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Maumee River Pilot Watershed Study

Continued Watershed Monitoring (1978-80)

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THE MAUMEE RIVER BASIN PILOT WATERSHED STUDY

Volume III
Continued Watershed Monitoring (1978-80)

by

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DISCLAIMER

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ABSTRACT

Monitoring, which was started in 1975 as part of the PLUARG Task C Pilot Watershed Study in the Maumee River Basin of Ohio, was continued in 1978-1980 on three small watersheds in Defiance County and eight plots in Wood County. Runoff and tile drainage were monitored for flow, suspended solids, total P, filtered reactive P(FRP), NH_3-N and NO_3-N.

Runoff and soil loss (4388 kg/ha) continued to be greatest on the poorly drained Paulding soil compared to other sites with spring-seeded crops, but winter wheat on the Paulding site greatly reduced runoff in 1979 and there was no runoff with wheat in 1980. Wheat in 1980 on the other two Defiance watersheds did not affect runoff. No till soybeans on the Blount soil in 1978 reduced erosion to near zero (66 kg/ha) compared to previous years with fall-plowed soybeans where sediment yields ranged from 900 to 2500 kg/ha. Runoff volume with no till, however, was not measurably different than with fall plowing and filtered reactive P loads with no till were no different than fall-plowed FRP loads.

Tile drainage had no effect on runoff volume from Hoytville soil, and no till contineud to have no effect on soil loss compared to fall plowing on this soil where soil losses have been low (< 750 kg/ha) throughout the study. Phosphate fertilizer broadcast in the fall on the no till and fall-plowed Hoytville plots every year from 1975-1979 steadily increased total and FRP concentrations and loads in this period. FRP loads decreased rapidly in 1980 after fall fertilization was terminated.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

1. INTRODUCTION

The Maumee River was chosen by PLUARG to be one of four pilot watersheds to be studied on the U. S. side of the Great Lakes drainage basin as part of Task C - pilot watershed studies. Since there was already an ongoing PL-92-500 Sec. 108 demonstration project in Black Creek basin, an Indiana tributary to the Maumee, the Task C project was directed to the Ohio portion of the Maumee to supplement the work being done in Black Creek.

The objectives of PLUARG were to determine the effects of prevailing land use practices on pollution entering the Great Lakes. Specifically, the PLUARG Task C objectives were to answer the following questions:

1. From what sources and from what causes (under what conditions, management practices) are pollutants contributed to surface and ground water?
2. What is the extent of pollutant contributions and what are the unit area loadings by season from a given land use or practice to surface or ground water?
3. To what degree are pollutants transmitted from sources to boundary waters?
4. Are remedial measures required? What are they and how effective might they be?
5. Were deficiencies in technology identified? If so, what is recommended?

The Maumee River Basin is primarily agricultural in land use, and the intensive crop production in the Basin accounts for most of the sediment and a major part of the nitrogen and phosphorus delivered to Lake Erie (Corps of Engineers, 1975; Sonzogni et al, 1978). Because of the importance of agriculture as a source of pollutants in the Maumee Basin, it was decided to place emphasis in the Task C project on soil and nutrient loss from small agricultural watersheds and on specialized studies on sediment transport.

Specific objectives of this study were:

1. To determine the effects of land use practices on the loss of sediment and associated chemicals from representative small agricultural watersheds in the Basin and to compare these data with downstream reference samples.
2. To study and determine the physical, chemical, and mineralogical properties of major soils in the Basin and relate these data to their susceptibility to erosion and fluvial transport.
3. To determine the physical, chemical, and mineralogical properties of suspended sediments and bottom sediments in order to identify fluvial transport mechanisms and to evaluate equilibrium stabilities of minerals in suspended and bottom sediments.
4. To determine phosphate sorption-desorption and precipitation interactions with sediment characteristics and concentration levels.
5. To determine heavy metals leaving small agricultural watersheds as contrasted to downstream reference sources.

The results of this study (1975-1977) have been published previously (Logan and Stiefel, 1979; Logan, 1979) and the reader should consult them for more complete details of the study results. This report presents the results of the continued monitoring of three of the Defiance County watersheds and the Hoytville plots for the period 1978-1980.

1.1 Study Approach

The basic approach of this study was to measure the generation of sediment and nutrients from intensively cultivated cropland under prevailing management practices. The study investigated the differences in pollutant generation on several of the major soils of the Maumee Basin and determined the effects of season and soil characteristics on sediment and nutrient generation. Pollutant transport by tile drainage was also studied because of the extensive use of underground tile for drainage in the Basin.

1.2 Study Methods

Five sites were chosen in Defiance County on four major soils of the Basin (Figure 1 and Table 1) ranging from 0.6 to 3.2 hectares in the area. Surface runoff was monitored at all sites and tile drainage on the Paulding and Blount sites. A continuous-flow monitoring system and integrated sampler were used so that all events were monitored and sampled. The sampling period was from January, 1978 - May 1980. Rainfall was monitored at each site. At the OARDC branch research station in Wood County, eight plots (0.04 ha) on Hoytville soil were subjected to a number of different tillage treatments, and runoff and tile drainage were monitored.

1.21 Monitoring Sites in Defiance County

Five small agronomic sites were chosen in Defiance County to monitor soil and nutrient loss under prevailing crop management practices. The sites represent four of the more important series in the Basin: Paulding, Blount, Roselms and Lenawee (similar to Latty). The sites were selected with the following criteria:

1. Topography was typical for that series
2. The watershed was dominated by a single series

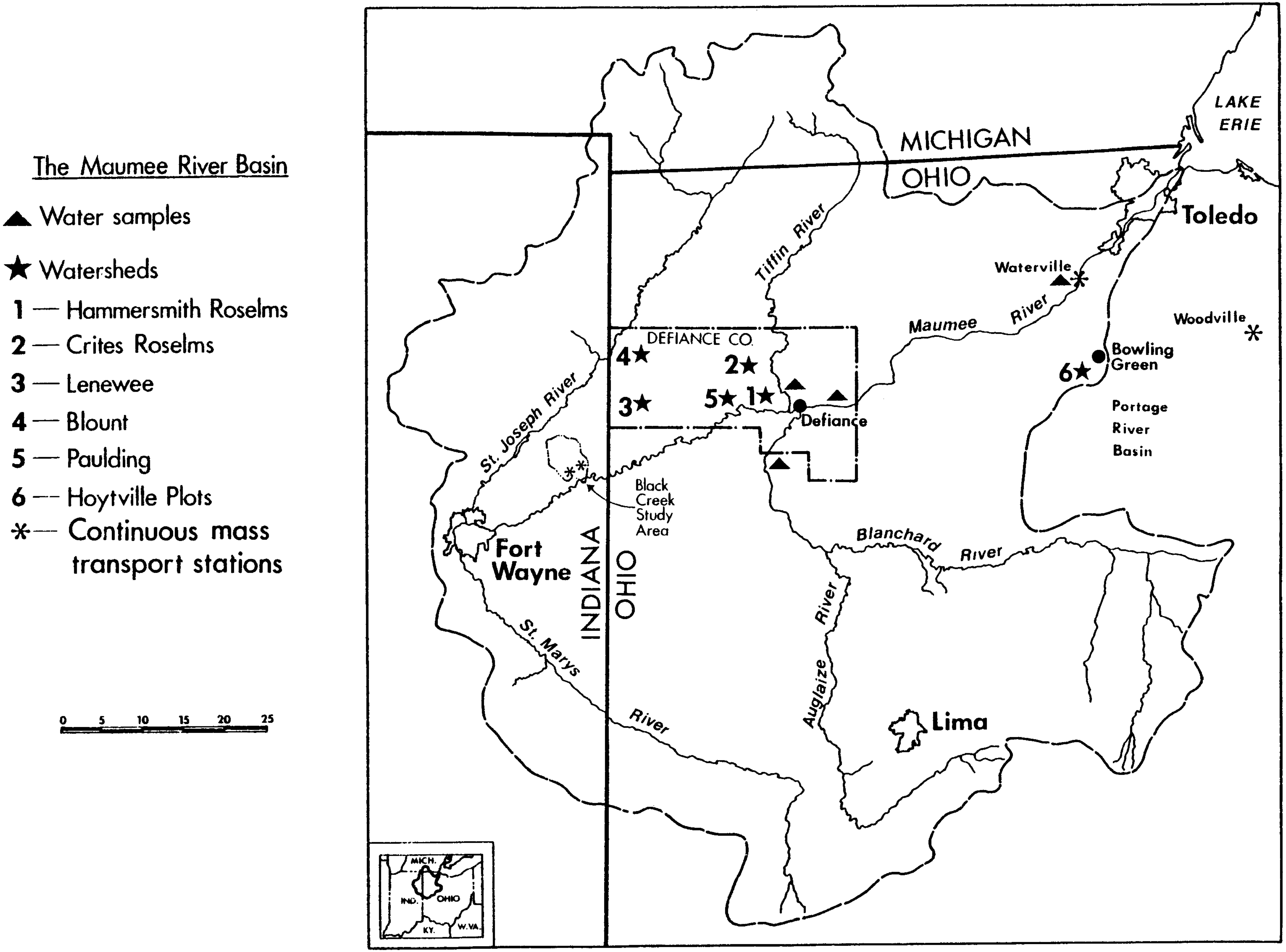


Figure 1. Watershed and plot locations in the Maumee River Basin.

Table 1. Characteristics of the Defiance County watersheds (111, 401, 501) and Hoytville plots monitored in the period 1978-1980.

Site Code	Dominant Soil Series	Soil Taxonomy	Physiographic Region	Parent Material	Slope (%)	Drainage Area (ha)	Drainage Systems Monitored
111	Roselms	Aeric Ochraqualf	Lake Plain	Lacustrine Clays	3-16	3.2	Surface Runoff
501	Paulding	Typic Haplaquept	Lake Plain	Lacustrine Clays	1	1.0	Surface Runoff
502	Paulding	Typic Haplaquept	Lake Plain	Lacustrine Clays		0.1	Subsurface Tile
611-681	Hoytville	Mollic Ochraqualf	Lake Plain	Clay Till	< 1	0.04	Surface Runoff
612-682	Hoytville	Mollic Ochraqualf	Lake Plain	Clay Till		0.04	Subsurface Tile
401	Blount	Aeric Ochraqualf	Till Plain	Clay Loam Till	3-4	0.9	Surface Runoff
402	Blount	Aeric Ochraqualf	Till Plain	Clay Loam Till		0.9	Subsurface Tile

3. The watershed could be defined hydrologically
4. There were no septic tank or livestock waste discharges within the watershed
5. Cooperation from the landowner was available
6. Site was accessible from the road, had adequate flow outlet, and electrical service could be brought to the site.

Using these criteria, a large number of sites were examined and five were selected. These were described in detail by Logan and Stiefel (1979) in their report on the 1975-77 monitoring period. In the 1978-80 period reported here, only the Hammersmith Roselms (111), Heisler Blount (401, 402) and Speiser Paulding (501, 502) watersheds and the Hoytville plots (60X) were monitored. A detailed description of the properties of the watershed soils has been previously given by Logan (1979).

Table 1 summarizes the site characteristics and Figure 1 identifies their location. A more detailed description of each site is given next. A 3-digit code was used to identify the sites and for identification of samples from each site:

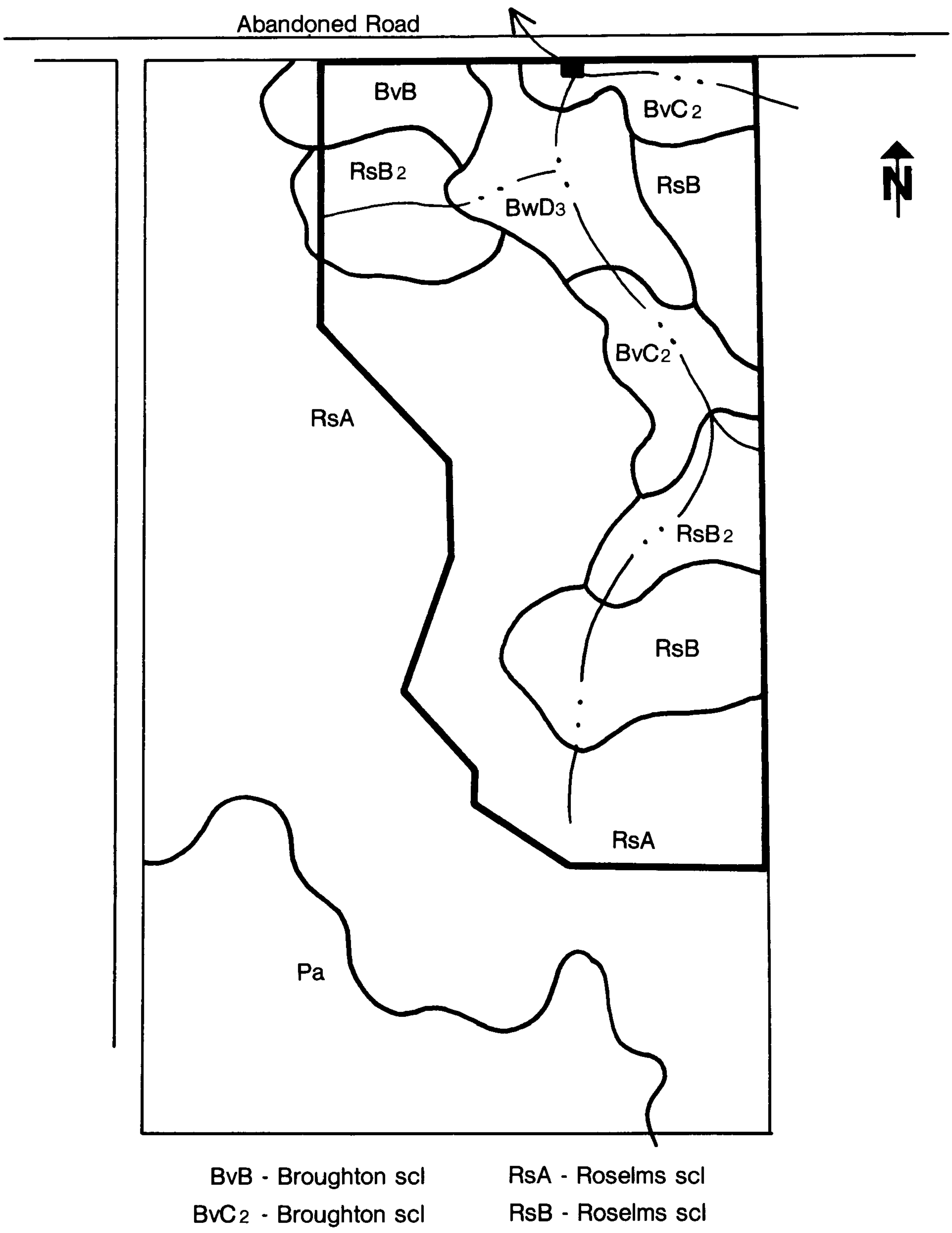
First digit: 1-6 identifies the primary site

