

FIELD NOTES OF FRANK LEVERETT

Note Book No. 171 - Leverett

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Flows along the North Branch of Chippewa on the west side in Nottawa Township one to two miles back. There is one on north side of Stevenson Lake.

Well 275 feet from James Swadlehurst in west part of Sec. 26, Isabella County. Head is 4 feet below top. Water from 100 feet mainly till.

Flowing Wells

Elmer Landis in northeast corner of Sec. 11, Isabella County has a well 100 feet that flows ½ inch stream. James Fitzpatrick, northwest of Sec. 12, has one 130 feet. East of Rosebush flowing wells reach nearly to the Denver Township line. They extend into the west edge of Sec. 18, Denver Township. They are 50 – 200 feet.

Joseph Horning's well in Rosebush is 200 feet and barely reaches the surface. It was blue clay for 4 or 5 feet down to water at bottom. The strongest flows are southwest of Rosebush 1½ miles. About 1½ miles northeast, sand is struck at 40 feet and extends to the gravel at 100 feet. In Rosebush, Mr. Dennis Ragan's well struck soft blue-black clay at about 50 feet, possibly a soil, it was several feet. Head seldom reaches 15 feet and is greatest southwest of Rosebush. Probably 100 flows.

September 5, 1901. 7:00 a.m.

An. 28.920 at Marion, 1117 feet. An. 28.875 on summit ¾ mile east = 1160± feet. Highest points in field south are 1170 feet, fill, with but few boulders. 28.900 at middle of line of Secs. 24 & 25 at Marion, where we turn north, 29.000 at West Clam River on line of Secs. 17 & 20, Winterfield township; 28.970 on till tract east of river; 29.020 at East Clam River on line of Secs. 15 & 22; 28.980 on sand plain east of river. The tract west of this river is till in large part and good farming land where swampy, but east of the river there are pine barrens. There is a rolling tract in Secs. 1, 2, 11 and north edge of Sec. 12 that has gravelly drift, there are basins as well as swells in it. A plain extends up Cranberry Creek valley to the lake at the line of Clare and Missaukee Counties, but east of this lake in Secs. 3 & 4, Summerfield Township, T. 20 N., R. 5 W., there is a high tract called "The Mountain". It stands over 100 feet above the plain south of it.

We drive around the north edge of the high part over a lower morainic tract through Secs. 33 and 34, T. 21 N., R. 5 W. reaching an altitude of only 60 feet above the plain, there is a gravelly drift here with occasional boulders, there are a few farms on it. We go east to the State road that enters Missaukee County from the south one mile west of its SE corner, and follow that road north to Wm. Jones at bank of Muskegon River in Sec. 11, T. 21 N., R. 5 W. there is a high moraine ½ mile to a mile west of this road, rising 100 - 150 feet or more above the plain through which the road passes. It has a gravelly drift so Mr. Jonas states and but a few boulders. (See notes September 12.)

An. 28.950 at Muskegon River in Sec. 11, T. 21 N., R. 5 W. at 11:45 a.m. = 1090 feet ±; 28.920 at 1:00 p.m. = 1090 feet ±.

We cross river and take a road leading east to Bear Creek in Sec. 6, T. 21 N., R. 4 W. crossing a sandy plain, the road leads up the west side of Bear Creek to Sec. 28, T. 22 N., R. 4 W. the surface is flat to Sec. 32 when we come to a small tract of moraine with knolls 75 feet ± above the plain. It lies mainly in Sec. 29 but extends into north half of Sec. 32. North of it there is a large marshy tract, last of it is a gently undulating till tract extending NE to Houghton Lake. It rises near Houghton Lake to a height of about 60 feet above the lake. There are a good many boulders on it. I am told by Mr. F. E. Skeels, Land agent of State Board of Agriculture, that the till scarcely extends to the east side of T. 22 N., R. 4 W. on south side of Houghton Lake. Farther east is a sand plain. Mr. F. E. Skeels also states that nearly all of T. 21 N., R. 4 W. is a sand plain with some swamps and lakes. There are slight undulations in the NW part between Bear Creek and Wolf Creek. There is more or less till on the west side of Houghton Lake wherever the land rises a few feet above lake level but a marsh covers much of Secs. 8, 9, 10, 16, 17, 18, 19, 20, 21, 28, 29, 32 & 33, T. 23 N., R. 4 W. Sec. 30 and west part of Sec. 29 contain a little rolling land 40 – 50 feet above lake level that is utilized by the road that leads NW. It is very stony land, and is known as "Stony Point". There are also boulders in this marsh at various places.

Well data

An. 28.870 at outlet of Houghton Lake at 5:00 p.m.

A flowing well here in Sec. 4 is 50 feet deep and overflows 8 feet above level of Muskegon River. It was largely through blue till. A well at the "Hall farm" in Sec. 2, T. 22 N., R. 4 W. is 52 feet through blue till. It is on ground only 25 feet above Houghton Lake.

Well data

A well at O. N. Kings Store in Sec. 11 also on ground 20 – 25 feet above the lake is 74 feet. It has but little head.

We go north along an old railroad grade two miles across a swampy plain. We then turn Northeast and cross a morainic tract in a pass 30 - 40 feet above level of sandy plain. This moraine rises in places over 100 feet above Higgins Lake. We stop for the night at Mr. Charles Lyon's in Sec. 24, T. 24 N., R. 4 W. at bank of Higgins Lake. Mr. Lyon reports that there is considerable swampy land near the corners of Townships 23 and 24, Rs. 3 & 4 W. but on the border of Higgins lake and for 1½ - 2½ miles back on the west side there is a moraine.

September 6, 1901. An. 28.890 at Higgins Lake at 6:15 a.m.

The hills in the moraine back of Mr. Lyons rise fully 100 feet above the lake. We drive north at west end of Higgins Lake on a narrow strip of flat land that borders the lake to Sec. 10 where the plain extends west a long distance. The moraine in Sec. 15 rises about 75 feet above Higgins Lake. The plain extends west across Secs. 3 & 10, 4 & 9 and also south edge of the sections north of 4 & 3 in Crawford County (T. 25 R. 4 W.) There is a moraine in Secs. 34, 35 & 36, T. 25 N., R. 4 W. rising 50 – 75 feet or more above Higgins Lake. It is a narrow range of hills scarcely a mile wide trending E – W north of it is an extensive plain. We come back to shore of Higgins Lake at a summer resort in Sec. 6, T. 24 N., R. 3 W. An. 28.900 at 7:40 a.m.

I go east 1½ miles then north to county line and east along county line crossing the range of hills and coming down to a plain that is traversed by a tributary of Au Sable River about middle of line of R. 3 W. Townships 24 & 25. An. 28.920 on plain; An. 28.940 in swamp a mile farther east; An. 28.960 at Roscommon at 9:30 a.m. An. 28.930 at 11:00 a.m.; An. 28.900 on sand plain at border of moraine line of Secs. 4 & 32 on county line at 11:40 a.m.; An. 28.890 at Higgins Lake 12:20 noon. (See notes 2 pages ahead)

Higgins Lake 1155 L.W. (From HD)
1158 H.W. (72nd Congress)

An. 28.860 at 1:45 p.m.

An. 28.780 on crest north of Lake

An. 28.820 on plain north of moraine in Secs. 25 & 30.

28.840 at branch of AuSable in Secs. 25 & 30.

Turn east on center road. An. 28.740 on summit on line of Secs. 16 & 21 on moraine. Moraine is much higher in Sec. 10 and neighboring sections. An. 28.800 on flat tract with cobbly surface near corners Secs. 15, 16, 21 and 22, T. 25 N., R. 3 W; 28.840 at R.R. crossing near corners 14, 15, 22 and 23; 28.650 on ridge in Sec. 23; 28.840 on low ground in Sec. 25; 28.780 on high tableland in Sec. 36; An. 28.840 in bog in Sec. 14, T. 24 N., R. 3 W; An. 28.850 at Higgins Lake.

I drove in the morning from Higgins Lake to Roscommon along or near county line and returned by same route. While at Roscommon, Wm. F. Johnston, formerly county clerk, outlined for me the extent of prominent morainic tracts south and west of Roscommon. The morainic tract runs past the north side of Higgins Lake and continues south of east across T. 24 N., R. 2 W., passing through Secs. 6, 5, 4, 3, 2, 1, 10, 11 & 12. It then swings southward to Sec. 19, T. 24 N., R. 1 W. through Secs. 7 & 18. It is scarcely a mile wide and rises 50 - 100 feet above the low tract that borders it on each side. It is largely a gravelly drift but has some till and a moderate number of boulders on it.

Well data

A well on this moraine west of Roscommon in Sec. 1 at Robert Brown's is 62 feet and is largely till. Another morainic tract known as Murray Hills is west of St. Helens in Secs. 3 & 4, T. 23 N., R. 2 W. and parts of all the bordering sections. Another high tract is called "Nine Mile Hills" being 9 miles south of Roscommon. It is mainly in T. 23 N., R. 2 W. in Secs. 17, 18 and border sections, but it extends west across Sec. 13, T. 23 N., R. 3 W. and touches Secs. 12 & 24. Between Murray Hills and "Nine Mile Hills" there is a swamp that extends southeast to the lakes south of St. Helens. A narrow swamp extends east on north side of Murray Hills across Secs. 32, 33, 34 & 35, T. 24 N., R. 2 W. There is a swamp south of Nine Mile Hills. There is a still larger one between Higgins Lake and the ridge that leads toward Roscommon. It covers the southeast quarter of T. 24 N., R. 3 W.

In the afternoon Dr. Lane and I drive north 3 miles into Crawford County from the Higgins Lake resort crossing the moraine on line of Secs. 36 & 31 and entering a plain in Secs. 25 & 30 that has a thin deposit of gravel 10 feet \pm beneath which bouldery drift sets in that seems to be a sandy till, the boulders show in basins and in shallow ravines but are rarely seen on general level of plain.

A swampy channel was crossed near north end of line of Secs. 25 and 30. It is 8 - 10 feet deep and about 60 rods wide, the channel is now drained eastward by a small tributary of AuSable River. There is so much gravel here that it makes the plain barren but the basins are productive spots. There is a very prominent moraine in the central part of T. 25 N., R. 3 W. with points that reach or exceed 1400 feet A.T. It covers the northeast half of the township except where narrow flats extend back into it. The relations of these moraines to each other is not clear and the study must be extended before interpretations can be made.

We ascended a hill east of the M.C.R.R. near line of Secs. 23 & 24, T. 25 N., R. 3 W. and found its altitude to be about 1365 feet, from here we look over an extensive morainic tract to the northeast and north. The part of T. 25 N., R. 2 W. north of south Au Sable River seems to be nearly all strongly morainic and the moraine covers a large area north of the point on which we stand. There is an extensive plain directly east of Roscommon and also southeast along the railroad to the lakes south of St. Helen, last of this plain there is a great moraine in eastern Roscommon and western Ogemaw counties.

We go south through Secs. 25 & 36, T. 25 N., R. 3 W. and continue south into Roscommon County through Sec. 1 rising to the moraine in south part of section that leads west past north side of Higgins Lake. This has some till here, and there is till north of it in Secs. 1 & 36 on gently undulating land. There is more or less till and a moderate number of boulders from Sec. 36 Northwest to sec. 17, T. 25 N., R. 3 W. on the southwest slope of the great moraine. It is good farming land and is, much of it, settled.

The moraine that leads past north side of Higgins Lake is settled only near Roscommon and at a few places farther west. South of this moraine we enter a marshy tract partly a hay marsh and partly covered with poplar brush. It stands only 10 - 20 feet above Higgins Lake and was probably once a part of that lake for the level of the lake seems to have once been about 20 feet above its present level. The cause for its lowering was not ascertained. Possibly the artificial outlet has lowered it a little but not all. We follow the east side of the lake northward from Sec. 22 to the resort in Sec. 6, entering higher ground in north part of lee. 16. In Secs. 9 & 10 there are a few swells south of the main moraine. There is also a knoll in Sec. 14 about 20 feet high.

September 7, 1901. 7:00 a.m.

An. 28.860. 1155' at Higgins Lake. I drive to Stratford with F. E. Skeels, taking a westward course along and just south of the moraine about to Sec. 5, T. 24 N., R. 4 W. The road then turns southwest and comes to a morainic tract in the north part of Sec. 7, that is perhaps a continuation of the one we have been following, it being a projecting spur. This covers much of Secs. 1, 2, 3 and 12 in the northeast corner of Missaukee County and projects a spur into Sec. 9. From Higgins Lake to Stratford there is a sand plain south of this moraine that seems likely to be an outwash from it. It is a dry tract with no settlers. The timber is a scrubby jack pine and oak brush. This barren plain slopes southward to extensive swamps and marshes that cover a tract northwest of the west end of Houghton Lake (See maps of Roscommon and Missaukee counties for extent of these swampy tracts.

The highest point crossed is on line of Secs. 2 & 11, T. 24 N., R. 5 W. where aneroid reads 28.700 = 1325' \pm . On the plain at line of Sec. 3 & 10 it read 28.840 and near east end of line of Secs. 4 & 9, 28.870 at Stratford at 9:30 a.m. = 1170 feet \pm A.T.

There is a very broad morainic tract crossing at the northwest part of Missaukee County in a northeast-southwest course and continuing westward into Wexford County past Boone to Harrietta. Its southeast border passes just west of Stratford and north of Moorestown. Stittsville also is at east border. The border is very irregular between Stittsville and Lake City, there being swamps and sandy nearly plane tracts extending back into it two or three miles in T. 23 N., R. 7 W. There are also outlying groups of hills, a prominent one being crossed by the road 3 - 3½ miles south of Stittsville on line of Secs. 7 & 8, T. 23 N., R. 6 W. The morainic hills northeast of Moorestown are an outlying group, there being a level tract west and north of them ½ mile to a mile wide.

I drive from Stratford to Moorestown passing along the east side of this group of hills in Sec. 13. T. 24 N., R. 6 W. They are only 20-40 feet above a plain east of them. There is some till and an occasional boulder in the moraine here. The plain east of Moorestown soon

descends to a swamp with elm and birch timber. The plain has a gravelly soil and is cultivated in Secs. 13, 24, 25 and 26. There is a swamp west of Moorestown covering much of Secs. 21 & 22 and 8 level tract extends north from it across Secs. 15 and 10 to another swamp. (See County map). The moraine is prominent and stony in the northwest part of T. 24 N., R. 6 W. and the east half of T. 24 N., R. 7 W.

An. 28.770 at Stittsville at 11:20.

Well data

An. 28.750 at 12:30 = 1260± ft. A.T.

I am told at Stittsville that Mark Chiavis, in north part of Sec. 20, T. 24 N., R. 6 W., has a well nearly 200 feet. Near there C. McCullum has one of similar depth.

A. E. Howe, in southwest part of Sec. 18, has one 198 feet. Wells at Stittsville are only 20 feet. I drive south from Stittsville passing for a mile through a rather sandy tract with gentle swells. I then enter a till tract with occasional swells 10 - 15 feet and a few boulders. The strong moraine is only a short distance west of this road in Secs. 30 _ 31. There is an isolated high tract in Sec. 7 and bordering parts of 6 and 8, T. 23 N., R. 6 W. rising 50 feet above the till tract around it. It has more boulders than the lower tract. I come to a sandy plain near corners of Secs. 7, 8, 17 & 18. This extends south to a swamp in Secs. 19 & 20 and is said to run west on north side of this swamp about to the center of T. 23 N., R. 7 W.

The swamp is a peaty tract a mile wide here and it maintains that width for three or four miles west and becomes still wider to the east (See map).

An. 28.900 in swamp at corners of Secs. 19, 20, 29 & 30 at West Branch Stream. 1140 ft.± A.T. South of this swamp there is a till plain with patches and low ridges of sand that extends south to a sharp bouldery morainic "belt in northwest corner of T. 22 N., R. 6 W. This morainic ridge only extends to the northwest part of Sec. 6, but it leads east southeast across the township to Butterfield.

An. 28.730 on crest on line of Secs. 5 & 6 at 2:40 p.m. 1300 ft.±.

This is apparently a terminal moraine and seems to have been formed by ice standing on its northeast side. It has swells 20 - 30 feet high and is very bouldery. It is said to be a sharp range and bouldery dear across this township. The main ridge is scarcely a mile wide but south of it are irregular ridges and knolls out to a distance of 1½ or 2 miles from the main ridge.

The road I am on drops down to a creek on line of Secs. 7 and 8. An. 28.860. South of this an ascent is made to "Ellis Hill" near the corners of Secs. 17, 18, 19 & 20. An. 28.740 = 1300 ft.± A.T. There is a very abrupt descent to a swamp west of this hill but toward the east and southeast it is continued in lower knolls.

From this hill there is an abrupt descent on the south to a till plain. An. 28.840 only ¼ mile south of crest of hill, there is till with patches of sandy drift from here to Falmouth. 28.900 at stream near corners of Secs. 29, 03, 31 & 32 = 1150 ft.± A.T. 28.870 on hill plain in Sects. 31 and 32; 28.915 at Clam River in Falmouth at 4:00 p.m., 1140'± A.T.

The bluffs here are about 30 feet and have a sandy drift with boulders imbedded. On the west side of the river there is a narrow gravel plain standing 25 feet ± above this stream. I go south on township line between R.s 6 and 7 W., T. 21 N. and reach the edge of this gravel plain near south end of line of Secs. 7 & 12. A moraine here sets in that extends southward nearly to the county corners. It is narrow, there being till plains on each side within a mile east or west of this range line. It rises about 40 feet above the till plains. The northern end has a sandy textured drift and but few boulders, but in Secs. 25 and 30 boulders are very numerous. Sec. 36 is flat and the moraine is weak in Sec. 31, but in Secs. 6 and 7 Winterfield Township Clare County, it is very sharply ridged and has sand and gravel. The ridges extend into the east edge of Secs. 1 & 12 Marion Township, Osceola County. An. 28.980 at West Clam River in Sec. 12, Marion Township. This has a narrow valley with till bluffs 40 feet high. I go west to corners of Secs. 10, 11, 14 & 15 passing through a till tract with low swells and a few boulders. This topography extends from here south to the sandy plain in east part of Middlebranch Township (T.19N., R.7W.) and east to Clamm River in Winterfield Township, Clare County (T.20N., R.6W.) It is not so sharply morainic as the tract along the town line south of Falmouth yet it is too undulatory to be classed as a plain. It is like the subdued swell and sag morainic tract that contains much till and this is the case here. An. 28.980 at Marion at 5:45 p.m. 1119 feet A.T..

