



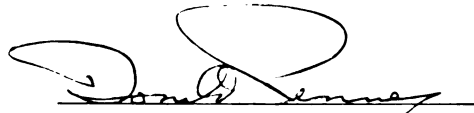
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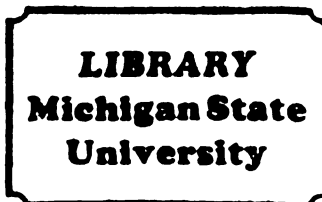
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**Evaluation of Leaching Prediction Models
for Herbicide Movement in the Soil Vadose Zone**

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Ruth Deborah Shaffer

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EVALUATION OF LEACHING PREDICTION MODELS FOR HERBICIDE
MOVEMENT IN THE SOIL VADOSE ZONE

By

Ruth Deborah Shaffer

A DISSERTATION

Submitted to
Michigan State University
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ABSTRACT

EVALUATION OF LEACHING PREDICTION MODELS FOR HERBICIDE MOVEMENT IN THE SOIL VADOSE ZONE

By

Ruth Deborah Shaffer

Three computer models were used to predict herbicide leaching in soil under Michigan agricultural conditions. The models were: the Chemical Movement in Layered Soil (CMLS), the Pesticide Root Zone Model (PRZM), and Groundwater Loading Effects of Agricultural Management Systems (GLEAMS). In studies designed to validate the models, the soybean herbicides metolachlor and alachlor were applied preemergence at 2.2 and 2.2 kg/ha, respectively. Leaching was monitored at two sites representing two different soil types. Soil samples were analyzed for herbicide residues. Herbicide leaching was monitored over time and soil depth. Comparisons were made among models and between model predictions and observed results. The maximum depth of leaching predicted for each model was PRZM > GLEAMS > CMLS. Parameters which greatly affected predicted depth and concentration of herbicide leaching (i.e., sensitive parameters) included pesticide half-life, partition

coefficient normalized for organic carbon (K_{oc}), and the soil parameters field capacity, wilting point and porosity. The model-estimated leaching depths were not as great as those found in field studies. The maximum depth of detectable metolachlor residues found in June was 61.0 cm at East Lansing and 76.2 cm at Hickory Corners, while all models did not predict such deep leaching depths. Nevertheless, the models were successful in predicting that no detectable herbicide residues would leach below the root zone.

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I would like to express my deep appreciation to my advisor, professor Donald Penner, for his constant encouragement and guidance throughout this study. I am sincerely grateful to all the members of the doctoral committee for their helpful suggestions and review of this dissertation: Dr. Steve Boyd, Dr. Jim Kells and Dr. Matt Zabik. Finally, I would like to thank my husband, Dr. Will Hansen, and my family, without whose steadfast love and encouragement this work would not have been possible.

TABLE OF CONTENTS

	PAGE
LIST OF TABLES.....	v
LIST OF FIGURES.....	vi
INTRODUCTION.....	1
MATERIALS AND METHODS.....	7
A. Comparison of Models.....	7
B. Site and Soil Evaluation.....	9
C. Field Studies.....	16
D. Soil Residue Analysis.....	20
RESULTS AND DISCUSSION.....	23
A. Comparison of Models.....	23
B. Analysis of Parameter Sensitivity.....	33
C. Field Results.....	45
D. Comparison of Model Predictions with Field Results.....	62
CONCLUSIONS.....	77
APPENDIX A. Sample data used in GLEAMS.....	79
APPENDIX B. Sample data used in PRZM.....	83
APPENDIX C. Sample data and output for CMLS.....	85
APPENDIX D. PRZM sample output.....	93
APPENDIX E. GLEAMS sample output.....	113
BIBLIOGRAPHY.....	117

LIST OF TABLES

TABLE		PAGE
Table 1.	Hardware and software requirements for PRZM, GLEAMS, and CMLS.....	8
Table 2.	Base values for parameters used in CMLS for East Lansing, MI.....	10
Table 3.	Base values for predictions used in GLEAMS for East Lansing, MI.....	11
Table 4.	Base values for parameters used in PRZM for East Lansing, MI.....	12
Table 5.	Soil moisture values used in PRZM for East Lansing, MI (base 2).....	13
Table 6.	Soil description from soil test results for Capac soil at East Lansing, MI.....	15
Table 7.	Soil description from soil test results for Kalamazoo soil at Hickory Corners, MI.....	15
Table 8.	1987 Leaching study management and sampling schedule.....	17
Table 9.	Effect of parameter variation on predicted leaching depth, and concentration at greatest depth, for metolachlor using PRZM.....	34
Table 10.	Effect of parameter variation on predicted leaching depth, and concentration at greatest depth, for metolachlor using GLEAMS.....	36
Table 11.	Effect of parameter variation on predicted leaching depth, and concentration at greatest depth, for metolachlor using CMLS.....	38
Table 12.	Half-life values for Metolachlor.....	40
Table 13.	Koc values for Metolachlor.....	40
Table 14.	Half-life values for alachlor.....	61

LIST OF FIGURES

FIGURE		PAGE
Figure 1.	Protected and sensitive aquifers in the Lower Peninsula, MI.....	5
Figure 2.	Leaching of metolachlor at East Lansing, MI as predicted by PRZM.....	25
Figure 3.	Leaching of metolachlor at Hickory Corners, MI as predicted by PRZM.....	27
Figure 4.	Leaching of metolachlor at East Lansing, MI as predicted by GLEAMS.....	29
Figure 5.	Leaching of metolachlor at Hickory Corners, MI as predicted by GLEAMS.....	31
Figure 6.	Observed leaching of metolachlor at East Lansing, MI.....	47
Figure 7.	Observed leaching of alachlor at East Lansing, MI.....	49
Figure 8.	Observed leaching of metolachlor at Hickory Corners, MI.....	51
Figure 9.	Observed leaching of alachlor at Hickory Corners, MI.....	53
Figure 10.	CMLS-predicted degradation curves, with and without adjustment for $T_{1/2} = 15$ days, and observed curves for metolachlor at East Lansing, MI.....	55
Figure 11.	CMLS-predicted degradation curves, with and without adjustment for $T_{1/2} = 7$ days, and observed curves for alachlor at East Lansing, MI.....	58
Figure 12.	CMLS-predicted degradation curves, with and without adjustment for $T_{1/2} = 10$ days, and observed degradation curves for metolachlor at Hickory Corners, MI.....	60

Figure 13. CMLS-predicted degradation curves, with and without adjustment for $T_{1/2} = 7$ days, and observed degradation curves for alachlor at Hickory Corners, MI.....	63
Figure 14. Depth of maximum detectable metolachlor residues over time, as observed versus as predicted by CMLS, PRZM and GLEAMS, at East Lansing, MI.....	66
Figure 15. Depth of maximum detectable metolachlor residues over time, as observed versus as predicted by CMLS, PRZM and GLEAMS, at Hickory Corners, MI.....	68
Figure 16. Depth of maximum detectable alachlor residues over time, as observed versus as predicted by CMLS, PRZM and GLEAMS, at East Lansing, MI.....	70
Figure 17. Depth of maximum detectable alachlor residues over time, as observed versus as predicted by CMLS, PRZM and GLEAMS, at Hickory Corners, MI.....	72

INTRODUCTION

Over the past 5 years a number of studies have led to heightened concern over the quality of groundwater for human consumption. Cases of particular concern involved the contamination of groundwater supplies with agriculturally-related compounds such as pesticides and nitrates. Aldicarb [2-methyl-2-(methylthio)propionaldehyde o-(methylcarbamoyl) oxime], a highly toxic insecticide, triggered concern when it was discovered in wells in New York, California, Wisconsin, and Florida (43). In 1986, the Environmental Protection Agency (EPA) published a background paper on pesticides in groundwater which noted that 17 pesticides had been detected in wells in 23 states. Many of these pesticides were herbicides (43). Although most of these compounds were found at levels below the health advisory concentrations set by EPA, the public has the perception that there is risk (11). These concerns are compounded by the great importance that groundwater plays as a primary source of drinking water for the rural community; in Michigan, 17% of public health supplies are from groundwater. About 43% of Michigan residents depend on groundwater for home use (17).

The EPA requires data on the environmental fate of pesticides before they can be registered under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The EPA allows the use of computer models such as PRZM (Pesticide Root Zone Model) to assess long-term leaching potential of new pesticides (12). Yet the accuracy of PRZM and other computer models to predict leaching potential and leaching depth is critical, both to assure the public welfare and to support the effort of the agrichemical industry in bringing new products to market. Concerns about the degree of validation of models developed and used by EPA were voiced by the Science Advisory Board's Environmental Engineering Committee (38).

There are many computer models available which could be used to assess the potential of herbicides to leach through the vadose zone (i.e., the unsaturated zone from the soil surface to the groundwater table). Each model has strengths and weaknesses which need to be assessed before application to a particular case. More importantly, the original purpose of the model needs to be considered before the model is used for other purposes, since assumptions made in the model may lead to erroneous or misleading results. At this point it is not known if comparisons have been made between all three models.

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Nofzinger and Hornsby (34) developed the CMLS (Chemical Movement in Layered Soil) model for use as a demonstration tool in extension and teaching in Florida. Hornsby has also suggested that the model could be used to provide guidance to state agencies as they develop groundwater management plans, to aid as a screening tool for environmental sampling and to aid in designing more cost-effective environmental fate studies (21,22).

The PRZM model was developed by EPA in 1984 as a regulatory tool (6) and has been widely used by industry. The model has been tested at several locations on different soils (7,12,13,23,31), and has been recently combined with saturated-zone models and/or used with advanced statistical techniques such as Monte Carlo numerical simulation (9,10,42). In his introduction to the user's manual, Carsel points to several other uses for PRZM, such as a management and screening tool (6).

The GLEAMS (Groundwater Loading Effects of Agricultural Management Systems) model was developed in 1985 by the USDA-ARS to evaluate the effects of agricultural management systems on the movement of agricultural chemicals on and through the root zone (27,29,30). It is based on the CREAMS (Chemical Runoff and Erosion from Agricultural Management Systems) model, with the addition of a component for vertical flux of pesticides. The model has also been used

ans a screening and research tool. The CREAMS model on which it is based is one of the oldest and has undergone many years of testing and use in many areas of the country (25,26).

These models were developed in such places as Florida, California and Georgia. Because of the differences between these areas and the Great Lakes region, it is important that these models be evaluated under Michigan conditions to be certain that the algorithms developed in these models will be applicable to local conditions. Geologically, Michigan has been most affected by glacial action, and there is much spatial variability and diversity in soils and underlying geologic formations (16). Some areas of the state have been identified as having vulnerable aquifer formations (Figure 1). Although there has been no extensive statewide assessment of the presence, extent of severity of pesticide contamination in Michigan groundwater.

Two herbicides were chosen for this study based on their potential for leaching to groundwater. The EPA classifies herbicides as "leachers" based on their physical and chemical properties, including water solubility, field dissipation half-life, and soil sorption (43). Metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)acetamide] and alachlor [2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide] have been found in groundwater

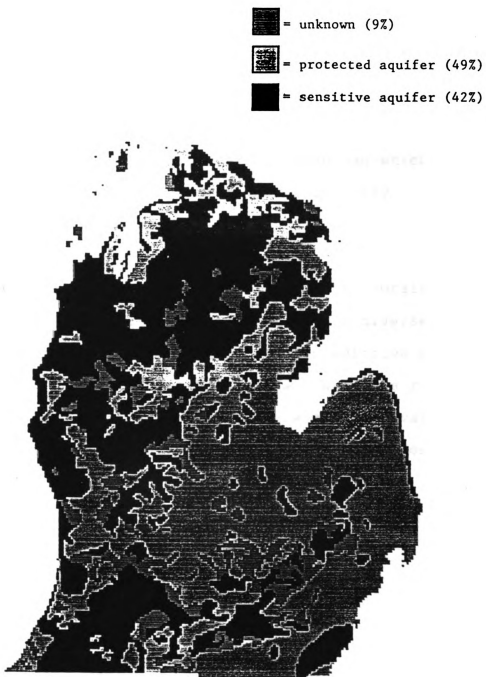


Figure 1. Protected and Sensitive Aquifers in the Lower Peninsula, MI
(Source: MDNR, 1988)

in other states following what EPA has suggested as normal land application (43). Both herbicides are recommended for use in soybean production in Michigan (24).

The goal of this work is to find prediction and management tools to aid in protecting groundwater, while keeping chemical tools available to producers in Michigan which they need to produce a diversity of crops and still stay competitive on the world market.

The objectives of this investigation are: (1) to obtain and evaluate readily available computer models of a diverse nature to determine their applicability as predictive models for herbicide persistence, leachability and ultimate risk of groundwater contamination; and (2) to determine the validity of these models by comparison with actual field studies.