Second digit: 0-8 identifies the sub-site within the primary site

Third digit: 1 refers to surface runoff and 2 to tile drainage, which were monitored separately.

Hammersmith Roselms (111): This site is located in the central area of Defiance County and in the lake plain. The soil and plot map is given in Figure 2, and the area is shown in Figure 3. The drainage area is 3.2 ha (8.0 acres) and is composed of Roselms on most of the area with Broughton on the steep slopes. The watershed has a well-defined drainageway (Figure 3),

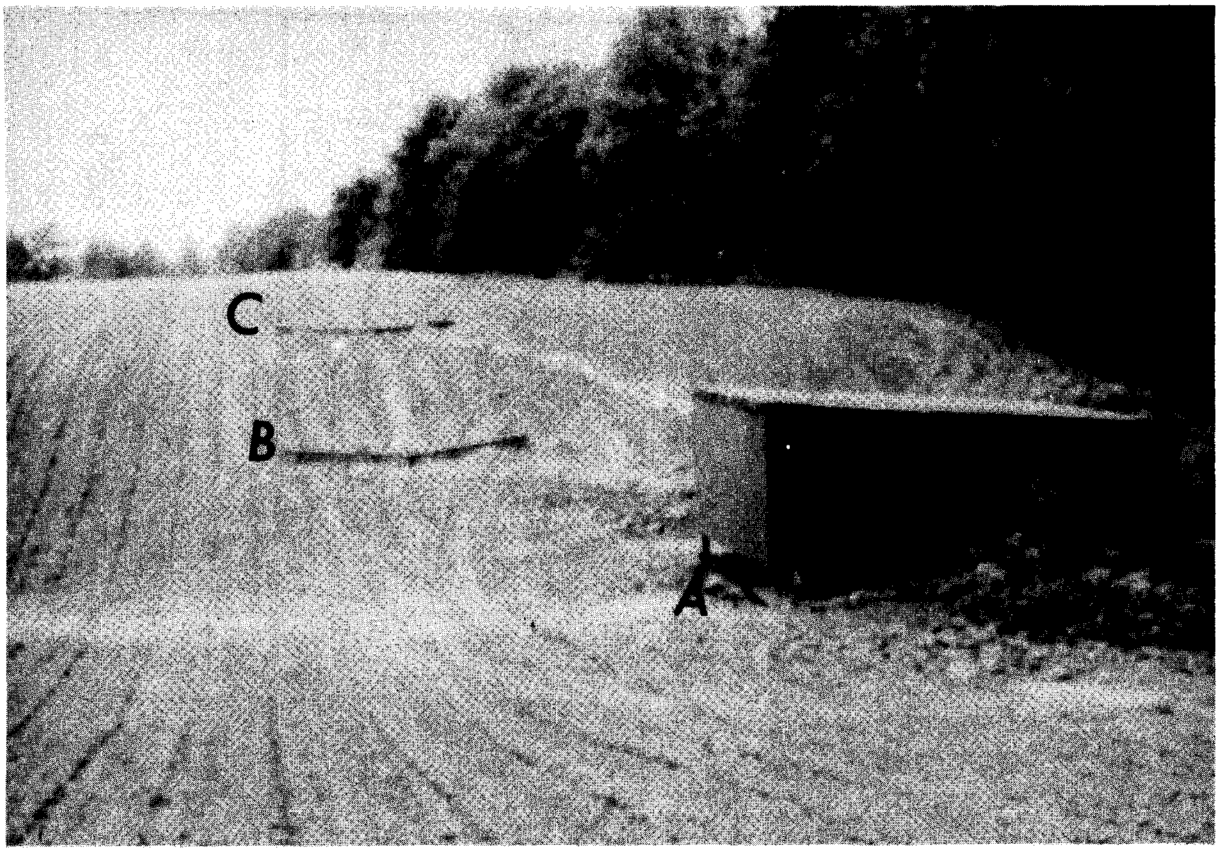
Hammersmith Roselms (10X)
Location: Noble township, T4N, R48, Sec. 6, NW¼



BvB - Broughton scl
BvC2 - Broughton scl
BwD3 - Broughton Clay
Pa - Paulding Clay
RsA - Roselms scl
RsB - Roselms scl
RsB2 - Roselms scl

1 inch = 165 feet

Figure 2. Layout of Hammersmith Roselms watershed. (Heavy line denotes the monitored area).



A: Sampling shelter. Front end is open to allow runoff to enter the sediment drop box.

B, C: Component plots on different slope positions, showing the V-shaped flumes.

Figure 3. Hammersmith Roselms watershed showing the sampling shelter.

and the monitoring system is placed at the point where the drainageway exits the watershed. Slopes vary from 1-3% on the more level part of the watershed to as high as 15% where the landscape breaks into the drainageway.

Heisler Blount (401, 402): This site is located in the northwest corner of Defiance County and is in the till plain region of the Maumee River Basin. The soil and plot map is given in Figure 4 and the watershed is illustrated in Figure 5. The area is bermed on the upslope perimeter and on the lower side to channel the flow toward the flume. The upper part of the site is Blount loam while the lower end is Mermill loam, which represents the unconsolidated soil eroded from the top of the slope and deposited downslope. The surface drainage area (401) is 0.8 ha (2.1 acres). A previously installed tile system was also monitored (402), and the drainage area has been estimated to be between 2 and 4 acres. The tile drainage pattern shown in the plot diagram (dotted lines) (Figure 4) is only speculative.

Speiser Paulding (501, 502): This site is located in the southcentral area of Defiance County in the lake plain region. The soil and plot map is given in Figure 6 and the area is illustrated in Figure 7. The major part of the plot is occupied by Paulding-Roselms clay, a series which has all the characteristics of a typical Paulding clay but whose clay content is minimal for Paulding. About a third of the plot is Paulding clay itself. The surface-drained area (501) is 0.9 ha (2.5 acres) and was defined by throwing up a berm. This soil is normally surface-drained by using shallow field ditches, and in this instance, the ditches were used to carry surface runoff to the sampler. Three tile drains were installed 12.7 m apart and 1 m deep.

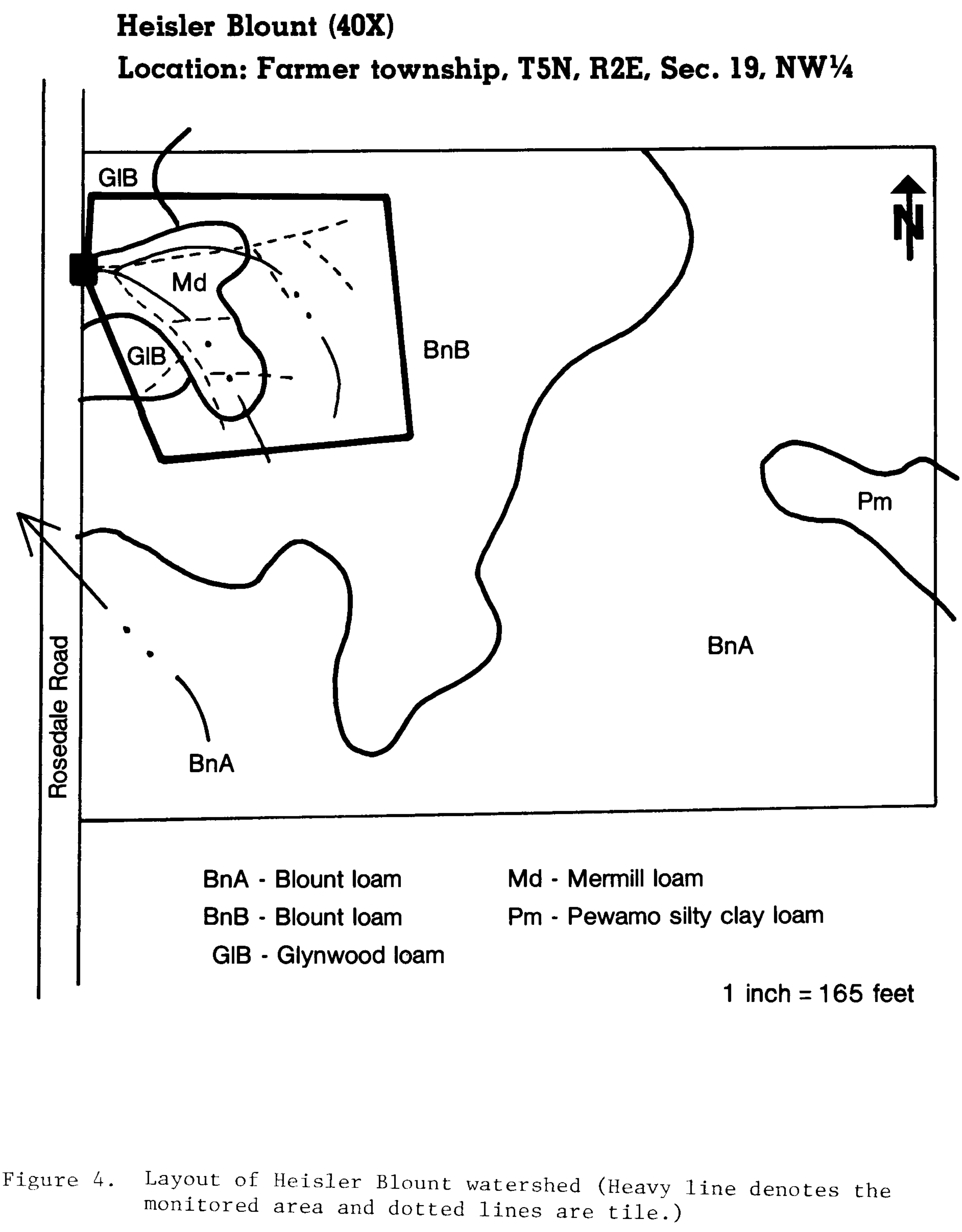


Figure 4. Layout of Heisler Blount watershed (Heavy line denotes the monitored area and dotted lines are tile.)

Figure 5. Heisler Blount watershed looking downslope.

