harrison's well on Sec. 3, T. 15, R. 13.

E. half of S. E. quarter. Depth to rock 130 or 135 feet, total depth 140 to 141 feet. A. T. 879.

The water rises 81 feet and is pumped 60 feet with force pump. T. Rapson, driller; Richard Harrison, owner. Record as follows:

Hardpan	20	
Blue clay	60	80
Mainly quicksand	50	130
Coarse sandstone	10	140

1420 N., 50 W.

50 N., 50 W. A. T. 824. Depth about 25 feet.

Section 8.

School house well 85 to 108 feet deep. A. T. 780. Most wells around here are 115 feet deep.

Section 9.

0 N., 800 W. Depth to rock 90 feet, total depth 95 ft. A. T. 831. This is a drilled well.

Section 10.

On the S. E. quarter of the N. E. quarter is a driven well.

1950 N., 880 W. A. T. 862 feet. Depth to rock 106, total depth 112.
The water rises to 65 feet from top. If the water has the same head as at Harrison's 3-15-13, this well has about equal elevation, and this appears to be the case.

Section 16.

2000 N. A. T. 859. Depth to rock 100 feet, total depth 124 feet. John Wilson, owner.

Section 17.

0 N., 1900 W. A. T. 802. Depth to rock probably 73 feet, total 80 feet. This well was drilled.

Section 18.

1120 N., 1900 W. 782 A. T. Not 18 feet deep. Richard Nugent, near a marked rise in the road.
560 N., 2000 W. A. T. 774. Depth to rock 25 feet, total depth 35 feet. Samuel Donaldson, owner. The water rose to within two or three feet of the top.

Section 19.

2000 N., 1260 W. A. T. 770. Depth 28 feet to rock through gravel.
1360 N., 1950 W. A. T. 772. Depth 25 feet to rock.

Section 20.

0 N., 520 W. A. T. 864. Depth to rock 110 feet, total depth 115 feet. Owner, J. Hagen.
0 N., 1240 W. A. T. 864. Depth to rock about 100 feet, total depth 150 feet. James Richardson, owner.

Section 21.

2000 N., 1520 W. A. T. 820. Total depth 115. This well is 20 rods south of road in rock of unknown depth.

Section 23.

0 N., 1340 W. A. T. 800. SO_4 none, Cl none, Ca very low, Fe perceptible to taste. Depth to rock about 20 feet, total depth 70 feet. Owner, Geo. Baskin.

Section 29.

2000 N., 940 W. A. T. 863. Depth to rock 100 feet, total depth 150 feet. John Wurm, owner. This well is through clay to rock.
1000 N., 2000 W. A. T. 560. Depth to rock 90 feet, total depth 130 feet. Thomas Richardson, owner. This well is a quarter of a mile south of the north and south road.
600 N., 1900 W. Depth to rock 120 feet, total depth 140 feet. A. T. about 860. R. Richardson, owner.

Section 30.

1050 N., 50 W. Depth to rock 100 feet, total depth 130 feet. Robert Donaldson, owner.

Section 31.

560 N., 1700 W. Depth to rock about 102 feet, total depth 111 feet. This well is 50 rods east of road. A. T. 865.
1860 N., 1950 W. Not to rock though 50 feet deep. A. T. 830.
300 N., 1950 W. Total depth 100 feet, probably just to the bed rock.

Paris Township (T. 15 N., R. 14 E. D.).

Section 1.

400 E., 50 N. of S. W. corner. A. T. 768. Total depth 12 feet. This well is through sandstone and conglomerate and not noticeably salty.

Sections 7 and 8.

1000 N., near quarter post between the sections. A. T. 792. Depth to rock 50 feet, total depth 60 feet. This well is drilled through sandstone.

Section 11.

740 W., 100 N. S. E. corner. A. T. 770. John Sinda, owner. Depth to rock 40 feet, total depth 70 feet. The water is bad and is said to be black. A well used to flow in this neighborhood.

Section 12.

680 S., 100 E. N. W. corner. A. T. 770. Depth to rock 30 feet. Thomas Loch, owner. This well is bored through 78 feet of sandstone and the water is not noticeably salty.

Section 13.

100 N., 50 W. A. T. 766. Depth to rock 60 feet, total depth 68 feet. The water is salty.

Section 16.

720 W., 140 S., N. E. corner. A. T. 800. Depth to rock 65 feet, total 95 feet. This well was in 1896 being drilled through sandstone and shale, and they have not found water yet. John Oborski, owner.
1½ mile E. of S. E. corner of section 7. No rock or water found. Depth 172 feet (the same well?).

Section 20.

1020 W., 2000 N. SO_4 low, Ca low, Cl strong (brackish). Depth to rock 103 feet, total depth 168 feet. Owner, Arch. Curry.

Section 23.

1990 N., 1990 W. Cl. med.. H_2S present also. A. T. 784. Depth to rock 80 feet, total depth 150 feet. The water has a nasty sweet taste (from decomposing pyrite?).

Section 24.

1990 N., 1300 W. A. T. 790. This is a mineral well.

Section 26.

At hotel N. W. corner. Depth to rock 90 feet, total depth 93 feet. A. T. 712. Owner, Zuiger.

Section 29.

1380 W., 2000 N. Depth to rock 100 feet, total depth 117 feet. A. T. 840. Chas. McMillan, owner. This well furnishes a good supply of sandstone water.

Section 32.

0 N., 1240 W. Total depth 20 feet, just to rock?. A. T. 795.

Section 34.

S. W. quarter. Depth to rock 110 feet, total depth 114 feet. A. T. 880. Owner, W. Wilson. This well is through sandstone.

Section 36.

The general range of rock wells here is from 40 to 70 feet.

Sherman Township (T. 15 N., R. 15 E.).

Section 7.

"Good water" occurs in gravel wells twenty feet deep on gravel ridges of the Forest Beach. A. T. 756.

Section 12.

420 N., 140 E. Total depth 70 feet, depth to rock 54 feet. A. T. 680. 16 feet through shale. There is not much water in this well and it is salty. Martin Hoeldke, owner.

Section 30.

S. E. quarter. Total depth 47 feet, depth to rock 40 feet. This well is through sandstone and the water rose to surface. Hipps, owner.
N. E. quarter. Total depth 162 feet, depth to rock 114 feet. A. T. 790. Witwer's Cheese Factory. This well is through shale.

Section 31.

N. E. quarter. Depth to rock 55 feet, total depth 114 feet, A. T. 790. The water in this well is very little salty.

Section 32.

N. W. ¼, N. W. ¼. Depth to rock 60 feet, total depth 64 feet. A. T. 780. Owner, Hanselman. This well is through shale and the water is salty.

White Rock Township (T. 15 N., R. 16 E).

Section 6.

900 N., 50 W. A. T. 610. Total depth 24 feet. This is a dug well.

Section 29.

1100 W., 800 N. A. T. 590. Total depth 566 feet. Owners Thomson and Bro. This well is abandoned. See brine analysis in Chap. VI, § 4.

600 N., 110 W. A. T. about 590 feet. Owner, W. Thomson and Bro. Total depth 1311. See above.

The exact records of the above two wells cannot be disentangled, for the works are abandoned and the references to them do not serve to distinguish them. As Dr. Rominger saw samples down to 700 feet the record may be relied upon down that far.* In his report the depth of one well is variously given as 555, 566, and 565 feet and the other deeper one of which he saw the samples he reports as 700 feet in depth. It was probably deepened later, for a note of Wright gives a record to 1311 feet, whence we may derive the following column:

From 1 to 495 (Rom. about 450) blue shales with pyritiferous sandy streaks.

From 495 to 555 (Rominger about 100 feet of porous gray sandrock) strong and pure brine, as analyzed, 80g at 45° F. (or according to Garrigues in Rom. III, 184, 78.5°)

brown sandrock, the Berea sandrock.

From 555 to 700 (Rominger reports only blue shales. According to Wright.

From 555 to 1311 are alternating strata of blue shale and limestone, shale predominating 20 to 1. From 600 to 610 feet down a three foot stratum of gaseous black shale was found, which is in the right place for the Cleveland shale. (See Chap. II, § 8). The drill must have gone into the Traverse (Hamilton) group, but probably not through it or the change would have been noticed. Besides according to the record of the Harbor Beach well it is not due. The chances are that this well stopped at the same belt of "extremely hard rock," found at 1,400 ft. at Harbor Beach, and at 153 feet in an Alpena well, which may be the Encrinal limestone.

Fairhaven Township (T. 16 N., R. 9 E.).

Section 1.

1340 N., 50 W. Total depth, just to rock, 7 feet. A. T. 622.

1000 N., 50 W. Total depth 30 feet. SO_4 and Cl low. A. T. 622.

It is 12 feet to rock in this well and water was struck at 13 feet which rises just to the surface. On top of the water was a hard scale (limestone) then a 6 in. cavity and grindstone below.

620 N., 50 W. Total depth 33 feet, depth to rock 11 feet. A. T. 622.

The first 11 feet of this well was dug, the rest was drilled. The well flows every spring.

50 N., 140 W. A. T. 612. This well is 50 or 60 feet deep and into rock.

Section 10.

50 N., 50 W. Total depth 150 feet. A. T. 590. Owner, J. D. Weeks. This is a flowing well and is salty.

Near mouth of Shebeon. Total depth 130 feet, cased for 31 feet, according to W. Hartmann, driller. This well was drilled mostly through soft grey rock, with an occasional four or five inch seam of hard stuff. e. g., at 128½ feet, but the driller already felt the springiness of the water underneath and urged him to go on. When struck water rose to the surface in ½ a minute.

Section 11.

30 N., 1200 W. Depth 40 to 45 feet. This well used to flow at first, according to Bullock the following was passed through:

Limestone, 12 feet; Blue rock, pyritiferous zone struck at 17 feet here, at 35 feet on Sec. 14.

Section 12.

1900 N., 1400 W. Cl low, SO_4 low, Depth to rock 63 feet, total depth 64 feet. A. T. 622. This well was sunk 48 feet 4 inches before reaching rock, then 10 inches rock (boulder) 14 feet quicksand, 1 foot limerock.

1050 N., 50 W. Depth to rock 30 or 36 feet, total depth 36 to 40 feet. A. T. 669. H. Dewing, owner. Pump used.

50 N., 50 W. A. T. 617. Depth to rock 11 feet, total depth 33 feet. Analyst, D. Fall of Albion. 0.008 Cl per thousand.

Section 13.

50 N., 900 W. Depth to rock 42 feet, total depth 50 feet. A. T. 618. Flowing with 2½ feet head.

50 N., 800 W. Depth to rock 43 feet, total depth 56 feet. A. T. 618. Flowing well with 2 feet head. SO_4 med. Sp. Wt. 1.002.

	Thickness.	Total.
Clay and gravel	31	31
Rock	3	34
Blue clay	19	53
Limestone	3	56

500 N., 50 W. Depth to rock 40 feet. Total variously reported as 150, 160, or 186 feet. A. T. 622. H. Rather, owner; well at barn.

SO_4 very strong, Cl str., Ca str. Sp. Wt. 1.004. Mr. Webber sent for this water

*III, pp. 76-77, 184, 201.

to Bay Port for a cathartic. Dr. J. W. Campbell reports it to have a powerful cathartic effect on cattle. Analysis by Prof. Delos Fall of Albion. 0.323 parts Cl per thousand.

(2) At house—

Depth to rock 40 feet, total depth 50 feet. SO_4 not so strong as in well No. 1, Sp. Wt. 1.002. Water rises to 1½ feet from surface.

860 N., 720 W. 47 feet casing and 47 feet deep. A. T. 616. Temp. of flow 51½°, Cl 0.

620 N., 700 W. A. T. 616. Well at barn, Temperature of flow 50°, about 3 feet head. Total depth 45 feet.

1160 N., 50 W. This is 35 feet deep and drilled. A. T. 621; Cl low, SO_4 low. Water about 1 foot from top.

1700 N., $SO_4$0. Total depth 30 feet. A. T. 620 feet. Temperature of flow 49° F. About 6 in. above ground.

Section 14.

W. half of N. E. quarter on Tom Snell's 80. D. Bullock, driller. This well was down 7 feet at 9 A. M. Thursday, June 11, and down 18 feet on Friday.

1980 N., 912 W. Depth 45 feet. It is said that lead was struck in this well. Calcareous fossiliferous sandstone is the surface rock; a darker limestone comes next underneath, then under that from 30 to 45 feet is blue shale with more or less pyrite, and the galena (?) The chances are that if struck this was a mere nodule in the shale.

Section 15.

280 N., 360 W. Depth 33 feet to rock, 107 total. A. T. 597. Collison's well. Land now owned by J. G. Tarry. D. Bullock, driller, July 15, 1896. Rock was struck at 31 feet, then blue shale with cubes of pyrite, at about 51 to 52 feet 7 to 8 ft. bed of gypsum. At 65 ft. a bed of pyrite. July 21 report with samples.

0 to 33 feet hard white clay, cased 37 feet.
35 to 40, gray rock (argillaceous limestone free eff.).
40 to 45, gray rock with pyrite and galena at 45 gypsum in large flakes. (?)
45 to 60, said to be gypsum. Bullock says only 7 ft. of gypsum.
60 to 65, pyritiferous shale with galena.
69 to 73, shale.
73 to 85, very pyritiferous.
85 to 107 fine grained dark sandrock. At 89 feet the water rose to within 6 feet of surface. It flows from the bottom, Sp. Wt. 1.005, SO_4 strong.

100 N., 1260 W. Depth to rock 25 to 30 feet, total depth 50 feet. Water rises to six feet of surface. At 35 to 40 feet there is said to be lead.

Section 21.

50 N., 320 W. A. T. about 597. This well is 18 feet deep. In surface deposits. George Schack is said to have found a piece of galena in digging this well.

Section 22.

1980 N., 600 W. Depth to rock 33 feet, total depth 60 feet. A. T. 597. Sp. gr. 1.005, SO_4 strong. This well is in shale and soapstone and has a pyrite galena veir between 40 and 50 feet.(?)

1800 N., 800 W. Depth 63 feet. A. T. 597. The water in this well rises to 6 feet from surface, but does not stand pumping.

(S. W. of S. W.) 100 N., 1900 W. Temperature of flow 51½°. A. T. 597. D. Bullock's record as follows:

0-52, surface.
52-58, soap rock, etc.
75, mineral, pyrite and galena.
110-130, brown sandrock, then white sandrock following.

They say at the house they have but 52 feet casing. They stop in white gypsum rock and show samples of gypsum. SO_4 tr., Cl low.

50 N., 1560 W. A. T. 597. This is a surface well.

450 N., 1450 W. Depth 50 to 70 feet. A. T. 597. Well at schoolhouse. "Flow about 1½ feet above the surface, in the winter and spring gradually growing less. A north wind increased the flow and an east wind diminished it." Geo. Kleaber.

Section 23.

N. E. of S. E. 50 W. This well was sunk to rock.

1950 N., 50 W. Total depth 12 feet. A. T. 608.

50 N., 400 W. Cl low, SO_4 str. Total depth 135 feet. A. T. 612. Water rises to 8 feet from surface. Mrs. Estman, owner.

100 N., 100 W. Depth to rock 50 feet, total depth 140 feet. A. T. 615. Jacob Brown, owner. This well is said to have four feet of black coal, cf. Weiser's well on Sec. 26.

Section 24.

1950 N., 900 W. A. T. 620. Total depth 55 feet. The water rose to within 20 inches of the ground.

1950 N., 800 W. Depth to rock 40 feet, total 49. A. T. 620. Water rises to the surface.

1950 N., 1740 W. A. T. 618. Depth to rock 7 to 8 feet, total depth 48 feet.
480 N., 50 W. A. T. 624. This is a shallow surface well.
820 N., 50 W. A. T. 623. This is a shallow surface well, not drilled.
1280 N., 50 W. Total depth 18 feet. A. T. 618. This well was dug in summer of 1895.
1620 N., 50 W. Total depth 7 feet. A. T. 618. There is said to be a spring on the east side of the place.
In W. ½ of N. W. ¼ of 24.
50 N., 1900 W. Depth 8 feet.

Section 25.

N. E. of N. W. 1900 N., Cl low, SO_4 strong. Total depth 78 feet. A. T. 622. Anton Adams, owner.
1600 N., 1950 W. SO_4 strong. A. T. 620. Anton Adams, owner. This well is drilled.
1260 N., 1950 W. Cl trace, SO_4 strong. Total depth 85 feet. A. T. 622.
50 N., 1840 W. Cl low, SO_4 low. Depth to rock 166. A. T. 626. Owner, J. Finkbeiner. This well was drilled 12 years ago in hard rock.
340 N., 50 W. Cl 0, SO_4 strong. Depth to rock about 80 feet, total depth 175 feet. A. T. 624. Owner, Buschlein. Rock was found at 40 or 50 feet, but it shaled off.
680 N., 50 W. Cl low, SO_4 strong. Depth about 180 feet.

Section 26.

400 N., 1950 W. Depth to rock 60 feet. A. T. 610. Owner, Wm. Henry.
1950 N., 400 W. Cl low, SO_4 strong. Casing 48 feet, 100 deep. A. T. 612. Carl Weiser, owner. Blue slate (with four feet of black) at 50 feet.
1900 N., 100 W. Depth to rock 50 feet, total depth 148 feet. A. T. 620. Owner, L. Engler.
1360 N., 50 W. Total depth 10 feet. A. T. 620. This is a surface well.
900 N., 50 W. Cl low, SO_4 strong. Total depth about 92 feet. A. T. 622. George Davis, hand drilled.
540 N., 50 W. Cl low, SO_4 strong. A. T. 626. Depth to rock 66 feet, total depth 102.
50 N., 660 W. Total depth 8 feet. A. T. 620 feet. Six feet of clay and two feet of water bearing sand.
(2) Total depth 18 feet.

Section 27.

1950 N., 760 W. A. T. 610. This is a surface well.

Section 28.

1950 N., 520 W. Depth to rock 60 feet, total depth 100 feet. A. T 630. Temperature of flow 51½° F. E. Rose, owner. W. Smith, driller. There is over 40 feet of casing to a big boulder, then small casing to rock at 60 feet. The mixed drillings show pyritiferous shale and limestone.

Section 33.

1701 N., 100 W. Cl med. Depth to rock 46 feet, total depth 175 feet. A. T. 600. Owner, Mrs. Schuch. Chas Hofmeister, driller. Record from samples:

	From	To
Brown dolomite	48	52
Blue shale	62	68
Sandstone	148	175

640 N., 940 W. Total depth 14 feet. A. T. 609.
1400 N., 1800 W. Cl med., SO_4 low. Depth to rock 51 feet, total depth 205 feet. A. T. 610. Owner, J. Haffner; driller, Bullock.

	From	To
Blue shale looks like a good clay	53	85
Dolomite and shale	85	100
Blue shale	100	117
Impure pyritiferous limestone	117	124
Pyritiferous limestone	125	132
White sandstone with pyrite, Napoleon sandstone	133	205

Section 35.

50 N., 1900 W. A. T. 630. Cl low. SO_4 trace. Depth to rock about 80 feet, total depth 116 feet. Sample at 75 feet was pyritiferous shale. Driller's record:

	Thickness.	Total.
Clay surface	60	
Loose lime rock	5	65
Soap rock (i. e., calcareous shale with pyrite)	23	88
Very hard dark rock	4	92
Sandrock	24	116

1640 N., 1950 W. SO_4 low. Cl low. Casing 64 feet. Total depth about 150 feet. A. T. 612. Owner, August Rehbein. Record by J. Russell:

	Thickness.	Total.
Clay	49	
Hardpan	5	54
Dark lime rock	6	60
Slate rock	2	62
Lime rock	2	64
Soap rock	16	80
Hard lime rock	2	82
Slate rock	7	89
Hard sand rock	3	92
Fine sand rock	26	118
Dark lime rock	4	122
White sand rock (Napoleon)	21	143

Section 36.

1440 N., 50 W. A. T. 630. SO_4 low, Cl low. Depth to rock 60 feet, total depth 154 feet. S. Stahl, owner, of Bay Port.
50 N., 1760 W. Cl low, SO_4 strong. Depth to rock 50 to 55 feet, 80 to 90 feet of casing, total depth 136 feet. A. T. 630. This well passed through various kinds of rock, mainly soap rock.
50 N., 700 W. Depth to rock 70 feet, total depth 200 feet. A. T. 630. This water is not salty and rose to 18 feet below surface.

Winsor Township (T. 16 N., R. 10 E.).

Section 1.

1950 N., 1320 W. Depth to rock 30 feet. A. T. 633. Water rose to about 6 feet from the ground.
1950 N., 1040 W. A. T. 635. (1) This well was dug for 12 feet and is not cased. The water rises to the top. SO_4 low.
(2) Depth to rock 60 feet. This well used to flow, but is now stopped up.
1950 N., 400 W. Depth 40 feet, through gravel. A. T. 637. Water rose to within 6 feet of the top.
60 N., 50 W. SO_4 low, Cl med. Depth to rock 40 feet, total depth 40 ft. This is a dug well.
360 N., 1950 W. SO_4 low. Cl low. Total depth about 47 feet. A. T. 635.
860 N., 1950 W. SO_4 low. Total depth 32 feet. A. T. 634. This well was dug 8 feet, then drilled in gravelly clay and about 6 in. in black slate. This well is not flowing now.
1060 N., 1950 W. Depth to rock 30 feet. A. T. 633. This well flowed fast 3 or 4 years ago. it now stands about one foot from ground. When this well was dug the one above, just south, stopped flowing.
1200 N., 1950 W. A. T. 633. Depth to rock 30 feet, total depth 30 feet. The water in this well stands two feet from the surface and the well passes through sand, clay, gravel and at the bottom fine sandy bluestone.
S. E. quarter of N. W. quarter. A. T. 639. This well used to flow a ½ in. stream, but has now gone down to 3 feet from the surface. SO_4 low, Cl low. Total depth 41 feet. The water comes from a soapstone. (A windmill was put in 3 or 4 years ago and I suspect is partly to blame for the other wells not flowing.)

Section 2.

(Pigeon.) Wells from 29 to 40 feet deep used to flow. The surface water and water generally is hard.
160 N., 1287 W. Depth to rock 43 feet, total depth 90 feet. A. T. 630. H. Moeller, owner; W. Smith, driller.
The first rock was coarse, impure pyritiferous sandstone, then bluish arenaceous shale at 48 feet, then a mixture of fine sand, black shale, pyrite, etc.
50 N., 1075 W. Total depth 163 feet. A. T. 632. This well is at the Kleinschmidt house next to P. O.
Depth to rock 49 feet 3 inches, total depth 50 feet 6 inches. This well is 15 inches in rock at the store.
450 N., 1900 W. Depth 39 to 40 feet. A. T. 632. The water rises only 6 inches. The surface water is hard.
360 N., 50 W. Total depth 36 feet. A. T. 635. The water flowed at first, but is now 5 feet from the surface.
700 N., 50 W. Total depth 30 to 33 feet. A. T. 634. The water is about at level of ground.
1200 N., 50 W. Total depth 29 feet. Berne, 2d house from N. E. corner. A. T. 633. SO_4 and Cl low, like other wells on this road. This well used to flow and now rises to five feet from the surface.
1980 N., 880 W. Cl low, SO_4 low. Total depth 36 feet. A. T. 627. This well is at Leipprandt's store.
1950 N., 1820 W. Cl low, SO_4 medium. Total depth 31 feet. A. T. 626. This well was dug for 16 feet and drilled 16 feet.
There is no casing in this well, the stream was so strong that it lifted the one-inch casing out.

Section 3.

1320 N., 1925 W. Depth to rock 40 feet, total depth 80 feet. A. T. 626. F. D. MacCauley, owner; drilled by Hofmeister. Water was struck at 30 feet and rose to 8 or 9 feet below surface.
520 N., 1200 W. Driller, F. Mueller. A. T. 629. This well is but 9 feet deep and they found gypsum. In a dug well at 32 feet was "a big layer of gypsum," very good according to samples, but probably in the drift. On the other side of the stream he says that a well struck the same layer, say 2 feet thick, and that an adjacent drilled well cut some 4 or 5 feet of it.
20 N., 760 W. Total depth 23 feet. A. T. 629. This well was dug 22 feet and bored to rock which is not very hard. There is 14 feet of water in the well.
50 N., 1180 W. Total depth 60 feet. This is said to have been a well all in hardpan, with no casing.
1950 N., 460 W. Total depth 17 feet A. T. 612. This well was dug 14 feet and drilled 3 feet.
1950 N., 810 W. SO_4? Depth to rock 35 feet, total depth 40 feet. A. T. 626.
1950 N., 1320 W. A. T. 626. This is a shallow well.

Section 4.

1970 N., 1280 W. Total depth 18 feet. A. T. 626. This well was dry in July, 1895.
1980 N., 720 W. Depth 19 feet. A. T. 626. At house, in gravel and hardpan, quite often dry.
(2) Depth 14 feet. At barn, barely dry in hot summers. Next houses east, three wells and all were dry in summer of 1895. Total depths 14, 18 and 20 feet.
1320 N., 25 W. Total depth 35 feet. A. T. 626. This well was dug for 20 feet and hand drilled the rest of the way. Water was struck about 7 feet below surface.
750 N., 50 W. Total depth 60 feet. A. T. 626. The water in this well nearly rose to top.
700 N., 50 W. Total depth 35 feet. This well was dug 20 feet, and drilled 15 feet. It was never dry from 1892 to 1896 and was afterward drilled to 40 feet and filled up. There is gravel at the bottom.
300 N., 50 W. Depth just to rock 44 feet. A. T. 626. This well goes to rock which is limestone like the quarries.
S. E. quarter of S. W. quarter. H. Eimers' well strikes rock near surface.
1980 N., 1000 W. Total depth 53 to 54 feet. Cl low, SO_4 strong. A. T. 626. At 58 feet there is blue rock with seams of plaster.

Section 5.

1900 N., 1350 W. Depth 49 feet. A. T. 624 (42.5). This well passes through 13 feet of limestone similar to that of quarry, then 24 feet sandstone, then 4 feet soft, fine sandstone, then 7 feet (last few feet a mixture) slate and sandstone mixed.
400 N., 1950 W. Depth to rock 16 feet, total depth about 22 feet. A. T. 622.
840 N., 1950 W. This well is about 7 to 11 feet deep. A. T. about 622.
1050 N., 800 E. A. T. 630 (48.2). Surface of quarry is 51 to 52 feet above lake. This is a test bore hole at the quarry. In atlas of Huron county is a view of Bay Port quarry 40 feet down. See Fig. 8.

	Thickness.
Limestone	16
Grindstone or coarse sandstone	20
Fine sandstone, red brown or brindle	13-15
Shale, which I assign to the Michigan series	50

From 25⅓ to 29 feet the sandstone dipped decidedly according to diagram, 6:11, being cross bedded, the rest being practically horizontal stratification.
Sample marked "(1) 41 feet" is fine grained sandstone with some mica, light brown; "50 feet slate" is a shale; "Sample taken in 1884 at 9 feet, 8 in., from the bottom of this hole No. 1" is a fine grained light grey shale with laminae across core, at one end a lump of Fe S_2 weathered to sulphates. Also at the bottom of hole 100 feet from surface, a very soft grey slightly calcareous shale with a streak 1-10 inch of sand cemented with pyrite. At total depth 28 feet 3 inches the core saved was 18 feet 4 inches, a portion of loss from earthy deposits between layers.

(2)	Thickness.	Total.
Limestone	13	
Sandstone	24	37
Soft fine sandstone	4	41
Slate and sandstone mixed	7	48

The variation in the record of these two borings and the quarry section shows how variable the beds of the sandstone, etc., are.
720 N., 1950 W. Total depth 29 feet. A. T. 617. This well flowed for the first few years.
100 N., 1950 W. Depth to rock 28 feet, total depth 32 feet. A. T. 617. This well passes through rock, then through clay and gravel. (Cavern clay, or some of the shale beds of quarry record.)
50 N., 1720 W. Cl trace, SO_4 strong. A. T. 619. This well usually flows until about July 4th and then stands at surface.
50 N., 1300 W. Total depth 27½ feet. A. T. 620. This well used to flow.

260 N., 50 W. Depth to rock 16 feet, total depth 22 feet. A. T. 622.
840 N., 50 W. Depth to rock 7 to 11 feet, total depth 12 feet. This well passes through 5 feet of limestone and flint, sandstone below; 50 rods on it is 6 inches to rock.

Section 7.

950 N., 740 W. Total depth about 28 to 30 feet. A. T. 617. This is a drilled well.
950 N., 1280 W. Depth to rock 26 (?) feet, total depth 33 feet. A. T. 619. This well is in quicksand and did not flow, water rose about 6 feet from ground. Nine feet of this well is said to be in rock, the rest is in gravelly sand.
1050 N., 1900 W. Total depth 27 to 37 feet. A. T. 618. This well flowed 2 feet above ground. Cl and SO_4 not more than trace. Temperature 49½°.
700 N., 1950 W. Total depth 29 feet. A. T. 619. Temperature of flow 49° F. SO_4 trace.
50 N., 1320 W. Total depth 33 feet. A. T. 622. E. Harder, driller.
50 N., 640 W. Depth to rock 32 feet, total depth 36 feet. A. T. 624. A. Graves, owner. Water was struck at about 31 feet.
50 N., 300 W. A. T. 625. This is a shallow well at the school house.
N. W. of S. W. Total depth 24 or 28 feet. Adam Mueller, driller. These wells are of muck and clay loam. Clay 3½-4 feet, then hardpan gravel, etc.
50 N., 1950 W. Total depth 24 or 40 feet. Cl trace, SO_4 0. Temperature 50° F. This well has a strong flow at school house.
1850 N., 1950 W. This is about like flow opposite in Sec. 6.
1950 N., 720 W. Depth to rock 27 feet, total depth 29 feet. A. T. 612. T. Radloff, owner. In the spring water was at surface now it is more than 7 feet from the top.
840 N., 50 W. Total depth 25 feet. J. B. Harder, owner.
1460 N., 50 W. Total depth 40 feet. Less than 40 to rock.
1700 N., 50 W. Depth to rock 30 feet, total depth 100 feet. A. Grant, owner. The well was sunk this deep in order to get a flow, in vain.

Section 8.

A. T. about 624.
S. W. ¼. Depth to rock 21 to 26 feet; total depth 22 to 26 feet. The wells around here are to rock (F. G. Harder's place, 3½ miles E. and 1 mile south of Pigeon).
N. E. Depth to rock 2 to 8 feet.
1950 N., 1020 W. Depth to rock 25 feet, total depth 39 feet. Cl 0, SO_4 low. This well gets roily at times.
1950 N., 60 W. Depth to rock 38 feet 8 inches, total depth 110½ feet. There is a little water in this well at 40 odd feet, but not enough even now. It is very strongly cathartic, Cl 0, SO_4 strong. D. Grant, owner.
500 N., 1950 W. This well is 7 or 8 feet deep in quicksand.
450 N., 1120 W. Cl 0, SO_4 trace. Total depth to rock 33½ feet.
510 N., 1120 W. Total depth 15½ feet.
1460 N., 1950 W. Total depth just to rock 40 feet.
1700 N., 1750 W. Cl 0, SO_4 med. Total depth 52 feet. This well is in rock and the water is cold and good.

Section 9.

W. ½ of S. E. ¼. Two miles south of north part of Sec. 4. A. T. 630. Total depth 80 feet. W. Challis, owner. This well is in rock.
1680 N., 50 W. Total depth 180 feet. A. T. 628. C. J. Hofmeister, driller. This is a flowing well with over 1 foot head. Temperature of flow 48°. The water is salty.
1220 N., 50 W. Depth to rock about 30 feet, total depth 190 feet. A. T. 628. H. Maier, owner; C. J. Hofmeister, driller. This well is through soapstone, limestone and sandstone. The water was struck in sandstone and rises to within 7 feet of the surface. The temperature of water is 47° F.
380 to 420 N., 50 W. Depth to rock 2 feet, total depth 180 feet. Cl low, SO_4 0. A. T. 630. Only 2 feet to limestone which is close to the surface and like that of the quarries on Sec. 5, T. 16, R. 10; the rock drops 18 feet suddenly to north and to south slopes off gradually.
1950 N., 1540 W. Depth to rock 8 to 10 feet, then the rock limestone is 18 feet thick. A. T. 627.
50 N., 660 W. Cl low, SO_4 trace. Depth to rock 18 feet, total depth 76 feet. A. T. 630.
500 N., 600 W. Depth to rock 3 feet. A. T. 629.

Section 10.

1680 N., 1950 W. Total depth 198 feet. A. T. 628. This well is mostly through soapstone.
620 N., 1950 W. Depth to rock 24 feet, total depth 240 to 242 feet. A. T. 630. Henry Eimers, owner. D. Bullock, driller. This is about the same as at 1220 N., 50 W. Sec. 9-16-10, 24 feet to rock, 4 feet limestone, then white stuff.
50 N., 1740 W. Total depth 30 feet. A. T. 630. Temperature of flow 48° F. Perhaps this well does not strike rock. A. Aublam, owner.
1980 N., 1220 W. Total depth 22 feet. A. T. 629. This is good water.
1160 N., 50 W. Total depth 163 feet. A. T. 632. Owner, J. Reither. The water in this well is hard, the wells near by are shallow and not so hard.
1980 N., 1640 W. Total depth 22 feet. A. T. 628.

Section 11.

Pigeon village. See also Sec. 2-16-10. Depth to rock about 40 feet, total depth 150 feet. A. T. about 623. Maclean, owner.

1850 N., 950 W. Depth to rock 50 feet, total depth 223 feet. This well is at the Elevator. It passes largely through slate and soap rock, some sulphur rock, black and pyritic seams.

1900 N., 1100 W. Depth to rock 40 feet, total depth 109 feet. This well is at the Arlington house and the water rises to 5 feet below surface. Winter, proprietor. Bullock, driller.

About 1 rod away is a well 50 feet deep. This water is good and it is plenty. Fisher, blacksmith. There is a well 140 feet deep at the planing mill, and 149 feet deep at the cheese factory. Other wells are 45 to 50 feet to rock.

840 N., 1900 W. Depth to rock 63 feet, total depth 163 feet. Louis Schultz, owner. There is sandstone from 130 to 163 feet in this well.

120 N., 1900 W. Total depth 140 feet. A. T. 631. Henry Schultz, owner. The depth to rock in this neighborhood is generally 40 feet. This well is 48 feet to rock, then 1 foot blue rock, then mainly soaprock and calcareous shale down to 98 feet, from 98 to 102 water-bearing rock.

