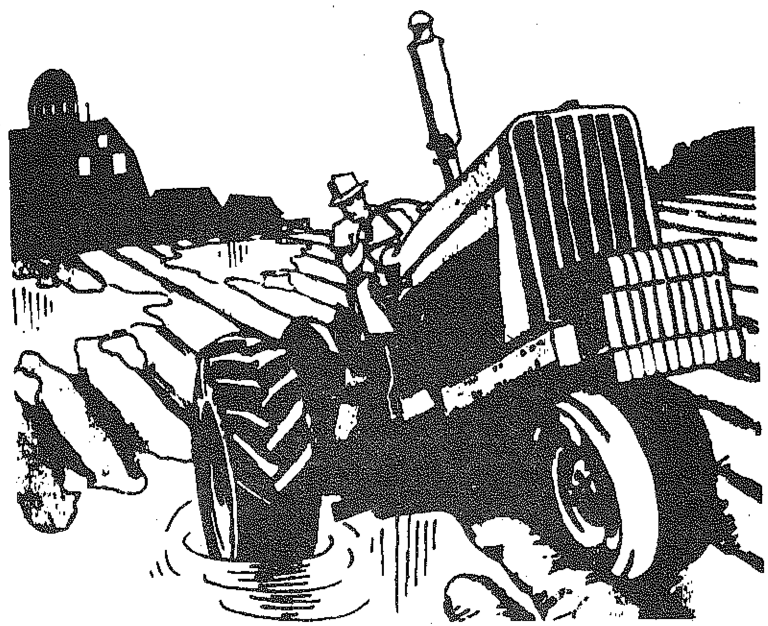
DRAINAGE RESEARCH
MINER INSTITUTE - 1979

SOIL and CROP RESPONSES

F.N. Swader
L.D. Geohring

September 1980



Agronomy Mimeo 80-37
A.E. Res. 80-33
Ag. Engr. Staff
Report 80-06

An interdisciplinary project of the New York State College of Agriculture and Life Sciences

Acknowledgements

This publication reports data obtained during 1979 by a cooperative project (Hatch 498) conducted at Miner Institute, Chazy, N.Y., involving the Departments of Agricultural Engineering, Agricultural Economics, and Agronomy at the College of Agriculture and Life Sciences. The respective cooperators are R. D. Black and L. D. Geohring; R. A. Milligan; and F. N. Swader. The field data were collected under the active supervision of Mr. David H. Wilson.

This is the third in a continuing series of reports on the research into soil and water management for increased crop production in Northern New York. Previous reports were published as follows:

1977: Agronomy Mimeo 78-21

1978: Agronomy Mimeo 80-36; Agr. Economics Research 80-32; Agr. Engr. Staff Report 80-05.

Hatch 498

Drainage Research - Miner Institute

1979

Crop and Soil Responses

F.N. Swader

A. Introduction

This report covers the third year of a project (Soil and Water Management for Increased Crop Production in Northern New York, Hatch 498) designed to reflect the effects of drainage on crop yields. The project is comprised of fields 3I-1, 3I-2, 4-2 and a field at Lake Alice. The general locations are shown in Fig. 1.

The Lake Alice site is managed as a control treatment both with respect to intensive cropping (and drainage improvement) and with respect to an optimum cropping system (without drainage improvement). The yield subplots and soils are shown in Fig. 2.

The west half of the area constitutes the control for the drainage treatments, and is cropped (as much as possible) like field 3I-1. In 1979 corn was planted late due to field wetness.

The east half is considered as a control for a traditional (non-intensive, non-drained) situation. The area is currently being managed and harvested as a "native meadow" with a wide variety of grass and sedge species present. It had no tillage operations for at least 15 years. The grass is harvested as hay, and this is the first year for harvest to be recorded as subplots.

Field 3I-1 is a comparison of sub-surface drainage systems with two drain spacings (50 and 100 feet) in 4 distinct soil types. The field plan and plot locations are shown in Figures 3 and 4-7.

Field 3I-2 is a comparison of surface drainage treatments, as indicated in Fig. 8.

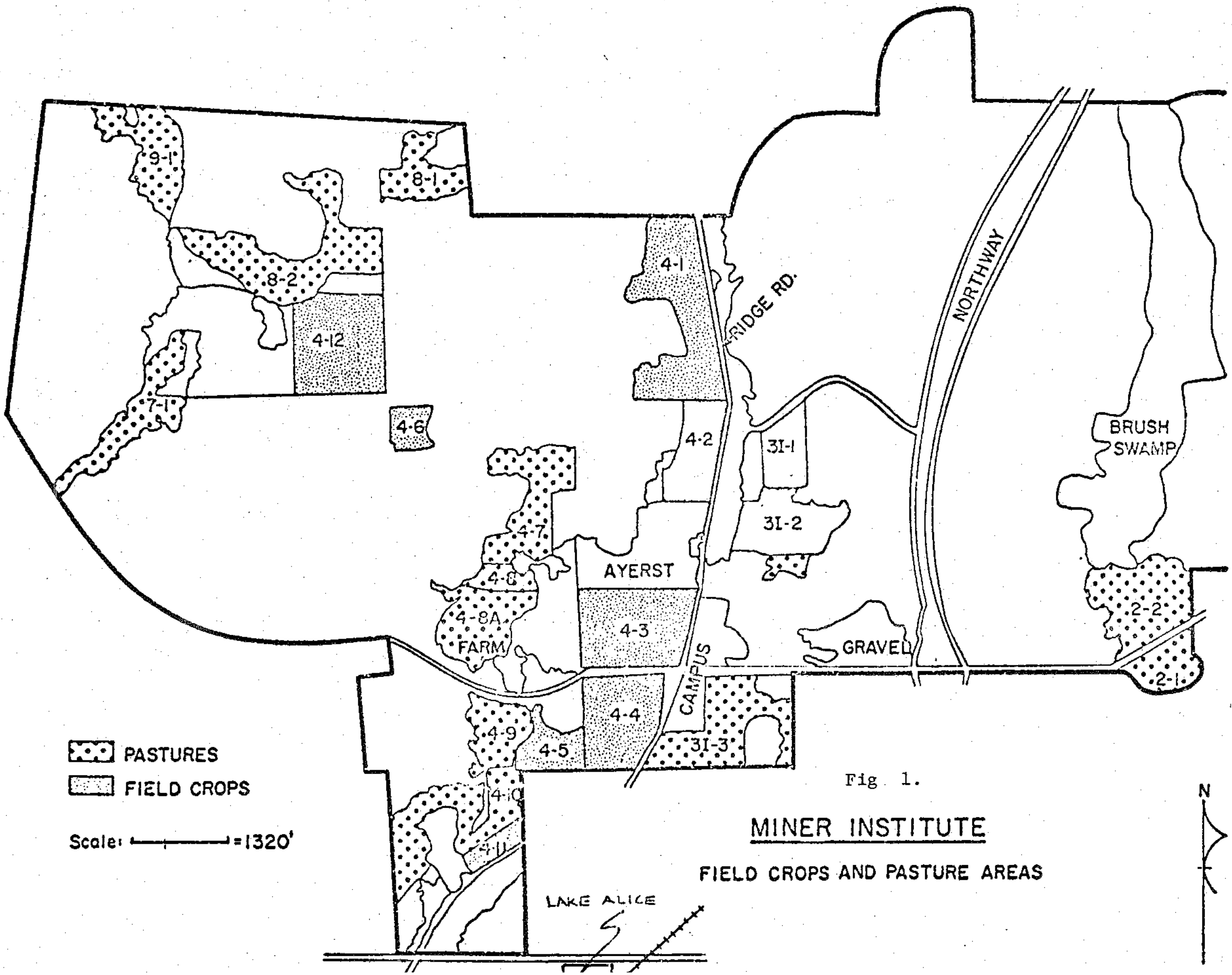


Fig. 1.

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FIELD CROPS AND PASTURE AREAS

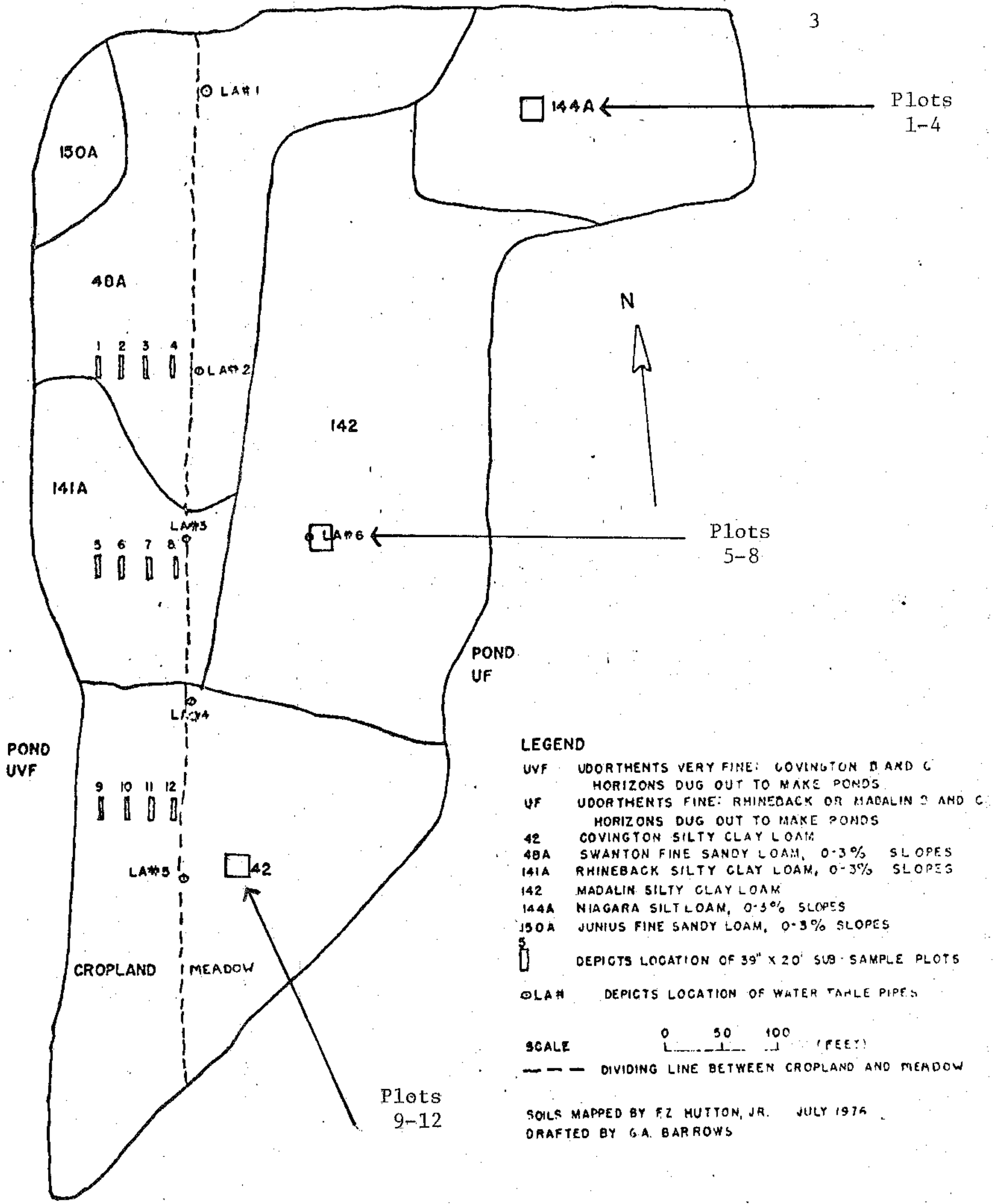
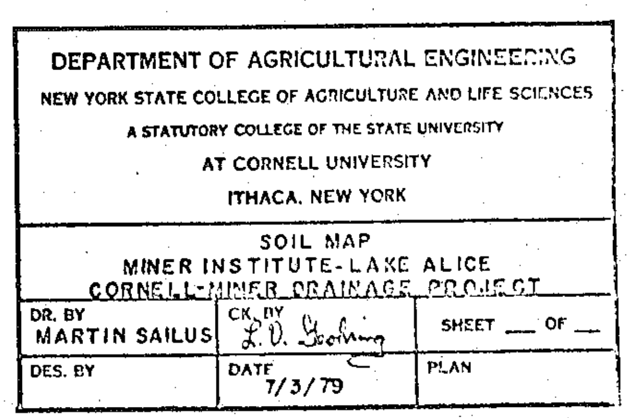