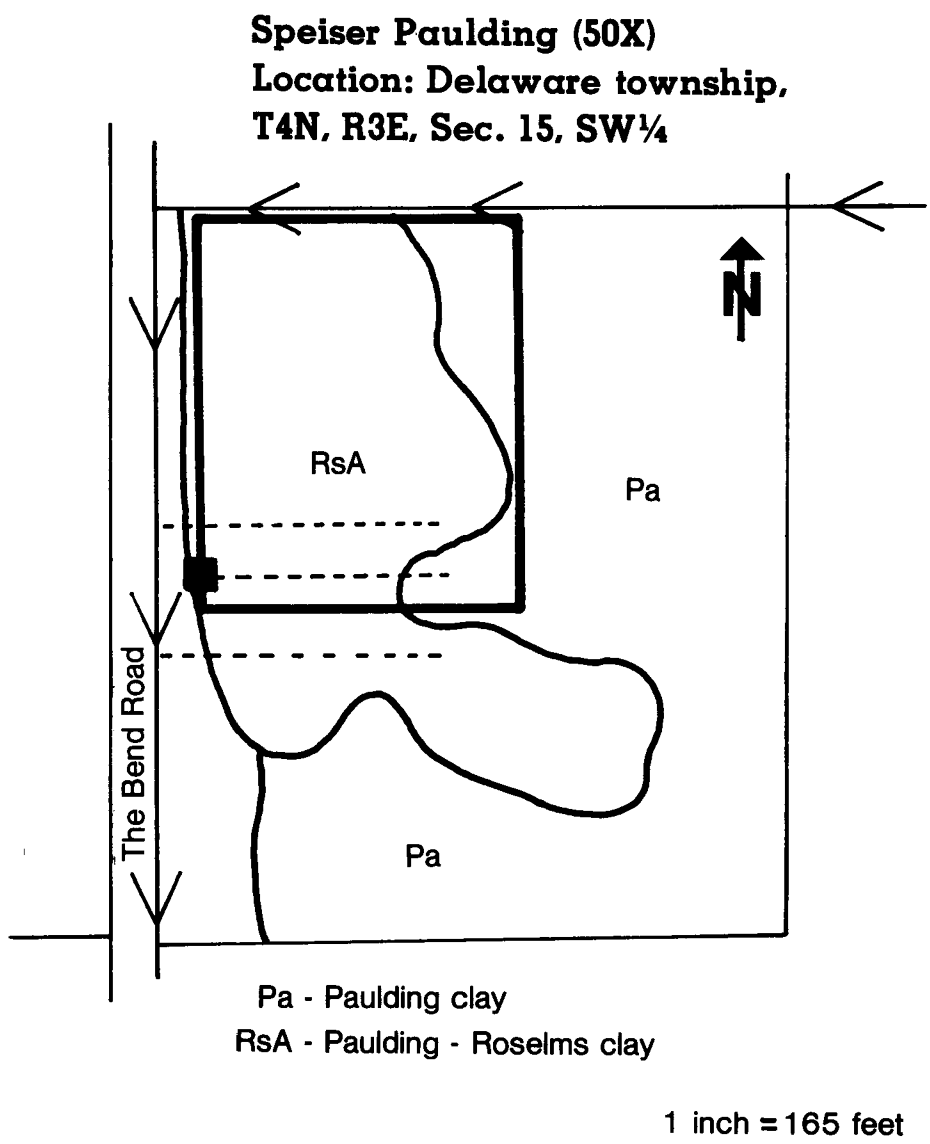


Figure 6. Layout of Speiser Paulding watershed (heavy line denotes monitored area and dotted lines are tile.)

Figure 7. Speiser Paulding watershed showing the sampling shelter.

The central tile, 55.7 m (220 feet), was monitored with a drainage area of 0.09 ha (0.23 acres).

1.22 Surface Runoff and Tile Drainage Measurement - Defiance County Sites

Surface Runoff: It was decided early in the development of this research that sophisticated instrumentation of the sites in Defiance County was not feasible or warranted. A number of physical restraints guided the selection of monitoring devices: both small and large events must be monitored; equipment would have to be automatic because events on small areas are very rapid and the sites had to be serviced by a single technician; it was important to be able to operate in the winter because much of the runoff occurs in the initial storms after thawing in the early spring; there was a general lack of hydraulic head at all sites. The system that was developed had the following basic principle: the runoff was channeled over a drop structure and a known fraction of the flow was intercepted. The intercepted flow was then passed over a Coshocton wheel, which intercepted another fraction. This water then discharged into a sump. A sump pump of known discharge rate (gallons per minute) was activated when water in the sump reached a given level. The pump was connected to a timer, which recorded time of pumping. The water was pumped up into a container from which a sample could be taken. By knowing the fraction of total runoff intercepted and the pump rate and time of pumping, total runoff in a given interval was calculated. The sample taken from the pump discharge represented runoff for that interval. Samples were taken after each event.

A diagram of the equipment used is given in Figures 8, 9 and 10. Figure 8 shows a standard SCS concrete drop-box, which is used to carry runoff from surface drains to the stream or drainage ditch without causing

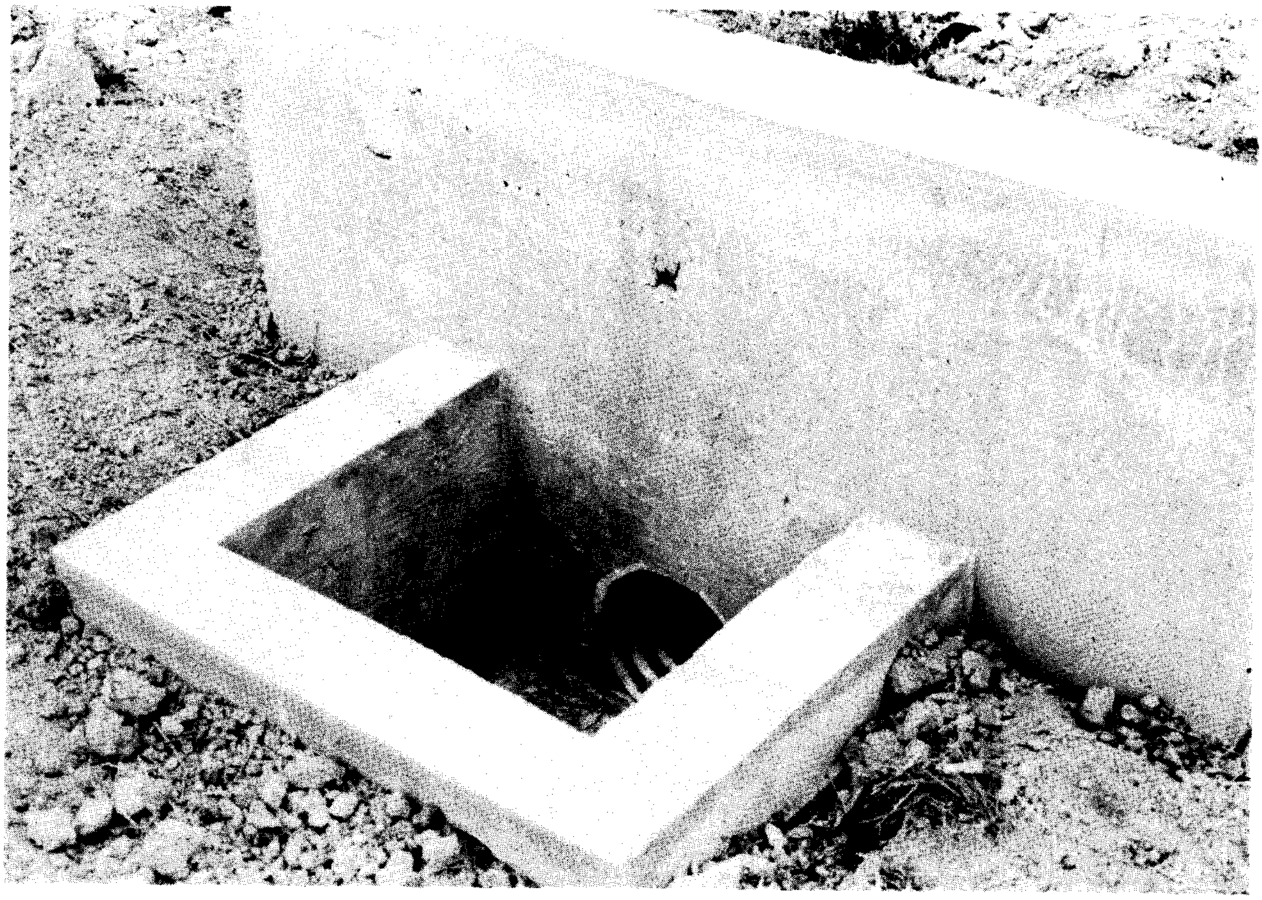
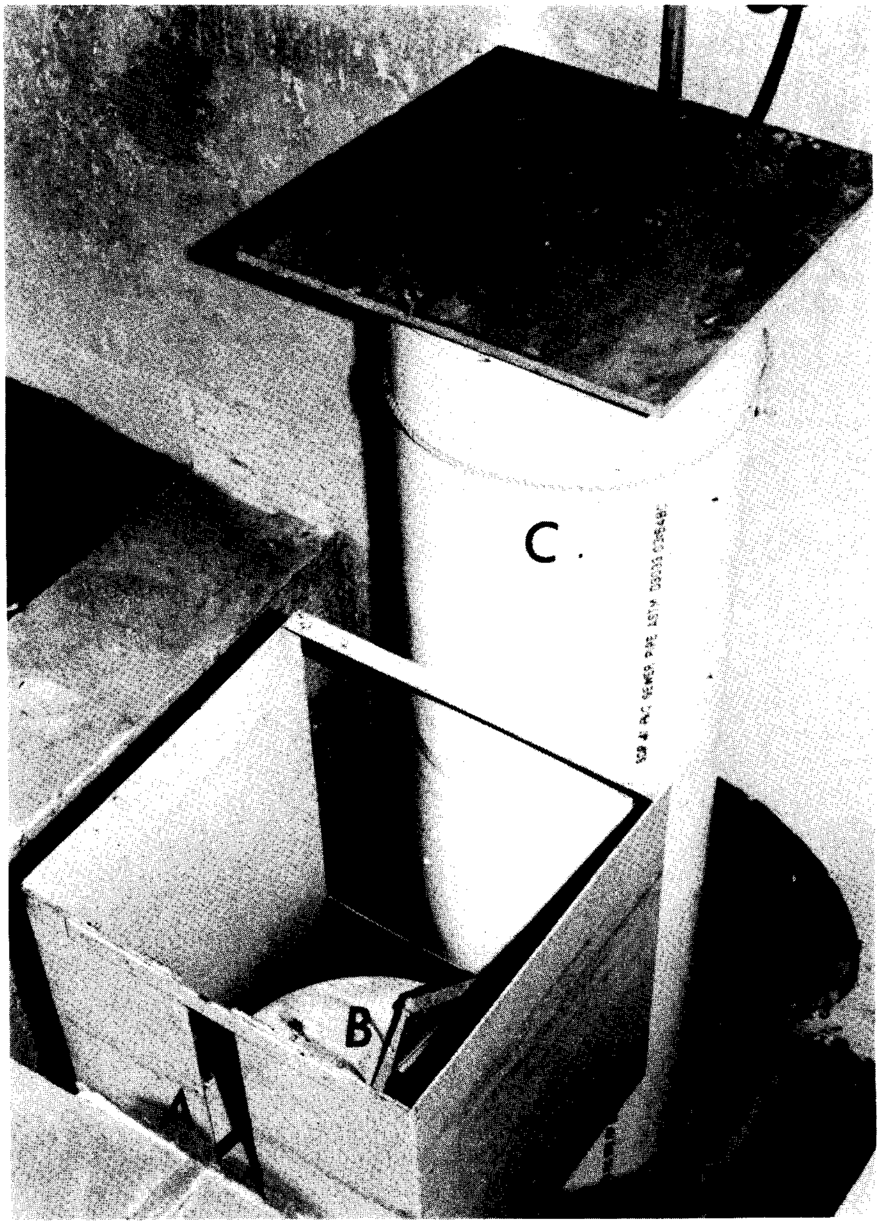


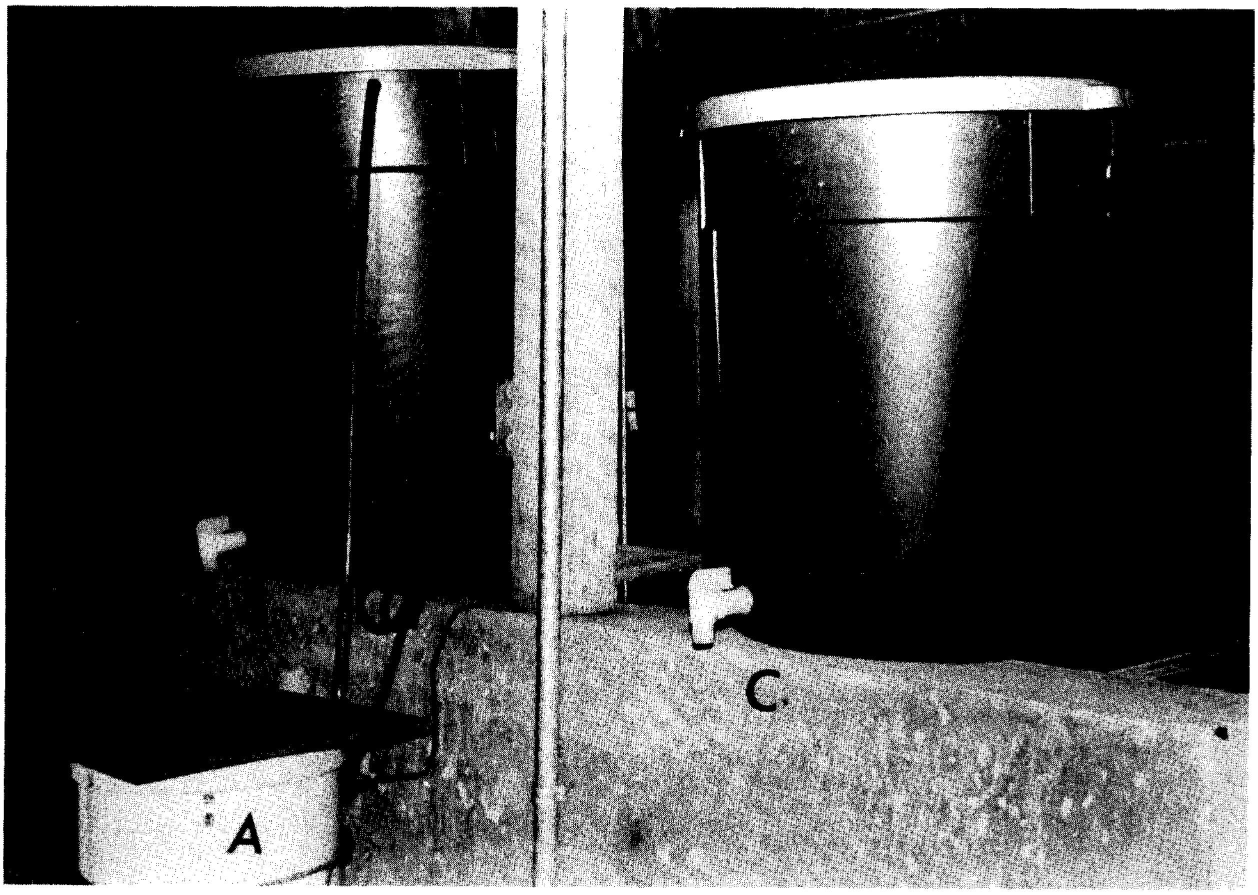
Figure 8. Sediment drop box used to collect runoff from Defiance County watersheds.