1900 N., 1337 W. Total depth 285 feet. A. T. 633. This well is at the steam stave mill, Liken and Bro. Bullock, driller. This well got into red stuff and salt, Bullock says the red rock was 200 feet down. At 160 feet they found fresh water. The general section for Pigeon is therefore as follows.

0-50, surface.
50-90, blue clay, brick clay near surface.
90-120, sandstone, Napoleon or Upper Marshall.
120-126 (perhaps sandstone), Napoleon or Upper Marshall.
160-200, sandstone, fresh water, Napoleon or Upper Marshall.
200-285, red rock at first, with salt water, the Lower Marshall, the same as at 350 feet at Bay Port, and at 196-208 in Elkton. The Schultz well in the W. part of the section shows a dip of about 40 feet while toward Bay Port the dip must be about (350 — 200), + (30—50) = 170 ÷ 5.2 (miles) = 33 feet per mile.

1780 N., 50 W. Depth to rock 40, total depth 150 feet. A. T. 637. SO_4 med., Cl low. This well is cased.

1700 N., 50 W. Depth to rock 40 feet, total depth 40 feet.(?)

1440 N., 50 W. A. T. 637.

600 N., 50 W. Depth to rock 39 feet, total depth 65 feet. A. T. 639. At first the water rose 4 feet above ground and flowed, and at 50 feet the water was very hard. SO_4 mod., Cl trace. A second well in same locality is 27 feet deep.

50 N ? W. A. T. 637. Water was struck at about 70 feet. (?)

Section 12.

800 N., 1813 W. (1) Total depth 46 feet. A. T. 640. The water rises to 6 or 7 feet from surface. On top of the water-bearing stratum is a greasy or slippery blue clay which tends to close up the wells. (2) Depth 49-80 feet; closed up.

50 N., 740 W. SO_4 low, Cl low. Depth 150 feet. A. T. 644.

1950 N., 860 W. SO_4 low, Cl low. Depth about 90 feet. A. T. 641.

Section 13.

1080 N., 1950 W. SO_4 mod., Cl low. Depth about 160 feet. A. T. 640.

1900 N., 1900 W. Depth of casing to rock 47 feet, total depth 50 feet. A. T. 640.

1950 N., 1420 W. Total depth 15 feet. There are some 12 and 15 feet dug wells.

Section 14.

1930 N., 1980 W. Depth a little over 15 feet. A. T. 630. This well goes dry in summer.

1420 N., 1980 W. Depth 12 feet. A. T. 635. This well is not dry.

840 N., 980 W. Depth to rock about 75 feet, total depth 110 feet. A. T. 638. Temperature of flow 47° F. This well was drilled in 1895.

240 N., 1940 W. Depth 20 feet. A. T. 637. J. String, owner. This well was dry in summer, and another was drilled. Depth to rock 80 feet, total depth 200 feet in sandstone.

1080 N., 80 W. A. T. 642. Wells around here are said to be 175 to 200 feet deep when drilled, 14 to 16 feet when dry.

Section 15.

1300 N., 1775 W. Total depth 120 feet. A. T. 632. There was limestone with Lithostrotion at surface. The limestone was at least 3 feet thick. J. Zinzer, owner.

1950 N., 250 W. Depth to rock 50 feet, total depth 100. A. T. 632. This well was drilled by Reithel and Hofmeister in 1894.

1420 N., 20 W. This well is only 12 feet deep. A. T. 632.

980 N., 20. Depth 32 feet, 12 feet dug and 20 feet bored. This well always has water.

50 N., 1240 W. Total depth 42 feet.

S. half of N. W. quarter. On H. Bergmann's farm rock occurs at or near surface.

Section 16.

1950 N., 1680 W. A. T. 628. This well is 32 to 36 feet deep according to different reports.

Section 17.

1950 N., 620 W. Cl 0. Total depth 24 feet. A. T. 627. Barr, owner.

1950 N., 1420 W. About 26 feet to rock. Total depth 26 feet. A. T. 627.

Section 18.

760 N., 1900 W. Depth to rock 40 feet, total depth 110. A. T. 622. Owner, Chas. Rather. Cl low, SO_4 low. The water rises just to the top.

1600 N., 1950 W. $SO_4$0. Total depth 30 feet. A. T. 620. This well flowed about 6 inches above ground. A sample has been sent to Lansing or to D. Fall, by Snell.

1900 N., 1000 W. A. T. 624. This well is like the others around here. i. e., about 30 feet deep.

1950 N., 940 W. Total depth 33 feet. A. T. 624. This well is drilled. The water rises to two feet below ground.

50 N., 1360 W. Depth to rock 46 to 48 feet, total depth 120 feet. A. T. 626.

Section 19.

50 N., 1440 W. Total depth 10 feet. A. T. 626. Blue sandy clay just opposite in the ditch. (Perhaps some of the wells entered under Sec. 24-16-9 belong in this section.

Section 20.

0 N., 260 W. Cl low, SO_4 strong. Total depth 235 feet. A. T. 634. The water tastes puckery.

50 N., 1000 W. Total depth 35 feet. A. T. 632. 25 feet of this well is dug and 10 feet bored in gravel.

1950 N., 740 W. Cl trace. SO_4 strong. The water has a slight inky taste. Total depth 65 feet. A. T. 628. Eimer, owner. There is no house near by.

Section 21.

1720 N., 20 W. Total depth 56 feet. A. T. 635.

600 N., 20 W. Total depth 20 feet. A. T. 637.

50 N., 700 W. SO_4 low. Depth to rock 28 feet, total depth 30 feet. A. T. 637. T. Titz, owner.

1950 N., 1740 W. Total depth 22 feet. A. T. 634. (1) 5 in. well. (2) Largely in bluish boulder clay.

50 N., 1950 W. Total depth 9 feet. This is a surface well.

Section 22.

In general it is said to be from 22 to 38 feet to rock.

1950 N., 840 W. Total depth 33 feet, 14 feet through clay and 19 feet through gravel. A. T. 637. Chas. Knott, owner. The water is moderately hard.

1950 N., 1240 W. Depth 28 feet. A. T. 637.

1950 N., 1740 W. Total depth, just to rock, 48 feet. A. T. 637. Water was struck on top of the limestone. Down to it was all clay. One-fourth of a mile south and one-half mile east it is said to be only 4 feet to limestone.

1360 N., 1900 W. Depth to rock 27 feet, total depth 40 feet. A. T. 637. A. Lindeberger, owner. This well was dug 20 feet and drilled 20 feet, and the water is roily in stormy weather.

1020 N., 1900 W. Total depth 27 feet. A. T. 637.

600 N., 1900 W. Total depth 27 feet. A. T. 637.

660 N., 100 W. Depth to rock 16, total depth 45 feet. A. T. 637. On the 40 acres of August Blunde, only 4 to 5 or 8 feet to rock.

Section 23.

1740 N., 1950 W. Total depth 210 to 220 feet. A. T. 640. W. Wagner, owner. The water is too bitter for cooking (i. e. SO_4 strong), Cl trace. Tastes of S and Mg.

1240 N., 1950 W. Total depth 30 feet. A. T. 641. This well is never dry.

1900 N., 50 W. SO_4 strong, Cl trace. Depth to rock 70 feet, total depth 125 feet. A. T. 645. S. Foster, owner.

1000 N., 50 W. SO_4 low. Depth to rock 150 feet, total depth 223 feet. A. T. 643. This well is cased for 150 feet. The first rock is soaprock, it is mainly blue rock and not so very hard, then 35 to 40 feet of sandrock, i. e., about 185-223. As the SO_4 is low it is probable that it begins below the gypsiferous layers of the Michigan series which lie more than 35 feet above the Napoleon sandstone.

Center of the N. W. ¼ of the S. E. ¼. Depth to rock 96 feet, total depth 145 feet. A. T. 645. F. J. Reithel, owner.

S. E. ¼ of N. W. ¼. 1050 N., 1100 W. A. T. 645. Cl trace, SO_4 strong, cathartic, alum taste. This water "hardens butter." Depth to rock 90 to 99 feet. Total 99 feet. This well is through soft rock. B. Franklin, owner.

500 N., 1950 W. Cl trace, SO_4 strong. Total depth 137 feet. A. T. 644.

Section 24.

1950 N., 1250 W. Depth, not to rock 70 to 80 feet. A. T. 645.

Section 25.

50 N., 340 W. Depth to rock 14 feet. A. T. 648.

1950 N., 1950 W. Total depth 100 feet. A. T. 648. This is a new well, Aug. 28, 1896, and has 100 feet 3 inches casing, but is not to rock yet. There is plenty of water in this well.

Section 26.

1925 S., 75 W. Depth to rock 75 feet, total depth 141 feet. A. T. 647. J. Decher, owner. Fred J. Reithel, driller. This well passed through soaprock, then limerock and hard slate, blue argillaceous limestone and dolomite (cement rock). This well was deepened to 144 feet on Aug. 28th. Cl trace, SO_4 strong.

Section 27.

1820 N., 1950 W. Total depth, not to rock, 38 feet. A. T. 637. This well was dug 12 feet and then drilled to gravel. There is another well on the other side of the road. Depth to rock 31 feet, total depth 61 feet. A. Hartman, owner.

1000 N., 1900 W. Total depth 60 feet.(?) A. T. 637.

100 N., 1260 W. Depth to rock 68 feet, total depth 100. A. T. 630. Soaprock, sandstone at 100 feet. John Lucht, owner.

100 N., 840 W. A. T. 641. This well was down 138 feet to rock on the forenoon of June 3d, 1896, through clay, sand and gravel. Engelhardt Stueck, owner. Chas Hofmeister, driller.

Cf. Brown's well on § 23 in Fairhaven, T. 16 N., R. 10 E.

680 N., 1950 W. 148 feet to rock, 150 feet deep. A. T. 637. Louis Kain, owner. This well used to flow.

Section 28.

50 N., 950 W. A. T. 636. SO_4 strong.

840 N., 50 W. Cl low, SO_4 strong. Total depth 220 feet. A. T. 636. This well passed through much soaprock.

480 N., 30 W. SO_4 strong. School district No. 1. Winsor. Sept. 30, 1895. A. T. 636. Record of J. Russell as follows:

	Thickness.	Depth.	
Red clay	12	12	Post-glacial.
Blue clay	39	51	
Hardpan and boulders	3	54	Glacial.
Sand and gravel	1	55	
Hardpan and boulders	19	74	
Light slate rock	7	81	Michigan series.
Black slate rock	2	83	
Light slate rock	3'6"	86'6"	

Cf. Brown's well on § 23 in Fairhaven, T. 16 N., R. 10 E.

1950 N., 1950 W. Total depth 41 feet. A. T. 634. This well goes through soapstone (probably solid clay).

50 N., 1900 W. Cl low, SO_4 strong. Depth about 60 feet. A. T. 636.

50 N., 660 W. SO_4 low. Total depth 85 feet. A. T. 636. This well passed through a few feet of gravel, then it was hand drilled for 27 feet through hardpan, i. e., till; then sand 9 feet thick was found at 45 feet, then 18 feet of soapstone, 2¾ feet of hard rock.

1950 N., 1240 W. SO_4 med. Depth 45 feet or more. A. T. 635.

Section 29.

50 N., 700 W. SO_4 strong. Depth to rock 69 feet. A. T. 636. Wm. Weinlander, owner. Chas. Hofmeister, driller. Record of samples sent to survey:

126 to 128, sandstone fine grained arenaceous.

128 to 150, yellow and brown limestone and sandstone.

150 to 216, clear white sand (a few green grains of spinel?) apparently good enough for glass making.

50 N., 1820 W. Total depth about 183 feet. A. T. 632. The water is very hard, Cl trace, SO_4 strong. W. Kappen, owner.

50 N., 1100 W. Total depth 125 feet, about 59 feet casing. A. T. 636.

50 N., 940 W. Cl trace, SO_4 strong. Depth to rock about 69 feet, total depth 148 feet. A. T. 636. Miller, owner. C. Hofmeister, driller. At 82 feet dolomitic limestone; 107-148 sandstone slightly calcareous.

50 N., 260 W. Total depth 188 feet or more. A. T. 637.

1660 N., 50 W. Depth to rock about 70 feet. A. T. 635.

1950 N., 1000 W. A. T. 632. Cl trace, SO_4 strong. This water is cathartic and probably comes from decomposed pyrite. Depth to water 60 feet, total depth 225 feet. Jacob Hoist, owner. This well is through soaprock and at 160 feet ("stuff like gold, called sulphur") pyrite.

Section 30.

(Depth to rock said to be in general about 60 feet.)

140 N., 1950 W. Total depth 200 feet or more. A. T. 630. This well is mainly shale and soaprock. C. Buschlein, owner.

50 N., 700 W. Cl 0, SO_4 med. + total depth 40 feet, but not to rock. A. T. 632.

Cl trace, SO_4 strong. Depth to rock 60 feet, total depth 180 feet. A. T. 632. M. Regenscheit, owner; C. Hofmeister and Crafts, drillers.

1000 N., 50 W. Cl trace, SO_4 strong. Depth to rock 64 feet, total depth 220 feet. A. T. 631. From 200-215 in sandstone. The tools were stuck fast, and some pyrite was encountered. George Kramer, owner; Smith, driller.

Section 31. (Kilmanagh.)

50 N., 540 W. Total depth about 60 feet. A. T. 630. This is like the well just south.

50 N., 990 W. A. T. 630.

50 N., 1300 W. Cl low. About 100 feet deep. This well is cased to rock for 80 feet. There was hard rock at the top of bed rock. C. Heckert, owner.

A. T. 630. Geo. Kindig, owner. Record as follows:

	Thickness.	Total.
Clay	55	
Hardpan with boulders	3	58
Loose dark rock (hard slate)	4	62
Hard rock, water	5	67
Soapstone	6	73
Light colored hard rock with 8-16 in. soft seams	25	88
Sandy fine clay, slate	4	102
White hard sand rock with some pyrite	4	106
Soft white sand rock	21	127

SO_4 trace.

1460 N., 1950 W. Total depth about 185 feet. A. T. 630.

1950 N., 700 W. Cl trace, SO_4 med. Depth to rock about 64 feet, total depth 200 feet. A. T. 630. This is mainly through soaprock, water was struck in sandrock.

1200 N., 50 W. Cl low, SO_4 med. Total depth about 170 feet. A. T. 636. Gottleib Layhen, owner.

50 N., 50 W. Depth to rock 60 feet, total depth 85 feet. A. T. 638.

A. T. 630. Frank Thompson, owner. Cl low, SO_4 med.

	Thickness.	Total.
Clay	60	
Slate or soap	10	70
Hard rock	25	95
Hard sandrock	12	107
Water sandrock	12	119

Section 32.

50 N., 660 W. This well was drilled. A. T. 676.

50 N., 1760 W. SO_4 low, Cl low. Depth to rock 80 feet, total depth 155 feet. A. T. 637. C. Finkbeiner, owner. The first rock encountered was slate, the last 25 feet was sandrock in which was water. Water also occurred at the surface of the rock

1950 N., 1820 W. Depth to rock 64 feet, total depth 172 feet. A. T. 636.

1950 N., 1100 W. Cl low, SO_4 med. Depth to rock 59 feet, total depth 116 feet. A. T. about 636. S. Ellenbaum, owner. The water has fallen from five feet below ground to 14 feet below.

1950 N., 940 W. Depth to rock 35 feet,(?) total depth 178 feet. A. T. about 636.

1950 N., about 300 W. Cl strong, SO_4 strong. Total depth 186 feet or more. J. D. Finkbeiner, owner.

Section 33.

1360 N., 20 W. Total depth 14 feet. A. T. 637. This well is shallow in gravel and gravelly clay.

750 N., 50 W. Total depth 135 feet. A. T. 637. Wm. Hinton, owner.

50 N., 1700 W. SO_4 trace, Cl med. Depth to rock 80 feet, total depth 170 feet. A. T. 637. Jacob Kain, owner.

1950 N., 1800 W. Cl tr., SO_4 strong. Total depth 226 feet. A. T. 635. This water is cathartic.

1950 N., 1300 W. A. T. 635. Cl trace, SO_4 strong. Total depth about 214 feet. This well has 70 or 80 feet of casing.

Section 34.

1900 N., 1260 W. Depth to rock 104 feet (or 96), total depth 175 feet. Henry Einwochter, owner.

820 N., 1950 W. A. T. 637. Depth to rock 120 feet, total depth 165 feet. Cf. § 3-15-9.

Section 35. (Linkville, = Winsor, = Kilkenney). A. T. 648.

100 N., 950 W. Depth to rock 73 feet, total depth 101 feet.

	Feet.
Blue clay	71
Red clay	71-73
Grey rock	73-101

100 N., 950 W. Strong of SO_4. Depth to rock 75 feet, total depth 105. This well is in soapstone and hard black rock. C. Link, owner.

150 N. Total depth 225 feet. This well is at the stave mill, and has about 40 feet of red rock at the bottom.

50 N., 950 W. SO_4 trace, Cl low. This well is at the saw mill and has 120 feet casing. There was a bad flow from 105 to 110 feet, but it is cased off. "Grindstone" occurs from 135-140 feet and 150 to 200 feet.

1050 W. Total depth 173 feet. SO_4 low, Cl low. The water rises to about 10-12 feet from the ground.

Probably 1 and 2 are the same well, but different reports, also 3 and 4. The general section would then be probably (compare Grand Rapids Pl. XXI, Vol. V, Geol. Sur. Mich., at 147, 191 to 248, and 248 to 265 feet).

	Feet.
Drift	70-75
Grey calcareous shale	75-101
Hard black rock, perhaps limestone, and gypsum, brackish water	101-120
Shale	120-140
Sandstone	140-185
Red sandstones and shales	185-225

880 N., 50 W. Total depth 16 feet. A. T. 645.

50 N., 1950 W. Dug in boulder clay.

Oliver Township (T. 16 N., R. 11 E.).

50 N., 1520 W. Total depth 10 feet. A. T. 667.

Section 2.

50 N., 700 W. SO_4 strong, Cl low. Temperature of flow 51° F. Total depth about 150 feet. A. T. 657.

50 N., 1100 W. Depth to rock 26 feet, total depth 142 feet. A. T. 663. This is a flowing well in very hard rock.

Section 3.

1900 N., 300 W. Depth to rock 25 feet, total 146. A. T. 644. Salt at 48 feet. This well used to flow 2 feet above ground, the water is salty and at 143 feet was not good. This well should be cased deeply. Compare Adams' well in Caseville; i. e., about 90-100 feet above the sandstone is a salt streak.

1780 N., 1900 W. Depth to rock 26 feet, total depth 239 feet. A. T. 647. At 180 feet the water was not good. It now rises to within 6 feet of the ground.

220 N., 1540 W. Cl trace, SO_4 low. Total depth 130 feet. This well is cased for 30 feet. A. T. 645. This well is at the brick yard.

Section 4.

1950 N., 1480 W. Total depth dug, and not to the rock, about 12 feet. A. T. 657.

Section 5.

50 N., 960 W. Total depth about 20 feet. A. T. 657.

700 N., 1950 W. SO_4 low, Cl low. Total depth 109 feet. A. T. 647. D. Bullock, driller, for Dwight and Heywood.

1420 N., 1950 W. SO_4 low, Cl low. Depth to rock 95 feet, total depth 156 feet. A. T. 647. D. Bullock, driller. The question is, is this casing really only to rock or did they case deeper to keep off bad water? The rock was blue "like slate pencils," i. e., blue shale in the Michigan series.

1950 N., 1280 W. SO_4 med. Cl low, like the one in Sec. 32-17-11. Depth to rock 60 feet, total depth 150 feet or more. A. T. 647. This well is in blue shale and sandrock.

1950 N., 1210 W. SO_4 med., Cl low. Depth to rock 40 feet, total depth 168 feet. A. T. 647. Fliege, owner.

Section 6.

360 N., 50 W. SO_4 trace, Cl low. This well is 50 to 60 feet to rock and 125 feet deep. A. T. 647. This well was put down by D. Bullock for J. E. Lynch.

160 N., 1950 W. Total depth 29 feet. A. T. 646. This well was dug for 11 feet, then hand drilled. The water rose to within 12 feet of the surface.

800 N., 1950 W. Total depth 40 feet. A. T. 642. This well was dug and drilled, and has not very much water. SO_4 low, Cl med.

1950 N., 1460 W. Total depth 40 feet, hand drilled. A. T. 640. Good supply of water.

1950 N., 980 W. Total depth 140 feet or more. A. T. 642. This well is a few feet deeper than next well east, which is steam drilled.

W. half of N. E. quarter. Total depth 140 feet, depth of casing 52 feet. A. T. 642. J. Ackerman, owner.

Section 7.

60 N., 1950 W. SO_4 trace, Cl trace. Depth to rock 48 feet, cased for 2 feet or more, total depth 68 feet. A. T. 646. D. Bullock, driller; A. Neely, owner.

Section 8.

The surface wells around here vary from 50 to 65 feet deep.

560 N., 50 W. A. T. 652. Not to rock.

600 N., 50 W. Depth to rock 50 feet, total depth 82 feet. A. T. 652.

1450 N., 50 W. SO_4 trace, Cl low. Depth to rock 58 feet, total depth 166 feet. A. T. 652. Hoffman, owner.

100 N., 1950 W. Total depth 14 feet. A. T. 648. This well is in hard, tough, drab, very compact hardpan or boulder clay. This well was not finished.

1600 N., 1950 W. A. T. 650. This well was not drilled.

Section 9. (Elkton)

135 N., 37 W. Total depth 215 feet. John Grill, owner. SO_4 trace, Cl low. There were flows of water at 66 feet, but at 110 feet came the regular flow. The rock consists of slate rock, black rock "coal" (not so), white rock, and passing through the sandstone the well goes into 10 feet of red rock. This well is cased to rock and piped to 110 feet. When the wind came from the S. E. it flowed a 1-inch stream, when from N. or W. it did not flow. This well used to flow until they cut the packing of the R. R. well 4 feet below ground.

125 N., 37 W. Cl. med. Total depth 23 feet. Compare sec. 10.

1900 W., 600 N. SO_4 trace, Cl low. Depth to rock 55 feet, total depth 80 feet. This well starts in sandy soil. H. Becker, owner; 50 to 65 feet is the usual depth of surface wells around here.

Section 10. (Elkton)

There are two or three wells for engines 2½ miles east of Pigeon.

Andrew Newly, 18 to 28 feet of white rock (gypsum)?

"There are 14 or 15 wells right in Elkton and they are robbing each other and wells that used to flow do so no more."

150 N., 1800 W. Depth to rock 25 feet, total depth 228 feet. A. T. 650. S. T. and H. R. R. station. Cf. John Grill's well on Sec. 2. Summary:

	Feet.
Surface	0-25
Mainly sand rock with occasional seams of slate and limestone	25-99
Sand rock (hard down to 170 feet)	99-196
In soft red rock, slate	196-208

Water would flow at 207 feet, five feet or over above ground. Drilled by Cyrus G. Wells, of Badaxe, under a contract dated October 10, 1899. Daily report:

Oct. 23, 1890. Reached 25 feet below surface and struck rock.
Oct. 24, 1890. From 25 to 35 feet sand rock; occasionally an inch or two of slate.
Oct. 25, 1890. From 33 to 40 feet, hard sand rock.
Oct. 27, 1890. From 40 to 58 feet, hard sand rock, intermediate layer of about 6 inches of limestone.
Oct. 28, 1890. From 58 to 75 feet, hard sand rock.
Oct. 31, 1890. From 75 to 99 feet, hard rock and slate.
Nov. 4, 1890. From 99 to 102 feet, very hard sand rock.
Nov. 6, 1890. From 102 to 120 feet, hard sandrock.
Nov. 7, 1890. From 120 to 129 feet hard sand rock.
Nov. 8, 1890. From 129 to 130 feet, hard sand rock.
Nov. 10, 1890. No progress, hard sand rock.
Nov. 13, 1890. From 130 to 140 feet, hard sand rock.
Nov. 14, 1890. From 140 to 145 feet, hard sand rock.
Nov. —, 1890. From 145 to 150, hard sand rock.
Nov. 20, 1890. From 150 to 158 feet, hard sand rock.
Nov. 22, 1890. From 158 to 170 feet, hard sand rock.
Nov. 25, 1890. From 170 to 178, soft sand rock.
Nov. 26, 1890. From 180 to 196, soft sand rock.
Nov. 28, 1890. From 196 to 202, soft red rock.
Dec 2, 1890. Down 207 feet, red soft rock; broke down, not drilling at present.
Dec 6, 1890. Well will flow, if fixed with piping and packing, five feet or over, above ground.
Dec. 6, 1890. Down 208 feet in red slate; the pipe has been put in and tried and water flowed five feet above surface.

1200 N., 950 W. Total depth 130 feet. A. T. 642. SO_4 med., Cl low. This well does not flow.

Section 11.

1950 N. Total depth 170 feet.

1950 N., 50 W. Depth to rock 26 feet, total depth 130 (128 to 138) feet. A. T. 664. Water at first rose to 3 feet from surface, and was struck at 100 feet.

1000 N., 50 W. SO_4 med., Cl trace, taste of H_2S. Depth to rock 100, total depth about 130 to 170. Wells of D. Rolph and neighbors. This well did flow.

Section 12.

1950 N., 540 W. Depth to rock 25 feet, total depth 220 feet. A. T. 670. This well is mainly through slate and soapstone. The first water was at 90 feet. This well flowed for sometime and the water is now within 4 feet of the ground.

Section 13. Grassmere.

1040 N., 50 W. Cl 0, SO_4 0. Depth to rock 40 feet, total depth 175 feet. A. T. 694. This water was tested by Prof. W. B. Prescott as follows: Hardness, 0.171 per thousand. Cl = 0.0025 per thousand; contains Ca, Mg, Na, Cl, SO_4, Cl and Co_2 in

minute quantities and trace of Fe. This well goes 48 feet to a bluish grey sandstone, shelly, i. e., flags. At 158 feet is a coarse grey sandrock.

Concerning the behavior of this well we insert the following from the Bad Axe Republican of Aug. 10, 1900. Compare what we have said on p. 126 about varying flows. The sweating of the pipe in times of storm is due to the extra humidity of the air which is congealed by the cold pipe.

Practically all of the water used for drinking purposes at the little hamlet of Grassmere comes from a well on the Grassmere stock farm. The well stands just inside a field on the road near the station and is patronized by everyone in the vicinity as the water is very pure, clear and cold. An iron pipe has been driven into the earth to a depth of 170 feet and the water from it is carried to a large trough in the adjoining barnyard where the cattle on the farm are watered. Where the pipe comes out of the ground a barrel has been sunk in the earth and the water flows direct from the well into this barrel. Manager Sam Goodwill says this well has several peculiarities that are odd, to say the least. When the wind is in the southwest the flow of water is abundant, but let it veer around to the opposite point of the compass and the supply is diminished at least one-half. The well is also a faithful barometer. When a storm is in the air the water in the barrel is greatly disturbed. It boils violently and the sediment at the bottom rises and roils the water so that it has to be taken direct from the pipe for drinking purposes. At the same time the pipe, otherwise dry, becomes covered with moisture and great beads of perspiration drop from its rough, iron surface. This is due doubtless to the coldness of the pipe condensing the moisture already gathering in the warm air surrounding it. On Saturday all the conditions were present, and that night this vicinity was visited by a copious and welcome rain storm.

Section 15.

860 N., 1950 W. A. T. 650. This is a flowing well and is about the same as 800 N., 50 W., 16-16-11.

Section 16.

200 N., 50 W. A. T. 650. This is a shallow well.
800 N., 50 W. This is a flowing well. Depth to rock 35 to 40 feet (25), total depth 140 feet.
1950 N., 980 to 1620 W. SO_4 low. Total depth 12 to 16 feet. A. T. 647. There is no rock well near here.

Section 18.

1950 N., 220 W. Depth to rock 82 feet, total depth 304 feet. A. T. 650. Meredith, owner. At 180 or 190 there was plenty of water but they went lower hoping for a flow and got bad water, which was shut off. From 200 to 304 is red rock.

Section 21.

S. E. quarter of S. E. quarter. Depth to rock about 30 feet, total depth 85 feet. A. T. 670. Temperature of flow 47½° F.; water not as hard as that of the 16 foot well at the same place.
800 N., 50 W. Flow not strong. Total depth 91 feet.
1260 N., 50 W. Depth to rock 27 feet, total depth 104 feet. A. T. 662.
1740 N., 50 W. Temperature of flow 47½° F. Total depth 104 feet. A. T. 660.

Section 22.

800 N., 50 W. Total depth 20-30. A. T. 665.

Section 27.

½ mile E. and ½ mile N. of 1280 N., 50 W. in Section 28. Total depth 110 ft. A. T. 672.
1920 N., 1950 W. Depth to rock 30 to 35 feet, total depth 110 feet. A. T. 672. This well is like the one 1280 N., 50 W., in Sec. 28-16-11.
0 N., 440 W. Ca trace, Cl none, SO_4 none. Total depth 149 (140 to 145) feet. A. T. 684. John Wooster, owner. This is a flowing well.

Section 28.

50 N., 320 W. A. T. 670. Paul Praseham, owner. This is not a flowing well.
50 N., 780 W. A. T. 670. This well is probably to rock, 32 feet deep.
1280 N., 50 W. T. 47½° F. Depth to rock 30 to 35 feet, total depth 106 feet. A. T. 670. This well is through sandrock and some slate, and did not have a strong flow.
750 N., 50 W. Total depth 140 to 145 feet. A. T. about 670. This is a flowing well.
1920 N., 50 W. Depth to rock about 30 to 35 feet, total depth 110 feet. A. T. about 670. This well is like 1280 N., 50 W.

Section 29.

50 N., 800 W. A. T. 667. This is a fifteen-foot dug well.
50 N., 400 W. A. T. 667. Total depth 16 feet. This is a dug well. The country is sandy all along here and to the west.

Section 30.

112 N., 1560 W. Depth to rock 54 feet, total depth 178 feet. A. T. 652. Head of flow 6 feet. J. Cassinke, owner. The first rock was sandstone at 54 feet, lots of slate in the rock, blue sandstone, then 7 or 8 feet of clear white sandstone, water bearing rock. According to Bullock, of same well, soaprock, lime and slate made up the well which went from 130-178 into sandrock.

Section 31.

1950 N., 460 W. Total depth 13 feet. A. T. 660. 4 feet of gravelly sand, the rest is clay. There was about 6 feet of water in this well all summer.

Section 33.

1950 N., 780 W. Depth to rock 30 feet, total depth 127 feet. A. T. 662. SO_4 trace, Ca trace, Cl 0. Fe present. Fred Elbe, owner. At 35 feet went through gypsum bed 1 foot thick. Water was struck at 127 feet, it flowed a water pail a minute and rusts iron. Temperature 47½° F., Lane, 48° F., Davis.

Section 36.

S. E. corner. Ca low, Cl trace, H_2SO_4 low. Total depth 13 feet. A. T. 730. This water is strongly impregnated with H_2S. When wind is E. water is said to turn black.

Colfax Township (T. 16 N., R. 12 E. L.).

Section 1.

50 N., 1900 W. Total depth 20 feet. A. T. 734. This well is not deep enough.

Section 6.

200 N., 260 W. Depth to rock 30 or 35 feet, total depth 242 feet. A. T. 690.
The water was good and rose to surface. B. Kreutziger, owner. There was loose rock to 35 feet to which it was cased. At 85 feet the water rose to the top. The well was continued through soap rock in the vain endeavor to get more head, though the supply was increased.
N. W. quarter of N. W. quarter. Total depth to rock 40 feet.
100 N., 1260 W. A. T. 670. J. Klemmer, owner. Cl 0, SO_4 med. The water rose originally to 3 feet of surface, now it rises to 7 feet of surface. Water was struck at 50 or 70 feet, then 21 feet hard rock, then 4 feet of plaster.
A general section for this part of the country is 20 feet to rock, 21 feet to flinty limestone, gypsum and calcareous shales to top of Marshall sandstone at 70 feet, and at 240 feet were shales of the Lower Marshall.

Section 7.

N. W. quarter of N. W. quarter. Depth to rock 20 feet, total depth 150 feet. A. T. 677. This well flowed at first.

Section 9.

A. T. 708. Total depth 26 feet. J. Hutchinson, owner. The water in this well is not good.

Section 13.

1300 N., 50 W. Total depth 15 to 16 feet. A. T. 752.
1950 N., 860 W. Total depth 12 to 16 feet. A. T. 744. This is the general depth of wells around here.

Section 18.

200 N., 50 W. Cl 0, SO_4 0. Depth of casing to rock 40 feet, total depth 85 feet. A. T. 709. The water rises to 3 feet from top.
A. T. 693. Grassmere. See Sec. 13, Oliver. Around Grassmere wells are said to be about 90 feet deep.

Section 20.

340 N., 50 W. Depth to rock 60 or 70 feet, total depth about 200 feet. A. T. 745. Fred Wettzel, owner. This is a sandstone water. D.
S. W. ¼ of S. E. ¼. Depth to rock 50 feet, total depth 75 feet. A. T. 745. Robt. I. Hazard, owner. This well used to flow.

Section 23.

1000 N., 640 W. Total depth 8 to 9 feet. A. T. 762.
1050 N., 1060 W. Total depth 10 to 12 feet. A. T. 762.
1250 N., 1200 W. Depth to rock 50 feet, total depth 85 feet to 102 feet. A. T. 762. This well is at the county poor house, in soaprock (?).
1200 N., 1250 W. Total depth 91 feet. A. T. 762. This well is at the road.
220 N., 1950 W. A. T. 757. The water rose 8 feet from top.

Section 24. (Badaxe.)

T. Rapson says that it is mostly sandstone around here, now and then soapstone, but as we go north toward Grindstone City there is very little rock (i. e. sandstone)

until the soapstone, then 100 to 200 feet of soapstone with seams of sandsone, i. e., Lower Marshall. Other deep wells generally to rock are put down in Badaxe at the jail, Connaton House, Bank of F. W. Hubbard & Co., Post and Seely, Skinner, School house and R. R. station, etc.

Lot 17, John Street, 1400 N., 700 W. Depth to rock 40 feet, total depth 90 feet. A. T. 770. S. Burgess, owner.

1050 N., 1050 W. Total depth 80 feet, in rock. A. L. Wright, owner.

1450 N., 1800 W. Depth 10 to 12 feet. This well is at the cemetery and went through 4 feet gravel, 4 to 12 feet sand, and the rest clay.

A. T. 770. Depth to rock 56 feet, total depth 110 feet. Well at the new cemetery, drilled in 1896. This well was through sandstone, with no change all the way. This compared with the flowing well on Sec. 19-16-13, Verona, shows that there is a very heavy sandstone at the top of that.