MATERIALS AND METHODS

A. Comparison of Models

Three computer models were chosen for study. CMLS (Chemical Movement in Layered Soil), Version 4.2, was obtained from the Cooperative Extension Service, University of Florida, Institute of Food and Agricultural Sciences, Gainesville, FL. PRZM (Pesticide Root Zone Model), Version 2, was obtained from the U.S. Environmental Research Laboratory, Athens, GA. The GLEAMS (Groundwater Loading Effects of Agricultural Management Systems), Version 1.8.54, was obtained from the USDA-ARS Southeast Watershed Research Laboratory, Tifton, GA. Source code was also obtained for the public domain software PRZM and GLEAMS, while only executable code is available for CMLS.

First, all programs were tested using the sample data sets provided to insure proper operation. Hardware and software requirements for each model are given in Table 1. All programs are available as compiled, executable code for DOS-based personal computer systems. PRZM requires an 8087 math co-processor for operation, although a version could be compiled by the user which does not require a math co-processor, using the source code provided and a commercially

Table 1. Hardware and software requirements for PRZM, GLEAMS and CMLS.

<u>Model</u>	<u>Requirements</u>
PRZM	IBM-PC or compatable 256 K RAM 8087 math co-processor 5 mB hard disk DOS 2.10 of higher
GLEAMS	IBM-PC/AT or compatable 512 K RAM 8087 math co-processor ¹
CMLS	IBM-PC or compatable DOS 2.0 128 K RAM color/graphics card

1. Recommended.

available compiler. The other two computer programs recommend the use of a math co-processor. CMLS includes a menu-driven program for creating data sets as part of the program. This version of GLEAMS includes a separate set of user-friendly front-end software, which includes help screens and example references, for input parameter files. The input files for PRZM and GLEAMS are in fortran format statements which are well-explained in the users manuals, and files can easily be constructed in flat ASCII using a number of commercially-available, full-screen editing programs.

Input files were developed using field data and literature sources. The models were first evaluated for parameter sensitivity. Base values used in the input parameter files are given in Tables 2-5 and in Appendices A through C. Each parameter value was then varied over a wide range, and model output was compared to determine the effect of parameter variation on predicted herbicide leaching and concentration over time.

B. Site and Soil Evaluation

The sites chosen for study were at the Michigan State University (MSU) Research Farm, East Lansing, MI, and at the Kellogg Biological Station (KBS), Hickory Corners, MI. These sites are located in geographical areas which have

Table 2. Base values for parameters used in CMLS for East Lansing, MI

a. Soil description - Capac¹.

Soil Layer ²	BD ³ (g/cc)	FC ³ (%)	WP ³ (%)	Sat. ³ (%)
1	1.34	19.0	5.8	49.4
2	1.35	19.0	5.8	49.0
3	1.56	16.0	10.8	41.1
4	1.50	16.0	10.8	43.4
5	1.51	16.0	10.8	43.0
6	1.50	15.0	10.4	43.4

b. Chemical description - Metolachlor

Parameter ²	Value ¹
Koc	250
Half-life (days)	18

1. Sources: soils data from SCS, 1980; chemical data provided in CMLS.

2. Soil layers 1 through 6 refer to depths of 0-15.2, 15.2-30.5, 30.5-45.7, 45.7-61.0, 61.0-76.2, and 76.2-91.4 cm, respectively.

3. BD = bulk density; FC = field capacity; WP = wilting point; Sat. = water content at saturation; Koc = partition coefficient normalized for organic carbon.

Table 3. Base values for predictions used in GLEAMS for East Lansing, MI.

<u>Model Parameters¹</u>	<u>Value</u>	<u>Reference</u>
a. Hydrology submodel		
RC (in/in)	0.2	SCS, 1980
BST	1.0	field data
CONA	3.3	Kniesel, 1980
CN2	85	"
CHS (ft/ft)	0.005	field data
WLW	3.3	"
RD (cm)	91.4	"
GR	1.0	Kniesel, 1980
b. Erosion/Sediment yield submodel		
K factor	0.32	SCS, 1987
Slope (ft/ft)	0.005	field data
C factor	0.5	SCS, 1987
P factor	1.0	"
manning's n	0.014	ERO.EXE ²
c. Pesticide submodel		
H2OSOL (mg/L)	530	WSSA, 1984
COFUP	1.0	"
SOLLIF (days)	18	PST.EXE ²

1. RC = effective saturated conductivity; BST = fraction of plant-available water in soil when simulation begins; CONA = soil evaporation parameter; CN2 = SCS curve number for moisture condition II; CHS = hydraulic slope of field; WLW = ratio of field length th field width; RD = effective rooting depth; GR = winter cover factor; Ksoil = soil erodibility factor; C factor = soil loss ratio for overland flow; P factor = contouring factor for overland flow; H2OSOL = pesticide water solubility; COFUP = coefficient of plant uptake; SOLLIF = soil pesticide degradation half-life.

2. ERO.EXE = front-end software for construction of parameter set for erosion/sediment yield submodel; PST.EXE = front-end software for pesticide submodel parameter set.

Table 4. Base values for parameters used in PRZM for East Lansing, MI.

<u>Model Parameters</u> ¹	<u>Value</u>	<u>Reference</u>
a. Hydrology		
PFAC	0.765	Carsel, et.al, 1984
ANETD (cm)	15.0	"
CN2: fallow	91	"
crop	85	"
residue (0%)	91	"
crop emergence (date)	May 23	field data
crop maturity (date)	Sept 12	"
crop harvest (date)	Sept 24	"
b. Pesticide (Metolachlor)		
SOL (ppmw)	530	WSSA, 1984
COFUP	1.0	WSSA, 1984
decay rate (days ⁻¹)	0.0385	PST.EXE

1. PFAC = pan factor; ANETD = annual minimum depth from which evapotranspiration is extracted; CN2 = SCS curve number for moisture condition II; SOL = pesticide water solubility; COFUP = coefficient of uptake.

2. PST.EXE = front-end software for pesticide parameter set for GLEAMS.

Table 5. Soil moisture values used in PRZM for East Lansing, MI (Base 2).

Soil Layer ¹	Field capacity (FC)	Wilting Point (WP)
1	0.19	0.06
2	0.19	0.06
3	0.16	0.11
4	0.16	0.11
5	0.15	0.10
6	0.15	0.10

Source: SCS, 1980.

1. Soil layers 1 through 6 refer to depths of 0-15.2, 15.2-30.5, 30.5-45.7, 45.7-61.0, 61.0-76.2, and 76.2-91.4 cm, respectively.

been classified by the Michigan Department of Natural Resources (33) as having low and high potentials of groundwater contamination, respectively (Figure 1). Soil samples at both sites were taken at 15.2 cm increments down to 91.4 cm. Samples were combined within depths and analyzed for pH, percent organic matter, and soil texture by the MSU soil testing laboratory.

The field at East Lansing was identified as a Capac sandy clay loam (fine-loamy, mixed, mesic Aeric Ochraqualfs). Soil characteristics from various soil layers are given in Table 6. Capac soil is a somewhat poorly drained soil formed in loamy glacial till on till plains and moraines. It has a dark, loamy surface layer approximately 20 cm thick, and the subsoil is mottled yellow-brown and grayish-brown loam and clay loam. It is classified as hydrologic group C (39). Thus this soil has a low potential for leaching.

The soil at Hickory Corners was identified as a Kalamazoo loam (fine-loamy, mixed, mesic Typic Hapludalfs). Soil characteristics are given in Table 7. The Kalamazoo series includes well-drained soils formed in loamy over sandy glaciofluvial deposits. The surface is a loam. The B horizon contains loam, clay loam and sandy loam. The C horizon consists of coarse sand. It is classified as

Table 6. Soil description from soil test results for Capac soil at East Lansing, MI.

Depth (cm)	OM ¹ (%)	Sand (%)	Silt (%)	Clay (%)	Soil Type ¹
0.0-15.2	2.6	49.84	27.44	22.72	scl
15.2-30.5	2.0	41.84	31.44	26.72	loam
30.5-45.7	0.7	47.84	25.44	26.72	scl
45.7-61.0	0.5	51.84	25.44	22.72	scl
61.0-76.2	0.4	50.56	22.72	26.72	scl
76.2-91.4	0.5	48.56	26.72	24.72	scl

1. OM = organic matter; scl = sandy clay loam.

Table 7. Soil description from soil test results for Kalamazoo soil at Hickory Corners, MI.

Depth (cm)	OM ¹ (%)	Sand (%)	Silt (%)	Clay (%)	Soil Type ¹
0.0-15.2	1.6	39.84	39.44	20.72	loam
15.2-30.5	1.2	39.84	37.44	22.72	loam
30.5-45.7	0.4	51.84	17.44	30.72	scl
45.7-61.0	0.3	73.84	7.44	18.72	sl
61.0-76.2	0.3	81.84	3.44	14.72	sl
76.2-91.4	0.1	87.84	1.44	10.72	ls

1. OM = organic matter; scl = sandy clay loam; sl = sandy loam; ls = loamy sand.

hydrologic group B (39). This soil, therefore, has a high leaching potential.

It should be noted here that although the sites are located in vulnerable areas, the term "leaching potential" is not synonymous with groundwater contamination potential. All of the models look only at movement through the soil profile, and estimate the movement of a chemical past some arbitrarily-set root zone. Since the models do not include any simulations of movement through subsoil or glacial materials to the aquifer, one can only make the assumption that chemicals moving past the root zone have the potential of contaminating groundwater, given sensitive geologic conditions. No field studies were done to measure leachate past this root zone, nor were groundwater investigations carried out. Therefore this study does not attempt to simulate or measure groundwater contamination, and no such assumptions of groundwater contamination are made.

C. Field Studies

Leaching studies were conducted in 1987 at the two sites discussed above. The management schedule is given in Table 8. Both sites were conventionally tilled prior to planting. The site at East Lansing was fall-plowed and the seedbed mechanically prepared in the spring. Conventionally-tilled soybeans were grown at the site the previous year. The site

Table 8. 1987 Leaching study management and sampling schedule.

<u>Event</u>	<u>Site</u>			
	<u>MSU</u>	<u>Depth</u>	<u>KBS</u>	<u>Depth</u>
	(date)	(cm)	(date)	(cm)
Planting date	5/13	--	5/27	--
Background sample	5/14	91.2	5/29	91.2
Treatment	5/20	--	6/1	--
1st Sample	5/21	30.5	6/9	61.0
2nd Sample	6/16	61.0	7/3	91.2
3rd Sample	7/15	91.2	8/8	91.2
4th sample	8/20	91.2	--	--
Harvest	9/24	--	10/15	--
Postharvest Sample	9/26	91.2	10/24	91.2

at Hickory Corners was in alfalfa sod for the 5 previous years, and was spring-plowed and prepared for planting. The site at East Lansing was planted to soybeans (Hodgson 78, a Group II variety) on May 13, with a row spacing of 76 cm. The site at Hickory Corners was planted to soybeans (Great Lakes 2634, a Group I variety) on May 27, with a row spacing of 76 cm. Soil samples were collected 1 day prior to herbicide treatment to determine herbicide residues remaining, with samples taken in 15.2 cm increments down to a depth of 91.4 cm.

Two herbicides were applied preemergence and an untreated control was left for yield comparisons. The treatments were arranged as randomized complete blocks, with four replications. Plot size was approximately 3 by 9.1 meters at East Lansing, and 4.6 by 9.1 meters at Hickory Corners. Metolachlor (2.2kg/ha) and alachlor (2.2kg/ha) were applied. The plots at East Lansing and Hickory Corners were treated on May 20 and June 1, respectively. Herbicides were applied with a tractor-mounted compressed air sprayer, using 8003 flat fan nozzles. Treatments were applied at 210 kPa with a total spray volume of 215 L/ha. Although soil moisture data are not available, soil moisture levels were estimated as being near field capacity since there had been rain at both sites within the last 3 days.

At East Lansing, soil samples were collected 1 day after treatment with a 2.5-cm diameter soil probe to a depth of 30.5 cm. Samples were divided into 15.2 cm segments. Ten samples were collected per plot and were combined within soil depths and plots. Treatment replicates were sampled separately. At Hickory Corners, The first samples were collected 9 days after treatment, because of rain delays, with a 7.6 cm diameter soil auger. Samples at later dates for both sites were also taken with the 7.6 cm auger at times and depths listed in Table 8. Three samples were collected per plot per sample date with the larger soil auger, and samples were combined across soil depth. In every case, samples were kept cool and shaded, and were placed in storage at -11 C within 8 hours of sampling and frozen until analysis. A known amount of herbicide was added to an untreated soil aliquot and placed with field samples at the time of storage for later analysis of storage losses.