Well data

A well at the Marion House, 52 feet deep, overflows with a head 11 feet above surface or 1130 feet A.T. A well on opposite (west) side of the river at Mark Ardis's did flow but has about stopped, there is a flowing well east of Park Lake in an unsettled district where there used to be a lumber camp. It is shallow but quite strong. I am not able to learn its precise location but it seeing to be in Sec. 4 Marion, only a short distance from the county line.

September 8, Sunday, spent at Marion.

September 9, Temple, Michigan.

I drive south and find that a strip of till extends from the hilly tract south of Clarence westward nearly to the Muskegon River. It is gently undulating and has a moderate number of boulders. Much of it is clayey. The till extends as far west as Secs. 28 and 33, Reading Township, T. 19 N., R. 6 W. The altitude there is but little above Temple or about 1050 - 1060 feet A.T. but

within a mile or so east it rises to 1100 feet or more. The altitude at Clarence is about 1130 feet.

East of Temple also in Sec. 14, there is till and from there east into Greenwood Township till alternates with sand and swamp, there is a large amount of swamp in the northeast quarter of Reading Township. Greenwood township has bouldery till and a large amount of good farming land.

There are only 5 or 6 square miles of sand and swamp and this is in the northwest corner. The appearance both in Greenwood and leading is as if the ice margin passed east-west and fronted south, resting on the high range that leads westward along the "borders of townships 18 & 19, T. 5 W. and the northeast part of T. 18, R. 6 W. (See Clare County map). It has been my supposition heretofore that the ice margin trended NE-SW across Greenwood Township (T.19N., R.5W) and fronted toward the northwest - - this making it a distinct Saginaw lobe which formed the moraine. But now it appears probable that the reentrant between the Saginaw and Lake Michigan lobes extended no farther north at the time this moraine was forming than the latitude of Clarence. I am coming now to favor the interpretation that the great moraine in Osceola County and adjacent parts of bordering counties is interlobate.

I drove southeast past Windover Lake around the west end of the prominent hills in northeast part of T. 18 N., R. 6 W. there is considerable gravel in these hills and slopes south of them near Windover and Dollar Lakes in Secs. 11 & 14. J. W. Sutton has examined into its depth and thinks it may be extensive enough to justify opening a gravel pit by Ann Arbor R.R. Sutton's address is Lake George, Michigan. I drive past Lake George and take a road northeast over the high range of hills to Lilly Lake reaching an altitude of 1240 feet southwest of the Lake in Sec. 33 Greenwood Township. The lake is about 1125 feet. This high range has some sandy till with the clear sand and gravel and a few boulders, but north of it, as above noted, there are clayey till and numerous boulders, and a swell and sag topography extending to the Muskegon River swamps. This clayey tract is 1100 - 1150 feet A.T.

The gravelly sand plain between Muskegon and Middle Branch Rivers, Townships 19, R.s 6 & 7, seems to have its head in Secs. 1 & 2, T. 19 N., R. 7 W and Sec. 7, R. 6 W. It stands higher than the till tract east of the Muskegon in Secs. 14 & 22, T. 19 N., R. 6 W. and is fully as high as till on west side of Middle Branch River in T. 19 N., R. 7 W. Its altitude is about 1100 feet at the north and 1084 feet at Pennoch's Station. It is flat surfaced and has only a few saucer-like basins. The till tract north of it rises 20 feet or more above the gravel plain but has not a bluff as if there had been erosion. On the contrary it seems to have been formed about contemporaneously with the gravel plain. I return to Marion on the afternoon train.

September 10. See previous page.

It was rainy and I worked over my maps and finished reading proof of Monograph XLI.

September 11, 1901 - 7:00 a.m. Marion, Michigan.

I drive south from Marion through a low tract along Middle Branch River that has sandy gravel in low knolls 10 - 20 feet high. (There is swampy land west of road in Secs. 28 and 33. The strip of sandy land is about a mile wide. It is not a sand plain but has knolls among which the stream winds. The till tracts are higher than the sandy tracts in this township; but upon passing south into Middle Branch Township, I find a low till plain on west side of the stream. It is strewn with boulders as thickly as the higher tracts west of it. Boulders are numerous on the southeast border of the till tract all through Middle Branch Township. The border between till and gravel as already noted follows Middle Branch Creek across T. 19 N., R. 7 W. It then goes west through Secs. 2, 3, 4, 5, 6 and 7, Sylvan Township and Sec. 12 Osceola. It then swings southward across Secs. 14 and 23 to the bank of the Muskegon River 1½ miles above Evarts. There is a sandy and rather swampy plain in Sylvan Township southeast of this till tract. It seems to have till at slight depth, and as noted last June there is till on the south bank of Muskegon River in this township.

The river seems to pass from a till plain or gently undulating till tract into a strong moraine near the line of Sylvan and Osceola townships, this exports the view that the drift here is Saginaw rather than Late Michigan drift. There is a very bouldery tract in Osceola Township. The flowing well in northeast part of Sec. 26 Osceola township, noted last June, is about 170 feet deep and flows 75 to 100 gallons a minute from a 2-inch pipe. Its force is very great. It discharges horizontally and the stream strikes about 8 feet from the orifice which is 3 feet above the ground. I filled a four gallon bucket in about 3 seconds. There are two other flowing wells near this one at John E. Beach's in southeast corner of Sec. 23, 130 feet, and another in Sec. 24, but they are both weak compared with this well, and are shallower. I do not find any accurate data on the wells. On my way to Evarts I learned of the following deep farm wells. Floyd Roe, Sec. 33, Middle Branch, northwest part, has a well 106 feet largely through gravel. A well on south side of Sec. 22, Middle Branch, at Ed Underwoods is 96 feet. John Framer, southwest corner of same section, has a well 120 feet. A well on the Charles Rose farm in Sec. 22, Hartwick Township is 205 feet. Wells 2 - 3 miles north of Evarts are 80 - 115 feet on ground 1200 feet. John Rowley's in east part of Sec. 16 is 115 feet. Mr. Niergarth's in southeast part of Sec. 15 is 94 feet and has 20 feet of water. There is 5 feet of clay below which it is through sand.

An. 28.740 at Evarts at 1:00 p.m. 1002 feet A.T.

I go west between Secs. 28, 33, 29 & 32. There is a flat tract carrying boulders in Secs. 28 & 33 that stands hut a few feet above the Muskegon gravel plain. It looks like a fluvial terrace, being a very sandy drift, but the boulders seem out of keeping with this interpretation.

West of this I rise through a till tract with deep basins and numerous boulders, reaching 1175 - 1200 feet near the corners of Secs. 29, 30, 31 & 32. the altitude is still higher farther west. The drift to the west is said to be sandy except in a few spots. It is rather bouldery. As yet there are scarcely any settlers west of here in the eastern half of Cedar Township and there are only a few old lumber reads in that region, a tract of 24 miles in Cedar, 6 miles in Hersey, 8 miles in southeastern Rose Lake and 9 miles in southwestern Hartwick township.

I find that the till tract in Osceola Township extends only 4 miles north and two miles west of Evarts. Farther north, as well as west, there is a very sandy drift and sharply morainic topography - Hummocks, 20 feet high, cover only a fraction of an acre. This hummocky topography covers the northeast part of Osceola and south part of Hartwick Townships. It reaches an altitude of 1275 - 1300 feet in the southwest part of Hartwick Township and northwest part of Osceola. The center N-S road in Hartwick is at the 1300 feet contour at several points in the south half. Boulders are numerous all over this hummocky tract and they abound also in till tracts east of it in southeastern Hartwick Township being exceedingly numerous west and south of Avondale. I turned east between Secs. 22 & 27 Hartwick and continued to Avondale at corners of Secs. 23, 24, 25 & 26, inking a descent of 150 feet, Avondale being about 1150 feet. I then go north a mile and east into Middle Branch Township passing through a swell and sag till tract with knolls 25 feet \pm high having gentle slopes compared with the sharp hummocks of southwestern Hartwick Township. This swell and sag tract covers Secs. 24, 25 & 34 as well as 13, 14 and 22 and continues east across Middle Branch Township. It now seems probable that the sharp hummocky moraine is the crest and the swell and sag tract the inner slope of a great moraine formed by ice on the east of it. It seems likely to be interlobate from the accounts given by supervisors last June I infer that the eastern part of Highland, as well as the eastern part of Hartwick, is on the inner slope toward the Saginaw ice lobe. I found a gravel hill in the southeast part of Sec. 13 Hartwick 30 feet high covering several acres. I go north between Secs. 17 & 18, 7 & 8, 5 & 6 Middle Branch and Secs. 31 & 32, 29 & 30 Marion through a gently undulating till tract with only a few boulders. It is about 1150 feet A.T. but fluctuates between 1130 and 1175 feet. A point 2 miles west of Marion is 1180 feet but this is higher than any point to the south for several miles. An. 28.520 at Marion at 6:30 p.m. = 1119 feet A.T.

September 12, 1901

I walked from Marion to McBain along the T. & AARR track. The cuts for 2½ - 3 miles show abrupt changes from till to sand or sandy gravel. The drift has a hummocky topography with knolls 10 - 20 feet high. About two miles southeast of Bark Lake a nearly plane till tract is entered which stands 1175 feet \pm A.T. In it there is a short esker about ½ mile long, coming to the railroad from the east ¾ mile southeast of Park Lake. Its trend is nearly east-west; height 20 - 25 feet, and where cut by railroad it contains a sandy gravel. This may be a profitable place for the railroad to open a gravel pit. I have written to Gen'l. Manager H. W. Ashley about it. West from here morainic topography soon sets in and Park Lake village is on knolls. There is swampy land much of the way between Park Lake and McBain. It does not extend west a mile but extends east a long distance. McBain stands at the east edge of a moraine. There is a very strong moraine with knolls and ridges 50 - 100 ft. or more in height from McBain west to Hobart. The T. & AARR. skirts its northeast border from McBain to Lucas and traverses the moraine between Lucas and Cadillac as noted last June.

Well data

Notes on several flowing wells east of McBain and some deep wells in and around McBain are found in back part of this notebook.

From McBain (1246 ft.) I drive west 2½ miles reaching an altitude ½ mile west of the village about 80 feet higher or 1325 feet A.T. Hills south of Lucas ¾ mile reach about 1350 - 1360 feet and a mile west of Lucas they rise above 1400 feet. I return to McBain and drive east through a till plain to the moraine at the east side of T. 21 N., R. 7 W. (See notes September XX7).

There is a descent of 60 feet in two miles and 20 feet more in the next two miles or to about 1160 feet A.T. A till ridge a mile north of this road runs east to the east part of Sec. 16 from the town line north of McBain. Its west end in Secs. 18 and 19 reaches about 1300 feet but its end is lower and the altitude may not exceed 1200 feet. This runs out like a spur from the great moraine, there is said to be a till plain on its north as well as south border extending to the Clam River Swamp. This ridge seems to have no connection with the one on the east side of the township. I cross that ridge on line of Secs. 24/25 & 19/30. Its altitude is about 1200 feet. The till plain east of it is 50 feet lower. = 1150 feet. On this plain there are patches of sand but clay comes to the surface on much of it and wells penetrate clay. The wells at Vogel Center near corners of Secs. 20, 21, 28 and 29, T. 21 N., R. 6 W. are 30 to 50 feet. East of Clam River there is a sandy plain with few basins and hay marshes covering Secs. 22, 23, 24, 13, 14 and 15 as I could see from the angling road that leads across Secs. 22, 23 & 13. It is said to extend down the east side of Clam River past the county line and also north through Secs. 11, 12, 1 & 2, T. 21 N., R. 6 W. to the Butterfield

Creek Swamp in Secs. 35 and 36, T. 22 N., R. 6 W, but from Secs. 2 and 11 westward to Falmouth there is said to be a clay plain. There is a prominent ridge of sandy drift in Secs. 16 and 17, T. 21 N., R. 6 W. standing 60 – 75 feet above the plain southeast of it. Its closest morainic connection is with the moraine on the township line south of Falmouth. It is a pine stump tract and not settled. The sand plain southeast of it is unsettled, but the clay plain north of it, like that around Vogel Center, is all settled. I come to a settlement at the line of T. 21 N., R. 5 W known as the Moddersville settlement. The post office in Moddersville is in Sec. 7. There is a till tract here standing 30 or 40 feet above the sand plain west of it or 1170 – 1180 feet A.T. It has a moderate supply of boulders and is gently undulating. This tract covers Secs. 4, 5, 6, 7, 8, 9, 17, 18, 19 and 20, T. 21 N., R. 5 W. It has knolls 10 – 20 feet high though much of the surface is nearly plane. Wells are sunk 40 to 80 feet for water. East of this till tract is a very prominent moraine known as "The Blue Mountain" that extends from Secs. 9 and 10 south to the county line. I cross it on line of Secs. 9/16 & 10/15 and find the crest on east part of line of Secs. 9 and 16 to be about 250 feet above the Muskegon River at William Jones in Sec. 11. By aneroid it is 1335 feet and the river at Jones is 1090 feet A.T. This range of hills has a sandy and gravelly drift with only a few boulders. There are basins on its eastern slope as if that were the outer face. The extensive and plain east of it and the till plain west of it suggest the same interpretation but till plains near McBain suggest that the moraine west of that village was formed by ice on its east side so I am still in a quandary as to the interpretation. I stop for the night at William Jones in Sec. 11, T. 21 N., R. 5 W. An. 28.350 at 6:30 p.m. = 1090±. The sand plain south of here is about 20 feet above the river or 1110± feet A.T.

September 13 – 6:00 a.m.

An. 28.560. At Muskegon River in Sec. 11, T. 21 N., R. 5 W. Ditto at Dolph Postoffice in Sec. 3, T. 21 N., R. 5 W. at 6:30 a.m.

Flowing Wall

A flowing well at the post office and others in the vicinity are noted in back part of this notebook.

West of the river for a mile there is a clay plain almost swampy that extends north across Sec. 34, T. 22 N., R. 5 W and south across Sec. 3, T. 21 N., R. 5 W. West of this is a low morainic tract with considerable till though gravelly in part. An. 28.415 on the highest place crossed by the town line read about middle of line of Sec. 32 and 5 = 1225± A.T. I go north between Secs. 31 and 32 and have a view to the west over an extensive swamp. I descend near north end of section line to the low plain that borders Butterfield creek. An. 28.550 at the creek on line of Secs. 29 and 30, Butterfield Township (T.22 R. 5W). The moraine continues into the bend of the creek in Sec. 29 and reappears on the north side of the creek

in north edge of Sec. 30, there being a gap of about a mile at the creek valley.

Around the corners of Secs. 19, 20, 29 and 30 there is a gravelly tract, standing 30 feet ± above the creek and its swampy plain, which may prove valuable for road ballast. It is in a plain that skirts the southeast end of the moraine. It only extends a short distance north and is said to only extend west ½ mile. The moraine rises 20 – 40 feet above it in Sec. 19 and is quite bouldery, with considerable till. At the corners of Secs. 17, 18, 19 and 20. I am on a till plain that extends north to the swamp on West Branch Creek. The moraine leads west northwest across T. 22 N., R. 6 W as noted September 7, traversing Secs. 13, 14, 15, 9, 8, 5 & 6 and extending a little into Secs. 10 and 11. North of it is a flat clay plain extending to the West Branch Swamp.

I go west to town line between Secs. 18 and 19. An. 28.460 at corners of Secs. 18 and 19, 23 and 24.

(For notes on wells east of here see back part of notebook)

I then go north descending to the till plain at north end of line of Secs. 13 and 18. An. 23.520. From there I am in a till plain in Secs. 12 and 1, T. 22 N., R. 6 W. and along the line of T. 22 N., and 23 N R. 6 W its entire length.

In secs. 5 and 6 the moraine is close at hand on the south, this moraine seem to have been formed by ice on its northeast side and it seems also to be a natural continuation of the moraine that leads north through the central part of T. 21 N., R. 5 W. It seems not to fit in with the interpretation that that moraine was formed by the Lake Michigan ice sheet, but rather throws the balance of evidence in favor of the Saginaw.

In Secs. 35 and 36, T. 23 N., R. 7 W and Secs. 1 and 2, T. 22 N., R. 7 W. there is a tract with a few low swells. It has till at surface in places but generally there is a sandy coating. South of it there is an extensive swamp. It may be a connecting link between the moraine that terminated in in Sec. 6, T. 22 N., R. 6 W. and a strong moraine that sets in in the northwest part of Sec. 35, T. 23 N., R. 7 W and leads westward along south side of the West Branch Swamp.

I continue to Lake City, crossing a few sandy knolls 2-3 miles east of the town and then entering a till plain. An. 28.420, 2½ miles east of Lake City at summit on township line road.

An. 28.460 at Lake City at 11:45 a.m. An. 28.450 at 1:00 p.m. The till plain extends from Lake City south to McBain, there being only a little sand and a few low swells 10 – 20 feet high. Boulders are rather scarce all the way from Lake City to McBain. An. 28.530 at Clam River north of McBain at 2:00 p.m.

An. 28.450 at McBain 1246 feet A.T. at 2:45 p.m. (Notes on wells at McBain are in back part of notebook. Also notes on trip McBain to Cadillac.)

September 14, 1901.

I drive from Cadillac into the tract south of Big Clam Lake then east past Hobart into the strong moraine that lies east of the G.R. & I.R.R. For notes on this moraine and wells in it see back part of notebook. Also see notes there on trip from Cadillac to Lake City on G.R. & I.R.R. I spend Sunday at Lake City. There is a storm period on and the aneroid registered only 28.040 at 7:00 a.m. Sept. 15.

September 15, 1901. at 7:00 a.m.

An. 28.040

September 16, 1901 - 6:30 a.m.

An. 28.330 at Lake City. An. 28.350 at 7:30 a.m.

I go east across Sec. 6 through a flat till tract then south $\frac{1}{2}$ mile and east between Secs. 5 and 8. There are sandy knolls 15 - 20 feet high in SW $\frac{1}{4}$ of Sec. 5. But farther south the surface is plane as far as I can get a view 12 miles or more, there are low sandy ridges in Secs. 5 and 8 near west side and then soil is sandy in the east part but the subsoil is till and boulders are not rare. The surface continues flat across the township toward the east and there is very little sand along this road between Secs. 4 and 9, 3 and 10.

I go north between Secs. 2 and 3 to town line, then east a mile and north between Secs. 35 and 36 Forest Township (T. 23 N., R. 7 W). The north part of Sec. 35 is 80 - 100 feet higher than the south. The high ridge runs east to within 80 rods of the east end of line of Secs. 35 and 36, and low knolls extend southeast from it into the northwest part of Sec. 36.

An. 28.380 on plain at corners of Secs. 35 and 36 Forest and Secs. 1 and 2 Reeder Township at 8:20 a.m. An. 28.400 at corners of Secs. 25, 26, 35 and 36 Forest Township at 8:30 a.m.