Figure 2. Plot locations, Lake Alice, 1979



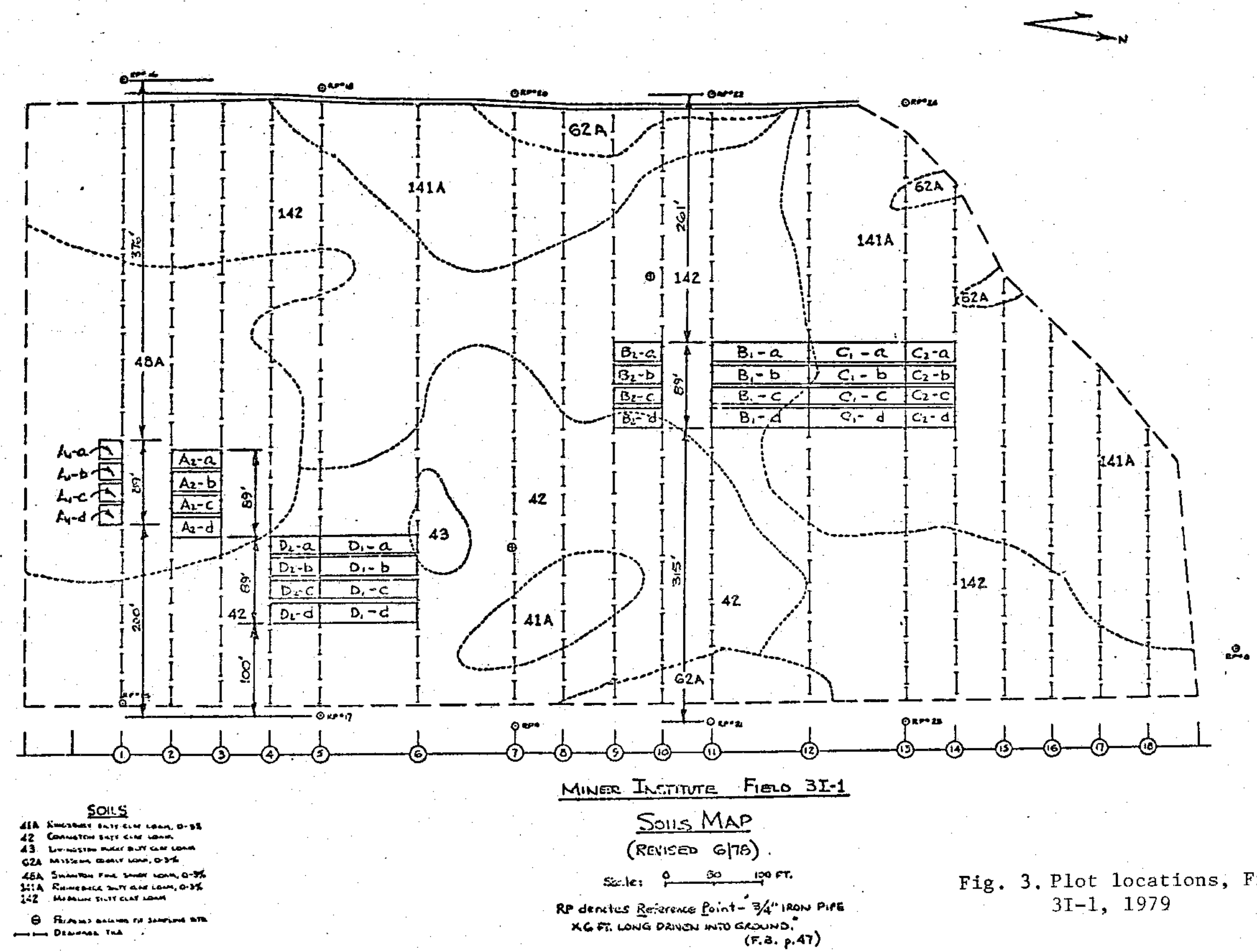


Fig. 3. Plot locations, Field 3I-1, 1979

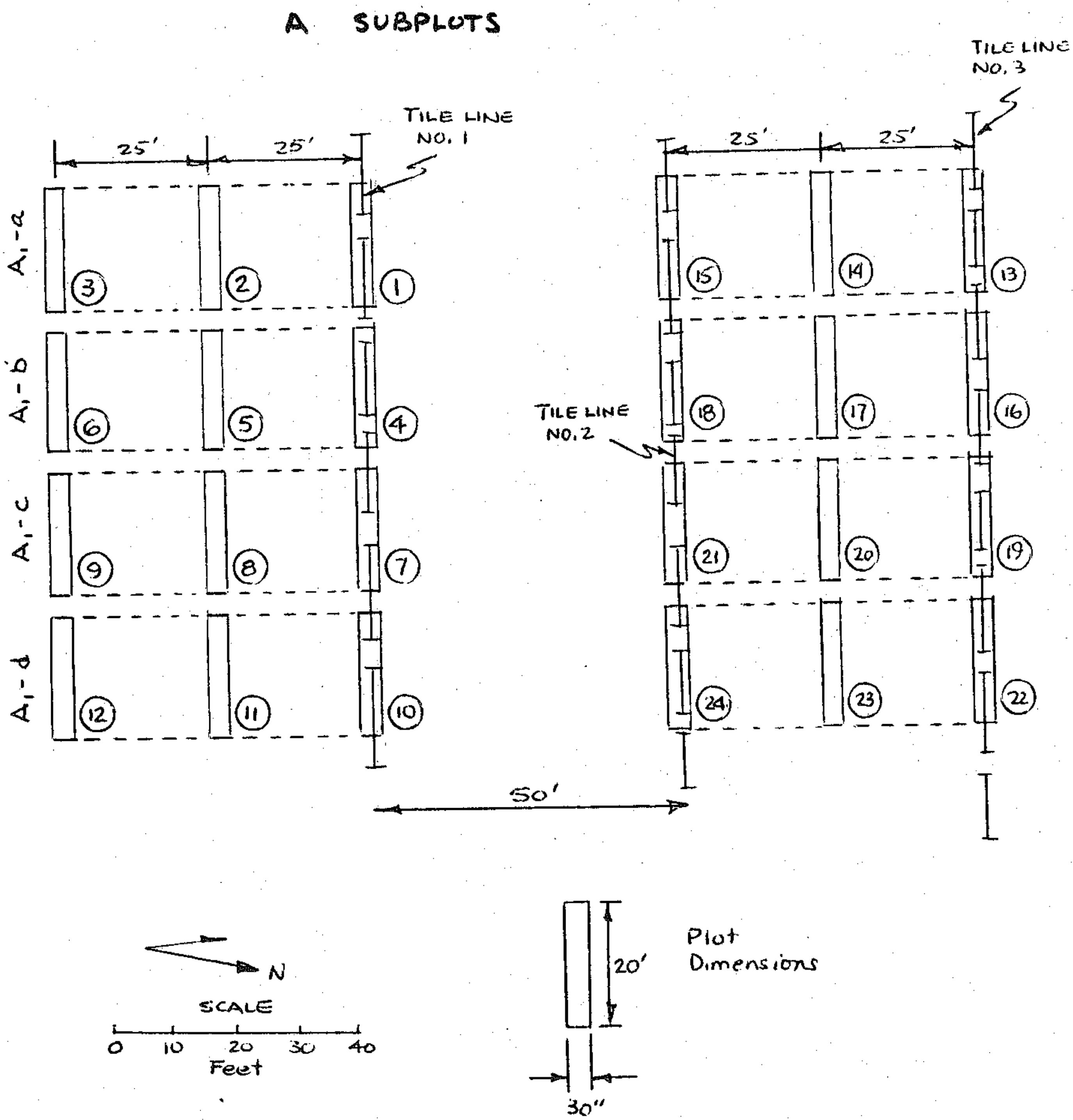


Figure 4. Subplot locations, Field 3I-1, 1979

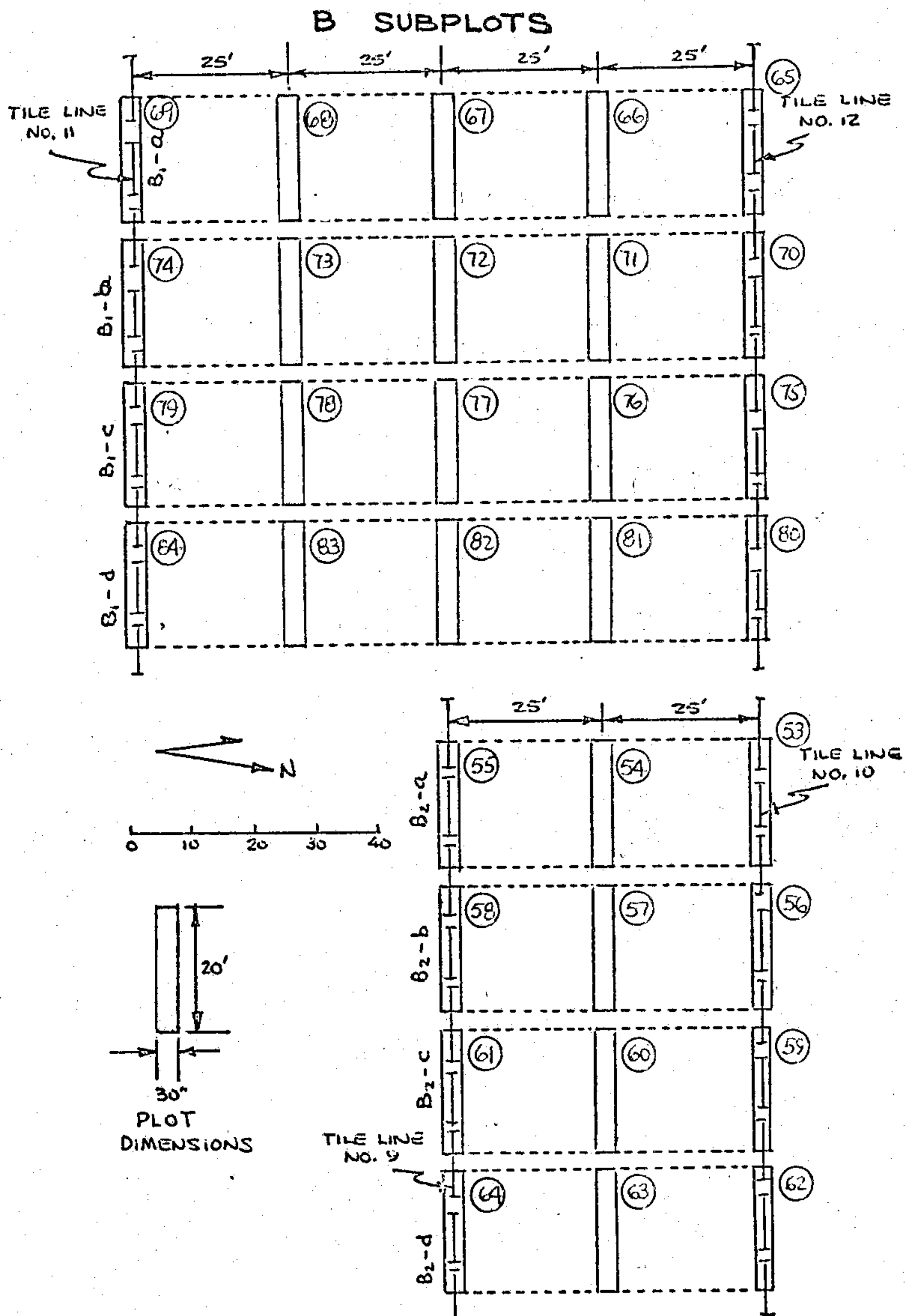


Figure 5. Subplot locations, Field 3I-1, 1979

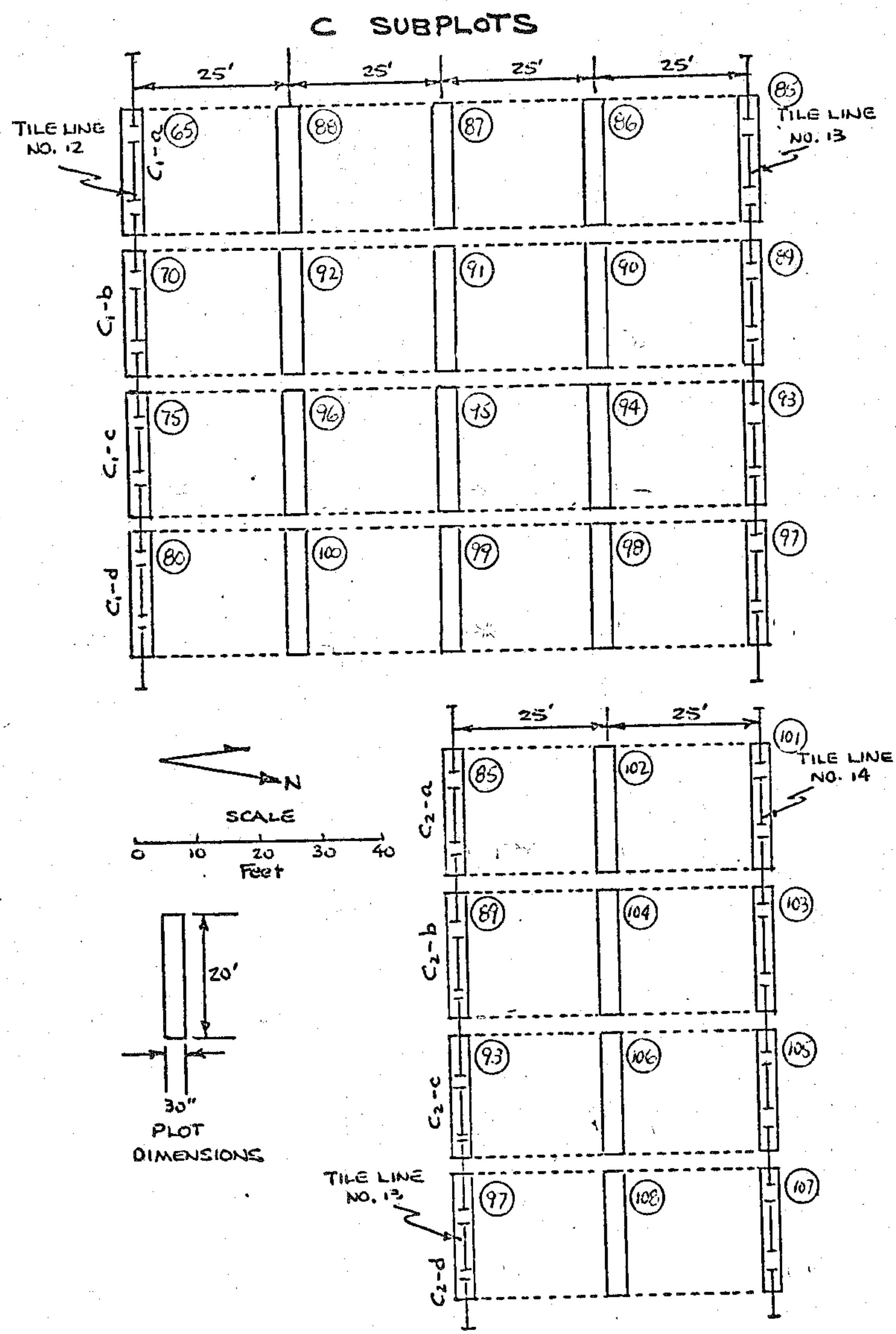


Figure 6. Subplot locations, Field 3I-1, 1979

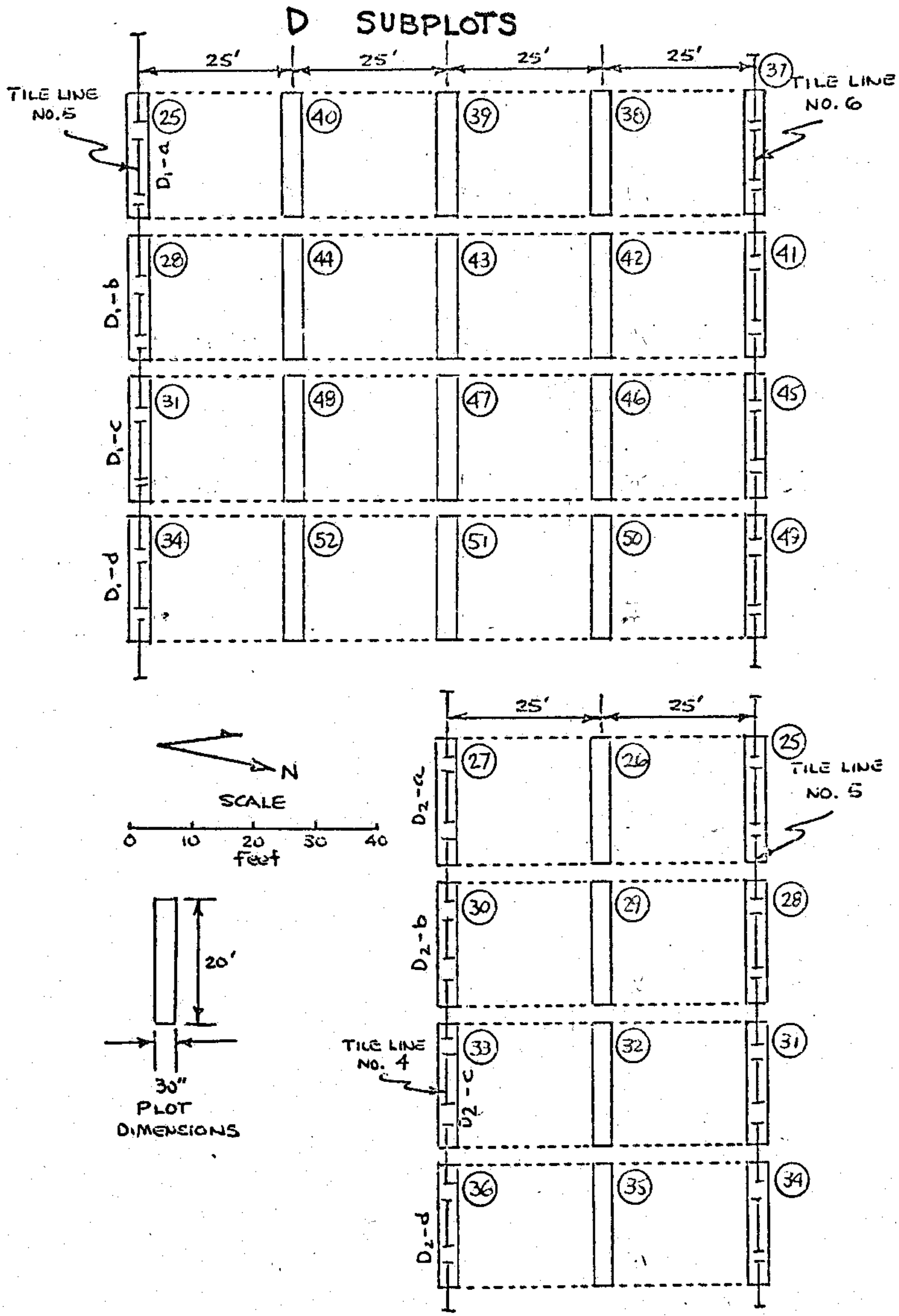
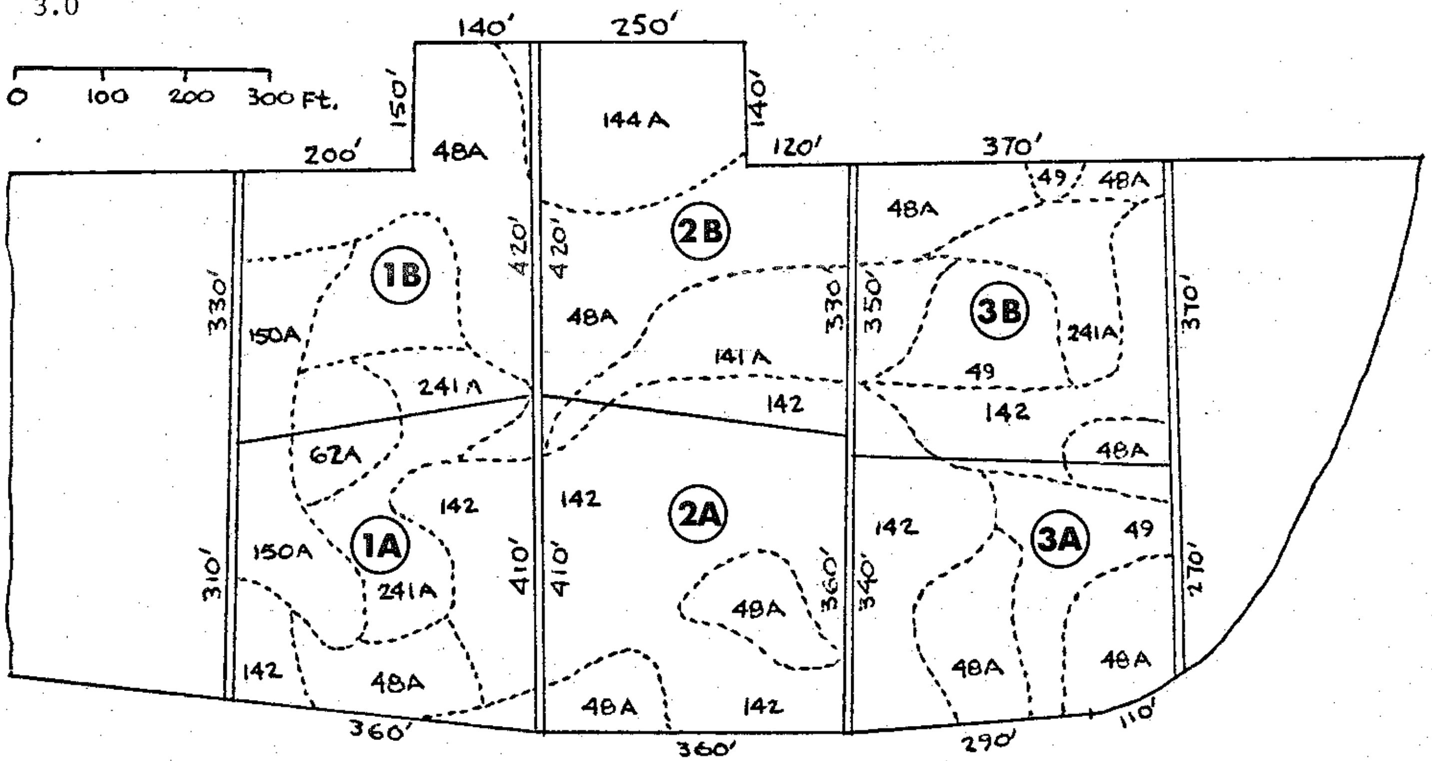