Section 26.

1780 N., 1950 W. A ten-foot well in hard clay, not stoned up. A. T. 752.

Section 27.

1780 N., 50 W. Seven feet hard blue clay, 6 inches gravel, 4 feet blue clay, then more gravel. A. T. 752.

Section 29.

1950 N., 260 W. Depth to rock 60 feet, total depth 66 or 75 feet. A. T. 745. The first 60 feet were mostly clay, but there were 12-15 feet of quicksand on the rock, and 5 to 6 feet sandrock at the bottom. The water rose to within 4 feet of the surface, it was clayey but otherwise good.

50 N., 300 W. Total depth, not to rock, 18 feet. A. T. 762.

Section 30.

440 N., 200 W. Depth to rock 60 feet, total depth 66 feet, or depth to rock 70 feet, total depth 75½ feet. A. T. 730. Robert Brown, owner; T. Rapson, driller.

	Thickness.	Total.
Clay	45	45
Quicksand on top of rock	12 to 15	60
Sandrock	5 to 6	66

The water rose to within 15 feet of the surface. There was good water in this well which rose to 16 feet of surface.

Section 32.

1950 N., 140 W. Total depth 12 feet. A. T. 765.

Section 33.

E. half of S. E. quarter. Total depth 17 feet. A. T. 757.

Section 34.

1950 N., 260 W. Total depth 12 feet. A. T. 770. This well is in clay but the road is sandy.

920 N., 50 W. In Sec. 35 (?). Depth 18 feet. A. T. 762. Ten feet to water through a bluish gravelly clay with much white chert.

480 N., 50 W. Depth 13 feet. A. T. 764. This well is through the clay which seems to "drop out" at the bottom, with a quicksand and gravel beneath yielding plenty of water.

50 N., 1565 W. Total depth 20 feet or more. A. T. 764. This well struck water at 20 feet.

50 N., 1950 W. Total depth 18 feet. A. T. 760. This well is through gravel into coarse gravel. The water is very hard and "furrs the kettle right up."

Section 35.

1450 N., 950 W. Total depth 6 feet. A. T. 752.

1050 N., 1950 W. A. T. 760.

Verona Township (T. 16 N., R. 13 E. L.).

Section 6.

1037 N., 1476 W. Probable depth 63 feet. A. T. 750. There was plenty of water in this well for 30 head of cattle, and it rose nearly to the top.

Section 7.

50 N., 1950 W. Total depth 10 to 12 feet. A. T. 770.

1180 N., 1950 W. Total depth 10 to 12 feet. A. T. 750.

Section 11.

1000 N., 1000 W. Depth to rock 50 feet, total depth 60 feet. A. T. 756.

Section 18.

1950 N., ? W. Total depth, just to rock, 40 feet. A. T. 770. Mott, owner.

1000 N., 1950 W. Depth to rock 40 feet, total depth about 85 feet. A. T. 712. H. Wilcox, owner.

Section 19.

890 N., 1700 W. June 2d, 1896. See record from J. Coreyell, see also analysis of Badaxe water below. These wells rose to 11 feet below ground, now they have to raise it about 15 feet.

About 300 feet south and 800 feet E. of W. ¼ post of Sec. 24, on Hanselman street. Depth to rock 40 to 45 feet, total depth 200 feet. A. T. 760. Waterworks of Badaxe. Very pure from mineral matter. T. 49° F.

The town is supplied by these three artesian wells, about two hundred feet deep, from which the water is pumped to the stand pipe, 200 feet high. The record turned in by Coreyell below may be from one of these wells by mistake as it does not match that of the 400 foot well which it was supposed to be. I copied the original record of the latter. The main flow is at about 200 feet. During the summer there was some complaint of the taste of the water, and I was shown a piece of wood which was said to have come up from the well. But in spite of my tests showing that the trouble was not with the water as it came from the well, it seemed wise to send off to the Agricultural College and have the water tested. Two samples were sent. No. 1 was from the dead end of a water main, i. e., beyond any water connection to a house. No. 2 was from a pump direct. The following was Prof. F. S. Kedzie's report:

"The two samples of water sent some time ago have been very carefully examined with the following result:

	(In grains per imperial gallon.)		
	No. 1.	No. 2.	Lansing city.
Total solid matter in a gallon	23.45	20.65	19.00
Organic	7.00	6.30	4.00
Inorganic	16.45	14.30	15.00
Hardness, degrees of	5.9	5.2	13.00
Free ammonia	0.0024	Slightest trace.	0.08
Albuminoid, degrees of	0.072	0.048	0.10

(Lansing City water given for comparison.) We consider this water very good, and I think that your water may be safely placed in the same class if not better. We are, however, always troubled with bad water at the dead ends of the mains, and find it necessary to have the pipes frequently flushed. The cause for the bad smell and taste given to the water by standing at the dead ends of the pipes is thought to be the organic matter acting on the sulphate of lime contained in the water, causing the liberation of H_2S in the water which gives the water a strong and decidedly unpleasant smell when the faucet is first opened in the morning. We are never free from that trouble here, and probably never will be, so long as the water contains the lime compound and the amount of organic matter which seems to be natural to most of our Michigan waters. The only remedy is frequent flushing."

The Badaxe water does not contain anything like as much Ca SO_4 as the Lansing certainly, and from my inspection I am inclined to attribute the difficulty more to the rapid growth of vegetable matter in the stagnant ends or stand pipe in a water with much carbonic acid. But the well water is extremely pure. It will be well to exclude light from the stand pipe.

Sand Beach Ave., White Elm. At the Morrow House there is a shallow well.

Heisterman and Sand Beach Ave. Post and Seeley's bank.

Sand Beach Ave. and Hanselman's deep well at Hubbard's bank.

Block 11, Irwin and Hanselman Street. Skinner, owner.

Block 8. There is a deep well at the school house.

A. T. 758. Total depth 40 feet. This well is at the R. R. Station. This well is through solid clay. "Clay is not as thick on hills as in lowlands."

E. part of town. Locke's well is just 49 feet to rock.

970 N., 12 W. Total depth 400 feet. A. T. 757. John Sullivan, driller. This well flows a strong stream 3 feet above ground at the rate of 1 quart per second. Temperature 47° F. Lane or 49° F. Davis. The two thermometers were about 2° apart, SO_4 0, Cl 0, Ca slight traces.

Fifteen feet was unaccounted for in depth to rock, probably 5 feet of muck; also 5 feet unaccounted for in the total. Size of hole 5⅝ inches. This I copied from original record which was hunted up for me. Depth to rock 45 feet.

	Thickness.	Total.	
Muck and shell marls? not in record	5	.....	Pleistocene.
Clay	20	.....	
Gravel	5	.....	
(Glacial) hardpan	5	*45 or 50	
Sand rock	30	80	Upper Marshall, Napoleon.
White shale	5	85	
Sand rock	30	115	
Lime rock	8	123	
Sand rock	30	153	
Lime rock	10	163	
White shale	27	190	

Here is said to have been the main flow at about 200 feet or 175-200 feet (i. e., by record 190-215), according to report through W. L. Webber from J. Coreyell at 270 feet was sandstone with a strong stream of water rising above surface (probably read 207 for 270 feet).

	Thickness.	Total.	
Sand rock	25	215	Port Austin sandstone?
Lime rock	5	220	
White shale	10	230	
Sand and lime	20	250	Point aux Barques sandstone?
Blue shale	25	275	
White shale	20	295	
Red sand	5	300	
Black lime	7	307	
Sand rock	5	312	*Grindstone quarry beds?
Black lime	5	317	
Gravel and sand rock (conglomerate)	3	320	*Bottom of Lower Marshall.*
Blue shale	15	335	
Lime rock	5	340	Coldwater shales.
Sandy shale	10	350	
Lime rock	10	360	
White shale	40	400	

John Coreyell's record through W. L. Webber, dated May 11, 1894. This is evidently not a record of the same well as above, although it was supposed to be; it may be one of the city waterworks wells.

	Thickness.	Total.
Gravel	12	12
Hardpan	20	32
Blue clay	7	39
Gravel	3	42
Hardpan	2	44
Sandrock	20	64
Blue shale	36	100
Sandy shale, blue	21	121
Sticky shale	22	143
Sandy shale	2	145
Grey sandrock	45	190
Blue shale	7	197

Cf. letter of W. L. Webber, Nov. 3d, 1896.
1037 N., 1963 W. Total depth 18 feet. A. T. 770. At the Irwin House. This well never goes dry.
Hanselman street. A. T. 760. This is a shallow well at the county jail.

Section 20.

950 N., 460 W. A. T. 768. This well is on a gravelly rise.
1050 N., 50 W. Total depth 16 feet. A. T. 782. This well went dry in the summer of 1895.

Section 21.

1050 N., 1120 W. Total depth 16 feet. A. T. 765. This well is on a muck, sand and gravel knoll. All the wells around here are shallow.
950 N., 500 W. A. T. 772. This well contains 5 to 6 feet of water.

Section 22.

950 N., 1280 W. Thomas Rapson, driller.
1050 N., 700 W. Total depth 20 to 22 feet. A. T. 807. This was a dug well.

Section 25.

1760 N., 0 W. Depth to rock 78 feet, total depth 84. A. T. 812. Sandstone water.

*Totals obtained by subtraction from 400 feet leaving discrepancy indicated by 45 = 50.

Section 29.

1650 N., 140 W. Total depth 16 feet. A. T. 782. D. McCrea, owner.

Section 31.

A. T. 757. There are shallow wells around here. Water was within 4 feet of surface on June 10, 1896.

Section 34.

1900 N., 500 W. Total depth 10 feet. A. T. 780. Two or three wells (one of them used to be a spring), all went dry in the summer of 1895.
1060 N., 50 W. 27 feet deep. A. T. 834. This well never went dry. This well is on top of a hill; near by are undrained hollows on the hill, and water standing in them.

Section 35.

460 N., 1850 W. Total depth, perhaps, just to rock, 47 feet. A. T. 798.

Sigel Township (T. 16 N., R. 14 E. L.).

In this township there are large surface deposits of sand or gravel in connection with the Forest Beaches so that deep wells have not been found necessary yet, but except at the extreme east side possibly it will be possible to get water in the sandstones which occur in the first hundred feet of the underlying rock. There will be no flows and the deeper water will be somewhat salty. In this township it will not be improved by going deeper as in Chandler.

Sand Beach Township (T. 16 N., R. 15 E.).

Section 5.

100 paces W., 20 N.
20 N., 100 W. SO_4 low, Ca low, Cl strong. Depth to rock 73, total depth 82 feet. A. T. 700.+ J. Gerstenschlager's well. 5 feet shale and 4 feet solid.

Section 18.

40 rods N., 40 rods W. SO_4 low, Ca low, Cl strong, as at Cowpers. Depth to rock 48 feet, total depth 100 feet. A. T. about 750. This well passed through shale 6 feet, slate 2 feet, limestone 2 feet, shale and sandstone 42 feet. R. A. Brown, owner.
250 N., 250 W. of N. W. corner of 19, half way from Brown's to Cowpers. Ca low, Cl med., SO_4 low. Depth, just to rock, 22 feet.

Section 19.

N. W. corner. Ca low, Cl med., SO_4 low. Depth to rock 6 feet, total depth 12 feet. A. T. 750. Cowper's well, with 6 feet of "grindstone" rock.

Section 25.

640 paces W. of Engert's, Ca low, SO_4 low, Cl strong. Depth to rock 83 feet, total depth 85 feet. A. T. about 650. Jacob Layer, owner. There was a layer two feet thick of sandy shale.
140 W., 80 S. of N. E. corner. Ca low, SO_4 low, Cl strong. Depth to rock 54 feet, total depth 57 feet. A. T. about 640. George W. Engert. This well passed through sandy shale.

Section 12. L. Harbor Beach.

The village is supplied by water works taking water by lake from a 1200 foot conduit near north end of breakwater, described in Huron Times, Friday, Sept. 17, 1897, cost $16,000. Walker system of water supply. Rock is soon reached and is within a few feet of the surface for 2 or 3 miles north and south.
Two deep wells have been put down, fully reported in previous volumes, and discussed in the description of the geological column, and the analyses of waters given above.
(1) Depth 702, 715, 800 to 900. See Geol. Survey of Mich., Vol. III, p. 184; V, p. 80. Sandstone from 650-715.
(2) Geol. Surv. of Mich., V, p. 81. Abstract of record:

Coldwater shales	1-500 feet.
Berea black shale	500-603
Berea grit	603-664
Bedford and Erie shales	664-850
Huron black shale	850-1120
Traverse, i. e., Hamilton shales and limestones	1120-1725
Encrinal limestone?, 15 feet of hard rock at	1400
Helderberg limestone	1725-1920

T. 16 N., R. 16 E. Sand Beach.

Section 30.

600 paces N., 700 W. SO_4 trace, Ca low, Cl high. Depth to rock 24 feet, total depth 65 feet. A. T. 622.+ S. Lincoln, owner. Situated 3.94 miles from Sand Beach on lake shore road.

1950 N., 1400 W., 600 paces E. of the N. W. corner. T. 16 N., R. 16 E. Total depth 18 feet. A. T. 602. Robert Brennan, owner.

660 S., 400 W. of the N. W. corner. Sec. 30, T. 16 N., R. 16 E. Depth to rock 16 feet, total depth 22 feet. A. T. 622.+ SO_4 low, Ca low, Cl medium. Ingall, owner. This well is through sand and clay to rock, then in 2 feet sandy shale. The water is not so hard but that it can be used in washing. There is 7 feet of water in the well. This well is situated 3.55 miles south from Harbor Beach on Lake Shore road.

200 paces E. of the N. W. corner. Depth to rock 30 feet, total depth 50 feet. A. T. 682. SO_4 low, Ca low, Cl high Davis, Chas. Keane, owner. This well is through sandy shale.

1890 N., 1800 W. A well 300 feet from road.

Fairhaven Township (T. 17 N., R. 9 E.).

Section 36. Bayport.

420 feet W. of center line, 946 feet N. of center line.

1358 N., 1159 W. Cl med., SO_4 med. Sp. Wt. 1.0017. Total depth 328. A. T. 590 ± Located below the bluff and between the hotel and the bay. Water was found in a coarse grey sandrock, and rises above the surface and forms a flowing well. The temperature of the flow is 47°, "uniform winter and summer." Analyzed by Prof. A. B. Prescott. See p. 136.

1400 N., 1500 W. Total depth 338 feet. This is similar to the one above.

Near the W. line of E. ½ of S. W. ¼. A. T. 602. Webber's No. 3 well. This well passed through 4¼ feet of "firestone," so called because used for hearths; 3⅜ feet limestone; 15 feet sandstone, sample grey white, fine grained at 12 feet 9 inches; 4 feet sand and limestone, light "cement bed" shale and sandstone; 23½ feet shale with occasional mixture of sandstone.

Laurence Smith's well. Total depth 39 feet. These wells are through rock, 2½ feet surface, 10 feet limestone, 4 feet sandstone.

Stoll's well. Depth to rock 18 feet, total depth 40 feet. Rock powder like milk at 40 feet. Cf. records above. This must be in the shale formation and is probably a gypsum streak.

1075 N., 520 W. 200 feet N. of center line. A. T. 612. From 264 to 350 was water bearing sandrock; from 350 to 453 "red stuff, stopped in it." Cf. Sovereign's well on Sec. 30. Lake Tp. There is another report of the same well as follows:

Depth to rock about 30 to 50 feet, total 500 to 600 feet. The well passes through soapstone, sandstone, limestone and gypsum and shows some fool's gold (pyrite). At 250 feet they struck good water which rose to within 2 feet of top of casing. The first rock is sandstone.

1550 N., 650 W. Total depth 80 feet. A. T. 627. This well begins in sandstone at the house.

Depth to rock 20 feet, total depth 100 feet. A. T. 592 feet. This well is at the engine house.

Depth to rock 30 feet. A. T. 602. This is at the barn.

Pyrite was found near Bayport at 44½ and at 94½ feet.

All the above wells were on L. P. Mason's place.

665 feet N. of center line and 660 feet W. of center line. 1250 N., 1250 W. Depth to rock 3 feet, total depth 15 feet. A. T. 600. This well is said to be in sandstone, but from outcrops near by probably also passes into limestone. The analysis is No. 10, by Prof. R. C. Kedzie, given on p. 136. It is the Bayport springs as advertized, under the Arbor.

640 N., 50 W. Total depth 6 or 7 feet. A. T. 620. This well is in rock and can be dipped dry.

260 N., 50 W. A. T. 625. This well is to rock, but it is shallow.

1250 N., about 1350 W. At Bayport R. R. station. About 19 feet deep. This well has been analyzed by Prof. Prescott, analysis No. 9 on p. 136; it is somewhat more strongly mineralized than the Bayport springs and being a little deeper probably penetrates the limestone more.

900 N., 250 W. Depth to rock 0, total depth 47 feet. A. T. 593 (11.16). This is W. L. Webber's No. 4 well.

10½ feet of fire stone (as in hole No. 3, and the stone in the railroad cut, used by early settlers instead of fire brick for lining their arches, whence the name), 15 feet sandstone, 8½ feet superior coarse sandstone, 1½ feet shale, 7 feet whetstone (fine) for honestone, 4½ feet shale. This hole begins very close under the outcrop of Lithostrotion beds near by. Sp 19170-19173.

Caseville Township (T. 17 N., R. 10 E. L.).

Section 1.

1260 N., 1950 W. This well is about 17 feet deep and is not cased, but has plenty of water. SO_4 probably strong. Cf. Sec. 2.

50 N., 540 W. Total depth 16½ feet. A. T. 600. The water is not salty, but gives a white kettle scale. Cl low, SO_4 trace.

50 N., 1580 W. A. T. 610. Owner, J. A. Holmes.

800 N., 1950 W. Depth to rock 20 feet, total depth 178 feet. A. T. 607. J. Adams, owner; Mozier and Erb and later D. Bullock, drillers. At 93 feet they struck

salty water and at 96 feet gas indications. Bullock cased to 112 feet and at 178 feet found fresh water. This is the house well.

The one at the barn is dug 24-26 feet, then tubed. The first water is probably at 20 feet or 25 feet. Cf. Libby's well across the way.

Section 2.

800 N., 50 W. SO_4 probably strong. Total depth (just to rock?) 21 or 23 feet. A. T. 609. Libby, owner. This well is "to plaster rock."

1800 N., 50 W. SO_4 strong. Total depth 14 feet. A. T. 608. J. Gardner, owner. This well is to rock.

Section 10.

50 N., 280 W. There is no SO_4 in the water. Total depth 32 feet, dug 8 feet and drilled 22 feet. A. T. 617.

740 N., 50 W. SO_4 strong. Depth to rock 22 feet, total depth 26½ feet. A. T. 617.

Section 11.

50 N., 500 W. A. T. 617. This is a "mineral" water, that is SO_4 strong. Total depth about 30 feet. 14 or 15 feet was dug and 10 feet drilled.

Section 12.

Around here it is 26 to 30 feet to rock. At 10 feet the water shows SO_4 0 and at 23 feet SO_4 trace.

50 N., 1400 W. Total depth of well 9 feet. A. T. 612.

200 N., 1300 W. Total depth 16 feet. A. T. 612. This is not a drilled well.

50 N., 240 W. SO_4 strong and Cl strong. Total depth 27 feet. A. T. 619. This well was bored with an auger, and the water came up with a rush when it struck rock. There was 16 feet of water in the well.

Section 13. (Hayes.)

1460 N., 1950 W. A. T. 612. C. F. Leipprandt, owner. Depth to rock 30 feet, total depth 55 feet. This water is not salt to taste but contains SO_4 strong.

1500 N., 1900 W. Depth to rock 28 feet, total depth 100 feet. A. T. 610. The water is very salt to taste and is also strong of SO_4. The owner makes his own family salt and frees it from iron by setting it in the sun for 24 hours.

1580 N., 1900 W. SO_4 0, not salty tasting. A. T. 610. This is a flowing well. Total depth 278 feet. At about 228 feet very white sandstone. It is cased for 260 feet. Three days of north wind will make the head rise a foot, and three days of south wind will make the head fall a foot. This is a more than usually accurate observation, as Mr. Leipprandt is an observer of the State Weather Service.

50 N., 540 W. SO_4 strong, Cl med.+ Total depth, just to rock, 25 feet. A. T. 620. W. Steinmann, owner. Sp. Wt. 1.005. The water in this well stands at five feet from the surface.

1950 N., 1300 W. This well is not drilled. A. T. 615.

1950 N., 560 W. Total depth about 30 feet. A. T. 617. This is a dug well.

1950 N., 240 W. A. T. 619. This well is slightly mineral and is 16 feet deep.

Section 14.

600 N., 1950 E. The water is hard. SO_4 strong. Total depth 20 feet. A. T. 619. This well is at barn and was dug.

There is a well at the house which is only 12 feet deep and the water is not so hard.

600 N., 1700 E. Total depth 52 feet. This well was dug for 19 feet and passed into two feet of blue clay.

1840 N., 1100 W. SO_4 strong. Total depth 26 feet. A. T. 617. Geo. Anderson, owner. This well was dug for 16 feet and drilled for 10 feet.

100 N., 400 W. Cl med. Total depth 35 feet. A. T. 617. This well was drilled for some 16 feet. Chas. Stewart, owner.

150 N., 400 W. SO_4 low, Cl low. Total depth 40 feet. This well was hand drilled.

940 N., 50 W. This water is good. Total depth 12 feet. A. T. 617. M. C. Gregory, owner.

Section 15.

1950 N., 420 W. A. T. 617. This water is not very good. Depth of wells 6 and 11 feet.

Section 16.

S ½ of N. W. ¼ of S. E. ¼. This is a salt spring found by F. Lawrence.

50 N., 780 W. Cl strong, SO_4 strong. Total depth 18 feet. A. T. 600. They found gypsum in digging this well, Sp. 19159.

Section 21.

50 N., 780 W. A. T. 612. This is a shallow well and the water is about 6 feet below surface. Another well near by has SO_4 0. Total depth about 27 feet.

There is a well 7 feet deep at the house and one 11 feet deep at the barn which contains only two feet of water. It is said to be 37 feet from ground to bed rock hereabouts.

880 N., 50 W. SO_4 strong. Total depth 40 feet. A. T. 619. This well was dug 12 feet and drilled to 40 feet.

Section 22.

1240 N., 1950 W. Total depth 9 feet. A. T. 620. T. D. Smith, owner.
1760 N., 1950 W. Total depth about 40 feet. A. T. 620. This well was dug 20 feet and drilled the rest of the way.
1050 N., 1300 W. Depth to rock 30 feet, total depth 242 feet. A. T. 619. This well has about 50 feet of casing. There was good surface water at 28 feet, but the water now is salty. Hon. J. J. Murdock, owner. At the bottom of this well there is about 40 feet of white sandstone: it also passes through limestone and soapstone, but gray and white sandstone are supposed to make up half the depth. The water would be better if tightly cased 200 feet.
1050 N., 1820 W. Total depth 6 feet. A. T. 610. This is a dug well.
1840 N., 1420 W. Total depth 3 feet. A. T. 610. This is a spring on the side of the well marked stream valley.
1950 N., 50 W. A. T. 619. This well is 10 to 20 feet, and is a dug well.
400 N., 50 W. A. T. 617. SO_4 trace. (1) 73 feet deep. There was six or seven inches of hard rock struck in this well, which was drilled with hand drill. It must be right in a channel. (2) Total depth 50 feet.

Section 23.

N. E. quarter of N. W. quarter. 1700 N., 1050 W. SO_4 strong, Cl strong. Sp. Wt. 1.009. Total depth, just to rock(?), 50 feet. A. T. 617. J. Newman, owner. This well was put down in July, 1896.
1750 N., at the barn there is a well 40 feet deep. The water contains SO_4 med., Cl med.
400 N., 1950 W. Total depth 18 feet. 11 feet of this was drilled. A. T. 617.
S. E. quarter of S. E. quarter, 50 N., 200 W. A. T. 617. The water is salt. Cl med., SO_4 med.
1400 N., 50 W. SO_4 strong, Cl low. Total depth 50 feet. A. T. 617. D. Schubach, owner.

Section 24.

400 N., 50 W. SO_4 trace. Total depth 12 feet. A. T. 623. This well contains fresh water. Schram, owner.

Section 25.

1950 N., 960 W. SO_4 strong, Cl strong. Total depth about 42 feet. A. T. 622. This well was dug for 10 feet and 42 feet drilled by hand. A strip of country ½ mile N. and S., and more than a mile east and west has yielded bad, i. e., salty and sulphated water.
1950 N., 1360 W. Total depth 40 feet. A. T. about 620. (1) Cf. This is salt (said to be the most so in this area). (2) Depth 14 feet, said to be fresh.
1580 N., 1950 W. A. T. 618. This water is salty. Total depth 49 feet.
800 N., 1950 W. SO_4 strong, Cl low. Total depth 42 feet.

Section 26.

840 N., 1950 W. SO_4 strong. Total depth 14 feet. A. T. 617. J. Barr, owner. There were large blocks of gypsum found in the drift.
400 N., 1850 W. Total depth 40 feet. A. T. 620. Old drilled well now closed up.
(2) This well was dug 18 to 20 feet and is now down to 25 feet and is to be drilled farther. In the drift a loose piece of pyritiferous rock with spirifers was encountered (some of the Soule limestone) hand drilled.
800 N., 50 W. SO_4 strong, Cl low. Total depth 51 feet. A. T. 620.

Section 27.

A. T. 621. Harry Barr, owner. Gypsum was found at 25 to 30 feet.

Section 28.

280 N., 1950 W. SO_4 strong. A. T. 622. This is a dug well.
950 N., 1860 W. SO_4 strong. A. T. 617.
750 N., 1200 W. SO_4 strong. Total depth 59 feet. A. T. 620. J. P. Smith owner. This well was dug for 10 feet, and drilled for 40 feet.
950 N., 120 W. SO_4 0. A. T. 620. This is a shallow well at house.
1100 N., 1050 W. A. T. 619. 8 feet deep at house.
1100 N., 1150 W. Total depth less than 40 feet. A. T. 619. This well is in quicksand and is both dug and drilled.
950 N., 1300 W. Total depth 8 feet. A. T. 620.
1050 N., 1200 W. SO_4 trace. A. T. 622. This is a dug well 18 feet deep.
1050 N., 1300 W. Total depth 37 feet. A. T. 620. This well passed through a boulder 3 feet thick with quicksand beneath.

Section 29.

50 N., 400 W. Total depth 17 to 18 feet. A. T. 620.
980 N., 50 W. Total depth 40 feet, 20 feet dug and 20 feet drilled. A. T. 612. This well had a great flow. The water was very hard and not good for cooking. SO_4 strong.
950 N., 1350 W. SO_4 low. Total depth 20 feet, not to rock, in blue clay. A. T. 607.

Section 30. (Old Bayport.)

Depth to rock 7 feet, total 2,000. A. T. 590

See analysis on p. 136; about 550 feet below surface it is stopped off, and the head is +15 feet or 20 feet; at 600-700 the head is even greater, +25 to 30 feet, but the water is charged with salt.
Total depth 2000. This is the Old Bayport well and is over 2000 feet deep. It was cleaned by J. Coreyell. W. L. Webber, Dec. 3, '97, reports that in 1873-74 the well was put down for salt. It failed soon after and W. L. Webber bought the property. John Coreyell redrilled it and got him to recase. At 500-800 feet there was a flow so strong as to equal 32 feet head. At present the head is almost 10 feet. When stopped off at 750 feet according to one account, it was still salty, when stopped off at 500 to 550 though it was strongly mineral it was not salt. This is, therefore, probably near the line between Upper and Lower Marshall. J. Coreyell reports the record to be about the same as at Caseville, but with more limestone, as follows: (From memory.)

	Feet.
To top of rock	7
Limestone	3-4
Very hard limestone, then sandstone	12-15
Very large flow of water	250-260
Beginning of 135 feet of sandstone (Napoleon L.)	270-280

At 600 perhaps a streak of plaster (probably not, he is thinking of the Saginaw valley. L.).
At 900. Only 10 feet of salt rock which pinched out as compared with Caseville. (Conglomerate I of Point aux Barques lighthouse? L.)
At 1900. Stopped in shale with no sufficient flow of brine.

Section 31.

950 N., 1440 W. Total depth 15 feet. A. T. 622. This well is through solid clay. S. M. Fuller.
950 N., 1000 W. This is a similar well, John Severn.
260 N., 20 W. Total depth 61 feet. A. T. 630. There are 5 feet of sandstone at the bottom of this well, limestone at top, water 20 feet from top of ground. There are five other wells on this place. Cf. records of Sec. 5, T. 16 N., R. 10 E.

Section 32.

50 N., 900 W. A. T. 637. This well has good water.
20 N., 300 W. This well is about 10 feet deep. There is 4 feet of sand in the well, the rest is clay and the water is poor.
50 N., 1600 W. Depth 15 feet. A. T. 630. This well is through clay? and contains water all the year.
50 N., 1360 W. Total depth 10 feet. A. T. 630. This well runs dry.
1950 N., 400 W. Depth to rock 48 feet, total 62 feet. A. T. 626. Plenty of water, but SO_4 strong. This well is owned and drilled by Byron Lutson. The water is said to come up white and creamy.
1050 N., 1420 W. A. T. 626. This well is not drilled.
1050 N., 800 W. SO_4 trace. This well is not to rock at 40 feet depth. A. T. 625. It was dug 20 feet and had 12 feet of water in it.
1050 N., 890 W. SO_4 strong. Depth to rock 40 feet, total depth 50 feet. A. T. 625.

Section 33.

1050 N., 1440 W. SO_4 0. A. T. 622.
950 N., 1440 W. Total depth 7 feet. A. T. 622.
50 N., 1700 W. A. T. 645. This was a new well July 24, 1895. At 41 feet it stopped in quicksand.

Section 34.

50 N., 320 W. Total depth to rock 35 feet. A. T. 622. SO_4 med. Much white kettle scale. This well used to flow. The water comes in the rock. This well was hand drilled.

Section 35. (Berne).

2 miles north of Moeller of 2-16-10, i. e., N. W. of 35. A. T. 622.
"There is plenty of water and it rises to the top of the well. This well was dug 8 feet, and drilled 20 feet, into a cement rock like soapstone blue and soft, the blue soapstone was on top of the water-bearing rock."
1300 N., 1950 W. Total depth 10 feet. A. T. 620. This is not a drilled well.
50 N., 800 W. Total depth about 50 feet. A. T. 627.
50 N., 800 W. This well is about 35 feet deep. A. T. 627. There is plenty of water just above rock, at 28 to 30 feet in Berne village near south quarter post.
A. T. 627. Depth 29 feet and cased. H. Dominis, owner. Well at mill 75 to 80 feet deep.
1200 N., 50 W. SO_4 med., Cl trace. Total depth, just to rock, 39 feet. A. T. 627. This well is hand drilled.
860 N., 50 W. Depth to rock 30 feet, total depth 34 feet. A. T. 627. The water rises to about 7 feet below surface.

Section 36.

1380 N., 50 W. Total depth, just to rock, 43 feet. See Sec. 36-17-10. A. T. 632.
50 N., 900 W. Total depth, just to rock, 35 feet. A. T. 636. The water rises to within two feet of the ground.

50 N., 1000 W. A. T. 632. This is a similar well, at the house, which used to flow.
1800 N., 1950 W. Cl low, SO_4 0. Depth to rock 70 feet, total depth 78 feet. A. T. 622. (1) Is a shallow well at the house. (2) At 25 feet struck a rock but did not strike rock "for good" until 70 feet.

Chandler Township (T. 17 N., R. 11 E. L.).

Gould's well is said by Hartman to have found gypsum from 70 to 72 feet, and left off in it. Cf. Sec. 16 Chandler.

Section 2.

0 N., 80 W. Total depth, just to rock, 25 feet. A. T. 627.
0 N., 1320 W. SO_4 none, Ca low, Cl low. A. T. 629. This well is 25 feet deep, probably.

Section 3.

2000 N., 1640 W. A. T. 627. SO_4 low, Ca low, Cl traces. D. Wm. Riddle, owner. Total depth 64 to 68 feet. Abundant supply of water.
1900 N., 600 W. SO_4 trace, Ca and Cl low. Fe present. D. Depth to rock 29 feet, total depth 275 feet. A. T. 627. J. Lonsberry, owner. Wm. Church, driller. This well was drilled in 1895 and water rises to about 10 feet of surface. This well passes through sandstone rocks, not very different all the way down.
1900 N. Depth to rock 20 feet, total depth 22½ feet. This well is in the same vicinity.

Section 4.

50 N., 1280 W. A. T. 632.
50 N., 1060 W. A. T. 640. SO_4 0, Cl trace.
50 N., 200 W. A. T. 640. This is a shallow surface well on an 8 foot ridge.
1950 N., 1640 W. Depth to rock 40 feet, total depth 185 feet. A. T. 620. Sandstone was struck at about 80 feet. Cl 0, SO_4 low. The water rises to within 2 feet of the surface, at 130 feet it stood 6 feet above the surface.
1950 N., 820 W. Total depth 46 to 56 feet.

Section 5.

50 N., 1440 W. A. T. 627. This is a well that they dip water out of.
50 N., 260 W. (1) Cl low, SO_4 0. A. T. 627. Total depth 23 feet. (2) Cl med., SO_4 low. Depth to rock 23 feet, total depth 60 feet. This well was dug 23 feet and then hand drilled. (3) SO_4 low, Cl low. This well fell into the one above. It was down to sandstone and the water rose four feet from the surface.
1000 N., 50 W. Depth to rock about 20 feet, total depth about 90 feet. A. T. 620. This well is at the school house.
200 N., 1700 W. A. T. 620. Cl strong, SO_4 brackish, and so is a spring nearly on the section line. This well is about 25 feet deep. T. B. Woodworth, owner.

Section 6.

1950 N., 820 W. SO_4 0. Total depth 23 feet. A. T. 612.
1950 N., 220 W. This well is not drilled and is only 12 feet deep. A. T. 612.
400 N., 0 W. A. T. 615. This is a salt spring.
50 N., 600 W. Cl 0, SO_4 trace. A. T. 615. Total depth 18 feet. This is a persistent spring and has plenty of water.
50 N., 1840 W. A. T. 615.

Section 7.

1950 N., 1380 W. Total depth 303 feet. A. T. 617. Cl strong, SO_4 strong. This well has 250 feet of 1½ inch casing, which is leaky and lets the salt down on the sandstone, but the water is fresher after pumping. James McCoubrie, owner. Drilled by O. & W. Church.
At 303 feet there was grindstone, and white stuff at about 200 feet. Salt water was struck at top of rock, and there was also a smell of kerosene, at 280 feet there was 25 feet of white sandstone.
1950 N., 1000 W. A. T. 620. This is a dug well 8 feet deep and contains plenty of water.
1950 N., 1700 W. A. T. 617.