During the growing season, climatological information was gathered at the field site and from nearby National Weather Service weather stations. At East Lansing, evaporation readings from a Class A open pan were taken at the field site, and rainfall records were recorded at the Crop and Soil Science Barn, which was 40 meters from the field site. Records from the East Lansing weather station on the MSU Horticulture Farm were also collected for the entire year.

Missing data was extrapolated from Lansing weather station records. Evaporation and rainfall data was gathered for the growing season from the KBS Agronomy Research Farm, Hickory Corners, which was 40 meters from the field site. Gull Lake weather station records were gathered for the rest of the year.

D. Soil Residue Analysis

The metolachlor analysis technique was based on the method of Braverman et al. (5). A soil sample was brought to room temperature, mixed, and brought to uniform size. A 10 g sample was oven-dried for 24 hr to determine moisture content. A soil sample weighing 45 g was shaken in a stoppered 250-ml Erlenmeyer flask with 100 ml methyl alcohol, ACS grade, and 10 ml distilled water for 2 hr on a reciprocating shaker. The solvent was filtered with Whatman no.2 filter paper under house vacuum. An additional 100 ml of water was added, plus 10 ml of saturated NaCl solution, and the metolachlor was extracted with three 50-ml aliquots of hexane in a separatory funnel. Anhydrous sodium sulfate was added to the combined hexane aliquots, and the decanted solvent was evaporated to dryness with a rotary evaporator on a water bath at 40 C. Final sample cleanup was done on a column of basic alumina which had been deactivated with 16% distilled water. The sample was eluted from the column with 8% ethyl ether- hexane, evaporated just to dryness on the

rotary evaporator and dissolved in 10 ml analytical grade hexane. Samples were frozen until analysis. Recovery was found to be about 89% using soil samples that were treated with known quantities of metolachlor before extraction.

The alachlor extraction method is a simplified version of the metolachlor method. A 25-g air-dry soil sample was mixed and brought to uniform size. The sample was shaken with 150 ml ACS grade acetone for two hours in a stoppered 250-ml Erlemeyer flask. The acetone was filtered using a Whatman no.2 glass fiber filter under house vacuum. The acetone was evaporated just to dryness using the rotary evaporator with the flask immersed in a water bath at 35 C. Cleanup of alachlor was accomplished on a column containing basic alumina which had been deactivated with 14% water, and overlain with anhydrous sodium sulfate. An 8% ethyl ether-hexane solution was used to elute the alachlor from the column. The extract was evaporated to dryness and redissolved in 10 ml analytical grade hexane, then frozen at 0 c until analysis. Recovery was estimated at 89%.

Both metolachlor and alachlor were analyzed using gas-liquid chromatography with an ECD Ni-63 detector and nitrogen carrier gas at 30 ml/min. The column contained 10% DC-200 on 80/100 Chrom Q. Column temperature was 216 C, injector temperature was 250 C, and detector temperature was 290 C. A

5- μ l injection volume was used. The detection limit for both compounds was 10 ppb by the method of four-times noise.

RESULTS AND DISCUSSION

A. Comparison of Models

Information contained in the output from the simulation models in this study was not identical in form. Sample output is given in Appendices C to E. The output from PRZM is given as pesticide concentration at various soil depths on a day-by-day basis, which is most convenient for comparison of leaching depth and concentration at specific days throughout the growing season. The output from GLEAMS is given as pesticide concentration before and after rainfall events. This is logical, since solute movement is tied to changes in soil moisture conditions, but it makes it difficult to compare pesticide concentrations at various soil depths for those days between rainfall events. Field sampling may not always be possible immediately after a rainfall event. Often a day or two is needed for the soil to dry out sufficiently for sampling. Therefore pesticide concentrations for the nearest rainfall event were used for comparison. It should also be noted that unequal soil depths are used, as the first soil sample is from 0 to 1 cm, with the following soil depths set at 1 to 8, 8 to 15 cm, etc. This will affect the concentrations given, since calculation of concentration of a comparable mass of

pesticide in the upper versus next soil layer will result in a greater concentration in the top layer. The output from CMLS was not available as pesticide concentration at various soil depths on specific days, but as depth of the pesticide "pulse" on a time line over the growing season. Total pesticide remaining in the soil is also calculated and displayed separately. Also, PRZM and GLEAMS can simulate pesticide losses from surface runoff, whereas CMLS is only a leaching model. Within these limitations, model outputs were compared for leaching of metolachlor.

The PRZM model output predicted the greatest depth of pesticide leaching, with metolachlor residues predicted at the bottom of the deepest horizon (91.4 cm) in simulations for both East Lansing and Hickory Corners (Figures 2 and 3, respectively). This agrees well with findings of other researchers (23,31). The herbicide concentrations predicted, however, were far below feasible detection limits. Although they could represent levels of residue which may be measurable in the future, they probably are only artifacts of the calculations which the computer program carries out while solving the algorithms. Depth of leaching predictions produced by the CMLS model were most conservative, i.e., predicted movement was far less than that predicted by other models (Appendix C). The prediction for depth of herbicide leaching by GLEAMS was intermediate (Figures 4 and 5).

Figure 2. Leaching of metolachlor at East Lansing, MI as predicted by PRZM.

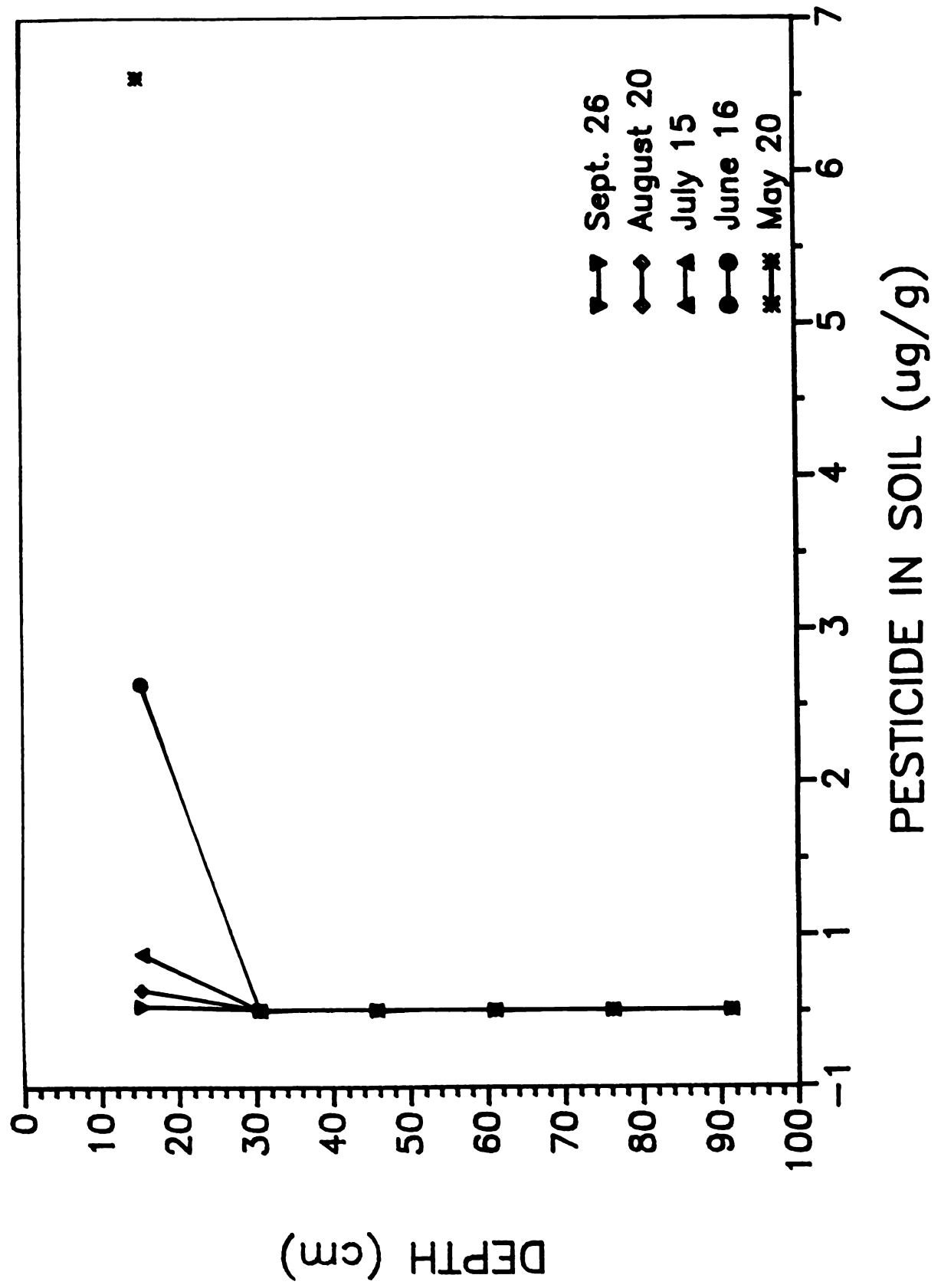


Figure 3. Leaching of metolachlor at Hickory Corners, MI as predicted by PRZM.

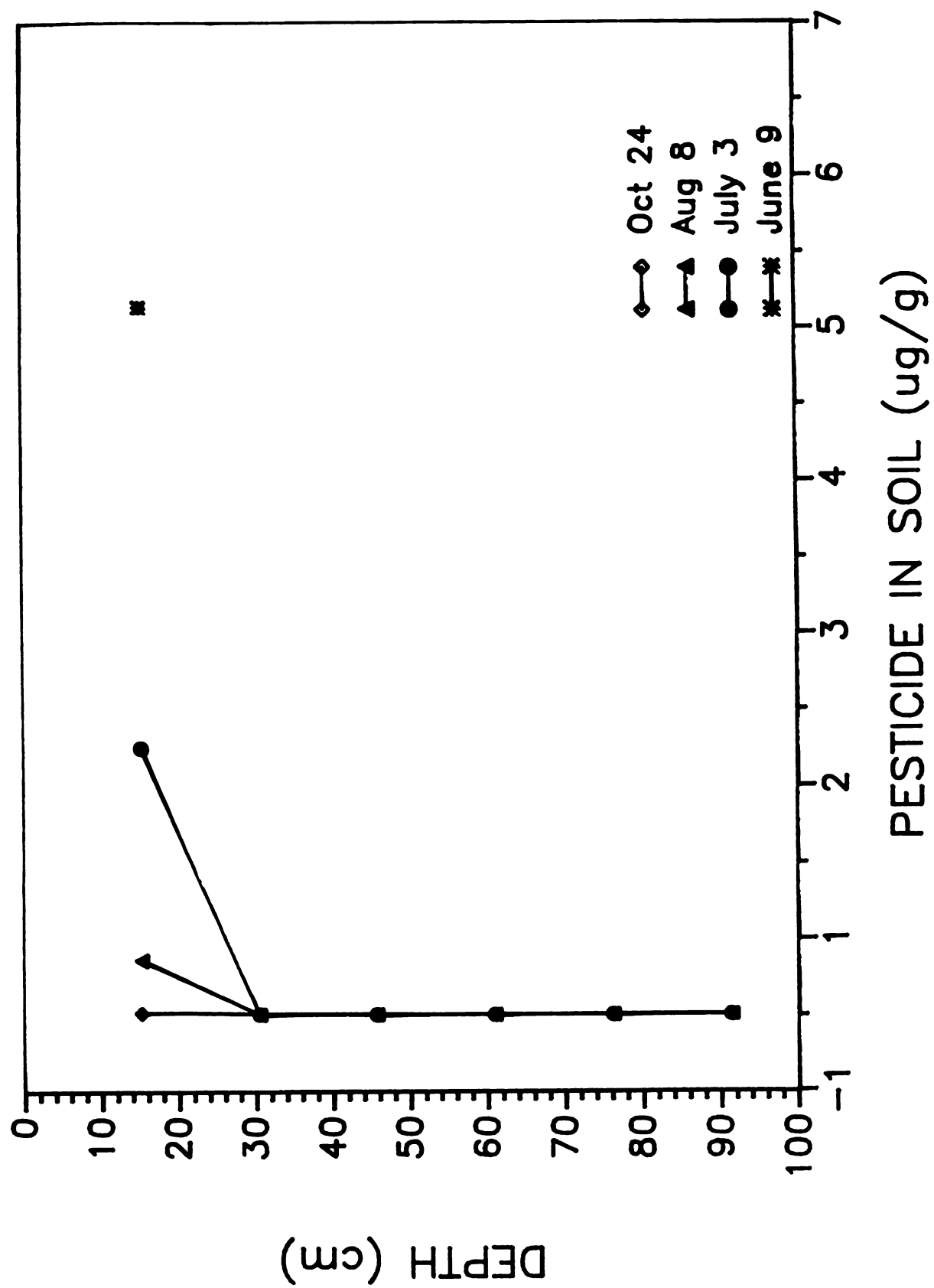


Figure 4. Leaching of metolachlor at East Lansing, MI as predicted by GLEAMS.