The northeast half of Sec. 26 is flat. It is 2 or 3 miles north from these corners to a moraine. I go east on line of Secs. 25 and 36 through a plain that has a few low sand knolls and ridges 6-10 feet high. The flat tracts among the ridges are sandy also, but upturned stumps show till in their roots and there are a few surface boulders.

An. 28.420 at railroad track on line of Secs. 30 and 31, T. 23 N., R.6W. An. 28.460 at West Branch Creek on North - South road near corners of Secs. 19, 20, 29 and 30. There is a sandy gravel under the peat in the swamp. An. 28.430 on sandy plain a mile north of West Branch Creek. There is an occasional boulder here and a few pebbles and cobblestones.

An. 28.430 at middle of line of Secs. 17 and 18 where I turn east. There is a flat sandy tract in Secs. 17 and 18 but the sections north of there, as noted September 7, have till, some of which is rolling. The sandy plain reaches to east part of Sec. 15. I then strike into a till

plain. An. 28.460 at Mr. Louchs. This till plain extends east into Sec. 18, T. 23 N., R. 5 W. but farther east there is swampy land for over a mile, but I am told that clay land with flat surface covers Sec. 16 and tracts east and south of there on south side of the Hay Marsh Creek.

An. 48.490 at Hay Marsh Creek on line of Secs. 1 and 2.

An. 28.410 on hill in Sec. 34. This is composed largely of gravel of suitable grade for road ballast. An. 28.460 at Mr. Woodruffs in Sec. 31 at 11:30 a.m. An. 28.370 on hill at southeast end of morainic belt in Sec. 7 (?) or 10.) T. 23 N., R. 5 W. From here I overlook Houghton Lake and the hills southwest of Higgins Lake. There is a level tract, largely swamp, from here to Houghton Lake.

There is hardwood timber in Sec. 36 and west part of Secs. 6 and 31 but from there east the moraine had pine timber. It was a sandy gravel where the pine stood, in which there are occasional boulders. An. 28.470 at Mr. Henry Woodruff's in Sec. 31 at 12:45. where I stop for dinner = 1230 \pm feet A.T.

Well Data

Mr. Woodruff's well is 57 feet and has only 12 - 15 feet of water. It was entirely sand and gravel. Mr. Edwin Colgrave, in Sec. 36, T. 24 N., R 6 W., has a well on high part of moraine 50 feet above Woodruff's that is 129 feet. It was entirely sand and gravel. There was a well at an old lumber camp east of here about 2 miles was over 130 feet. It was on a high part of the moraine. The east end of this morainic ridge is called "Norway Hill" because of the great growth of Norway Pine on it. Mr. Woodruff says the level land in T. 23 N., R. 5 W. is nearly all clay with a little sand coating in places about as in Sec. 14, T. 23 N., R. 6 W., but T. 24 N., R. 5. W. has a good deal of sand on the flat land.

The general width of the moraine from Mr. Woodruff's southeast is about $\frac{3}{4}$ mile and the height 75 - 125 feet above the bordering swamps. An. 28.470 at Mr. Woodruff's at 2:15 p.m. = 1230 feet.

An. 28.500 at swamp on township line between Secs. 36 and 31, T. 24 N., R. 6 and 5 W. = 1200 feet. \pm . North from here the drift is sandy and flat surfaced but there are a remarkably large number of small boulders in it. An. 28.500 at corners of Secs. 24 and 25, T. 24 N., R. 6 W. and Secs. 19 and 30, T. 24 N., R. 5 W.

I go west from this corner rising through a sandy plain that has numerous small boulders on the sand. An. 28.475 at corners of Secs. 23, 24, 25 and 26. There is a level sandy tract on this road with a swamp to the north that is 8 - 10 feet lower in Sec. 22 and west part of Sec. 23. An. 28.470 at line of Secs. 22 and 27. I go south to a till ridge in Sec. 27 and follow it westward to a swamp on line of Secs. 28 and 33. It stands 30 - 50 feet above the swampy tract, is over a mile long east - west and fully $\frac{1}{2}$ mile wide. South of the swamp there are knolls 10 - 25 feet high scattered over a plane till tract. This topography extends west to the strong moraine west of

Stittsville. An. 28.440 on plain 1 mile south of Stittsville = 1250± feet.

I go west through Sec. 31 rising about 40 feet. An. 28.400. I then descend at township line into a swamp. An. 28.440 and go south rising to township corners. An. 28.400.

I go west on line of Forest and Pioneer Townships though a gently undulating tract of sandy till with very few boulders. It has hardwood timber. An. 28.325 on knoll near middle of line of Secs. 2 and 35. This is 20 feet above tracts east and south but west and north, it is not so much lower. The drift is very loose textured till. An. 28.320 at corners of Secs. 34 and 35 Pioneer and Secs. 2 and 3 Forest at 4:40 p.m.

I here turn south and descend 40 feet within ½ mile, an. 28.370, and hold this level past corners of Secs. 2, 3, 10 and 11. I then begin to descend to the cedar swamp on West Branch Creek. An. 28.440 at swamp near middle of line of Secs. 14 and 15. It extends about a mile south, thus, having a similar width to what it has three miles east of here. South of this swamp is a sand plain 1 – 1½ miles wide covering the north half of Sec. 21 and 2/3 of Sec. 26 as well as sections to the north. Sec. 18 is morainic except on the north edge. The high range that sets in mar east end of line of Secs. 26 and 35 nearly covers the south half of Sec. 27. I cross it in Sec. 28 in a pass 30-40 feet lower than hills near by. An. 28.240 at summit on road. The moraine is very sandy and has only a few boulders. There is some hardwood timber on the south slope but the crest and north slope were covered with pine. An. 28.370 at township line 2 miles east of Lake City on plain. 28.390 at Lake City at 6:30 p.m. The moraine northeast of Lake City seems likely to have been formed by ice on its north side, yet that side has a sandy plain and the south side a till plain, or the reverse of what is usually found. The steepness of the north side is such as to suggest that a stream flowed there between the ridge and the ice front.

September 17, - 1901 – 7:00 a.m.

An. 28.390 at Lake City. I go south 2 miles then west a mile (on line of Secs. 12 and 33) then south to corners of Secs. 13, 14, 23 and 24 and west to west end of line of Secs. 15 and 22 all of the way through a till tract with only a few low swells. The swells usually have a more sandy or loose textured till than flat tracts. The flat tracts have, in places, a very stiff clay. I pass abruptly into sand near middle of line of Secs. 15 and 22. The sand extends north to Sec. 10 like across Secs. 16 and 9 but Secs. 15 and 10 have till. The northwest quarter of the township (T. 22 N., R. 8 W.) is a sand plain, but from Sec. 27 there is only a strip a mile wide leading down Clam River.

Sec. 1, 2, 3, 24 and 25 and the northeast parts of Secs. 26 and 36 are heavy clay. South of Clam River there is till in much of Secs. 33 and 34 and the east half of Sec. 32. This has a flat surface. There is a similar flat

surfaced till in the northeast quarter of T. 21 N., R. 8 W. but Secs. 4 and 9 and the west edge of Secs. 3 and 10, T. 21 N., R. 8 W. have a level sand or gravel. There are gravelly places in the northeast quarter of the township. I crossed the river on line of Secs. 27 and 34 and drove around Sec. 34. This gave a good view of the border of the moraine as well as offered me opportunity to learn by inquiry the extent of the clay and of the sand and gravel in the plane tract. The moraine extends slightly into Secs. 31 and 32, T. 22 N., R. 8 W. and covers Secs. 5, 6, 7 and 8, T. 21 N., R. 8 W. its east border being only ½ mile or so west of the road that leads north from Lucas.

Reported Earthworks

I look for earthworks, said by Mr. Richardson former County Lawyer to be in Sec. 35, T. 22 N., R. 8 W. but see nothing except natural ridges or mounds. Near the center of the section there is an island-like tract about 250 feet being east – west 100 feet wide and 20 feet high, separated by a very narrow slough from the gravel plain to the north. This may be the supposed earthworks. I learn however, from residents that there is an earthwork six miles east near the line of Secs. 26 and 35, T. 22 N., R. 7 W. on northeast bank of Mosquito Creek. It is a circle or ring, 60 paces in diameter and 3 – 4 feet high, with a ditch on the outside from which the earth was obtained. In it there is charcoal usually a foot or more below the surface. On this circle, trees 1½ feet in diameter are standing so it is over a century old. Informed by Jacob McGarry who lives on south side of Sec. 35, T. 22 N., R. 7 W.). Mr. McGarry says there is a similar circle about a mile east of the center of Aetna Township, on north side of a road that traverses the north part of Sec. 23. There is considerable sandy drift or sandy till along south side of T. 22 N., R. 7 W. and but little clayey till. Boulders are not numerous here nor on the till tracts in T. 22 N., R. 8 W. There are occasional boulders on the sandy gravelly tract that follows Clam River. This tract has some basins in it and appears to be a glacial rather than fluvial deposit. Possibly it is subglacial, if this plain that borders it was formed by Saginaw lobe. The trend of this gravelly sand strip is parallel with the moraine that lies northeast of Lake City and runs east south east to Butterfield but the clay tract north of it is not morainic either in topography or in carrying boulders, so I see no good evidence that an ice margin followed the north edge of the gravelly tract.

An. 28.480 at Clam River north of McBain at 11:00 a.m.

An. 28.540 at Clam River at Falmouth at 1:00 p.m. where I step for dinner.

An. 28.550 at Clean River at Falmouth at 2:00 p.m.

An. 28.530 at general level of village.

I drive east through a till plain for 2½ miles, having a moraine in the south in Secs. 8, 9, 16 and 17. In Sec. 4 the moraine comes north across this road but it has here a relief of only 25 - 30 feet above the plain west of it. An. 28.500 on moraine near east side of Sec. 4.

An. 28.530 on till plain at west side of Sec. 4.

An. 25.530 on plain near center of Sec. 3.

Boulders are very numerous in the west half of Sec. 3 on the ridge and the flat land east of it. The ridge only extends 40-50 rods east into this section. The till extends over Sec. 3 and slightly into northwest part of Sec. 2. It extends north to the swamp on Butterfield Creek in SEcs. 33 and 34. Secs. 1 and 2, T. 21 N., R. 6 W. are largely a sandy swamp connected with that on Butterfield Creek. An. 28.565 at Butterfield Creek near line of Secs. 34 and 35, T. 22, R. 6 W. at 2:45 p.m. Boulders are numerous in part of the swamp in Secs. 34 and 35 but the drift seems to be a sandy gravel as deep as the upturned stumps expose it. This was a pine tract while the till plain to the south has maple, beech, etc. Secs. 25, 26 and 27 and the south parts of Secs. 23 and 24 are a sand plain with some basins and swampy tracts. Sumac hill at and west of corners of Secs. 21, 22, 27 and 28 rises abruptly over 100 feet above the plain south of it. An. 28.400 on summit on line of Secs. 21 and 28. It is gravelly with a few boulders and is covered with sumac bushes. It had pine timber and so did the plain to the south, Secs. 22, 23 and 24 were largely pine hut the sections north have hardwood. indeed the north half of this township of Aetna is timbered mainly with hardwood, beach, maple, etc. and there is considerable hardwood and till in the southwest quarter of the township.

I command a wide view from Sumac hill except toward the north. The altitude is high in that direction. The south border turns north of east into Sec. 24 from the northeast part of Sec. 28 and northwest to Ellie Hill at corners of Secs. 17, 18, 19 and 20. There is a sand plain south of the moraine from Sumac Hill eastward and a till plain westward.

An. 28.520 on till plain west of Sumac hill near corners of Secs. 20, 21, 28 and 29. I continue west to the town line through a till plain. I then go north a mile through a swampy tract with clay islands on it.

An. 28.540 at swamp at the middle of Township line T. 22 Rs. 6 & 7 W. There I turn west, rising into a till tract with very gentle swells and a few boulders that covers parts of Secs. 12, 14, 23 and 24. An. 28.500-510. Much of Sec. 23 is sandy and a sandy strip follows Butterfield Creek up from here across Sec. 15 and 16 and then runs north across Sec. 9 and 10 to the low swells of sandy drift noted in Sec. 4. It takes in the northeast part of Sec. 8 and southeast part of Sec. 5 also. Secs. 1, 2, 3, 11 and 12, as noted Sept. 13, have till with a thin coating of sand. The southwest half of T. 22 N., R. 7 W. is nearly all till and has only a few low swells. It is more compact in the central and northwest parts of the township than on the south border.

An. 28.460 at Lake City at 5:30 p.m. Wells in Lake City are 25 - 28 feet deep to get the best supply though some are shallower. Wells have been sunk to a greater depth but strike into a chalybeate water, so I am informed by George W. Wood of Lake City, a real estate man who

has made several in the village. Mr. C. B. Marsh and old surveyor (P. O. Butterfield), says much of Houghton Lake has 7-10 feet of water. There are places in the middle that are scarcely 10 feet. Muskrat Lake at Lake City is, much of it, scarcely 10 feet deep.

September 18, 1901. 5:45 a.m.

An. 28.600 at Lake City. An. 28.640 at 7:30 a.m.

An. 28.610 at Jennings at 8:45 a.m. - 20 feet shove lake level.

An. 28.590 in village on level of sand plain. (See notes in hack part of hook for trip from Lake City to Jennings). I go north from Jennings through a sharply pitted tract for a mile or more to a moraine. An. 28.450 on high part on west side of road about 2 miles north northwest of Jennings. This is by aneroid about 1435 feet. A hill 120 rods northwest is about 15 feet higher or 1450 feet. This is the highest one in view on this part of the moraine, forth of here I soon enter a tract of hardwood timber and a loamy clay and gravel drift. The high range lies south of Secs. 16, 17 and 18, Caldwell Township but extends into the southeast part of 15 and covers much of Sec. 14 and 13. It also extends north into Sec. 12. This high range was timbered with pine but the lower ridges and knolls northwest of it have much maple, beech, elm, etc. Secs. 1-6, 7-10, 15-18 and 19, T. 23 N., R. 8 W were largely hardwood. In T. 24 N., R. 8 W the south half was largely hardwood and the north half mainly pine.

Secs. 10, 15 and 16 and parts of bordering sections in T. 23 N., R. 8 W. are nearly plane. The east half of Sec. 7 is also but the rest of the hardwood tract in this township is rolling with knolls 20 - 50 feet high and very little level land. In T. 24 N., R. 8 W there is a similar rolling tract in Secs. 23, 24, 25 - 28 and 31 - 36. Secs. 29 and 30 are largely clay swamp and so is much of Secs. 13 and 14.

Secs. 20 and 21 hare considerable clay and there are patches of clay in Secs. 17, 18 and 19. There are low hills in Sec. 19 and north part of Sec. 20.

There is a loamy or loose textured till of excellent quality for farming in the south half of T. 24 N., R. 8 W. and north half of T. 23 N., R. 7 W. there is good agricultural land of loamy till except a strip 1 - 2 miles wide along its north side where there are sand plains and sandy knolls. I got much of the above information from John Caldwell in north part of Sec. 4, T. 23 N., R. 8 W. but afterwards drove through Township 24, Rs. 7 and 8 W. enough to verify his statements. My route was north through Sec. 33 to center of Sec. 28, T. 24 N., R. 8 W. then east to town line at middle of line of Sec. 25 and 30. I stop for dinner at Mr. H. S. Lamb's on west side of Sec. 30. Then I go north ½ mile and east two miles, then north between Secs. 20 and 21, 16 and 17 crossing an elevated point near the section corners, an. 28.530, and descending to a sand plain in north part of Sec. 17 an. 28.790. This plain is bordered on the east and west by hills that rise very abruptly above it; those on the west, in Secs. 6 and 7 about 150 feet, and those on the east, in

Secs. 4, 9 and 16 about 200 feet. This plain is a recess form an extensive plain that follows down Manistee River. The range of hills west of it are like a spur extending out into the plain for there is a sand plain on their west side in the northwest quarter of T. 24 N., R. 8 W. extending into Sec. 2 and 10.

Secs. 1, 11 and 12 are undulating and sandy but scarcely so high as the sections east (Secs. 6 and 7 T. 24 N., R. 7 W). An. 28.560 on hill near east end of line of Secs. 9 and 16. East from here there is an elevated tract 1350 - 1375± with loose textured till and hardwood timber. There are not many boulders in this moraine either in Pioneer or Bloomfield Townships. I go east to corner of Secs. 10, 11, 14 and 15 Pioneer on elevated moraine, and it seems to extend north nearly to the county line.

I go south between Secs. 14 and 15 descending nearly 100 feet to corners Secs. 14, 15, 22 and 23, an. 28.650. I then begin an ascent southward. An. 28.580 at corners of Secs. 22, 23, 25 and 27.

An. 28.480 at summit in road on line of Secs. 26 and 27. The altitude is 20 feet higher a short distance east of road, or about 1450 feet. This high range leads eastward, passing north of Stittsville. To the west it is broken by deep gaps but the altitude continues high through the south-west part of Pioneer Township and northwest part of forest.

In Secs. 34, 35 and 36, Pioneer Township there is a very sandy till with gently undulating surface. The till throughout Pioneer is loose textured and very productive. The only barren tracts are in the sandy hills and the plain in north part. I take a road that angles southwest through Secs. 4, 9, 17, 18 and 19 Forest. There is a pitted gravel plain in Secs. 8 and 9 and parts of the bordering sections that stands about 1325 - 1350 feet A.T. The moraine west of it in Secs. 4, 5, 6, 7 and 8 is a little higher. The outwash apron seems to belong to the moraine northwest of it. The basins are 10 - 15 feet deep and rather small, often but a few rods across. There are channels on this pitted gravel plain that open southward into the swamp that West Branch runs through. This swamp near the present divide is less than 1200 feet, perhaps 1190 feet. There is sand and gravel here without peaty covering.

South of it in Secs. 20 and 21 there is a sand plain standing 40 - 50 feet about the swamp. An. 28.700. This road continues southwest and ascends what looks to be a ridge when viewed from the north but really is no higher than the plain south of it. An. 28.650. The gap in the range here is about 3/4 mile. There is a rise of over 100 feet to the high point in Sec. 29 or to a high tract in Sec. 13. This range is very gravelly and it was timbered mainly with pine. South of this gap I descend gradually to Lake City. An. 28.685 or about 1250 feet A.T. at 4:00 p.m. An. 28.730 at 5:00 p.m. I take a train to Cadillac.

September 19, 1901

Proclaimed by President Roosevelt to be a day of prayer because of death of President McKinley, this being the day of the funeral. I go afoot from Hobart southeastward to the hills of Sherman township and then to Lucas. (See notes in back part of this notebook).

September 20, 1901 - - 7:50 a.m.