Section 8.

800 N., 1950 W. Cl low, SO_4 strong. Total depth 30 feet. A. T. 622. E. Gericke, owner.
1950 N., 1740 W. SO_4 low. This well is 18 feet deep. A. T. 627.
1950 N., 1200 W. Cl low, SO_4 strong. Total depth 25 feet. A. T. 622.
1950 N., 500 W. Total depth 24 feet. A. T. 627.
1900 N., 425 W. SO_4 strong, Cl low. This well has a strong flow and its temperature is 49½° F. Total depth 18 feet. A. T. 625.
740 N., 50 W. A. T. 640. This is a dug well.

Section 9.

1950 N., 1800 W. Cl low, SO_4 trace. A. T. 630.
1950 N., 1400 W. Total depth 24 feet. A. T. 635.
1500 N., 50 W. A. T. 642. This well is 32 feet deep and is dry sometimes because it has only surface soakage.

50 N., 122 W. Cl trace +, SO_4 mod. This is a surface well at the house. There is also a well at the barn.

Section 10.

N. E. Cor. of N. E. quarter of Sec. 10. Depth to rock 37 feet, total depth 40 feet. A. T. 657. John Quinn, owner; A. W. Rapson, driller. This well was dug to rock through hard blue clay. The rock is soapstone.
1900 N., 1400 W. (about). Depth to rock 27 feet, total depth 37 feet. A. T. 650. Ca low, Cl none, SO_4 low. Fe present in considerable amounts. D.
1500 N., 1950 W. Cl low, SO_4 strong. A. T. 644.

Section 11.

760 N., 100 W. Total depth 30 feet. A. T. 645. This well is in clay.

Section 14.

2000 N., 420 W. Depth to rock 40 feet, total depth 97 feet. A. T. 613. A. Malphus owner. There is sandstone or soapstone then water. SO_4 0. Ca and Cl low. Fe present. D. There is a dug well at the same place in clay, 18 feet deep. SO_4 none, Ca and Cl less than in deep well. No Fe. D.
50 N., 1400 W. Total depth 12 feet. A. T. 620. There is said to be a spring in the bottom of this well.

Section 16.

W. ½. Depth to rock 12 feet, total depth 217 feet. A. T. 640. At 80 feet a dark water was cased off. It is possible that this well should be in T. 17 N., R. 12 E.
700 to 1200 N., 1900 W. SO_4 strong. Total depth 33 feet to rock. A. T. 640. This is like Maxwell's well on Sec. 17.
1950 N., 800 W. Cl low, SO_4 strong. Depth to rock 35 feet, total depth 74 feet. A. T. 615. (1) This well was drilled by Hartman and Hill of Bayport. (2) This is a dug well.

Section 17.

50 N., 920 W. SO_4 strong, Cl med. Total depth 26 feet. A. T. 636. Alex Maxwell. Water burst in at the bottom of this well.
? N., 100 W. A. T. 640. Frank McArdle, owner. This is the same in quality as Maxwell's well.

Section 18.

50 N., 640 W. A. T. 627. This is a surface well.
1950 N., 1620 W. SO_4 strong, Cl strong. Depth to rock 28 feet, total depth 28 feet. A. T. 620.

Section 19.

1950 N., 640 W. A. T. 627. Total depth about 16 feet. This is a surface well.
50 N., S. ½ of S. E. ¼ of Sec. 19. Total depth 40 feet. A. T. 627. This well is hand drilled and the water is bad, i. e., strongly sulphated. Fisher, owner.

Section 20.

200 N., 50 W. SO_4 0. This well is dug and is 14 feet deep. A. T. 642.
1950 N., 920 W. SO_4 strong, Cl med., "like the well in Sec. 17." About 26 feet to rock, total depth about 26 feet. A. T. 636. J. Drummond, owner.
1990 N., 1920 W. Depth to rock about 20 feet, total depth about 20 feet. A. T. 626. Thos. Maxwell, owner. This well is similar to A. Maxwell's on Sec. 17.

Section 21.

1000 N., 1950 W. Total depth about 50 feet to rock. This is a dug well, but was once drilled. It has no water now.
1950 N., 780 W. Total depth 24 feet. A. T. 640. This is a dug well. There are no drilled wells nearby.

Section 23.

240 N., 1060 W. Total depth 214 or 217 feet. A. T. 640. Mrs. Harvey, owner. Mozier, driller.

Section 24.

1440 N., 1050 W. SO_4 trace, Cl low. Depth to rock 12 feet, total depth 100 feet. A. T. 632. At 12 feet a thin bedded, blue-brown, slightly bituminous fetid fossiliferous limestone or cement rock, as seen in creek, was struck; below this was soapstone rock (arenaceous, blue, ripple-marked, micaceous shale) and about 14 feet of sandstone at the bottom, 86 to 100 feet, i. e., the Napoleon or Upper Marshall.
1300 N., 1050 W. Cl 0, SO_4 low. Depth to rock about 20 feet, total depth 225 to 250 feet. A. T. 640.
950 W. SO_4 med.+ Cl low. Depth to rock 20 feet, total depth 80 feet. A. T. 620. This is Mr. Cody's old well which was only 14 feet deep at first. It passed through a few feet of (limestone) cement rock, then soapstone, and goes only about 2 feet in sandstone.
340 N., 950 W. A. T. 642. (1) Total depth about 200 feet. This well has 20 to 22 feet of casing. It passed through, first, plaster rock, then mainly all white sand-

stone. This well was at first drilled to 133 feet and it flowed freely at this depth, but when I. Heaton's well "broke loose" two years ago, on Sec. 26, this well went dry. (2) A dug well nearby showed plaster (gypsum).
50 N., 1060 W. SO_4 med.+ Cl trace. Total depth 100 feet. A. T. 642. This well has 15 to 22 feet of casing.
50 N., 1070 W. Total depth 22 feet. A. T. 642. The water in this well is much harder.

Section 25.

E. half of S. W. quarter. Depth to rock 20 feet, total depth 25 feet. A. T. 662. S. Shaw, owner.
400 N., 1050 W. Total depth 26 feet. A. T. about 662. This well was dug and blasted through plaster.
400 N., 950 W. Total depth 177 feet. A. T. 662. This is good water. It will make a suds, but the water is hard.
700 N., 1050 W. Total depth 40 feet. A. T. 660.
750 N., 950 W. Depth to rock 20 feet, total depth 140 feet. A. T. 660. This well used to flow but now the water comes close to the top. When it flowed the water was softer. This is significant probably; the flow came from the Napoleon, the Upper Marshall sandstone, and dissolved more or iess gypsum on the way.
1950 N., 560 W. A. T. 650. This is probably a drilled well, the water rose to the surface.
900 N., 1950 W. Cl low. Total depth, just to rock, ? 60 feet. A. T. 652. F. Gould, owner. The cost of this well was $60.00. Mosher and Erb, drillers.
1½ miles south of Soule. Gershom Wilson Smith, owner. This well is said to have passed through gypsum on top of cement.

Section 26.

1720 N., 940 W. I. Heaton, owner. The water broke out from this deep drilled well around the casing and made a spring in the river bank and stopped adjacent flowing well.
1950 N., 1400 W. Total depth 18 feet. A. T. 640. This is a dug well. It is also a spring in the side of the river valley.
1950 N., 1950 W. Total depth 30 feet. A. T. 642. This well was nearly dry in summer of 1895.
600 N., 1950 W. Total depth 153 feet, dug 20 feet. A. T. 652.
50 N., 920 W. A. T. 567. SO_4 strong, Cl med. Total depth 90 feet. 85 feet dug or cased. At first the water was salty, then cased off, but it is still strongly mineral.

Section 28.

640 N., 1950 W. Depth to rock 60 feet, total depth 157 feet. A. T. 647. The water is cathartic, strongly mineral and turns tea black, i. e., Fe strong, SO_4 strong, Cl med. +, Mg present, Sp. Wt. 1.002. This well passes through blue and black rock and at 120 feet strikes mineral water.

Section 30.

Probably S. ? E. quarter of S. W. quarter. A. T. 632. Total depth 120 feet.
1040 N., 1950 W. A. T. 627. SO_4 strong, Cl strong. The water is poor. Sp. Wt. 1.010. Total depth 22 feet. Newberry, owner.
1950 N., 1500 W. (1) A. T. 627. Cl strong, SO_4 strong. Depth to rock 40 feet, total depth 223 feet. Here are three wells belonging to W. McPherson of Berne. Drilled by Agnew of Fairgrove. At 100 feet was strong salt brine in bluish soapstone, at 200 feet black sandrock, water not so salty. At 210-223 pure white sandrock. It is now packed down at 130 feet, but is still salt (probably not packed well or low enough), Sp. Gr. 1.032. (2) Total depth 10 feet. (3) A. T. 625. Depth to rock 28 + feet, total depth 140 feet. The water was salty and was stopped up. This well was cased 28 feet, but not to rock. The well was muddy and went to 140 feet. (4) The water in this well is brackish, Sp. Gr. 1.003, total depth 22 feet.

Section 31.

1280 N., 1950 W. SO_4 strong, Cl low. Depth to rock 45 feet, total depth 45 feet. A. T. 632. W. Eichler, owner. The water came out of "soapstone."
1380 N., 1950 W. Total depth just to rock 43 feet. A. T. 632.
1380 N., 1900 W. SO_4 strong, Cl trace. Total depth 150 feet. A. T. 632. H. Bean, owner.
1860 N., 1950 W Depth to rock 51 feet, total depth 56 feet. A. T. 630. SO_4 strong, and at more than 60 feet depth there would be salt water. This well is through soaprock.
50 N., 240 W. SO_4 strong, Cl low. Sp. Wt 1.006. Depth to rock 54 feet, total depth 165 feet. A. T. 640.

Section 32.

50 N., 1780 W. SO_4 med., Cl low +. Depth to rock 63 feet, total depth 129 feet. A. T. 679. The other wells nearby are said to be deeper, i. e., about 10 feet in sandrock.
50 N., 1280 W. SO_4 med., Cl low. Total depth 140 to 145 feet.
50 N., 100 W. A. T. 645. This is a dug well, total depth about 30 feet.

Section 33.

100 N., 1950 W. A. T. 649.

50 N., 1480 W. A. T. 651. SO_4 0. (1) Total depth 7 feet. This was dug through gravel. (2) Total depth 14 feet. Gravelly.
50 N., 740 W. Total depth 12 feet. A. T. 650. This well is not to rock.
1950 N., 500 W. Total depth 33 feet. A. T. 650. This well is in sand and gravel.
1950 N., 1400 W. SO_4 trace, Cl low. Total depth 80 feet. A .T. 650. Down to 45 feet hard gravelly soil, 15 feet quicksand, 20 feet gravel. This well is piped to 80 feet.
50 N., 700 W., SO_4 0, Cl low. Total depth 15½ feet. This well is on a stony clay (till) rise.

Section 34.

Norton, owner. The water was very salt at first, then they drilled deeper.
1730 N., 90 W. Depth to rock 46 feet, total depth 250 feet. A. T. 642. This well passed mostly through slate, but went 18 feet (232-250) in sandrock. Olmstead, owner. The water is good and flowed freely.

Section 35.

10 N., 50 W. Depth to rock 20 feet, total depth 190 feet. A. T. 652.

Section 36.

1950 N., 1000 W. Depth to rock 20 feet, total depth 40 feet. It is 20 feet to rock with gypsum in the blue clay at 15 feet and in layers and great chunks just above the rock.

	Feet.
Cement rock	4
Gypsum	8
Hard rock	4
Gypsum	4

This well stopped in slate. There is generally a sandstone at 80 feet. The water was very hard and gypseous.

Meade Township (T. 17 N., R. 12 E. D.).

Section 2.

0 N., 720 W. Depth to rock 40 feet, total depth 40 feet. A. T. 693. This well is down to sandstone and belongs to Arnold. The well at the old saw mill on main road struck rock at 12 feet.

Section 3.

2000 N., 820 W. Depth to rock 30 feet, total depth 30 feet. A. T. 658. This well is not quite to rock.
2000 N., 1900 W. Depth to rock 20 feet, total depth 28 feet. A. T. 647. H_2, SO_4 none, Ca medium, Cl trace.

Section 4.

2000 N., 1220 W. Total depth 22 feet. A. T. 631. This well is to gravel.

Section 5.

1000 N., 2000 W. SO_4 none, Ca and Cl low. Depth to rock 8 to 18 feet, total depth 65 feet. A. T. 644. M. Dibb, owner.
SO_4 none, Ca and Cl trace. Depth to rock 6, total depth 20 feet. At the house of same owner, rock seems like a thick bedded compact sandstone. On the other side of the road rock at 6 feet, 14 or 15 feet drilling gives good water. The rock is very close to the surface three miles south of this place.

Section 6.

680 N., 0 W. SO_4 none, Ca and Cl traces. Depth to rock 4 feet, total depth 40 feet. A. T. 632. M. E. Parsonage, owner. Rock found in post holes in front of house at four feet from surface.

Section 7.

980 N., 0 W. Depth to rock 20 feet, total depth 23 feet. A. T. 651. The other wells in the neighborhood find about the same depth to rock.

Section 8.

920 N., 1950 W. Depth to rock 20 feet. A. T. 649.

Section 12.

2000 N., 1280 W. Total depth 22 feet. A. T. 704. This is a dug well.

Section 14.

S. W. corner. Depth to rock about 40 feet, total depth 60 feet. A. T. 700. Mark Colts, owner.

Section 15. (Napoleon sandstone near the surface.)

1950 N., 1950 W. Depth to rock 5 feet, total depth 6 feet. A. T. 685. This is a dug well and rock is only 2 feet below the surface near by.
1950 N., 1900 W. Depth to rock 4½ feet, total depth 21 feet. A. T. 665. The sandstone is thin bedded and greenish. Rock is also 4½ feet from the surface in the cellar of the house.

Section 17.

1040 N., 2000 W. Total depth 16½ feet. A. T. 642. They struck no rock in this well.
560 N., 2000 W. Total depth 20 feet. A. T. 642. There was no rock in this well.
2000 N., 140 W. Depth to rock 4 feet, total depth 12 feet. A. T. 667. This well passed through one foot of rock, then 12 feet of "clay." There was plenty of water in this well.
2000 N., 440 W. SO_4 none, Ca and Cl trace. Depth to rock 7 feet, total depth 10 feet. A. T. 650. The water in this well was abundant.
0 N., 1840 W. SO_4 trace, Ca low, Cl trace. Depth to rock 10 feet, total depth 24 feet. A. T. 658. 18 feet of this well was drilled by hand. This is a surface water.
In a prospecting hole in Sec. 19, 2000 N., 1300 W., rock is only 5 or 6 feet from surface, and is dark, compact, soft grained, with conchoidal fracture and weathers to a light color.
0 N., 1100 W. SO_4 none, Ca low, Cl slight trace, Fe present. Depth to rock 1½ feet, total depth 132 feet. A. T. 667. Henry Clark, owner. Mosher and Erb, drillers. This well passes through 5 feet of shell rock, 19½ feet of "cement" (argillaceous limestone), and then soapstone.
50 N., 1900 W. SO_4 none, Cl low. Depth to rock 12 feet, total depth 58 feet. A. T. 650. This well is cased 14 feet and 9 in. There was 20 feet of "cement rock" in this well and sandstone was struck at 52 feet.

Section 19.

There is an outcrop of "cement rock" Michigan series limestone, on Pinnebog river.
20 rods S. of corner. Depth to rock 13 feet, total depth 200 feet. A. T. 660. James Thompson, owner. Erb and Mosher, drillers. This well passed first, through sandstone, then cement rock 18 feet, then soapstone, then hardrock. The water was never pumped out of the pipe and it smells of decaying organic matter.

Section 20.

W. half of N. E. quarter. A. T. 670. W. H. Stephenson's well has grindstone within 3 feet of the surface.

Section 21.

S. E. quarter. Depth to rock 29 feet, total depth 34 feet. A. T. 703. Lackey, owner. This well was dug 25 feet and then drilled 4 feet to rock and then 4 or 5 feet in rock, when the drill dropped and water rose to within five feet of the surface.
0 N., 1140 W. A. T. 712. Depth 14 to 18 feet. E. Stephenson, owner.
2000 N., 1920 W. Total depth, just to rock, 16 feet. A. T. 680.

Section 22.

0 N., 1800 W. Depth to rock 28 feet, total depth 38 feet. A. T. 717.
1975 N., 25 W. SO_4 none, Cl none, Ca very low. Depth to rock 40 feet, total depth 47 feet. A. T. 720. This well is at Filion P. O., 50 feet south of the corner.
860 N., 25 W. A. T. 727. Total depth 40 feet.

Section 27.

0 N., 1160 W. Ca trace, Cl slight trace, SO_4 none. Depth to rock 24 feet, total depth 81 feet. A. T. 710. J. Church, owner. This well passed through sandstone and then shale.
2000 N., 460 W. SO_4 0, Ca traces, Cl low, tastes of Fe. Depth to rock 48 feet, total depth 56 feet. A. T. 717. L. A. Mosey, owner. The water comes to within 9 feet of the top of pipe which does not quite reach rock.

Section 29.

2000 N., 800 W. A. T. 692. SO_4 none, Ca trace, Fe present. Depth to rock 30 to 40 feet, total depth 171 feet. Philip Schad, owner; Erb and Soule, drillers.

Section 32.

2000 N., 640 W. Depth to rock 24 feet, total depth 87 feet. A. T. 692. Max Ritter, owner.

Section 33.

2000 N., 1220 W. Depth to rock 20 feet, total depth 58 feet. A. T. 699.

Lincoln Township (T. 17 N., R. 13 E.).

Section 5

0 N., 1400 W. Total depth 18 feet. This well is in clay. It is a dug well, there are no drilled wells in this vicinity.

Section 6.

Kinde. A. T. 702.
Mr. Hall, a banker at Bayport, has three wells, 11, 18 and 20 feet deep, respectively, all through blue clay into gravel and they each have plenty of water.

Section 18.

S. E. quarter of S. W. quarter. Desire Filion has a drilled well.
1400 N., 1950 W. Total depth 20 feet. A. T. 717. This well was dug 3 feet and bored 7 feet, in clay and quicksand. Jas. Penna, owner.
1900 N., 1950 W. A. T. 717. T. Rapson was to bore this well.

Section 19.

1780 N., 2000 W. Depth to rock 37 feet, total depth about 38 feet. A. T. 722.

Section 20.

2000 N., 1580 W. SO_4 none, Ca trace, Cl slight trace. Depth to rock 50 feet, total depth 55 feet. A. T. 717. H. S. Tilt, owner. Water is abundant in this well.

Section 22.

A little W. of the north quarter post. Total depth 21½ feet. A. T. 712. This well was through black loam, very hard red clay, blue clay, sand. It was dug just to sand. After digging the well was left dry, but next morning it had 16 feet of water in it. The water could not run a boiler a week. It had to be blown off for it was red, soapy and foaming. The water rose to 1 foot below the surface.

Section 30.

100 N., 50 W. This is a shallow well, dug 9 feet. A. T. 746.
75 N., 1700 W. Total depth 12 feet. A. T. 745. "This well is like a spring."

Section 31.

112 N., 1950 W. Depth to rock 40 feet or more, total depth 60 feet or more. A. T. 746. The water rises to 7 feet below the surface.

Section 32.

220 N., 1950 W. Total depth 13 feet. This, the old well, had 20 inches of water. The new well was 66 feet deep, and the water rose to 17½ feet below the surface. It was a mineral water, but not as hard as the surface water.

Bloomfield Township (T. 17 N., R. 14 E.).

Section 5.

1680 N., 2000 W. Total depth 30 feet. A. T. 690.? This well is in blue clay.

Section 6.

2000 N., 1580 W. Total depths 11 and 16 feet, in clay. A. T. 697.

Section 14.

20 N., 100 W. Depth to rock 30 feet, total depth 65 feet. A. T. 715. W. R. Stafford, owner. The water in this well is salty.

Section 17.

1250 N., 750 W. (about). Total depth 22 feet. A. T. 709. There are two wells here in clay. Wells in the region to the north are shallow in the clay, but there is as yet plenty of water.

Section 18.

0 N., 1120 W. A. T. 694. Total depth 22 feet. This is a dug well, no rock.

Section 20.

S. W. quarter of Sec. 20. Depth to rock 40 feet, total depth 150 feet. J. W. Kelly, owner. The water in this well is salty and comes to within 1½ feet of the surface. The well passes through 40 feet clay, 20 feet sandstone with water, 20 feet soapstone, 70 feet unknown, blue, hard, "kind of slate," between soaprock and hard rock.

Section 22.

200 E., 400 S. of N. W. Depth to rock 40 feet, total depth 135 feet. W. Wright, owner. A. T. about 732. Water was salty at 80-90 feet. There is no water in this

well now. The well passed through sandstone (shale?) and soapstone. Another report says 50-60 feet to rock, total depth 145 feet.

Rubicon Township (T. 17 N., R 15 E.)

Section 4. Port Hope.

A. T. 610. There is a salty shallow well at the hotel. There were also deep wells for the manufacture of salt.

See Geol. Sur. of Mich., Vol. V, Pt. II, p. 76, an abstract of the record is as follows:

1-16 feet drift.
Coldwater shales:
16-22 feet green micaceous sandstone, outcrops along shore.
22-532 feet blue arenaceous shales with occasional seams of sand rock.
532-533 feet hard rock, pyrite or siderite.
533-687 feet dark-blue shale.
687-716 feet arenaceous shales.
Berea Grit:
716-787 or 800-865 feet coarse whitish sandstone impregnated with strong salt brine.

Section 15.

700 N., 800 W. Total depth 13 to 14 feet in blue clay. A. T. 622.

Section 27.

S. W. quarter of N. E. quarter. Depth to rock 70 feet, total depth 103 feet. A. T. about 610. John Schmucker, owner. SO_4 trace, Ca and Cl low. This well is through blue sandrock. There is not much water and it is apparently from the clay.

3¼ miles W. of this there is reported a salt well. The well was not stoned and was abandoned. There is also a surface well near that of John Schmucker about 12 feet deep.

Section 35.

20 paces E. of shore road, 1850 N., 950 W. Surface well 12 feet deep. A. T. 622. John Hopson, owner.

Section 36.

20 paces E. of shore road, 950 N., 1950 W. SO_4 trace, Ca low, Cl med. Depth to rock 20 feet, total depth 23 feet. A. T. about 612. This well went through one foot of thin sandstone and the drill dropped beneath it. Wm. F. Burley, owner.

Caseville Township (T. 18 N., R. 10 E.).

Section 25.

S. W. of N. E., or Sec. 26, lot 4, perhaps more likely. A. T. 607. It is reported that they went through 40 feet of plaster on Mintline's place.

Near center, Cl 0. A. T. 607. Mr. Corless, owner. This is a dug well.

Section 26.

1950 N., 700 W. A. T. 612. Lot 4. D. Mintline, owner. It is reported that they went through 40 feet of plaster.

Section 35.

(2030 feet) 840 paces N. (2740 feet) 1950 paces W. There are various reports as to the total depth, viz.: 2200, 2300, 2270. (1) The first well of the grist mill was deeper than the rest, and gave a 96% brine and some gas. In this well at 18 feet they struck boulders with sandstone and had about 100 feet of it. The well was put down by Hiram Adams, and was one of F. Crawford's wells, Geol. Sur. of Mich., III, p. 94, 184, 201, V, p. 53. It was 2200-2300 feet down to third salt rock. They had to wash the pans when they used the brine from the various levels below 1800 to 2300 feet every 24 hours and later every 12 hours. Whereas before they only needed to wash every 48 hours to get rid of bittern. This shows the relative impurity of this lowest brine. From 1700 to 1800 was hard sandrock (the Berea Grit), another at 1900, then some clay and a streak of very hard rock with brine again at 2200 feet. This is probably from some horizon below the Genesee or Huron black shale. Compare from 2560 to 2740 in the deep Bay City well, in which the Berea Grit is at 2100 to 2260.

(2) 2300 feet N., 3880 feet W. A. T. 585. Curran Flach and Conley. Total depth 1800 feet.

At 8 feet rock.
At 18 feet sandrock, first casing to 20 feet.
23 feet sandrock.
10 feet blue clay and hardpan.
10-12 feet "hard rocks like flint with boulders," probably cherty limestone.
About "100 feet slate or shale."
About 50 feet gray sandstone.
At (165 feet) about 190 to 200 feet, a seam of coal.?
At about 300 feet black clay as per sample.

At about 400 feet a fine powder, like copper filings, mixed with clay. Casing hard to pull.

750 feet salt rock.

The well is cased to 800 feet (not far enough), shutting off this brine. From 800 feet down was mostly dark grey slate. At 1800 second salt rock. When the casing was pulled the water flowed out at first and even now is only 4 feet from the top.

(3) 1780 N., 3700 W. About 590 feet. F. Crawford, owner. Cf. Rominger III, p. 94, 184, 201. Total depth 1735, 1760, or 1750.

1-900 feet. "Principally through blue shale, sometimes through red shales with no important seam of harder rock in the whole interval." (This is not so.)

At 900 feet. Large body whitish rock with strong brine; "near bottom another supply." C. E. Wright says from 850 to 950 was sandstone, and from 1650 to 1770 sandstone.

J. Coreyell reports 2 to 3 feet bed rock, limestone shell and slate.

At 115-120, first sandstone.

From 125 to 150 sandstone with streaks of shale.

At 900-950 first salt rock, 80°.

At 1750 feet second salt rock, i. e.

From 1680 to 1765 sandstone.

(4) About 1600 N.? in Sec. 26. Total depth 1760. Pigeon River Furnace Company.

950 N., 1000 W. SO_4 strong. Depth to rock 40 feet, total depth 140 feet. A. T. 602. Well at Adams' store. There was a little limestone, then shale most of the way, then bottom in sandrock. The well at his house in Sec. 1-17-10 is about the same. Campau dug gypsum on his place, also something like gypsum was dredged from the river in blocks.

South part of Caseville. Total depth 48 feet. A. T. 607. C. Crawford, owner. There are "several kinds of rock" in the short distance of 48 feet, viz., "limerock, shale, sandrock, gypsum."

1800 N., 80 W. Total depth 14 feet. A. T. 612. This well is in quicksand.

Lake Township (T. 18 N., R. 11 E.).

S. E. quarter, 50 W. Total depth 12 feet. A. T. 610. This well is not to rock.

Section 18.

Lot 1, close to lake about 300 N., 100 W. Depth to rock 9 feet, total depth 100 feet or more. A. T. 690. G. M. Stewart, owner. D. Bullock, driller. 0 to 100 sandstone, then black slate, soapstone and red stuff, according to driller, or another report says all sandstone. Mr. Flach thinks that 4 or 5 inches of coal were struck, i. e., black slate, but Mr. Dufty says it was all sandstone and no coal.

Section 23.

50 N., 50 W. Total depth 10 to 12 feet. A. T. 624. (2) Depth to rock 15 feet; total depth 30 feet. This well was dug 15 feet and then drilled 15 feet, but they got no water.

S. W. quarter of S. E. quarter. Total depth to rock 4 or 4½ feet. A. T. 612. There is plenty of water in this well.

50 N., 1300 W. Total depth 9½ feet. A. T. 607. W. King, owner.

Section 24.

1780 N., 50 W. SO_4 trace, Ca low, Cl low. Depth to rock 20 feet, total depth 20 feet. A. T. 612. T. Welsh, owner.

Section 25.

1950 N., 1350 W. SO_4 low, Ca low, Cl low, signs of Fe. Total depth 18 feet in rock. A. T. 623.

Over 1000 N., 1950 W. Total depth 40 feet. A. T. 622.

Section 26.

0 N., 260 W. SO_4 none, Ca and Cl trace. Depth to rock 40 feet, total depth 68 feet. A. T. 638. Alex. Champine, owner. J. McLaren and C. Jones, Bay City, drillers.

1320 N., 2000 W. H_2SO_4 trace, Cl trace, Ca low. Depth to rock 27 feet, total depth 37 feet. A. T. 635. This well is first through shell rock (shale), then a harder one.

1950 N., 1360 W. Total depth probably 14 feet. A. T. 610.

420 N., 0 W. Total depth 36 feet. A. T. 632. This well was drilled part way.

1750 N., 1000 W. A. T. 612. Cl trace, SO_4 med. Ed. Sovereign, owner; D. Bullock, driller.

RECORD.

	Thickness.	Total.
Surface	7 feet	7
Black slate, perfectly dry, with coal at 42 feet, and at 60 feet and 12 (?) feet of "sulphur" pyrite, in the middle	80	87
Sandrock light grey	67±	154
Iron ore (compare this with the paint rock so often spoken of. Cf. Mauch Chunk shales or Catskill shale, and the Lower Marshall sandstones	100	254

1162 W., 1450 N. Cl trace, SO_4 strong. Total depth 100 feet. A. T. 612. Mrs. McKay, owner.

1100 N., 1400 W. The water is very hard. Total depth 13 to 18 feet. A. T. 607. "River sand" occurs at the surface.

Section 32.

50 N., 660 W. Wm. Dufty, owner. A. T. 622. (1) Depth to rock 40 feet, total depth 202 feet. The water rose at first to 3 feet, now to 20 feet below surface. Cl trace. SO_4 trace. At 40 feet rock, at about 80 feet sandrock, coarse at first, then whiter and finer to the end. (2) Depth to rock 40 feet, total depth 75 feet. Cl low, SO_4 strong. This is in dark slate, never in sandstone. There was a sinkhole near by thirty years ago, filled up with stumps and rubbish, but a second drop took place about 1883, like a well 6 feet across and 20 feet deep. A line of similar holes seem to extend E. S. E. It used to be a salt lick. These sinks are probably over a limestone, possibly gypsum.

Section 34.

80 N., 1820 W. Total depth 28 feet. A. T. 632. R. Gotts' three wells.

Section 35.

1925 N., 820 W. Depth to rock 23 feet, total depth 35 feet. A. T. 629. This well is 150 feet south of road.

2000 N., 1320 W. Depth to rock 26 feet, total depth 29 feet. A. T. 635. This well is opposite the last.

Section 36.

150 N., 1300 W. SO_4 none, Ca low, Cl low. Depth to rock 23 feet, total depth 53 feet. A. T. 637. There is also a dug well 27 feet deep.

Hume Township (T. 18 N., R. 12 E. D.).

1950 N., 500 W. Ca low, Cl low, SO_4 trace. Temperature 46° F. This is not a flowing well. This is probably one of Learned's drilled wells.

Section 10.

1605 N., 450 W. Brackish SO_4 med., Ca med., Cl strong, Fe present. This is an old salt well flowing slightly near Port Crescent. Williams, Eakins and Soule, owners. Hi Adams of Waukesha, Wis., driller.

About 1500 N., 1000 W. Total depth 1250 feet. This is a flowing well. The water is brackish, SO_4 strong, Cl strong, Ca strong, Fe present. Miss Haskell's well "from pipe N. E. of well;" 600 feet to mineral water now flowing; 1250 feet to bottom of salt well.

900 N., 10 W. Depth to rock 18 feet, total depth 20 feet. A. T. 612. Tom Clancy, owner. He has another well which is flowing. Total depth 23 or 29 feet. It was dug 18 feet, drilled 11 feet to a flow, through hard clay. There is no rock in this well, but I think it likely that the water is just above bed rock. Total depth 30 feet.

Carter, owner. This is a flowing well.

Section 11.

Most of the wells here are dug down to bed rock, and then holes drilled farther.

E. half of S. W. quarter. Depth to rock 12 feet, total depth 30 feet. A. T. 612. The water rises to about 8 feet from the top in dry times. John Clancy, owner. This well was dug 12 feet to rock and went 18 feet through grindstone.

950 N., 740 W. There are two surface wells here. Both went dry in 1895 and water had to be drawn from the lake.

1050 N., 840 W. Depth to rock about 22 feet, total depth 43 feet. A. T. 616. Sinclair, owner. 22 feet basin, 21 feet drilled, or another says 20 and 20.

1050 N., 1360 W. Depth to rock 12 feet, total depth 37 feet. A. T. 612. The water supply is constant but not large. This well has a twelve-foot basin to rock, probably shale.

Section 12.

1050 N., 1340 W. SO_4 0, Ca low, Cl trace. Depth to rock 5 feet, total depth 100 or 118 feet. A. T. 624. Ed Ahearn, owner.

950 N., 1260 W. SO_4 0, Ca low, Cl trace. Depth to rock 7 feet, total depth 80 feet. A. T. 628. Henry Conley, owner.

	Thickness.	Total.
Clay	7	7
Then 44 feet rock, no casing	44	51
Then 1 foot blue clay, *i. e.*, shale, but compare section at Hardwood Point	1	52
Rest gravel, etc (*i. e.*, conglomerate)	28	80

950 N., 1760 W. SO_4 0, Ca trace, Cl low. Depth to rock 6 feet, total depth 54 feet. A. T. 627. 14 feet basin. Rock is a soap rock, i. e., shale, hard at first but dissolves away. At 50 feet, sandrock with water, then a black sticky shale. All along this ridge it is but 6 feet to rock while down at the corner it is 18 feet to rock, which is a soapstone and bits of gypsum are reported in it.

1050 N., 1760 W. Depth to rock about 6 feet, total depth 54 feet. A. T. 627. This is similar to wells just south.

950 N., 1900 W. Ca traces, SO_4 low, Cl low. Depth to rock 18 feet. A. T. 617. The bits of rock about well site are blue micaceous flags or sandy shale.

1000 N., 1890 W. Depth to rock 6 feet, total depth 54 feet. A. T. 627. This well is through soapstone 50 feet to sandrock below which was a black soft rock.

1050 N., 50 W. Depth to rock 25 feet, total depth 398 feet. A. T. 639. Mr. Carpenter says that in going down they had to blast through 3 feet of grindstone, then underneath struck dirt and below this there was a crevice in the rock at 30 feet where they left off. Church Bros. report first a hard flint rock for a few feet, a sort of crust then a few feet of grindstone. At 200 feet about 15 feet of sandstone with no crust over it. Under this sandstone the shale was quite black for about 20 feet. The pumping water shows traces of oil. A coarse sandstone at 365 to 375 feet. Cl med., Ca strong, SO_4 strong, Mg Cl_2 probable, white kettle scale, Sp. Wt. 1.006. The well was 340 feet deep, Saturday night, June 7th, and 350 feet deep at noon, June 9th, apparently in a blue shale. Chas. Wright, owner. This well was deepened by Church Brothers. Reactions:

355. Citric acid gives no effervescence, H Cl trace; for SO_4 strong reaction.
365. Citric acid gives a trace, H Cl strong effervescence, for SO_4 only a trace of reaction.
375. In hot citric acid a strong, in cold citric acid moderate affervescence: trace of sulphate.
385. In citric acid traces of effervescence, in H Cl not strong, no sulphates.
389. In hot dil. H Cl traces of effervescence, sulphates present(?).