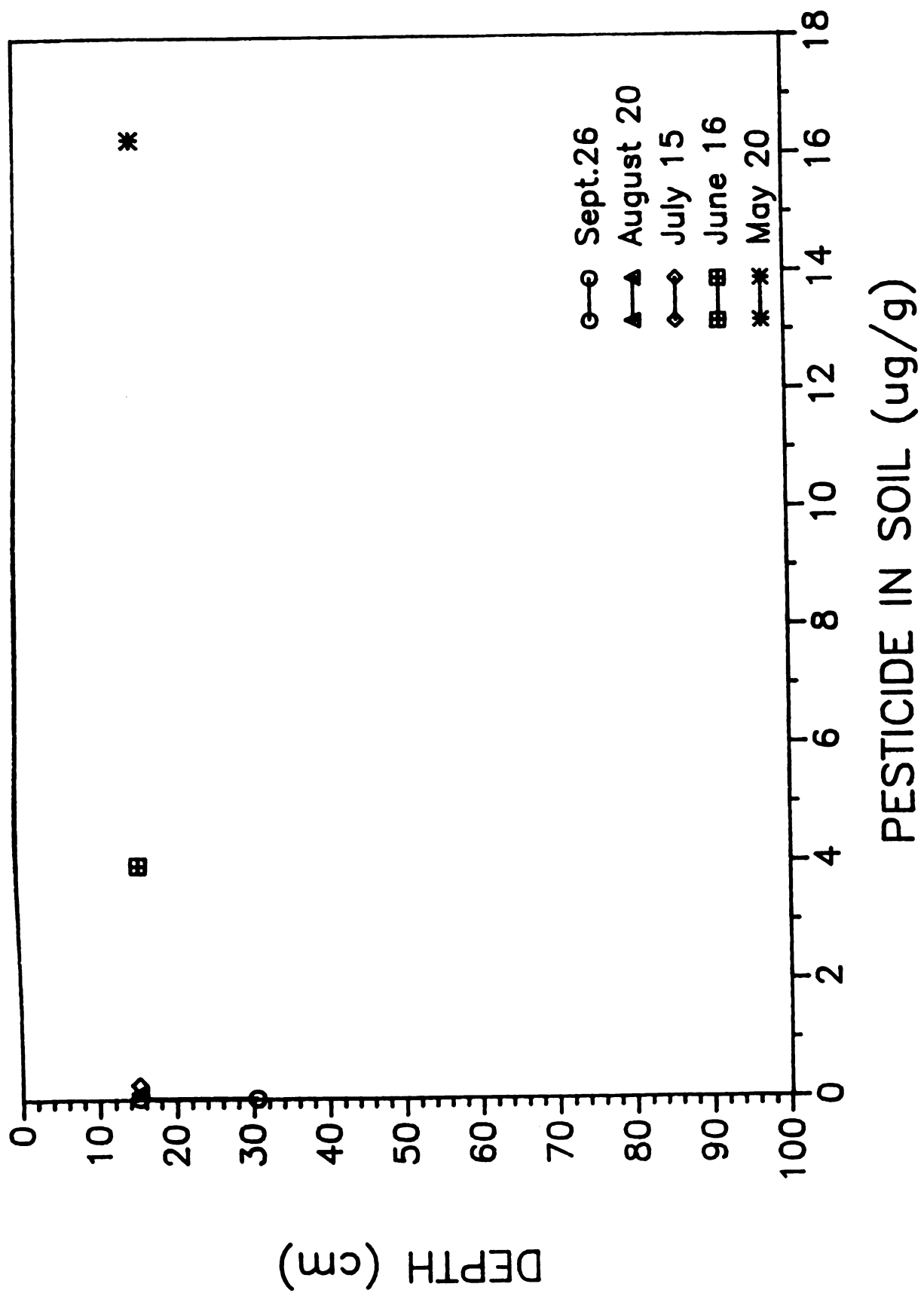
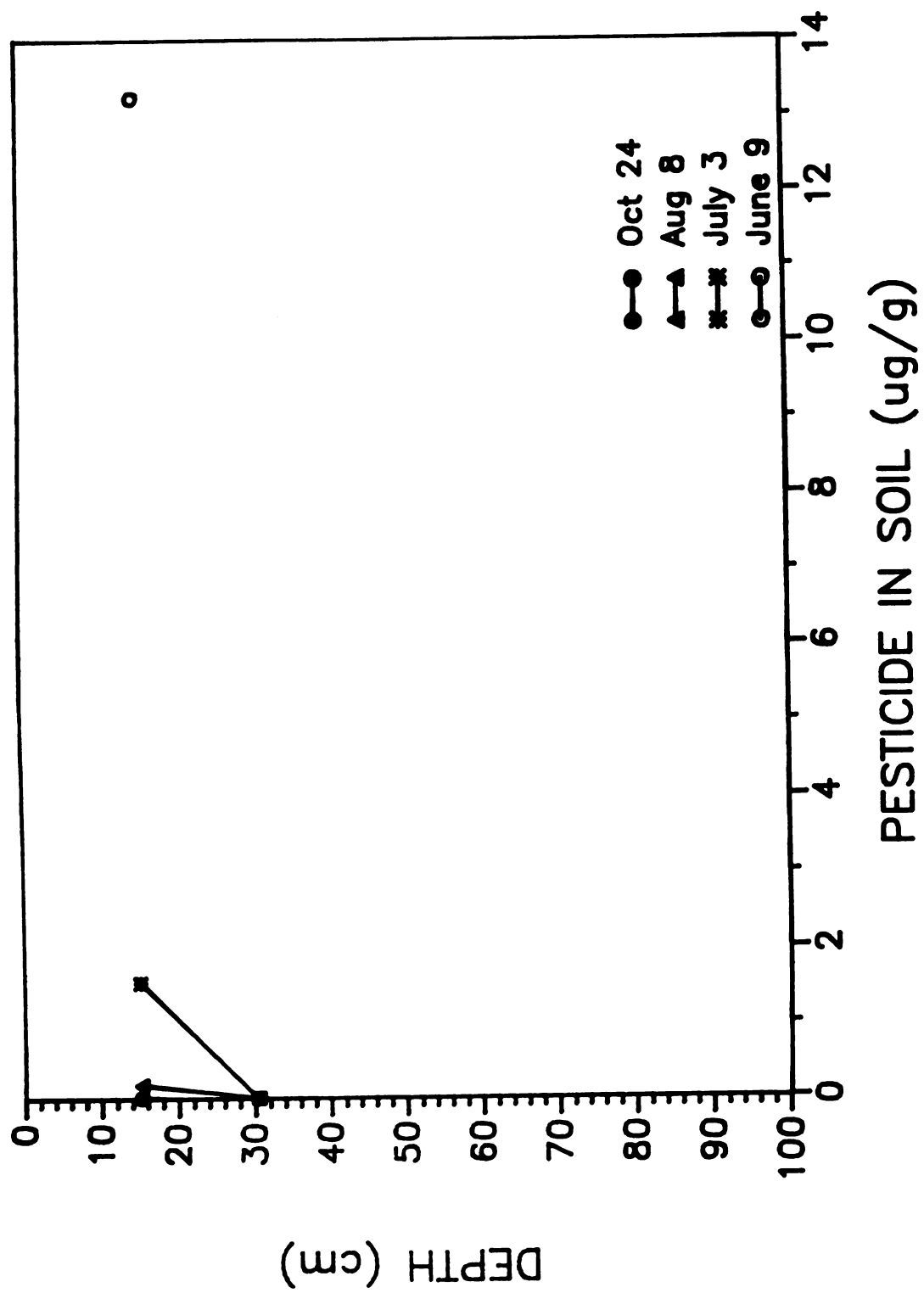


Figure 5. Leaching of metolachlor at Hickory Corners, MI as predicted by GLEAMS.



B. Analysis of Parameter Sensitivity

Variability in input parameters may markedly affect the results of model simulations. Frequently a range of values are reported for constants included in the program.

Therefore, sensitivity analyses were run to determine the parameters whose variability would have the greatest impact on predicted herbicide movement. Tables 9,10, and 11 list results of sensitivity analysis for selected parameters using PRZM, GLEAMS, and CMLS, respectively.

The pesticide parameters half-life and partition coefficient normalized for organic carbon (Koc) were varied under a series of simulations of metolachlor leaching, under conditions found at Michigan State University in the summer of 1987. Soil and climatological information gathered at the site are used. Values for half-life and partition coefficient were taken from the literature (Tables 12 and 13), and illustrate the wide range of values available. The range of values for half-life reflect the differences in results for field versus laboratory studies, and the variability in values due to climatic and soil conditions. Differences in Koc values, which should not be this great, could be due to experimental error.

Table 9. Effect of parameter variation on predicted leaching depth, and concentration at greatest depth, for metolachlor using PRZM.

Parameter ¹	Input Value	Date			
		6-16-87		9-26-87	
		Depth (cm)	Concentration (µg/g)	Depth (cm)	Concentration (µg/g)
base run	base 1 ²	25	0.1960E-11	91	0.1750E-15
CN2	CN1	28	0.1237E-12	91	0.1786E-10
	CN3	13	0.1899E-04	25	0.4846E-12
FC,WP	-50%	91	0.5794E-14	91	0.3272E-11
	-25%	66	0.1188E-23	91	0.1115E-12
	base 2 ²	46	0.5849E-23	91	0.3456E-14
	+25%	13	0.1177E-03	91	0.6695E-16
	+50%	13	0.1793E-04	91	0.6250E-18
degradation	0.0577	25	0.1006E-11	91	0.1104E-16
coefficient ³	0.1733	25	0.4153E-11	91	0.3917E-14
(day ⁻¹)	0.0099	25	0.5418E-11	91	0.1176E-13
	0.0038	25	0.6755E-11	91	0.2927E-13

Table 9 (cont.).

Parameter ¹	Input Value	Date			
		6-16-87		9-26-87	
		Depth (cm)	Concentration ($\mu\text{g/g}$)	Depth (cm)	Concentration ($\mu\text{g/g}$)
SOL (ppmw) ⁴	181	25	0.1968E-13	91	0.3573E-20
	1787	25	0.2072E-09	91	0.1246E-11
	959	25	0.2076E-10	91	0.2033E-13
	13	25	0.9009E-19	91	0.7836E-23
COFUP	0.0	25	0.1960E-11	91	0.1815E-15
	0.5	25	0.1960E-11	91	0.1782E-15

1. CN2 = SCS Curve Number II; SOL = water solubility; COFUP = coefficient of uptake, FC = field capacity; WP = wilting point.
2. Base 1 and Base 2 values for PRZM are given in Tables 4 and 5.
3. Degradation rate = $0.696/\text{half-life}$.
4. $\log K_{oc} = 3.64 - (0.55 * \log \text{SOL})$.

Table 10. Effect of parameter variation on predicted leaching depth, and concentration at greatest depth, for metolachlor using GLEAMS.

Parameter ¹	Input Value	Date			
		6-16-87		9-23-87	
		Depth (cm)	Concentration (µg/g)	Depth (cm)	Concentration (µg/g)
base run	base ²	8	0.5340	30	0.0005
CN2	CN1	8	0.5340	30	0.0005
	CN3	8	0.4526	15	0.0017
POROS, FUL, WP	-50%	15	0.0012	30	0.0003
	-25%	8	0.3774	30	0.0004
	+25%	8	0.8168	30	0.0070
	+50%	8	1.4198	30	0.0012
T _{1/2} (days)	12	8	0.5340	15	0.0005
	40	8	0.5340	45	0.0002
	70	8	0.5340	45	0.0005
	182	8	0.5340	45	0.0012

Table 10 (cont.).

Parameter ¹	Input Value	Date			
		6-16-87		9-23-87	
		Depth (cm)	Concentration ($\mu\text{g/g}$)	Depth (cm)	Concentration ($\mu\text{g/g}$)
Koc	71	8	1.1355	45	0.0010
	100	8	0.9627	30	0.0013
	1078	8	0.1532	15	0.0016
COFUP	0.0	8	0.5340	30	0.0005
	0.5	8	0.5348	30	0.0005

1. CN2 = SCS Curve Number II; POROS = porosity; FUL = field capacity;
WP = wilting point; $T_{1/2}$ = half-life; Koc = partition coefficient
normalized for organic carbon; COFUP = coefficient of uptake.
2. Base values for GLEAMS are given in Table 3.
3. There was no output for 9-26-87. Therefore the nearest date was
used for comparison.

