Senior Agricultural Thesis.

on

"FARM SEWERAGE SYSTEM."

by

R. E. Morrow,

Class of '98.

Michigan Agricultural College,

Agricultural College, Mich.

FARM SEWERAGE SYSTEM.

Many people, if they ever think of such a thing at all, would think that a farm sewerage system was an extravagant thing. Possibly it is, if just looked at from one side of the question. Possibly it is extravagant to have a barn when you can stack your hay and grain out doors, or have a reaper when you can cut your grain by hand. Possibly it is extravagant to have a roof over the manure pile, or shelter for the farm machinery, when all could be left out exposed to the weather.

These comparisons are perhaps striking, especially as viewed from an economist's standpoint; but that is just the view we purpose dwelling most upon.

A sewer, whether in the city where they are so generally used or on a farm where they are so seldom used, is a conduit for carrying away wastes. It is economically important that the wastes be removed and disposed of properly, because,1st: They are very liable to pollute the air, water or soil, and therefore causes sickness or death. The question of how to to preserve good health is a great economical one. 2nd. If properly disposed of wastes are used as fertilizers of the soil, and do not contaminate the air, food or water which we use. The impurities which tend to render air, water and food unfavorable for man's best development are the product of his own life. The removal of the source of this impurity must be effected by his own act.

It is my purpose to give the plans of a farm sewerage system which I have designed for a farm in Northern Michigan, but which would be about the same and cost about the same for any farm of ordinary size. The portion of the farm upon which this particular sewer is to be laid is described as follows: The E. 1/2 of the N. E. 1/4 of Sec. 16, T. 31 N., R. 8 W.

This sewer is designed not only to remove the wastes, but to distribute them over a given area of soil, thus increasing its fertility.

One of the great municipal questions of late is: How to dispose of the city sewage; for the time is not far distant when they will be prohibited from dumping it into rivers or lakes. Several systems are now in successful operation where the sewage is disposed of by using it to irrigate a tract of land near by, which is used for agricultural purposes. Several extensive ones, as well as many smaller ones, may be found both in Europe and America.

Both surface and subsurface irrigation is used. The latter requires the laying of tile just the same as in land drainage, except that the tiles are placed from 8 to 12 inches below the surface.

The principle of disposing of sewage by irrigation is this: When foul water as sewage is delivered onto land not already occupied by water it descends by gravity. Its impurities are strained out and attached to the particles of soil, just as they would be attached to the particles of any other filter. Within a certain distance of the surface the impurities are all removed, and the water descends below that point in a pure state.

With this brief explanation of why a farm irrigating system would be a good thing on most farms of any considerable size, I will now take up the one designed.

Map No. 1 is a topographical one of that portion of the farm concerned with the sewerage system. A mark on the cellar wall of the house was used as a bench mark, and an assumed plane 100 feet below this point was used as a reference or datum plane. It so happens that this, along with a certain slope of the surface there, causes the 100 foot contour line to pass through both house and barn.

Map No. 2 illustrates the plumbing system in the house. Just outside of the house is a well and windmill. A force pump raises the water to the supply tank in the attic. Fig. III shows the position of the tank in the attic. Fig. IV is a sectional view of the whole plumbing system. "a" is the pipe which conveys the water to the tank. The tank has a capacity of 100 cubic feet, which equals 750 gallons, or about 6250 pounds.

A safe arrangement must be provided in case of overflow; accordingly an overflow pipe "b" is put in. It empties into the vertical soil-pipe "c" near the floor of the first story. The reason this pipe is carried so far down before entering the vertical soil-pipe is to get five feet below where the vent pipe "d" enters, for it is a rule in sanitary plumbing to have all vents enter the stack, or vertical soil-pipe, at least five feet above where the highest fixture entrance occurs. The other pipe "e" connected with the tank carries water from it to the fixtures below.