A: Variable slit flume which diverts fraction of runoff into Coshocton wheel (B).

C: Sump collects discharge from Coshocton wheel; discharge is then pumped into sample container (Figure 13).

Figure 9. System for monitoring and sampling surface runoff at Defiance County watersheds.



A: Sump for collecting runoff. Contains sump pump which discharges into sample container (B).

C: Sample container for tile drainage.

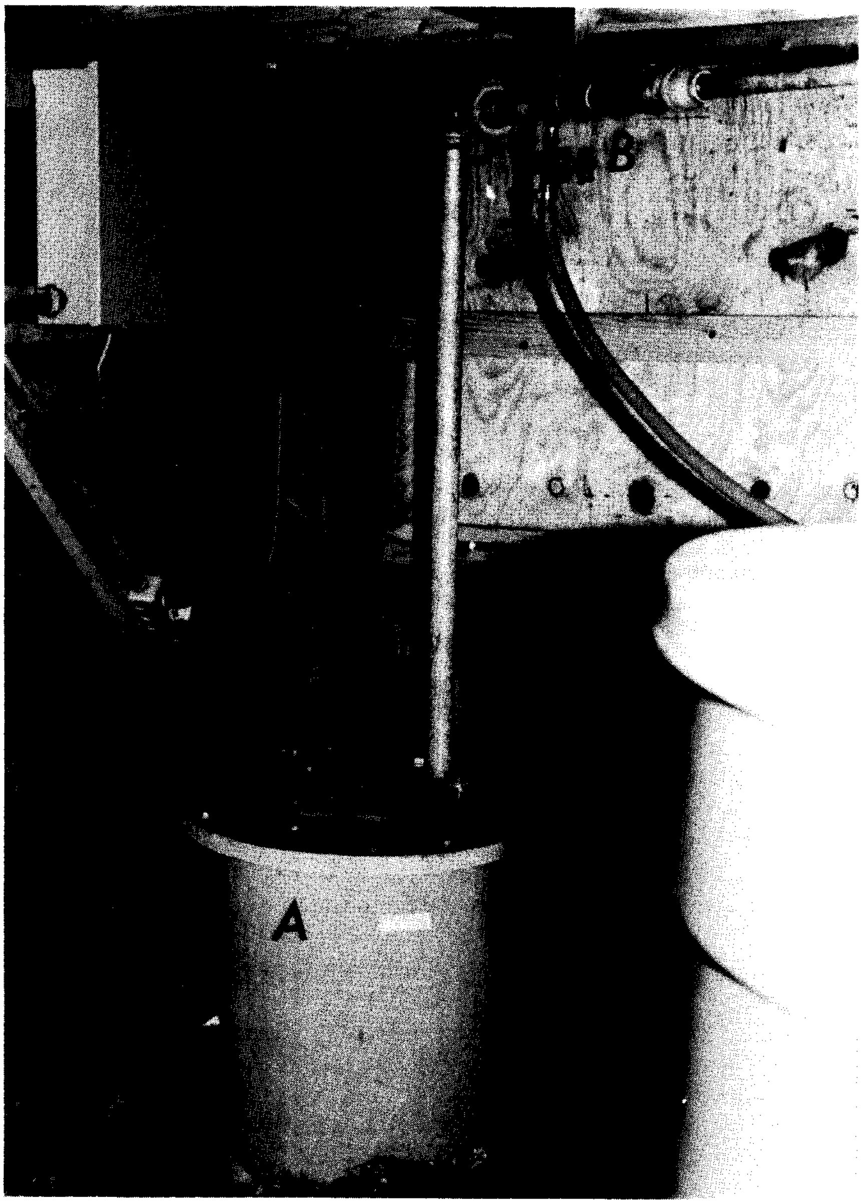
Figure 10. Sample containers for runoff and tile drainage at Defiance County watersheds.

undue erosion of the bank. A similar structure was used at all five sites in Defiance County. The perimeter of the box was levelled so that flow would be uniform around it. A flume with adjustable vertical slit (Figure 9) was bolted to the front rim of the drop-box. The runoff from the slit fell over a Coshocton wheel (Figure 9) and then from the Coshocton wheel into a sump which was bolted to the floor of the drop-box (Figure 9). The runoff was pumped by a "Haynes Demon Drainer" submersible pump. This particular model was used because it would pump to near dryness and this prevented an accumulation of sediment in the sump. Recovery of sediment was tested in the laboratory during the development and calibration of this equipment and was found to be acceptable. The pump was activated by electrodes set to turn on when approximately 0.1 inch of runoff was recieved. The pump could also be activated manually. The pump was connected to a timer, which could either accumulate pumping time or be reset between events. The runoff was pumped into a 20-gallon plastic garbage can with a fitted lid (Figure 10). After each event, a subsample (usually 1 gallon) was taken from the container by a faucet at the bottom after thorough mixing. The remaining sample was discarded. The entire system was housed in a shed open only at the front, where the drop-box faced the field. The equipment was winterized by the use of heat lamps directed onto the Coshocton wheel and mounted in the sump and garbage lids. Heating tape was used for all pipes. Even during the extremely low temperatures of 1977, the system never failed to operate during winter events.

Tile drainage. In all cases, a single tile line was monitored, except for the Blount site (402), where a small tile system was monitored by intercepting the main at the point where it discharged into the drainage ditch. The tile was usually at a depth of 1 meter, and a specially constructed fiberglas sump was set into the ground in the same sampling shelter used for surface runoff. The sump (Figure 11) intercepted the tile and collected all discharge. As in the case of surface runoff, a calibrated sump pump was used to pump the water out of the sump. A timer was used as before to measure pumping time, and the pump was activated at a given water level by electrode; it could also be activated manually. An orifice inserted into the discharge pipe from the pump delivered a sample of the water to a 20-gallon plastic garbage can, where it was subsampled as described previously. This sample was considered to be representative of the tile flow for a given time interval, since all of the flow was sampled. The amount of sample taken by the orifice was adjusted by a valve.

Sampling Handling and Processing - All sites in Defiance County were serviced by a technician every 48 hours or sooner if significant precipitation occurred. A 1-gallon subsample of the sample in the garbage can was taken after thorough mixing and the remainder discarded. Sumps were pumped dry manually after subsampling, time of pumping was recorded and rainfall at the site was measured from a manual rain gauge. Samples were stored in a refrigerator at 4^{o} C at field headquarters until they could be transported to the laboratory at Columbus. Samples usually reached the laboratory within 7 days or less. Additional measurements taken in the field included depth of snow cover, depth to frozen soil and all pertinent details on field operations (times of planting, plowing, harvesting, rates of fertilization, etc.).

Cropping Practices - The following cropping practices were employed by the cooperating farmers on the Defiance County watersheds in 1978-1980:



A: Fiberglas sump which intersects field tile. Contains submersible sump pump with flow-activating electrodes.

B: Sampling valve which diverts portion of sump pump discharge into sample container.

Figure 11. System for monitoring and sampling tile flow.

Hammersmith Roselms (111) - Fall chisel every year. In 1978 and 1979 soybeans was the crop. In fall of 1979 wheat was planted. Grassed waterway was established in fall of 1979.

Heisler Blount (401, 402) - In 1978, no till soybeans were grown. Residue cover was good because of a heavy weed infestation in the previous year which was killed with paraquat prior to no till soybeans. In fall of 1978, the watershed was chisel plowed and soybeans grown in 1979. In fall of 1979, the watersehd was planted to wheat.

Speiser Paulding (501, 502) - Fall molboard plowed every year. Oats were grown in 1978, followed by wheat in 1979 and 1980. The oat crop was fertilized with 33 kgN/ha and 15 kgP/ha just after seeding.

1.23 <u>Surface Runoff and Tile Drainage Measurement -- Hoytville Plots</u>

In 1974, a research facility was constructed at the NW Branch, Ohio Agricultural Research and Development Center (OARDC), located at Hoytville in Wood County (Figure 1), to study the loss of soil and nutrients by runoff and tile drainage. Eight plots, each 30.5 m (100 ft) x 12.1 m (40 ft), were laid out, four in a block, with a sampling house in the center (Figure 12). Each plot was trenched to a depth of four feet and heavy plastic sheeting was placed against the plot wall; the soil was then backfilled to hold the plastic in place. Earth berms (15-30 cm high) were raised on the sides of the plots and seeded with fescue. The backs of the plots were left open to allow passage of equipment; a berm was then formed after each operation to enclose the plot. A concrete gutter was built on the other end of the plots with a 10 cm (4 inch) diameter drain to collect runoff. The drain was connected by 10 cm (4 inch) plastic pipe (placed at 90 cm depth) to the sampling house. A 10 cm (4 inch) perforated corrugated plastic tile

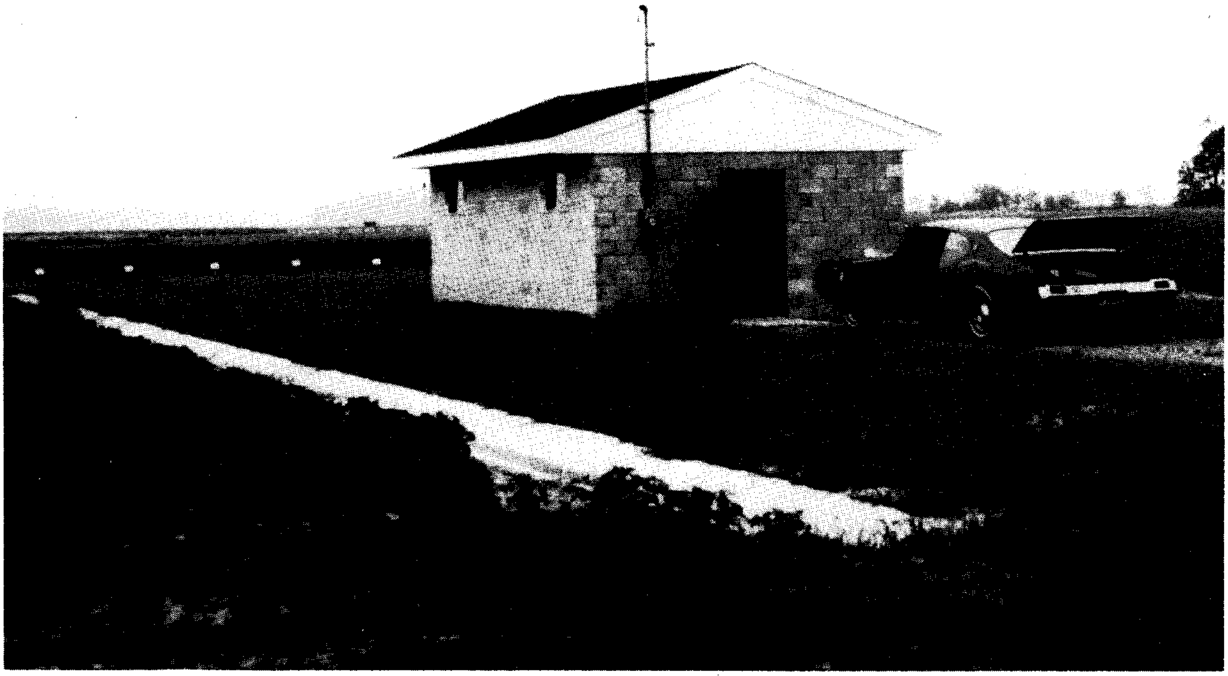


Figure 12. Runoff and tile drainage plots at OARDC Research Station, Hoytville, Ohio.

was installed in the center of each plot at a depth of 90 cm. The tiles were also connected by 10 cm (4 inch) solid pipe to the sampling house. Additional field tile was placed outside the plot area to keep water other than that intercepted by the plots from entering the area. The hydraulic conductivity of the soil (Hoytville clay) was low enough to prevent any significant water movement between plots. The area between the plots and sampling house was seeded with fescue to prevent erosion.