Table 11. Effect of parameter variation on predicted leaching depth, and concentration at greatest depth, for metolachlor using CMLS.

Parameter ¹	Input Value	Depth (cm)	Total Concentration (µg/g)
Base run	base ²	5.6	0.02
POROS, FC, WP, BD	-50%	4.3	0.02
	-25%	4.8	0.02
	+25%	6.6	0.02
	+50%	7.9	0.02
T _{1/2} (days)	12	5.6	0.0016
	40	5.6	0.24
	70	5.6	0.64
	182	5.6	1.36
Koc	71	12.9	0.02
	100	10.4	0.02
	1078	1.5	0.02

Table 11 (cont.).

1. POROS = porosity; FC = field capacity; WP = wilting point, BD = bulk density; $T_{1/2}$ = half-life; Koc = partition coefficient normalized for organic carbon.
2. Base values for CMLS are given in Table 2.

Table 12. Half-life values for Metolachlor.

<u>Half-life (days)</u>	<u>Reference</u>
11 - 70	Braverman <u>et al.</u> , 1986
26	Gerber <u>et al.</u> , 1974
30 - 50	WSSA, 1983
20.9 - 107.8	Walker and Brown, 1985
36.4 - 203.0	Bouchard <u>et al.</u> , 1982

Table 13. Koc values for Metolachlor.

<u>Koc</u>	<u>Reference</u>
71	Braverman <u>et al.</u> , 1986
100	Donigian and Carsel, 1987
255	Bouchard <u>et al.</u> , 1982
342	Rao and Davidson, 1980
1078	Obrigawitch <u>et al.</u> , 1981

Predictions from all three models indicate that half-life and partition coefficient are sensitive parameters that markedly influence the prediction. Half-life (T_{1/2}) values within an order of magnitude of each other had little effect on depth of herbicide leaching unless the concentration remaining was such that very little chemical was available for leaching. The herbicide concentrations present in the lowest soil horizon at the end of the prediction period were greater as half-life increased, as expected. There was little difference between results at the June 16 sample date in comparisons within and between model runs of PRZM and GLEAMS (Tables 9 and 10). All three models have an option for changing half-life values of various soil depths. There has been some research which shows decreased half-life with increasing soil depth (2,4,28). However, in the absence of data for the particular herbicides and soils studied, soil half-life was kept constant through the soil profile, and the resulting half-life represents an average across all soil layers.

Partition coefficient (K_{oc}) also appears to be a very sensitive parameter. Predicted depth of herbicide leaching at September 26 increased as the partition coefficient decreased (Tables 9-11). This is expected as the amount sorbed to soil versus the amount in soil solution has a profound influence on leaching potential. This trend was seen in all simulations, both within and between models. It

should be noted that the PRZM model uses water solubility of the herbicide instead of partition coefficient. The reference value of 530 ppm solubility was used for metolachlor when using the equation provided to estimate Koc from water solubility. The resulting Koc is 137, almost one-half of the value of 250 which was used in base runs of GLEAMS and CMLS. Therefore a second base run was performed for PRZM using a value of 181 ppm solubility, which would correspond to a Koc of 250. The model has the option of using user-supplied Kd values (i.e. partition coefficient not normalized for organic carbon) if the routine KDCALC=0 is chosen. However, model simulations using this option would not run successfully with the soils data provided, and it appears that modification in the source code will be needed to use this option. Carsel (6) discusses this problem briefly in the user's manual.

The parameter coefficient of uptake (COFUP), the relative amount of pesticide taken up by crop plants, was varied between 0 and 1, with 0 being no uptake and 1 being free uptake with water. There is little data available in the literature on this parameter. However, it was not found to be a critical parameter in any model.

The SCS curve number, which is used to calculate surface runoff and sediment loss, was varied from CN2, which reflects average antecedent water conditions or field

capacity, to CN1 (dry) and CN3 (saturated) (25). This was done to determine the potential for miscalculation of leaching potential if the modeler assumes average conditions when in fact the soil is too dry or too wet at the time of pesticide application. Predictions from GLEAMS and PRZM showed that CN3 conditions were critical. Under saturated conditions the runoff and sediment yields would increase with a concomitant decrease in leaching potential (Tables 9,10). Results using CN1 were not significantly different from results using CN2. It should be noted that the range of values used is greater than that of a soil in hydrologic group C. The curve number for such a soil would vary between 78 and 89; the high value of 96 would be more appropriate for a very poorly drained (hydrologic group D) soil.

Finally, the variables field capacity (FC), wilting point (WP) and porosity were varied above and below base values, which were obtained from SCS laboratory studies of Capac soil (39). Values that were 25% and 50% greater and smaller than cited values were used (Table 5). Thus the available water content remained the same, while overall porosity and water-holding capacity were varied. In all three models, there were marked differences in simulated leaching depths and herbicide concentrations with changes in soil parameters, although different models showed different trends (Tables 9,10,11). Although the overall range of

input values represent an extreme case which would not be found in any one soil series, it illustrates the sensitivity of the models to changes in soil parameters, and how the differing methods used to calculate water content and flux will produce different trends. Also, field capacity and wilting point are parameters which can be estimated from laboratory studies but which do not represent constant values in the field.

There are uncertainties involved in estimating field capacity and wilting point if experimental data is unavailable. There are two options provided by the PRZM model. The user may either supply known field capacity and wilting point values for each horizon, or have the model estimate these parameters from values of the fraction of sand, clay and organic carbon in the horizon. In Table 9, the "base run" utilized the option THFLAG=0, with field capacity and wilting point values from SCS laboratory studies (39). The resulting estimates of leaching depth and herbicide concentration at the deepest depths were markedly different, with the latter method predicting greater leaching depth and lower herbicide concentration in the deepest soil layer on June 16 (Table 9). Both methods estimated similar herbicide leaching depth and concentration at the end of the model run. Both options utilized information gathered from both the literature and from an actual field site, with varying results.

C. Field Results

Results of herbicide analysis for the East Lansing site are given in Figures 6 and 7 for metolachlor and alachlor, respectively. Corresponding results for Hickory Corners are given in Figures 8 and 9. At East Lansing, metolachlor residues were found at all sampling dates (Figure 6). The maximum depth of leaching found consistently was 61 cm, and this was first found on the June 16 (28 DAT, or Days After Treatment) sample date. One sample from 76.2 cm taken July 15 (56 DAT) showed detectable metolachlor residues.

Metolachlor was found at a greater depth than alachlor. This may be the result of a longer half-life, since residues remain in the soil long enough to be leached. Figure 10 shows degradation curves generated by the CMLS model for $T_{1/2}$ = 15 and 18 days, compared with the degradation curve of metolachlor as calculated from field results. The figure shows that the half-life of metolachlor at East Lansing is approximately 15 days. This value is very close to the half-life value of 18 days suggested in the GLEAMS front-end software package. It is also in the range of values found in the literature (Table 12). The majority of metolachlor remained in the soil surface layer, from 0.0 to 15.2 cm, and the last sample dates showed detectable herbicide residues only in this top layer (Figure 6). This is consistent with the relationship between sorption of metolachlor and the higher organic carbon levels in the upper soil layers

Figure 6. Observed leaching of metolachlor at East Lansing, MI.

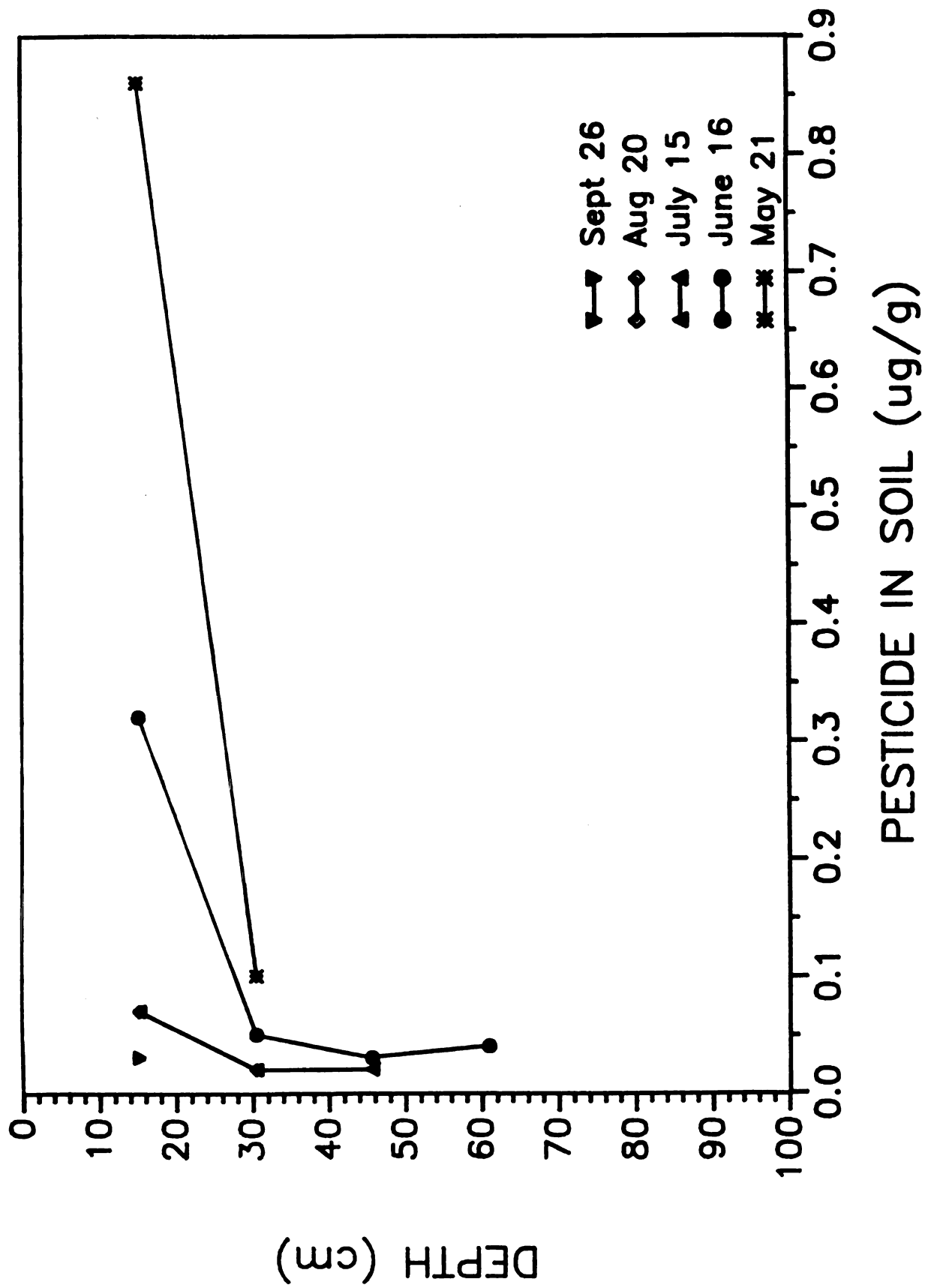


Figure 7. Observed leaching of alachlor at East Lansing, MI.