Only three fixtures are put in the design; viz: a sink, bath tub and water closet; but more could easily be put in if necessary. These are all in one room, in the first story, Fig. I. This room is drawn to a larger scale, Fig. V, to

better show the relative size and position of the fixtures. In Fig. V "a" is a marble sink, with wash bowl. This Figure also shows the hot water pipe "d" which comes from a cylindrical galvanized hot water heater near the kitchen stove. This pipe branches, one branch going to the wash bowl and the other to the bath tub. All these water pipes leading to fixtures are 3/4 inch iron pipes.

It will be noticed in the sectional view, Fig. IV, that the fixtures are all trapped. The pipe leaving each fixture is, for the first three or four feet, a lead pipe, and a portion of this is bent somewhat like a letter S to make the trap. In one classification of traps this would be known as the S trap; and under another it would be known as the water seal, because it always contains some water when being used, in such a manner as to shut off all possibility of foul gas from the sewer entering the room. Where the pipes from these fixtures enter the vertical soil-pipe a T branch is put in for each one, as will be seen at "f", Fig. IV. Now the wastes or sewage, as it would properly be called, runs down along the soil-pipe "g", which is laid at a grade of one foot in eight in this case. After this cast iron pipe passes beyond the house wall a running trap with two four inch vents is put in, "h", Fig. IV. This is where the plumbing system ceases and the sewer begins. The object of a trap here is to prevent the sewer gas from getting into the plumbing system. It passes up the first vent "i" and escapes into the air above all windows of the house. This particular vent is so arranged that it will catch water from the eave trough when it rains, and in this way the sewer can be flushed every time it rains. The plumbing system also must have ventilation.

This is provided for by having a fresh air inlet "j" in this same trap. The air passes in here through the soil-pipe "g" and up the vertical stack "c" which opens four feet above the roof of the house. What little flushing the system in the house will need can be obtained from the water supply in the tank.

It will be observed that; 1st: No foul air can enter the house, because all fixtures are trapped and, at the same time, all wastes can easily flow away; 2nd: That both sewer and house systems have separate and efficient means of ventilation; 3rd: That both systems have the necessary provisions for flushing.

Space will not allow us to describe more fully the finer details of the system, so we will follow the sewer down to the settling and flushing chambers, Fig. VI, Map No. 2.

The sewer is 420 feet long, and made of 4 inch vitrified sewer pipe. The grade is one foot in one hundred. On its way down a little branch enters it from the barn. The first chamber is the settling chamber. Both are provided with man-holes, so a man can get into them. The sewage flows over into the next chamber, which is arranged with a siphon in it. so when it is full its whole contents will be discharged at once, and will flow out in the little trenches prepared to receive it on the piece of ground to be irrigated. These trenches are shown by red lines on Map No. 1.

Having briefly described the system, I will now proceed to give the cost of the various items that enter into its construction:

One Supply Tank	$ 8.00
Water pipe:	
From pump to supply tank, 60 feet of one inch pipe	3.00
Overflow pipe, 30 feet of one inch pipe	1.50
From supply tank to fixtures, 40 feet of 3/4 inch pipe	1.60
From hot water tank to fixtures, 30 feet of 3/4 inch pipe.	1.20
Cast iron sewer pipe;	
Extra heavy for soil and vertical stack, 65 feet,	14.62
One quarter bend	.27
Three sanitary T-branches	1.20
One running trap with two 4 inch vents	1.07
Fixtures;	
Bath tub	12.00
Bath tub connection	.25
Bath tub lead pipe	1.00
Reducer	.20
Sink and wash bowl	10.00
16 feet of 2 inch extra heavy sewer pipe	1.68
4 feet of lead pipe	.80
One sink trap	.40
One reducer	.20
Water closet	18.00
Connections	1.00
The 420 feet of 4 inch vitrified sewer pipe, according to prices obtained from The Columbus Sewer Pipe Co., O., would cost	15.12