The sampling procedure used was similar to that used to measure tile drainage on the Defiance County sites. Fiberglas sumps intercepted the flow from the surface runoff and tile drain lines. Sump pumps (Hydromatic submersible pump) and timers were used to measure flow as described previously, and water was sampled as before by placing an orifice in the discharge line from the sump pump. The sampled water was collected in 1-gallon or 5-gallon plastic bottles housed in a refrigerated (4^{o} C) compartment so that the samples were refrigerated immediately. Samples were returned to the laboratory at Columbus within 1 week or less. Samplers were serviced daily and sumps were pumped dry between events. Precipitation records were kept by the personnel at the research station which has a 20-year weather record.

The facility was completed early in 1975, and some flow and sediment monitoring was initiated in April 1975; water quality sampling was begun in May 1975. The previous fall, the plots were fall plowed and left bare until planting in May 1975. The area had been in sod for at least 10 years prior to construction of the plots and had received no fertilizer during that period. In May 1975, soybeans were planted and all plots were treated the same through November 1975 to measure variability among the plots. From 1976-1977, soybeans were grown with varying tillage treatments ranging from fall moldboard plow to no till (Logan and Stiefel, 1979). In November 1977, the tillage treatments were consolidated into fall moldboard plowing and no till, with the previous no till and fall plowing plots continued, and the intermediate tillage plots no tilled or fall plowed. One half of the plots had their tile drainage pump systems disconnected to give four tile drained and four non-tile drained plots. The plots and their treatments were:

Plots	Tillage	Drainage
641, 661	Fall plow	Tile drained
642, 662	"	"
651, 611	"	Not tile drained
621, 671	No till	Tile drained
622, 672	"	"
631, 681	"	Not tile drained

Crop management practices in 1977-1980 are given in Table 2. In 1978 and 1979 corn was grown and then soybeans again in 1980.

1.24 Analysis of Watershed and Plot Water Samples

As soon as samples were received in the laboratory, the 1-gallon polyethylene bottles were shaken thoroughly and a 250 ml sample was placed in another bottle and refrigerated (Figure 13). A 100-ml aliquot of the unfiltered sample was filtered through a preweighed 1.0 um Nucleopore membrane filter. The sediment and filter were oven-dried, reweighed, and sediment concentration calculated. The filtered solution was refrigerated until further analysis. Tests showed that a 1.0 um filter was effective in retaining fine clay. The filtered sample was routinely analyzed for: (NO_3 + NO_2), NH_3, and filtered reactive-P. The unfiltered sample was analyzed for total P. Methods of analysis were discussed in detail by Logan and Steifel (1979).

Table 2. Summary of crop management practices on Hoytville plots (1977-1980)

1977

1. Tillage - Half of the plots (1, 4, 5 and 6) were moldboard plowed November 7. The other plots (2, 3, 7 and 8) were in no till.
2. Fertilization - 19 kgP/ha was broadcast October 5.

1978

1. Fertilization - 180 kgN/ha as urea broadcast April 14.
2. Tillage - Plowed plots were field cultivated twice April 28.
3. Planting - DeKalb XL 64 corn planted in 30 inch rows April 28.
4. Pesticides - 1 kg/ha Furadan (AI) with planter; 2 kg/ha Atrazine, 2 kg/ha Lasso and 2 kg/ha Roundup (no till only) April 29.
5. Harvest - October 5.
6. Fertilization - 86 kgP/ha broadcast October 30.
7. Tillage - Fall moldboard plowed (plots 1, 4, 5 and 6) October 31.

1979

1. Tillage - Plowed plots were field cultivated twice April 23.
2. Fertilization - 179 kgN/ha as anhydrous NH_3 injected April 27. Also 112 kg/ha of 6-24-24 was applied through the planter April 23.
3. Pesticides - 17 kg/ha Counter applied at planting; 2 kg/ha Atrazine, 2 kg/ha Lasso and 1.5 kg/ha Roundup (no till only) applied May 1.
4. Planting - Landmark C747X corn planted in 30 inch rows April 23.
5. Harvest - October 24
6. Fertilization - 30 kgP/ha broadcast December 13.
7. Tillage - Fall moldboard plowed (plots 1, 4, 5 and 6) December 14.

1. Tillage - Plowed plots were field cultivated twice May 2.
2. Planting - Williams soybeans planted in 30 inch rows May 2.
3. Fertilization - 112 kg/ha 6-24-24 was applied through the planter May 2.
4. Pesticides - 2 kg/ha Dual 6E, 3 kg/ha Amiben and 1.5 kg/ha Roundup (no till only) applied May 3.

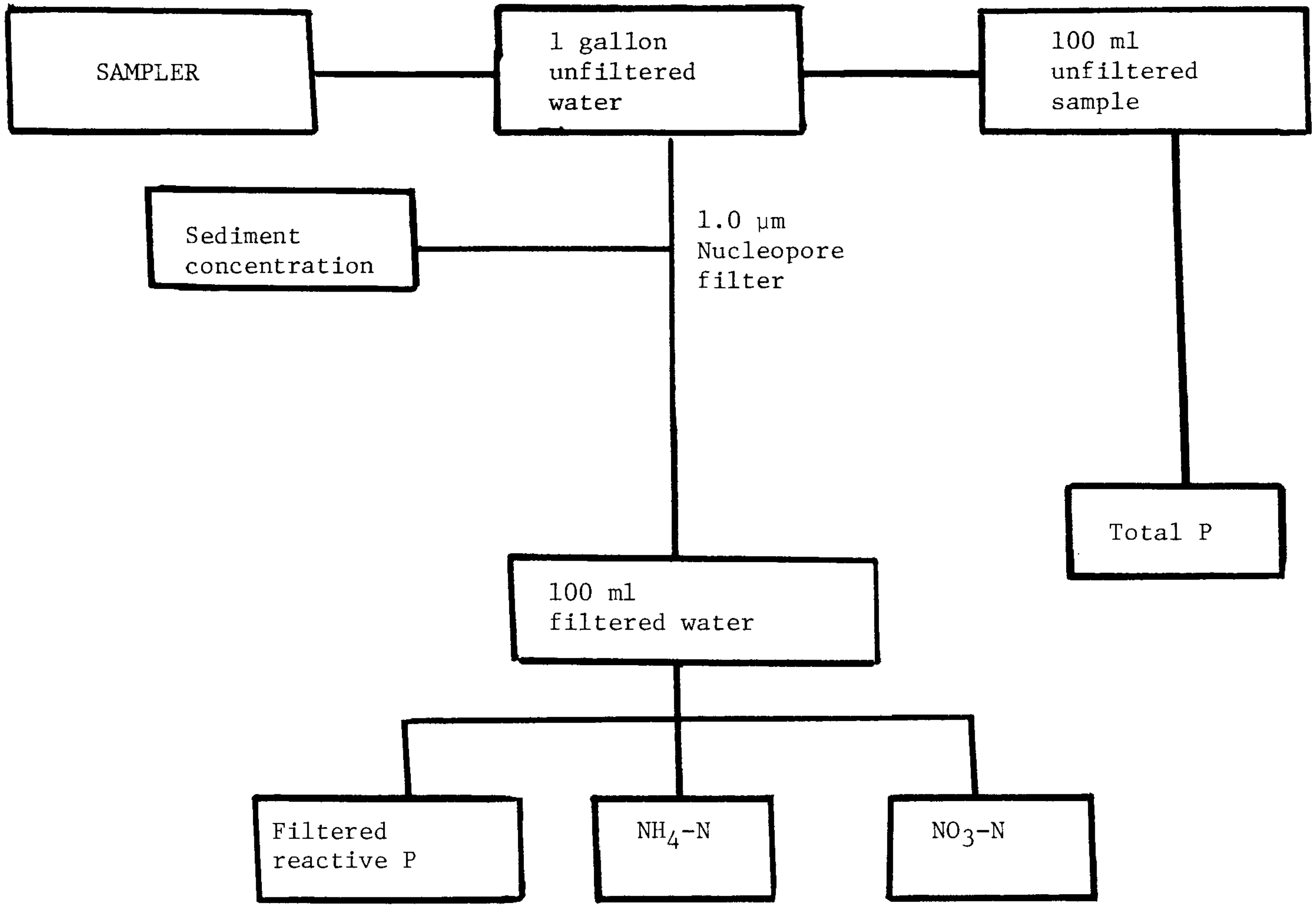


Figure 13. Analytical scheme for water samples.

2. RESULTS

2.1 Precipitation and Flow (1978-1980)

Table 3 gives annual precipitation and flow (surface runoff and tile drainage) for the Defiance watersheds and Hoytville plots. The 1980 data is through May only. Precipitation was lower in 1978 than in 1979, and this is reflected in the flows for these years. Surface runoff was very high on the Roselms site (111) in 1979, but there is no explanation for this increase. However, this is the most precipitation received on this site since monitoring began in 1975.

Runoff and tile flows on the Blount site (401, 402) in 1978-1980 were similar to these monitored in 1975-77. In 1978, no till soybeans were grown on this site as compared to fall-plowed soybeans in previous years and again in 1979. No till appeared to have no effect on runoff and tile drainage flows. The wheat crop in 1980 also appeared to have little effect on drainage flows.

Surface runoff was very high on Paulding soil (501, 502) in 1978 and tile flow very low. This was similar to the results of the 1975-77 monitoring, although the 1978 surface runoff was higher than in previous years. The crop in 1978 was spring seeded oats, and since much of the runoff occurs in late winter and early spring (Logan and Stiefel, 1979), the oats crop would have had about the same effect on surface soil conditions as the soybean crops grown in previous years. In 1979 and 1980, winter wheat was grown on the Paudling watershed and this dramatically decreased surface runoff to 4.2 cm in 1979. In 1980 there was no runoff through May when monitoring stopped. There was also a slight increase in tile flow in 1979-1980 compared to previous years. It would appear that

Table 3. Precipitation and flow from Defiance watersheds and Hoytville plots (1978-1980).

	1978		1979		1980*	
	Flow	Ppt	Flow	Ppt	Flow	Ppt
	cm					
111	23.5	70.9	71.5	87.6	27.7	31.4
401	13.8	67.5	17.0	83.1	9.7	32.4
402	12.2	67.5	9.7	83.1	6.4	32.4
501	52.1	61.6	4.2	89.8	0.0	28.2
502	3.7	61.6	13.7	89.8	8.5	28.2
641/661†	19.9	65.8	23.5	98.7	6.3	28.6
642/662	38.9	65.8	51.9	98.7	16.8	28.6
611/651	28.4	65.8	26.0	98.7	6.8	28.6
621/671	25.1	65.8	30.2	98.7	3.5	28.6
622/672	22.5	65.8	32.4	98.7	16.5	28.6
631/681	29.1	65.8	25.5	98.7	7.8	28.6

* Through May 31.

† Mean of duplicate plots.

this large of a decrease in surface runoff must be due to increased moisture removal with the fall-seeded wheat crop in addition to any increased infiltration capacity that the increased vegetative cover might have provided in the winter-spring runoff period.

In 1978-1980, half of the Hoytville plots were tile drained, while the other half had only surface drainage. There were no significant differences in surface runoff as a result of tile drainage, with either no till or fall plowing. There were also no significant differences in either surface runoff or tile flow between no till and fall plowing.

2.2 Soil and Nutrient Losses (1978-1980

2.21 Hammersmith Roselms (111)

Table 4 gives the mean annual soil and nutrient losses for this site for 1978-80. This soil is on moderate to steep slopes (2-15%) and is high in clay. In 1975-77, soil loss varied from 1284 to 3714 kg/ha. Loss in 1978 was similar to this, but 1979 and 1980 losses were higher, especially the 1980 soil loss which was only for the period January-May. In fall 1978, an attempt was made to establish a grassed waterway in the natural draw which drains this watershed (Figure 3). The fescue stand was only partly established by spring of 1979, and was reseeded in fall 1979 and again in spring 1980. In addition, wheat was seeded on this watershed in fall 1979 and the wheat was seeded across the waterway to increase vegetative cover. By winter 1979, there was an adequate stand of wheat and fescue in the waterway. However, neither the grassed waterway nor the wheat crop had any effect on soil loss; in fact soil loss increased in 1979-80.

Table 4. Concentrations and pollutant loads from Hammersmith Roselms (111) surface runoff.

	1978				1979				1980			
	Concentration	(ug/ml)		Load	Concentration	(ug/ml)		Load	Concentration	(ug/ml)		Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	3741	16	667	1395	5100	0	755	4801	5133	868	2375	5848
Filtered reactive-P	0.47	0.02	0.09	0.18	0.15	0.00	0.02	0.09	0.95	0.04	0.35	0.86
Total-P	2.15	0.00	1.37	2.86	2.05	0.16	0.41	2.59	--	--	--	--
(Nitrate + nitrite)-N	2.3	1.1	2.0	4.3	12.0	0.0	1.2	7.2	13.3	3.3	5.4	13.3
Ammonia-N	0.6	0.0	0.2	<0.1	1.0	0.0	0.1	0.1	0.6	0.0	0.3	0.2

*Flow weighted mean concentration (FWM)

Nitrogen and phosphorus losses were similar to those in 1975-77 and were quite low. This watershed has been in soybeans and wheat for the six years of the study and has received no nitrogen fertilizer in this period and very little P and K.