Figure 7. Subplot locations, Field 3I-1, 1979

FIELD	ACRES	TREATMENT
1A	3.0	Smoothed
1B	2.8	
2A	3.2	Smoothed and Graded
2B	3.4	
3A	2.7	Smoothed
3B	3.0	



48A	Swanton fsl	142	Madalin sicl
49	Whately fsl	144A	Niagara sil
62A	Massena cobbly l	150A	Junius fsl
141A	Rhinebeck sicl	241A	Rhinebeck fsl

Fig. 8. Field Areas, Hatch 498, 1979. Field 3I-2.

B. Crop Management and Yields

Lake Alice (corn):

Tillage: spring chiseled and disced 2 times

Pesticides: Furadan 1 #/A, 7" band over row

Aatrex 2 #/A

Fertilizer: 0-0-60 - 50 #/A Broadcast

13-52-0 - 150 #/A Banded at Planting

32-0-0 - 313 #/A Sidedress and cultivated

Planting: Pioneer 3958 @ 32,000 K/A; June 21.

Harvested: Only yield plots were harvested (Sept. 17).*

Yields:

Table 1. Corn silage yields, (70% moisture), Lake Alice, 1979

Soil: Swanton fine sandy loam

Plot No:	1	2	3	4	Mean
Corn silage yield T/A	14.96	14.94	15.26	12.96	14.53

Soil: Rhinebeck silty clay loam

Plot No:	5	6	7	8	Mean
Corn silage yield T/A	17.47	15.77	15.28	14.52	15.76

Soil: Covington silty clay loam

Plot No:	9	10	11	12	Mean
Corn silage yield T/A	19.21	18.03	17.17	17.97	18.10

Table 1a. Corn grain yields, Lake Alice, 1979

There were no corn grain yields at this site. Because of the late planting (June 21) there was no harvestable grain on the corn plants.

*Because of the very wet field situation, it was judged that the field could not be successfully harvested with field machinery until the soil was frozen. The soil was not sufficiently frozen until early January. The corn was not harvested for silage.

Lake Alice (meadow):

Tillage: none

Pesticides: none

Fertilizer: 34-0-0 150 #/A broadcast

Planting: none

Harvested: 7/2/79 baled hay

Yields:

Table 2. Hay yields, (15% moisture), Lake Alice, 1979

Soil: Niagara Silt Loam

Plot No:	1	2	3	4	Mean
Hay yield T/A	2.48	1.28	1.92	1.35	1.76
% legume in hay	5	10	10	10	8.75

Soil: Madalin Silty Clay Loam

Plot No:	5	6	7	8	Mean
Hay yields T/A	1.28	1.60	1.86	1.40	1.54
% legume in hay	10	10	5	10	8.75

Soil: Covington silty clay loam

Plot No:	9	10	11	12	Mean
Hay yield T/A	1.25	1.08	1.20	0.61	1.04
% legume in hay	10	5	5	5	6.25

Field 3I-1

Tillage: spring chisel plowed and disced once

Pesticides: Furadan 1 #/A banded over row

Aatrex 2 #/A

Fertilizer: 0-0-60 50 #/A broadcast

Planting: Pioneer 3958 @ 32,000 K/A; April 14.

13-52-0 150 #/A banded at planting

32-0-0 313 #/A sidedressed

Harvested: 9/20/79 for silage

Yields:

A. 50 foot drain spacing

Table 3. Mean Silage Yields, T/A (70% moisture), Field 3I-1, 1979

		Treatment[2/]		
Plot Area[1/]	Soil	A	B	C
A_2	Swanton fsl	21.4[abc][3/]	23.5[a]	21.3abcd
B_2	Madalin sicl	20.8[abcd]	20.7[abcd]	21.0[abcd]
C_2	Rhinebeck sicl	19.1[cd]	18.3[d]	20.6[abcd]
D_2	Covington sicl	20.4[bcd]	22.1[abc]	22.2[ab]

1/ See plot location maps (Figures 4-7).

2/ Treatments are distances (in feet) from the drain line: A = 0, B = 25, C = 0.

3/ Means superscripted by the same letter are not significantly different at P = 0.05 (Duncan's Multiple Range Test). Comparisons may be made both horizontally and vertically.

Table 4. Mean Grain Yield, Bu/A (15% moisture), Field 3I-1, 1979

		Treatment[2/]		
Plot Area[1/]	Soil	A	B	C
A_2	Swanton fsl	58.5^{b}	72.8^{a}	66.1^{ab}
B_2	Madalin sicl	61.0^{ab}	58.9^{b}	60.6^{ab}
C_2	Rhinebeck sicl	57.7^{b}	55.5^{b}	65.1^{ab}
D_2	Covington sicl	64.4^{ab}	60.5^{ab}	65.2^{ab}

[1/] See plot location maps (Figures 4-7).

[2/] Treatments are distances (in feet) from the drain line: A = 0, B = 25, C = 0.

[3/] Means superscripted by the same letter are not significantly different at P = 0.05 (Duncan's Multiple Range Test). Comparisons may be made both horizontally and vertically.

B. 100 foot drain spacing:

Table 5. Mean Silage Yields, T/A (70% moisture), Field 3I-1, 1979

		Treatment[2/]				
Plot Area[1/]	Soil	A	B	C	D	E
A_1	Swanton fsl	22.6^{abc}	21.2^{bc}	--	--	--
B_1	Madalin sicl	25.2^{a}	23.8^{ab}	23.6^{ab}	22.1^{abc}	21.2^{bc}
C_1	Rhinebeck sicl	20.6^{ab}	20.8^{ab}	20.8^{ab}	19.8^{b}	25.2^{a}
D_1	Covington sicl	20.2^{ab}	20.2^{ab}	20.8^{ab}	21.2^{ab}	20.4^{ab}

[1/] See plot location maps (Figures 4-7).

[2/] Treatments are distances (in feet) from the drain line: A = 0, B = 25, C = 50, D = 25, E = 0.

[3/] Means superscripted by the same letter are not significantly different at P = 0.05 (Duncan's Multiple Range Test). Comparisons may be made both horizontally and vertically.

Table 6. Mean Grain Yields, Bu/A (15% moisture), Field 3I-1, 1979

Plot Area[1/]	Soil	Treatment[2/] A	B	C	D	E
A_1	Swanton fsl	67.2[abcd]	61.7[cd]	--	--	--
B_1	Madalin sicl	76.9[a]	74.1[ab]	74.4[ab]	70.6[abc]	72.2[abc]
C_1	Rhinebeck sicl	65.1[bcd]	64.8[bcd]	64.1[bcd]	63.9[bcd]	76.9[a]
D_1	Covington sicl	59.8[d]	57.0[d]	60.1[d]	62.2[cd]	64.4[bcd]

1/ See plot location maps (Figures 4-7).

2/ Treatments are distances (in feet) from the drain line: A = 0, B = 25, C = 50, D = 25, E = 0.

3/ Means superscripted by the same letter are not significantly different at P = 0.05 (Duncan's Multiple Range Test). Comparisons may be made both horizontally and vertically.

Field 4-2

Tillage: Fall chisel plow and disced 2 times

Pesticides: none

Fertilizers: 5-20-20 - 200 #/A Broadcast before planting

0-20-20 - 200 #/A Broadcast after 1st cut

Planting: 8# Arlington red clover

6# Climax timothy

48# Garry Oats

all band seeded with grain drill, press wheels and cultipacked.

Harvested: 7/18 for haylage

Yields: No data.

Field 3I-2

Tillage: spring chisel plowed and disced once

Pesticides: Furadan 1 #/A band over row

Fertilizer: 0-0-60 50 #/A broadcast

13-52-0 150 #/A banded at planting

32-0-0 313 #/A sidedressed and cultivated

Planting: Pioneer 3958 @ 32,000 K/A; May 15-17.(1A,1B,2A,2B-May 15; 3A,3B - May 17).

Harvest: 9/17 & 9/24. (Wetness delayed harvest).

Yields:

Table 7. Corn silage,T/A (70% moisture), Field 3I-2, 1979.

Soils:	Rhinebeck Madalin	Swanton Madalin	Madalin	Niagara Swanton Rhinebeck	Madalin Swanton Whately	Rhinebeck Madalin Whately
Plot No.	1A	1B	2A	2B	3A	3B
Drainage Treatment	Smoothed		Smoothed and Graded		Smoothed	
T/A (70% moisture)	20.2	18.1	16.0	12.2	17.0	13.0

Total 1979 silage production: 290 tons (70%moisture)

C. Yield Responses to Drainage

Lake Alice:

These plots are maintained as a control to the drainage treatments on Field 3I-1 (see Table 1). The delayed planting (June 21) contrasts sharply with the drained fields, which were planted 5 weeks earlier.

Field 3I-1:

50-foot spacing: there were very few differences in yield as a function of distance from the drain. This essentially repeats the response observed with Sudangrass in 1977 and corn in 1978 (see Agronomy Mimeo 78-21 and 80-36).

100-foot spacing: few yield response differences were noted.

Field 4-2:

This field was half seeded with red clover, timothy, and oats, and corn in a manner which precluded comparisons with other fields in the experiment.

Field 3I-2:

The yield data were collected only on a subfield basis (see Table 7, page 15), and have not been statistically analyzed.

D. Discussion

The general level of silage yields was very high, and probably marks 1979, with 1978, as an exceptional year for corn silage. Corn grain yields were low; possibly due to a lack of adequate rain in June and July interfering with grain formation. Rainfall was below the long term mean (LTM) as indicated in Figure 9. The rainfall for May and October approximated the LTM for those 2 months; 2.6 and 2.6 actual inches, respectively, vs. 2.7 and 2.6 inches (LTM), respectively. Rainfall in August and September was about 2 inches more than LTM for each month, while very little rain fell in June and July (Table 8).

Since drainage is a method of removing excess soil water, one would expect reduced responses to drainage in a drier than normal season (when little or no excess water occurs).

The mean yields of grain and silage in field 3I-1, over all soil types were:

50 foot spacing: Grain 62.2 Bu/A; Silage 21.0 T/A

100 foot spacing: Grain 66.8 Bu/A; Silage 21.7 T/A

Clearly, there were no substantial differences attributable to tile spacings in 1979. The grain yields were considerably lower than in 1978 (64 bu/A vs 160^{+} bu/A), even though the silage yields were similar (21+ tons/A in 1979 vs 22 tons/A in 1978). This difference in grain yield may be due to differences in growing season rainfall. In 1978, there was 6.3 inches of rain in June and July, compared with only 1.8 inches in June and July 1979.

Comparing yield levels for 1978 and 1979 in field 3I-1 (table 9), it is clear that the 1979 grain yields were much lower than in 1978, while the silage yields decreased only a little.