Short branch to barn	$ 1.08
One Y-branch	.16
Settling and siphoning chambers:	
2,000 brick	10.00
2 barrels cement	2.00
Siphon pipe and screens	1.00
Safety overflow pipe	1.00
Lead pipe	.80
Estimated cost of labor to do the plumbing work	40.00
Estimated cost of labor to construct the sewer and chambers	30.00
Total	$179.15

To show how much land is really needed for the 500 gallons, approximately, that will be discharged at a time from the siphon chamber, would say that if we allowed one-half inch to flow over the surface each 24 hours, it would require about 1/27 of an acre to consume the sewage. If it was 1/4 inch, and a rainfall of 1/4 inch would be a small one, 1/13 acre would be sufficient. It is best to arrange it so we can send the sewage out one portion one day, and another portion another day. But even allowing for this, a half acre would be great abundance.

Map No. 3 shows how I proceeded with the field work to obtain data for Map No. 1. I was assisted in the field work by F. T. Williams. We adopted as a base line a line parallel to, and 20 feet east of, the west boundary line of the eighty acres. Beginning 600 feet south of the north boundary line of the eighty acres, we ran out a perpendicular. We continued running out perpendiculars every 100 feet, until we had run out thirteen. Then we ran a set of lines parallel to the base.

line and 100 feet apart, so we had an area 1200 feet long by 800 feet wide, laid off in 100 foot squares. The perpendiculars are designated by the small letters,"a" being farthest south.

The following are my levelling notes:

Level survey Dec. 28th.,'97, by R. E. Morrow and F. T. Williams.

Instrument, Mountain Gurley Transit, with level.

Sta.	B. S.	H. I.	F. S.	El.	
B. M.	.75	100.75		100.	Top of stone in wall at base of cellar window of south part of house.
a0			10.86	89.89	1800' S and 20' E of N. W. corner stake of N. E. 1/4 of N. E. 1/4 of Sec. 16, T. 31 N., R. 8 W., supposing the west boundary line of said area to be a N. and S. Line.
b0			12.05	88.70	
b1			9.16	91.59	
c1	1.72	93.50	8.97	91.78	Near south row of bee-hives
c2			5.24	95.51	
c3	11.75	111.07	1.43	99.32	In barn-yard.
b2			1.65	99.10	Front stoop of house.
a1			8.03	92.72	
d2			7.62	93.13	
d1			10.78	89.97	
e2	3.09	93.52	10.32	90.43	
c4			6.62	104.45	
d4			11.92	99.15	
c5			4.14	106.93	
b4			5.57	105.50	

Stations 100 feet apart

Sta.	B. S.	H. I.	F. S.	El	
b3			8.87	102.20	In grove back of house.
a3	11.65	119.96	2.76	108.31	
a2			9.74	101.33	
a4			2.94	117.03	At east end of strawberries
a5			10.36	109.70	
b6	11.78	131.37	.37	119.59	
c6			7.62	112.34	
d6			9.82	110.14	
a6			7.	124.37	
b7			4.73	126.64	
c7			6.77	124.60	
d7			11.17	120.20	
c0			5.88	87.62	
d0			6.29	87.19	
e0			6.53	86.97	
f0	9.99	99.24	4.25	89.25	Very nearly same as 80 rod stake
g0			8.06	85.44	
e1			6.25	87.25	
f1			8.67	84.83	
g1			6.96	86.54	
h0			9.83	89.41	
i0			9.36	89.88	
j0			8.38	90.86	
k0			7.89	91.35	
L0			7.06	92.18	
m0			4.99	94.24	600' from north boundary line
m1			1.07	98.17	
L1			3.76	95.48	