Section 13.

S. E. quarter of N. E. quarter. A. T. 648.

1360 N., 50 W. SO_4 med., Ca med., Cl med. Depth to rock 32 feet. Total depth 115. D. Ahearn, owner. This well was dug 32 feet in blue clay, probably 40 to 60 feet to rock which is soap rock. Another account says 118 feet in soaprock and sandstone.

30 N., 50 W. SO_4 med., Ca trace, Cl strong, Mg trace. Total depth 137 feet. A. T. 657. T. Walker, owner. The soil is a sandy loam.

50 N., 1210 W. Total depth not yet to bed rock 36 feet.

Section 14.

1500 N., 1050 W. A. T. 612. Depth to rock 7 feet, total depth 92 feet. Robert McAllister, owner. The water was June 26, 1896, 18 feet from top, but is generally about 15 feet from top, and is not enough for stock.

Depth to rock 50 feet, total depth 66 feet. A. T. 622. Ward's well.

Depth to rock 14 feet, total depth 55 feet. Wm. Starbeck, owner.

There are three or four feet of slate and at 14 feet brown rock, and 23 feet of solid rock.

A. T. 622. Total depth 25 to 36 feet. Ed. Gritzner, owner.

Depth to rock 7 feet, total depth 100 feet. Edward Haring, owner.

All the above wells are near by.

Section 15.

250 N., 1000 W. SO_4 trace, Ca low, Cl traces. Depth to rock 33 feet, total depth 47 feet. A. T. 612. This well was dug 23 feet and bored 10 feet, and the rest drilled. Wm. Kennedy, owner.

750 N., 950 W. Depth to rock 7 feet, total depth 83 feet. A. T. 608. This is on the farm next north and east of the last. Shell rock at 7 feet, four feet thick, and then 12 feet through to hard rocks.

About 1000 N., 1000 W. Cl and SO_4 traces, Ca low. Depth to rock 26 feet, total depth 56 feet. A. T. 609. This well was dug 26 feet and drilled 30 feet. Water is scarce on the east side of the road.

Section 19.

50 N., 900 W. Total depth not to rock 37 feet. A. T. 632. This well was dug.

Section 20.

S. W. quarter about 1500 W. Total depth, just to rock, 16 feet. A. T. 602.

740 N., 1000 W. Depth 15 to 20 feet to rock, total depth 42 feet. A. T. 607. Wm. Sawyer, owner. This well is dry in summer. In summer water is taken from spring hole 3 feet deep in shell marl, 100 yards back (W.) of the house in valley of Pinnebog river. SO_4 none, Ca low, Cl trace (in spring water).

1000 N., 1280 W. Total depth 18 feet. A. T. 608. This well is dug in clay.

50 N., 940 W. Depth, not to rock, 40½ feet. A. T. 620. This well is close to margin of valley.

Section 23.

1950 N., 400 W. Depth to rock 50 feet, total depth 66 feet. A. T. 640. SO_4 low, Ca low, Cl low, Mg trace. Ward, owner. Rapson Bros., drillers.

1950 N., 1050 W. A. T. 635. SO_4 low, Ca low, Ca med., Mg tr. J. R. Learned, owner.

1620 N., 950 W. Total depth 14 feet. A. T. 632. SO_4 trace, Ca med., Cl low, white kettle scale. Water is 6 feet below the ground.

900 N., 1000 W. Total depth 30 feet. A. T. 646. SO_4 trace, Ca low, Cl med. L. Scharizer, owner. This well is dug in blue clay.

900 N., 1000 W. A. T. 616. SO_4 trace, Ca low, Cl med. Depth to rock 40 feet, total depth 53 feet. This well passed through 3½ feet of sandstone, then gravel rock, and at very last clear hard rock.

900 N., 2000 W. SO_4 low, Ca low, Cl low. (1) J. Campbell, owner. This is a dug well. (2) SO_4 low, lower than No. 1, Ca low, about equal to No. 1. Ca low, more than in No. 1. This well is about 30 feet deep and probably just to rock.

Section 26.

0 N., 880 W. Total depth 14 feet. A. T. 662. There are other wells in the neighborhood of about the same depth. There is a layer of quicksand about 12 to 14 feet down, below clay.

Section 27.

1950 N., 340 W. Total depth 16 feet. A. T. 632. No. 1 at house.
1950 N., 300 W. SO_4 low, Ca low, Cl low. Depth to rock 8 feet, total depth 22 feet. A. T. 632. This well was dug 18 feet, then drilled 3 or 4 feet in stone. No. 2 is at the barn.

Section 28.

There are dug wells around here 15 to 30 feet deep which do not reach rock.
1900 N., 1240 W. SO_4 trace, Ca low. A. T. 622. This is a flowing well. T. 54° F. June 26, 1896. There are two springs in the place. Total depth 40 feet. This well was hand bored for 40 feet, the auger dropped a little when water was struck.
40 rods N. of the corner, i. e., 250 N., 1980 W. Total depth 50 feet. A. T. 627. This well was dug to sandstone and deepened in 1895. The water was abundant, and the sandstone was of a dark-blue color like grindstone. This answers to the Port Crescent samples.
1000 N., 2000 W. Depth to rock 50 feet, total depth 90 feet. A. T. 639. This well is at the school house. There are other deep wells in the vicinity of the school house.
740 N., 50 W. A. T. 639. H_2, SO_4 none, Ca and Cl low. This well is about the same depth as at school house (about 90 feet to rock).

Section 31.

1950 N., 1200 W. H_2, SO_4 trace, Ca low, Cl low. Depth to rock 30 feet, total depth 96 feet. A. T. 639. James Whelihan, owner. The rock is probably a sandstone.
1950 N., 1840 W. Depth to rock 30 to 40 feet. A. T. 627. Wm. Wheliham, owner.

Section 32. [Pinnebog.]

0 N., 720 W. Total depth about 46 feet. A. T. 627. It is not known whether this well is in rock or not.
0 N., 1280 W. Total depth 32 feet. A. T. 617. This well is not to rock.
0 N., 2000 W. A. T. 614. Smells and tastes of H_2S, SO_4 trace, Ca low, Cl traces. Total depth 110 feet. James Casey, owner. McLaren, Unionville, driller. The well is said to have flowed at the top of the ground with a strong stream when first dug, H_2S odor and taste not present until 1896.
Depth to rock 50 feet, total depth 87 feet. Dr. Sellers, owner. A. T. 617. SO_4 trace, Ca low, Cl trace, Fe present, slight H_2S taste. The rock at top is slate (shale), the rest is sandstone. The water rises to within 6 feet of surface. At one-fourth mile to south rock is 6 feet from surface. O. Erb of Soule, driller.

Section 35.

50 N., 1000 W. Total depth about 52 to 53 feet. A. T. 679. The water is not clear, milky, SO_4 absent, Ca low, Cl trace. Jerome Farwell, owner. This well is said to have struck rock at 9 feet. The water is not clear and is not used. The more it is pumped the more fine sand seems to come up so that the water is almost milky. The sand which settles first is very fine and micaceous. The drillers (McLean and Reed, of Bay City) said bottom of pipe was 6 feet in rock, which is doubtful. Something is wrong with the casing.
There is a well 14 feet in clay 8 feet south of last. SO_4 absent, Ca low, Cl trace.
250 N., 1050 W. Total depth 35 feet. H_2, SO_4 absent, Ca low, Cl trace. The water is milky. The well is "40 rods north of road on W. side." It is said by the drillers to be in rock.
1500 N., 2000 W. SO_4 trace, Ca low, Cl trace. Depth to rock 35 feet, total depth 120 feet. A. T. 661. The water contains much sand of fine grey color. A neighbor said rock was 35 feet from the surface. Thomas Lockman's well.

Section 36.

50 N., 780 W. A. T. 674. The water is abundant. Total depth 14½ feet. The well is dug in clay. Also several others in the same neighborhood with about the same depth and with abundant water.

Dwight Township (T. 18 N., R. 13 E. D.).

Section 1.

1560 N., 0 W. SO_4 traces, Ca and Cl low. Total depth 22 feet. A. T. 637. This well is at the barn and has 14 feet of water.
S. half of S. E. quarter. A. T. 646. (1) Depth to rock 4 feet, total depth 30 feet. This well went dry in the summer of 1895. W. Noble, owner. It was drilled 16 feet in a blue lime rock; in 6 hours it was 26 feet deep. (2) This is a well at the house, it used to flow, but does not flow now. It is 15 feet deep.
50 N., 1160 W. Depth to rock 22 feet, total depth 34 feet. A. T. 652. J. Walsh, owner. Half way back on this farm it is but 5 feet to rock; 11 to 13 feet of grindstone rock.

Section 2.

S. end of E half of N. W. quarter. Total depth 16 feet. Coal is said to occur in this well.

50 N., 1820 W. A. T. about 745. This well is probably 13 to 14 feet deep. Jas. Higgins says that "coal" in a blue-black shale and blue clay occur.
50 N., 1260 W. Water in this well is plenty. SO_4 trace, Ca low, Cl low. L. Total depth 14 to 15 feet. Another well is 18 feet deep.
50 N., 1200 W. Total depth, not to rock, 20 feet at barn.
1840 N., 0 W. Ca trace, Cl trace, SO_4 none. Total depth 90 feet. A. T. 636. This is said to have struck coal "probably through sandstone to a black rock." M. Cary of Badaxe, driller. There was sandstone near the surface, then blue clay 16 or 20 feet, after that blue rock. There is 65 feet of water in the well, and the supply is good.
1420 N., 0 W. Depth 16 feet. A. T. 635. There is no rock, the well is in sand. (2) SO_4 none, Ca trace, Cl none Depth to rock 4 feet. Total depth 10 feet. This well is at the barn in the same locality on property of H. O. Smith, Saginaw.

Section 3.

1900 N., 1420 W. Total depth, not to rock, 7 feet.
50 N., 1740 W. Total depth 10 feet, to rock.
50 N., 1320 W. Total depth not more than 10 feet.
50 N., 800 W. Total depth not more than 77 feet. This well is probably to sandstone. The S. W ¼ of this section is full of boulders and hard heads. From the south quarter post a ridge strikes N. E. on which the sandstone is near or at the surface. It is 4 to 6 feet to rock as shown by the ditches.
1950 N., 700 W. SO_4 trace, Ca low, Cl med. Mr. Sommerville, owner.

Section 5.

50 N., 1100 W. SO_4 and Ca trace, Fe trace, Cl low. Water rose to within 6 feet of the surface. Depth to rock 40 feet, total depth 121 feet. A. T. 628. This well passed through sandstone, then soapstone, then sandstone again. Good water was struck at 45 feet.

Section 6.

E. half of S. E. quarter. Total depth 30 feet, perhaps nearly to bed rock. A. T. 629. This well is through hard blue clay. When the water broke in it came to within 4 feet of the top of the well. C. Culhane, owner. SO_4 low, Ca low, Cl med. Total depth about 60 feet. P. Smeder, driller.
750 N., 1500 W. SO_4 trace, Ca low, Cl trace. Total depth 66 feet. Wm. Davis, driller. This well is now owned by Bleicher.
400 N., 1700 W. SO_4 low, Ca med., Cl low. Depth to rock 9 feet, total depth 10 feet. This well is 8 or 10 inches in rock, a greenish micaceous sandstone.

Section 8.

100 N., 1500 W. SO_4 trace, Ca low, Cl med., Fe trace. Depth to rock 40 feet, total depth 88 feet (other accounts say 100 to 103 feet). A. T. 639. This well passed through soaprock at first, then grindstone and sandstone. Homer Filion, owner; A. Rapson, driller. This is a flowing well. The water rose 2 feet above the surface, which is 10 or 15 feet above the stream valley, but below country level. It has now about one foot head.
1950 N., 1440 W. Depth to rock 42 feet, total depth 66 feet. A. T. 650. SO_4 none, Ca tr., Fe tr., Cl low; rises now to 10 feet below ground. W. McGargle, owner; N. Mosher, driller. There was lots of water at 28 feet before they came to rock.
1950 N., 1200 W. SO_4 trace, Ca low, Fe none, Cl less low than at McGargle's well. Total depth 27 feet. A. T. 652. This well is in a very blue clay, under which is water. There is also a dug well 20 feet, perhaps, to rock.
1660 N., 100 W. Total depth 18 feet. A. T. 630.
50 N., 400 W. Total depth 19 feet. A. T. 660.

Section 9.

50 N., 260 W. Total depth 16 feet. A. T. 662.
50 N., 660 W. and 860 W. A. T. 662.
50 N., 146 W. A. T. 662. The water stands at 4 feet below the surface. Total depth of well 14 feet.

Section 11.

1950 N., 1100 W. Total depth 19 feet. A. T. 645.
1950 N., 820 W. A. T. 650.
1950 N., 780 W. A. T. 650. SO_4 low, Ca med., Cl low.
1950 N., 380 W. A. T. 652. There are three wells on this place 18, 22 and 27 feet deep respectively.
50 N., 200 W. A. T. 672. There are outcrops of sandstone at barn and in the woods.

Section 12.

1950 N., 1360 W. Total depth to rock 18 feet. A. T. 652 feet.
1200 N., 1200 W. Total depth 5, 6 or 7 feet to rock.
50 N., 900 W. A. T. 662. SO_4 none, Ca trace—, Cl low. This well is in blue boulder clay, and not to rock.
50 N., 1420 W. Total depth 8 feet. A. T. 665. The water does not come in fast. This well is through very blue stuff. N. of the house in the hollow it is 22 feet to bed rock.
50 N., 1900 W. Total depth 14 feet. A. T. 672. This well is at the barn.
1700 N., 1900 W. Depth to rock 9 feet, total depth 23 feet. A. T. 646. The water

is brackish when pumped. The first well is 30 rods west of road, and passes through some conglomerate; the lower part is very hard. Surface water good. SO_4, Cl and Ca all medium when dipped from top. All strong when pumped. (2) Depth to rock 20 feet, total depth 30 feet. SO_4 and Ca are medium, Cl low. There is not much water in this well in the dry part of summer. It is 5 feet higher than No. 1, and 15 rods east of No. 1. (3) Depth to rock 20 feet, total depth 36 feet. This is at the house. It was drilled 16 feet in rock and it is thought "soapstone" was struck. No water. (4) Across the road is a well 30 to 35 feet deep. (5) Depth to rock 10 feet, total depth 23 feet. The water is brackish. This is in the same vicinity, dug a number of years ago.

Section 13.

1950 N., 1180 W. SO_4 none, Ca trace, Cl low. Depth to rock 7 feet. A. T. 662.
1900 N., 1180 W. Depth to rock 6 feet.
1900 N., 1700 W. Depth to rock 3 feet, total depth 6 feet. A. T. 662. This well passes through not more than 3 feet of shelly grindstone.
1625 N., 1700 W. Total depth 5 feet. A. T. 680. S. E. of the school house is sandstone at the surface.
520 N., 640 W. SO_4 none, Ca trace, Cl trace. Total depth 101½ feet. A. T. 697. Geo. Robinson, owner. There are outcrops of a massive sandstone like that of Port Austin close to the top of the well. At 20 feet there was "vein" of water, and at about 75 feet more water.
100 N., 200 W. Total depth 12 feet. A. T. 692.

Section 14.

1950 N., 200 W. Depth to rock 5 feet. A. T. 680. The water is not plenty in this well, which is at the barn.
1500 N., 200 W. Total depth to rock 9 feet. A. T. 680. This well is at the house near the road. 40 rods south it is only 2 feet to rock, so that they could not drive post holes.
1950 N., 740 W. Total depth, perhaps to rock, 28 feet. A. T. 680.
50 N., 520 W. Total depth, not to rock, 14 feet. A. T. 687. Spalding, owner.
400 N., 50 W. Total depth 20 feet. A. T. 690.

Section 15.

600 N., 100 W. Depth to rock 18 to 20 feet. A. T. 687. At 18 to 20 feet there is a coarse sandrock and the water rises to 4 feet from ground. At 35 feet there was a very hard, very white rock; at 36 feet a sand stream in a seam of the rock.
600 N., 150 W. Depth to rock 22 feet, total depth 25 to 40 feet. A. T. 687. This well was dug 22 feet and drilled 3 feet, and is without much water.
600 N., 50 W. Depth 5½ or 11 feet to water. A. T. 687.
1950 N., 640 W. A. T. 662. This well is through blue sandy clay.
50 N., 1440 W. Total depth about 12 feet. A. T. 698.

Section 16.

1950 N., 780 W. Depth to rock 12 feet, total depth 14 feet. A. T. 662. This well passes through 2 feet of sandrock.

Section 17.

1975 N., 400 W. SO_4 trace, Ca med., Cl med., no iron. Total depth 17 feet. A. T. 658. There was 12 feet of water in a well twenty feet deep, not to rock, near by.
1950 N., 1260 W. Total depth 16 feet. A. T. 654. There is 3 to 4 feet of water in this well.
950 N., 1260 W. Depth to rock 6 to 8 feet.
1140 N., 1950 W. A. T. 650. (1) Depth, just to rock, 32 feet. Whitechurch, driller. (2) Total depth 28 feet.
50 N., 220 W. Total depth 29 feet. A. T. 657.

Section 18.

50 N., 960 W. Total depth 25 feet. (1040 if R. R. is center line.) A. T. 650.

Section 20.

980 N., 220 W. Depth to rock 54 feet, total depth 181 feet. A. T. 652. At about 85 feet the main stream of water came. J. Bleicher, owner. Rapson drilled deeper after Kelly had drilled it to 55 feet with no water. They wanted a flow and therefore had to go deeper than otherwise for water. The rock passed through is bluish. SO_4 trace, Ca low, Cl med. No Fe.
1240 N., 1950 W. A. T. 652. SO_4 trace, Ca low, Cl low. Depth to rock 24 feet, total depth 48 feet. M. Fremont, owner. This well is at the house. Another well at the barn goes 30 feet without striking rock.

Section 21.

1980 N., 1780 W. SO_4 trace, Ca trace, Cl low. This water is unsuitable for washing. Depth to rock 30 or 40 feet. Total depth about 60 feet. A. T. 660. Wooster, owner.
50 N., 840 W. Depth to rock 18 feet, total depth 21 feet. A. T. 672.

Section 22.

1950 N., 1440 W. Depth, not to rock, 16 feet. A. T. 697.

Section 23.

1950 N., 1360 W. Total depth 9 feet. A. T. 688. This well is on the edge of a five-foot gully.
1950 N., 50 W. Total depth 14 feet. A. T. 690. This water is hard.
50 N., 50 W. Depth to rock 10 feet, total depth 10 feet. A. T. 689. This well is to sand rock, and could get no further. There are numerous large blocks of fossiliferous sandstone around here, especially on Sec. 26, which seem to be the outcrops or almost so. In post-holing, and also back on the north end of the lot the rock is shown to be surely in place.

Section 24.

1950 N., 810 W. SO_4 none, Ca trace, Cl trace. Depth to rock 7 feet, total depth 9½ feet. A. T. 690. This well is in soft rock, like sand.
300 N., 100 W. A. T. 677. SO_4 0. Ca trace, Cl trace. Total depth 90 feet. Mr. W. J. Wilson, owner. Tom Rapson, driller. The soil was sandy. At first this well was only 50 feet deep, but the water was not good, and the well was then put down to 90 or 96 feet.
260 N., 50 W. A. T. 672. Total depth 16 feet. This well is through boulder clay.

Section 26.

250 N., 1560 W. SO_4 trace, Ca and Cl low. Total depth 24 feet. A. T. 699. Wm. Robinson, owner. This well is in quicksand 40 rods north of road.
A. T. 689. The sandstone is near the surface at the northeast corner of this section.

Section 27.

0 N., 1640 W. SO_4 tr., Ca low, Cl low. Total depth 38 feet. A. T. 692. This well was dug 16 feet and bored with a two-inch auger to 38 feet. It is not in rock.

Section 28.

1950 N., 50 W. A. T. 646. (1) Total depth 40 to 46 feet. SO_4 trace, Ca low, Cl low. (2) Total depth 24 feet.
1950 N., 1500 W. Depth to rock 12 feet, total depth 15 feet. A. T. 667. This well is through sandy gravel soil; a 15 feet gully occurs just south.
1900 N., 1950 W. Total depth 18 feet. A. T. 662.

Section 30.

820 N., 2000 W. SO_4 low, Ca trace, Cl trace. Total depth 20 feet. A. T. 679. Joseph Thompson, owner. This well is in clay.
1480 N., 2000 W. Total depth 14 feet in clay. A. T. 682.
1040 N., 2000 W. Total depth 12 feet.

Section 31.

1950 N., 780 W. This water is not very hard. Total depth 14 feet. A. T. 682. Frederick Engels, owner. This well is in clay.

Section 32.

2000 N., 1600 W. Total depth 22 feet. A. T. 720. There are four wells here in clay to "gravel."

Section 33.

2000 N., 1860 W. SO_4 trace, Ca and Cl low. Total depth 18 feet. A. T. 698. Jacob Knaski, owner. This is the old saw mill well. There was quicksand at 18 feet, and the well is very full.

Section 34.

2000 N., 1340 W. SO_4 traces, Ca low, Cl low. Total depth 38 feet. A. T. 685. This well is dug 16 feet, and was bored with a two-inch auger to 38 feet. There was no rock.
0 N., 360 W. Total depth 30 feet. A. T. 710. This well is through gravel and clay to bottom of clay where the water broke through.

Section 35.

220 N., 0 W. Total depth 16 feet. A. T. 706. This well is in clay.
640 N., 2000 W. Total depth 22½ feet. A. T. 708. This well is through coarse gravel to clay.
Total depth 22 feet. This well is of the same character as the last and is in the same locality.

Section 36.

2000 N., 1960 W. A. T. 1663. There are two shallow wells here, one 8 feet and the other 12 feet deep in clay. There are no drilled wells in this neighborhood.

Huron Township (T. 18 N., R. 14 E. D. and L.).

According to T. Rapson there is a strip of country about 2 miles wide from Grindstone City to Sand Beach where the water is salty, the section being about as follows:
4 to 5 feet surface, then blue clay.
40 feet rock, a soapstone with a few feet (8-10) of sandstone.
At 100 feet we get salt water.
The wells around here should be 65 to 75 feet deep, if much deeper the water is too salt. In other words, soon after striking the Coldwater shales we get salt water.
Back of Huron City the depth to rock is 25 to 30 feet, total depth 70 feet. The surface wells are 12 to 14 feet deep. The deeper drilled wells are 60 to 70 feet deep. At 65 to 75 feet a sandstone is met, with blue clay above it and soaprock like the bottom of Willow Creek (i. e., shales) below.

Section 2.

150 N., 1400 W. SO_4 tr., Ca low —, Cl low. Depth to rock 3 feet, total depth 10 feet. A. T. 669. Wm. Bruce, owner. It is 3 feet to "shell" rock.
450 N., 320 W. SO_4 trace, Ca low, Cl low. The water is pretty hard. The depth to rock 12 feet, total depth 12 feet. A. T. 659. A. Morrison, owner. This well is at his house. He has a well at the barn 16 feet deep, just to rock, and in 1895 he was short of water.
500 N., 500 W. Total depth, just to rock, 4 feet. A. T. 650. This well is 30 rods back of barn.

Section 4.

1660 N., 640 W. SO_4 low, Ca low, Cl strong, Mg trace. Depth to rock 12 to 13 feet, total depth 18 feet. A. T. 611.
1660 N., 500 W. Total depth 14 feet. A. T. 611.
1600 N., 425 W. SO_4 low, Ca med., Cl med. + Total depth 40 feet. A. T. 636. This well was at Hubbard's barn, now owned by W. L. Phelps.

Section 5.

0 N., 760 W. SO_4 low, Ca low. Depth to rock 25 feet. A. T. 630. In this well there was shell rock 1 foot 10 inches thick and then grindstone. There was a seam containing water between the two.
900 N., 950 W. Total depth 23 feet. A. T. 632. This well was dug by Forbes.
760 N., 1050 W. A. T. 632. (1) Total depth, not to rock, 24 feet. Geo. Wressel, owner, at house. (2) Depth to rock 37 to 39 feet, total depth 63 feet. This well is in sandstone at the barn.
440 N., 1050 W. (1) Depth to rock 11 feet, total depth 15 feet 4 inches. A. T. 637. This well is in rock, a sandstone with a good grit. (2) Depth to rock 5½ feet, total depth 8 feet. A. T. 633. This well is back in the orchard and is lower by four feet.
220 N., 950 W. Depth to rock 5 feet, total depth 8 feet. This well is five feet to rock and goes through 3 feet of grindstone.

Section 6.

1560 N., 2000 W. A. T. 632. SO_4 trace, Ca low, Cl low. There are two wells here, one at the house, and one at the barn. They are 22 feet to rock, total depth 22 feet, and contain 14 feet of water.
260 N., 1000 W. Total depth 35½ feet. A. T. 637. This well was dug 23½ feet and drilled 12 feet. They did not find water. (2) Total depth 11 feet. A. T. 639. (3) Total depth, just to rock, 37 feet. A. T. 639. This well was dug 22 feet and drilled 15 feet, and was probably through grindstone. There was no water at rock.
50 N., 1640 W. A. T. 640. Total depth to rock(?) 22 feet.

Section 7.

1950 N., 400 W. Total depth 28 feet. A. T. 632. Thos. Colander, owner. This well is at the house, and is only to chunks of sandstone.
1900 N., 400 W. Total depth 21 feet. This well is at the barn. There is sandstone in stream 16 feet lower, not far off and blue slate is said to lie over it.
Depth to rock 25 feet or more, total depth 35 feet. A. T. 650. SO_4 tr., Ca low, Cl low, Fe 0. There is plenty of water in this well. McBrine, owner.
1300 N., 1500 W. Depth to rock 40 feet, total depth 60 feet. A. T. 642. From 10 to 40 feet there is blue clay. Chas. Schubel, owner.
About 2000 N., 2000 W. It is 26 feet to rock.

Section 8.

1920 N., 1000 W. Total depth, probably not to rock, 18 feet. A. T. 640.
1920 N., 1000 W. Total depth 13½ feet. A. T. 640.
1120 N., 900 W. Total depth 16 feet. A. T. 657. This well was dry in summer of 1895.
50 N., 1140 W. Total depth probably 14 feet. A. T. 650.
50 N., 1660 W. Total depth 22 to 25 feet. A. T. 657. This well used to be only 18 feet deep, and now goes probably to rock.
50 N., 740 W. SO_4 low, Ca low, Cl trace. Total depth 25 feet. A. T. 640. This well passes through blue grindstone with 1 foot 10 inches of shale at the bottom, with a seam of water between them.

Section 9.

0 N., 1160 W. Depth to rock 4 feet, total depth 5 feet. A. T. 621. This well is in stream valley.
0 N., 1780 W. Total depth, just to rock, 18 feet. A. T. 643.

Section 10.

900 N., 50 W. Ca tr., SO_4 0, Cl 0. Depth to rock 10 feet, total depth 15 feet. A. T. 663. This well was incomplete, and passed through soft slabby sandstone that could be handled with pick and shovel.
1240 N., 50 W. Total depth 9 or 10 feet, not to rock. A. T. 642.
1640 N., 50 W. Total depth 8 feet. A. T. 642.

Section 11.

1700 N., 1100 W. The water is harder than in the well north. (1) Total depth 16 feet at the house. SO_4?, Ca med., Cl low. (2) Depth to rock 4 feet, total depth 87 feet at the barn.
4 feet surface before rock.
12 feet dug in sandstone (Lower Marshall sandstone?).
87 feet drilled, but not enough water came to drill with (Coldwater shale).
There was no gravel in this well.
1700 N., 950 W. Depth to rock 4 to 6 feet, total depth 22 feet. SO_4 none, Ca tr., Cl tr., soft water. This well is right on front of the terrace close to a steep descent.
465 N., 50 W. This well is in rock, total depth 6 feet.
300 N., 1950 W. Depth to rock 8 feet, total depth 18 feet.

Section 12.

460 N., 1950 W. Total depth 13 feet. A. T. 632. This is a drilled well for 12 feet. The water comes slowly (probably in the shale).

Section 13.

750 N., 1950 W. Depth to rock 15 to 16 feet. A. T. 652. The last ten feet of this well was dynamited through fine grained sandstone (grindstone with streaks of blue shale), not very fossiliferous.
50 N., 700 W. Depth to rock 6 feet, total depth 18 feet. A. T. 652. A. Brinning, owner.
1900 N., 1200 W. A. T. 627. (1) This well is said to be in rock only 8 feet, total depth 32 feet, but the bluff nearby shows arenaceous shale close to the surface. (2) Total depth 22 feet. (3) Total depth 14 feet. The wells around here are never dry, but do not yield much water.

Section 14.

50 N., 200 W. Depth to rock 10½ feet, total depth 12 feet. A. T. 645.
100 N., 360 W. Total depth 4 feet. A. T. 645. This is merely a hole, and has poor water.

Section 15.

1900 N., 1600 W. SO_4 0, Ca tr., Cl low. Depth to rock 4 feet, total depth 16 feet. A. T. 676.
1900 N., 1120 W. Depth to rock 8 feet, total depth 15 feet. A. T. 683. This well has plenty of water. This well is in grindstone rock. Rock has been found in post holes between the two wells just mentioned.

Section 16.

2000 N., about 475 W. Depth to rock 16 feet.
180 N., 1050 W. Depth to rock 3.5 feet, total depth 15½ feet. A. T. 645. This well passes through 5 feet of rock and 7 feet of clay, then grindstone and water.
Depth to rock 7 feet. This is north of the last mentioned well and found water.
1500 N., 600 W. Depth to rock 2½ feet, total depth 12½ feet. A. T. 640. This well passed through 10 feet of sandstone, then grindstone, and is at the school house.
1900 N., 440 W. Depth to rock 16 feet. A. T. 649.

Section 18.

1900 N., 1100 W. Depth to rock 25 to 26 feet, total depth 30 to 36 feet. This well is in rock. Water around here is generally found at 8 to 10 feet in gravel.
980 N., 1000 W. SO_4 strong, Cl strong, Ca med. Depth to rock 52 feet, total depth 87 feet. A. T. 666. Evan Wade, owner. This well has been also reported to be 40 feet to rock and 60 to 80 feet deep. It goes through 15 feet of grindstone, then through soap rock or clay into sandstone again. In the bottom of the creek there is blue clay.
1600 N., 950 W. Depth to rock 52 or 53 feet, total depth 52 or 53 feet. A. T. 627. M. McDonald, owner. This well was dug 20 feet, and bored 32 feet.
SO_4 low, Ca med., Cl med. Total depth 7 feet. A. T. 627. This is a dug well at the barn.
1280 N., 1950 W. Total depth, not to rock, 19½ feet. This well is in clay.

Section 19.

1950 N., 1140 W. Depth to rock 22 to 23 feet. A. T. 653. This well is in clay to quicksand.

Section 21.

300 N., 950 W. Total depth 13 feet. A. T. 670. This well is in clay.
2000 N., 950 W. Depth to rock 10 feet, total depth 11½ feet. A. T. 642. There is 2 feet of grindstone in this well, then 1 foot of blue clay.
Depth to rock 11 feet, total depth 14 feet. A. T. about 642.
2000 N., 1900 W. Depth to rock 10 feet, total depth 14 feet. A. T. 652. This well is in sandstone. The rock is said to be 9 to 11 feet from the surface and makes a layer of sandstone 2 feet thick, then comes 10 feet of blue clay, then sandrock again. The clay probably represents shale.

Section 24.

1800 N., 1800 W. Depth to rock 10 feet, total depth 12 feet. A. T. 650. Tischendorf, owner.
1900 N., 1160 W. Depth to rock 6 feet, total depth 22 feet. A. T. 650. This well was drilled and blasted. A. F. Banker, owner.
1900 N. Total depth 14 feet. A. T. 650.

Section 28.

50 N., 820 W. A. T. 687. SO_4 tr., Ca tr., Cl low. Depth to rock 13 feet, total depth 16 feet. This well is at the house east of road, and passes into grindstone rock. There is a well 13 feet deep, just to rock, east of this one.

Section 29.

1750 N., 1700 W. 40 rods E. and 40 rods S. of N. E. corner of Sec. 29. H_2SO_4 trace, Ca trace, Cl low. Depth to rock 38 feet, total depth 52 feet. A. T. 692. Thomas King, owner; T. Rapson, driller. The rock in this well is probably grindstone for 12 feet, then soapstone.
1000 N., 1000 W. Depth to rock 28 feet, total depth 28 feet. A. T. 644. Mr. Gaine, owner. This well is at the edge of the stream ½ mile N. and W. of S. E. cor. of Sec. 30 (?).

Section 30.

50 N., 1720 W. Depth 16 feet. A. T. 691. This well is in gravel and clay.
50 N., 50 W. Total depth 26 feet. A. T. 684.

Section 31.

1950 N., 160 W. Total depth 10 feet. A. T. 684. In clay. There is 4 feet of water in this well.

Section 33.

1900 N., 700 W. Total depth, just to rock, 13 feet. A. T. 685. This well is to grindstone.
About 1500 N., about 1000 W. Depth to rock 13 or 14 feet.

Section 34.

2000 N., 500 W. Depth 10 to 20 feet. A. T. 691. This is the average depth for wells around here to grindstone rock.
0 N., 480 W. Depth to rock 7 feet. A. T. 704.

Gore Township (T. 18 N., R. 15 E. L.).

In a strip of country about 2 miles wide, water is salty at about 100 feet, for example, Weiss's well.

Section 18.

0 N., 1900 W.. A. T. 627. (1) W. H. Cole, owner, at house. Total depth 26 feet. (2) Water in a blue stony gravelly clay (till), cold but not abundant.

Section 30.

Cl med. Depth to rock 28 feet. A. T. 681. This well was bored but the tools stuck. Chas. Gettz, owner.

Section 32.

100 N., 1600 W. Depth to rock 30 feet, total depth 154 feet. A. T. 659. Cl strong, salty taste. F. Weiss, owner. At about 35 feet soapstone, a little water, no more was found in going deeper.

Section 33.

900 N., 1360 W. Wm. Schlaach, owner. A. T. 600. This well is said to vary with the wind, rising when the wind is off the lake. The well is close to the lake.