An. 28.620 at Cadillac, 1293 feet A.T. I take train to Tustin.

An. 28.615 at Hobart, 1299 feet. An. 28.670 at county line.

An. 28.700 at Osceola Jc., 1218 feet. This is at west border of the moraine, there being an extensive swamp west from here.

An. 28.715 at Tustin, 1221 feet A. T. at 8:25 a.m. I drive east crossing a ridge 1260 feet A.T. on line of Secs. 24 and 25 and dropping to 1200 feet at creek near township line. One half mile south the altitude is about 1275 feet, but to the north along town line it scarcely exceeds 1225 feet for a mile north, but 1½ miles north it rises to 1275 or 1300 feet. Much of Secs. 15 and 30, Sherman is a gently undulating till tract with but a few boulders. An. 28.680 at corners of Secs. 19, 20, 29 and 30. Sherman Township - 1255 feet at 9:00 a.m.

A hill south of here 1¼ miles on line of Secs. 31 and 32 probably reaches 1300 feet A.T. but Secs. 20 and 29 are below that contour. They have a swell and sag topography and clayey drift with but few boulders. Knolls are 15 - 20 feet high.

An. 28.670 at corners of Secs. 20, 21, 28 and 29 = 1260 - 1270 feet. The altitude reaches 1300 feet 60 rods east and the 1300 foot contour runs southeast from there across Sec. 28. It runs east in south part of Sec. 21. Secs. 21/28 are bouldery.

An. 28.660 at corners Secs. 16, 17, 20 and 21. The 1300 foot east-west contour is nearly ½ mile north of this corner but is only 60 rods east and bears southeast from there across northeast part of Sec. 21, Secs. 16, 17 and 21 have sharp knolls 30 - 60 feet high and many boulders. At church and cemetery just east of corners of Secs. 15, 16, 21 and 22 on a knoll, an. 28.550 = 1375 feet. The 1400 foot contour curves west just across line of Secs. 15 and 16, 3/4 mile north of here.

There is a hill north of center of Sec. 22 that rises above 1400 feet, and the contour runs north a mile from there before swinging west.

An. 28.530 at corners of Secs. 14, 15, 22 and 23 = 1400 feet. A hill 40 rods southwest is 35 or 40 feet higher. A hill ½ mile north reaches about to 1500 foot contour.

An. 28.500 at corners of Secs. 13, 14, 23 and 24 = 1427 feet at 10:00 a.m. My barometric observations yesterday made the same cross roads 1440 feet. An. 28.550 at corners of Secs. 23, 24, 25 and 26 in a basin

25 feet below ground level there. The 1400 foot contour is 80 rods north and 80 east of this cross road. I rise to a high ridge on line of Secs. 24 and 25 at a school house near middle. An. 28.400 = 1515 feet. This ridge runs ½ mile north northwest and 120 rods southeast from here shove the 1500 foot contour.

An. 28.440 at township line of Sherman and Highland 2 miles from south and = 1475 feet.

A hill in central part of NW¼ of Sec. 30 is about 1520 feet and this contour extends west across the township line in a narrow ridge connecting with the hill in Secs. 25 and 24 just crossed.

An. 28.430 on hill near middle of line of Secs. 19 and 30, Highland Township = 1485 feet. An. 28.500 at corners Secs. 19, 20, 29 and 30 = 1440 feet. The 1400 foot contour passes north-south about 40 rods west of here. I there enter a swell and sag till tract of loose textured till with numerous small boulders. 28.610 at corners of Secs. 22, 21, 28 and 27 = 1325 feet. The 1300 foot contour is about 100 rods south and 1/3 mile east of this crossroad and runs northeast-southwest across NW¼ of Sec. 28.

An. 28.690 at swamp near middle of line of Secs. 22 and 27 = 1250 feet. this has a heavy clay and but few boulders. From here east it is a till plain rather than moraine.

An. 28.735 at stream near middle of line of Secs. 22 and 27 = 1200 feet A.T. An. 28.690 on hill near east end of section line = 1240 feet. The corners of Secs. 22, 23, 26 and 27 are 1230 feet. Only the west edge of Sec. 23 and the northwest and southwest corners of Sec. 26 are above the 1200 foot contour.

An. 28.740 in swamp on line of Secs. 26 and 27.

An. 28.700 at corners Secs. 26 and 27, 34 and 35. The 1200 foot contour comes back west across northwest part of Sec. 35 and runs up Middle Branch River on line of Secs. 34 and 35 at 11:30 a.m.

An. 28.720 at crossroads at line of Highland Township and Hartwick township, 2 miles from east end at 11:40 a.m.

The altitude is above 1200 foot contour for about 3/4 mile east of here. An. 28.710 at Mr. Jim Thompsons in Sec. 2, Hartwick Township on a knoll.

Well data

An. 28.700 at Mr. Thompsons at 1:00 p.m. Mr. Thomsons well is 60feet and is largely through till. It only has 6 feet of water. It is 40 or 50 feet above low land northwest of it. Boulders are store numerous and the surface more soiling in west part of Sec. 2.

An. 28.670 at middle of line of Highland and Hartwick township = 1250 feet. Knolls 60 rods southwest are 25 = 30 feet higher or about 1280 feet, the 1300 foot contour crosses this township line about 2 miles from its west

end. An. 28.690 at corners of Secs. 3, 4, 9 and 10 Hartwick township at 4:45 p.m.

The central part of Sec. 9 is high and probably rises above 1300 feet. Wells in the northwest part of Hartwick Township are 40-80 feet and largely through till of clayey texture.

An. 28.640 at E. O. Dorrs in northwest part of Sec. 9. His well is 81 feet. It has 30 feet of clay at top, the rest was sand.

An. 28.650 at corners Secs. 4, 5, 8 and 9 = 1275. Much of Sec. 8 is above 1200 feet hut Sec. 5 is largely below it. The north edge and southwest corner are about 1300 feet.

An. 28.600 at corners Secs. 5, 6, 7 and 8, Hartwick. From here I can see very high tracts in the southwest part of Hartwick and southeast part of Rose Lake Township that probably rise above 1400 feet and possibly reach 1500.

Section 6 and 7 probably section 18 also are hut little above the 1300 foot contour and have a clayey till with gentle swell and sag topography. There are some swamps (tamarack and hemlock) in Sec. 6 that are sandy. 28.560 on knoll ½ mile west of Township line on line of Secs. 1 and 12 Rose Lake. Rose Lake Post Office, corner of Secs. 1, 2, 11 and 12, is on a chain of sharp knolls 30-40 feet high.

An. 28.550 at Rose Lake Post Office. Knolls 60 rods north are 40 feet higher or nearly 1400 feet A.T. An. 28.530 at summit on road north of Rose Lake Post Office. The knoll west of road is 20 feet higher. There is a swell and sag tract for two miles south of Rose Lake Post Office similar to that east of here but north there is a very hilly tract with knolls 30 – 60 feet or more in height. An. 28.520 on knoll ½ mile north of Rose Lake Post Office. An. 28.590 at Township line of Sherman and Rose Lake 1 mile from east end. The north edge of Secs. 35 and 36, Sherman are above the 1400 foot contour. An. 28.560 at cross roads 2 miles from east end of Township line. A high range of hills leads northwest from the southeast part of Rose Lake Township past the south and west sides of the lake. There is a hill west of the lake fully 150 feet above the lake level and the lake is probably 1300 feet A.T. An. 28.630 at lake outlet on Township line in Secs. 4 and 33, near east end of Section line at 3:15 p.m. 28.580 on hill ¼ mile west of outlet. 28.565 on hill on line of Secs. 5 and 32. 28.600 at corners of Secs. 31, 32, 5 and 6 where road leads north. The high tract pine land leads northwest into Sec. 5, but Sec. 6 and 31, though high and rolling, have hardwood. An. 28.560 on ridge 40 rods east of township corners. There is a point on Township line ½ mile North of corners fully as high. An. 28.635 at G. R. & IRR on Township line of Burdell and Leroy at 3:50 p.m. The track here is crossing a basin and is 8-10 feet above the bottom of basin. An. 28.670 on swamp at north end of line of Secs. 1 and 2 Leroy Township. There are small swamps in Secs. 1 and 2 and a large

one in Secs. 35 and 36. Knolls rise sharply 20 - 30 feet above the swamps.

An. 28.630 at corners of Secs. 1, 2, 11 and 12. From here I have a view of a ridge that leads west from Leroy. It rises 75 - 100 feet above a valley north of it and is timbered with hardwood.

An. 28.610 at corners of Secs. 2, 3, 10 and 11.

An. 28.640 at corners Secs. 3, 4, 9 and 10.

An. 28.600 on hill 80 rods south of township line of Secs. 3 and 4.

An. 28.700 on Township line in a basin. There is a sharp knob and basin topography in Secs. 3, 4, 9 and 10 Leroy and apparently in sections to the west. The basins are 30 - 75 feet below bordering hills and very abrupt borders. The drift is sandy loam to clear sand with a few boulders. Timber is largely hardwood though there were a few conifers, hemlock, flat cedar etc. An. 28.730 in swamp on line of Secs. 33 and 34 at crossing of a narrow gauge R.R. tract. 28.720 at broad gauge R.R. near corners Secs. 27, 28, 33 and 34. An. 28.700 on hill north. There is a point east 130 rods 50 - 60 feet higher. An. 28.740 at a lake on line of Secs. 27 and 28. An. 28.685 on hill north side of lake.

28.720 at cross roads 2¼ miles west of Tustin; 28.690 on hill north of cross roads; 28.770 at stream near center of township. I go back a mile and turn east to Tustin. An. 28.680 on hill at a cemetery 1½ miles west of Justin. The top of this is gravelly but the west slope is till with boulders in moderate numbers.

A hill a mile north of here seems to be higher. An. 28.670 at Justin at 6:15 p.m. As set this morning the aneroid now reads 1255 feet where it should be 1221 feet A.T. I am told that choppy hills extend west and northwest from here beyond the county border. There are many swamps both large and small among the hills and the hills are generally a very sandy till though a few of them have a clayey till. This seems to be a morainic tract yet it stands lower than the plain at Cadillac.

Well data

There is a well at J. L. Rademachers livery barn that is 140 feet deep. It has fully 100 feet of water. Other wells are obtained here at 30 to 40 feet.

September 21, 1901.

The city engineer at Cadillac, A. J. Teed, states that there is a difference of about 10 feet between the lakes in southeast part of Cadillac and Little Clam Lake, lie former being lower, yet Clam Lake lies in a clay basin and is only 16 - 20 feet. Big Clam Lake is only 8-10 feet deep and half of it is not over 4 feet. There is soft water under the first bed of clay at about 10 feet below level of Little Clam Lake. The water gravel is several feet thick. Under this is a thick bed of clay. The deepest boring in

Cadillac is at the old Stan? Mill (now burned) and is only about 120 feet.

Well data at Cadillac

There are wells in the city almost 100 feet, one being near McKinnan Hotel in street. These deeper wells have had water. The water rises up to the level of the upper water vein.

An. 28.650 at Cadillac at 8:15 a.m.

Mr. A. J. Teed says Muskrat Lake at Lake City is 47 feet lower than Little Clam Lake, and Little Clam is 12 - 13 feet below G.R. & I. Station. He thinks Jennings on Crooked Lake is about 3 feet above Muskrat Lake. An. 28.650 at line of Secs. 21 and 28, T. 22 N., R. 9 W. An. 28.620 on low ridge in north part of Sec. 21.

An. 28.590 at line of Secs. 9 and 15 about 20 feet above Missaukee Jc. or 360 feet A.T. There is much till in south part of Sec. 15 and in 22. The north half of Sec. 15 is on high sandy hills with deep basins. There are spots of clay here. An. 28.500 on summit near line of townships 22 and 23, probably in south part of Sec. 30. There is a very choppy surface with small basins and sharp hummocks, the hummocks being 25 - 50 feet above basin. This covers much of Secs. 32, 33 and 34, I. 23 H., R. 9 W. north of here there is a range of very prominent hills 100 feet or more in height. Boulders are very scarce. The highest points in Sacs. 28 and 291 T. 23 N., R. 9 W. are about 1540 feet and several rise above 1500 feet. North of this range of hills is a pitted gravel plain standing about 1350 feet A.T. An. 28.600. the basins are 30 to 50 feet deep.

Well data

L. H. Dunton in NE¼ Sec. 23, Cedar Creek has a well 130 feet. There is 10 feet head. An. 28.610 = 1340 feet. Mr. Frank Harris in Sec. 23 and Newton Moffat in NW¼ of Sec. 24 have wells about 80 feet or same level as Duntons well. An. 28.620 at county line at corners of Secs. 13, 24 and 18, and 19. This is at the border of the sharp moraine. A knoll near center of NW¼ Sec. 19 is 75 feet higher and there are points fully as high in Sec. 24. There is a plain in Sec. 18, Caldwell township.

An. 28.680 at corners of Sacs. 12, 13, 7 and 18.

An. 28.730 at low tract on line of Secs. 12 and 18.

An. 28.660 at crossroads at middle of section line, Secs. 12 and 7.

There is a very prominent hill in west part of Sec. 8 and another in northwest part of Sec. 7. The south part of Sec. 7 is level and so is the east part. An. 28.580 at summit in road near north line of Secs. 12 and 7. The hill is 30 feet higher just east of here.

An. 28.750 in basin near east end of line of Secs. 1 and 12, Cedar Creek Township. An. 28.600 on hill near northwest corner. A hill on township line north seems to be about same height. Much of Secs. 1, 2, 11 and 12 is

far below the gravel plain south of here and is a bouldery moraine. An. 28.660 on hill 1 ¼ miles east of Manton. An. 28.820 at creek ½ mile east of Manton. An. 28.800 at Manton at 11:45 a.m.

The moraine extends south from here to a swamp a mile or so farther. Beyond this is the gravel plain noted above. This seems to be a Lake Michigan moraine and the gravel plain is probably an outwash from it. There is a hare possibility that the Saginaw lobe formed the moraine southeast of the gravel plain. The basins are very deep near that moraine and the plain seems to be higher there than on its north border. - features which are in support of the view that it is a Saginaw outwash. The Manton moraine north of the gravel plain might in that case be a contemporaneous Late Michigan moraine.

Well data

Wells in Manton are shallow, 20 - 35 feet in depth +

An. 28.785 at Manton 1132 feet A.T. at 12:40. There is a sharp range of hills east of the G.R. & IRR in Secs. 27, 28, 33 and 34, Liberty Township, but farther north, east and west there is a low tract, much of it swampy (see map). I go west a mile rising to a hill. An. 28.700. West from here there are only low swells. There is a high range in south part of Secs. 8 and 9, T. 23 N., R. 9 W. An. 28.640 on crest on line of Secs. 8 and 9 near south end. An. 28.730 on swamp on line of Sec. 16 and 17.

An. 28.615 at Gilbert Station at 1:15. An. 28.550 on sand plain near corners.

An. 28.510 at southwest end of sand plain near center of Sec. 33.

An. 28.330 on summit in Sec. 31. A hill a mile northeast in Sec. 29 is 20 feet ± higher. Secs. 31 and 36 are higher than the Secs. south of them. An. 28.480 at township corners. An. 28.490 1 mile south. In secs. 7 and 8 and 17, Haring township there is a gently undulating tract with spots of till hut generally covered with a sandy gravel that has a few boulders. It is like the tract south of Big Clam Lake. It is 1330 – 1340 feet A.T. being about the same as Missaukee Jc.

An. 28.510 on low ridge in Sec. 28. An. 28.540 at T & A.A. Depot in Cadillac at 3:20 p.m.

It now seems probable that the ice occupied the low tract on the north edge of the sand plain in Cedar Creek township south of Manton while that sand plain was being built up, and the line of discharge my prove to have been southeastward toward Jennings. The aneroid indicates that the plain is highest at its west end and there seems to be no outlet there. This may be worth looking into further by a drive southeast from Manton. The till tract north of Cadillac seems likely to be the inner slope of a Lake Michigan moraine. There appears to have been a point west of Jennings where the ice held its own during a retreat from the margin that passes from there past Cadillac to Luther and the margin that is

marked by the strong range in south part of Cedar Creek township that was westward past Boone. The Manton moraine is perhaps merged with this both west and east from the sand plain in central and eastern Cedar Creek township.

An. 28.520 at Cadillac at 4:15. I take train west on T. & A.A.R.R. to Harrietta passing through a tract of pine stumps and level dry sandy ground for 2 or 3 miles. I then enter a swamp that extends beyond Big Clam Lake to within 2 miles of Millers Siding. This swamp and the sand plain east stand about 1290 – 1300 feet A.T. I then rise rapidly through a nearly plane surfaced tract to Millers, an ascent of 100 feet in about 2 miles. There is no suggestion of a moraine except this rapid ascent, there being a smooth sandy surface nearly free from boulders. There are, however, slight waves so that the railway has cuts 10 feet or so in depth and fills of 5 or 6 feet. About a mile southeast of Boone where the railway makes its curve a morainic topography sets in with swells 20 – 25 feet high and with a bouldery drift. This border has a northeast – southwest trend here and is said to continued to northern Henderson Township where it swings southward. It leads northeast to the corners of Townships 22 and 23, Rs. 9 and 10 W. Between Boone and Harrietta the drift is very loose textured and in places is clear sand as exposed in the railway cuts.

An. 28.730 at Harrietta = 1115 feet at 5:00 p.m. This is in the valley of Slagle Creek 300 - 375 feet below the level of the bordering uplands. I go north to a hill in southwest corner of Sec. 6, T. 22 N., R. 11 W and find its altitude to be 1480 feet. An. 28.320. A hill ½ mile west - northwest in Sec. 1, T. 22 N., R. 12 W. may reach 1500 feet A.T.

The drift is a good road gravel at top of the hill in Sec. 6. In the valley around Harrietta there is some clay, samples of which have been sent to the State Geologist for analysis. It is fine textured and pebbleless. James T. Stanley of Harrietta has prospected it considerably and thinks it has a depth sufficient to warrant shipping for the cement industry.

Well data

Mr. Stanley reports a well in central part of Sec. 8, Boone Township at George Andersons that is 150 feet. - the deepest one in this vicinity. It penetrated:

- | | |
|--|---------|
| 1. Sand and gravel | 50 feet |
| 2. Clay | 18 " |
| 3. Sand | 82 " |
| 4. Rock at bottom, probably a boulder. | |

There are blocks of limestone in the drift near Harrietta exposed la gullies and these give the residents the idea that bedrock is close at hand, but it seems doubtful to me.