Sta.	B. S.	H. I.	F. S.	El.
kI			4.69	94.55
jI			5.47	93.77
iI			6.13	93.11
hI			8.02	91.22
h2			6.24	93.00
i2			4.32	94.92
i3			10.12	89.12
j2			4.88	94.36
j3			9.09	90.15
j4			11.05	88.19
k2			3.60	95.64
k3			4.93	94.31
k4			4.59	94.65
L2			3.28	95.96
L3			2.52	96.72
L4			2.71	96.53
m2			2.67	96.57
m3			6.11	93.13
m4			4.09	95.15
L3			.44	93.08
f2	1.10	88.62	6.00	87.52
f3			3.64	89.88
g4			3.67	89.85
g5	12.07	103.95	1.64	91.88
g2			4.99	83.63
g3			6.66	81.96
h3			5.07	83.55
h4			4.01	84.61
h5			1.43	87.19

Sta	B. S.	H. I.	F. S.	El.
i5			6.89	81.73
i4			8.02	80.60
i6			1.14	87.48
j6			7.75	80.87
j5			10.87	77.75
k6			11.99	76.63
k5			7.55	81.07
L5			3.19	85.43
L6			14.9	73.72
m5			.31	88.31
m6			10.91	77.71
L7			11.00	77.62
m8			4.04	84.58
k7			2.49	86.13
j7			2.8	85.82
g6			9.11	94.84
h7			7.11	96.84
h6			13.97	89.98
i7			14.23	89.72
i8			8.44	95.51
j8			10.21	93.74
k8			12.76	91.19
f6			4.62	99.33
f5			8.17	95.78
f4			10.94	93.01
e4			8.40	95.55
e5			4.53	99.42
d5			2.24	101.71
d3			8.57	95.38

A traverse survey of that portion of the farm which it would be possible to irrigate from the buildings.
Instrument, Large Gurley Transit: vernier at 0, eye end te
Surveyed by Morrow and Williams, Dec. 30, 1897.

DE crosses line h of contour survey 64' E of sta. h3
Line i 22' E. of sta. i4
Line j 88' E of sta. j4
Line k 46' E of sta. k5
Line l 27' E. of sta. l6.

Traverse ∠ DE = 123°-3'
DE = N. 32°-18' E.
DE = 700'

Δ sta. D.

Sta. D is 15' N. and 6' E. of g3 of contour survey.

Traverse ∠ CD = 165°-45'
CD = N. 75°-0' E.
CD = 226'

CD crosses line g of the contour survey 65' E. of sta. g2

Δ sta. C

Traverse ∠ BC = 108°-22'
BC = N. 17°-37' E.
BC = 273'

BC crosses line f of the contour survey 64' E of sta. f0.

Δ sta. B

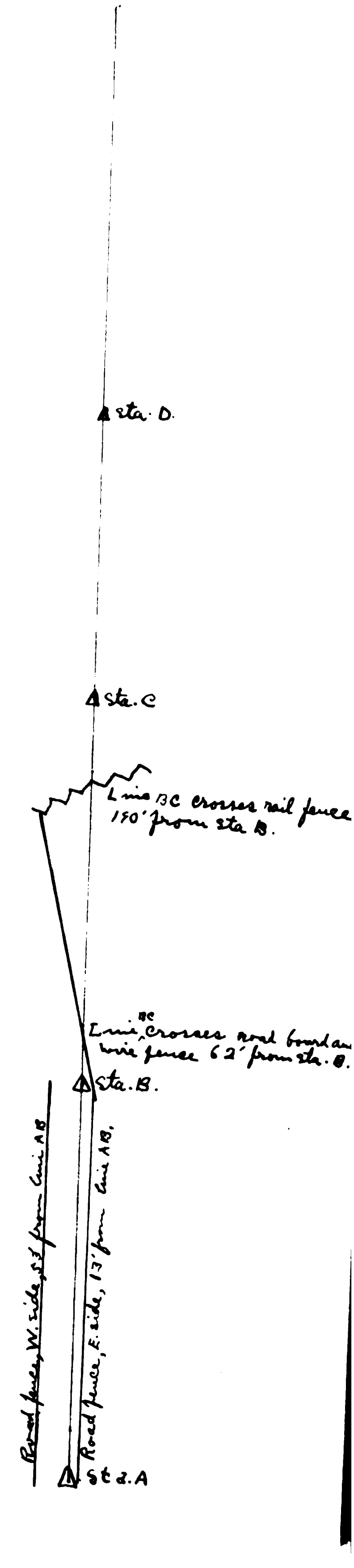
Sta B. is same as d0 on contour survey.