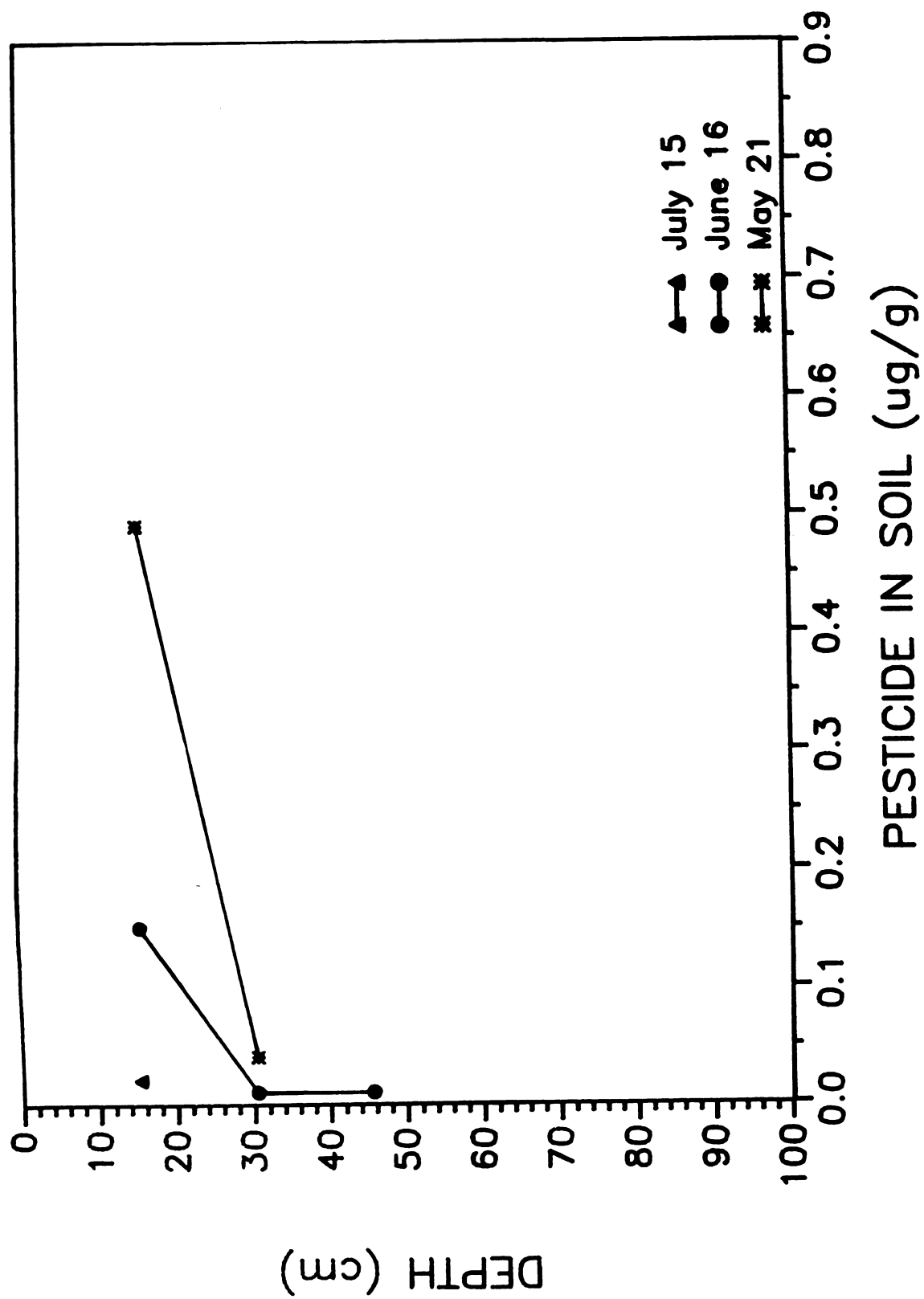


Figure 8. Observed leaching of metolachlor at Hickory
Corners, MI.

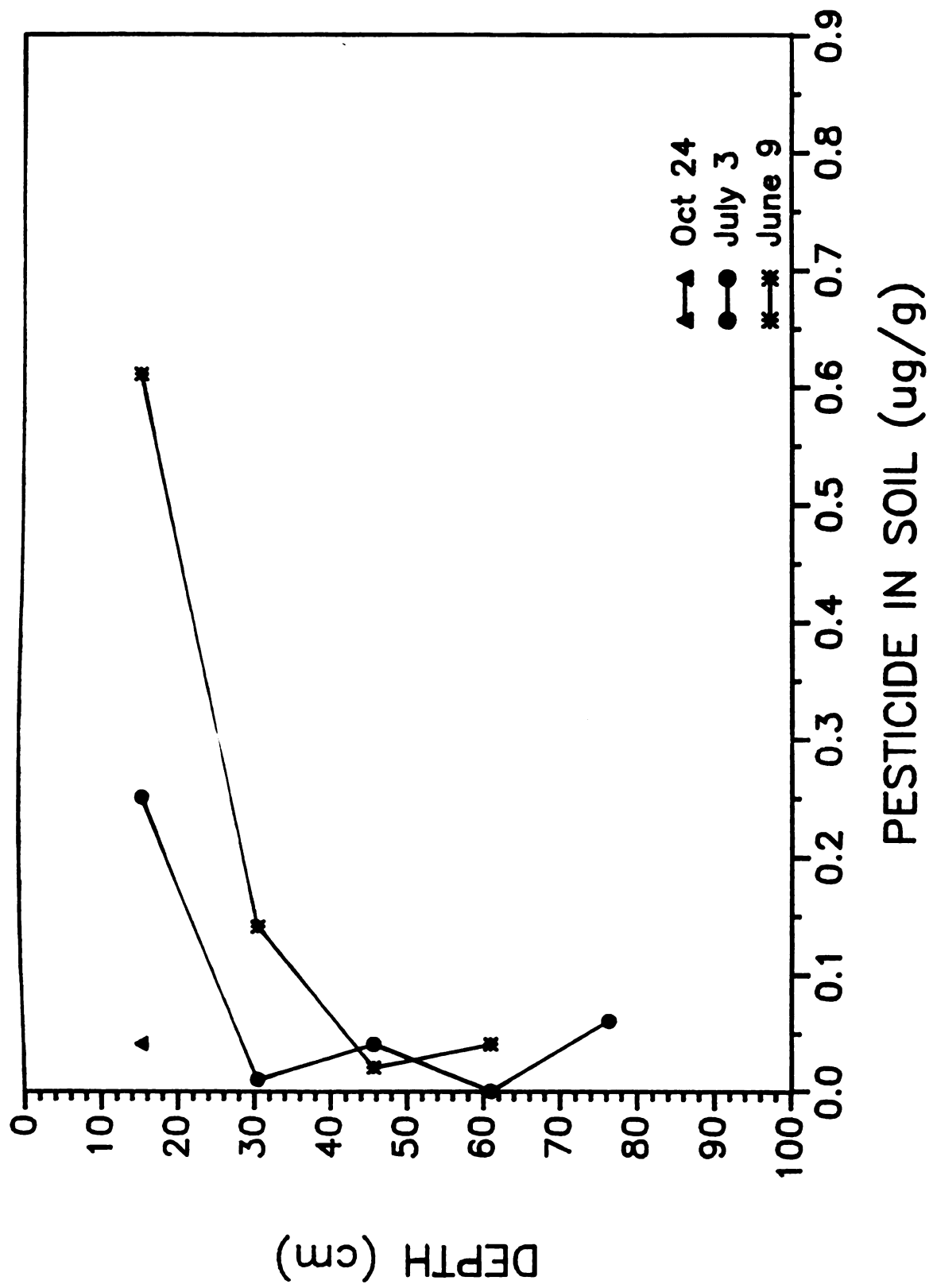


Figure 9. Observed leaching of alachlor at Hickory Corners,
MI.

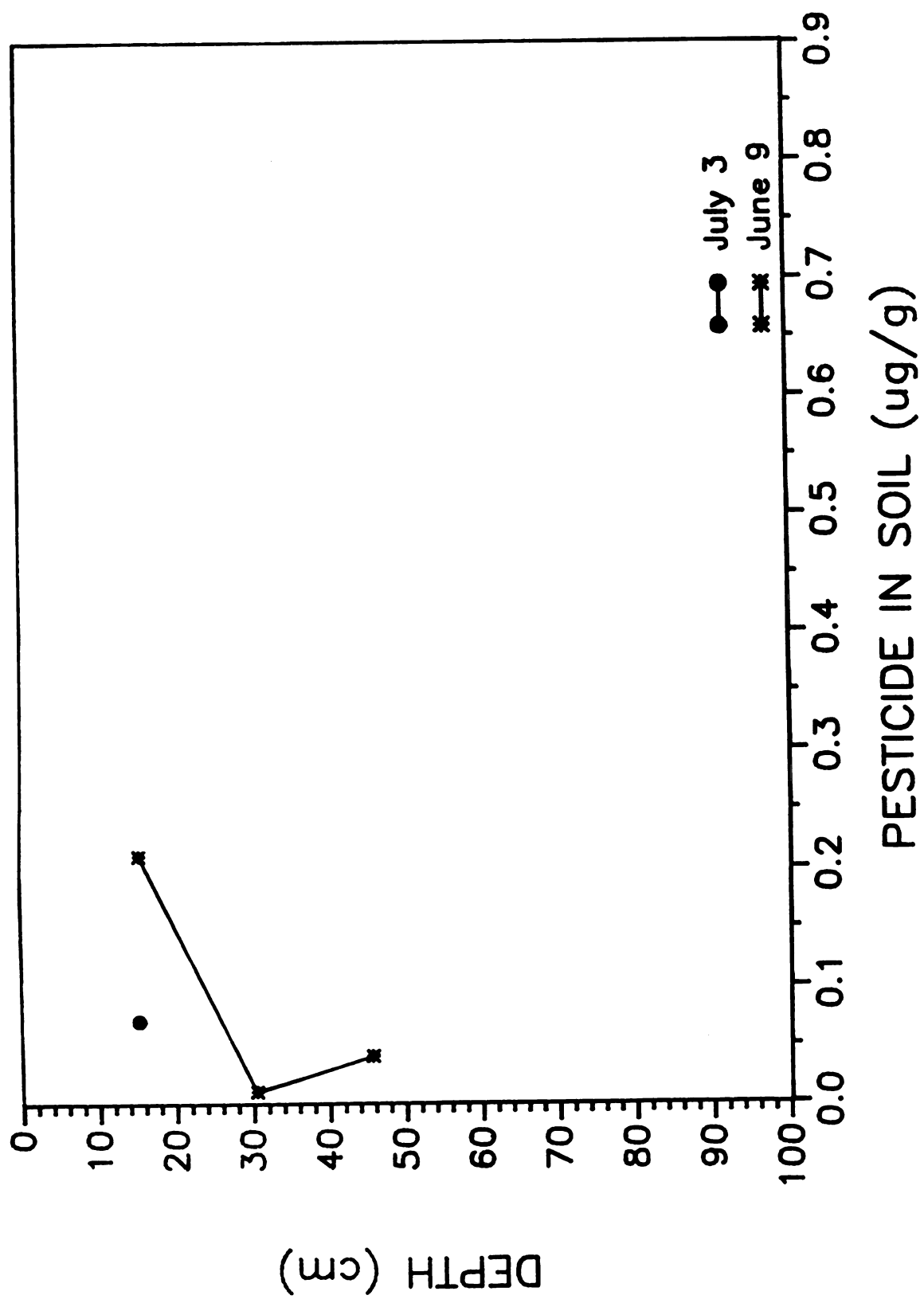
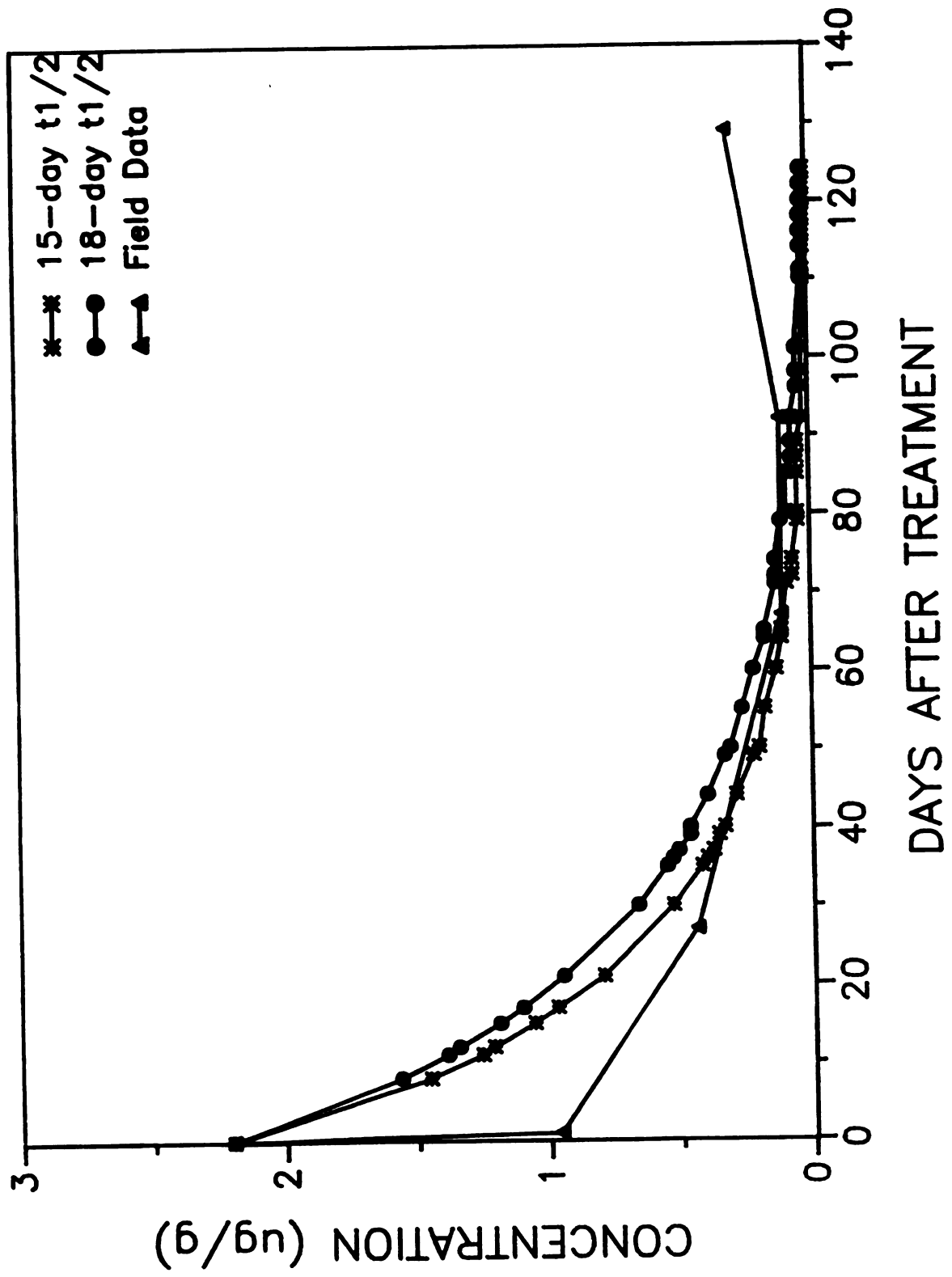


Figure 10. CMLS-predicted degradation curves, with and without adjustment for $T_{1/2} = 15$ days, and observed degradation curves for metolachlor at East Lansing, MI.