September 22, 1901 5:30 a.m

An. 28.670 at Harrietta = 1115 feet. An. 28.685 at 7:00 a.m. = 1115 feet. Slagle Creek is 20 – 25 feet below the railway station. I go south along the old state road rising to about 1270 feet at corners of Secs. 18, 19, 13, and 24. At top of hill 100 rods south the altitude is over 1400 feet. An. 28.370. An. 28.360 at middle of line of Secs. 24 and 19 = 1425± feet A.T. There is a tableland here with sandy drift.

An. 28.350 at corners of Secs. 19 and 30. 24 and 25 = 1434± feet A.T. There is a sandy loam here and the timber is hardwood.

An. 28.360 at middle of line of Secs. 25 and 30. An. 28.470 on moraine 100 rods south. An. 28.540 at sag near middle of line of Secs. 31 and 36 = 1250 feet.

There is no higher land to the west or east than the upland in south part of Secs. 36 and 31 = 1300±.

An. 28.470 on upland south part of Secs. 36 and 31.

An. 28.556 in moraine 40 rods north of township corners, Ts. 21 and 22, Rs. 11 and 12 = 1230 feet± A.T.

There is a sharp knob at the township corners. An. 28.350 = 1434 feet at 8:00 a.m. The road runs along the east base and only reaches 1290 feet at township line. This is an isolated knob of sandy gravel. There are hills fully as high southeast of here in northwest part of Sec. 6. The road reaches 1425 feet about the middle of line of Secs. 1 and 6 and the altitude 30 rods east is 25 or 30 feet higher.

An. 28.510 at corners of Secs. 1, 12 and 6 and 7 in sag at place where Clay Hill Post Office was located. There is a little day on the side hill north of the corners, there are scarcely any boulders along this road from Harrietta to Clay Hill.

An. 28.600 at corners of Secs. 12, 13, and 7 and 18. A knoll just south is about 50 feet high. Share is a flowing well in Sec. 36, Slagle township about 100 feet deep, probably escaping air. An. 28.620 at corners of Secs. 18, 19, 13 and 24. There are gentle swells east of here but to the west it looks to be plane for a mile or more.

An. 28.650 at school house at corners of Sec. 15 and 30, 24 and 25 = 1160 feet. There are sharp hills on the east edge of Secs. 19 and 30. Henderson township. An. 28.530 on hill near west end of line of Secs. 20 and 29 = 1270 feet, this is on a knob and basin tract of gravelly drift with few boulders.

An. 28.630 = 1175 feet at Frank Waites on low ground near Downing Creek. His well is 60 feet and largely clay.

Mr. Waite states that the western 2/3 of Henderson Township is rolling land. On the south line it is hilly as far east as Sec. 34. An. 28.650 at corners of Secs. 29, 30, 31 and 32.

An. 28.735 on bank of Poplar Creek at railroad crossing 80 rods south of corners. An. 28.760 at Creek = 1045

feet. This is in a narrow ravine. An. 28.660 on a hill in northwest part of Sec. 6, Dover Township, Lake County. Points 25 - 30 feet higher both east and west of this road. An. 28.730 on a terrace or nearly flat tract with basins on line of Secs. 7 and 12, 80 rods from south end. This plain is extensive west of here across Pine River and is about 1050 feet A.T.

There are a few boulders here and occasional low knolls. An. 28.850 at Pine River in Sec. 13, T. 20 N., R. 12 W. = 970 feet A.T. at 10:15 a.m.

I go east on center line road of Dover rising into a morainic tract and reaching a submit near corners of Secs. 17, 18, 19 and 20. An. 28.630 = 1175 feet.

The drift from here east has considerable till of clayey texture. An. 28.600 on hill 20 rods west of corners Secs. 16, 17, 20 and 21. A hill 30 rods southeast of corners is 20 - 30 feet higher and so is a hill 60 rods east. An. 28.570 = 1225 feet A.T.

There are prominent hills in view a mile north near corners of Secs. 8, 9, 16 and 17, Dover Township.

I go southeast across Sec. 21 crossing a hill that reads 28.520.

An. 28.650 at a camp 2½ miles west of Bristol.

There is a strip of pine land with sandy soil, 1- 2 miles west of Bristol but around Bristol there is a till moraine with swells 20-40 feet and a few surface boulders. The soil is from a clay loam to a stiff clay.

An. 28.550 at Bristol at 11:30 a.m. 1250 feet ±, in a sag 20 - 30 feet below bordering upland. An. 28.520 at schoolhouse 80 rods east of store on hill = 1270 feet & A.T. 28.460 at same schoolhouse at 1:30 p.m. 28.440 on hill 40 rods west of county line = 1300 feet. This overlooks the country east to the hills of Sherman township. Tustin is in plain view. The drift continues to be bouldery east from here, and has a loamy clay soil to Pine River.

I go north on county line and find till for 1½ miles to middle of line of Secs. 13 and 18, but north from here the drift is very sandy. It is nearly plane except for basins. These are numerous and deep.

An. 28.430 at general level of sandy tract near north end of line of Secs. 13 and 18 = 1300± at 2:00 p.m. There is an occasional boulder here and an occasional low swell. It is like the tract south of Big Clam lake 2-4 miles but rather sandier.

An. 28.500 at creek in line of Secs. 12 and 7.

An. 28.410 on inland north of creek near corners Secs. 1, 12, 6 and 7. There are some large boulders here and a relief of 10 - 15 feet above the general level. An. 28.385 at corners of Secs. 19 and 30, Cherry Grove and Secs. 24 and 25, Henderson Township on flat swampy land.

An. 28.355 at middle of township line 3:20 p.m. Clay pit here on side hill shows scarcely a pebble. It has a

capping of sand 2 feet thick. An. 28.380 on low tract on line of Secs. 13 and 18. It discharges eastward. An. 28.340 on inland north of creek. There is hardwood timber from about Secs. 25 and 30, northward but there is much swamp in Secs. 24 and 25, Henderson township to Secs. 19 and 30, Cherry Grove. Farther north is a tract similar to that at Millers siding east of the moraine. The moraine becomes strong on the center east-west road 2 – 2½ miles from east end of line. An. 28.320 on low swell stout 1 mile from north end of township line of Cherry Grove and Henderson. An. 28.340 at township corners of Boone, Selma, Henderson and Cherry Grove. There are a few boulders in Secs. 1 and 6 and 31 and 36. The soil is a sandy loam in the low swells and clayey lower in the sags.

An. 28.310 on knoll 10 feet high near middle of line of Secs. 31 and 36. An. 28.310 on flat land at corners Secs. 25, 36, 30 and 31.

An. 28.320 at corner Secs. 25, 26, 35 and 36. Boone Township. It is flat for a mile west from here but farther west it is rolling country. An. 28.360 in basin south of Boone 1 mile. An. 28.295 at Boone, 1387 feet. 4:20 p.m.

An. 28.250 on hill ½ mile north of Boone. There is a hill at least 50 feet higher in south part of Sec. 14. Another a mile west of Boone is about 100 feet above the station. An. 28.250 on knoll in southwest corner of Sec. 12.

From here I see a hill about the northeast corner of Sec. that is 50 – 60 feet. The rest of the section has only low swells 20 feet or so and sags of similar depth. There is clay along Slagle Creek valley from Sec. 15 and west past Harrietta. An. 28.570 at Harrietta at 5:30 p.m. I go to some outcrops of a calcareous rock in a moraine just north of the railway water tank near the dam that holds the water which supplies the tank at an altitude about 50 feet above R.R. It seems likely to be glacial conglomerate but has few pebbles in it. There is an outcrop several feet thick and 30 or 40 feet long near the dam. Mr. Stanley says it appears at a few other places on the borders of this ravine. He took it to be a rock ledge brought up by an upheaval and says it dips into the bluff northward. Dr. Lane has visited this outcrop also.

There is clay just east of here from the creek level up to a height of 90 feet above it that wherever exposed is free from grit and thought to be good for the cement industry. It has been examined by men interested in that industry and samples have been sent to Dr. Lane.

West of the place where this calcareous rock outcrops there is sand and gravel at the same horizon at which clay appears to the east. A well penetrated it 57 feet without striking clay so Mr. Stanley informs me. The outcrop of this calcareous rock at bank nearest railroad just east of water tank is 28 feet above track at tank.

September 23, 1901 6:00 a.m.

An. 28.650 at Harrietta. Ditto at 7:00 a.m.

An. 28.770 3 miles west of Harrietta. An. 28,830 at Slagle Creek on line of Secs. 9 and 10. Slagle township. The hills are high for scarcely a mile west of the meridian of Harrietta. West from there is a plain with only a few knolls. It has some till and is timbered with hardwood. It was probably covered by the Lake Michigan lobe while the range of hills east of it were forming.

An. 28.800 at Yuma Station 988 feet A.T. (It would be 970 if no weather change had occurred). The moraine sets in ½ mile east of Yuma. It sends out a spur on north side of Newton Creek in Sec. 22 nearly to the Ann Arbor railroad. The west end rises abruptly to about 1100 feet, and is sharply morainic east from there. A depression ½ mile wide leads up Newton Creek to Sec. 32, Antioch township (T.23 N. R.11W) There is a very prominent range north of it as well as south. Brier Hill, in Sec. 24, T. 23 N., R. 12 W., is considered one of the highest points in the county.

An. 28.890 on flat tract at middle of line of Secs. 14 and 15, Springville. A sharp hill 120 rods east is 175 - 200 feet higher. An. 28.890 at Mesick Station 912 feet at 9:05 a.m. Hill 150 feet high in southeast corner Sec. 7, Antioch township, but much of Secs. 7, 8, 17 and 18, Antioch and Sec. 13, Springville have low knolls 20 - 50 feet or less.

An. 28.650 at corners of Secs. 13 and 24, Springville and Secs. 18 and 19, Antioch at north base of the high range. An isolated hill west of the road near north edge of Sec. 24 is 100 feet high and one on east side is higher. An. 28.380 = 1380 feet on summit in road at Brier Hill near line of Secs. 24 and 25, Springville. Points each side of road may possibly reach 50 feet higher. There is a rapid descent of 180 feet in the road south of this hill 28.680 at Newton Creek in Sec. 36 = 1090 feet. A.T. at 10:30 a.m.

An. 28.270 on hill on north edge of Sec. 6 = 1470 feet A.T. A hill in group of hills a mile north seems to rise above the 1500 foot contour and so does the wooded hill in southwest part of Sec. 1. An. 28.360 at summit on east-west road in north part of Sec. 6, at B. T. Stanleys residence = 1390 feet.

An. 28.320 on summit on east-west road just west of line of Secs. 5 and 6, Boone township.

An. 28.280 on summit in Sec. 5 just south of township line.

An. 28.300 on township line 20 rods east of corners of Secs. 4 and 5, Boone and 32 and 33, Antioch township = 1450 feet. The altitude is high across north part of Sec. 4, Boone, 1450 – 1475. Considerable till in Secs. 3 and 4, Boone and north from here in Antioch township. The south half of Antioch is very hilly. An. 28.490 in flat tract at middle of line of Secs. 3, Boone and 34, Antioch. The hills are high on line of Secs. 2 and 3 but the north side of these sections is less elevated. An. 28.410 at

middle of line of Sec. 2, Boone and Sec. 35, Antioch
11:50 a.m. at Mr. Hicksons.

An. 28.400 at 12:45 noon at Mr. Hicksons. A hill 100 rods south is 75 feet higher or about 1450 feet A.T. and a basin 100 rods east is 50 feet lower. An. 28.460 in has in east of Hicksons on township line.

An. 28.280 = 1450 feet on hill near middle of line of Sec. 1, Boone and Sec. 36, Antioch. There are two other points near east end of section line equally high and a point in southeast corner of Sec. 36 near center of SE $\frac{1}{4}$ of SE $\frac{1}{4}$ is about 1465 feet.

An. 28.370 in swamp at township corners Antioch, Colfax, Selma and Boone = 1370 feet. It is a small basin 40 - 50 feet deep opening north through a lower tract than there is east, south, or west. The surface in Secs. 5 and 6, Selma is a very sharp knob and basin with knolls 100 feet or more above the basins or lowest point.

An. 28.410 at corners of Secs. 5 and 6, Selma and Secs. 31 and 32, Colfax township. The general level is much lower in Secs. 31 and 32 than in Secs. 5 and 6. A lake of perhaps 100 acres (Dayhoff lake) is on the "borders of Secs. 31 and 32 and is in a basin fully 50 feet deep. The topography is a sharp tool and basin east from here along the township line to the corners where I was last Saturday, September 21.

An. 28.500 at the lake level in SW $\frac{1}{4}$ of Sec. 32 at 1:45 p.m. Dayhoff lake, An. 28.420 at Meauwataka Post Office corners of Secs. 28, 29, 32 and 33, Colfax township.

There is a nearly plane tract in Secs. 29, 28, 27 and the north edge of Secs. 32 and 33. It has a thin coating of gravel but till is sometimes struck at moderate depth. The drift is said to be very irregular in structure. A well at a schoolhouse $1\frac{1}{4}$ miles east of the Post Office. An. 28.470 is 125 feet and several farm wells are 100 - 125 feet. There is a valley-like depression between this plane tract and the strong moraine south of it that may be a "fosse". It has knolls and basins in it yet its general level is about 50 feet below the plane tract. It leads east from Dayhoff Lake passing south and east of Meauwataka Post Office. An. 28.480 in fosse(?) 80 rods east of postoffice.

An. 28.460 at corners of Secs. 27, 28, 33 and 34. The fosse here is full of basins except a narrow flat near its north edge.

School Well

An. 28.470 at schoolhouse on south side Sec. 27, where well is 125 feet. This section is rolling in the southeast corner and the NW $\frac{1}{4}$ contains some upland. The rest is nearly all in the valley-like depression. An. 28.480 at middle of north line at the north edge of valley. There is a rise of 30 or 40 feet west of here to the upland but not so much north. The lowest part of the valley near center of Sec. 27 is 50 feet lower, an. 28.525. I go eastward and soon descend into the valley-like tract. It covers the

north part of Sec. 26. An. 28.560 in its lowest part near line of Secs. 26 and 27 about 40 rods south of north end. An. 28.550 at Gilbert at 5:30 p.m.

An. 28.470 at Mr. Pollocks. An. 28.560 at Cadillac.

The depression that I have taken to be a fosse is continuous along the north side of the prominent moraine to where the gravel plain sets in a mile southwest of Gilbert and along the north side of the gravel plain farther east. It has a flat bottom in places and in places is a pitted plain. About 2-3 miles west of Gilbert there is a nearly plane tract where aneroid reads 28.560 and below this on the north, and at a lower level - 30 feet \pm a pitted tract and one small lake. For $1\frac{1}{2}$ miles west of Gilbert there is some till and a few boulders on the slope or bank south of this depression.

September 24, 1901 5:00 a.m.

I take train from Cadillac to Clare. I note nothing new except that there is a stiff clayey till in a cut mar south end of Lake George opposite the gravel pit that the railroad company opened. Boulders are numerous in the southeast face of the great moraine 5-6 miles northwest from Clare and are sprinkled over much of the surface from there down to Clare.

The till ridge just east of Farwell has many boulders as far east the Harrison Branch of Pere Marquette railroad.

An. 29.230 at Clare at 6:30 a.m. An. 29.300 at 9:15 a.m. at Clare 848 feet. An. 29.300 at 10:00 a.m. by our survey and 834 feet by another.

I take train to Harrison. An. 29.170 at a siding just south of the strong moraine in Sec. 29, Hatton township (T.18N., R.4W) This is 981 feet A.T. by R. R. survey. The moraine is very bouldery for $\frac{1}{2}$ mile or more back (north) from its south border and they are not scarce farther north. Some cuts show a stiff clayey till but the drift generally is loose textured. An. 28.930 at a siding in Sec. 9 = 1183 feet. Hills near there rise a little above 1200 feet. There is much more till of clayey texture here than on the direct wagon road from Clare to Harrison which I traveled last June. Boulders are common in the sags and on some of the knolls. The knolls rise 20 - 50 feet or more above the sags. An. 28.990 at Harrison 1150 feet A.T. at 11:00 a.m. The ridges northeast of Harrison are 1225 - 1250 feet A.T.

The plain at Long Lake is about 1160 - 1170 feet A.T. The moraine east of Long Lake is about 1200 feet. This runs northeast, passing just north of Meredith.

An. 29.070 at Meredith 1080 feet A.T. at 3:30 p.m. The hills $\frac{1}{4}$ - $\frac{1}{2}$ mile north and northeast are 50 - 75 feet or more above this level. Considerable till in this moraine and a moderate number of boulders. The topography is sharply morainic with sharp knolls and ridges 15 - 75 feet in height. For a couple of miles east of Meredith basins are conspicuous.

I go south 1½ miles to center of Sec. 24, Franklin township and there turn southeast toward Gladwin. This north – south part of road is largely in a tamarack swamp, but I come to low knolls of boulder strewn till in Sec. 24. An. 29.090 where I turn southeast at the county line = 1060 feet. An. 29.150 in a valley-like depression nearly ½ mile wide and 20 – 30 feet deep that leads northeast – southwest across Sec. 30, T. 20 N., R. 2 W. This was probably a line of border drainage along ice front. This seems to be still lower next to the southeast bluff. An. 29.170 = 1000 feet±. After rising to the low bluff on southeast border of this depression 1025 feet ±, I descend through a till tract with knolls 10 – 25 feet high and a generally undulating surface to a stream - - North Branch Cedar River - - in south part of Sec. 32, T. 20 N., R. 2 W. An. 29.265 = 920 feet at 4:30 p.m.

An. 29.230 = 950 feet ± on a till ridge southeast of the Creek that probably govern its course to the southwest. There is till on the creek banks and no gravel plain along the stream here. This low till ridge gentle swells 10 – 20 feet high for a width of ½ mile. The slope on southeast side then becomes nearly plane. I cross a narrow swamp in Sec. 4, T. 19 N., R. 2 W. where aneroid reads 28.310. On the southeast side of this swamp, an. 29.275. About 6 miles from Gladwin I enter a swamp ½ mile wide in which the aneroid reads 29.340 = about 860 feet A.T. It seems to lead northeast – southwest and may be a line of glacial drainage. The till on each side of this swamp is a very stiff clay but has a liberal admixture of small pebbles. After crossing this within ½ mile I come to another ¼ mile wide that narrows to the east but seems to continue wide to the west. The tract between the swamps is only 8-10 feet above them and has a moderate supply of boulders. Southeast from here I enter a moraine with numerous boulders and with swells 5-25 feet high. An. 29.310 at summit southeast of the last swamp 40 rods. An. 29.350 on low places and 29.210 - 320 on knolls in the moraine 2 miles north of Gladwin. An. 29.395 at border of lake plain, 1 mile north of Gladwin north of corners of Secs. 25, 26, 20 and 31 about 80 rods. An. 29.400 on a low sandy knoll 40 rods north of section corners. This is a probable beach. It trends south of east and crosses the section line 50 rods east of corners. It soon turns directly east across north part of Sec. 31, T. 19 N., R. 1 W.