Table 8 . Rainfall and Evaporation, Miner Institute, 1979

	April		May		June		July		August	
Date	Pptn	Evap	Pptn	Evap	Pptn	Evap	Pptn	Evap	Pptn	Evap
1	0.49	N/A	–	?	–	0.04	0.09	0.02	0.97	0.17
2	T		–	0.15	–	0.10	0.08	0.31	–	0.11
3	0.50		–	0.18	–	0.27	0.07	0.16	0.34	0.31
4	–		0.40	0.03	–	0.31	–	0.31	–	0.14
5	0.35		0.11	0.02	–	0.34	0.13	0.23	–	0.17
6	0.10		–	0.07	0.02	0.06	0.01	0.14	0.47	0.09
7	–		–	0.25	–	0.29	–	0.24	–	0.27
8	–		–	0.32	–	0.17	–	0.13	0.37	0.18
9	T		–	0.27	0.02	0.11	–	0.27	0.01	0.21
10	0.44		–	0.21	–	0.12	–	0.08	0.08	0.11
11	–		–	0.18	–	0.15	–	0.31	0.02	0.13
12	–		–	0.02	0.22	0.18	0.02	0.01	–	0.10
13	–		–	0.04	–	0.04	–	0.26	–	0.10
14	0.01		0.13	0.03	–	0.16	–	0.03	0.05	0.26
15	–		–	0.16	–	0.19	–	0.37	0.05	0.18
16	0.20		0.21	0.24	–	0.33	0.48	0.33	0.09	0.09
17	0.02		–	0.19	–	0.22	–	0.07	–	0.06
18	–		–	0.08	–	0.27	–	0.36	–	0.26
19	–		–	0.04	–	0.15	–	0.19	0.43	0.10
20	–		–	0.28	–	0.25	–	0.16	T	0.02
21	–		–	0.25	–	0.14	–	0.35	–	0.09
22	–		0.07	0.11	–	0.33	–	0.21	–	0.11
23	–		–	0.21	0.07	0.14	–	0.26	–	0.18
24	–		–	0.25	0.02	0.13	–	0.16	0.03	0.16
25	–		0.28	0.01	0.02	0.01	–	0.17	0.88	0.07
26	–		0.59	0.01	–	0.20	T	0.45	0.05	0.21
27	0.17		0.16	0.02	–	0.35	0.48	0.05	0.99	0.15
28	0.71		0.11	0.03	0.02	0.05	–	0.22	0.05	0.05
29	0.25		0.40	0.09	–	0.24	–	0.13	–	0.17
30	–		0.01	0.19	–	0.18	–	0.27	0.83	0.15
31			0.13	0.03			–	0.20	0.04	0.34
Totals	3.23		2.60		0.39		1.36		5.75	
LTM*	2.41		2.66		3.46		3.34		3.74	

* Long Term Mean

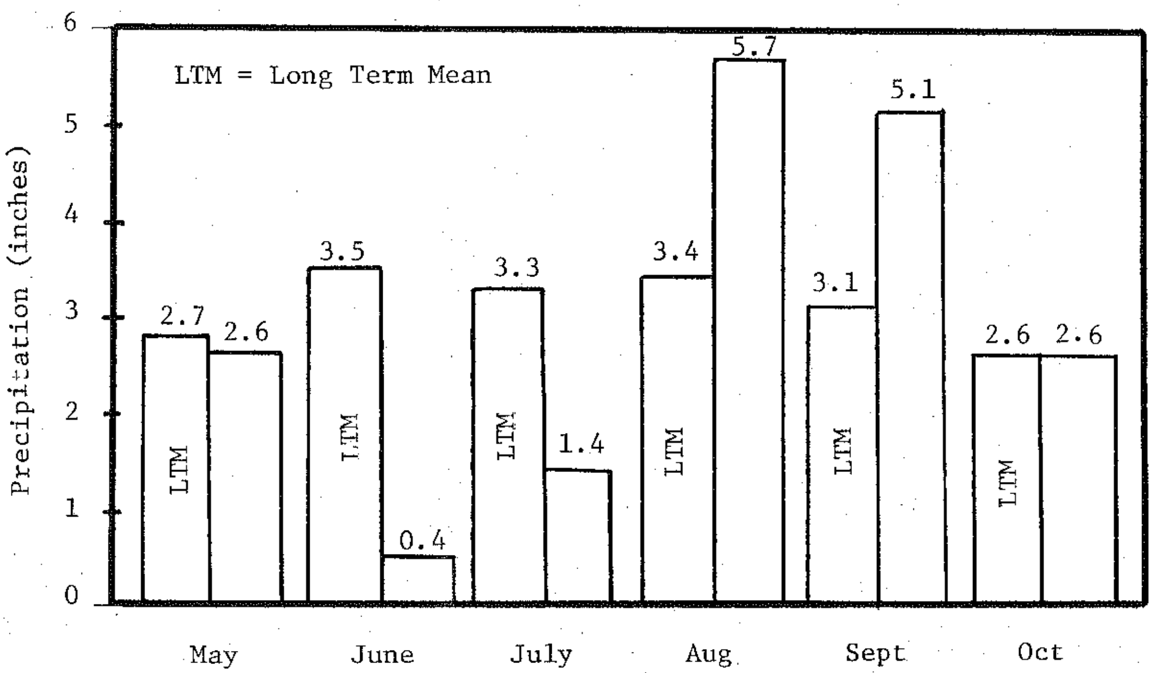


Fig. 9 Growing Season Rainfall, Chazy, N.Y., 1979

Table 9. Corn yields, field 3I-1

Year	Grain, bu/A	Silage, tons/A
1978	159	22.2
1979	65	21.4

The differences in yields are likely to be due to differences in soil moisture during the growing season. In 1978, May rainfall was 1.3 inches below normal, while June rainfall was 1.2 inches above normal, so the corn entered July with no great deficit of soil moisture. July 1978 had 2.1 inches of rain (compared to a usual 3.2), most of which came in 3 major rains (0.47 inches on July 17, 0.46 inches on July 22 and 0.46 inches on July 24). There should have been no serious shortage of soil moisture when pollination occurred (pollination is the crucial time for adequate soil moisture).

By contrast, the 1979 season was much drier, with 0.4 inches in June (compared to a usual 3.5 inches), which should have resulted in a serious lack of soil moisture; compounded by only 1.4 inches in July which increased the shortage of soil moisture during the critical pollination period (from July 24 to July 31, 1979).

Like 1978, it is interesting to note that, in field 3I-1, there were similar yield levels in the poorly drained, fine textured Covington soils, which normally show limited responses to subsurface drainage. The mean yields for Covington soils were:

50 foot spacing: Grain 63.4 Bu/A; Silage 21.6 T/A

100 foot spacing: Grain 60.7 Bu/A; Silage 20.6 T/A

While the drier-than-normal season prevents observations about the relative effectiveness of the tile spacings, the data illustrate the productivity of Covington soils when excess soil water does not limit plant growth.

A comparison of the corn silage yields of field 3I-1 with Lake Alice should show the benefit of draining poorly drained soil. This benefit is not only due to the effect of growing crops in a better aerated medium but also due to a longer growing season on the drained sites since planting corn is delayed due to wetness on the undrained sites.

Table 10. Silage yields on similar soils, Lake Alice and Field 3I-1

	Corn Silage Yield, tons/acre	
Soil	Lake Alice	Field 3I-1
Swanton fsl	14.5	22.0
Rhinebeck sicl	15.8	20.7
Covington sicl	18.1	21.0

E. WATER LEVELS AND TILE DISCHARGE

1. METHODS

In addition to crop yield data, the influences of drainage on the levels of water in the soil were monitored, by installing perforated plastic pipes in the soil. The pipe locations are shown in figure 10.

Twelve pipes were installed in field 3I-1, between tile lines #5 and #8, and six were installed between tile lines 2 and 3 (see figure 10). The depth to the water surface was measured intensively from April 19 through June 30, and less frequently thereafter. The data are shown in Appendix B.

Six pipes were installed at the Lake Alice site (Figure 2), and similarly monitored. These provide a non-drained comparison for many of the soils which occur in field 3I-2. The data are shown in Appendix C.

Water table pipes were also installed in field 3I-2 at distances of 1, 30 and 45 feet upslope from a subsurface drain which is located at the boundary of 3I-2 and the adjacent pasture to the west, and in locations in field 3I-4 which are located where the subsurface drain would have been if it were extended to the north, and 30 feet on either side of such an extension. These data are shown in Appendix D and E, respectively.

The discharge from some tile lines (#3, 6, 9, and 12) were measured at times, to ascertain whether there were differences in the rate of flow, which might be related to soil differences. These data are shown in Appendix F. The data were gathered by catching the outflow for a specific period of time, measuring it, and calculating the flow in gallons per minute (g.p.m.). It should be noted that these are instantaneous data, and may not accurately represent tile flow for any entire day, or perhaps even a significant portion of a day. Continuous data have not been obtained.

2. Data.

The field data are shown in Appendices B, C, D, and E (pages -).

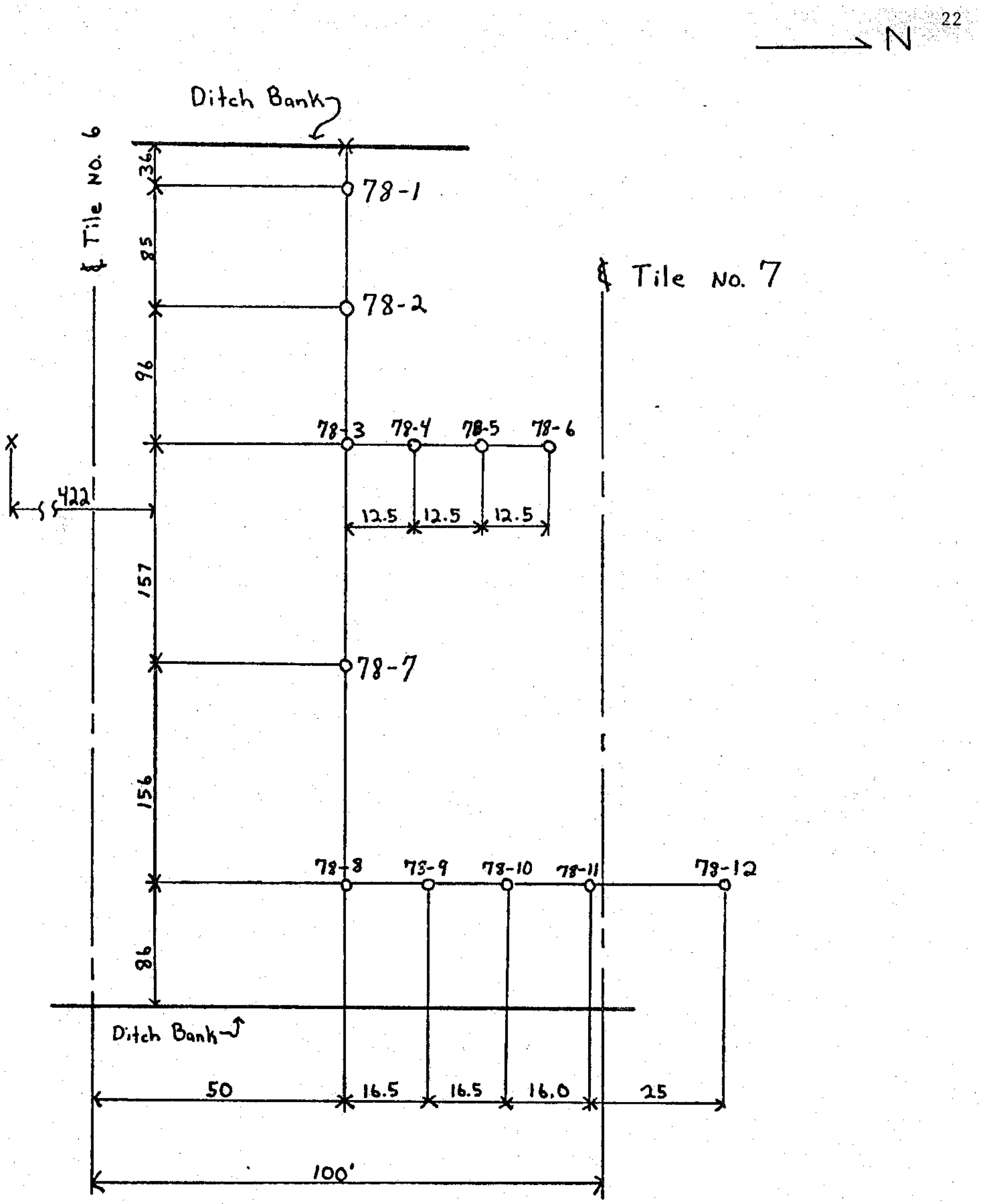


Figure 10. Water Table Pipes
Miner Institute-Fld 3I-1
installed 6/27/77

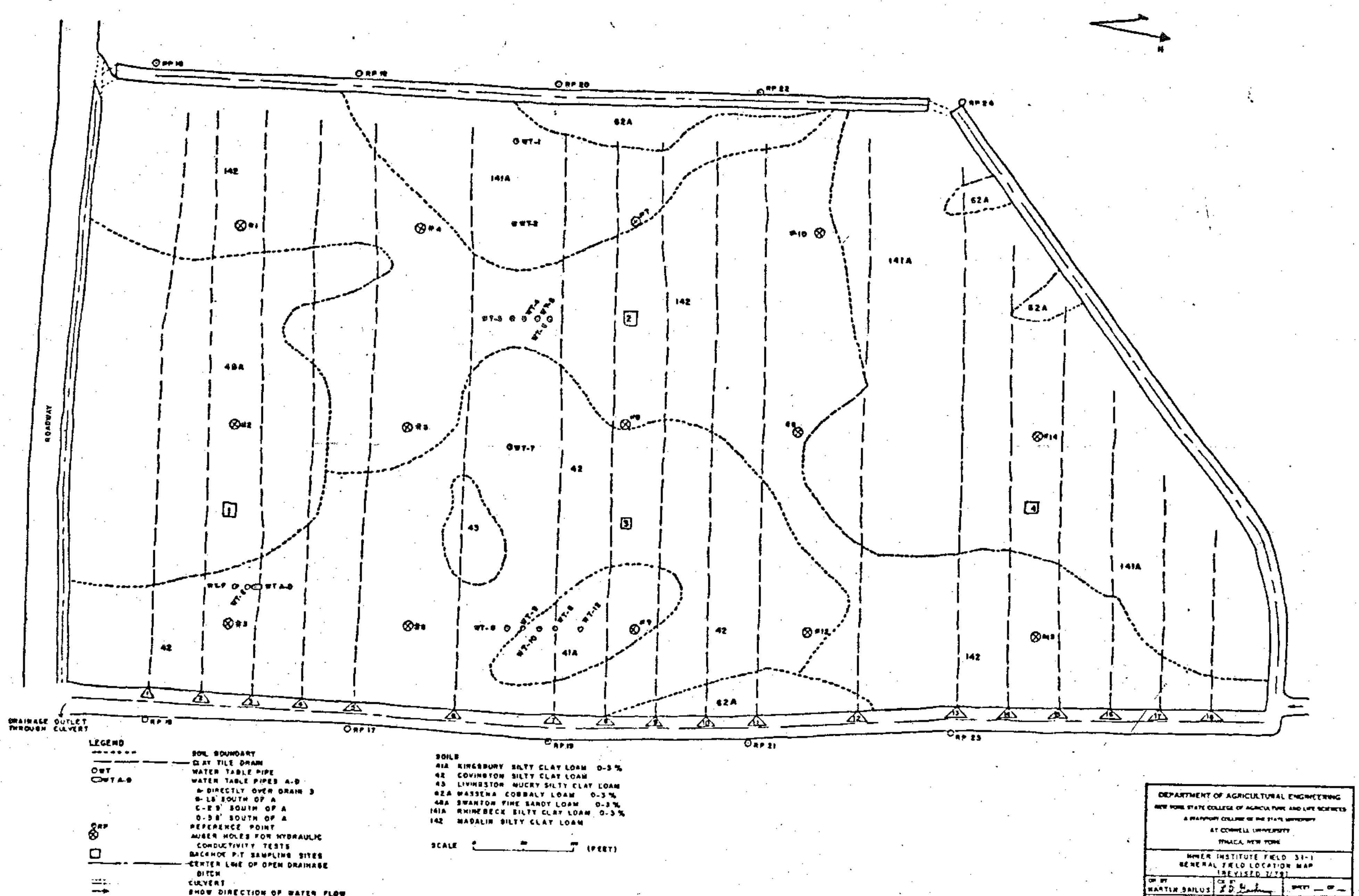

ROADWAY
DRAINAGE OUTLET THROUGH CULVERT
RP 16
RP 18
RP 20
RP 22
RP 24
RP 17
RP 19
RP 21
RP 23
62A
141A
142
48A
42
43
41A
WT-1
WT-2
WT-7
LEGEND
SOIL BOUNDARY
CLAY TILE DRAIN
WATER TABLE PIPE
WATER TABLE PIPES A-D
A- DIRECTLY OVER DRAIN 3
B- LS' SOUTH OF A
C- 2.5' SOUTH OF A
D- 3.8' SOUTH OF A
REFERENCE POINT
AUGER HOLES FOR HYDRAULIC CONDUCTIVITY TESTS
BACKHOE PIT SAMPLING SITES
CENTER LINE OF OPEN DRAINAGE DITCH
CULVERT
SHOW DIRECTION OF WATER FLOW
SOILS
41A KINGSBURY SILTY CLAY LOAM 0-3 %
42 COVINGTON SILTY CLAY LOAM
43 LIVINGSTON MUCKY SILTY CLAY LOAM
62A MASSENA COBBALY LOAM 0-3 %
48A SWANTON FINE SANDY LOAM 0-3 %
141A RHINEBECK SILTY CLAY LOAM 0-3 %
142 MADALIN SILTY CLAY LOAM
SCALE (FEET)
DEPARTMENT OF AGRICULTURAL ENGINEERING
ITHACA, NEW YORK
INSTITUTE FIELD 31-1
GENERAL FIELD LOCATION MAP
(REVISED 7/79)
MARTIN SAILUS
DATE
PLAN

Figure 10a.