(4,5,35). These trends can also be seen from data from Hickory Corners (Figure 8). The maximum depth of leaching was 61 cm on June 9 (9 DAT). One sample from the 76.2-cm depth taken on July 3 (33 DAT) showed metolachlor residues at the limit of detection. However, the majority of the residues remained in the top 15.2 cm of soil. Samples taken on October 24 (146 DAT) showed detectable residues only at the soil surface. Half-life of metolachlor at Hickory corners was approximately 10 days (Figure 11).

In contrast, alachlor residues were degraded more rapidly. At East Lansing, samples taken after July 15 (9 DAT) showed no detectable alachlor residues (Figure 7). Residues present on June 16 (28 DAT) were not found consistently at the same depths over all replications. This was probably due to inherent soil and leaching spatial variability and has been seen in other herbicide residue studies (9,23,37). Two replications showed detectable alachlor residues in the top 15.2 cm on July 15 (56 DAT). Results on total concentration over time suggest that alachlor has a half-life of approximately 7 days (Figure 12). This value is in the range of literature values (Table 14). This is consistent with the value of 7 days suggested by CMLS (34) but is lower than the value of 18 days suggested by GLEAMS (in PST.EXE, the front-end software provided) and PRZM (6). As with metolachlor, the majority of alachlor remained in the top 15.2 cm of the soil. Sorption of alachlor has been

Figure 11. CMLS-predicted degradation curves, with and without adjustment for $T_{1/2} = 7$ days, and observed degradation curves for alachlor at East Lansing, MI.

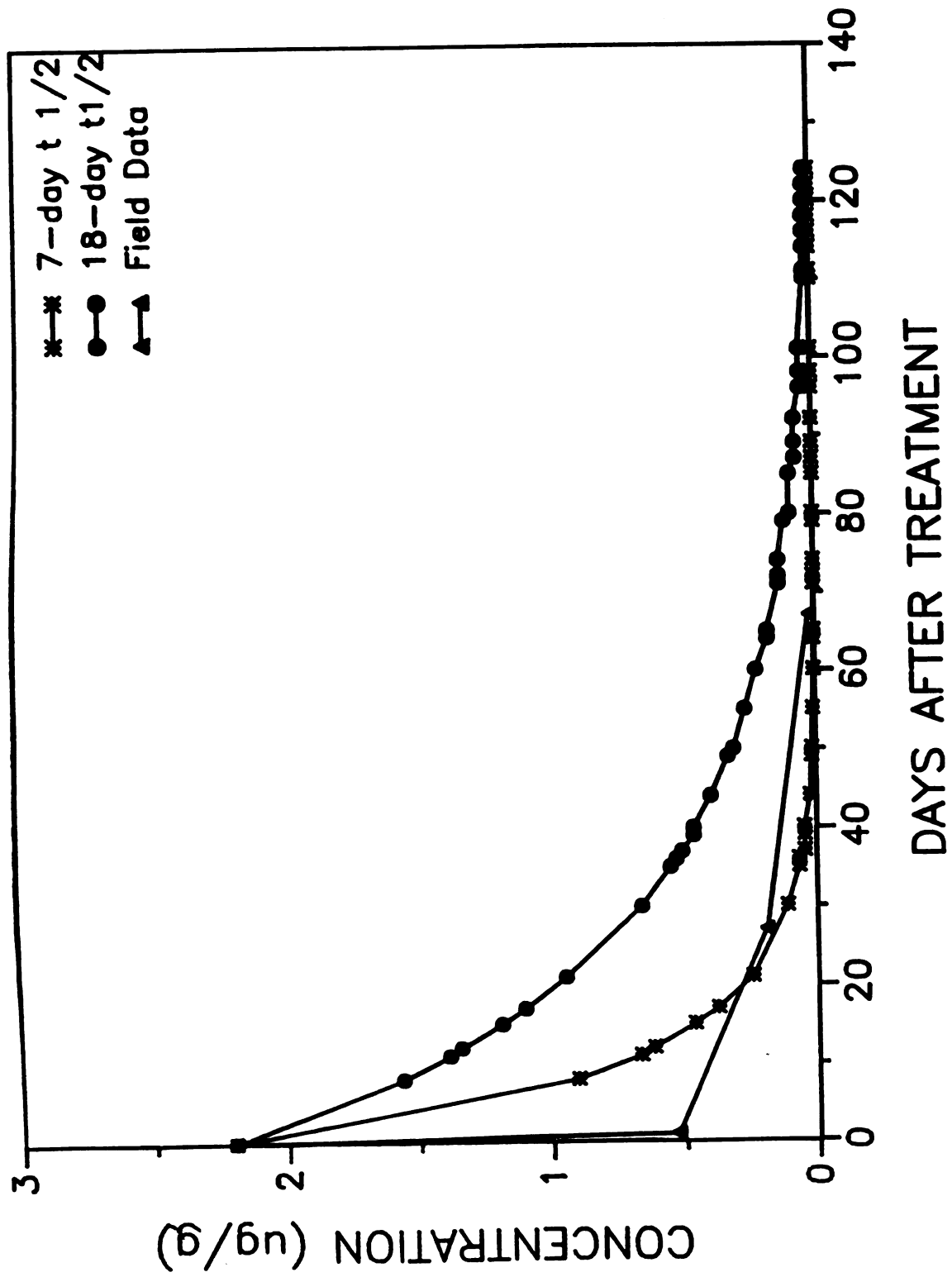


Figure 12. CMLS-predicted degradation curves, with and without adjustment for $T_{1/2} = 10$ days, and observed degradation curves for metolachlor at Hickory Corners, MI.

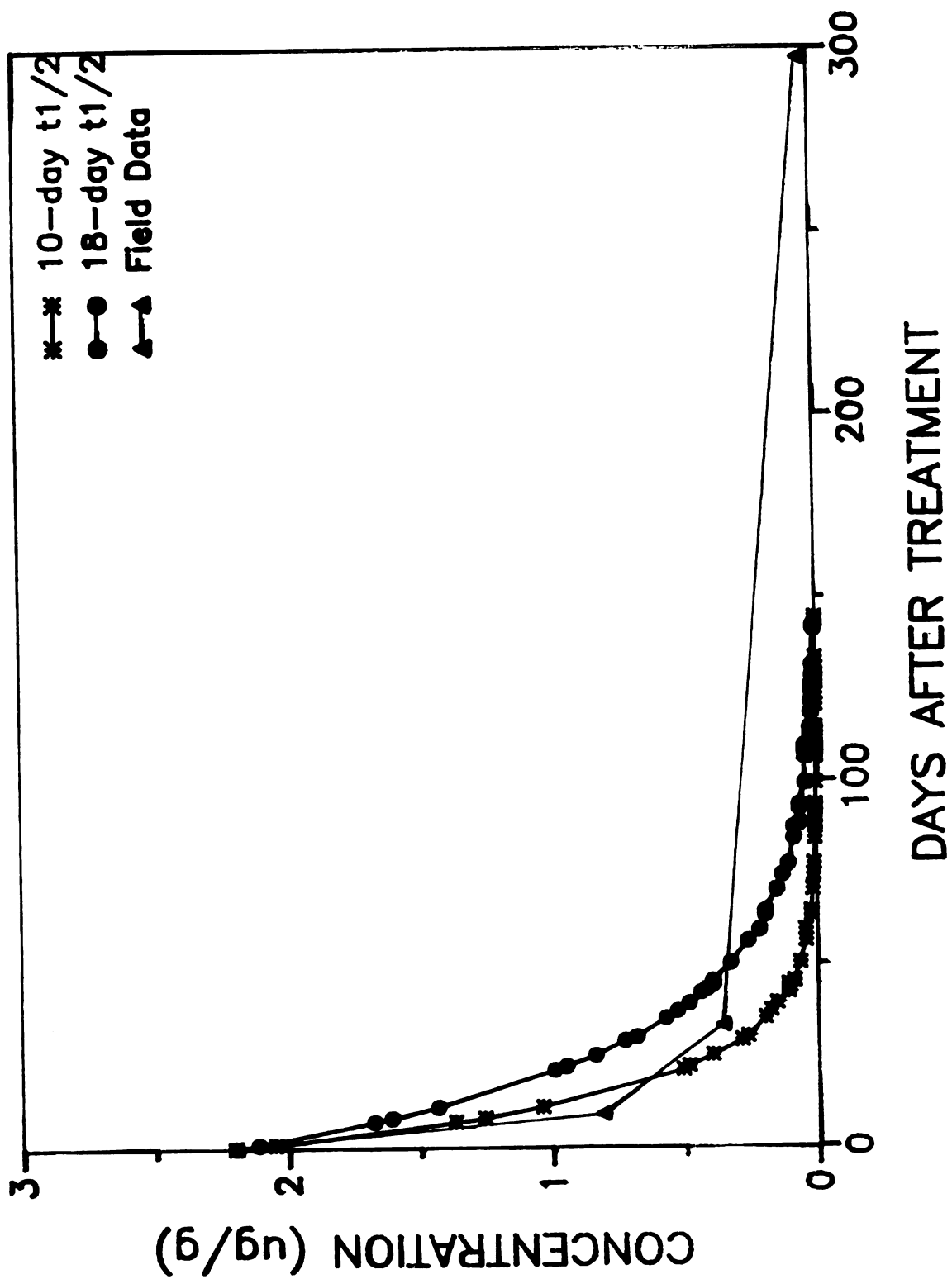


Table 14. Half-life values for alachlor.