An. 29.430 at Gladwin at hotel and business part of town at 6:15 p.m. Altitude about 782 feet. There is a sandy gravel on the plain between Gladwin and tie beach north of here. It seems to be a thin deposit for water is struck at a few feet in ditches and there is poplar brush on it.

Well data

On the Poor farm in Sec. 25 there is a flowing well only 60 feet. On the farm of Jacob Schwartz one mile north of McClure there are several flowing wells, of moderate depth. There are other flows on farms near Gladwin.

The old beach seems to run southward from Gladwin on west bank of Cedar River, there being a moraine on

west side of the river in Secs. 2 and 11, Grant township, T. 18 N., R. 2 W. The proprietor of Central Hotel at Gladwin, Phil Matthews, thinks the border runs through Secs. 15, 21, 29 and 31, there being a plain in the southeast quarter of Grant township. The undulating tract leads toward McClure.

September 25, 1901 6:45 a.m.

An. 29.550 at Gladwin, 782 feet ± A.T.

The well at waterworks is on ground about 15 feet lower or 765 feet ±. The head is 25 feet above surface or 790 feet ±. Rock was struck at about 160 feet and the deepest well is 465 feet. There was sandstone, 90 feet, near bottom. There is another 165 feet.

Flowing Wells

The well at Poor Farm in Sec. 25., T. 19 N., R. 2 W is 37 feet. Its head is 6 feet above surface. There is a flowing well on the Bush farm about a mile below Gladwin that is 140 feet. There are several near McClure (See notes below)

Southwest of Gladwin several wells about 80 feet deep, on plain near border of moraine, barely reach the surface. (Information by George Straley, Engineer of Waterworks). There is a prominent ridge in south part of Secs. 2 and 3 that leads west southwest to Sec. 7. A spur from it runs north on the line of Secs. 34 and 35, Sage township.

An. 29.400 on high point near west end of line of Secs. 2 and 11. Grant township (T. 18 N., R. 2 W. = 910 feet A.T.; 29.500 at east end of section line; 29.515 on low land ½ mile farther east on line of Secs. 1 and 12 at old lake border.

An. 29.545 at Waterworks well in Gladwin = 765 feet.

An. 29.530 at Gladwin Station 782 feet at 8:00 a.m.

An. 29.510 at low ridge of gravelly sand, probably a beach, 80 rods south of north end of line of Secs. 36 and 31 = 800 feet ± A.T. An. 29.505 at beach 40 rods north of corners of Secs. 25 and 36, 30 and 31 = 805 feet ±.

Well data

An. 29.440 on ridge just south of school near north end of line of Secs. 29 and 30. Ditto at Roscoe Bellingers, middle of north side of Sec. 29 on ridge. Well here is 72 feet and there are several others 40 feet deep. It was till 20 feet, sand 20 feet, blue clay 10 feet, then sand and gravel to bottom. The head is 40 feet below surface. Most of them are only 40 feet on this ridge. The ridge here is only ½ - ¾ mile wide including slopes. It becomes very faint toward McClure though it has a relief of 20 – 30 feet above the lake plain southeast of it. An. 29.485 at McClure. The road I took came into McClure from the south 1½ miles.

The Saginaw Beach

An. 29.540 in the swamp 1½ miles south of McClure. The beach is about 1 mile south of McClure and is a well defined ridge 5 – 6 feet high from here westward.

Flowing Wells

There are six flowing wells on Jacob Schwartz farm 2 miles north of McClure, and one on Mr. Dutscher farm near there on east side Sec. 33, T. 20 N. R. 1 W. overflows a weak stream. It is thought to be about 100 feet. An. 29.470 ½ mile north of McClure at section corners. The surface here is slightly wavy and there are a moderate number of boulders, not nearly so many as on the sharper part of the ridge southwest of McClure. An. 29.510 at Little Sugar River 1¼ miles north of McClure Post Office. 815 feet ± A.T. at 9:30 a.m. An. 29.485 on a low swell ¼ mile north; An. 29.470 at township line north of McClure at 9:40 a.m.; an. 29.500 at Mr. Dutscher's flowing well in a moraine on east side of Sec. 33. Those on the Schwartz farm in Sec. 34 are at fully as low an altitude, there being a slope to the east. This till plain in Secs. 33 and 34 has a few low swells 8 – 10 feet and a moderate supply of boulders.

An. 29.470 on Sugar River above plain in Sec. 31, Butman township, 10 feet above stream. The north hank here is till capped by 3 - 5 feet of it. There is a very sandy drift with nearly plane surface except basins in Secs. 17 and 20 and east part of Sec. 15, Butman township. West and north from these sections there is a morainic topography— swells 10 - 30 feet high composed largely of till and with a moderate number of boulders.

I go north between Secs. 17 and 18, 7 and 8 rising rapidly through the moraine. An. 29.300 at corners of Secs. 5, 6, 7 and 8, Butman = 1000 ± at 11:00 a.m. An. 29.250 on crest of moraine near north end of line of Secs. 6 and 5. I here enter a sandy plain that covers much of Sec. 31 and leads northeast and southwest from there. An. 29.270 in southeast corner of Sec. 31. I rise through a feebly morainic tract in Sec. 30 and come to a pitted plain in Sec. 19 with basins 20 feet ± in depth. An. 29.150 at Nolan at noon. This is at the south edge of a very prominent moraine that is the continuation of the one traced yesterday to Meredith. An. 29.120 at Nolan at 1:15 = 1125 ±.

I go northwest across Sec. 13, R. 2 W to crest near northwest corner of the section at an old railroad grade. An. 28.890. This is known as Lindsay Hill. It is the mean range of the moraine and I cross on a sag 50 - 75 feet below the highest points. The highest hill is ½ mile south near middle of line of Secs. 13 and 14, probably mainly in Sec. 14. There are deep basins on the southeast face of this high range 30 - 40 feet and but a few rods across. The drift is loose textured, mainly sandy gravel, and has only a few boulders. An. 28.950 at outer border of this main range at a well in SW¼ Sec. 9, at Mr. Davis residence. An. 28.750 on very high point in west part of Sec. 7. This section is all morainic and so

is Sec. 8 except perhaps the east side. Secs. 5 and 6 are plane and so are sections to the west as far as the ridge south of Houghton Lake this side of Kings Store. This ridge is in plain view and so is Houghton Lake and all the bordering country. From sec. 7 the west border of this moraine trends southwest into Clare County across the southeast quarter of T. 21 N., R. 3 W. The main range runs northeast - southwest parallel with the one I am on and distant 2 miles ±. This passes just north of Meredith near the county line. An. 28.930 on plain at outer border of moraine near line of Secs. 13 and 24, T. 21 N., R. 3 W. This is in a recess in the moraine. Much of Sec. 13 is morainic and so is 24 and some of Sec. 23. I take a road that leads southwest parallel with an old railroad in Sec. 24 nearly to the county line. It is on the edge of the moraine for a couple of miles. There it comes out into a plain that is a recess in the moraine. An. 28.980 on plain. It is a barren tract with a scrubby jack pine. The moraine from Nolan to here has been heavily timbered with pine. From this plain the road leads west of south onto the slope of the moraine to a height of 75 or 80 feet above the plain. An. 28.900 and past mm old log buildings and the site of a good sized structure that has been burned. The moraine within ½ mile southeast of the road rises 75 feet or some 100 feet above the level just given or more than 150 feet above the bordering plain on the northwest. I drive northwest 2 or 3 miles into the plains and find a descent in that direction. An. 29.040 at a marsh with small pond in it.

An. 28.990 at Harrison at 8:20 p.m. = 1150 feet.

September 26, 1901 8:00 a.m.

An. 29.320 at Clare 834 feet A.T.

An. 29.285 at crest of moraine in southeast part of village on county line. An. 29.290 at corners of Secs. 1 and 2, Vernon township and Secs. 35 and 36, Grant township. An. 29.300 at corners of Secs. 1, 2, 11 and 12, Vernon township. The northwest part of Sec. 12 and nearly all of Sec. 11 is on this till ridge.

I drop down to the plain east of the moraine near middle of line of Secs. 1 and 12. An. 29.330 at the border of plain.

An. 29.340 on low tract on line of Secs. 6 and 7.

Saginaw Beach

There is a gravel capped ridge near middle of this section line, an. 29.320, which may be the product of the lake. It runs southeast from here and also northeast. It crosses the line of Secs. 5 and 6, 80 to 120 rods from south end. The ridge has a base of till and may not be a shore line. Its altitude seems to be too great to match the shore at Gladwin, being 25 – 30 feet higher or 835 ± A.T. An. 29.335 on plain southeast of this gravel capped ridge. This is a till plain with low swells 3 – 5 feet high and a few boulders. An. 29.350 at Pere Marquette railroad on line of Secs. 5 and 8, T. 16 N., R. 3 W. = 800 feet ±. An. 29.360 at corners of Secs. 4, 5, 8 and 9 =

790 feet ± A.T. This is at the edge of a swampy tract, along the edge of which there is a sandy bank 3 – 5 feet high. There are also sandy gravel ridges in it. It is probably near the old lake level and the swamp was probably lake bottom. There is some till between these corners and the railroad crossing west of them but near the crossing there is a bank 5 – 6 feet high that may mark shore action. It trends north – south. I do not, however, feel confident of lake action above the level of the border of this swamp. The northeast part of Sec. 5 is flat and has a sandy gravel that may be a delta of the Tobacco River. A bank on the west side of this gravelly plain leads northwest across the northwest ¼ of the section. I go north between Secs. 4 and 5 through this plain.

Tobacco River enters the plain a mile west near line of Secs. 31 and 32, T. 17 N., R. 3 W. (Sheridan township, Clare County). An. 29.370 on terrace south of Tobacco River ½ mile ± wide.

An. 29.395 at river on line of Secs. 32 and 33. the north bank here is till and the moraine is close by and rises to a height of 80 - 90 feet above the stream.

An. 29.300 at summit on road on line of Secs. 28 and 29, T. 17 N., R. 3 W at 9:30 a.m.

George Chunz in Sec. 15 has a flowing well and there is one on east side of Sec. 16. Joseph Schunk's is 103 feet. The head is 5 feet above the surface.

Flowing Wells

An. 29.350 at Joseph Schunks. This was in till 75 feet and sand the rest to a crest at bottom.

George Schunk is on west side of section 10 and his well is 75 feet. It is weaker than that at Joseph Schunk's. Joseph's flows 5 gallons per minute from ¼ inch pipe. It flowed 12 gallons per minute from the 2 inch pipe before the reducer was put on. The temperature is 47° F. There is a very weak flow at a schoolhouse on northeast corner of Sec. 14, 66 feet deep. John Smith in southwest corner of Sec. 11 has a flow from well 106 feet. This is on ground 10 - 12 feet higher than at schoolhouse and is stronger. An. 29.380 at schoolhouse. An. 29.365 at John Smith's well at 10:30 a.m. There is an undulating till.

Lake Beach

An. 29.400 at gravel ridge on line of Secs. 12 and 13, that is apparently the beach. Height 3-5 feet; width 10 - 15 rods. There is a drop to lower land on the east so that water would be 8 feet deep to reach top of beach.

An. 29.415 at corners of Secs. 7, 8, 17, and 18, Beaverton township, Gladwin County at 11:00 a.m.

The lake plain east of the beach in these sections is quite bouldery in places. An. 29.425 at middle Tobacco River on line of Secs. 5 and 6, Beaverton.

An. 29.400 on north bank on the delta » 800 ± feet A.T. Higher ground sets in ½ mile up the river from here. The beach runs east ½ mile on the north bank and then strikes north to the North Tobacco.

Flow

W. H. McCulloch on east side of Sec. 34, T. 18 N., R. 2 W. has a flowing well 68 feet deep. It is on the north bank of Tobacco River at a height of 25 feet ± above the river.

Well data

An. 28.365 at Wm. Lytles in NW¼ Sec. 28, where I stop for dinner. Robert Lytle dug a well 79 feet on south side of NW¼ Sec. 28 that rose when dug within 4 feet of top but is now about 15 feet below surface. It was entirely clay of blue color until a crust was reached 79 feet that lifts the water up when penetrated.

Frank Finzel in Sec. 32 south of North Tobacco River has a well 135 feet all clay and water rises just to the surface. There are several wells in the morainic ridge in Secs. 4, 5, 8 and 9, altitude 875 to 900 feet that are 100 – 130 feet. An. 28.360 at Mr. Wm. Lytles at 1:00 p.m.

An. 28.330 at turn in road in Sec. 21. Swells 10 - 15 feet high and more numerous boulders in Secs. 15, 16, 21 and 28. The border of the lake plain leads north northeast across west part of Sec. 27 and east part of Sec. 22 and central part of Sec. 14 and southeast corner of Sec. 11 and northwest part of Sec. 12. Mr. Lytle says it is marked most of the way by a sandy ridge. An. 29.270 at cross reads on knoll at corners of Secs. 9, 10, 15 and 16.

An. 29.240 on crest of morales near north end of line of Secs. 9 and 10 = 900 feet ±. This commands a view to the north and west as far as the high range of hills that passes north of Nolan and Meredith and east of Harrison. The intervening country has it as sand much till with a gently undulating surface. There are numerous swampy tracts among the knolls and it is very sparsely settled. It had considerable pine but that has been culled out.

The ridge I am on in the north part of Grant township, T. 18 N., R. 2 W has a wavy surface and a sharply outlined crest which trends east-northeast - west southwest. There are scarcely as many boulders here as on the southeast slope. A creek valley follows its north side east northeast into Sugar River. It has a flat bottom ¼ mile or more in width that has gravel and cobble along it. It seems likely to be an old line of glacial drainage and the stream may have discharged southwestward. An. 29.290 in the valley north line of Sec. 7, Grant township at 2:20 p.m. = 850 feet ± A.T.

North of this valley is a ridge 25 - 40 feet above it that is as thickly strewn with boulders, there being large piles in the cultivated fields. In Sec. 6 it is a sandy drift and the ridge is broken into knolls with swanks among them but farther east it is a till ridge and less broken into knolls.

An. 29.275 in swamp on county line on west line of Sec. 7. This swamp runs west across north part of Sec. 12 to a tributary of north Tobacco River and the moraine runs along line of Secs. 12 and 13 into Sec. 14. Here the Tobacco River crosses it. An. 29.335 at North Tobacco River in Sec. 14 at 3:20 p.m.

An. 29.240 - 250 on crest of moraine in southwest part of Sec. 14 on south side of North Tobacco River. The ridge continues westward along line of Secs. 15 and 22 lying mainly in Sec. 15 and is said to form a high divide between the north and middle Tobacco rivers from here westward into Hatton township. It is only ½ mile wide and stands 60 - 75 feet ± above the low tracts on each side.

There is another moraine branching off from this in the west part of Sec. 22 on north side of the Middle Tobacco River. That stream cuts across in a narrow passage on the line of Secs. 27 and 28 near north end of section line. The morainic knolls on opposite banks are scarcely 20 rods apart.

An. 29.250 on the moraine ½ mile north of Middle Tobacco on line of Secs. 21 and 22. An. 29.335 at river. 29.270 on upland.

An. 29.290 at Middle of township line of Arthur and Sheridan.

An. 29.245 at summit on township line just west of corners of Secs. 4 and 5, Sheridan and Secs. 32 and 33, Arthur. This terrain is broken up.

An. 29.260 in swamp west of the moraine at corners of Secs. 5 and 6, 31 and 32. This is about 1/3 mile wide and runs south southwest from Middle Tobacco to Beaver Creek on north tributary of South Tobacco River.

An. 29.220 at corners of Secs. 5, 6, 7 and 8, Sheridan township. A point ½ mile south is perhaps 25 feet higher or about 920 feet.

An. 29.265 at Beaver Creek moraine on line of Secs. 6 and 7 = 860 feet. ±. There is a low terrace 5-6 feet above the swamp on east border that has a gravel pit in it. The gravel is good for wagon road use, being rather fine.

An. 29.200 at summit near middle of line of Secs. 1 and 12, Grant township.

An. 29.200 at Denver Post Office corners of Secs. 1, 2, 11 and 12 on a low knoll = 925 feet A.T. The swells here are 10 - 25 feet high and the surface is all wavy, from Dover there is a good view of the great moraine to the northwest noted last June where southeast herder passes across Secs. 25 and 35, Hatton township, T. 18 N., R. 4 W. A large part of Grant township has a gentle swell and sag morainic topography. It is similar to that of the above moraine east of Beaver Creek channel. There are so many boulders that one can see large piles on nearly every farm in the fields. The till is clayey and not loose textured like mat of the great moraine northwest of here. The channel leaves Beaver Creek in Sec. 24, Grant township and runs southwest into South tobacco

River across Secs. 23, 26 and 27 coming to the river just west of Clare.

An. 29.290 in channel in Sec 24, Grant township = 840 feet ±.

An. 29.315 at Tobacco River northeast of Clare.

Test for coal

An. 29.295 at Clare at 6:15 p.m. Jacob Mason of Clare states that a prospect boring for coal was made near the Fin Lakes in Secs. 8 and 9, Grant township to a depth of about 280 feet and stopped in gravel and sand. A boring was made in northwest part of Sec. 15 about 130 feet. There was a boring made 225 feet at waterworks. The head is several feet below the surface. There were alternations of till and gravel. There are two strong flowing wells at Wm. Hubbell's in north part of Sec. 14 that are shallow (50 feet ±). At the schoolhouse in northwest corner of same section is a weak flowing well.

Flowing wells

George Hersey has a boring 255 feet in west part of Wigs township, Isabella County that failed to get water. It was in blue clay down to about 160 feet. The rest was a greenish clay. The timing wells near Rosebush are 80 to 140 feet and are very strong.

Saginaw shore

September 27, 1901. 6:00 a.m.

An. 29.250 at Clare 834 feet. I take train on Pere Marquette railroad to Loomis. It rises to 850 feet about a mile southeast of Clare and crosses a ridge ½ mile farther east that is about 860 feet; 29.260 at Herrick Station on the gravel, capped ridge noted yesterday. It is apparently 825 feet; 29.285 at cut bank (?) where the railroad crosses an east-west wagon road 2 miles west of Loomis.

L. Saginaw Beach

An. 29.300 at Loomis 784 feet A.T. at 6:30 a.m.

A ridge just east of the station reaches 805 feet. An. 28.275 on highest point. It has till within 3 feet of surface but carries a coating of sand. It covers perhaps 40 acres and the village is built on it. There is a narrow ridge leading north nearly ½ mile on west side of the north-south road that was probably formed by the late. It is sandy and stands about 795 - 800 feet A.T.