3. Discussion

The daily rainfall and evaporation for the summer months are shown in table 8 (page 18), and in graphic form in figure 9 (page 19). Rainfall was just about normal in May, well below the LTM in June and July, and well above the LTM in August and September.

The data in figure 11 indicate that, even at a distance of 50 feet from the tile drain, water table levels were lower in a drained Covington soil than in a non-drained one. The earliest conceivable data that the non-drained Covington could have been safely planted would have been May 24, while the drained Covington had a consistently lower water table for a whole month earlier.

Figure 12 indicated that the differences in the depths to a water table were even greater in the Madalin soil, but that the drainage had a greater effect on lowering the water table.

Figure 13 shows the late summer/early fall response on Covington soils; figure 14 shows these responses on Madalin soils.

These data indicate that, on either soil, it would have been very wet, and very difficult to harvest corn on September 7. But on the drained soils, the water table rapidly dropped to near 2 feet by Sept 13, and again by September 27. On the non-drained soils, the water table was high enough to be within the plow layer continuously after Sept. 7, making harvest extremely difficult.

In these comparisons, drainage would have been the major factor in a successful crop harvest.

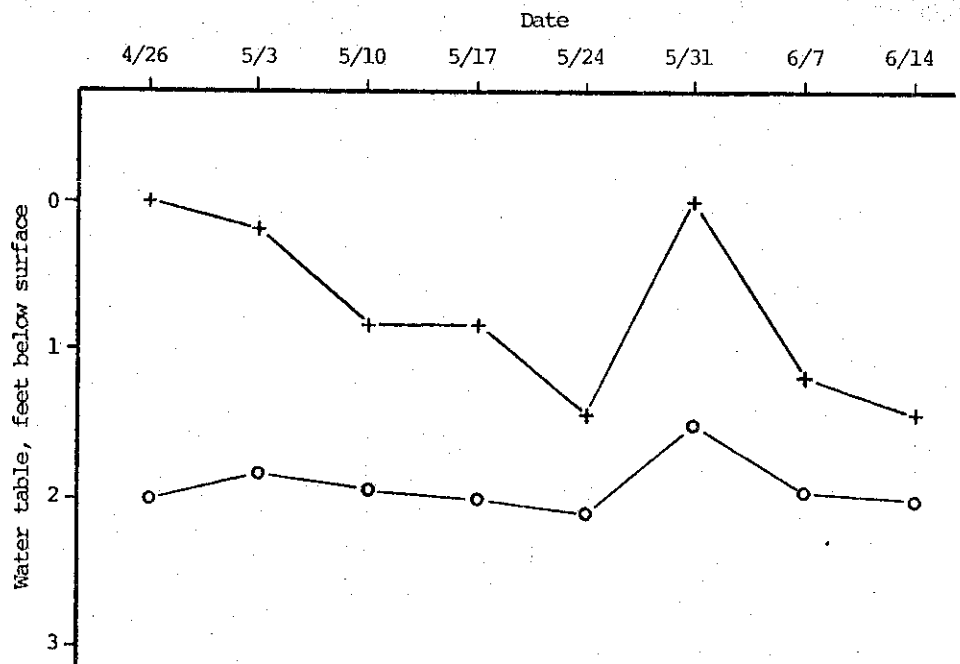


Figure 11. Effect of drainage on water tables,
Miner Institute, Spring 1979
Covington soils

+——+ nondrained

o——o drained

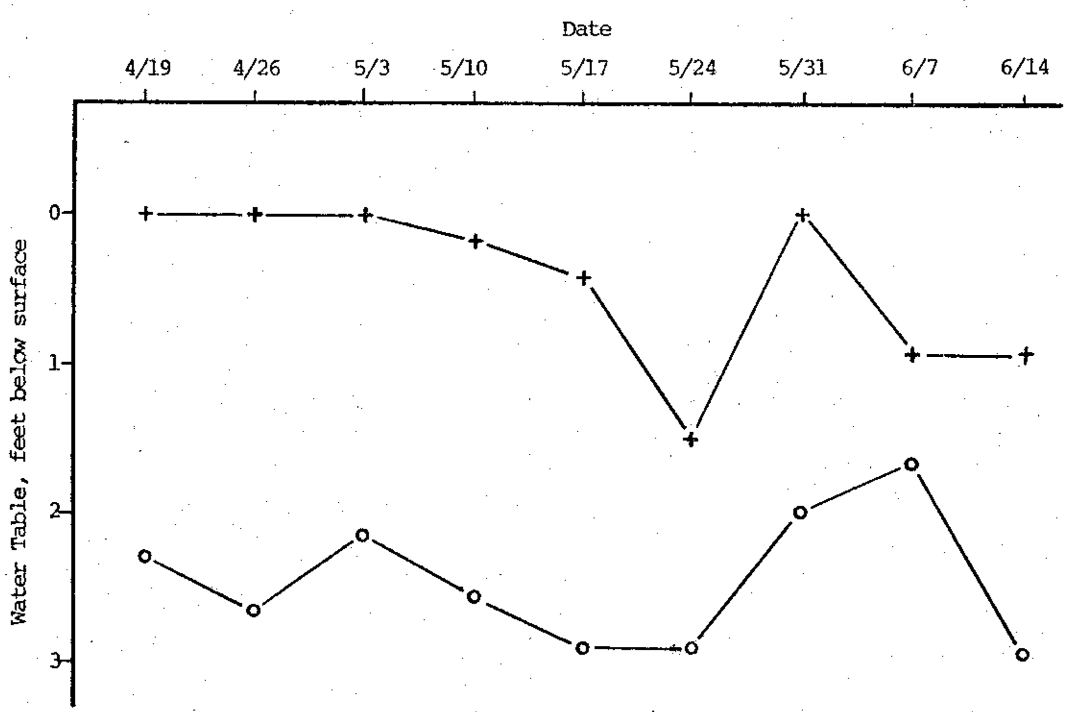


Figure 12. Effect of drainage on water tables
Miner Institute, Spring 1979
Madalin soils

+——+ Nondrained

o——o Drained

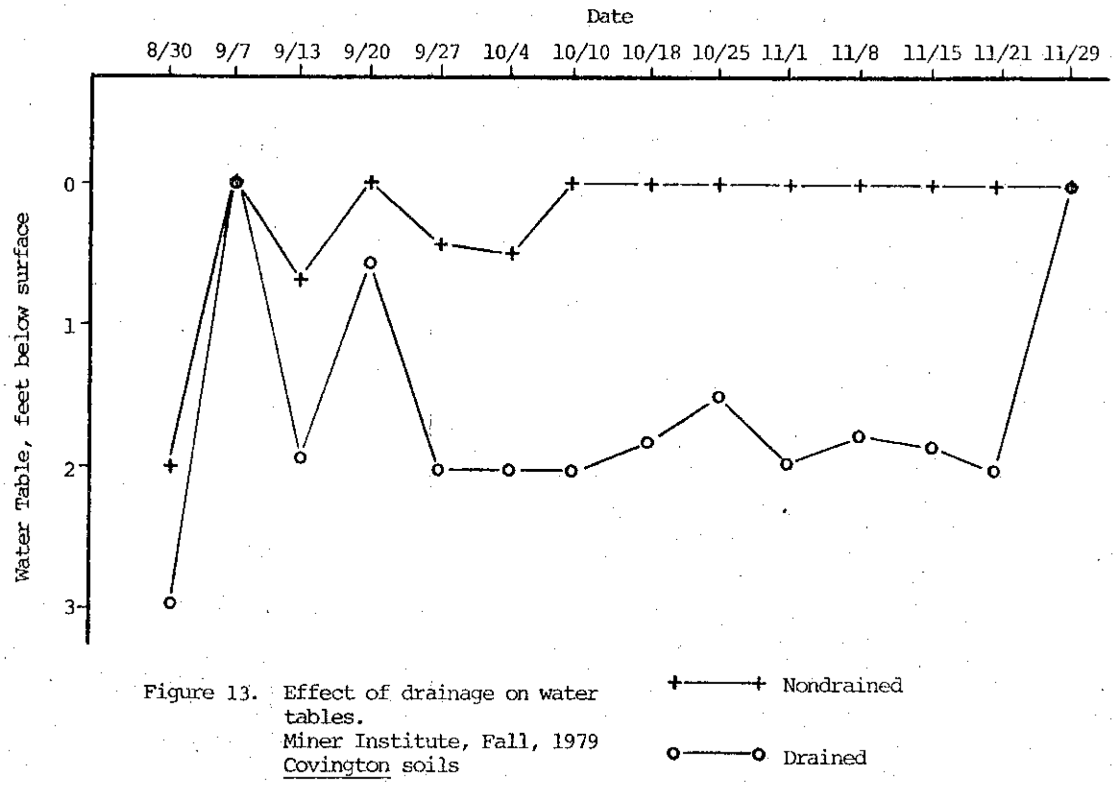


Figure 13. Effect of drainage on water tables.
Miner Institute, Fall, 1979
Covington soils

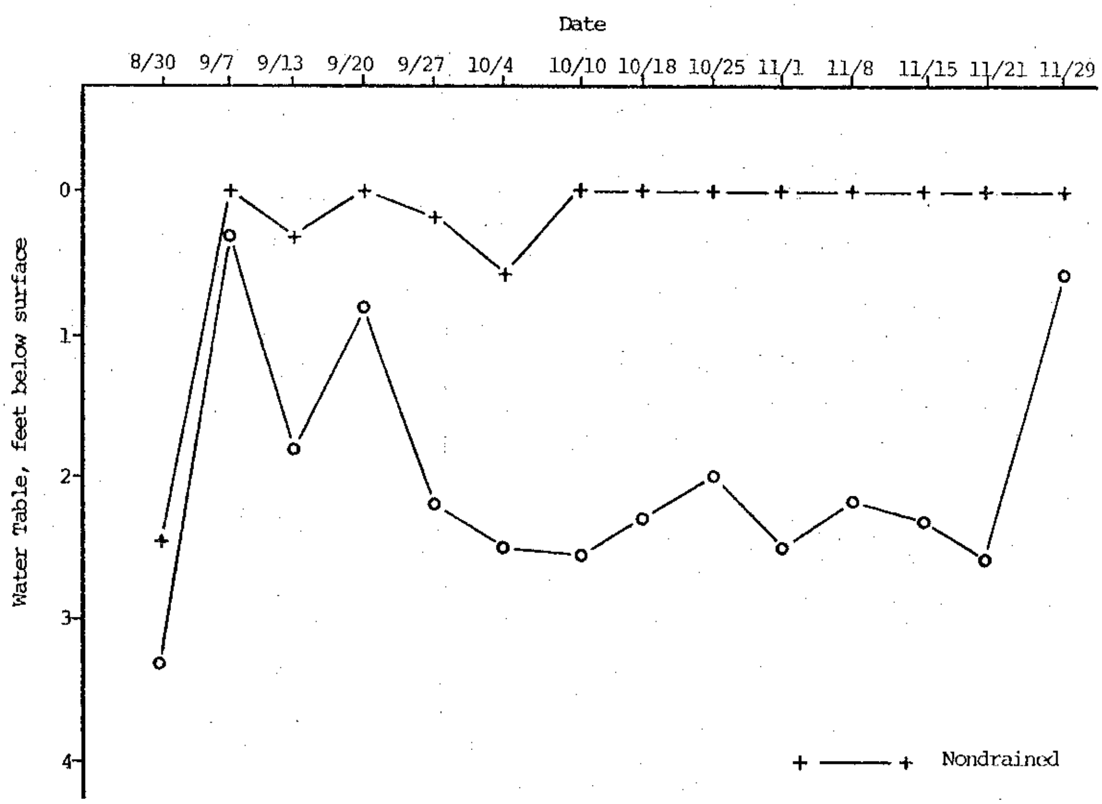


Figure 14. Effect of drainage on water tables
Miner Institute, Fall, 1979
Madalin soils

Figures 15 and 16 show the effect of the tile drains on water table levels (depth below the surface) and elevation (depths with respect to one another) in Covington and Kingsbury soils. These data indicate that, since the water table pipes are nearly identical in their ground elevations, the 2 sets of data may be used interchangeably.

The data indicate that for the period from April 19 to May 24, the water table depth at a distance of 1 foot from the tile line ranged from 1.6 to 2.2 feet. During the same period, the range in depths to water table at a distance of 50 feet from a tile line ranged from 1.2 to 2.5 feet.

One unexpected observation is that the water table elevations in tubes 78/3 and 78/18; (both of which are 50 feet from a tile) are lower than water tables in the tubes which are about 35 feet from a tile.

Such anomalies may be explained during the 1980 investigations.

The tile discharge data are shown in Appendix F. Some selected data are also shown in figure 19. These data were collected by measuring the tile flow for a minute or less, once a week. They give some comparison of instantaneous flow rates, making it possible to say, for instance, that the measured discharge from tile #6 was consistently greater than that from tile #9, and was usually slightly greater than that from tile #12 during the spring.

Since tiles #6 and #12 were installed at 100 foot spacings, and #9 at a 50 foot spacing, the differences in flow are not unexpected. These data do not allow comparisons of total discharges, which should also be consistently greater for tiles #6 and #12, since they drain a greater soil volume than does either #3 or #9. Whether the tile discharges reflect differences in soils distribution along the tile line cannot be ascertained from these data.

Information about the rates of tile discharge over a period of several days would be helpful in determining the relative effectiveness of the tile drains, and the influence of soils on such effectiveness.