2.22 Heisler Blount (401, 402)

Mean annual soil and nutrient losses in surface runoff (401) and tile drainage (402) are given in Tables 5 and 6, respectively. Soil losses in 1975-1977 varied from 890-3400 kg/ha. In 1978, no till soybeans were grown in a mixture of soybean and killed quackgrass sod (surface residue was > 50%). No till reduced soil loss to 66 kg/ha, essentially zero at the level of detection of this study. As discussed previously, this reduction was not a result of runoff volume, which was not greatly different than previous or subsequent years, but was due to the greater protection of the soil surface by the residue cover. In 1975-77, total P loads varied from 1.14 to 2.33 kg/ha, and in 1978 this was reduced to 0.37 kg/ha as sediment load was reduced. However, filtered reactive P (FRP) loads were unchanged with no till. Loads ranged from 0.02-0.08 kg/ha in 1975-1977 when the watershed was plowed, and was 0.08 kg/ha with no till in 1978.

2.23 Speiser Paulding (501, 502)

Nutrient and sediment losses for 1978-1980 are given in Tables 7 and 8. In the period 1975-1977 this watershed had the highest soil loss of all sites studied and ranged from 3849 to 4576 kg/ha/yr. Soil was fall plowed and soybeans were grown in these three years, and the high soil loss was attributed to the high clay content and poor structure of this soil together with the lack of subsurface drainage (Logan and Stiefel, 1979). As previously discussed, oats were grown in 1978 followed by wheat in 1979 and 1980. Table 3 showed that runoff volume in 1978 was similar to previous years, but

Table 5. Concentrations and pollutant loads from Heisler Blount (401) surface runoff.

	1978				1979				1980			
	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	95	0	53	66	1184	48	390	515	1365	511	1265	1092
Filtered reactive-P	0.13	0.04	0.07	0.08	0.07	0.00	0.03	0.04	0.72	0.04	0.49	0.43
Total-P	0.37	0.16	0.30	0.37	0.51	0.26	0.31	0.47	--	--	--	--
(Nitrate + nitrite)-N	4.8	0.9	2.2	2.7	8.0	2.3	5.0	7.5	0.0	0.0	0.0	0.0
Ammonia-N	0.9	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*Flow weighted mean concentration (FWM)

Table 6. Concentrations and pollutant loads from Heisler Blount (402) tile drainage.

	1978				1979				1980			
	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	66	0	34	37	222	0	131	112	197	0	73	41
Filtered reactive-P	0.28	0.01	0.09	0.10	0.20	0.00	0.08	0.07	0.14	0.02	0.07	0.04
Total-P	0.79	0.10	0.30	0.32	0.56	0.00	0.27	0.23	--	--	--	--
(Nitrate + nitrite)-N	35.8	0.0	8.3	8.9	27.0	0.9	13.9	11.9	18.0	1.7	13.7	7.7
Ammonia-N	0.9	0.0	0.2	0.2	0.6	0.0	0.6	<0.1	0.8	0.0	0.4	0.1

*Flow weighted mean concentration (FWM)

Table 7. Concentrations and pollutant loads from Speiser Paulding (501) surface runoff.

	1978				1979				1980†			
	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	2519	0	946	4388	1733	381	1204	453	--	--	--	--
Filtered reactive-P	0.97	0.02	0.57	2.65	0.10	0.00	0.03	0.01	--	--	--	--
Total-P	6.35	0.31	3.35	15.50	1.89	0.92	1.49	0.56	--	--	--	--
(Nitrate + nitrite)-N	2.3	0.0	0.6	2.6	0.0	0.0	0.0	0.0	--	--	--	--
Ammonia-N	1.5	0.0	0.1	0.7	0.0	0.0	0.0	0.0	--	--	--	--

*Flow weighted mean concentration (FWM)
†There was no flow in 1980.

Table 8. Concentrations and pollutant loads from Speiser Paulding (502) tile drainage.

	1978				1979				1980			
	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	847	0	289	94	510	0	133	163	247	0	138	104
Filtered reactive-P	1.31	0.03	0.18	0.06	0.08	0.00	0.03	0.03	0.15	0.01	0.06	0.04
Total-P	1.63	0.11	0.47	0.15	1.33	0.00	0.24	0.29	--	--	--	--
(Nitrate + nitrite)-N	27.8	1.3	5.6	1.8	23.8	0.6	13.0	15.9	14.0	3.0	8.6	6.5
Ammonia-N	1.5	0.0	0.6	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*Flow weighted mean concentration (FWM)

was drastically reduced in 1979 and stopped completely in 1980 (through May when sampling was terminated). These reductions were in spite of near normal precipitation. The reduced runoff greatly reduced soil and nutrient loss in 1979. The very high total P load in 1978 was associated with events in March and April and were, therefore, not affected by the fertilizer application in May after the oats were planted. Total P loads were also high in 1976 (4.02 kg/ha) and 1977 (6.89 kg/ha) and these may reflect the higher P content of clay-sized soil particles compared to coarser particles.

2.24 The Hoytville Plots (611-681, 612-682)

In the first three years of this study, surface runoff and tile drainage were monitored on the eight plots with varying degrees of tillage ranging from fall moldboard plowing to no till. The 1975-1977 data showed that surface runoff volume was much lower than tile flows on this Hoytville soil, and as a consequence, soil loss never exceeded 750 kg/ha/yr. Tillage had no effect on soil loss at these low levels. In 1978, the treatments on the plots were changed. The tillage treatments were reduced to two: fall moldboard plow and no till, and on half of the plots the tile drainage was stopped and surface runoff was the only means of drainage. The results are summarized in Tables 9-14.

In 1978-1980, tile drainage had no effect on surface runoff volume, as has already been shown (Table 3), and Tables 9, 11, 12 and 14 show that soil loss remained very low (< 300 kg/ha/yr), regardless of drainage or tillage.

In 1975-1977, soybeans were grown and no nitrogen fertilizer was added. In this period, NO_3-N in runoff was < 5 kg/ha and < 21 kg/ha in tile drainage. NH_4-N loads were generally < 1 kg/ha. In 1978 and 1979, corn

Table 9. Concentrations and pollutant loads in runoff from Hoytville plots (621, 671). Plots were no tilled and tile drained. Mean of two plots.

	1978				1979				1980			
	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	2927	0	57	94	1647	0	45	101	111	0	48	15
Filtered reactive-P	1.87	0.00	0.48	1.37	5.02	0.01	1.79	4.76	2.24	0.07	1.00	0.30
Total-P	5.45	0.00	0.78	1.87	7.09	0.11	2.28	5.92	--	--	--	--
(Nitrate + nitrite)-N	31.9	0.0	2.9	8.1	12.7	0.0	1.9	4.6	4.8	0.0	1.8	0.5
Ammonia-N	6.5	0.0	0.1	0.1	2.0	0.0	0.5	0.9	0.6	0.0	<0.1	<0.1

*Flow weighted mean concentration (FWM)

Table 10. Concentrations and pollutant loads in tile drainage from Hoytville plots (622, 672). Plots were no tilled and tile drained. Mean of two plots.

	1978				1979				1980			
	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	126	0	9	18	377	0	12	35	45	0	5	7
Filtered reactive-P	1.04	0.00	0.10	0.21	1.23	0.00	0.19	0.52	0.42	0.00	0.05	0.07
Total-P	1.68	0.00	0.22	0.47	1.63	0.00	0.25	0.72	--	--	--	--
(Nitrate + nitrite)-N	37.1	0.0	10.5	21.9	21.2	0.0	4.7	13.4	5.3	0.0	2.5	3.7
Ammonia-N	2.0	0.0	0.1	0.1	1.4	0.0	0.4	0.1	1.9	0.0	0.2	0.1

*Flow weighted mean concentration (FWM)

Table 11. Concentrations and pollutant loads in runoff from Hoytville plots (631, 681). Plots were no tilled with no tile drainage. Mean of two plots.

	1978				1979				1980			
	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load	Concentration (ug/ml)			Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	1373	0	29	55	1877	0	118	164	6467	0	267	72
Filtered reactive-P	1.74	0.04	0.57	1.79	5.38	0.01	0.95	3.01	2.34	0.01	0.35	0.29
Total-P	4.46	0.05	0.83	2.38	7.34	0.00	1.48	4.30	--	--	--	--
(Nitrate + nitrite)-N	21.9	0.0	2.1	5.9	15.1	0.0	2.3	4.3	6.2	0.0	1.3	0.8
Ammonia-N	6.5	0.0	0.2	0.4	4.1	0.0	0.6	0.7	1.6	0.0	0.1	<0.1

*Flow weighted mean concentration (FWM)

Table 12. Concentrations and pollutant loads in runoff from Hoytville plots (641, 661). Plots were fall plowed and tile drained. Mean of two plots.

	1978				1979				1980			
	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	1303	0	78	135	1246	0	54	111	838	0	91	37
Filtered reactive-P	0.98	0.02	0.25	0.44	1.84	0.00	0.28	0.59	0.52	0.00	0.15	0.07
Total-P	4.61	0.00	0.62	1.11	3.20	0.00	0.67	1.39	--	--	--	--
(Nitrate + nitrite)-N	19.0	0.0	3.2	5.8	13.6	0.0	3.4	7.2	7.2	0.0	2.1	1.2
Ammonia-N	3.6	0.0	0.1	0.2	1.4	0.0	0.4	0.4	1.4	0.0	<0.1	<0.1

*Flow weighted mean concentration (FWM)

Table 13. Concentrations and pollutant loads in tile drainage from Hoytville plots (642, 662). Plots were fall plowed and tile drained. Mean of two plots.

	1978				1979				1980			
	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	100	0	4	16	77	0	15	72	123	0	11	17
Filtered reactive-P	1.12	0.00	0.16	0.57	0.46	0.00	0.12	0.49	0.34	0.00	0.07	0.10
Total-P	3.30	0.00	0.28	1.39	0.42	0.00	0.15	0.62	--	--	--	--
(Nitrate + nitrite)-N	20.9	0.0	8.2	27.1	20.0	0.0	3.9	17.1	5.9	0.0	2.5	3.9
Ammonia-N	7.9	0.0	0.2	0.6	1.0	0.0	<0.1	<0.1	1.9	0.0	0.2	0.1

*Flow weighted mean concentration (FWM)

Table 14. Concentrations and pollutant loads in runoff from Hoytville plots (611, 651). Plots were fall plowed with no tile drainage. Mean of two plots.

	1978				1979				1980			
	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load	Concentration		(ug/ml)	Load
	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)	High	Low	FWM*	(kg/ha)
Sediment	1443	0	63	153	2274	0	122	307	997	0	37	23
Filtered reactive-P	1.87	0.00	0.20	0.50	2.31	0.00	0.25	0.55	1.05	0.00	0.10	0.06
Total-P	3.15	0.02	0.46	1.09	4.25	0.00	0.61	1.40	--	--	--	--
(Nitrate + nitrite)-N	26.4	0.0	4.6	10.6	13.3	0.0	3.6	8.6	8.7	0.0	1.7	1.1
Ammonia-N	5.6	0.0	0.1	0.2	0.9	0.0	<0.1	<0.1	1.6	0.0	<0.1	<0.1

*Flow weighted mean concentration (FWM)

was grown with nitrogen fertilizer (anhydrous NH_3) applications of 180 kgN/ha. In these two years NO_3-N loads in runoff were < 11 kg/ha and ranged from 13-27 kgN/ha in tile drainage. This indicates small but not significant increases in nitrate losses with fertilized corn as compared to nonfertilized soybeans. In 1980, soybeans were again grown and NO_3-N loads decreased slightly.

Total phosphorus loads have increased steadily since 1975 with increased fertilization of these plots. Table 15 gives concentrations and losses of total and filtered reactive P in runoff from fall-plowed and no till plots since 1975. Also given are the P fertilizer applications during that period, and the increase in Bray P1 extractable P which is a measure of crop-available phosphate. Flow weighted mean (FWM) concentrations of filtered reactive P (FRP) remained steady from 1975-1979 and decreased in 1980 after fall application of P fertilizer was stopped on the fall-plowed plots, while unit area loads increased through 1979 and then decreased in 1980. Total P showed the same trend. Bray extractable P increased from 18 μg/g in 1975 prior to P fertilizer application to 47 μg/g in 1979.

On the no till plots, concentrations and loads of total P and FRP increased dramatically from 1975 to 1979. FRP then decreased rapidly in 1980 after fall P fertilizer applications were terminated. The higher losses of soluble and total P are due to the accumulation of fall broadcast fertilizer at the surface. This is indicated by the increase in Bray P1 extractable P in the surface 5 cm of soil from 18 μg/g in 1975 prior to P fertlization to 168 μg/g in 1979. Oloya and Logan (1980) have shown a very high correlation ($r^2 > 0.98$), on this Hoytville soil, between Bray P1 extractable P and P that can desorb into water. They also showed that a large fraction of the desorbable P was desorbed instantaneously, and this fraction may represent

Table 15. Changes in concentration and unit area loads in runoff of total and filtered reactive phosphate with fertilization of fall-plowed and no till Hoytville soil (1975-1980).