Port Austin Township (T. 19 N., R. 12 E.).

Section 25.

E. ½ of S. E. ¼. Total depth about 1200 feet. A. T. 592. This is the well reported by Rominger and Garrigues had drillings of it. See Vol. V, Pt. II, p. 75-76. Summary of record: 1-336 feet sandstones and conglomerates of the Lower Marshall, fresh water; 336-1120, blue shale; 1120-1160, red shale (Berea shale) at bottom; 1160-1225, sandstone, brine (the Berea Grit).

Section 36.

Depth to rock about 16 feet, total depth 40 feet. A. T. 616. SO_2 trace, Ca med., Cl low, red matter. This well went through 10 feet of sand, then red clay to rock.
Depth to rock 6 feet, total depth 80 feet. A. T. 610. 50 steps farther on, SO_4 trace, Ca low, Cl trace. Some parts of this well are blue stone, and from 78-80 is hard blue rock.
1000 N., 50 W. Depth to rock 2 feet, total depth 40 feet. A. T. 632. SO_4 0, Ca trace, Cl trace. Water comes in at about 5 feet. J. R. Learned, owner. There is a well near by about 7 feet deep.

T. 19 N., R. 13 E.

Section 23.

The section exposed June 24, 1896, showed 9 inches arenaceous shale, 3 inches conglomerate, 12 feet grindstone. There was a well according to Supt. Wallace,
800 N., 1000 W. A. T. 592, which shows 0-25 feet, grindstone, then soaprock, etc., at 80 feet brine in 3 feet of sandstone, at 95 feet soap rock. It is probably the same well as the following; also said to be at Eagle Bay: 0-24, sandstone; 24 to 54 soaprock, 54 to 78 feet sandstone, and the rest shale. The sandstone has conglomerate streaks, bits of coal and fish teeth. A well, 100 yards away is said to have shown coal, cf. Geol. Surv. of Mich., III, p. 71. Winchell also reports a pocket of coal as having been uncovered in grindstone quarrying. At the grindstone quarries, "there are 30 feet of soapstone, 24 feet of sandstone, and the rest is shale." 100 yards away there was another well with core.
340 N., 950 W. Depth to rock 5 feet, total depth 10 feet. A. T. 596. This is on top of a slight rise and goes into fine grained rock.

Section 25. Grindstone City.

1600 N., 600 W. A. T. 592. (1) This is at the present meat market, close to the station. See Vol. V. p. 62. The Berea sandstone is said to occur at 1010 to 1080 feet depth.
(2) In the present grindstone mill about 200 feet east, about as deep.
1600 N., 525 W. A. T. 592. In September, 1897. Church Brothers and Company put down, close to this well in the Cleveland Stone Company's quarry, a well for water. In the first ten feet some water was met in some salty shales which was cased off. Cf. E. Wade's well on Sec. 18, T. 18 N., R. 14 E. Then they went (360 + 75) 435 feet without getting water, i. e., in the Coldwater shales all the way.
1250 N., 200 W. Total depth 19 feet. A. T. 602. It is five feet to loose rock in this well, and 8 feet through grindstone to water, and then 7 feet of soaprock.
50 N., 1460 W. A. T. 612. At school house. This water is yellow. Pumping two pails exhausts the well. SO_4 0, Ca tr., Cl low. Drilled well.
1950 N., 120 W. 7 feet to rock. A. T. 599. The record at the quarry near by is as follows: 1 foot dirt, 1 foot loose stuff, 10 feet quarry, 30 feet from bottom of quarry to soaprock. There is no water in this well.

Section 26.

50 N., 1820 W. A. T. 636. SO_4 low (like R. Lundy on Sec. 34, T. 19 N., R. 13 E.), Cl med., Ca low, Mg trace. This is a drilled well.
50 N., 1280 W. Depth to rock 5 feet, total depth 112 feet. A. T. 632. SO_4 tr., Ca (lowest of the wells anywhere near) tr., Cl tr., Mg. tr. Wm. Nash, owner. This well passed through 5 feet of surface. 10 to 12 feet of sandstone, 20 feet of grindstone, 5 to 6 feet of soaprock, then grindstone and then soaprock, mainly, with hard veins and black stuff at bottom. There is black oil on the water. (The hard veins are probably nodules of carbonates or pyrite.)
50 N., 740 W. Depth to rock 4 feet, total depth 10 feet. A. T. 640. This well passes through 4 feet of drift, 6 feet of sandstone, then blue shale. In some places it is but 18 inches to rock on this farm.
1060 N., 160 W. SO_4 low, Ca low, Cl low. Total depth 20 feet. A. T. 603. Wm. Jackson, owner.
1950 N., 1900 W. Depth to rock 18.5 feet. Total depth 19 feet. A. T. 632. The water rose at first to 8 feet from top, now it is 14 feet from the surface, Ca low, SO_4 low, Cl med.

Section 27.

50 N., 1900 W. Total depth 10 feet. A. T. 622. There are four wells around here and they were dry in the summer of 1895. SO_4 low, Ca med., Cl strong, Mg low. Mrs. Kramer, owner. Some people like the salt taste of this well better.
50 N., 1760 W. SO_4 very low, Cl med., Mg tr., Ca med. (all less than in the ten-foot wells. Total depth 17 feet. A. T. 622. This well was drilled by Tom Rapson.
50 N., 800 W. SO_4 trace +, Ca low, Cl med., Mg tr. Brownish white scale of

carbonates on the kettle, pretty hard. Depth to rock 12 feet, total depth 90 feet. A. T. 610. Ed. Meagher, owner. This well passed through 12 feet of surface, 40 feet of sandstone with 2 to 3 feet of gravel bed (conglomerate) at bottom, 41 feet of soapstone. There was no gain in water supply in this last.
1080 N., 1900 W. SO_4 tr., Ca low. Cl low. Depth to rock 16 feet. A. T. 612.
1950 N., 1320 W. Total depth 8 feet. A. T. 612. This well is 2 feet in rock.
1950 N., 180 W. Cl low, SO_4 low, Ca low. Total depth 14 feet. A. T. 642. J. Hall, owner. This well is at the house and goes only into loose broken rock.
1950 N., 280 W. Cl low, SO_4 low, Ca low. Ca and SO_4 less than at house. Depth to rock 8 feet, total depth 10 feet. A. T. 642. This well is at the barn.

Section 28.

A. T. 610. Depth to rock 18 feet, total depth 75 feet.

Section 29.

(1050 feet) 400 N., 1990 W., A. T. 596. Railroad well. This is hard water. The record is by J. Pearson, Dec., 1895. Total depth 102 feet, soil, sand 5 feet, 95 feet rock, clay and water under.
(3040 feet N., 80 feet E.) 1150 paces N., 1940 paces W. A. T. 587. Total depth 1200 feet. SO_4 strong, Cl med., more Ca than lake water, Fe not enough to give yellow precipitate. Carrington's salt works has an abandoned flowing well.
(2) 1000 N., 225 W. Depth 1198 feet. A. T. 590. Ayres' well is similar, "second salt well in Michigan." Cf. Record given by Wright, Geol. Surv. Mich., V, p. 76.
1-275 feet sandy shale.
275-1100 feet blue and red shales.
1100-1200 feet porous sandstone.
The analysis of the brine is given in a previous section.

Section 30. Port Austin.

The wells around Port Austin are 60 to 100 feet deep and the rock is close to the surface. Some of the wells are flowing.
A. T. about 600. 13½ feet to rock, total depth 14 feet. Carpenter, owner. This well is 3 feet in gravel and 6 inches in rock. There are several wells about 14 feet deep, all similar, owner by Addison, Williams, Cartwright, and Latham.
450 N., 1200 W. A. T. 610. Depth to rock 16 feet, total depth 60 feet. (At the Methodist church the rock surface leaves the sand and begins to get clay on top.) It is about 16 feet to rock.
A. T. 802. Depth to rock 4 feet, total depth 75 feet. Ayres, owner. The record is from memory, white sandrock, slate rock with a darker black scum to water. Quite a streak to soaprock, grindstone, coarse gravel and sandrock.
400 N., 1000 W. SO_4 low, Ca low, Cl strong. Total depth 104 feet. A. T. 607. J. Buttars, owner. The water was cut off at 75 feet.
800 N., 450 W. Depth to rock 15½ feet, total depth 112 feet. A. T. 595. The water rose to 5 feet below the surface and there was plenty of it. Cl low, Ca low, SO_4 low, Mg, CO_2 present. The water left a red tea kettle scale. 96½ feet of the rock was blue stone, etc. Mr. Lundy, owner, on Spring street.
650 feet N., 900 feet W. 245 paces N., 337 W. Cl low, SO_4 low. Ca low. Depth to rock 12 feet, total depth 60 feet. A. T. 599. J. R. Learned, owner.
225 N., 150 W. Cl strong, SO_4 med., Cl med. Total depth 165 feet. A. T. 596. This well is at the barn and used to flow more than at the house.
300 N., 75 W. Depth to rock 10 feet, total depth 10 feet. A. T. 592. This well is at the creamery. There is a well 17 feet deep at the planing mill.
750 N., 710 W. Lot 20 of original plat. Total depth 90 feet. A. T. 590.
A water from Port Austin has Sp. Wt. 1.004. Cf. Learned's well. In a well ½ mile from shore, the water is said to be roily when the lake is stormy.

Section 31.

920 N., 500 W. A. T. 610. Total depth 17 feet. There is no bed rock in this well, but there is 10 feet of water.
160 N., about 500 W. A. T. 610. Total depth 24 feet. This well is through clay to sand and has 12 feet of water.

Section 32.

810 N., 50 W. Total depth, not to bed rock, 16 feet. A. T. 612.
1950 N., 1240 W. A. T. 612. Blue sand and clay were thrown out of this well.

Section 33.

1950 N., 300 W. Total depth 100 or 110 feet. SO_4 low, Ca low, Cl med., Mg low. The water is too salt. The well is at J. Ryan's house.
1950 N., 1840 W. Mg?, Ca low, Cl med., SO_4 low, Mg SO_4 rather marked. Depth to rock 17 feet, total depth 22 feet. A. T. 609. S. J. Murdens, owner.
1950 N., 1260 W. Depth to rock 12 feet, total depth 12 feet. A. T. 602. SO_4 low, Cl med., but less than at Murden's, not half as much Mg SO_4, but more Ca. This well was dug to rock. This is a flat ground moraine country.
1950 N., 860 W. Total depth, just to rock, 16 feet. A. T. 610. The well is sometimes dry. SO_4 low, Ca low, Cl med. +, Mg low.

Section 34.

E. half of N. W. quarter, 1950 N., 700 W. There is plenty of water in this well. SO_4 low, but more than in last well on Sec. 27-19-13. Depth to rock 21 or 18 feet, total depth 40 or 42 feet.

100 N., 100 W. Total depth 16 feet, not to rock. A. T. 627.
50 N., 1260 W. Total depth 22 feet. This well once went dry.
50 N., 1960 W. SO_4 low, Ca low, Cl med. Total depth 18 feet (just to rock?).
640 N., 107 W. Total depth 22 feet. V. Kula, owner (nearly to rock?).
1950 N., 700 W. A. T. 620. SO_4 low. Depth to rock near 21 feet, total depth 42 feet. R. Lundy, owner.
50 N., 740 W. A. T. 622. This is a shallow well.
50 N., 860 W. This is another shallow well.
50 N., 1260 W. A. T. 622. Total depth 22 feet. This well once went dry.
50 N., 1960 W. SO_4 low. Ca low. Cl med. Depth to rock 18 feet, total depth 18 feet. A. T. 617. This well is through clay.

Section 35.

1950 N., 1640 W. Depth to rock 8 feet (? a boulder), total depth 10 feet. A. T. 625. Wm. Underwood, owner. The well is about 6 feet above stream, which does not expose rock, SO_4 low, Ca low, Cl med., Mg low.
1950 N., 740 W. Ca tr, SO_4 tr. Total depth 18 to 20 feet. A. T. 640. This well is mostly through shale.
100 N., 1900 W. Total depth 18 feet. A. T. 627.

Section 36.

1950 N., 680 W. SO_4 tr, Ca low, Cl low. Depth to rock 16 feet, total depth 23 feet. A. T. 622. W. J. Harrington, owner. Drilled by W. Smith.
50 N., 1340 W. A. T. 629. Depth to rock 20 feet, total depth 23 feet.

Huron Township (T. 19 N., R. 14 E.).

Section 31.

1900 N., 900 W. SO_4 tr., Ca low, Cl med. The water rises to about 17 feet. Depth to rock, just 16 feet., total depth 100 feet. A. T. 616. Record as follows: 2 feet of soil, 14 feet of hardpan, 12 feet grindstone and the rest soap rock with seams of grit. F. Kinch, owner. There are also two other wells just to the rock 14 and 16 feet deep.
920 N., 50 W. Total depth, not to rock, 17 feet. A. T. 603. This well contains 10 feet of water.
160 N., 50 W. Total depth 24 feet. A. T. 618. This well is down in clay to sand and contains 12 feet of water.
1160 N., 50 W. Depth to rock 35 feet, total depth 40 feet. A. T. 607. 5 feet of this well is drilled in rock.

Section 31.

840 N., 1950 W. Total depth 13 feet. A. T. 624. This well is in clay.

Section 32.

500 N., 100 W. A. T. 607. This is a shallow well in gravel, practically a spring.
100 N., 500 W. A. T. 612. Total depth 40 feet.
A. T. 606. The New River salt well, vol. V, pp. 72-5.
1-15 feet grindstone.
15-45 feet blue shale.
At 90 feet salt brine, probably from the Point aux Barques lighthouse conglomerate.
45-800 feet alternate shale and sandrock.
800-900 feet rotten, bad smelling soft rock, including the Berea shale.
900-1000 feet porous coarse grained white sand rock, brine 85°. This is the Berea Grit.
1000-1029 feet blue shale. Bedford shales.
S. W. quarter of S. W. quarter. SO_4 low, Ca low, Cl med. Depth to rock 22 feet, total depth 39 feet. A. T. 604. Moses Thompson, owner. Through 17 feet of blue arenaceous shale. (2) Depth to rock 19 feet, total depth 21 feet. A. T. 607. This well is 2 feet in rock, 4 or 5 feet of sand came, then clay, hardpan and gravel. Dixon is said to have a well over 100 feet deep.

CHAPTER VII.

ECONOMIC GEOLOGY, OR RAW MATERIALS OF THE COUNTY.

§ 1. Introduction.

There are many things classed as raw materials which are not so. Pig iron is classed as raw material by the user of it, but it is the finished product of the furnace man. Wool is the raw material of woolen manufacturer, but the product of the farmer. The only real raw materials are those to which man has contributed nothing of value by his labor. They are the natural resources of the country, and their value cannot be separated from the value of the land which controls their production. We do not, however, intend in this chapter to be rigidly academic in our classification, but intend to supplement Chapter V by trespassing somewhat on the domain of the Commissioner of Mineral Statistics and giving some account of the principal industries that are or may be developed in the county, in their immediate geological bearings. As the great foundation industry is farming, it is fit that we should begin with some notes on the soils.

The map of the Surface Geology, which is given on Plate VIII, may also be taken, as is obvious from the explanation, as in some degree a map of the soils also.

§ 2. Soils.

It is impossible to make a soil map of a county which shall be really accurate and, even then it would be so only for a short time, without going into a detail expensive beyond reason. Moreover, any wise man will look at a farm for himself before buying it. In a previous chapter (Chapter III, § 6, and Pl. VIII), in describing the physiographic districts we have suggested the general distribution of soils. Some hints may be of practical advantage, nevertheless. If an early map of the county such as Farmer's be consulted, it will be found that a large part of the latter was described as swamp, and beaver dams are sometimes noted along the streams (Land Office

maps and early railroad surveys). As the land is cleared and drained, the swamp would disappear but the vegetable mold or muck e. g., southwest of Caseville and Badaxe would remain as the base of a fertile black soil if not removed. The great fires which swept the county have, however, largely burnt off this vegetable mold and all the native seeds with it, as noted in Chapter X, on the flora. Not only that, but even now it is quite common, as I have observed for example in Fairhaven and Winsor townships, in clearing up low land in dry summers to burn off all the old vegetable mold. Something of possible fertility is thereby always lost, and when as sometimes happens, especially in the western shore district, below the mold there is nothing but clean sand, the lasting fertility of the land is seriously injured by this carelessness. However, it sometimes happens that these swamps were once shallow ponds, like the cranberry bog back of Hat Point and on Charity Island, and the swamps south of Badaxe and north of Ruth. In that case under the muck are likely to come beds of shell marl which are extremely fertile. Such marly drained lake bottoms make the most fertile of land, and a number of ponds offer tempting opportunities for such drainage. Bear Lake near Port Austin has thus been drained quite recently, and the lake bottom is now said to yield two and a half tons of timothy per acre. Consequently on the map Plate VIII of the surface Geology I might easily have indicated the swamps as more extensive if I included all that land which had had a peaty black soil covering at one time. I have tried rather to indicate the more characteristically swampy parts, where it still exists and has considerable depth. On the other hand the map will soon be inaccurate the other way as the peat is burnt off.

The main soil of the county is clay, clay loam, or gravelly clay, and there are usually enough limestone pebbles scattered through it to keep it well supplied with lime and prevent souring. What Davis says about the greater amount of lime in the surface clay wells is significant. At the same time there is enough mica and feldspar to keep it well supplied with potash, so that its fertility will probably be quite lasting. In the area enclosed within the outcrop of the Michigan series where the water is sulphated, land plaster will not be necessary. The fertilizer most needed would seem to be phosphates like guano.

A word about the boulders and stones strewn over the surface in belts very often roughly parallel to the shores of the county. Out-

side the district of glacial deposits in the boulder benches proper these thickly scattered boulders are likely to prove superficial, and once picked up, the soil beneath may prove comparatively free from stone. In the hill district, however, the case is different, and some of the moraine hills are likely to yield their crop of "hard-heads" quite steadily. Sand dunes are indicated on the map, Plate VIII, by broken contours, as well as by the yellow dots assigned to sand, and I regret that the registration is not always all that it should be.

The least fertile soil in the county is that of the dune sands of the western shore. Yet it must be remembered that just such a soil in New Jersey has proven excellent material to hold plants upright while they were fed by fertilizers, and more money has been made out of small farms and small fruit in that region than can easily be computed. The sand region of Huron county is much resorted to about blueberry time, and when Saginaw and Bay City have a million population these sand dunes may be full of truck farmers. But successful farming on such a soil means fertilizers in large and frequent doses,—intensive cultivation. In the meantime these sands are not devoid of value for other purposes. Where the sand is thin, and this is frequently the case especially in the regions indicated as sandy above the Algonquin, 610 feet, level the soil with a light six inches of sand above and clay below is most excellent for farming, and more easily worked than the stiffer clays.

§ 3. Sand.

Frequently dune sand is too round for building purposes, but certain parts of the sands of the district we have just mentioned are tolerably sharp. This is probably because they have been derived with comparatively little handling from the sandstones of the Marshall, which have angular grains of sand. The only points from which I know of shipments are from Port Austin, shipped by E. M. Carrington, and from Port Crescent, shipped by Miss E. Haskell. Sands equally good probably occur at intervals from New River to Oak Point. This sand is largely shipped to the Lake Superior copper regions where it is used as a lining for the bottoms of furnaces employed in copper smelting and for repairs; it requires for this work a moderately clean and sharp sand of medium fineness. It should be nearly pure silica, but requires a trace of iron or some fluxing material sufficient to cement the sand in a mass under a very high heat,

but in no case melt it, or soften it so that any part of it will slag. It requires a sharp sand on the same principle that sharp sand will make the strongest mortar.

"The lake smelters have used 500 to 700 tons of this sand for a term of years, but are not likely to use so much in the future as there is a Pennsylvania sand that is more economical for the surface bottoms. The Port Austin sand will continue to be used for repairs."*

The sand from Port Austin and Port Crescent is "of the same quality, so far as we can see. The sand we get is shore sand washed up by the waves during heavy storms. That portion of the sand from any considerable distance from the shore is of no value to us*

There has been an analysis of the sand made but we have not been able to get it, and it has not been deemed necessary to make another as we are assured by the users, that next to its being nearly pure silica, the essential is its angularity. We do not know why it must be close to the waves unless that the farther it gets from the waves the rounder it becomes by rebounding; possibly the lime that exists in the water of the lake and would be deposited on evaporation furnishes just that minute amount of flux necessary.

An examination of the sand shows that it is mainly of quartz grains though little garnets and bits of feldspar, etc., occur. There is much less iron than many sands have. The form of the grains is sharp and much more irregular than in many sands, for example the Sylvania sand and similar beds. It is in other words nearly the sharp grits of the Marshall disintegrated by solution of the sideritic cement and not essentially rounded in rehandling. Besides being shipped to Hancock and Dollar Bay in the copper country it is also shipped to Toledo and Detroit. The price realized was in 1896 $1.00 a ton loaded or 40 cents unloaded. In 1897, at least 600 tons were shipped to Lake Superior.

From what has been said it is obvious that this sand would make an excellent mortar or all round building sand.

§ 4. Sandstones and grindstones.

The same angularity which we have just noticed in the sand is also to be noted as an important fact in the grains of the grindstones of the Marshall group. Like the Berea they may properly be called "grits." The principal use of the sandstone has been for

*(Letters of J. R. Cooper, Supt. Detroit and L. S. Smelting Works.)

whetstones and building, and the former use is so much the more important that we treat it first.

(a) The grindstone quarries.

The grindstone quarry industry was one of the earliest developed in the county. It was started by A. C. Peer in 1850. It has been mainly carried on by two firms. Mr. Peer's firm became Johnson Peer & Wallace, and later the Huron Grindstone Company with L. R. Wallace as superintendent. The other company is the Cleveland Stone Company with Geo. S. Robertson as Superintendent. In 1896 the Cleveland Stone Company had its main quarry on Sec. 24 and 25 and the Huron Grindstone Company on Sec. 23, T. 19 N., R. 13 E., but the coast all along to Sec. 30, where the quarry was in Winchell's time, has been worked over, the waste stone being thrown into the old workings, which have in some cases then been reoccupied by buildings. There is quite an area yet to be worked along shore, and apparently along Willow Creek the same or similar beds can be found. This stone has already been partly described in a previous chapter. The thickness of the most uniform bed is about 15 feet, and often the cross-bedding is entirely obscure, so that the rock seems perfectly homogeneous. This is the most valuable part. At other times the cross-bedding interferes with the production of large stones. Stones weighing up to 7,800 pounds, or say three tons, have been secured. I noticed one that had been abandoned for its original purpose and turned into a fine drinking trough, about 7 feet across. The face of the quarry is liable to check—crack—under the action of frost and therefore it is the custom to protect the face of the quarry with sawdust in winter. The best stone is turned into grindstones of various sizes, which are sold all over this country and even sent abroad, and are especially valuable for not glazing. This is due to the fact that the sharp angular cutting quartz grit is embedded in a softer cement of mica, siderite, clay, etc., which wears away just fast enough not to allow the rock to polish. It is the combination of evenness of grain, sharpness of grit, and cementing material just soft enough which gives this stone its peculiar value.

The smaller material is made into scythestones (Sp. 19017), and the waste material remaining is used for building and underpinning. For this purpose it is not so very well adapted, owing to its porosity, and tendency to check already mentioned. It is a much better grindstone than building stone. However, it has a pleasing color, blue to bluish grey, with a greenish cast, and has been more or less

worked up into caps and sills, etc. A number of underpinnings and one or two houses may be noticed in Badaxe made of this stone. The Sebewaing Marble Works also use it for sills to marble gravestones. Its fine grain and free working make it very amenable to the mason's chisel.

Underneath the sandstone layers come more argillaceous ones variously called blue shale, soaprock, etc., which are quite firm and being presumably less porous would, I should think, be even better for sills and underpinning than the main quarry. The underpinning of the Dunster block in Badaxe is, I understand, of this bed.

The following figures for which we thank Mr. H. W. Caldwell give the product of the Cleveland Stone Co. for 1898 and 1899:

From Grindstone City.		From Port Austin.		Description.
1898.	1899.	1898	1899.	
1,626 cu. ft.....	681 cu. ft.....	.....	.....	Block stone.
2,990 cu. ft.....	2,288 cu. ft.....	.....	.....	Sawed flagging.
3,307 tons.....	3,733 tons.....	.....	.....	Perch stone.
3,606 tons.....	3,855 tons.....	1,232 tons.....	1,576 tons.....	Loose grindstone.
6,320 pcs.....	11,292 pcs.....	5,292 pcs.....	8,532 pcs.	Mounted "
3,957½ gross.....	4,259 gross.....	1,316 gross.....	1,951 gross.....	Scythe stones.

(b). The Babbitt sandstone quarry.

This quarry was opened in the Napoleon sandstone near Rush Lake, on Lot 3 of Sec. 15, T. 18 N., R. 11 E. Mr. B. Smalley of Caseville was also interested in this quarry. An example of sandstone may be seen in the monument to the memory of his wife, Nancy M. Smalley, in the cemetery near Caseville, which was erected in 1887. Buckley in his report on the Building and Ornamental stones of Wisconsin* says that coarse pores are not as deleterious as fine pores. So here in spite of the high porosity of the stone (Sp. 19161, Table II, p. 90) the monument seems to have held its lettering well. The sandstone is rather coarse (grains about 1 mm. or one twenty-fifth of an inch in diameter), nearly white with a buff or olive hue showing minute brown points, which might on deeper quarrying prove to be weathered pyrite. It is at present owned by Mrs. J. W. Babbitt, of Ypsilanti, and has not been operated lately. Some of this sandstone has been shipped to Detroit, and may be seen in a house there.

*Bull. Wis. Survey, No. IV, 1898, p. 21, etc.

§ 5. Shales and clays.

The use of an argillaceous bed next to the grindstone for underpinning in the Dunster block opposite the Irwin House in Badaxe I have just mentioned, but in general the shales and clays are not firmly enough consolidated to make building material without farther treatment. In other words they are suited better for brick. Most of the clay of Huron county that I have examined have occasional little pebbles of limestone that cause a certain amount of loss in making brick, as in the burning process such pebbles slake more or less, and the escaping gas "bursts the brick, and there is a spot of slaked lime left as a weak spot in the brick." Such waste brick, however, make excellent material for road mending, and should be widely used.

The clay at Sebewaing is washed, as is more fully described below and in Vol. VIII, Part I. The clays are probably, like almost all the surface clays of the state, calcareous, containing much carbonate of lime in a finely divided state. This tends to produce white brick as it neutralizes the iron but such clays are readily fusible and cannot be burned hard without melting.

The shales, especially some of the beds of the Michigan series, seem quite plastic and pure, but it is dangerous to judge from churn drill samples. They are exposed extensively only by the coal working around Sebewaing, in connection with the grindstones as already described, thence south to the Point aux Barques lighthouse, and on Section 32 White Rock. Here they are well exposed in the bluffs for over a quarter of a mile, and also in a bed of a creek up to the road. This last exposure appears to be a very clean shale, and well suited for making high grade clay products. It is similar in character to the shales used for the manufacture of Portland cement in Branch county and should the marl beds back of the Forest Beaches or in Sanilac county prove to be extensive, it might well assist in the establishment of a cement industry. A description of the shales near White Rock and their tests, and analysis will be found in Part I of Vol. VIII by Prof. Ries, as follows:

White Rock.

Excellent exposures of Coldwater shale occur along the shore of Lake Huron between White Rock and Forestville (Part III), but they have not thus far been utilized.

The shale forms a line of cliffs, and when fresh appears brittle and gritty; in places, however, it has mellowed down to a tough clay.

The rock is a thinly laminated shale (179), which contains much sand of a very fine nature, and slakes slowly along the layers. It worked up with 19% of water to a mass of fair plasticity. The bricklets had an air shrinkage of 4%, and the briquettes had a low tensile strength of 36 to 42 pounds per square inch.

Incipient fusion took place at 03, vitrification at 3, and viscosity at 6. The total shrinkage when the vitrified condition was reached was 11%, the color being deep red.

An analysis of this material yielded to A. N. Clark:

Silica	58.70
Alumina	18.31
Ferric oxide	7.19
Calcium carbonate	1.80
Magnesium carbonate	.98
Alkalies	3.67
Water and organic matter	9.35
	100.00
Ferrous oxide	2.73
Total fluxes	13.64

Among the brickyards are:

(a). Warren's brickyard, Badaxe, on the east branch of the Pinnebog River, on the south half of the southeast quarter of Sec. 13, Colfax, T. 16 N., R. 12 E. This brick has been used for the jail, schoolhouse and private houses and banks in Badaxe, and the Wadsworth schoolhouse, and has been shipped as far as Port Austin, Harbor Beach, and Gagetown. The color varies from cream to red. The red are the outside of the kiln, the white inside, and the sandy clay under the main clay bed which is somewhat used also makes a whiter brick. Toward the top of the burning they become chalky, the top one or two layers of each burning being spoiled with the amount of mineral in the water. Of the refuse brick the better are used for scoving, i. e., outer casing of the next burning. The section of the clay used is:

One foot of clay loam, beneath which are 5-6 feet of clay, then sandy clay.

This clay is not directly connected with the present Pinnebog, but may probably date back to the time of the Forest Beach. About a

quarter of a mile west of the road on the east line of Sec. 13, it is said to become very bouldery with Canadian hardheads,—one or two as much as six feet long,—an old boulder bench.

In this yard the limestone pebbles are not as much trouble as the mineral water, i. e., soluble salts, the remedy for which Dr. Ries gives in his report, Part I, of Vol. VIII.

The yard has been at work some 13 years. In 1895, 300,000 brick were burnt, and it is thought to have averaged about 250,000 brick a year.

(b). Elkton brickyard, Ginter and Heist, on the southeast quarter of the southwest quarter of Sec. 3, T. 16 N., R. 11 E., near the west branch of the Pinnebog. Here the clay is directly from the valley of the Pinnebog, and is probably an alluvial clay, the section being $2\frac{1}{2}$ feet of dirt, under which lie 4 feet of clay.

At the south end is a bed which yields a light orange red brick (Sp. 19228), while the ordinary brick is of a cream color like Sp. 19223. Probably in the former bed some of the lime which neutralizes the coloring matter of the iron is leached out. They are more or less bothered with limestone pebbles, causing a loss in burning (Sp. 19224). The product in 1896 was 500,000 brick. The brick has been shipped as far as Unionville and Fairgrove, and may also be seen in J. Ryan's house in Badaxe.

(c). Sebewaing brickyard, Ernst Reinhold, on the southwest quarter of the southwest quarter of Sec. 9, T. 16 N., R. 9 E.

This yard is close to the valley of the Sebewaing and gives a red brick. They are removing the pebbles by washing. See report on clays and shales by H. Ries Vol. VIII, Part I, which also gives illustrations, as follows:

Sebewaing.

"The surface clay used at the Sebewaing brickyard is a river clay, and is overlain in places by dune sands. The upper two or three feet burns red, while the lower clay in the bank is very calcareous and burns buff. Both clays contain large quantities of lime pebbles, and they are especially numerous in a layer at the juncture of the two kinds of clay. In order to eliminate these from the red-burning clay it is treated to a washing process, which consists in putting the clay into a circular sheet iron tank, with water, and the mixture stirred by arms attached to a vertical shaft. The effect of this stirring process is to get the clay particles in suspension, while the sand

and concretions fall to the bottom of the tank. In front of the machine is a screen with half inch meshes, through which the washed and suspended material is discharged into a trough about 50 feet in length. At the end of this trough is another screen with one quarter inch meshes. After passing along this trough most of the sand is dropped, and the clay and water flow out into the settling tanks which have wooden sides and a sand bottom. The water evaporates from these and leaves the washed clay forming a layer about six inches thick in the bottom of the trough. While the clay is settling and drying in the trough the material being discharged from the machine at a later period is conducted into a second or third trough.

"It is stated that two men can put enough clay for 16,000 bricks through the machine in one day. This ingenious washing process is a highly important one, and could be utilized at many other localities in the state where there are red burning clays containing lime pebbles or concretions. It furthermore removes the coarse sand from the clay and permits of the production of a much smoother brick, a point which is serious when front brick are to be manufactured.

"At the Sebewaing brick works the clays are molded in a Quaker soft mud machine, dried on pallets and burned in scove kilns. While the product is chiefly common bricks still some pressed bricks are made in various shapes and sizes. Their surface is, however, unfortunately roughened by the use of very coarse molding sand."

The burnt product is shown by Sp. 19229 and the clay, which is coarser and sandier than some of the other clays, by Sp. 19230.

The following is the result of some absorption tests on bricks of this county which shows a high ratio.

Number of specimen.....	19168	19225	19226	19227
Locality.		Elkton yellow.	Elkton red.	Sebewaing red.
Absorption rates, i. e., ratio of weight wet to weight dry.....	1.25	1.29	1.17	1.17

(d). In the lower valley of the Pigeon, on the southwest part of Sec. 13, T. 17 N., R. 10 E., Caseville, New Hayes, P. O., Chas. F. Leipprandt had a brick and tileyard which he afterward sold to Chas.

(?) Steinman who moved it to the southeast quarter of the same section. This yard also yielded a red brick. There are numerous other places along the river valleys where clays equally well suited for brick making may be found. There are some not far from the town of Pigeon. These river clays are, however, quite variable in character. It is not likely that any of the surface clays will be free from limestone pebbles, and as adjacent counties are at least as well supplied with such material, that any brick made from them will find a very wide market. See p. 213 regarding paving brick.

§ 6. Road metal.

There is no feature more marked in the recent development of the United States than the attention paid to better roads. In view of the recent development of the bicycle industry, and the figures showing what a large proportion of the cost of shipping wheat to Liverpool comes in getting it to the railroad, the attention paid is amply justified. A few notes on the care of the roads may be of value. See also Part I of this volume. The essential thing in a good road is that it should be well drained, i. e., with a coarse and porous underpinning, and with a hard surface not likely to soften when wet. The cementing properties of limestone are valuable to produce the latter feature. There is ample material in the county for making excellent roads. The sandy roads of the shore should be mended with a clayey material. Clay is not bad; shale or argillaceous limestone is better. Around Sebewaing the burnt waste of the coal mines is used with excellent effect,—the best material of all. (Sp. 19236). In Missouri clay is burnt expressly for road material. Burnt brick waste will not be bad. An excellent road may be made from the limestone waste, though somewhat dusty.

In general, however, the roads tend to be too clayey. For such roads coarse gravel is a good material for road mending, and the old Forest Beach shore lines described in a previous chapter and more elevated gravels furnish excellent material which is largely drawn upon. The coarse material is better for road mending and is also good ballast for railroads. The presence of a considerable amount of lime and iron is of value as adding cementing power. Between 60 and 118 feet above present lake level are numerous other generally more sandy deposits. The Bayport limestone is largely crushed for macadam. Crushed boulders would also be excellent.