An. 29.315 at Loomis at 7:10 a.m. An. 29.330 at swamp west of Loomis, 770 feet A.T. A till ridge sets in just west of Loomis Creek in north part of Sec. 16 and is 20 - 25 feet above the swamp. On its crest and south slope there is a coating of sandy gravel that seems likely to be the lake shore deposits. The old angling road, now abandoned, that led southwest across Secs. 16, 17 and 19 followed the shore pretty closely and utilized its

gravelly ridge where best defined. In Sec. 17 the ridge of sandy gravel is well defined and stands 15 - 20 feet above the swamp southeast of it. It is about on a level with the till tract northwest of it though in places it rises 5-10 feet above the till tract. South of a creek that passes southeast across the northeast corner of Sec. 19 there is a bar extending south ½ mile or more near the line of Secs. 19 and 20 that is 30 rods ± wide and 10 - 15 feet high. The beach is poorly developed back of this bar until I cross the next stream in central part of Sec. 19.

L. Saginaw Beach

from here southwest to the center of the southeast ¼, Sec. 25, Vernon township, T. 16 N., R. 4 W., there is a continuous ridge 8-15 feet high and 20 - 30 rods or more in width composed of sandy gravel. There is no beach ridge from the SE¼ of Sec. 25 to the NE¼ of Sec. 35 but the lace border runs through the south part of Sec. 25, there being a flat tract with a soil that is termed "black sand" along the south border of the section and in Sec. 36 while the rest of Sec. 25 is undulating till, the west half of Sec. 35 has undulating till but the east half is nearly all flat and a sandy beach ridge is developed across much of the section in a north-south course through the east half. The beach ridge continues across the west half of Sec. 2, T. 15 N., R. 4 W, in a course west of south and turns west along north side of a creek 1¼ miles north of Rosebush. It here is a ridge 10 - 12 feet above the plain southeast of it, or some what stronger than the average. Its crest is about 15 feet above the level of Rosebush station or nearly 800 feet A. T.

Tracing highest shore of Lake Saginaw

The beach sets in south of this creek about ½ mile west of Rosebush station and leads southwest to a cemetery on the line of Secs. 15 and 16, T. 15 N., R. 4 W. Much of it is only 3 to 5 feet high and 6 to 10 rods wide but near the cemetery it is fully 20 rods wide and 8 to 10 feet high. South from here to Mt. Pleasant I find but few places where a ridge is developed. The plain has very little eastward descent and water must have been shallow. There are low gravelly bars near the corners of Secs. 15, 16, 21 and 22, T. 15 N., R. 4 W., 3 to 5 feet high, one being just north and west of the cross roads and the other 40 rods southeast. They both trend northeast - southwest. A stream that crosses the middle of line of Secs. 27 and 28 has a sandy gravel on its borders that seems likely to be a delta. The tract north in northeast part of Sec. 28 was probably covered by the lake. The lake also seems to have extended back westward over a huckleberry swamp in the southeast part of Sec. 28. There is a till tract around the corners of Secs. 27, 28, 33 and 34 that stood above the lake a few feet, but south of it there is a low plain on a beach of Salt River that extends west a short distance into the SE¼ of Sec. 33.

South of this a till tract 20 feet higher extends east about to the Ann Arbor railroad in Secs. 3 and 10, T. 14 N., R. 4 W. The gravelly plain along the Chippewa south of the Indian School in the southwest part of Sec. 15 seems likely to be a delta of the river. It stands 7 and 8 feet above the Ann Arbor station at Mt. Pleasant. The Ann Arbor railroad makes the station at Clare 14 feet higher than the Pere Marquette for same point. So it may be necessary to deduct 14 feet from altitudes at Mt. Pleasant and Rosebush. The beach may be a few feet higher. The sand covered plain in Mt. Pleasant is very nearly 776 feet at business part of city and is about 780 feet at its south border (See topographic map). It seems probable that the lake level here was about 776 - 780 feet; at Rosebush, 786 - 790 feet; at Loomis 800 - 805 feet. The altitude of the same beach Bear the westward outlet just north of Elsie is about 100 feet lower than at Loomis.

Data on beaches in Saginaw Basin

I set the aneroid at 773 at Mt. Pleasant (this is too high) and it read 725 on the beach north of Elsie (710) and 680 feet at Bannister (665). It is working toward low barometer so the altitudes are probably a few feet less than here given.

Flowing Wells

The flowing well district near Rosebush covers about 25 square miles as outlined lay a well driller at Rosebush (See Isabella County Map). The wells vary in depth from 50 feet tap to about 200 feet, the strongest flows are southwest of Rosebush 1½ miles. They fill a 2 inch pipe. Many of them barely rise to the surface and flow a weak stream. They ordinarily pass through a large amount of blue till but some northeast of Rosebush 1½ miles entered sand below blue till at about 40 feet that is too fine to screen so the wells were put down through it to gravel at about 100 feet ±. The water is chalybeate in most of the wells.

There is a flowing well district of several square miles along west side of the north Branch of Chippewa River in Nottawa township (T. 15 N., R. 5W.). The wells are 60 - 100 feet ± in depth. There is a small tract along the line of Secs. 26 and 35, 25 and 36, T. 16 N., R. 4 W. and Secs. 30 and 31, 29 and 32, T. 16 N., R. 3 W in which flows are obtained at much shallower depths than near Rosebush. One well near center of Sec. 25 at Timothy Bogan's is only 9 feet and flows a strong stream. Sam Lichti in southwest corner of same section has 2 about 30 feet deep. Allen McDonald in the north-east corner of the section has one 19 feet and Frank Bottle in south part of Sec. 26 has a good flow at 19 feet. His neighbor la the southeast corner of Sec. 26, Patrick Maher, has one about 30 feet. The wells in Secs. 29, 30 and 31, T. 16 N., R. 3 W are deeper, being usually 60 - 70 feet.

The shallow flows probably have their intake dose by on the slope of the moraine but the intake of the deeper ones may be more remote.

From the beach there is a quite rapid rise to the moraine in Vernon township (50 - 75 feet in 2 miles) T. 16 N., R. 4 W) and the north part of Isabella township, T. 15 N., R. 4 W but west and southwest from Rosebush in the southwest part of T. 15 N., R. 4 W the rise is more gradual. The movement of the underground water is probably southeastward about with the surface slope. In places, knolls 10 - 20 feet high set in close to the beach. This is go in southwest part of Vernon and north part of Isabella township and boulders are quite common in the southeast slope of the moraine. They are rare on the lake plain so far as I could see in this route from Loomis to Mt. Pleasant and thus, this part of the lake plain is in contrast with its west border in southeastern Clare County and southwestern Gladwin County where they are abundant. I return to Ann Arbor from Mt. Pleasant on the afternoon train.

September 7, 1901 (Well records and wells and altitudes)

Higgins Lake – 6:00 a.m. An. 28.840

Higgins Lake – 7:00 a.m. An. 28.860

An. 28.700 on high ridge on line of Secs. 2 and 11, T. 24 N., R. 5 W. An. 28.840 on plain southeast corner of Sec. 3; 28.870 on plain near east end of line Secs. 4 and 9. An. 28.870 at Stratford at 9:30 a.m. An. 28.770 at Stittsville at 11:20 a.m.

C. McCullum, 1 mile north of Stittsville has a well nearly 200 feet. A. E. Howe, 1 mile north and 1 mile west of Stittsville has a well 298 feet in southwest part of Sec. 18. Mark Chivvis in northedge of Sec. 20 has a deep well nearly 200 feet. Wells in village are only 20 feet. 28.750 at Stittsville at 1:00 p.m. An. 28.900 at West Branch 6 miles south of Stittsville. An. 28.870 at Missaukee Station on south bluff. Some till north of Missaukee with low sandy ridges traversing till plain. High moraine in north half of T. 22 N., R. 6 W. An. 28.730 on crest on line of Secs. 5 and 6, T. 22 N., R. 6 W at 2:40 p.m. An. 28.860 at stream on line of Secs. 7 and 8. An. 28.740 at corners of Secs. 17, 18, 19 and 20 on crest of ridge. An. 28.840 on plain ¼ mile south of above corners. An. 28.900 at stream near corners Secs. 29, 30, 31 and 32. An. 28.870 on till plain in Secs. 31 and 32. An. 28.915 at Clam River in Falmouth at 4:00 p.m. The bluffs are 30 feet and have sandy drift with boulders imbedded. Gentle swells 10 – 15 feet or less. An. 28.980 at West Clam River. An. 28.930 on hill east of Clam River. An. 28.980 at Marion – 1119 feet A.T. at 6:00 p.m.

September 9, 1901

5:30 a.m. An. 28.960 at Marion = 1119 feet A.T.

An. 28.995 at Pennocks 1084. An. 28.930 at Temple – 6:00 a.m. An. 28.980 at 11:30 a.m. Highest altitude northeast of Lake George is 1240 feet. It is southwest of

Lilly Lake. Clay in southeast part of Reading township and in much of Greenwood township.

September 11, 1901

Well data

Floyd Rose in Sec. 33, Middle Branch in northwest part has a well 106 feet, largely sand and gravel.

A well at Ed. Underwood's on south side of Sec. 22 is 96 feet. Jobs trainer in southwest corner of Sec. 22 has a well 120 feet, mainly clay.

Well on Charles Iose farm is 205 feet. It is in Sec. 22, Hartwick township. Well in northeast corner of Sec. 26 overflows a strong stream 3-4 feet above the surface. There was 70 feet of clay under the gravel. An. 28.010 at well.

An. 28.740 on terrace north of Evert.

An. 28.760 at Evert Station at 11:45 a.m. An. 28.740 at 1:00 p.m.

Wells 2 - 3 miles north of Evert are 80 - 115 feet on land 1200 feet A.T. John Rowley's in east part of Sec. 16 is 115 feet. Mr. Niergarth's in southeast part is 94 feet and has 50 feet of clay from top below which is sand. Head is 18 - 20 feet.

An. 28.340 near north side of township north of Evert at 3:30 p.m. An. 28.300 on hill at orchard and residence 1 mile from south line of Hartwick at 3:45 p.m.

Hill just east of corners Secs. 21, 22, 27 and 28, Hartwick. An. 28.300. Corners Secs. 21, 22, 27 and 28, Hartwick. An. 28.300. Corners Secs. 22, 23, 26 and 27. An. 28.400. 28.400. An. 28.440 at Avondale Post Office corners Secs. 23, 24 and 25 and 26, Hartwick at 4:20 p.m.

Boulders very numerous all the way from Evert to here.

An. 28.460 one mile north of Avondale. An. 28.475 at Middle of township line of Hartwick and Middle Branch in till plain, travel knolls in Secs. 13, Hartwick suitable for road base. An. 28.460 at schoolhouse corner in Secs. 5, 6, 7 and 8, Middlebranch. An. 28.430 2 miles west of Marion. An. 28.420 1 mile west of Marion. An. 28.520 at Marion 6:30 p.m.

Gently undulating till in southwest Marion and northwest Middlebranch. An. 28.430-500.

Seedaar Hill in Sherman township say be highest point in county.

September 12, 1901 An. 28.270 at Marion at 6:00 a.m. = 1119 feet A.T.

An. 28.285 at 7:45 a.m. Well at Marion House is 51 feet and has head 11 feet above surface.

Well data

Mark Ardis has one on west side of river.

Flowing well on Sessions land near county line east of Pole Lake probably in Sec. 4, no settlement there now.

An. 28.170 at McBain at noon = 1246 feet. A ridge 1½ miles west is 80 - 90 feet higher or about 1330 feet. Immediately east is a till plain standing 1180 - 1210 feet, being 1180 about 2 miles east at McBain. Ridge south of Falmouth about 1200 feet. Vogel Center 1150 feet. On the sandy plain east of Clam River 1140 feet. This continues nearly to Moddersville where I rise to a gently undulating till tract 1175 - 1185 feet on ores of ridge over Moddersville Post Office in Sec. 7. There is flat surfaced till east of here in Secs. 8 and 17 but Secs. 9 and 16 have prominent sandy morainic hills reaching 1335 feet where road crosses near east side of the sections. An. 28.070. There are a few boulders here but more occur on the low clay tract to the west. The plain east of this strong moraine is 1100-1110 feet and Muskegon River 1090 feet at bridge in Sec. 11 near William Jones where I stop for the night. An. 28.350.

September 13, 1901 An. 28.510 at 5:20 a.m. at Muskegon River at William Jones in Sec. 11.

Well data

Mr. Seth L. Witherell at Dolph Post Office made a well 62 feet deep in ground 6-8 feet above Muskegon River that rises 8 feet above ground. There was 40 feet of blue clay and "putty sand" and below this a fine sand too fine to screen. The vein that overflows is at 36 feet in the bed of clay. It flows about 9 gallons per minute. Elische Clifford on north side of road in Sec. 34, Butterfield township has a flow that is weaker. It is about 40 feet deep. Mr. Bowman on Bear Creek has a flowing well about Sec. 28, T. 22 N., R. 4 W. An. 28.560 at Muskegon River at Dolph at 6:45 a.m.

Clay plain for 1½ miles west of Dolph. There is some gravel on the hills here. There are a few boulders. The moraine extends into Sec. 31 and 6 on the line of Butterfield and Clam Union townships. West from there for a couple of miles is a swamp south of which there are sandy basins. Clay sets in 3 or 4 miles east of Falmouth and extends west to that village. It has a nearly plane surface. I go north on line of Secs. 31 and 32, Butterfield descending to a gravelly plain at the north end of section line in which Butterfield Creek flows.

An. 28.550 at Creek on line of Secs. 29 and 30 at 7:45 a.m. The gravel plain is only 8-10 feet above creek level and extends north nearly a mile.

Well data

Charles Fitzpatrick in Sec. 8, Butterfield township has a shallow flowing well that flows level with the ground. It is 18 feet. J. M. Rutledge in northwest corner of Sec. 20

has a well 17 feet deep that has a head 5 feet below surface. An. 28.540 at Rutledges = 1120 ±.

An. 28.460 on moraine at township line of Aetna and Butterfield corners of Secs. 13, 24, 18 and 19 at 9:00 a.m.

An. 28.520 on till plain in Sec. 12 Aetna township. This level is held for several miles west along north side of Aetna township as far as Sec. 4. There is then a rise to the border of the moraine. An. 28.470 at cross roads corners of Secs. 5 and 6 Aetna and 31 and 32; West Branch at foot of morainic ridge. I passed here going south September 7 but did not read aneroid. 28.500 at railroad crossing near the township corners in a swamp. Some gravel on northeast border of swamp suitable for road ballast on ridge 20 - 30 feet and also at railroad track near level of swamp.

Till with thin sand coating in Secs. 1, 2, 35 and 36. A few low swells 10 - 15 feet ±. High ridge in southwest corner of Sec. 26 perhaps 100 feet above tract I am on. An. 29.500 at south side of Sec. 35. Enter moraine about 2½ miles east of Lake City. It is very sandy here and has but few boulders. An. 28.420 on summit on road about 2½ miles east of Lake City. An. 28.450 on level tract 2 miles east of Lake City. Knolls both north and south of road are 30 - 40 feet above this flat.

Just east of Lake City till with thin coating of sand and gravel. An. 28.460 at Lake City at noon. An. 28.450 at Lake City at 1:00 p.m.

Till plain with very little undulation from Lake City to Clam River. An. 28.530 at Clam River. There is a swamp ½ mile or more wide on north side of stream at township line. The south bluff is close to the stream and about 25 feet high composed of a stiff clayey till. An. 28.450 at McBain 1246 feet A.T. at 2:50 p.m.

Well data

Ridge northeast of McBain 1 mile reaches 1300 feet. The tubular wells in vicinity of McBain are 60 - 150 feet and penetrate much till. Dry wells are only 25 - 40 feet.

George Earl has one 150 feet, with head about 40 feet.

Ardis Brothers well is 98 feet. Three miles east and ½ mile north of McBain is a weak flowing well at William DeZwaans about 40 feet. At D. G. Spricksells 1½ miles east and 1 mile south of McBain is a weak flowing well. It is only 25 to 30 feet.

An. 28.450 at McBain at 3:40 p.m. = 1246.

An. 28.400 at Lucas - 3:50 p.m. = 1304.

Hills a mile south of Lucas are 1350 feet and hills a mile northwest are over 1400 feet. The railroad reaches 1380 feet 1½ miles west of Lucas in cut 20 feet deep. An. 28.320 at summit. Hills within ½ mile of railroad north or south are 75 feet at least. Hills 100 feet high are common between Lucas and Cadillac. There are basins among them. An. 28.410 at Cadillac at 4:00 p.m.

September 14, 1901

An. 28.420 at Cadillac at 6:30 a.m. An. 28.430 at Little Clam Lake in Cadillac. I drive on north side of lake and then southwest past south side of Big Clam Lake through a sandy plain that stands 10 - 25 feet above the lakes. It has clay spots and boulders show in the sags and in places on the general level of the plain.

The divide south of Big Clam Lake is only 20 - 30 feet above the lake and has a nearly plane surface. Boulders are numerous on it. An. 28.400 on divide near Benson Post Office at corners of Secs. 13, 14, 22 and 23, T. 21 N., R. 10 W. South of this divide there is a tract with basins 20 - 30 feet lower than the level of Big Clam Lake. An. 28.460 in basin on line of Sec. 22 and 23. An. 28.490 at a swamp and stream on line of Secs. 26 and 27 at 8:00 a.m.

The drift is very sandy on the borders of these swamps and basins, but has a few boulders in it. An. 28.420 on plain near south end of line of Secs. 26 and 27. I see no higher land south or west and the country seems level except for basins and valleys. Boulders are scattered over surface. There is considerable birch and maple timber on this sandy drift here and near Clam Lakes.

An. 28.520 at stream in east part of Sec. 26. An. 28.450 on east bluff near line Secs. 26 and 25. An. 28.420 at Hobart Station. 1299 feet A.T. at 8:40 a.m.

The rolling morainic topography sets in near line of Cherry Grove and Clam Lake townships just west of Hobart. There is much till and boulders are more numerous than on the sandy plain to the west.

Well data

Sam Anderson in southeast corner of Sec. 30 has a well 112 feet. An. 28.370 at well.

Ellis Larunbure in northeast corner of Sec. 31 has one 90 feet. An. 28.385. It was a loose textured drift in each well.

An. 28.250 on a hill near south end of line of Secs. 28 and 29, Clam Lake township = 1440 feet, at Swede Mission Church.

Near middle of east side of Sec. 29 is a point near Swedish Luthem Church which by leveling (with hand level) I estimate to be 20 feet higher or 1460 feet.