Year	P Fertilizer Applied (kg/ha)		Filtered Reactive P				Total P				Bray P1† extractable P
			Concentration (µg/ml)			Runoff Load	Concentration (µg/ml)			Runoff Load	
	Spring	Fall	High	Low	FWM*	(kg/ha/yr)	High	Low	FWM*	(kg/ha/yr)	(µg/g)
						Fall Plow					
1975‡	-	34	3.92	0.00	0.31	0.01	5.85	0.00	0.57	0.10	18.1
1976	12	34	0.78	0.00	0.25	0.13	2.95	0.00	0.43	0.22	
1977	12	19	2.18	0.00	0.29	0.30	9.18	0.00	0.82	0.84	
1978	-	86	1.87	0.00	0.23	0.47	4.61	0.00	0.54	1.09	
1979	12	30	2.31	0.00	0.27	0.57	4.25	0.00	0.64	1.40	46.6
1980	12	-	1.05	0.00	0.12	0.07	--	--	--	--	
						No Till					
1975	-	34	3.92	0.00	0.31	0.01	3.96	0.00	1.03	0.26	18.1
1976	12	34	1.79	0.00	0.37	0.22	1.81	0.00	0.54	0.34	
1977	12	19	4.33	0.04	0.82	0.94	10.70	0.10	1.46	1.56	
1978	-	86	1.87	0.00	0.53	1.58	5.45	0.00	0.81	2.13	
1979	12	30	5.38	0.01	1.37	3.89	7.34	0.00	1.88	5.11	168.0
1980	12	-	2.34	0.01	0.67	0.29	--	--	--	--	

* Flow weighted mean concentration (FWM).
† Sampled from the 0-5 cm depth.
‡ Plot area was in sod prior to 1975.

unreacted fertilizer P, soluble reaction products of soil and fertilizer, and P in solution in soil pores. The 1980 FRP data show that this effect of fertilization on dissolved P losses may diminish rapidly after P fertilizer is no longer broadcast.

2.3 Seasonal Trends of Precipitation, Flow and Soil Loss (1975-1980)

Figures 14-17 give precipitation, flow and soil loss by month for the period 1975-1980 for the Roselms (111), Blount (401, 402) and Paulding (501, 502) watersheds and for one of the Hoytville plots (621, 622). On the Roselms watershed, greatest runoff and soil loss were in the period February-April. Runoff was minimal in the summer months and soil loss was low even when monthly precipitation was high.

On the Blount watershed (401, 402), total flow (runoff and tile drainage) was highest in February-April also, and soil loss generally corresponded to runoff volume. In 1978 with no till, soil loss was greatly reduced although runoff and tile flow volumes were similar to other years. There was very little runoff or soil loss in the summer or early fall months.

Runoff continued to be highest in the early spring on the Paulding watershed (501) as it was on the other watersheds. With the exception of September 1975, summer runoff was low as was soil loss even though summer rainfall was often as high as in spring months. In 1979 and 1980 with wheat crops, runoff was low or absent while tile flow was somewhat higher than in other years.

Runoff and tile drainage (621, 622) were also higher in the spring on the Hoytville plot. On this soil, tile flow was often higher than surface runoff and soil losses were quite low. Unlike the Defiance watersheds, tile flow was common, although low, in the summer and fall months.

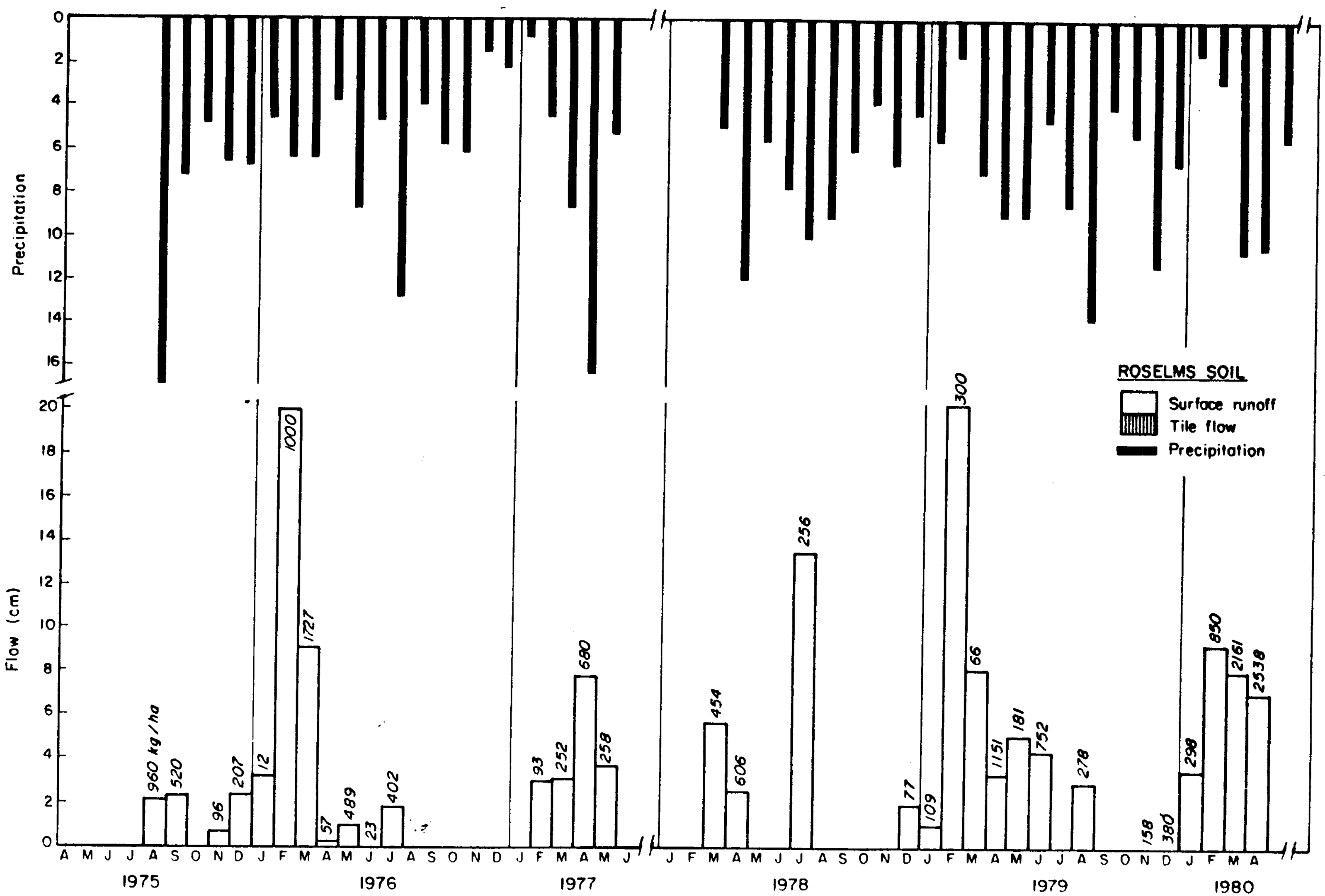


Figure 14. Monthly precipitation, flow and soil loss from Roselms watershed (1975-1980).

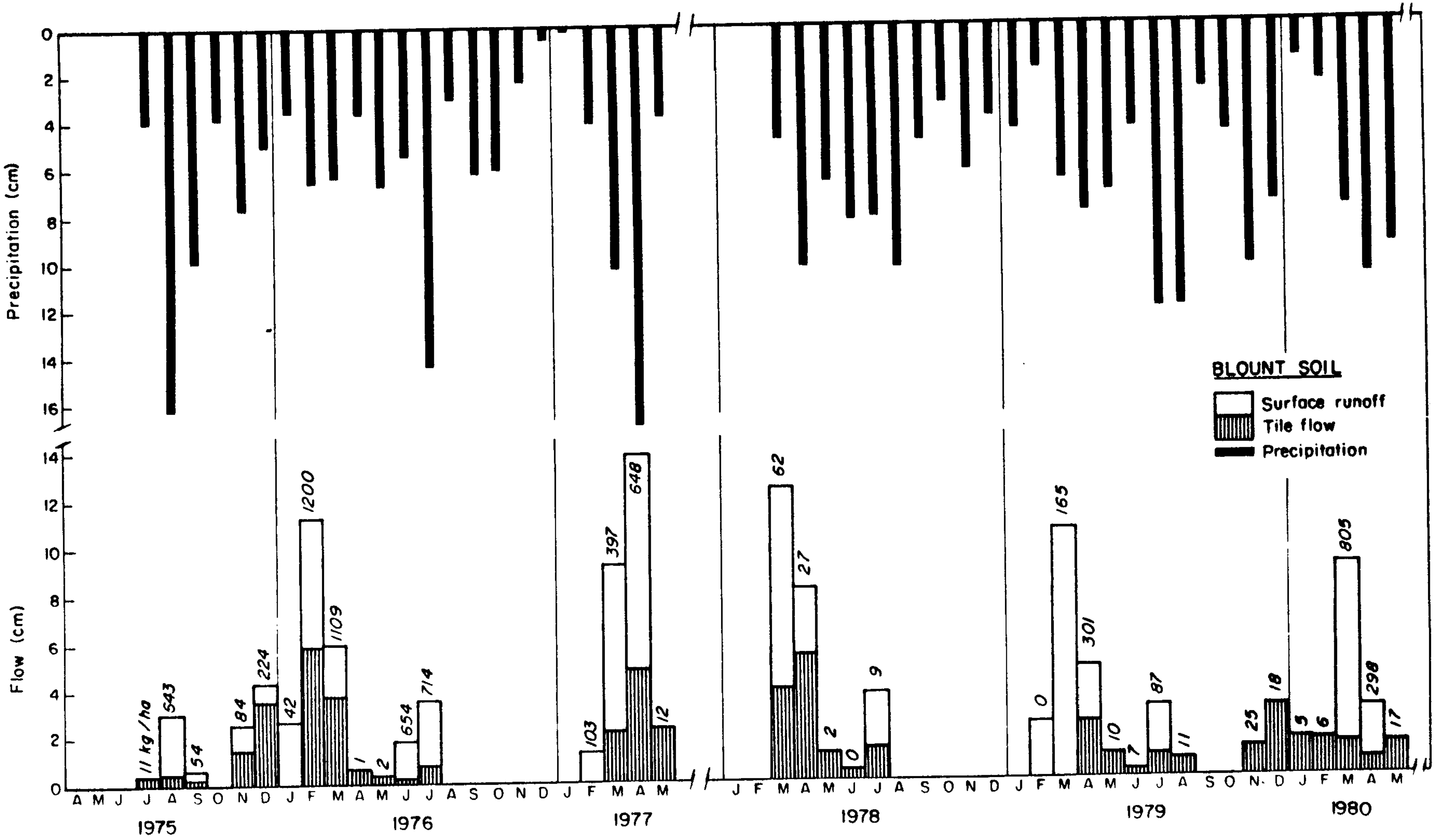


Figure 15. Monthly precipitation, flow and soil loss from Blount watershed (1975-1980).

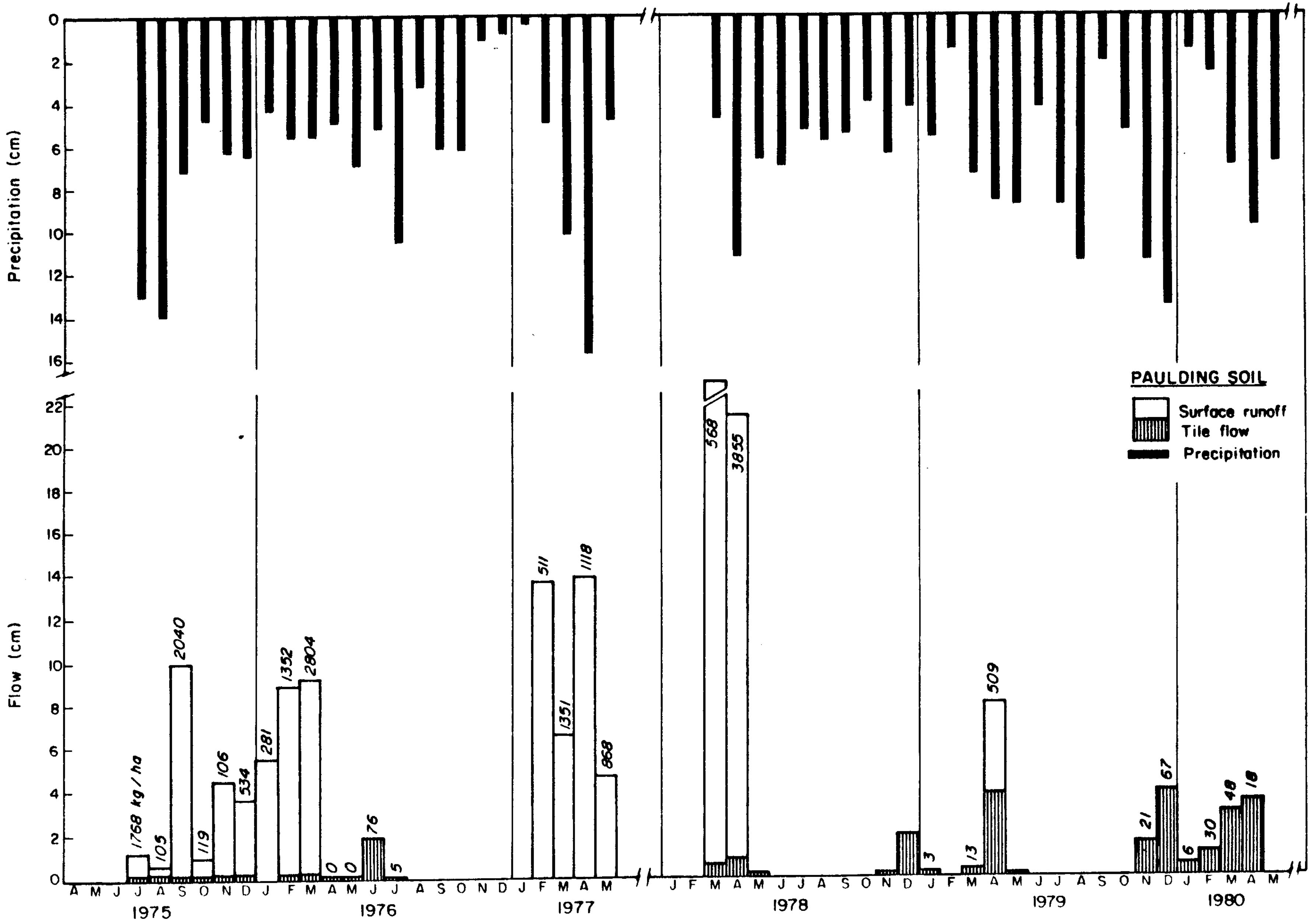


Figure 16. Monthly precipitation, flow and soil loss from Paulding watershed (1975-1980).