The possibilities of making paving brick have not yet been developed, but I may say that it is to the shales of the coal measures or Coldwater series of the eastern coast that I should look.

Dr. Ries makes the following report:

Sebewaing.

"The Michigan Standard Coal Co. has a shaft at the southern end of the town at which the coal is interbedded with shale.

"That over the coal is a brittle black bituminous shale with numerous nodules of pyrite, while that under the coal is gray and sandy. On exposure to the air it slakes readily to lumps the size of a hazel nut, but to get it finer requires grinding. Some of it was tried at the neighboring brickyard, and it was not found possible to melt it in the scove kilns.

"It was consequently thought desirable to test it physically.

"The sample collected (182) gave no effervescence with acid, and slaked very slowly in water. When mixed with 17% of water it gave a mass of good plasticity whose air shrinkage was 5%, and the air dried briquettes made from it had an average tensile strength of 100 pounds per square inch with a minimum of 90 lbs.

"In burning, incipient fusion began at cone 1, with a total shrinkage of 8%, the color being buff. It vitrified at 5, and became viscous at 9. The shrinkage at vitrification amounted to 13%. The soluble salts were .25%."

§ 7. Limestone.

The other material that needs particular notice is limestone. This has been used not only in macadam, but also as paving blocks.

(a). Bayport limestone quarries. See pp. 110 to 112.

The quarries now operated are upon Sec. 5, Winsor, T. 16 N., R. 10 E. As we have mentioned, similar beds lie near the surface to the southeast and to the northwest and have been opened on North Island. The present location is exceptionally favorable as regards drainage. The section of the quarry is given in Figure 8, and the general extent of similar stone may be seen on Plate VII the part above the 620 foot contour in the neighborhood being especially to be noticed. A number of test pits near the Shebeon on the east half of the northwest quarter of Sec. 14, T. 16 N., R. 9 E., show similar limestone, but at a lower level where the water would be more in the way.

An elaborate illustrated description of these quarries appeared in Stone for August 1898, by A. C. Benedict.

The main products of the quarries are limestone which is burnt into lime, paving blocks, crushed stone for macadam, and building stone. The top layers appear to be least magnesian, and hence best for lime. The analysis published in Vol. V, is from layer No. 1, p. 110, as follows:

Silica	3.330
"Oxide lime and alumina" (should be iron instead of lime)	1.334
Carbonate of magnesia	.944
Carbonate of lime	91.538
Phosphorus and sulphur	traces
Organic matter and loss	2 854
	100.000

(Quicklime, 51.29.)

With so low a percentage of magnesia, the lime will be a hot strong lime which will take much sand. Prof. Langley of Pittsburg says: "This is a very pure limestone and unusually free from anything except carbonate of lime. It contains nothing injurious to iron, and in my opinion will give entire satisfaction in the blast furnace." It seems as though picking of the upper layers might give the exceptionally pure limestone required in the soda ash business. The lower layers are undoubtedly more magnesian, and probably contain more bituminous organic matter. The percentage of Si O_2 is noteworthy. This is or was undoubtedly largely in the form of soluble, organic Si O_2 and some of the layers are saturated with it. It adds much to the hardness of the limestone and its availability for macadam, etc.

We quote from A. C. Benedict as follows:

"The upper sixteen feet in the quarries consist of even-bedded, homogeneous, tough, drab-colored limestone, followed by twenty feet of sandstone suitable for grindstones. This is followed by from thirteen to fifteen feet of fine brown-stone, which is underlaid by fifty feet of shale. A space of seventy-five feet was quarried to the shale for experimental purposes, and a fine quality of sandstone found.

The quarry may be divided as follows:

Ledge No. 1. 4 feet thick; used for macadam.
Ledge No. 2. 3 feet thick; burned for lime," (No. 1 of Fig. 8).
Ledge No. 3. 3 feet thick; building stone," (Nos. 2 to 5 of Fig. 8).
Ledge No. 4. 3 feet thick; building stone.

No 1 is drab, or dove-colored limestone, very hard and tough, used entirely for macadam, for which it is eminently fitted. The ratio of absorption, as determined by Prof. J. B. Johnson, C. E., Washington University, St. Louis, Mo., is one-half to seven-tenths of 1 per cent. Prof. Johnson's conclusions, after an exhaustive study of this quarry, is as follows:

'This is the strongest limestone of which I have any record. It is as strong as the best granite. It is also impervious to water, that is, non-absorbent as granite, and will weather perfectly. It is also as heavy as any limestone on record and as heavy as most granites. It is, therefore, an ideal material for all building and structural purposes, as well as for roads and sidewalks. For dressed stone it is rather hard, but for rock faced masonry it is perfectly adapted. A macadam road constructed of this rock (Ledge No. 1) crushed, properly graded, and well rolled, would make the best possible road for the country, or for the smaller cities and towns; and for cement sidewalks, a concrete made up of this rock crushed fine and used with Portland Cement, would be as good as the best "granitoid" walk in which granite is used.'

"Two carloads of Belgian blocks were placed in Tilden street, Saginaw, Mich., at the east end of Johnson street bridge across the Saginaw river, about eight years ago, and Stone recently examined this work and can testify that neither the traffic they have carried nor the elements have had an appreciable effect on them, except to make the top a little smoother than when fresh from the quarry. A material with this record certainly merits the careful investigation of users of this class of stone."

For macadam we need a tough non-porous, hard rock. Tests (Table II, p. 90) agree with Johnson that the Bayport limestone is in many layers practically non-porous, the water of the formation finding its way either in dissolved crevices or in the sandy layers. An excellent test of the utility of the rock for paving and macadam may also be found from its behavior under the drill. If with a core drill or churn drill progress be slow, and especially if with a core drill there be a large percentage of core saved, which comes out in large pieces, the indications are good. For example out of the first 28.3 feet drilled in the quarry hole No. 1, the aggregate of core saved was 18.4 feet, a portion of this loss being of earthy deposits between layers. In the lower grindstone layers more than half the core was lost, as this comparatively soft rock was broken up. A high crushing strength is also a desirable thing. A test at the Watertown Arsenal by Capt. Butler gave a crushing strength of 26,110 lbs. The weight was given as 170 pounds per cubic foot and specific gravity 2.72. A detailed description of these tests is quoted by A. C. Benedict in the article referred to. The specimen was 2.61 inches thick, with a compression surface of 29.65 square inches. It is true, however, as of all limestones, that this limestone is softer than iron and hence every concussion with iron wheels scrapes off a minute portion of white calcareous powder, so that such macadam tends to be dustier than that made from the more silicious rocks. Rain will dissolve this powder and soak it down to cement the macadam. In the opener country this dust will soon be dissipated, but in the city it may be unpleasant. Watering with the mother liquor of brines, or other solutions of salts that draw water would tend to check this tendency of this form of macadam. A number of the roads and the bicycle track near Bayport show what an improvement this macadam makes over clay roads. It has also been used in Saginaw.

This stone has been shipped quite a distance for building purposes.

We cite the following matter from Mr. Benedict's article. It must not be forgotten that his 3 and 4 are 2, 3, etc., of Fig. 8 and of Rominger's section.

"Nos. 3 and 4 are used for various building purposes. The following analysis, together with the tests relating to the crushing strength of the stone, show its

value for macadam, paving blocks for streets, cross-walks, curbing, sidewalks, foundations, bridge piers, buildings, etc.:

Carbonate of lime	61.52
Carbonate of magnesia	14.50
Sand	20.85
Clay	2.04
Phosphate of lime	.09
Bisulphide of iron	.15
Water	.85
Total	100.00

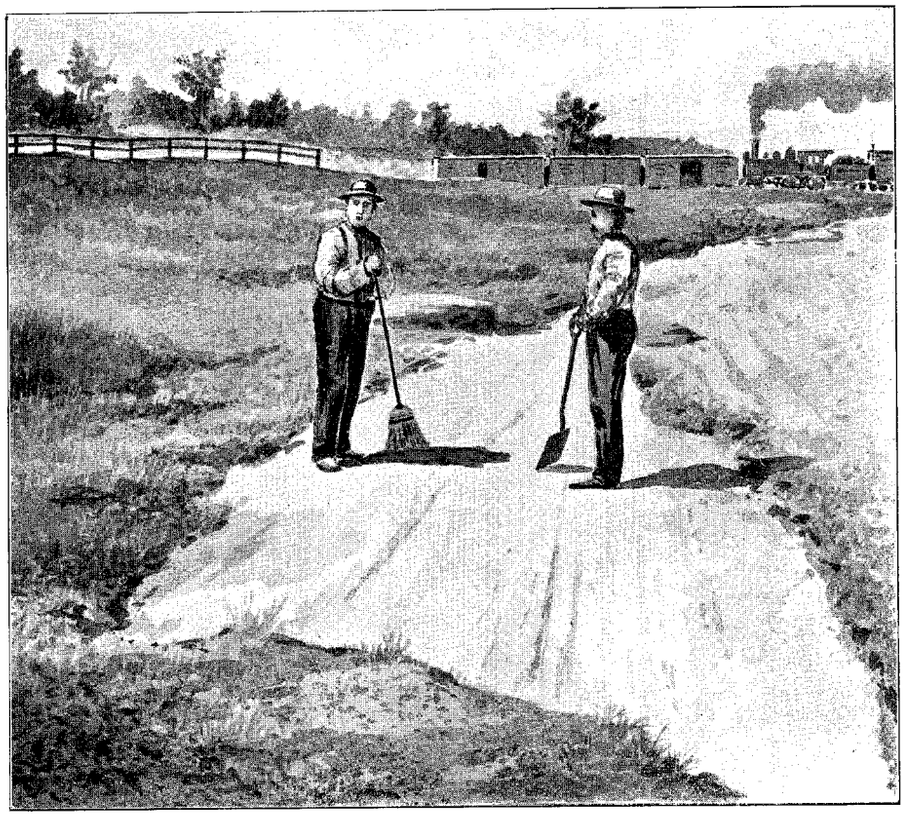
"This analysis shows the stone to be a magnesian dolomite with an addition of a notable amount of sand which gives it an appreciable power to resist the action of the elements, and also the abrasive effects of travel where it is used for streets or sidewalks. The low per cent. of water, which is a measure of its absorptive power, renders it practically frost proof and gives it unusual value for all outdoor uses. It is very compact, tough, even-grained stone of drab, or dove-color, certain layers of which with age bleach to almost a pure white, resembling marble, but with this advantage over marble, that it is so close-textured that dust, soot, etc., do not adhere to it, but are washed off by rains leaving a clean, fresh-looking face at all times. Tested both artificial and naturally by freezing processes it resists admirably, showing its high rank as building stone."

The station at Flint and the offices of the Saginaw, Tuscola and Huron in Saginaw are examples of its use. I do not think that any limestone is a very satisfactory building stone in cities where soft coal is in use, as it soon becomes dingy, but the dove-colored shades of the Bayport limestone harmonize not unpleasantly with the dingier smoke-stained parts.

(b). Soule limestones.

As I have remarked, near Soule there are outcrops of argillaceous limestones of the Michigan series. A good part of Sec. 19 in Meade township is owned by the Michigan Cement Company, which beyond some test pitting has done nothing to develop the property. It is understood to be under the same control as the cement quarries near Milwaukee. As may be seen from Plates VII and VIII, the northeast quarter of Sec. 24, and Sec. 18, in T. 17 N., R. 11 E., and Sec. 19, T. 17 N., R. 12 E., seem also to be favorably situated for development. Elsewhere the limestone may be below water level, though it might be found northeast of Caseville adjacent to water. The limestone (Sp. 19009, 19103, 19104, 19105, 19222, 19223) is extremely like the Milwaukee stone in appearance. I quote from the report of the Wisconsin Geological Survey* the description which may be applied word for word to our rocks, of the Hamilton cement rock near Milwaukee, which occupies a limited area near the lake and immediately north of the city. "In general lithological characteristics, it consists of a bluish-gray or ash-colored, impure dolomite, which weathers, upon exposure, to a yellowish or buff color, owing to the oxidation of the iron which constitutes one of its ingredients. The

*Vol. II, p. 395.



GLACIAL STRIÆ AT BAYPORT QUARRY.

impurities consist chiefly of silica and alumina. The rock is characterized in certain portions by the occasional presence of cavities in which occur crystals of pyrites and calcite, and, very rarely, zinc-blende. Crystals of the two former minerals are disseminated more or less through certain portions of the rock. In texture, it is somewhat varying, being quite homogeneous in some layers, and quite irregular and lumpy in others * * * In degree of induration, it ranges from rather soft to moderately hard. The beds are usually thick, with the exception of some portions, which are somewhat shaly." In the same report on the following page (p. 396) will be found a number of analyses of cement rock. See also Part I of this Volume. No analysis of the Soule rock has been made to our knowledge, but a bed similar in horizon near Grand Rapids analyzed by Rominger has a good analysis for hydraulic lime. In general it may be said that in a good hydraulic limestone there should be about 21% of insoluble matter classed as clay. This was told me by very successful manufacturers in Germany who were exporting their product to the United States and this agrees very closely with the proportions in the analyses of the Milwaukee rock. It must be remembered that common clay is largely finely divided silica (33%), with some hydrous silicate of alumina, so that most of the 21% will be silica. The percentage of carbonate of magnesia is generally considerably less than two-thirds that of carbonate of lime. Just at present, however, the manufacture of Portland cement, in which the exactly right ratios are obtained by mixing, is replacing that of rock cement.

Success in the manufacture of hydraulic cement means much more however, than merely finding a suitable stone. It means constant watchfulness, and continual analysis to secure a uniform composition, through grinding, and proper burning, and this is also true of Portland cement.

§ 8. Coal.

The thickness of the principal seam is from four to two feet and less in the area of the coal basin, and above it there are indications of a thinner seam. It is at times cut off by sandstones as previously described. The depth is from 80 to 120 feet, and the deeper we find it the more likely it is to be thick. The water which is associated is a serious detriment, but as I have said, I do not think it comes from above. If I were working I should be careful to avoid sandstones, either above or below, but I had as lief work under the lake

as not. In fact on some accounts I think that the coal might be thicker close to the lake to the southwest. All artesian wells like that at Oak Grove and the neighborhood for example, should, however, be cased off and avoided.* The main objection to the Sebewaing coal is its sulphur. The Sebewaing Coal Company say that their coal contains about 3% sulphur, and analyses of the product of the Saginaw Bay Coal Company are similar (Nos. 1 and 2 below).

TABLE IV.—TESTS OF SEBEWAING COAL.

	1.	2.
Moisture	4.46	4.82
Volatile carbon	47.92	44.58
Fixed carbon	40.45	41.52
Sulphur	3.06	3.38
Ash (probably mainly iron)	4.04	5.70
	99.93	100.00

Number	3.	3. Figured Dry.	4.
Location	Michigan Standard, Sebewaing.	.....	.....
Sp. Gr.	1.34	.....	.....
Moisture	6.09	.....	41.39
Volatile Combustible.	39.59	42.20	
Fixed Carbon	46.06	49.00	50.28
Ash	8.26	8.80	8.33
Sum	100.000	100.000	100.000
Total S	5.72	.....	5.80
S in ash	0.04	.....	0.05
Volatile S	5.68	6.05	5.75
S from Fe	.....	.....	6.52
Fe	.....	.....	5.71
C	68.07	72.49	.....
H	5.26	5.61	.....
N	1.49	1.59	.....
O	5.15	5.48	.....
Obs. with Calorimeter. Calories of heating power	7,070	7,520	.....
" " " B. T. U	12,714	13,538	.....

1 and 2, Saginaw Bay Coal Co., Vol. V, p. 84.
3. By H. J. Williams.
4. By C. H. Hilton.
This coal yields a coke of small volume fairly well fused. It is a coking coal.
Sample taken by H. Ries.

Since in 100% of (marcasite) sulphide of iron there are 53.3% sulphur and 46.7% iron, if all the sulphur of analyses 1 and 2 comes from

*Since writing the above an artesian well has burst into the coal mine at Sebewaing, making much more pumping in 1899, and the Sebewaing Coal Co.'s mine has been drowned out.

sulphide of iron there would have been 5.74 to 6.36% marcasite associated with the coal and the iron therefrom would when burned to $Fe^2 O^3$ make 3.82% to 4.23% of ash.

It is to be presumed that masses of solid "sulphur" or marcasite, such as often occur, were rejected, from analyses 1 and 2, as they are from the coal shipped. In the analysis of the Michigan Standard Coal above no such pains was taken, as the object was rather to get a fair sample of the coal seam as it occurred rather than as it was shipped. The marcasite if burned gives off much heat, and in fact it often catches fire spontaneously in the piles where the refuse to sulphurous coal is dumped. But while such coal makes a very hot steam coal (and tests have shown it to compare favorably with Ohio coals), the corrosive effect of the sulphurous fumes is disagreeable, making it unfit for gas making, passenger service, etc. The heating power measured in British Thermal Units, computed from the proximate analyses by the formula:

Heating power in B. T. U. = 146 (fixed carbon) + 147 (volatile carbon) + 40S would be: — 13,520 B. T. U. for No. 1; 13,210 B. T. U. for No. 2; and 12,767 B. T. U. for No. 3. This formula is an average one for Michigan coals. Kent's formula would give from the proximate analysis of No. 3 but 11,367 B. T. U. Dulong's formula would, however, from the ultimate analysis of No. 3 give 13,037 B. T. U. for the heating power of the same. The Sebewaing coal runs higher in volatile carbon and hydrogen than the Saginaw coal, as well as in sulphur.

At one time in the Jackson mines the miners were paid five cents a ton more for the "sulphur" or marcasite than for the coal. This sulphur is used in acid making, and it might be used in a fertilizer factory, but as there is a great deal to be found elsewhere, it could hardly be exported far. The most promising way of utilizing it would be in connection with some local industry or bone factory.

The Saginaw Bay Coal Company was the earliest producer, but was closed down by water. The Sebewaing Coal Company was still at work when the report was written, but succumbed to the same difficulty February 27, 1899. Maps have not been kept, but from the recorded output, and what I could learn of the thickness and extent of the workings, I have constructed a dotted line which may show the area within which the workings probably lay in 1897, within which area caution should be observed as to sinking wells, or

in advancing from any shafts hereafter to be opened. The field has been taken up by the Michigan Standard Coal and Mining Co., to whose manager, X. B. Konkel, we are indebted for information. The location of these properties is shown on Fig. 10. The Michigan Standard Coal and Mining Co. organized in October, 1898, and reached 4 feet 9 inches of coal at 92 feet depth on December 19, following. They have the coal rights for 300 acres which is said to be covered by 7 to 17 feet of hard slate roofing.

TABLE V.—STATISTICS OF COAL PRODUCTION.

	Saginaw Bay Coal Company. W. L. Webber, Pres.	Sebewaing Coal Company. S. O. Fisher, Pres. W. T. Chappell, Sec. and Mgr.
1890		
1891	10,635	
1892	16,800	
1893	13,820	
1894		38,523

In 8 months of 1899 the Michigan Standard took out about 5,000 tons and are hoping to make it 20,000 in 1900.

The coal is used mainly by railroads and others, as steam coal, and the Dorrance grate is especially recommended for use with it since with so much sulphur it is bound to run on the grate. No attempt has been made to use the associated clays, the only thing of the sort having been the use of the refuse for mending the adjacent sandy roads, for which it is well adapted, nor has the associated sulphide of iron been used. For farther description of the coal basin see § 2 of Chapter II, § 5, of Chapter V, and the records of borings in Sec. 7, 8, 17 and 18 of T. 15 N., R. 9 E. These records we have leave to publish now as the coal lands are pretty well known, and the records throw light on the prospects for water, and for shale industries, pyrite, etc.

§ 9. Ores, sulphides of iron, zinc and lead.

(a). Sulphide of iron, pyrite and marcasite.

The metals are frequently associated with sulphur as sulphides in nature, and these sulphides are frequently mined. The sulphides of iron have never, however, been utilized as primarily sources of iron, but as sources of sulphur or rather sulphuric acid they have a certain value (about $4.00 to $6.00 a ton at factory). I have already

mentioned that they occur with coal, and it is as a bye product of coal production that it is most likely that they will be of economic value. But they are by no means confined to the coal. They occur abundantly throughout the formation, nodules are common in the lower shales, and as already mentioned the sandstones of the Point aux Barques lighthouse are heavily charged with them. It is very common also to strike them in the wells, but from the nature of the case one cannot be sure whether the body struck is merely a nodule, i. e., irregular rounded mass, a form in which they frequently occur, or whether it is a more extensive bed. The top of the Napoleon sandstone is often heavily charged with sulphides of iron, and it will be noted that many of the wells around Tarry in Fairhaven township report considerable bodies of pyrite. The samples from these wells in Fairhaven township also show much pyrite. The sulphide of iron is likely to occur with the sulphides of zinc and lead, and when it does so occur it lowers the value of the others. The sulphide of iron must itself be quite pure to have any commercial demand.

(b). Sulphide of zinc, i. e., sphalerite, black jack or blende.

Small quantities of this mineral are very widely disseminated through limestone. It has a resinous lustre, good cleavage, and the powder has a dirty brown color, generally speaking. It is easily scratched with a knife. The lustre is so bright that a casual glance may not distinguish it from the sulphide of lead or galena, though they are easy enough to separate (p. 230). This mineral occurs in some quantity in limestones, probably of the Michigan series, in the adjoining county of Tuscola, near Cass City, and occurs as a mineralogical curiosity in Huron county (See Chapter VIII). Among the borings from Bauer's well, Sebewaing, I saw fragments from a cavity 118 feet down, i. e., near the top of the Bayport limestone, that showed specks of zinc blende.

(c). Sulphide of lead, galena.

This mineral has nearly the hardness and color of lead, but breaks into square angled pieces. At the time I was in Huron county there was quite an excitement as regards lead mining, and some explorations were carried on by Chas. Henning of Saginaw and others, with no success that I at present know. Since I made my examinations there have been reports of further explorations. The origin of the search for lead seems to be traditions of Indians finding it, so

that it seems to be worth while to sift these traditions, and see what they are worth, and what the real prospects are.

The traditions all agree that the Indians went off into the woods and would not allow themselves to be followed, but came back with lead that they said they had obtained. Now as the reduction of lead from galena is extremely easy this is not intrinsically improbable. From Port Austin they are said to have been gone three or four days and the direction they look led people to think that the lead ore was obtained along the Pinnebog. From Heisterman's Island they are said to have gone across to the main land. There are numerous reports as to their having been offered large sums to reveal the place.

Dr. W. C. Wright of Unionville, gave me a piece of galena, which he obtained from an Indian halfbreed in the winter of 1888, who said it came either from near the Shebeon or from a place where the Au Sable River cut through the formation.

Before we speak of the Indians farther we will take into account a few other facts.

Around Mosner's hotel were a number of pieces of galena which were said to come from near Shebeon.

Mr. George Schuch is said to have found a piece of galena in digging a well 18 feet deep in the drift, on Sec. 21, T. 16 N., R. 9 E. Mr. Lambert of Caseville, said he picked up a chunk of galena as big as your fist near the mouth of the Shebeon, on Sec. 11, T. 16 N., R. 9 E. Some of the samples from Collison's well on Sec. 15, T. 16 N., R. 9 E., show galena. (See record.)

Finally, I have seen a piece of lead, not lead ore, which was said to have come from a test-boring. This may have come thence, but must have been put there first. It is easy enough, not merely for the driller, but for any mischievous boy or anyone else, in any way interested, to drop something down a drill hole. We have therefore to take the evidence of churn-drill powder with caution. So, too, an Indian might be tempted to "fill up" an interviewer, especially if he thought the compliment might be returned and he himself filled up. Such a tale as that an Indian off hunting struck his tomahawk into an apparent stump to hold it, while skinning game, only to find a solid mass of lead, betrays itself as a work of overbold imagination.

But on the other hand we must consider that the reports unite in directing suspicion on the same formation, the Grand Rapids group,

—the Upper Mississippian,—the reports being without collusion, and by persons unacquainted with the geology, and that the samples of galena agree physically, being of the coarsely cleavable variety. When we consider, too, that zincblende, which is a common associate of galena is known to occur in this formation, and that the Upper Mississippian itself is in Missouri and elsewhere a well known producer of galena* we have a strong presumption that the Grand Rapids group is in Michigan also somewhat galeniferous. But in searching for deposits we must remember that Indians rarely if ever, mined, certainly never test-pitted, and what galena they may have obtained was almost certainly obtained from the surface. Again an Indian's time was worth very little, especially if in a congenial occupation. It is quite as likely as not, therefore, that they obtained their galena from the beds of streams or other surface deposits where experience had taught them it was to be obtained. Mr. Lambert's discovery and the Collison well samples, taken in connection with the fact that the Shebeon does cut down to the limestone, make that region, i. e., that colored on the map, Pl. VII, as underlain by the Michigan series or higher beds the most promising, but the plan of investigation which would commend itself to me would be that of panning, as the western miners do for gold, and seeing if the heavy residue at the bottom of such a pan showed signs of galena or rather of the heavy white carbonate into which it would be converted. At the same time it would be little extra trouble to watch the sand pump when a well is bored for water in the district most likely to show signs of galena, and perhaps sometime a well put down for water may show signs of galena sufficient to warrant the use of a core drill. I do not consider that the prospects of a paying lead mine warrant expensive exploration, or borings, for the express purpose of discovering lead, for the chances are decidedly that all the lead that has been discovered comes from pockets of no economic value. But any farmer's boy can do the panning suggested, and if the lower Shebon, Pigeon or lower Pinnebog gravels showed uniformly a considerable percentage of lead ore, the prospects for success would be improved. It is possible that the fissure which we have spoken of as cutting the Sebewaing coal mine, which seems to have concentrated the sulphide of iron along it, may lower down, where it passes through the limestone,

*Missouri Geol. Sur., VI, pp. 47, 150, 151, 157, 158, etc.

have served as a channel for waters which may there have deposited the other sulphides. And so the fault suggested by Mr. Wallace on Sec. 14, T. 16 N., R. 9 E., if it exists even as a mere break, may serve equally as a channel for the waters which concentrate ore bodies.

§ 10. Salt.

This was once a great industry and went hand in hand with the lumber industry, and as the one has declined, so has the other. The lumbermen are largely dispersed to Alabama, Minnesota, all over the United States, and the salt blocks are shut down. Only around Caseville, and around Owendale, does the lumber industry still linger. There was still quite a nice little area of pine to the east of Caseville, and some comes in from the south around Owendale. Flach and Conley of Caseville, have the only remaining salt blocks in operation in the county, when once there were over ten.

We give below a list of the companies, so far as we know, that have operated in the county. Up to 1887 Huron county produced about ten per cent of the product of the state. In the last decade it has dwindled to a mere local supply. We have endeavored to get the

TABLE VI.—STATISTICS OF THE SALT WELLS.

	Date.	Depths	Capacity.	Process.	
Tremain & Clark, Old Bayport, never in operation	1874	2,000	.....	.....	....
Frank Crawford, Caseville	.....	(1)	.....	.....	...
		1,760	.....	.....	....
		(2)	30,000	steam	....
		(3)	.....	.....	....
		2,270	.....	+pan	....
Pigeon River Furnace Co., (later Lake Huron Iron Company)	.....	1,760	30,000	steam	3
Flach & Conley (formerly Curran, Flach & Conley)	.....	1,800	.....	steam	6
Williams, Eakins & Soule, Port Crescent	.....	1,250	.....	.....	....
N. B. Haskell, Port Crescent	.....	.....	.....	.....	....
Ayres & Co., Port Austin	1863	1,198	20,000	pan	....
Ayres, Learned & Ayers (Skene well)	1875	1,226	.....	pan	....
M. Carrington, Port Austin	.....	1,200	.....	pan	....
? Grindstone City	(1)	1,000 ?	.....	.....	....
	(2)	?	.....	.....	....
New River Salt Co., New River	.....	1,029	15,000	pan	3
Port Hope Salt Co., (R. C. Ogilvie)	.....	787	20,000	pan	3
S. Jenks & Co., Harbor Beach	(1)	715 or	20,000	pan	....
		702 or	to	later	3
		900	50,000	steam	....
Huron Dairy Salt Co., 1886	(2)	1,920	.....	.....	....
Thomson & Bro., White Rock	(1)	555	20,000	pan	6
	(2)	700	.....	.....	....
	(3)	1,311	.....	.....	....

product more precisely, but have not been able to. The reports of the commissioners of mineral statistics have some misprints that we cannot straighten out.

The analyses of Chapter VI, p. 135, show the chemical nature of the brines. It will be noticed that the deep Harbor Beach well has a much larger proportion of other ingredients to the Na Cl (pure salt) than the brines from the Berea grit. This is also true comparing it with the shallower well at Harbor Beach, in which the Na Cl is over 98% of the solids (analysis 4). Though the wells at Caseville have not been analyzed, so far as known, a similar condition is indicated by the fact that Crawford's deepest well, which went down below the Berea grit and corresponds more or less therefore to the deeper Harbor Beach well, gave a brine so much more impure that they had to wash the pans every 24 hours, and later every 12 hours, to get rid of the bittern (which contains the chlorides of lime, potash and magnesia), whereas before, i. e., when it was only 1700-1800 feet deep, such washing was necessary only every 48 hours.

It will be noticed how comparatively free these deep brines are from sulphates. Now Leipprandt's 100 foot well, on Sec. 13, T. 17 N., R. 10 E.), which was quite salt and has been used for making salt for domestic use, and is said to make a pure salt though it needs to stand in the sun for a day to get rid of the iron (this is necessary for all brines), gives a strong reaction for gypsum, and this is characteristic of all the shallow salt wells.

In view of the vast fields of rock salt that have been discovered elsewhere in Michigan, which though they probably underlie Huron county, are many feet deeper than the deepest well, and in view also of the departure of the lumber industry, it is not to be expected that there will be any great revival of the salt industry. At the same time it will probably continue to supply a local demand unless crushed by some large association. The surplus is shipped outside, but the profits come from the local trade. Nothing has been done yet toward saving the by-products, the plaster and bitterns, and it is in that direction we must look for progress in the future. I have already suggested that there might be enough bromine and potash in some of the bitterns to pay for extraction, and it seems as though some of the bitterns might find uses as a base for disinfectant manufacture, etc. The calcium chloride has been used in putting up canned fruit,

and the county is an admirable fruit raising country. It is also used with water glass in making artificial stone.

The use of the refuse salts as fertilizers has a limit in this county owing to the fact that in the western part the soil is already rich in the same substances, but on the sandy strips, and in connection with manufacture of bone fertilizer and the use of the sulphur of the mines, there seems to be an opening for their use.

§ 11. Gypsum, or plaster of Paris.

This mineral is white when pure enough to be valuable and cleaves into scales of transparent friable flakes. It is soft enough to scratch with the finger nail.

Just across Saginaw Bay the gypsum quarries of Alabaster and Tawas Bay have long been known, but while it has early been observed by Rominger that the strata ought to extend into Huron county, but little has been known definitely in the matter. Here and there wells were supposed to have encountered gypsum, but drillers are likely to overlook it, when not going down to find it.

The work of the survey has put it beyond question that at least one considerable bed of gypsum does extend into the county and its probable extent is shown by a line upon Plate VII*, but it is nowhere exposed at surface. The few fragments of gypsum we have seen (Sps. 19004 and 19159) only show that there is some of good quality, but what the thickness of any certain grade may be, we do not know. So far as we can judge, it is everywhere covered too deep to permit of working by stripping and open quarrying but the southern part of Sec. 23, Chandler, and the neighborhood of Tarry near the center of Fairhaven, seem as good places to test as any. There has been quite an inquiry for plaster lands lately, but in view of other deposits, better known and quite as well located, the prospects are not too flattering. At the same time I doubt not that some time this resource of the county will be developed, when the prospects for pecuniary success are favorable, and it is certainly advisable that in all well-drilling throughout the district where the gypsum is liable to occur as shown on the map (Plate VII) an eye should be kept out for it, and as good samples as possible kept, as well as an idea of its thickness got, for its own sake, as well as to keep it out of the water.

§ 12. Marl.

Marl or rather bog lime is a white or bluish gray substance slimy

*See above Chap. V, § 3, pp. 100 to 103.

and sticky when wet, powdering when dry, which effervesces violently and dissolves largely in acids, and is found beneath lakes, ponds or marshes, and is often full of little shells, such as those listed in Chapter 10, § 2. Generally speaking, throughout the state the well and ground water contains considerable lime dissolved in the water as bi-carbonate. When this water finds its way by springs into ponds or marshes the carbon dioxide may be abstracted by plants (Davis), or sometimes escape directly, and carbonate of lime may be extracted by animals or precipitated directly if the loss of carbon dioxide to the vegetation or the atmosphere is sufficiently great.

It has long been recognized as a fertilizer, but usually the solids of Huron county have sufficient lime and its main application will be upon very sandy or sour soils. As a fertilizer no great purity is required and in fact most dictionaries refer to marl as a calcareous clay.

A new and important use for it has, however, sprung up in the manufacture of Portland cement. For this purpose it is wanted to be as pure $CaCO_3$ as possible, so that just the right proportions of clay can be added to it to make the best composition. Practically the dry marl should be not less than 9-10 $CaCO_3$. I have seen no marl as pure as this, but there are signs of the presence of marl in the marshes back of the Forest Beaches from Mud Lake to just south of Badaxe, and clear around to Ruth. It might be well to explore farther, as if there were much marl, especially just north of Ruth it could be worked in connection with the shale banks of White Rock.

Some other localities for marl are mentioned in the reports of various wells e. g. § 20, Hume township.

CHAPTER VIII.

NOTES ON MINERALS.

§ 1. Introduction.

It is the object in this chapter to gather together notes on the minerals as such. The mineralogy of the county, if we leave out of account the minerals that may occur in the drift, is very simple, and it would be possible to make it quite complete. But I have thought it would add to the utility of the report to the residents of the county, if I added few notes on the minerals which make up the rocks that are scattered as boulders upon the surface. As we made no extensive observations upon the drift, and almost any mineral rock or fossil that occurs in Canada or the whole lake basin is liable to turn up, transported here by the ice of the glacial sheet, or of the spring floes that drift here and there as the winds impel, this part of the work is very incomplete. I have arranged the work in this way. I have given each mineral a heading, taking them in the order in which they occur in Dana's mineralogy, and then taking each variety or different form of occurrence, have given briefly such characters as have actually been observed on Huron county specimens, and then appended the locations where the same were found.

§ 2. List of minerals.