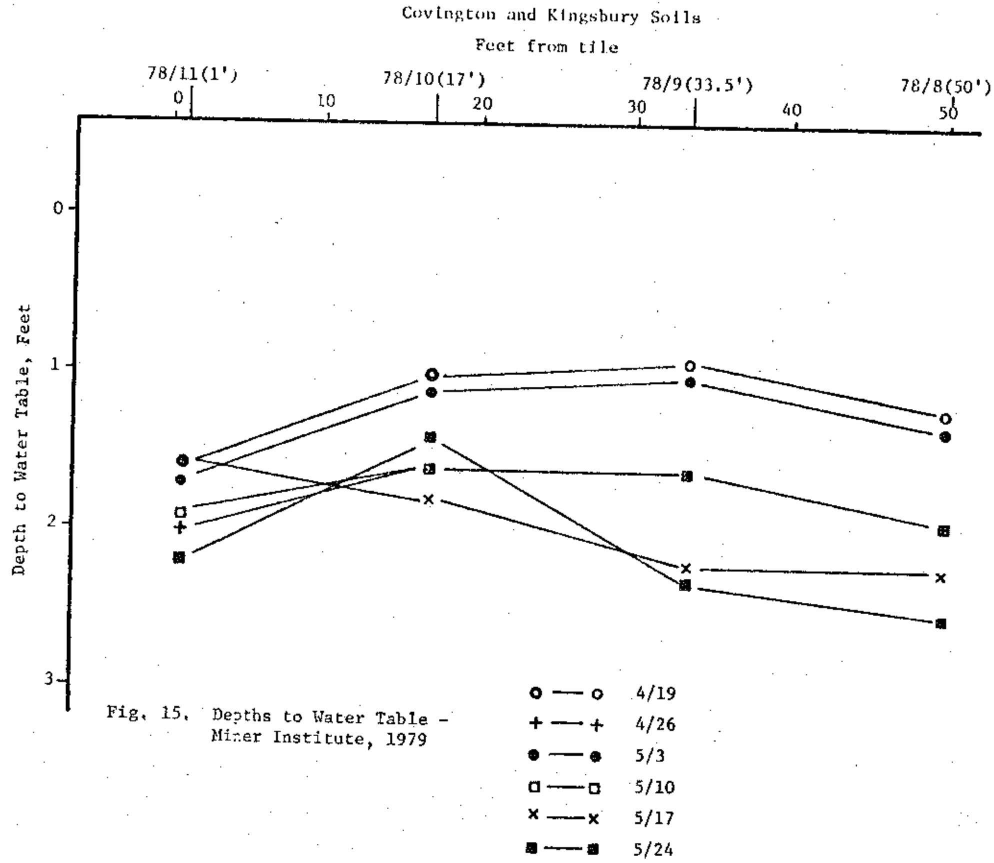


Fig. 15. Depths to Water Table - Miner Institute, 1979

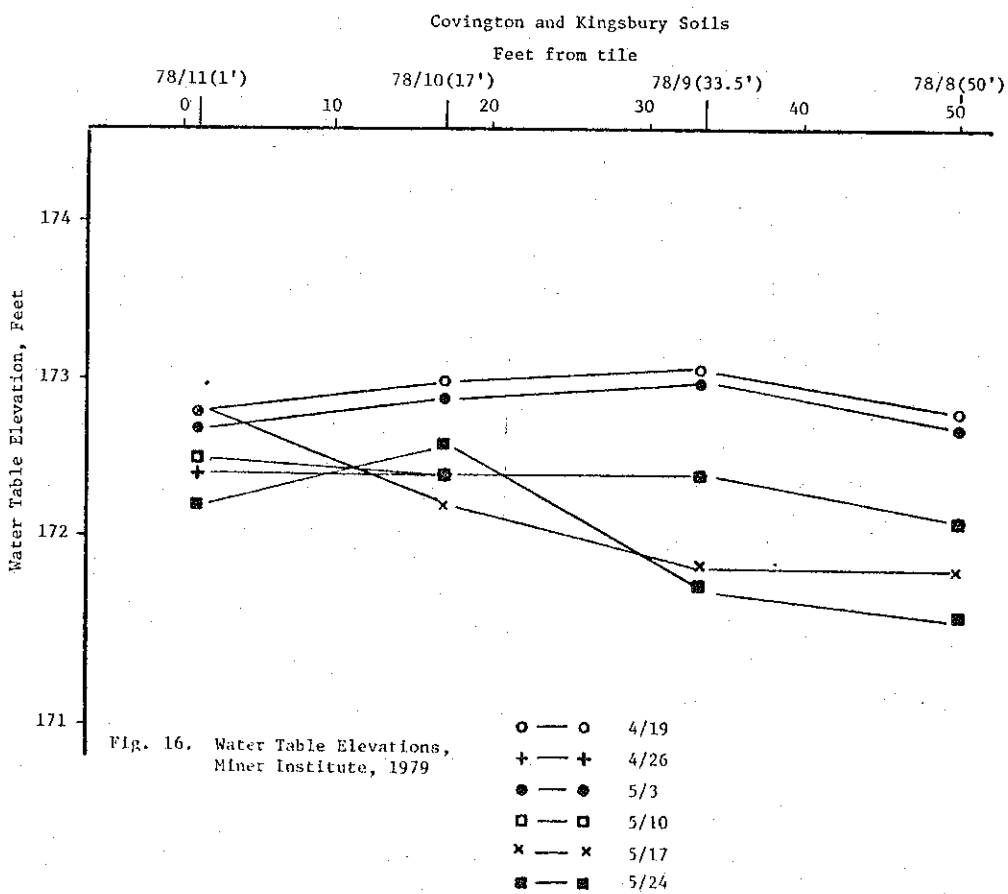


Fig. 16. Water Table Elevations, Miner Institute, 1979

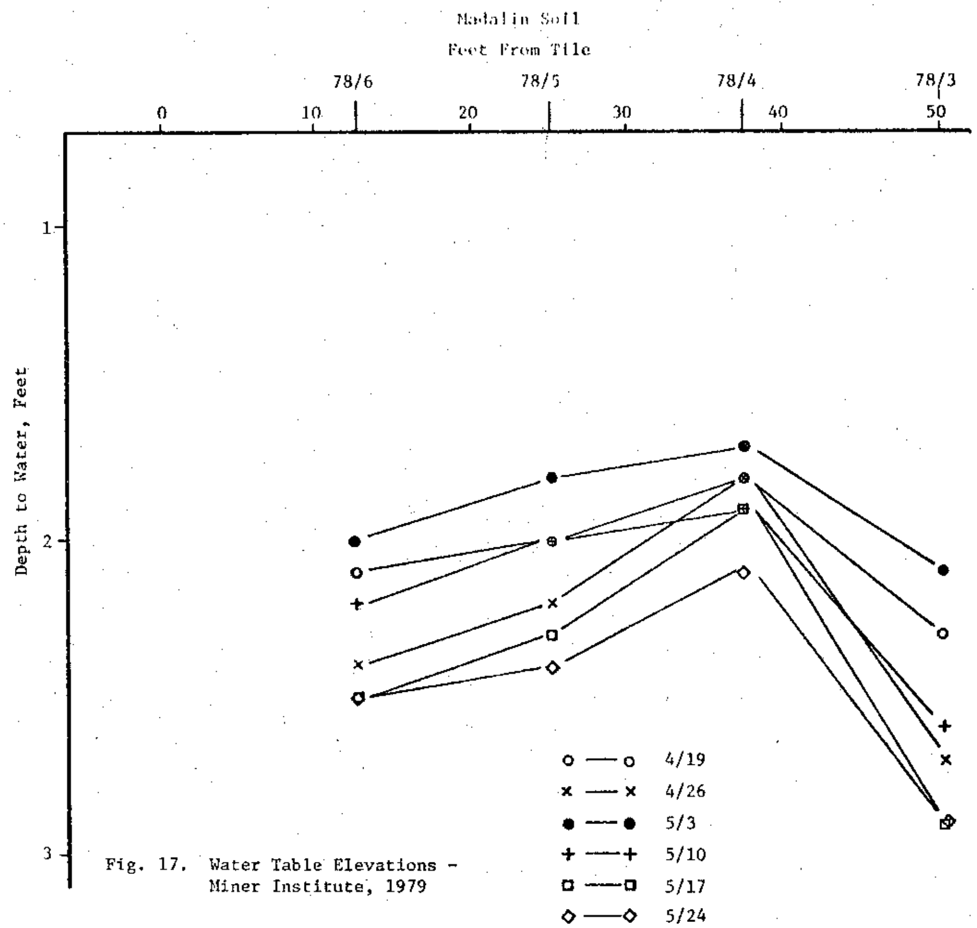


Fig. 17. Water Table Elevations - Miner Institute, 1979

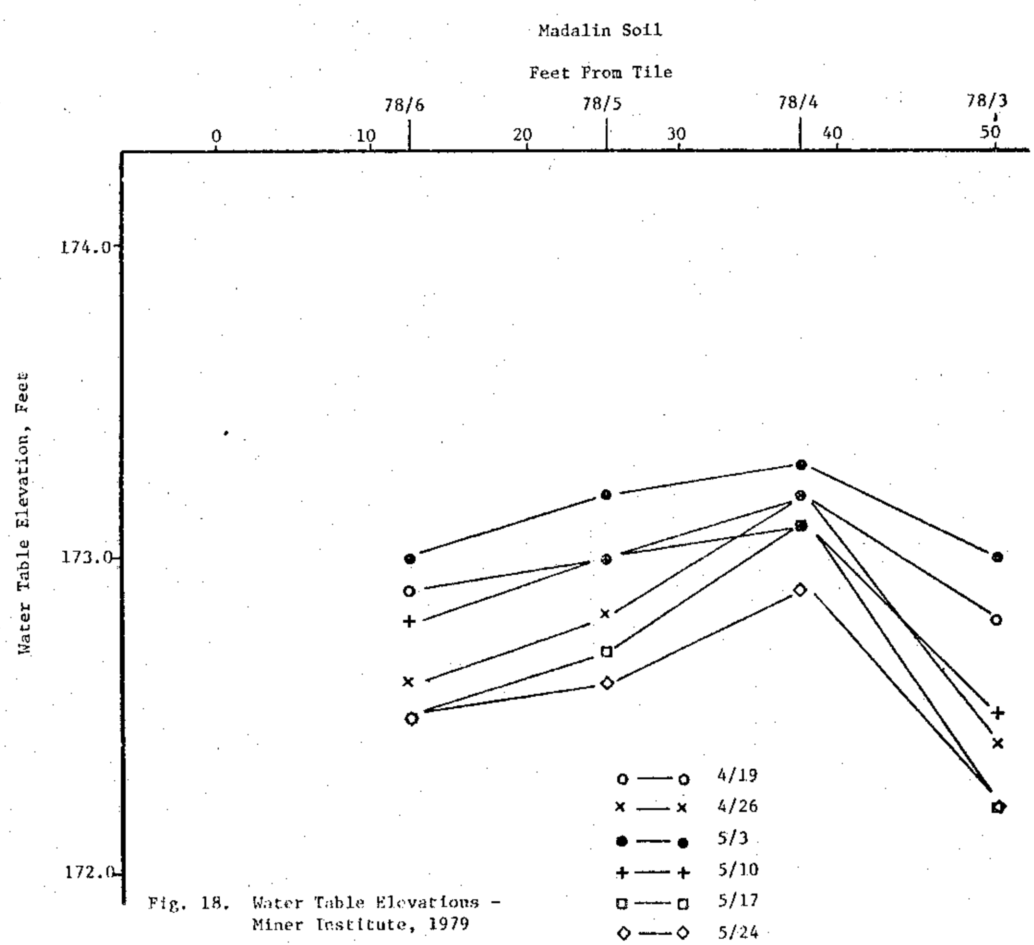
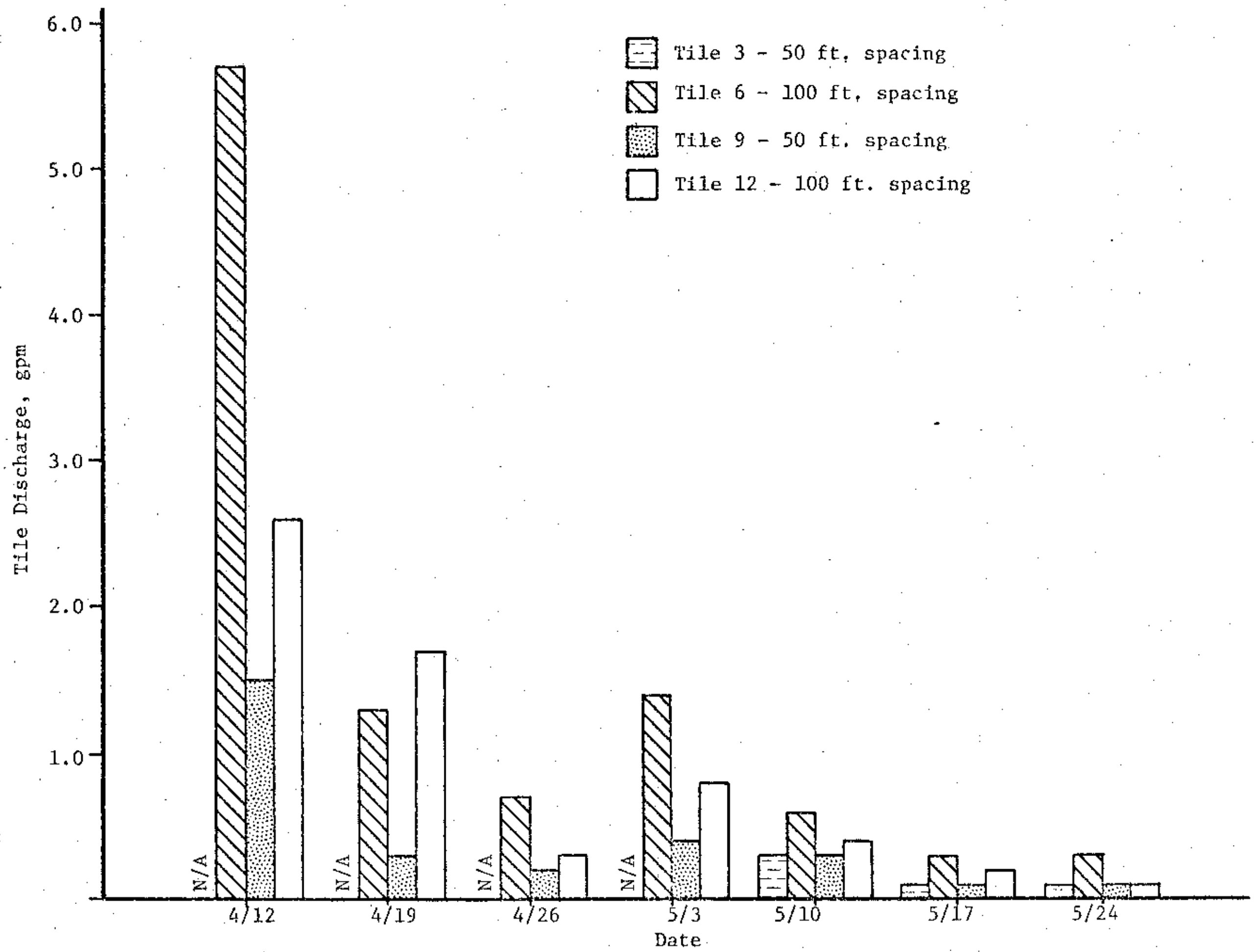


Fig. 18. Water Table Elevations - Miner Institute, 1979



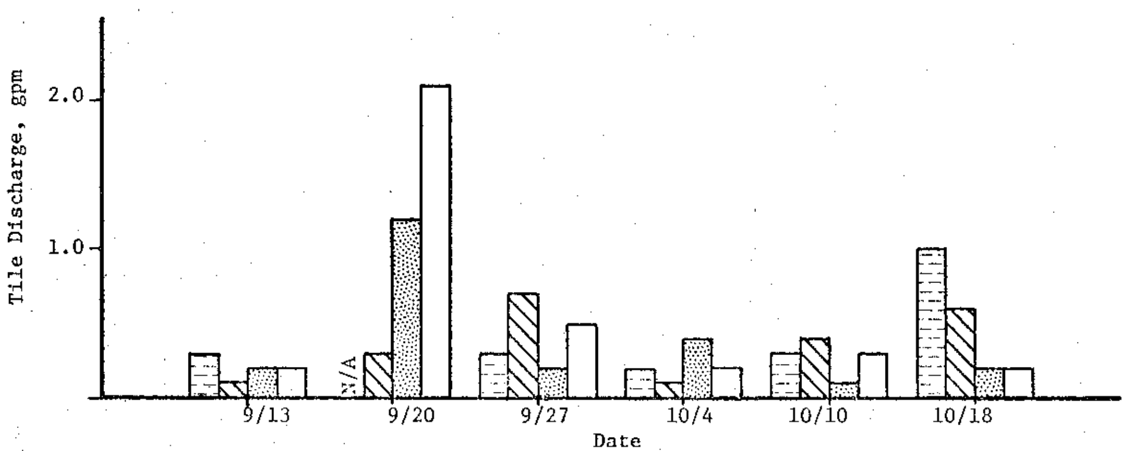


Figure 19. Instantaneous tile discharge rates
Miner Institute, 1979

APPENDIX A

CORN YIELDS - MINER INSTITUTE 1979

FIELD 31-1

PLOT		TREATMENT (Spacing, Feet)	GRAIN YIELD (Bu/A @ 15%)	SILAGE YIELD (T/A @ 70%)
A_1	1	0	63.26	21.84
	2	25	55.16	18.62
	3	0	67.24	24.03
	4	25	60.16	21.24
	5	0	64.46	20.65
	6	25	67.60	23.46
	7	0	73.77	23.91
	8	25	63.98	21.51
A_2	9	0	69.44	23.36
	10	25	68.96	22.78
	11	0	63.07	22.01
	12	0	70.79	23.59
	13	25	82.95	24.47
	14	0	66.59	20.34
	15	0	50.46	20.09
	16	25	72.48	23.71
	17	0	71.57	22.04
	18	0	43.21	18.60
	19	25	66.75	22.96
	20	0	63.20	20.91