Well data

A well in southwest corner of Sec. 28 at Peter Hagstrom's is 236 feet. It has only 25 feet head. An. 28.270 at Hagstrom's well. It was loose textured for 70 feet and below this a stiffer clay. Water was from gravel.

Nels Ockerwall on high point in east part of Sec. 29 has a well 263 feet. It has but little head. Altitude is about 1450 feet.

An. 28.440 at Lake in Secs. 27 and 34. There is a ridge on south edge of Sec. 34 that is in places more than 100 feet above this lake or about 1400 feet A.T.

The summit on line of Secs. 33 and 28 is about 1400 feet with some points 1425 or more. Sec. 27 is mainly below 1400 feet and so is west edge of Sec. 26, but in the northeast corner of Sec. 27 the altitude is about 1400 feet. An. 28.290 at corners of Secs. 22, 23, 26 and 27. An. 28.225 at summit in road on line of Secs. 23 and 26 = 1470 feet. A hill in NE $\frac{1}{4}$ of Sec. 26 reaches about 1520 feet being 50 feet above this summit on road. An. 28.170 on highest point in NE $\frac{1}{4}$ Sec. 26 at 10:00 a.m.

Well data

A high point near corners of Secs. 15, 16, 22 and 23 may reach 1500 feet. George Townsend in SE $\frac{1}{4}$ Sec. 23, altitude 1460 feet, has a well 248 feet. It has but little head. It was dug 176 feet and bored the rest. It had a hard clay in layers that had to be picked.

A well at cross road in Sec. 26 on slightly higher ground is not so deep.

Mr. Townsend says that a Mr. Miller in north part of Sherman township is about 300 feet. An. 28.320 at T & A.R.R. on line of Wexford and Missaukee Counties at 11:00 a.m. An. 28.225 on summit on county line north of railroad.

I soon enter a valley that leads north and descend from 28300 - 28360 to reach the township corners east of Cadillac. An. 28.180 on hill on line of Secs. 36 and 31 at 11:30 a.m. There is a hill of about same height near corner of Sec. 6. An. 28.360 at township corners 3 miles east of Cadillac. An. 28.270 on hill east part of Cadillac on township line.

An. 28.360 at Gr. & I Station 1304 feet at 12:20.

An. 28.300 at Cadillac at 1:40 p.m. An. 28.210 on hill 1 mile south. A hill $\frac{1}{4}$ mile east reaches 1400 feet and the country $\frac{3}{4}$ mile south is about 1400 feet. An. 28.300 at G R & I Station at Cadillac at 2:40 p.m. I take train to Lake City. An. 28.260 at Missaukee Jc. 1337 feet A.T. at 3:00 p.m. Boulders and low swells 10-40 feet high along and just east of railroad for $1\frac{1}{2}$ miles south of Missaukee Jc. Some till of loose texture with beds of clear sand. Some hardwood timber, birch and maple. The low hills extend $1\frac{1}{2}$ miles east of Missaukee Jc. Higher tracts then set in with hills 50 - 60 feet above railroad and the land is not settled whereas the gently undulating tracts are settled. Sharp knolls and ridges and deep basins with ponds in Secs. 1, 2, 11 and 22, T. 22 N., R. 9 W. Boulders not numerous. This moraine scarcely reaches to the county line. East of here in Missaukee County there is a pitted plain with basins 20 - 25 feet deep. It was a pine tract. Oaks are coming in with a few pines.

An. 28.280 on general level of sand plain 1320 \pm feet, one mile southwest of Jennings. An. 28.320 at Jennings station. = 1280 \pm feet. This is 30 feet or more above a

lake north of the station. An. 28.310 at Jennings Junction 3 miles southwest of Jennings as 1290 feet ±.

The drift changes to till near section 10 lake or Grays Mill Station. An. 28.325 at Grays Mill by Section 10. Lake 6 feet ± above lake.

An. 28.345 at Lake City at 3:40 p.m. a 1250 ± feet A.T.

September 18, 1901

John Armstrong 4 miles south of Lake City northeast corner of Sec. 25 knows Sec. 35, Lake township where Richardson saw ridges. I drive around north side of Muskrat and east side of Crooked Lake to Jennings. In Sec. 36, Caldwell there is a plain with sandy coating and only a few patches of till at surface. The plain extends north across Sec. 25 to hills in Sec. 24. In Sec. 35 and 34 Caldwell and on the borders of Crooked Lake there is a pitted plain with marshes and lakes. It stands 30-40 feet above Muskrat and Crooked lakes where best developed as a plain but the surface is largely below that level. There are a few boulders in this sand and gravel.

An. 28.610 at Jennings Station = 20 feet ± above Crooked lake.

An. 28.590 on plain in Jennings at 8:45 a.m.

Well data

Mr. F. L. Downing in Sec. 18, Caldwell has a well 140 feet.

David Brown in Sec. 2 has one of similar depth. Mr. John Caldwell's in north part of Sec. 4 is 100 feet. Head only 12 - 14 feet.

There are several wells near Mr. Caldwell's 100 - 120 feet. There are streaks of clay in the sandy drift here. An. 28.710 at Caldwell's at 10:45 a.m. An. 28.780 on low ground at center of Sec. 28, Bloomfield township. The swamp northwest of here is only a few feet lower. An. 28.720 on hill east side of Sec. 28. An. 28.800 at swamp by creek in Sec. 27. An. 28.660 at Mr. H. S. Lambs where I stop for dinner in Sec. 30, Pioneer township at 11:40 a.m. His well is 130 feet and is sandy drift the entire depth. It has but little head. Hills in north part of Sec. 31 are 50 - 75 feet above Mr. Lambs. Sec. 36 is also very high. An. 28.660 at Mr. Lambs in Sec. 30 at 12:30 p.m. An. 28.620 on hill at middle of line of Sec. 30 and 25 = 1300 feet. Boulders quite numerous. An. 28.570 on hill on line of Secs. 20 and 29. An. 28.530 on hill 1 mile west of Pioneer Center. An. 28.790 on plain of sand near corners of Secs. 8, 9, 16 and 17, Pioneer township. A hill on south side of Sec. 4 is 200 - 250 feet higher than this plain and a range of hills west of the plain in Secs. 6 and 7 is fully 150 feet higher than the plain and rises very abruptly. High range of hills north of the Manistee River. An. 28.560 near corners of Secs. 9, 10, 16 and 17. The hill at south edge of Sec. 4 is scarcely 50 feet high as indicated by hand level. Hills north of Manistee River nearly north of here are fully as high. An. 28.650 at railroad, crossing and schoolhouse

1 mile east of Pioneer Center in a sag. A hill about 1¼ miles east of here on south side of road appears to be about 100 feet higher. An. 28.580 at corners of Secs. 22, 23, 26 and 27. An. 28.480 on crest of ridge 40-50 rods south of corners = 1410 feet ±. It is 20 feet or so higher east of road a few rods.

An. 28.540 at small creek on line of Secs. 26 and 27 near surveyor, Richardsons. An. 28.600 at lake (Blind) on line of Secs. 33 and 34, Pioneer township. An. 28.570 at corners of Secs. 33 and 34, 2 and 3.

An. 28.630 at sag on middle of line of Secs. 3 and 34. An. 28.650 at sag south of corners of Secs. 3 and 4, 33 and 34. The corners are 20 - 25 feet higher. An. 28.590 on gravel plain. An. 28.750 on swamp in Sec. 17 just west of where the water divides. It is sandy gravel here and not boggy. "Genung Hill" in Sec. 29 is the highest hill on the range south of this swamp and is fully 200 and probably 250 feet above it.

An. 28.700 on sand plain south of swamp. An. 28.650 at summit in road in Sec. 19. There is a gap 3 miles wide here in the range of hills. There are shallow basins where the road crosses.

An. 28.685 at Lake City at 4:00 p.m. = 1250 ± feet. An. 28.730 at Lake City at 5:00 p.m.

I take train to Cadillac. An. 28.705 at Cadillac 5:45 p.m.

September 19, 1901 6:00 a.m.

An. 28.825 at Cadillac at G R & I Station and 28.830 at T & A A Station. The former is 1293 feet A.T. An. 28.840 at GE & I Station 1293 feet at 7:50. An. 28.830 at Hobart 1299 feet at 8:15 a.m. An. 28.880 where Railroad enters Osceola County at 8:40. An. 28.780 on hill 100 rods east on county line.

Well data

C. J. Carlson on this hill has a well 120 feet. It has 12 feet of water. (He is in Sec. 32). Well near schoolhouse in Sec. 5 on William Bresel's land in Sec. 33, Sherman township is 183 feet. An. 28.750 on hill 40 rods east of north end of line of Secs. 5 and 6. An. 28.700 at schoolhouse in Sec. 5. Claus Freese near schoolhouse has a well 181 feet with 11 feet of water. An. 28.650 on hill 80 rods west of southwest corner of Sec. 33 = 1450 feet A.T.

H. G. Mead in northeast corner of Sec. 5 on ground about 1410 feet A.T. has a well 187 feet. It has over 30 feet of water. There was 40 feet of till at top. The rest is sand and gravel. An. 28.750 at south end of has of Secs. 33 and 34 Clam Lake township in a basin. A point 30 rods north is 25 feet higher. Altitude is lower to the south.

William Discher on north side of Sec. 4 has a well 164 feet that struck water at 125 feet. The head is 125 feet below surface. There was 40 feet of clay at top. The rest was red sand.

Edward Brehm across the road in Sec. 34 has a well that struck water at 120 feet and it goes to 130 feet. Jacob Discher on south side of Sec. 34 has a well 174 feet. It has only 7 or 8 feet of water. It has 30 feet of clay and the rest is sand. An. 28.730 at William Discher's. Jacob Discher's is 28 feet higher as determined by level, an. 28.700. The sag between the two Discher wells at north end of line of Secs. 3 and 4 is 28.750.

An. 28.630 = 1475 feet on hill near middle of north line of Sec. 3. The altitude is about 15 feet higher 30-40 rods south. An. 28.710 in basin 20 - 30 rods east of this hill is 1400 feet A.T. An. 28.630 on hill on line of Secs. 2 and 3. Sherman 40 - 50 rods from north end.

Just south of here I cross a basin 20 feet deep then begin a southward ascent. An. 28.580 on hill north - middle of line of Secs. 2 and 3.

Well data

An. 28.560 at cross road at middle of section line. The 1400 foot contour would cross about 3/4 mile west of here.

A well near middle of east side of Sec. 3 on Francis Goodman's place is 240 feet. Altitude 1520 feet ±. It has very little head. Ira Cooper gives information.

Al Millers well is in northwest corner of Sec. 11, is 325 feet, and is abandoned. The head is so low town that it could not be pumped.

An. 28.530 on hill north of corners of Secs. 2, 3, 10 and 11, 20 rods. About 40 rods west of here is a point 20 feet higher or about 1590 feet. Much of Sec. 11 is above 1600 feet. Mr. Miller's well is nearly up to that contour. About 1/3 of the east side of Sec. 10 is above 1500 feet and the rest is above 1400 feet that contour nearly covers Sec. 9 near center?

An. 28.510 = 1590 feet at Miller's well.

An. 28.490 at first summit east of corners of Secs. 2, 3, 10 and 11.

Hills 1700 feet south of Cadillac

An. 28.450 at middle of line of Sec. 2 and 11 where road comes in from the north = 1640 feet. The 1600 foot contour crosses 30 rods north of this point and then runs northeast 80 rods and then east across section line 120 rods north of corners. A hill in the southwest 40 of Sec. 2 rises above the 1700 foot contour. An. 28.385.

1710 feet at 11:10 a.m. There is a high ridge above 1600 feet running east into the southwest quarter of Sec. 1, 120 rods ± but on the line of Secs. 1 and 12 there is a sag that is below 1600 feet. Sec. 12 is largely above 1600 feet,

An. 28.380 on "Grove Hill" about middle of line of Secs. 11 and 12 = 1715 feet A.T. There is 10 - 15 acres above the 1700 foot contour. Another hill called the "Root Hill" about a mile west - southwest is thought by residents to

be fully as high as "Grove Hill" and there is another high point on line of Secs. 10 and 16.

An. 28.480 at corners of Secs. 11, 12, 13 and 14 = 1625 feet ±. A point 30 rods west is 20 feet higher 1640 feet. Only the north edge of Sec. 14 was above the 1600 foot contour and I drop below the 1500 foot contour before reaching middle of line of Secs. 13 and 14. The south half of the section is nearly all below 1500 feet.

An. 28.680 = 1440 feet at corners of Secs. 13, 14, 23 and 24. The 1400 foot contour passes east-west across middle of Sec. 24.

An. 28.550 at summit near middle of line of Secs. 13 and 24 = 1550 feet.

An. 28.620 where I stop for dinner in north part of Sec. 24 at noon. In 28.630 at 12:45 p.m. An. 28.580 on hill just west of town line. An. 28.630 at corners of Secs. 17 and 18, 19 and 20 Highland. The 1400 foot contour crosses less than a mile east of here north-south and a mile or so south - east-west. An. 28.550 about 80 rods north of contour. Secs. 7, 8, 17 and 18. The 1500 foot contour is in east part of Sec. 18 and crosses in but two points in to Sec. 17 near middle and at northeast corner. In Sec. 8 the 1500 foot contour extends east mi. runs north through west part of section.

An. 28.550 about 80 rods south of north end of line of Secs. 7 and 8. I here descend below the 1500 foot contour. An. 28.690 at cross roads on line of Secs. 5 and 6. An. 28.725 at middle of Sec. 5. An. 28.690 at line of Secs. 4 and 5.

There is a hill fully as high a mile south and east of here 1/2 mile. The altitude is 1475 feet. The 1400 foot contour must be fully 1 1/2 miles east. Hills north of here near north end of line of Secs. 4 and 5 barely reach 1500 feet. An. 28.610-620. An. 28.650 at line of Secs. 28 and 33. The altitude is 50 feet higher near center of SW 1/4, Sec. 28.

An. 28.610 at summit in road 80 rods south of center of Sec. 28. The SE 1/4 is below this level.

Well data

John Wigger has a well here near the summit 215 feet with but little head. An. 28.640-650 at his residence near center of Sec. 28 where there are windmills. An. 28.700 at cross roads at line of Secs. 21 and 28.

Mr. Harry Klomporeus has well in south part of Sec. 21, 193 feet. It has 80 feet of water. An. 28.685. The well near center of Sec. 28 on west side of here is 215 feet at Mr. Burtons.

Well data

H. Doll in south part of Sec. 21 has a well 125 feet.

H. Klay near center of Sec. 21 has a well 168 feet with 60 feet of water. An. 28.650 at well. An. 28.650 = 1400 feet on summit in road at church 1 mile south of Lucas. An. 28.760 at Lucas 1304 feet A.T. at 3:10 p.m.

A change in aneroid of .040 inch since 8:15 a.m. - so levels near noon are 25.60 feet high. Hills 1¼ miles west in Sec. 17 reach about 1450 feet. There is nothing higher in view from here.

Wells

Wells at Lucas are 20 - 30 feet. There is considerable clay north of here and hardwood timber on the plain east of the pine clad hills.

An. 28.670 on summit on T & A.A. railroad in Sec. 18 in cut 25 feet deep. An. 28.690 at county line. An. 28.710 at Frog Lake in Sec. 12. Mainly hardwood south of this railroad to Frog Lake and in low tracts west of lake.

The range of hills leading south from Cadillac has pine south to center of township. There is pine north of the railroad nearly all the way from Lucas to Cadillac and north from there past Clam River.

An. 28.770 at Cadillac at 3:30 p.m.

September 21, 1901

There is scarcely any rise for five miles, the aneroid "being" between 28.500 and 28.520. Much swampy land around north herder of Big Clam Lake. There are low swells on the ascending slope east of Millerville with cuts 5-15 feet and fills of 5 and 10 feet. The drift is sandy till or in places entirely sand.

An. 28.430 at Millerville = 1396 feet. There are no sharp knolls and scarcely any boulders until I reach the corner southeast of Boone a mile. Here the knolls are 20 - 30 feet high and boulders are quite common. An. 28.440 at Boone 1387 feet. The knolls near here are barely 1400 feet A.T. Loose textured drift in all the cuts either gravelly or sandy loam. In Sec. 14 and 15, Boon, the cuts are clear sand or alternations of sand with the beds of gravel. An. 28.730 at Harrietta at 5:00 p.m. This is in a valley of Slagle Creek. An. 28.320 on hill 2¼ miles north of Harrietta near line of Secs. 6 and 7 just east of old State road. = 1480 feet A.T. There hills west of here near the line of Secs. 1 and 12 about the same altitude.

Well data

George A. Anderson near center of Sec. 8, Boon township has a well on high ground 150 feet.

| | |
|---------------------|------------------------------|
| 1st Sand and gravel | 50 feet |
| 2nd Clay | 18 " |
| 3rd Sand | 82 " Rock at bottom -boulder |

Well data

(James L. Stanley gives information)

Flowing wells

An. 29.310 at Clare at 6:00 a.m. September 27

Flowing wells

George Stevens in SE¼ of Sec. 25, Vernon township has very weak flow. Joseph McConnell in north side of Sec. 31, Wise township has well almost 74 feet. Mike McGuire in southwest part of Sec. 30 is about 70 feet. It was a strong well at first but stopped now. Daniel Walker in northeast corner of Sec. 31 has one about 70 feet. It has strong flow - 2 inch. Sam Lighty in southwest corner of Sec. 25, Vernon township has 2 flowing wells 30 feet deep. He bored 80 feet but got no more water. Allen McDonald in northeast corner of Sec. 25 has a flow 19 feet deep.

Near center of section 25 Timothy Rogan has a flow only 9 feet deep with strong flow.

Wilson Sharp on west side of Sec. 30 has one about 70 feet. Patrick Maker in southeast corner of Sec. 26 has a well about 30 feet just level with surface. Frank Battle in south part of Sec. 26 has good flow at 19 feet. John Pollett in west side of Sec. 1, Isabella has strong flow and so has nearly every farm between, there and Rosebush.

James Owen south side of Sec. 29, Wise township has a flow.

Wells are hard to obtain in the southeast part of Wise township. Some being 150 - 200 feet without getting a good supply and no flows.

Flowing wells

An. 29.320 at sand ridge 1¼ miles north of Rosebush = 790 ± feet A.T. An. 29.330 at Rosebush at 11:20, 5 or 6 feet above stream, or 783 feet A.T. This is on a low swell of till with sand capping. The beach is ½ mile west of here. Much sand for a mile north on the old lake plain. 12 wells flow in the village. D. J. Rogers is 168 feet and probably the deepest. An. 28.280 at Rosebush at 12:40 p.m. An. 28.270 on bank on line of Secs. 15 and 16, Isabella township at a cemetery.