Copper.—Copper-colored; can be cut, has a shining streak, tarnishes dark, and is likely to have greenish spots.

Mr. W. L. Webber has a piece about two ounces in weight which was found at the bottom of the stripping on top of the rock at the Bayport quarry. The stripping is of lake gravel, a water stage just above Lake Algonquin. The connection by water through to Lake Superior at this time is suggested. Label: "received March 10, 1887, from A. H. Wallace." The crystals of native copper referred to by Winchell (1860, p. 80) have not been verified.

Galenite. Pb. 86.6%, S., 13.4%. Lead-colored, metallic, easily cut, heavy, brittle, breaking into cubical pieces, weathers so as to have a

yellow coating. The occurrences have already been described in Chapter VII § 9 (c). None of them are satisfactorily authenticated, that is, there is no place where one can go back and be sure of finding even a very little galena. All of the finds may have been from drift deposits, except that in Collison's well. Galenite is most liable to be found in small vugs or cavities in the limestone.

Sphalerite. (Zn 67%; S. 33%). Lustre resinous to almost metallic; color deep yellow to black; very cleavable, the directions of cleavage being at angles of 60° streak rather dirty.

Found in the drillings from Bauer's well at Sebewaing; also (Sp. No. 19066) traces near the Point aux Barques lighthouse, with calcite replacing a shell; liable to occur under same conditions as galena.

Chalcopyrite? Cu 34.5%; Fe 30.5%; S. 35.0%. At the Point aux Barques lighthouse some of the pyritic matter seems from the copper blue-green weathering stains to show traces of copper, but the mineral as such has not been recognized.

Pyrite. Fe 46.6%; S. 53.4%. Brassy; in cubes or pentagonal dodecahedra, harder than a knife but brittle; powder greenish to brownish black; less decomposed and somewhat more yellow than marcasite, but also weathers fairly readily to sulphate of iron, or to hematite, in which case the rocks containing it smell sour and taste puckery. While pyritic matter is common in all the formations it is generally of the allied species, marcasite, which has exactly the same chemical composition but a different crystalline form, a lighter color and a greater readiness to change to sulphates. At the same time the two seem to be often intimately associated. I have pieces of coal in which marcasite seems rapidly to change to vitriol, while pyritic coatings on the faces near by remain untouched. Occasionally it occurs in vugs in the sandstone (Sp. 19011) in quite good sized crystals.

Marcasite. Like pyrite, but differing in crystalline form, and more readily decomposed. Some of the specimens appear very white on fracture, which suggests a trace of arsenic.

Abundant in the coal mines of Sebewaing, occasional in the limestones of Bayport, etc. Abundant in the shales in nodules and especially so at the Point aux Barques lighthouse, sometimes cementing the conglomerate.

Quartz. Si 46.7%, O 53.3%. Rock crystal, etc. This is the principal constituent of sand, and makes most of the pebbles of the con-

glomerates and gravels, and is most abundant in the boulders, and, is usually either colorless, transparent, or white and milky. It is the hardest mineral commonly met, and a steel knife will leave a metallic streak on it, and there is almost no trace of cleavage, the fracture being commonly glassy. When crystallized, it has the form of a hexagonal prism with triangular faces making the termination. In this form it occurs in the nodules of Charity Island (Sp. 19191), but is absent or rare around Bayport in the nodules, though many of the fossils and corals are composed of quartz.

Chalcedony. A variety of quartz, with a waxy lustre, and bluish to white tints, tending to have a botryoidal surface (composed of little round projections like a bunch of grapes or raspberries). Most abundant at Charity Island (Sp. 19191), and liable to occur elsewhere in the limestone.

Chert. Opaque gray silicious nodules, with a smooth conchoidal fracture and somewhat splintery, often tending to weather out into concentric shells. Occurs in the limestone (Sps. 19002, 19179).

Hematite. Fe 70%; O 30%: Red to steel-color; powder red. Occurs abundantly in the drift, associated with and coloring the blood red jasper which is so showy a constituent. It probably occurs at times as an alteration product of iron sulphides, but generally the mineral that results from these is limonitic, i. e., hydrous. Only once have I observed well developed hematite (Sp. 19020), near Hard Wood Point, lining a cavity. The bright metallic scales are arranged perpendicular to the walls of the cavity as in the specimens of grape ore that show a bloom.

The Lower Marshall sandstone is heavily charged with iron. Probably originally much was carbonate, but many of the flag layers have a blue or purplish color and give a red streak, showing that they are charged with hematite. Others are more altered and give the yellowish streak of limonite. (Sps. 19037, 19125, 19137, 19145.)

Limonite. Fe 59.8%; O_3 25.7%; H_2O 14.5%, Ochre and bog iron ore. Wide spread as iron rust, staining and coloring the soil and rocks. Davis has noticed that around the borders of bogs it is leached out of the sand by organic matter, to be deposited at the bottom. Specimen 19174 of bog iron ore shows the effect very characteristically. There are bright irregular seams which look like black varnish, yet give a yellow brown powder, embedded in a yellow brown ochre. The Marshall sandstones are often very heavily charged with limonite. Sometimes a concentric structure can be noticed, the original

green or blue shale lying in the middle, while there are brown lines around it as the weathering to limonite works in (Sps. 19089—19094, 19069).

Wad. Impure ore of manganese. Specimen 19174 gives no reaction for manganese, but Sp. 19158, which is probably from Tuscola county and is a blue black earth with calcareous pebbles, does. Similar deposits might be expected near Soule.

Calcite. CaO 56.0%; CO_2 44.0%. Effervesces in vinegar; soft, being readily cut with a knife but not with the finger nail; cleaves readily into small rhombs with faces making an angle of about 75° with each other. Crystallized it occurs best developed in vugs or in nodules in the Bayport limestone (Sps. 19002 and 19005). In these cavities there are two forms side by side which look different enough to be different species: (1) Dogtooth spar, in small white pointed scalenohedrons; (2) Generally older, more transparent but brownish crystals, in which 2R is the predominant face, though a number of other faces, and a twinning also appear. These crystals from their brown color and occasionally iridescent tarnish would be taken at first for some other carbonate, but in reactions with acids and in specific gravity they agree with calcite, and not with the magnesian or ferriferous carbonates, so that the different appearance must be due to a trifling percentage of impurity (organic matter ?).

Calcite also occurs quite commonly in small crystals lining the cavities of fossils, especially in the chambers of Goniatites (Sp. 19010 and 19018).

Calcareous tufa, a recent deposit of calcareous springs, looks at first glance more like old bone than anything else (Sp. 19107). In a massive form calcite composes the limestones, and limestone pebbles are widespread through the drift. The outcrops of limestone have already been described.

The other carbonates, now that what I took to be ankerite proves not to be such, have not been recognized in crystalline form, though dolomite doubtless exists as does certainly the massive form.

Dolomite. CaO 30.4%; MgO 21.8%; CO_2 47.8%. Less briskly attacked by acids than calcite and slightly heavier; similar in cleavage and hardness. Certain beds in the Bayport limestones are decidedly dolomitic. Generally such beds are darker and browner.

Spherosiderite. Fe 48.3%; O 13.8%; CO_2 37.9%. Concretionary iron ore, characteristic of the Lower Marshall, forming balls which turn to limonite on exposure, always more or less impure and acting as a cement to the sand. Specimen 19011 shows the balls well, but many

others of the Lower Marshall specimens effervesce slowly with acids, rapidly coloring the acid yellow.

Feldspars. Alumo-silicates of potash, soda, and lime, not quite as hard as quartz, generally white or light colored, with two cleavages which are not equally good and are at nearly right angles. Common among the drift pebbles, making with quartz the principal constituent of the granitic rocks. In the conglomerates it seems often to have changed to kaolin, and yet sometimes the feldspar is fresh enough so that the cleavage facets show well.

Pyroxene group, found in the drift only, in dark colored boulders.

Amphibole, or hornblende. Silicates containing alumina and magnesia, and usually iron, lime and a little soda.

A common, perhaps the commonest dark constituent of the boulders, usually dark green, giving a light powder, and showing a prismatic cleavage; gives a somewhat silky lustre when closely examined.

Garnet. Silicates of alumina, lime, and, in usually less quantities, of lime, magnesia and iron.

In small pink granules this is a common constituent of sand, and occurs in the drift formation. It is more marked in the residue left by panning.

Epidote. A silicate containing lime, iron, alumina and water; green to yellow-green, only in the drift, or in sand as yellow-green grains?

Mica. Silicates, containing alumina, water, and potash and soda or magnesia and iron, the darker ferriferous ones being often grouped as biotites and the lighter as muscovites.

Usually in thin flexible white or brown, silvery or golden scales well known as isinglass, sometimes mistaken for gold! The shales of the Marshall are generally exceedingly rich in mica, and scales of white mica (muscovite) may often be seen in the grindstones. The shales below the Marshall are even richer in mica, and the shales below the limestones at Soule are also micaceous. With quartz and feldspar it occurs in the granite boulders.

Also occurs in boulders of mica schist, etc., and with staurolite in staurolite schist.

Staurolite. (A silicate of alumina, magnesia, iron and water.) Occurs in prismatic crystals with an obtuse prism in front, frequently twinned so as to look like a St. Andrew's cross; scattered here and there on a fine grained micaceous ground in a staurolite schist in occasional boulders, as on North Island.

Chlorite. Silicates of alumina, magnesia and water, in green, flexible, not elastic scales in boulders. There are characteristic green stains in some of the limestones that seem to be due to some chloritic mineral.

Kaolin. Hydrous silicate of alumina. White; earthy smell; sticks to the tongue, soft; occurs after feldspar in rounded nodules in conglomerate (Sp. 19016).

Gypsum. CaO 32.5%; SO_3 46.6%; H_2O 20.9%. Cleaves into white brittle scales; soft, just scratched with the finger nail. In small crystals sharply formed like Fig. 1, under gypsum in Dana's System of Mineralogy, on shales in the Sebewaing coal mines, probably due the evaporation of the selenitic (gypsum-bearing) waters (Sp. 19233).

A piece from Sec. 16, Caseville, probably found in digging a well is satin-spar, with a satin-lustre, being an aggregate of parallel fibrous crystals (Sp. 19159).

Large rounded masses are found elsewhere in the drift digging wells. Being more or less soluble, it cannot remain very long exposed at the surface.

Melanterite. FeO 25.9%; SO_3 28.8%; H_2O 45.3%. In fibrous needles radiating from pyritic specimens of coal or marcasite; has an inky taste.

Occurs very abundantly on the specimens from the Sebewaing coal mine and probably occurs elsewhere on the nodules of iron sulphide. Another yellow iron sulphate, either copiapite or coquimbite, also occurs in similar circumstances.

Coal. Impure carbon; occurs both in the coal mines and in small pockets or coaly bits and fossils at various points in the Marshall series. The quarries generally show some slabs sprinkled with coaly bits. (Sp. 19015.)

One interesting occurrence already mentioned is that of a rounded pebble of bituminous coal in the conglomerate of Point aux Barques lighthouse (Sp. 19068).

The coal will generally differ from black shale by leaving, after it ceases to burn with a yellow smoky flame, a black residue which a lens shows to be full of bubbles, indicating that it has been melted. In any case if it is burned so that the residue ceases to be black, it will not amount to more than 20% of the whole. In black shale on the other hand the residue is apt not to be black, will retain the original shape of the fragment and be more than one-fifth of it in weight.

CHAPTER IX.

BOTANICAL NOTES, BY C. A. DAVIS.

§ 1. Geological, geographical, and practical relations of plant distribution.

The following list of plants is based on collections and notes made at odd moments and incidental to regular geological work, and entirely subordinate to it. The larger part of the work upon which it is based was done at Port Austin, outside regular hours of work. Moreover the territory assigned the writer for examination was a strip three townships wide through the center of the county and no study was made of the flora of the eastern or western sides except such as could be undertaken in a day at Harbor Beach in July and a few hours at Caseville and Bayport, late in August, hence the list must of necessity be incomplete and fragmentary and is published without any pretense of being complete.

It is, however, true that the sections of Huron county visited by the writer indicate that its flora is not very extensive or varied, as a large part of the county presents very nearly uniform conditions of soil and elevation, so that large areas are covered with a growth of practically identical species. The monotony of the vegetation is farther increased by the fact that a very large portion of the county has been devastated a number of times by fires, which have not only destroyed the primitive vegetation of the time when the fires occurred, but much of the vegetable mold as well, and with it the seeds and underground parts of the plants which might have survived the fires. As a result, these areas have been covered with a growth of such plants as could grow in rather thin light soil and whose seeds could reach the ground from a distance. Such areas must be seeded in two principal ways, by the winds and by animals, and of these two agencies, by far the most important is the wind. Hence we should expect to find those plants prevailing, whose seeds are easily carried by the wind, or whose fruits are attractive to

animals, especially to birds. The woody plants whose seeds are capable of being borne long distances by winds are best represented by the poplars and willows, and of the herbaceous plants whose seeds are thus carried about, the common fire-weed, milk-weed and thistles are excellent examples. Plants whose fruits are attractive to birds are well represented by the wild cherries, various berries, etc. If we examine the tracts of Huron county which suffered most from the great fires, we will find that the flora is almost wholly limited to those species whose seeds have been planted in the ways mentioned. The trees are various species of poplars, sometimes mixed with birches, the shrubs, blackberry and raspberry bushes, and the herbaceous species are represented largely by such forms as Epilobium, Solidago, Aster and others whose seeds are easily borne about by the wind. Plants whose seeds are less easily carried about from place to place are rare or wanting in such tracts, wherever they are found, and in the region under consideration there are whole sections whose entire flora does not exceed twenty or thirty species, except in the stream valleys, where the fires did not burn so vigorously, or into which seeds have been carried from unburned districts by the stream.

Still another consideration limits the productiveness of such areas as those above described, namely, that the soil is capable of supporting only a limited number of individuals of any species, and those species which can best endure the hard conditions imposed upon them will occupy the entire soil and prevent the introduction of less resistant forms. In places where supplies of moisture and mineral food are limited as they are over much of this county, each plant has also to cover relatively a large area with its roots, hence the number of individuals is small as well as the number of species, and vegetation is not luxuriant.

Of the entire territory visited by the writer, the region along the shores of the Lake and covered by the sand dunes showed the least change either from fire or from cultivation and hence was of most interest. Here the conditions producing scant vegetation are intensified to such an extent that herbaceous vegetation is reduced to the minimum and the ground is covered only by such forms of plants as have especially developed powers of resistance. These powers may develop along several lines, but chiefly they seem to be confined to increasing the moisture-absorbing or root system and decreasing the moisture-exhausting or leaf system. Or, as in certain species,

the vegetative processes may go on actively only during the cool moist portion of the year, the plant remaining nearly dormant during the hot dry summer months, or living on reserve food stored in some specially adapted part of the plant. Because of these modifications to fit the special environment, the plants of the dunes are of great interest to the botanist and are worthy of farther study. The flora of the dunes of Huron county is made up of: (1) plants peculiar to the shores of the Great Lakes; (2) those common to the shores of the Great Lakes and of the ocean; (3) those found on sand barrens generally; (4) those which have been introduced by the advent of white men; (5) northern species. The limits of the various groups are quite well marked and may be defined as follows: The plants peculiar to the shores of the lake and ocean are to be found only near the water, probably not much out of the range of the highest storm waves, and so far as observed in this county, never beyond the dune line nearest the lake or the most northern one. The sand-barren plants occupy the rest of the dunes, encroaching on the territory of the other groups frequently. The fourth class take up unoccupied portions of the land wherever they gain foothold. The northern species are found on the more exposed situations along the dunes.

A problem worthy of solution is that involved in the fact that a number of species of the shores of the Great Lakes are identical with those found in similar places by the Atlantic.

The formerly accepted theory that the plants growing along the lakes are survivals from the time when the lake was an arm of the sea, is no longer tenable in the light of modern investigations. The species from the two regions are absolutely identical and of comparatively modern and highly developed types, and must have attained their present forms long after all connection between the ocean and the lakes which would admit the passage of salt water had ceased. Moreover, these species when found on the sea shore are not usually found on soil that is saturated with salt water, as the salt marshes are, but on the contrary, are found growing on the sandy strip back of the beach, or, more frequently, on sand dunes. If the salt water ever reaches these situations, the salt is soon leached out from the porous sand by rains and the soil is practically as free from salt as on the dunes of the shores of the Great Lakes.

It would seem probable that these plants are capable of enduring the exceptionally unfavorable conditions under which they must

establish themselves from the seed, with greater powers of resistance than other plants. These conditions in part would be exceptional sterility of soil, for on newly formed dunes there is scarcely a trace of organic matter, and soluble mineral matter must be present in very small proportion, since the sand of both lake and ocean dunes is largely composed of silica or quartz. A second condition is exceptional mobility of the soil. Even in a slight wind, dune sand is in some motion and under stronger gales it blows about, even when the rain is falling, to such an extent that a plant may be buried out of sight, or have nearly all the soil removed from around its roots in a short time. A third condition is the great porosity of the soil, which makes it almost impossible for water to stay in it at all, especially near the surface. But few plants would be capable of enduring one of these difficulties, and undoubtedly many an ambitious weed perishes in the attempt to place itself among the plants which can get a foot hold despite all of them. When once established from seed the shore plants are vigorous, growing plants sending strong, wide-spreading roots deep into the soil and searching far and wide for food. The beach pea, *Lathyrus maritimus*, for instance, has been known to send its underground stem more than ten feet through the sand horizontally, and the tough thickly matted roots or rootstocks of some of the dune grasses make the best possible protection for the sand against the wind. So well is this recognized in regions where the wind moves the sand from exposed dunes to cultivated tracts, as for instance, on the shores of Cape Cod in Massachusetts, that stringent laws are enacted against breaking the sod on those dunes where these grasses have become established, and the inhabitants devote a certain season each year to planting the grasses on threatening dunes, to prevent the drifting of the sand.

As to the way in which the seeds of the plants growing on both lake and ocean shores traveled across the intervening land, it may be stated that migratory birds carry seeds of plants long distances, and this is particularly true of water fowl and wading birds, who carry seeds attached to beaks, feet and feathers, in considerable numbers, and migrate freely from the ocean to the lakes.

In general the flora of Huron county is most closely allied to that of the Saginaw valley, not a single species which is characteristic of the flora of the southeastern section of the state having been noted. Certain northern species are abundant enough to warrant the assumption that a portion of the flora has come from the northern

shore of the bay, or across the lake from the Canadian shore. This is easily explained when we remember that the migration of birds southward along the shore occurs at the time when the seeds of many plants are fully ripe and most abundant while the migration to the north occurs at a time least favorable for the transportation of seeds. The prevailing winds are also from northerly directions during the fall and it is quite certain as has been shown that they have much to do with scattering the seeds of certain types of plants. The evidence, geologically speaking, is that the lake currents run northward, not southward, along the shore of the county, and this taken in connection with the facts already pointed out in regard to the distribution of plants in the county would lead to the conclusion that such currents have little to do with carrying plant seeds. In this instance, however, the general law that such currents are important agents in distribution of plants is modified by the fact that only a few small and unimportant streams enter Lake Huron at its southern end, hence but small numbers of seeds are carried from the land into the lakes.

The importance of the wind as an agent of seed planting in isolated tracts of land is shown by the fact that Gull Island, a small tract of lake bottom exposed, near Port Austin lighthouse, by the late subsidence of the lake level, is covered with plants whose seeds are known to be disseminated by wind, only two species of a score or more noted, at the time of the writer's visit there, not being of this type.

The examination of the flora of Huron county made by the writer indicates climatic conditions which make possible the raising of nearly all the fruits which can be grown in the state, and the soil in many parts of the county is undoubtedly suitable for profitably raising all kinds of small fruits. Because of the northern location the ripening of these fruits is delayed beyond the season in the more southern counties and there should be a good demand for these late ripened fruits in the large cities. During the summer of 1896 there was a very large crop of fruits of all kinds in the older parts of the county and fruit trees of all sorts were thrifty and seemed unusually free from insect or plant parasites. The chief difficulties in the way of growing the more perishable fruits seem to be remoteness from markets and lack of cheap transportation, the latter especially.

§ 2. List of plants.

The nomenclature of the list here presented is that of Gray's manual, 6th edition, following for ease of comparison and the sake of those most likely to wish to use it, the order as given in Beal and Wheeler's Michigan Flora. From the fact also that Gray's Manual of Botany is still and must be for some time to come the most accessible work on systematic botany for students in the region covered by this list, this has seemed to be the wisest course to pursue in a list of this character.*

In conclusion the writer wishes to acknowledge the kindness of Prof. Charles F. Wheeler of the Michigan State Agricultural College, who has verified all doubtful determinations of species and rendered other valuable aid.

LIST OF PLANTS.

1. Anemone cylindrica, Gray. Longfruited anemone. Sandy pasture on the Lake shore west of Port Austin.
2. Anemone Pennsylvanica, L. Pennsylvania anemone. Low ground along streams.
3. Ranunculus sceleratus, L. Cursed crowfoot. Near a spring 2 miles west of Grindstone City.
4. Nymphæa reniformis, DC. Pond-lily. Tuber-bearing water-lily. Pinnebog River in Hume township.
5. Nuphar advena. Aiton. f. Yellow Pond-lily. Cow Lily. Common in streams.
6. Adlumia cirrhosa. Raf. Climbing Fumitory, Mountain Fringe. At the quarries, Grindstone City, on refuse piles. Also in talus of cliffs three miles west of that place.
7. Arabis lyrata, L. Common on the sand dunes along the lake.
8. Erysimum cheiranthoides, L. Worm-seed mustard. Near Port Austin on dunes.
9. Cakile Americana, Nutt. American Sea Rocket. Sand dune line nearest the lake. Not observed back of the outer row of dunes, and usually on the side facing the lake.
10. Saponaria officinalis, L. Bouncing Bet, Soapwort. Roadsides about Port Austin.
11. Silene antirrhina, L. Sleepy Catchfly. Sand dunes west of Port Crescent.
12. Silene noctiflora, L. Night flowering Catch-fly. Port Austin.
13. Lychnis Coronaria, L. Mullein Pink. Waste places, Port Austin.
14. Arenaria serpyllifolia, L. Thyme-leaved sandwort. Near Port Austin in barren sands.
15. Hypericum perforatum, L. Common St. John's Wort. Dry soil by roadsides near Port Austin.
16. Hypericum Canadense, L., var. majus, Gray. Crevices in the rocks on the lake shore near Port Austin.
17. Malva moschata, L. Musk-Mallow. Roadsides, frequent.
18. Malva sylvestris, L. High Mallow. Port Austin.
19. Malva rotundifolia, L. Common Mallow. Roadsides and waste places.
20. Tilia Americana, L. Basswood. Linden. Woods near Port Austin.
21. Geranium Robertianum, L. Herb-Robert. Along the Beach near Grindstone, also in rocky soil inland.
22. Impatiens fulva, Nutt. Spotted Touch-me-not, Jewel-weed. Low grounds.
23. Oxalis corniculata, L., var. stricta, Say. Yellow oxalis. Wood-sorrel. Common.
24. Xanthoxylum Americanum, Mill. Prickly Ash. Common in moist soils.
25. Vitis riparia, Michx. Wild or Fox-grape. Frost grape. Common along streams.
26. Ampelopsis quinquefolia, Michx. Woodbine, Virginian Creeper. Woods, Common.
27. Acer saccharinum, Wang. Hard maple, Sugar or rock-maple.
28. Acer dasycarpum, Ehrh. White Maple, Soft Maple. Low ground along streams.
29. Acer rubrum, L. Red Maple, Soft Maple. Moist woods.

*A few unimportant divergencies from the order of Beal and Wheeler's flora noted in proof reading have not been corrected. Thus the following numbers should change places: 17 and 19, 48 and 49, 54 and 55, 224 and 225, 267 and 268, 281 and 282, 309 and 310. No. 30 should come before 35, 181 before 179, 183 after 185 and there are no entries 139 and 264. L.

30. Trifolium pratense, L. Red Clover. Roadsides and fields.
31. Rhus typhina, L. Staghorn Sumach. Common.
32. Rhus copallina, L. Dwarf Sumach. Sand dunes.
33. Rhus Toxicodendron, L. Poison Ivy, Poison Oak. Common in rocky places, and in the moist places among sand dunes.
34. Rhus venenata, DC. Poison Sumach or Dogwood. In swamp about Mud Lake, Grant township.
35. Trifolium repens, L. White Clover. Pastures, etc., common.
36. Melilotus alba, Lam. Sweet Clover. Waste places, Port Austin.
37. Robinia Pseudacacia, L. Locust. Port Austin, Huron City, Etc.
38. Desmodium Canadense, DC. Tick-Trefoil. North Charity Island.
39. Lespedeza capitata, Michx. Bush Clover. North Charity Island.
40. Lathyrus maritimus, Bigelow. Beach pea. Beach at Port Austin.
41. Prunus Americana, Marshall. Wild Plum. Hume township, along streams.
42. Prunus pumila, L. Dwarf Cherry, Sand Cherry. Abundant on the dunes west of Port Crescent.
43. Prunus Pennsylvanica, L. Wild Red Cherry. Common.
44. Prunus Virginiana, L. Choke Cherry. Common on the sand dunes west of Port Crescent.
45. Spirea salicifolia, L. Meadow Sweet. Low grounds, common.
46. Rubus strigosus, Michx. Wild Red Raspberry. Common.
47. Rubus villosus, Aiton. High Blackberry. Common.
48. Rubus hispidus, L. Running Swamp Blackberry. Common on the sand dunes.
49. Rubus Canadensis, L. Running Blackberry. Dewberry. Rocky places.
50. Fragaria Virginiana, Mill. Strawberry. Common.
51. Fragaria vesca, L. Strawberry. Woods common.
52. Potentilla Norvegica, L. Port Austin.
53. Potentilla argentea, L. Silvery Cinquefoil. Roadsides.
54. Potentilla Anserina, L. In an abandoned quarry near the lake at Grindstone City. Also near the lake at Sand Beach. Bayport.
55. Potentilla palustris, Scop. Marsh Five-Finger. In a bog on Sec. 11, Chandler township.
56. Rosa blanda, Aiton, Sweet Wild Rose. Growing in the sand and nearly buried in it at Hat Point.
57. Rosa Carolina, L. Swamp Rose. Swamps. Common.
58. Rosa rubiginosa, L. Sweet brier. Roadside near Port Austin.
59. Pyrus arbutifolia, L. f. var. melanocarpa, Hook. Choke-cherry. Abundant on N. Charity Island.
60. Cratægus punctata, Jacq. Thorn-apple. Hawthorn. Dry fields and woods, Port Austin.
61. Amelanchier Canadensis, Torr. and Gray. Shad-bush. June-berry. Service-berry. Stream banks.
62. Amelanchier Canadensis, Torr. and Gray. Var. rotundifolia, T. & G. Sand dunes.
63. Amelanchier Canadensis, Torr. and Gray. Var. (?) oblongifolia, T. & G. Common on sand dunes.
64. Ribes Cynosbati, L. Prickly Gooseberry. Dry open ground along the lake. Port Austin.
65. Myriophyllum heterophyllum, Michx. Pinnebog River, Port Crescent.
66. Callitriche verna, L. Water Starwort. Dry bed of branch of Pinnebog River, Hume Township.
67. Epilobium spicatum, Lam. Great Willow-herb. Fire weed. Common on all sandy land following fires.
68. Epilobium lineare, Muhl. Bog in Chandler Township.
69. Epilobium coloratum, Muhl. Port Austin.
70. Œnothera biennis, L. Evening Primrose. Common.
71. Circæa lutetiana, L. Common in woods.
72. Circæa alpena, L. Common in low woods.
73. Pimpinella integerrima, Benth and Hook. Dry rocky soil. Port Austin Township.
74. Cicuta maculata, L. Spotted Cowbane. Beaver Poison. Musquash Root. Low grounds, common. Tuberous roots very poisonous.
75. Cicuta bulbifera, L. Bog in Chandler Township.
76. Hydrocotyle Americana, L. Water Pennywort. Moist woods, Port Austin.
77. Aralia racemosa, L. Spikenard. Rich woods, Dwight Township.
78. Aralia hispida, Ventenat. Bristly Sarsaparilla. Wild Elder. Sand dunes. Port Austin.
79. Aralia nudicaulis, L. Wild Sarsaparilla. Rich woods. Meade Township.
80. Aralia trifolia, Decsne & Planch. Groundnut. Dwarf Ginseng.
81. Cornus Canadensis, L. Bunch-berry. Most woods near Port Austin.
82. Cornus circinata, L'Her. Round-leaved Dogwood. Lake shore at Hat Point.
83. Cornus stolonifera, Michx. Red-osier Dogwood. Low ground along streams. Port Austin.
84. Cornus Baileyi, Coulter & Evans. Very common along the lake on sand dunes. Also at Bay Port.
85. Cornus alternifolia, L. f. Near Port Austin, in rich woods.
86. Sambucus Canadensis, L. Common Elder. Roadsides.
87. Sambucus racemosa, L. Red Berried Elder. Dry woods.
88. Viburnum acerifolium, L. Arrow wood. Woods, frequent about Port Austin.
89. Cephalanthus occidentalis, L. Button-bush. Found growing just back of the beach a short distance west of Port Austin, in comparatively dry, light soil. Inland in river bottoms, etc.
90. Galium pilosum, Ait. Sand dunes east of Port Austin.

91. Galium circæzans, Michx. Wild Liquorice. Dry woods.
92. Galium boreale, L. Northern bedstraw. At Point aux Barques.
93. Eupatorium purpureum, L. Joe Pye weed. Trumpet Weed. Along streams and swamps, common.
94. Eupatorium perfoliatum, L. Thoroughwort. Boneset. Low grounds. Common.
95. Eupatorium ageratoides, L. White snake-root. Valley of the Pinnebog River, west of Port Crescent.
96. Liatris cylindracea, Michx. Blazing Star. Sand dunes. West of Port Crescent where it is common.
97. Solidago cæsia, L. Golden-rod. Common.
98. Solidago latifolia, L. Golden-rod. Rich woods in central part of county.
99. Solidago bicolor, L. Var. concolor. Torr. & Gray. Sand dunes.
100. Solidago juncea, Ait. Dry fields and pastures near Port Austin.
101. Solidago serotina, Ait. Low grounds, borders of woods in center of county. Port Austin.
102. Solidago Canadensis, L. Borders of fields, etc., common.
103. Solidago nemoralis, Ait. Sand dunes west of Port Crescent.
104. Aster macrophyllus, L. Wild aster. Dry woods. Common.
105. Aster Novæ-Angliæ, L. A single plant found on north Charity Island. (Common along Saginaw River in Saginaw and Bay counties.)
106. Aster lævis, L. Along the older sand dunes.
107. Aster junceus, Ait. Bog on North Charity Island.
108. Aster puniceus, L. Low grounds throughout the county.
109. Erigeron Canadensis, L. Horse weed. Bitter weed. Waste places and cultivated ground.
110. Erigeron strigosus, Muhl. Daisy Fleabane. Port Austin.
111. Erigeron Philadelphicus, L. Common Fleabane. Common about Port Austin.
112. Ambrosia Artemisiæfolia, L. Ragweed. Roman wormwood. Waste places and roadsides.
113. Xanthium Canadense, Mill. Cocklebur. Clotbur. Along streams and ditches.
114. Rudbeckia hirta, L. Cone-flower. Fields, not common, about Port Austin.
115. Anthemis Cotula, DC. May-weed. Dog-fennel. Roadsides and waste places.
116. Achillea Millefolium, L. Yarrow. Grassy places, common.
117. Chrysanthemum Balsamita, L. Var. tanacetoides. Boiss. Mint Geranium. By the roadside near Port Austin.
118. Tanacetum vulgare, L. Common tansy. Growing in drifting sand near Port Crescent, also by the roadside at other points.
119. Artemisia caudata, Michx. Common on the sand dunes along the lake.
120. Artemisia Absinthium, L. Common wormwood. Roadside near Port Austin.
121. Artemisia Stelleriana, Bess. This plant is well established in the sand of a roadside dune between Port Austin and Port Crescent where it covers a large space. It is also abundant in the barren sand near Huron City, and a large tuft of the plant grows in the sand just back of the storm wave line near the old Carrington Salt Blocks at Port Austin. Prof. Wheeler of the Agricultural College informs the writer that it has not been previously reported as growing wild in the state.
122. Erechtites hieracifolia, Raf. Fireweed. Common in clearings and burned places in the woods.
123. Arctium Lappa, L. Burdock. Waste places, Port Austin.
124. Cnicus lanceolatus, Hoffm. Common thistle. Roadside and pastures.
125. Cnicus Pitcheri, Torr. Shore of the Lake, near Hat Point. Abundant at North Charity Island, not seen back of the crest on the first dune line.
126. Cnicus arvensis, Hoffm. Canada thistle. The northern part of the county is very badly infected with this pest, which seems to have taken possession of many fields and a large number of grain fields seemed to show more thistles than grain. The Canada Thistle Law should be enforced here.
127. Hieracium Canadense, Michx. Hawkweed. Shaded banks about Port Austin.
128. Hieracium venosum, L. Rattle snake weed. Sand dunes from Port Austin westward.
129. Lobelia cardinalis, L. Cardinal Flower. River banks and streams.
130. Campanula rotundifolia, L. Harebell. Rocks and dunes near Port Austin.
131. Campanula aparinoides, Pursh. Marsh Bellflower. Common in grassy swamps.
132. Gaylussacia resinosa, Torr. and Gray. Black Huckleberry. Along woods. Very common on the sand dunes.
133. Vaccinium Pennsylvanicum, Lam. Huckleberry. Low Blueberry. Abundant on the sand dunes and in dry soil generally.
134. Vaccinium vacillans, Solander. Low Blueberry. Sand dunes west of Port Crescent.
135. Vaccinium Corymbosum, L. Swamp or High bush Blueberry. Swamp and marshes about Rush Lake.
136. Vaccinium macrocarpon, Ait. Cranberry. Near Hat Point, and at North Charity Island.
137. Arctostaphylos Uva-ursi, Spreng. Bearberry. On the sand dunes west of Port Crescent.
138. Epigæa repens, L. Trailing Arbutus. Sand dunes under pines near Port Austin.
140. Cassandra calyculata, Dan. Leather-Leaf. Bog in Chandler Township.
141. Chimaphila umbellata, Nutt. Pipsissewa. Prince's Pine. Port Austin near Broken Rocks.
142. Pyrola elliptica, Nutt. Shin-leaf. Pine woods. Port Austin.
143. Trientalis Americana, Pursh. Star-flower. Rich woods near Port Austin.
144. Steironema ciliatum, Raf. Low grounds along streams. S.