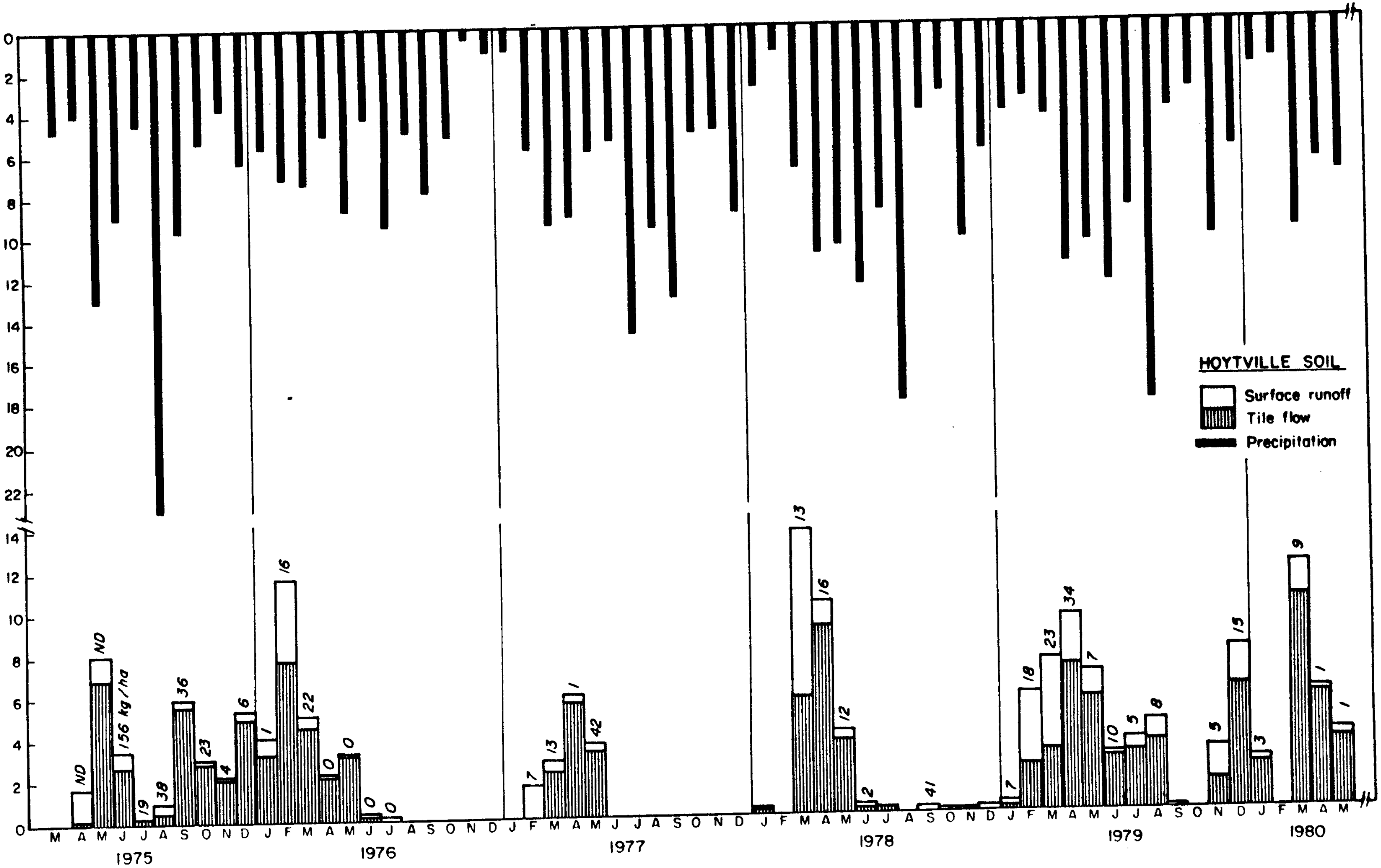


Figure 17. Monthly precipitation, flow and soil loss from Hoytville (621, 622) plot (1975-1980).

2.4 Crop Yields on Hoytville Tillage Plots (1975-1980)

Table 16 presents crop yields for the six years of the study. In the first three years, soybeans were grown on the plots with different tillage practices. There were no yield differences between any of the tillage treatments in any of the three years. The yields obtained each year were representative of yields for that year in that area. The large variation in yield between 1975 and the other two years is due to the more favorable rainfall distribution of that year. Bone *et al* (1977) reported lower soybean yields on Hoytville soil with no till compared to minimum tillage (plow plant) or conventional tillage (fall moldboard plow). However, soybeans always followed corn in their study and the large amount of crop residue provided by the previous corn crop may have contributed to the yield reduction with no till by keeping the soil wetter and cooler in the spring. In the study reported here, soybeans followed soybeans, and there is very little residue from a soybean crop. This may explain why no till yields were as good as other tillage treatments.

In 1978 and 1979, corn was grown with fall moldboard plow and no till tillage treatments, and half of the plots had no tile drainage. In 1978, there were no significant differences in corn yields due to differences in tillage or drainage. These data confirm the findings of Bone *et al* (1977) that no till corn yields are not significantly different than yields with fall plowing when corn follows soybeans. They also showed that tile drainage did not affect yields of corn following soybeans.

In 1979, corn yields were generally high because of a favorable growing season. No till yields were generally lower than fall plowing. These differences were not statistically significant because there were only two

Table 16. Crop yields (bu/acre) on the Hoytville plots for the period 1975-1980. Mean of two plots.

	1975-1977 Soybeans				
	Fall Plow	Fall Chisel	Fall Disk*	No Till	Mean
1975	59.7	58.8	59.0	60.2	59.4
1976	38.1	35.7	36.1	36.1	36.5
1977	41.4	42.1	46.2	43.0	43.2
Mean	46.4	45.5	47.1	46.4	46.4

	1978-1979 Corn			
	Fall Plow		No Till	
	Tile drained	No tile	Tile drained	No tile
1978	133.5	131.9	131.9	134.5
1979	183.9	174.3	119.0	152.2

1980 Soybeans			
Fall Plow		No Till	
Tile drained	No tile	Tile drained	No tile
51.0	48.4	37.8	35.3

*In 1975 and 1976, a 15 cm strip was rototilled for the seedbed. In 1977, these plots were disked once.

plots in each treatment. Also, since the plots were established in 1975, there has been some subsidence on several of the no till plots which reduced surface runoff and caused some temporary ponding. This probably overshadowed any effect of tile drainage on corn yields. Bone _et al_ (1977) found that no till corn following corn gave lower yields than fall plowing, and although the data reported here for 1979 show no significant differences due to tillage, the trend is to lower yields with no till.

In 1980, soybeans were grown and the results show that no till yields were significantly lower than with fall plowing, a finding also reported by Bone _et al_ (1977) for soybeans following corn. Tile drainage had no significant effect on yields.

The yield results from the Hoytville plots and the study of Bone _et al_ (1977) indicate that no till corn and soybean yields were the same as those with fall plowing when soybeans was the previous crop, but no till corn and soybean yields are reduced when corn is the previous crop. This yield reduction has been attributed to the colder and wetter soil conditions provided in the spring with the large amount of residue remaining after harvest of a corn crop.

3. DISCUSSION

Logan and Stiefel (1979) reported on the first three years of this study (1975-1977). They found that soil losses form Maumee River Basin soils, although not excessive in terms of soil productivity effects, were among the highest in the Great Lakes Basin. They showed that the internal drainage and structural stability of these soils were important in determining their susceptibility to erosion and sediment transport. The soils of the Maumee Basin are all poorly-drained and fine-textured, and Logan and

Stiefel (1979) found that those soils which could be effectively tile drained (Hoytville and Lenawee) had little runoff and low soil loss. A soil of similar slope (< 2%) and texture, Paulding clay, had poor internal drainage and structure and produced low tile drainage volumes and had the highest soil loss of the soils that were monitored in the study. Conservation tillage and no till were compared to fall moldboard plowing on the Hoytville soil but soil loss was so low on this soil that reduced tillage had no effect on erosion.

Logan and Stiefel (1979) also showed that, in the 1975-1977 period, most runoff occurred in the period February-May during spring thaw and spring rains. Occasional summer storms did not produce as much runoff or soil loss as precipitation in the early spring. This was attributed to the greater water saturation of the soils in the spring months. A conclusion of this finding was that soil protection was most needed in the period after crop harvest in the fall and crop canopy development the following spring and summer.

Watershed and plot monitoring (Logan and Stiefel, 1979) also showed that unit area loads of total and filtered reactive phosphate were high compared to other watersheds in the Great Lakes Basin, and this was attributed to the high clay content of the soils in the Maumee Basin, the youthful nature of the soils (∿ 8,000 years), and the intensive cultivation and fertilization of the area (Logan, 1979).

The results of the present study confirm some of the previous findings and also provide new information about soil and nutrient losses from Maumee Basin agricultural soils.

Runoff continued to be highest in the early spring months. Soil loss continued to be highest on the Paulding soil with spring-seeded crops, but fall-seeded wheat greatly reduced runoff in 1979 and there was no runoff with wheat in 1980. The effect of the wheat crop appeared to be related to drying of the soil and increased water storage and infiltration capacity rather than increased soil protection by the winter cover since runoff volume and not just soil loss were drastically reduced.

No till soybeans in 1978 dramatically reduced soil loss on the Blount soil without measurably changing runoff volume. Residue cover of the previous soybean crop was enhanced by a heavy infestation of quackgrass which was killed with herbicide prior to no till planting in 1978. Wheat in 1980 had no effect on runoff on Blount or Roselms soils, in contrast to the runoff reduction on Paulding soil. It should be noted, however, that the greatest reduction on Paulding occurred in the second year of wheat, indicating that the effect might be cumulative.

Results from the Hoytville plots showed that tile drainage had no measurable effect on surface runoff volume. This finding is not clear at this time. Perhaps tile drainage capacity is not adequate in the early spring months when most runoff occurs, or perhaps the effect of tile drainage on surface runoff does not develop for several years.

Phosphate fertilizer broadcast on the Hoytville plots in the fall in 1975-1979 steadily increased flow weighted mean concentrations and annual loads of total P and filtered reactive P in that period. Concentrations and loads of FRP decreased rapidly in 1980 after fall fertilization was terminated. Concentration and load increases were greatest on the no till plots because broadcast fertilizer remained at the surface where it was most susceptible to washoff in dissolved form or attached to soil particles. Oloya and Logan (1980) found a high correlation between Bray P1 extractable P of this soil and P that could be desorbed into water. In the period 1975-1979, Bray P1 of the 0-5 cm depth was increased from 18 to 168 μg/g soil, while the same amount of fertilizer applied to the plowed soil prior to plowing in the fall only increased Bray extractable P to 47 μg/g. This suggests that, if no till is to be used to control phosphorus losses from agricultural land (especially dissolved), then fertilizer management is also required. This would entail keeping available P levels in the soil no higher than needed for optimum crop production and also would involve methods to place the fertilizer into the soil rather than on the surface.

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16. ABSTRACT

The Maumee River was chosen by PLUARG to be one of four pilot watersheds to be studied on the U.S. side of the Great Lakes drainage basin as part of Task C-pilot watershed studies.

This report represents the results of the continued monitoring of three of the Defiance County watersheds and the Hoytville plots for the period 1978-1980.

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