PLOT	TREATMENT (Spacing, Feet)	GRAIN YIELD (Bu/A @ 15%)	SILAGE YIELD (T/A @ 70%)
D_2 21	0	60.55	21.41
22	25	67.77	22.66
23	0	66.99	23.01
24	0	63.26	21.66
25	25	71.28	20.30
26	0	82.76	26.71
27	0	75.87	22.96
28	25	69.36	22.55
29	0	82.23	23.39
30	0	78.73	23.76
31	25	89.54	28.84
32	0	79.16	25.95
D_1 33	0	96.84	28.04
34	25	75.13	23.73
35	50	67.92	20.09
36	25	74.71	23.63
(21)	0	(60.55)	(21.41)
37	0	73.68	23.72
38	25	64.58	20.82
39	50	61.79	19.53
40	25	70.88	20.72
(24)	0	(63.26)	(21.66)
41	0	44.76	17.14
42	25	53.84	18.78

PLOT	TREATMENT (Spacing, Feet)	GRAIN YIELD (Bu/A @ 15%)	SILAGE YIELD (T/A @ 70%)
43	50	48.96	17.75
44	25	72.75	23.81
(27)	0	(75.87)	(22.96)
45	0	66.66	22.54
46	25	65.61	22.06
47	50	62.45	20.57
48	25	54.31	20.66
(30)	0	(78.73)	(23.76)
B_2 49	0	58.64	21.20
50	25	64.00	21.62
51	0	60.83	20.61
52	0	69.17	23.14
53	25	72.15	22.89
54	0	75.41	25.02
55	0	63.23	21.12
56	25	69.20	20.76
57	0	60.55	21.41
58	0	56.47	18.20
59	25	55.31	19.07
60	0	66.84	20.82
B_1 61	0	61.14	19.30
62	25	82.76	26.71
63	50	65.40	20.75

PLOT	TREATMENT (Spacing, Feet)	GRAIN YIELD (Bu/A @ 15%)	SILAGE YIELD (T/A @ 70%)
64	25	69.05	20.74
65	0	62.98	20.53
66	0	60.65	19.42
67	25	89.54	28.84
68	50	66.32	20.36
69	25	59.56	18.19
70	0	63.17	20.65
71	0	64.79	19.73
72	25	74.71	23.63
73	50	59.90	19.90
74	25	52.74	17.43
75	0	72.15	22.89
76	0	71.60	21.08
77	25	47.27	16.78
78	50	56.47	18.20
79	25	41.40	15.96
80	0	57.10	18.74
C_2 97	0	59.67	19.44
98	25	66.44	21.73
(81)	0	(65.40)	(20.75)
100	0	58.59	20.95
101	25	51.81	19.03
(85)	0	(59.22)	(19.36)
103	0	61.52	21.84

PLOT	TREATMENT (Spacing, Feet)	GRAIN YIELD (Bu/A @ 15%)	SILAGE YIELD (T/A @ 70%)
104	25	68.61	20.88
(89)	0	(62.87)	(19.98)
106	0	59.46	21.81
107	25	66.41	21.60
(93)	0	(67.10)	(23.22)
C_1 81	0	65.40	20.75
82	25	57.95	19.53
83	50	64.79	20.56
84	25	66.32	20.36
(61)	0	(61.14)	(19.30)
85	0	59.22	19.36
86	25	50.23	19.04
87	50	61.41	22.49
88	25	53.82	18.16
(66)	0	(60.65)	(19.42)
89	0	62.87	19.98
90	25	59.29	20.72
91	50	67.85	21.95
92	25	62.71	21.08
(71)	0	(64.79)	(19.73)
93	0	64.10	23.22
94	25	63.49	19.98
95	50	62.19	19.86
96	25	58.20	20.57
(76)	0	(71.60)	(21.08)

APPENDIX B
WATER TABLE ELEVATIONS - MINER INSTITUTE, 1979
FIELD 3I-1

		WATER TABLE PIPES							
		78-1		78-2		78-3		78-4	
Calendar Date	Julian Date	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface
4/12	102	176.6	1.3	175.0	1.1	174.0	1.1	174.3	0.7
4/19	109	175.4	2.5	174.3	1.8	172.8	2.3	173.2	1.8
4/26	116	175.0	2.9	174.0	2.1	172.4	2.7	173.2	1.8
5/3	123	175.3	2.6	174.4	1.7	174.0	2.1	173.3	1.7
5/10	130	174.9	3.0	174.1	2.0	172.5	2.6	173.1	1.9
5/17	137	174.9	3.0	173.9	2.2	172.2	2.9	173.1	1.9
5/24	144	174.8	3.1	173.7	2.4	172.2	2.9	172.9	2.1
5/31	151	175.4	3.5	173.9	2.2	173.1	2.0	173.4	1.6
6/7	158	175.0	2.9	173.8	2.3	173.4	1.7	173.2	1.8
6/14	165	174.9	3.0	173.3	2.8	172.2	2.9	173.1	1.9
6/21	172	174.8	3.1	173.3	2.8	172.1	3.0	172.9	2.1
6/28	179	174.7	3.2	172.9	3.2	172.1	3.0	172.8	2.2
7/5	186	< 174.2	> 3.7	172.9	3.2	171.8	3.3	172.6	2.4
7/12	193	< 174.2	> 3.7	172.6	3.5	171.6	3.5	172.5	2.5
7/19	200	< 174.2	> 3.7	172.6	3.5	171.3	3.8	172.3	2.7
7/26	207	< 174.2	> 3.7	172.6	3.5	171.3	3.8	172.2	2.8
8/2	214	< 174.2	> 3.7	172.6	3.5	171.1	4.0	172.0	3.0
8/9	221	< 174.2	> 3.7	172.6	3.5	171.1	4.0	171.8	3.2
8/16	228	< 174.2	> 3.7	172.6	3.5	171.0	4.1	171.8	3.2
8/23	235	< 174.2	> 3.7	172.6	3.5	171.0	4.1	171.8	3.2
8/30	242	< 174.2	> 3.7	172.6	3.5	171.8	3.3	173.2	1.8
9/7	249	176.4	1.5	175.8	0.3	174.8	0.3	175.0	0
9/13	255	174.8	3.1	174.3	1.8	173.3	1.8	173.6	1.4
9/20	262	175.9	2.0	175.2	0.9	174.3	0.8	174.4	0.6
9/27	269	174.9	3.0	174.1	2.0	172.9	2.2	173.4	1.6
10/4	276	174.8	3.1	173.7	2.4	172.6	2.5	173.2	1.8
10/10	282	174.2	3.7	173.6	2.5	172.5	2.6	173.2	1.8
10/18	290	175.0	3.0	174.0	2.1	172.8	2.3	173.3	1.7
10/25	297	175.2	2.7	174.1	2.0	173.1	2.0	173.4	1.6
11/1	304	174.9	3.0	173.9	2.2	172.6	2.5	173.2	1.8
11/8	311	175.2	2.7	174.1	2.0	172.9	2.2	173.3	1.7
11/15	318	175.0	2.9	174.0	2.1	172.8	2.3	173.2	1.8
11/21	324	174.8	3.1	173.9	2.2	172.5	2.6	173.1	1.9
11/29	332	176.7	1.2	175.5	0.6	174.5	0.6	174.7	0.3

APPENDIX B
WATER TABLE ELEVATIONS - MINER INSTITUTE, 1979
FIELD 3I-1

		WATER TABLE PIPES							
		78-5		78-6		78-7		78-8	
Calendar Date	Julian Date	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface
4/12	102	173.9	1.1	173.6	1.4	--	ice	174.0	0
4/19	109	173.0	2.0	172.9	2.1	172.0	1.9	172.8	1.2
4/26	116	172.8	2.2	172.6	2.4	171.9	2.0	172.1	1.9
5/3	123	173.2	1.8	173.0	2.0	172.1	1.8	172.7	1.3
5/10	130	173.0	2.0	172.8	2.2	172.1	1.9	172.1	1.9
5/17	137	172.7	2.3	172.5	2.5	171.9	2.0	171.8	2.2
5/24	144	172.6	2.4	172.5	2.5	171.8	2.1	171.5	2.5
5/31	151	173.4	1.6	173.2	1.8	172.4	1.5	173.3	0.7
6/7	158	174.0	2.0	172.7	2.3	172.0	1.9	172.0	2.0
6/14	165	172.7	2.3	172.5	2.5	171.9	2.0	171.7	2.3
6/21	172	172.5	2.4	172.4	2.6	171.7	2.2	171.2	2.8
6/28	179	172.4	2.6	172.3	2.7	171.5	2.4	171.2	2.8
7/5	186	172.3	2.7	172.2	2.8	171.4	2.5	171.2	2.8
7/12	193	172.1	2.9	172.0	3.0	171.3	2.6	< 170.2	> 3.8
7/19	200	171.9	3.1	171.8	3.2	171.2	2.7	< 170.2	> 3.8
7/26	207	171.7	3.3	171.6	3.4	170.9	3.0	< 170.2	> 3.8
8/2	214	171.6	3.4	171.5	3.5	170.6	3.3	< 170.2	> 3.8
8/9	221	171.6	3.4	171.4	3.6	170.5	3.4	170.8	3.2
8/16	228	171.5	3.5	171.3	3.7	170.3	3.6	170.2	3.8
8/23	235	171.4	3.6	171.2	3.8	170.2	3.7	170.8	3.2
8/30	242	172.7	2.3	171.9	3.1	171.0	2.9	172.1	1.9
9/7	249	175.0	0	174.9	0.1	173.9	0	174.0	0
9/13	255	173.4	1.6	173.1	1.9	172.0	1.9	172.3	1.7
9/20	262	174.2	0.8	174.8	0.2	173.3	0.6	173.8	0.2
9/27	269	173.2	1.8	172.9	2.1	172.0	2.0	172.1	1.9
10/4	276	172.9	2.1	172.7	2.3	171.9	2.0	172.1	1.9
10/10	282	172.9	2.1	172.7	2.3	171.9	2.0	171.7	2.3
10/18	290	173.1	1.9	172.9	2.1	172.1	1.8	172.2	1.8
10/25	297	173.4	1.6	173.1	1.9	172.4	1.5	172.9	1.1
11/1	304	173.1	1.9	172.7	2.3	172.0	1.9	172.0	2.0
11/8	311	173.2	1.8	172.9	2.1	172.2	1.7	170.4	1.6
11/15	318	173.2	1.8	172.9	2.1	172.1	1.8	172.3	1.7
11/21	324	173.0	2.0	172.7	2.3	171.9	2.0	172.0	2.0
11/29	332	174.5	0.5	174.1	0.9	173.9	0	174.0	0

APPENDIX B
WATER TABLE ELEVATIONS - MINER INSTITUTE, 1979
FIELD 31-1

		WATER TABLE PIPES							
		78-9		78-10		78-11		78-12	
Calendar Date	Julian Date	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface
4/12	102	174.0	0	174.0	0	--	ice	173.7	0.9
4/19	109	173.1	0.9	173.0	1.0	172.8	1.6	172.9	1.7
4/26	116	172.4	1.6	172.4	1.6	172.4	2.0	172.5	2.1
5/3	123	173.0	1.0	172.9	1.1	172.7	1.7	172.9	1.7
5/10	130	172.4	1.6	172.4	1.6	172.5	1.9	172.6	2.0
5/17	137	171.8	2.2	172.1	1.9	172.8	1.6	172.0	2.6
5/24	144	171.7	2.3	172.6	1.4	172.2	2.2	172.0	2.6
5/31	151	171.5	2.5	173.5	0.5	172.9	1.5	173.4	1.2
6/7	158	171.2	2.8	172.2	1.8	172.4	2.0	172.4	2.2
6/14	165	171.7	2.3	172.9	1.1	172.2	2.2	172.4	2.2
6/21	172	171.3	2.7	172.5	1.5	172.1	2.3	171.6	3.0
6/28	179	171.0	3.0	171.1	2.9	171.9	2.5	171.2	3.4
7/5	186	170.7	3.3	170.9	3.1	171.7	2.7	171.3	3.3
7/12	193	170.7	3.3	< 170.2	> 3.8	171.7	2.7	171.3	3.3
7/19	200	170.6	3.4	< 170.2	> 3.8	171.6	2.8	171.3	3.3
7/26	207	170.6	3.4	< 170.2	> 3.8	171.6	2.8	171.2	3.4
8/2	214	170.6	3.4	< 170.2	> 3.8	171.5	2.9	171.2	3.4
8/9	221	170.6	3.4	< 170.2	> 3.8	171.5	2.9	170.7	3.9
8/16	228	170.6	3.4	< 170.2	> 3.8	171.4	3.0	170.7	3.9
8/23	235	170.6	3.4	< 170.2	> 3.8	171.4	3.0	171.2	3.4
8/30	242	172.1	1.9	173.0	1.0	172.4	2.0	172.0	2.6
9/7	249	174.0	0	174.0	0	173.6	0.8	174.1	0.5
9/13	255	172.6	1.4	172.5	1.5	172.3	2.1	173.3	1.3
9/20	262	174.0	0	173.0	1.0	173.0	1.4	173.5	1.1
9/27	269	172.2	1.8	172.2	1.8	172.2	2.2	172.3	2.3
10/4	276	171.7	2.3	171.4	2.6	172.2	2.2	172.2	2.4
10/10	282	171.8	2.2	171.8	2.2	172.0	2.4	171.8	2.8
10/18	290	172.4	1.6	172.4	1.6	172.4	2.0	172.5	2.1
10/25	297	173.1	0.9	173.1	0.9	171.7	2.7	172.0	1.6
11/1	304	172.1	1.9	172.2	1.8	172.3	2.1	172.3	2.3
11/8	311	172.6	1.4	172.6	1.4	172.4	2.0	172.6	2.0
11/15	318	172.5	1.5	172.5	1.5	172.4	2.0	172.5	2.1
11/21	324	172.1	1.9	172.2	1.8	172.3	2.1	172.3	2.3
11/29	332	174.0	0	174.0	0	173.3	1.1	173.8	0.8

APPENDIX B
WATER TABLE ELEVATIONS - MINER INSTITUTE, 1979
FIELD 31-1

		WATER TABLE PIPES					
		A		B		C	
Calendar Date	Julian Date	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface
4/12	102	171.2	2.5	--	ice	173.1	0.7
4/19	109	171.2	2.5	--	ice	171.4	2.4
4/26	116	171.4	2.3	171.3	2.3	171.2	2.6
5/3	123	171.6	2.1	171.5	2.1	171.4	2.4
5/10	130	171.1	2.6	171.0	2.6	171.2	2.6
5/17	137	171.1	2.6	170.9	2.7	171.2	2.6
5/24	144	171.1	2.6	170.9	2.7	171.1	2.7
5/31	151	171.1	2.4	170.9	2.7	171.2	2.6
6/7	158	171.0	2.7	170.9	2.7	171.2	2.6
6/14	165	171.0	2.7	170.8	2.8	171.1	2.7
6/21	172	171.0	2.7	170.8	2.8	171.0	2.8
6/28	179	171.0	2.7	170.5	3.1	170.8	3.0
7/5	186	170.9	2.8	170.4	3.2	170.6	3.2
7/12	193	170.9	2.8	170.4	3.2	170.3	3.5
7/19	200	170.7	3.0	170.4	3.2	< 169.7	> 4.1
7/26	207	< 170.3	> 3.4	170.4	3.2	< 169.7	> 4.1
8/2	214	< 170.3	> 3.4	170.4	3.2	< 169.7	> 4.1
8/9	221	< 170.3	> 3.4	170.4	3.2	< 169.7	> 4.1
8/16	228	< 170.3	> 3.4	170.4	3.2	< 169.7	> 4.1
8/23	235	170.9	2.8	170.4	3.2	170.2	3.6
8/30	242	171.1	2.6	170.6	2.8	171.0	2.8
9/7	249	171.2	2.5	171.0	2.6	170.6	3.2
9/13	255	171.1	2.6	170.9	2.7	171.7	2.1
9/20	262	171.1	2.6	171.0	2.6	171.4	2.4
9/27	269	171.1	2.6	170.9	2.7	171.2	2.6
10/4	276	171.1	2.6	170.8	2.8	171.2	2.6
10/10	282	171.1	2.6	170.9	2.7	171.2	2.6
10/18	290	171.1	2.6	171.0	2.6	171.2	2.6
10/25	297	171.1	2.6	171.0	2.6	171.4	2.4
11/1	304	171.2	2.5	171.0	2.6	171.2	2.6
11/8	311	171.2	2.5	170.9	2.7	171.3	2.5
11/15	318	171.0	2.7	170.9	2.7	171.3	2.5
11/21	324	171.0	2.7	170.9	2.7	171.2	2.6
11/29	332	171.2	2.5	171.1	2.5	171.5	2.3