Traverse ∠ AB = 90°
AB = N. 0°-40' W. needle bearing
AB = 300'

AB is 20' from and ‖ with W. boundary line of E. 1-2 of N.E. 1-4, Sec. 16, T 31 N., R. 8 W.

Δ Sta. A

Sta. A same as sta. a0 in contour survey
Int. at sta. A. Vernier at 0°-0'-0", with telescope reversed and backsighted at sta I.
Line IA is used as reference line of the traverse survey.
∠s turned to right



GH. crosses line g of contour survey 15.5′ E of sta. g6
Line f 14.5′ E. of sta f 8.

Traverse ∠ GH = 316°-46′.
GH = S.46°-1′ W.
GH = 283′.

△ sta. G

FG crosses line k of contour survey 64′ E. of sta. k7:
Line j 58′ E. of sta. j7
Line i 34′ E. of sta. i7
Line h 21′ E. of sta. h7

Traverse ∠ FG = 278°-27′
FG = S.7°-42′ W.
FG = 514′.

△ Sta. F.
Sta. F is same as sta. m8 in contour survey.

Traverse ∠ EF = 180°-41′
EF = N.89°-56′ E.
EF = 110′

△ sta. E.

△ sta. G.

△ sta. F.

△ sta. E.

Traverse < I A = 360°-1'
IA = S. 89°-19 W.
IA = 100'

Sta I. is same as sta. a1 in contour survey

Δ sta. I.

HI crosses line e of contour survey 32' E of sta. e4.
Line d 32' E. of sta d 3
Line c 63' E. of sta. c 2
Line b 85' E. of sta b1

Traverse ∠ HI = 309°-36'
HI. = S 38°-91' W.
HI = 650'

Δ sta. H.

IA crosses road fence 1[illegible] from sta. A, starting point of the traverse.

Δ sta. I.

HI touches N.W. corner of hou[illegible]
N.W. corner of house 495' from sta. H.

HI touches N.W. corner of barn
N.W. corner of barn is 256' from sta. H.

HI crosses a wire fence 96' from sta. H

HI crosses S. lane fence 78' from sta. H.

HI crosses N. lane fence 48' from sta. H.

Δ sta. H.

	Courses		Lat.		Dep.	
Sta.	Bearings	Feet Dis't	N.	S.	E.	W.
A.	N. 45' W.	300	299.97			3.93
B.	N. 17°-37'E.	273	260.20		82.62	
C.	N. 75°E	226	58.49		218.30	
D.	N. 32°-18'E	700	591.68		374.05	
E.	N. 89°-56'E	110	.13		110	
F.	S. 7°-42'W	514		509.36		68.87
G.	S. 46°- 1'W	283		196.53		203.63
H.	S. 38°-51'W	650		506.21		407.73
I.	S. 89°-15'W	100		1.31		99.99
			1210.47	1213.41	784.97	784.15
				2.94	.82	

Error of enclosure 1 in 1034.

Balanced		Courses	Area.	
Lat.	Dep.	D. M. D.	+	—
+300.33	-3.93	3.93		1180.30
+260.52	+82.58	82.58		21513.74
+ 58.56	+218.19	383.35		22448.98
+592.39	+373.85	975.39		577811.28
.13	+109.94	1459.18		189.69
-508.73	- 68.91	1500.21	763201.73	
-196.29	-203.74	1227.56	240957.75	
-505.30	-407.94	616.88	311338.93	
- 1.31	-100.04	107.90	141.35	

1315639.76 623143.99

2)692545.77

Area (346272.88 sq. ft.
-
(7.94931 acres.

Pocket has: 3 maps