APPENDIX B
WATER TABLE ELEVATIONS - MINER INSTITUTE, 1979
FIELD 3I-1

		WATER TABLE PIPES					
		D		E		F	
Calendar Date	Julian Date	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface
4/12	102	173.0	0.6	173.5	0	173.5	0
4/19	109	171.3	2.3	171.4	2.1	171.6	1.9
4/26	116	171.0	2.6	171.0	2.5	171.0	2.5
5/3	123	171.4	2.2	171.2	2.3	171.3	2.2
5/10	130	171.2	2.4	171.2	2.3	171.4	2.1
5/17	137	171.1	2.5	171.1	2.4	171.3	2.2
5/24	144	171.1	2.5	171.0	2.5	171.1	2.4
5/31	151	171.4	2.2	171.7	1.8	171.9	1.6
6/7	158	171.2	2.4	171.1	2.4	171.3	2.2
6/14	165	171.0	2.6	171.0	2.5	170.5	3.0
6/21	172	170.9	2.7	170.8	2.7	171.1	2.4
6/28	179	170.8	2.8	170.4	3.1	171.0	2.5
7/5	186	170.8	2.8	170.4	3.1	170.9	2.6
7/12	193	170.7	2.9	170.2	3.3	170.8	2.7
7/19	200	170.3	3.3	169.7	3.8	170.7	2.8
7/26	207	170.2	3.4	< 169.4	> 4.1	< 170.0	> 3.5
8/2	214	170.1	3.5	< 169.4	> 4.1	< 170.0	> 3.5
8/9	221	170.1	3.5	< 169.4	> 4.1	170.9	2.6
8/16	228	170.1	3.5	< 169.4	> 4.1	170.6	2.9
8/23	235	170.1	3.5	< 169.4	> 4.1	170.6	2.9
8/30	242	171.4	2.2	171.1	2.4	172.5	1.0
9/7	249	172.2	0.4	173.3	0.2	173.5	0
9/13	255	173.2	0.4	170.4	3.1	171.7	1.8
9/20	262	171.7	1.9	171.2	2.3	172.7	0.8
9/27	269	171.3	2.3	171.4	2.1	171.6	1.9
10/4	276	171.1	2.5	171.3	2.2	171.4	2.1
10/10	282	171.7	1.9	171.8	1.7	171.7	1.8
10/18	290	171.7	1.9	171.5	2.0	171.8	1.7
10/25	297	171.6	2.0	171.9	1.6	172.1	1.4
11/1	304	171.3	2.3	171.5	2.0	171.8	1.7
11/8	311	171.4	2.2	171.7	1.8	171.9	1.6
11/15	318	171.4	2.2	171.7	1.8	171.8	1.7
11/21	324	171.2	2.4	171.4	2.1	171.6	1.9
11/29	332	171.8	1.8	171.4	1.1	172.9	0.6

APPENDIX C
WATER TABLE ELEVATIONS - MINER INSTITUTE, 1979
LAKE ALICE

		WATER TABLE PIPES					
		LAWT-1		LAWT-2		LAWT-3	
Calendar Date	Julian Date	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface
4/12	102	361.8	0	361.7	0.1	361.9	0.1
4/19	109	361.5	0.3	361.7	0.1	361.5	0.5
4/26	116	361.6	0.2	361.6	0.2	361.6	0.4
5/3	123	361.4	0.4	361.5	0.3	361.4	0.6
5/10	130	360.5	1.3	360.6	1.2	360.8	1.2
5/17	137	359.9	1.9	360.5	1.3	360.6	1.4
5/24	144	< 359.0	> 2.8	359.6	2.2	360.0	2.0
5/31	151	361.5	0.3	361.6	0.2	361.5	0.5
6/7	158	359.7	2.1	360.0	1.8	360.2	1.8
6/14	165	< 359.0	> 2.8	359.8	2.0	360.0	2.0
6/21	172	< 359.0	> 2.8	359.7	2.1	360.0	2.0
6/28	179	< 359.0	> 2.8	359.6	2.2	< 259.3	> 2.7
7/5	186	< 359.0	> 2.8	< 359.0	> 2.8	< 259.3	> 2.7
7/12	193	< 359.0	> 2.8	< 359.0	> 2.8	< 259.3	> 2.7
7/19	200	< 359.0	> 2.8	< 359.0	> 2.8	< 259.3	> 2.7
7/26	207	< 359.0	> 2.8	< 359.0	> 2.8	< 259.3	> 2.7
8/2	214	< 359.0	> 2.8	< 359.0	> 2.8	< 259.3	> 2.7
8/9	221	< 359.0	2.8	< 359.0	> 2.8	< 259.3	> 2.7
8/16	228	< 359.0	2.8	< 359.0	> 2.8	< 259.3	> 2.7
8/23	235	< 359.0	2.8	< 359.0	> 2.8	< 259.3	> 2.7
8/30	242	< 359.0	2.8	< 359.0	> 2.8	< 259.3	> 2.7
9/7	249	361.8	0.0	361.8	0	361.8	0.2
9/13	255	360.3	1.5	360.6	1.2	360.9	1.1
9/20	262	361.8	0.0	361.8	0	361.7	0.3
9/27	269	360.6	1.2	360.8	1.0	361.0	1.0
10/4	276	360.4	1.4	360.5	1.3	360.7	1.3
10/10	282	361.7	0.1	361.8	0	361.9	0.1
10/18	290	361.4	0.4	361.8	0	361.6	0.4
10/25	297	361.8	0	361.8	0	361.9	0.1
11/1	304	361.5	0.3	361.5	0.3	361.6	0.4
11/8	311	361.8	0	361.8	0	361.8	0.2
11/15	318	—	—	361.8	0	361.7	0.3
11/21	324	361.5	0.3	361.5	0.3	361.6	0.4
11/29	332	361.8	0	361.8	0	361.9	0.1

APPENDIX C
WATER TABLE ELEVATIONS - MINER INSTITUTE, 1979
LAKE ALICE

		WATER TABLE PIPES					
		LAWT-4		LAWT-5		LAWT-6	
Calendar Date	Julian Date	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface
4/12	102	361.7	0.1	--	ice	--	ice
4/19	109	360.9	0.9	--	ice	361.1	0
4/26	116	361.8	0	362.2	0	361.1	0
5/3	123	361.8	0.0	362.0	0.2	361.1	0
5/10	130	361.1	0.7	361.4	0.8	360.9	0.2
5/17	137	361.0	0.8	361.4	0.8	360.7	0.4
5/24	144	360.2	1.6	360.8	1.4	359.6	0.5
5/31	151	361.8	0	362.2	0	361.1	0
6/7	158	360.5	1.3	361.0	1.2	360.2	0.9
6/14	165	360.4	1.4	360.8	1.4	360.2	0.9
6/21	172	359.9	1.9	360.4	1.8	< 358.7	> 2.4
6/28	179	359.8	2.0	360.2	2.0	359.2	1.9
7/5	186	< 359.3	> 2.5	360.3	1.9	< 358.7	> 2.4
7/12	193	< 359.3	> 2.5	360.3	1.9	< 358.7	> 2.4
7/19	200	< 359.3	> 2.5	< 359.7	> 2.5	< 358.7	> 2.4
7/26	207	< 359.3	> 2.5	< 359.7	> 2.5	< 358.7	> 2.4
8/2	214	< 359.3	> 2.5	< 359.7	> 2.5	< 358.7	> 2.4
8/9	221	< 359.3	> 2.5	< 359.7	> 2.5	< 358.7	> 2.4
8/16	228	< 359.3	> 2.5	< 359.7	> 2.5	< 358.7	> 2.4
8/23	235	< 359.3	> 2.5	360.2	2.0	< 358.7	> 2.4
8/30	242	359.8	2.0	360.2	2.0	< 358.7	> 2.4
9/7	249	361.8	0	362.2	0	361.1	0
9/13	255	361.0	0.8	361.5	0.7	360.8	0.3
9/20	262	361.8	0	362.2	0	361.1	0
9/27	269	361.3	0.5	361.8	0.4	360.9	0.2
10/4	276	361.1	0.7	361.7	0.5	360.5	0.6
10/10	282	361.8	0	362.2	0	361.1	0
10/18	290	361.8	0	362.2	0	361.1	0
10/25	297	361.8	0	362.2	0	361.1	0
11/1	304	361.8	0	362.2	0	361.1	0
11/8	311	361.8	0	362.2	0	361.1	0
11/15	318	361.8	0	362.2	0	361.1	0
11/21	324	361.8	0	362.2	0	361.1	0
11/29	332	361.8	0	362.2	0	361.1	0

APPENDIX D
WATER TABLE ELEVATIONS - MINER INSTITUTE, 1979
FIELD 31-2

		WATER TABLE PIPES					
		1		2		3	
Calendar Date	Julian Date	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface
4/12	102	182.4	0	181.5	0.8	170.3	1.7
4/19	109	< 181.2	1.2	180.5	> 1.8	170.3	1.7
4/26	116	< 180.6	> 1.8	< 179.9	> 2.4	170.3	1.7
5/3	123	< 180.6	> 1.8	< 179.9	> 2.4	170.2	1.8
5/10	130	< 180.6	> 1.8	< 179.9	> 2.4	169.9	2.1
5/17	137	< 180.6	> 1.8	< 179.9	> 2.4	169.9	2.1
5/24	144	< 180.6	> 1.8	< 179.9	> 2.4	169.8	2.2
5/31	151	< 180.6	> 1.8	< 179.9	> 2.4	170.4	1.6
6/7	158	< 180.6	> 1.8	< 179.9	> 2.4	169.9	2.1
6/14	165	< 180.6	> 1.8	< 179.9	> 2.4	169.8	2.2
6/21	172	< 180.6	> 1.8	< 179.9	> 2.4	169.8	2.2
6/28	179	< 180.6	> 1.8	< 179.9	> 2.4	169.9	2.1
7/5	186	< 180.6	> 1.8	< 179.9	> 2.4	< 169.3	> 2.7
7/12	193	< 180.6	> 1.8	< 179.9	> 2.4	< 169.3	> 2.7
7/19	200	< 180.6	> 1.8	< 179.9	> 2.4	< 169.3	> 2.7
7/26	207	< 180.6	> 1.8	< 179.9	> 2.4	< 169.3	> 2.7
8/2	214	< 180.6	> 1.8	< 179.9	> 2.4	< 169.3	> 2.7
8/9	221	< 180.6	> 1.8	< 179.9	> 2.4	< 169.3	> 2.7
8/16	228	< 180.6	> 1.8	< 179.9	> 2.4	< 169.3	> 2.7
8/23	235	< 180.6	> 1.8	< 179.9	> 2.4	< 169.3	> 2.7
8/30	242	< 180.6	> 1.8	< 179.9	> 2.4	170.0	2.0
9/7	249	< 180.6	> 1.8	< 179.9	> 2.4	170.6	1.4
9/13	255	< 180.6	> 1.8	< 179.9	> 2.4	172.0	0
9/20	262	< 180.6	> 1.8	< 179.9	> 2.4	170.4	1.6
9/27	269	< 180.6	> 1.8	< 179.9	> 2.4	170.7	1.3
10/4	276	< 180.6	> 1.8	< 179.9	> 2.4	170.6	1.4
10/10	282	< 180.6	> 1.8	< 179.9	> 2.4	170.9	1.1
10/18	290	< 180.6	> 1.8	< 179.9	> 2.4	170.7	1.3
10/25	297	< 180.6	> 1.8	< 179.9	> 2.4	170.8	1.2
11/1	304	< 180.6	> 1.8	< 179.9	> 2.4	170.7	1.3
11/8	311	< 180.6	> 1.8	< 179.9	> 2.4	170.9	1.1
11/15	318	< 180.6	> 1.8	< 179.9	> 2.4	170.8	1.2
11/21	324	< 180.6	> 1.8	< 179.9	> 2.4	170.8	1.2
11/29	332	< 180.6	1.8	180.6	1.7	171.0	1.0

APPENDIX E
WATER TABLE ELEVATIONS - MINER INSTITUTE, 1979
FIELD 31-4

		WATER TABLE PIPES					
		30W		0		30E	
Calendar Date	Julian Date	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface	Water Table Elevation (feet)	Feet Below Ground Surface
4/12	102	182.8	0.3	183.5	0	182.4	0.9
4/19	109	182.4	0.7	182.9	0.6	182.7	0.6
4/26	116	182.0	1.1	182.5	1.0	181.6	0.7
5/3	123	182.0	1.1	182.6	0.9	181.6	0.7
5/10	130	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
5/17	137	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
5/24	144	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
5/31	151	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
6/7	158	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
6/14	165	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
6/21	172	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
6/28	179	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
7/5	186	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
7/12	193	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
7/19	200	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
7/26	207	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
8/2	214	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
8/9	221	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
8/16	228	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
8/23	235	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
8/30	242	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
9/7	249	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
9/13	255	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
9/20	262	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
9/27	269	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
10/4	276	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
10/10	282	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
10/18	290	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
10/25	297	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
11/1	304	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
11/8	311	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
11/15	318	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
11/21	324	< 181.4	> 1.7	< 181.6	> 1.9	< 181.0	> 2.3
11/29	332	182.0	1.1	182.6	0.9	181.8	1.5

APPENDIX F
TILE DISCHARGE - MINER INSTITUTE, 1979
FIELD 3I-1

Calendar Date	Julian Date	# 3 (gpm)	# 6 (gpm)	# 9 (gpm)	# 12 (gpm)
4/12	102	OS	5.7	1.5	2.6
4/19	109	OS	1.3	0.3	1.7
4/26	116	OS	0.7	0.2	0.3
5/3	123	OS	1.4	0.4	0.8
5/10	130	0.3	0.6	0.3	0.4
5/17	137	0.1	0.3	0.1	0.2
5/24	144	0.1	0.3	0.1	0.1
5/31	151	OS	1.5	0.7	1.2
6/7	158	0.3	0.4	0.1	0.3
6/14	165	0.1	0.2	0.1	0.1
6/21	172	NF	0.1	NF	0.1
6/28	179	NF	NF	NF	NF
7/5	186	NF	NF	NF	NF
7/12	193	NF	NF	NF	NF
7/19	200	NF	NF	NF	NF
7/26	207	NF	NF	NF	NF
8/2	214	NF	NF	NF	NF
8/9	221	NF	NF	NF	NF
8/16	228	NF	NF	NF	NF
8/23	235	NF	NF	NF	NF
8/30	242	*	*	*	*
8/7	249	*	*	*	*
9/13	255	0.3	0.1	0.2	0.2
9/20	262	OS	0.3	1.2	2.1
9/27	269	0.3	0.7	0.2	0.5
10/4	276	0.2	0.1	0.4	0.2
10/10	282	0.3	0.4	0.1	0.3
10/18	290	1.0	0.6	0.2	0.2
10/25	297	OS	1.1	0.4	0.9
11/1	304	0.3	0.6	0.2	0.4
11/8	311	OS	1.0	0.4	0.7
11/15	318	OS	0.8	0.3	0.6
11/21	324	OS	0.5	0.2	0.4
11/29	332	OS	OS	1.9	3.2

Note: OS: outlet submerged
NF: no measurable flow
*: data not available