<u>Half-life (days)</u>	<u>Reference</u>
4 - 7.8	Beestman and Deming, 1974
7.4 - 38.6	Walker and Brown, 1985
25 - 50	Koskinen <u>et al.</u> , 1986

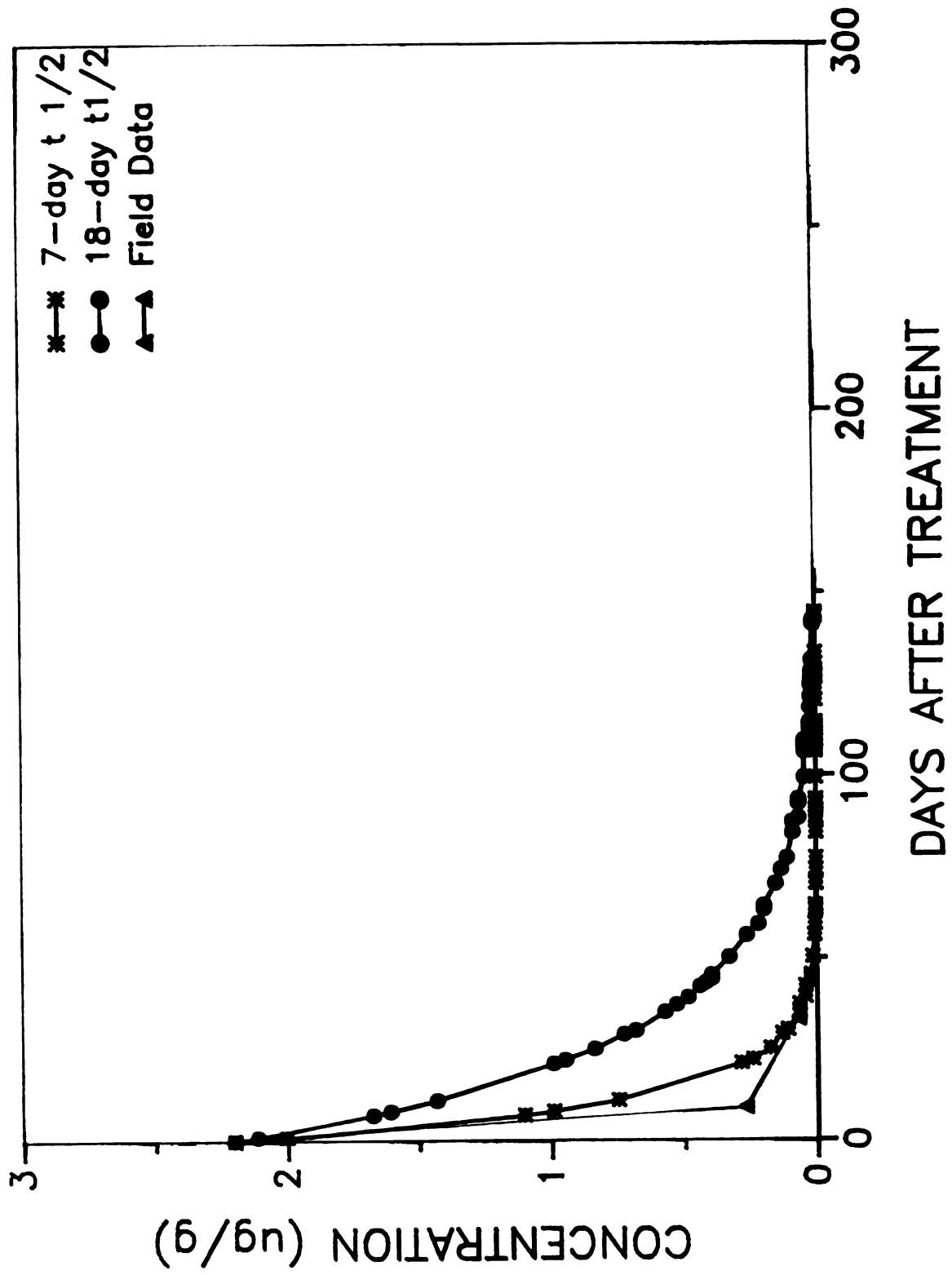
correlated with organic matter content in the soil (2,28). At Hickory Corners, similar results can be seen (Figure 9). Based on samples found at each level (when they could be found across two or more replication), alachlor residues were found down to 45.7 cm, with the majority of the herbicide remaining in the top 15.2 cm. Alachlor was found only in the soil surface layer on July 3 (9 DAT), and was only detectable in one sample on August 8 (33 DAT). Alachlor residues were not found in any sample thereafter. Based on this data, alachlor half-life was estimated at 7 days at Hickory Corners (Figure 13).

A comparison of leaching studies at East Lansing (Figures 6 and 7) with those at Hickory Corners (Figures 8 and 9) showed that there was slightly more leaching on the sandier soils of Hickory Corners. There was a slightly shorter half-life of metolachlor at Hickory Corners which could be due to a greater dilution as the herbicide moved downward through the soil profile.

D. Comparison of Model Predictions with Field Results

Base values were first used in the model simulation (Tables 9-11). Estimates of depth and concentration of metolachlor were produced using GLEAMS and PRZM, and are shown graphically in Figures 2 through 5. Tabular output of CMLS, showing leaching depth over time, is given in Appendix C.

Figure 13. CMLS-predicted degradation curves, with and without adjustment for $T_{1/2} = 7$ days, and observed degradation curves for alachlor at Hickory Corners, MI.



Then leaching simulations were run for alachlor and metolachlor using the corrected values for half-life. Corrections for partition coefficient could not be made, since soil samples were analyzed in toto, and it was not possible to determine the amount of herbicide in soil solution versus the amount sorbed to soil. Nevertheless, with this taken into account, a comparison of model predictions with field results was made. Comparison of estimated versus measured leaching of metolachlor is shown in Figures 14 and 15, for East Lansing and Hickory Corners, respectively. Comparisons for alachlor leaching at East Lansing and Hickory Corners are shown in Figures 16 and 17, respectively.

There were differences in the initial concentrations of herbicide, with the models showing greater concentrations than found in field results. This is a result of differences in the mass of soil used in the calculations. For example, the first computational layer used in GLEAMS is only one cm deep (Appendix E), while the first layer for PRZM is 2.5 cm thick (Appendix D). Differing estimates of bulk density and/or soil water could also affect soil concentration calculations. Conversely, the amount actually found in the fields could reflect losses by volatilization or other processes which are not accounted for by any of the models. A difference in actual versus intended soil

Figure 14. Depth of maximum detectable metolachlor residues over time, as observed versus as predicted by CMLS, PRZM and GLEAMS, at East Lansing, MI.

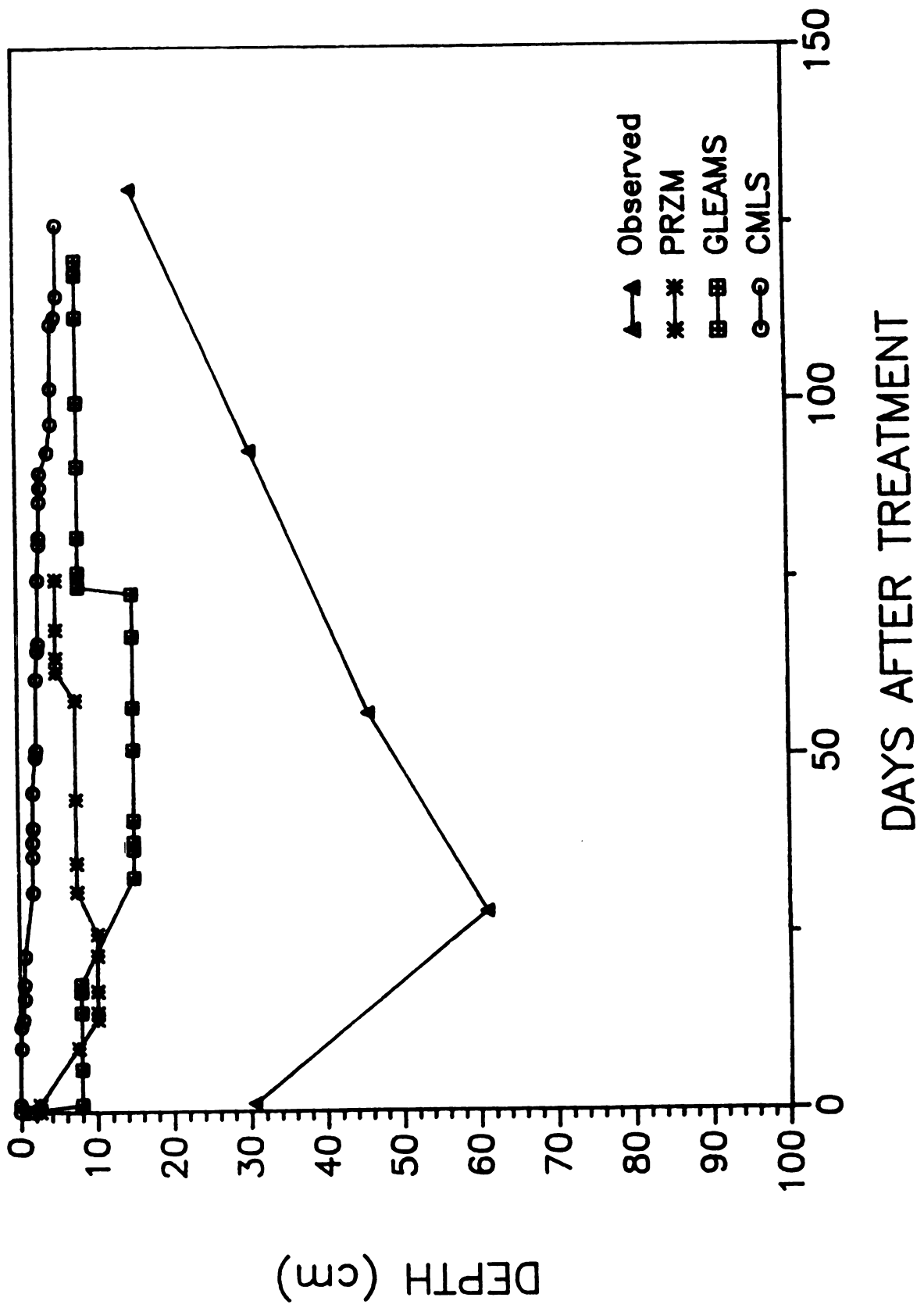


Figure 15. Depth of maximum detectable metolachlor residues over time, as observed versus as predicted by CMLS, PRZM and GLEAMS, at Hickory Corners, MI.

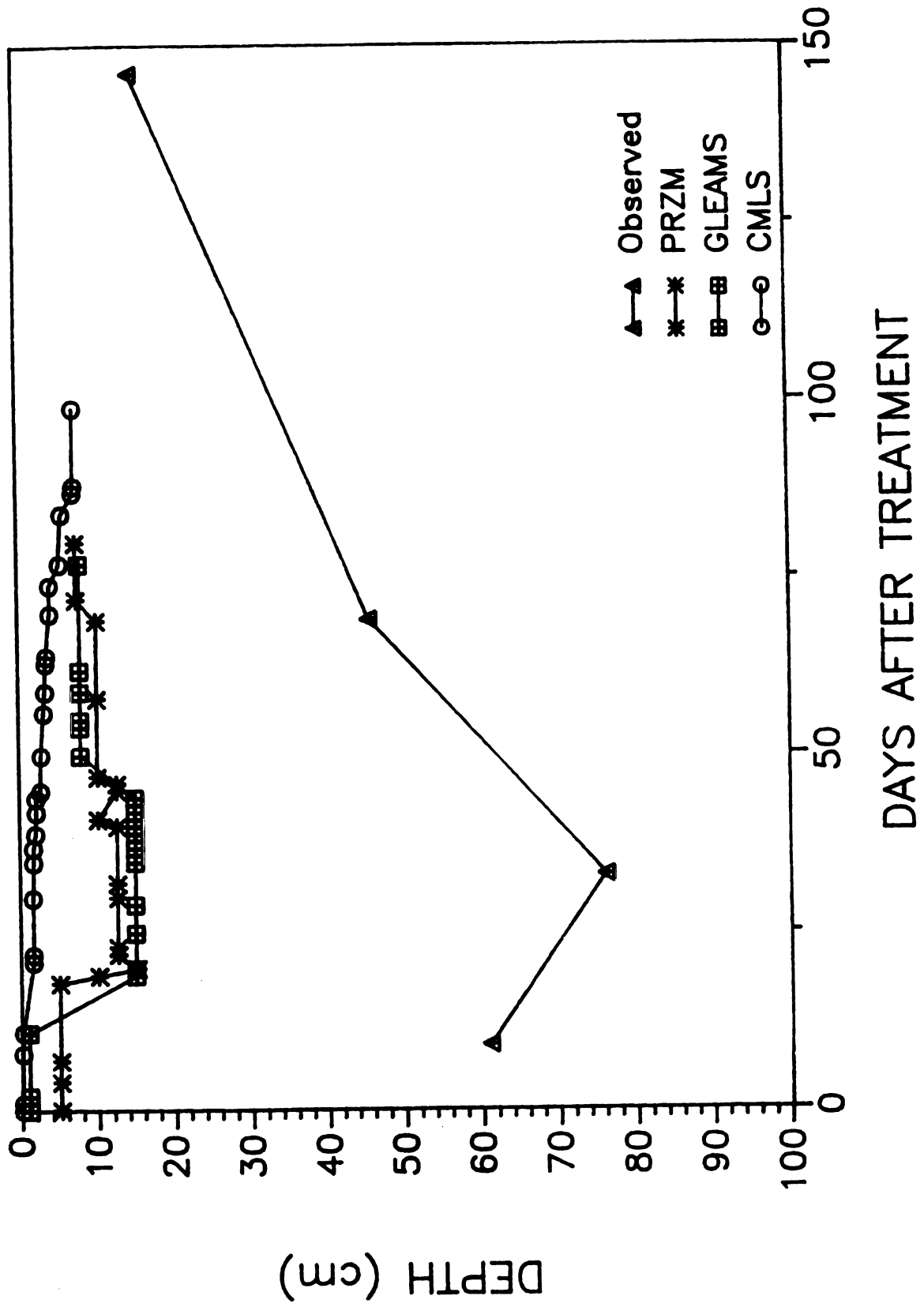


Figure 16. Depth of maximum detectable alachlor residues over time, as observed versus as predicted by CMLS, PRZM and GLEAMS, at East Lansing, MI.

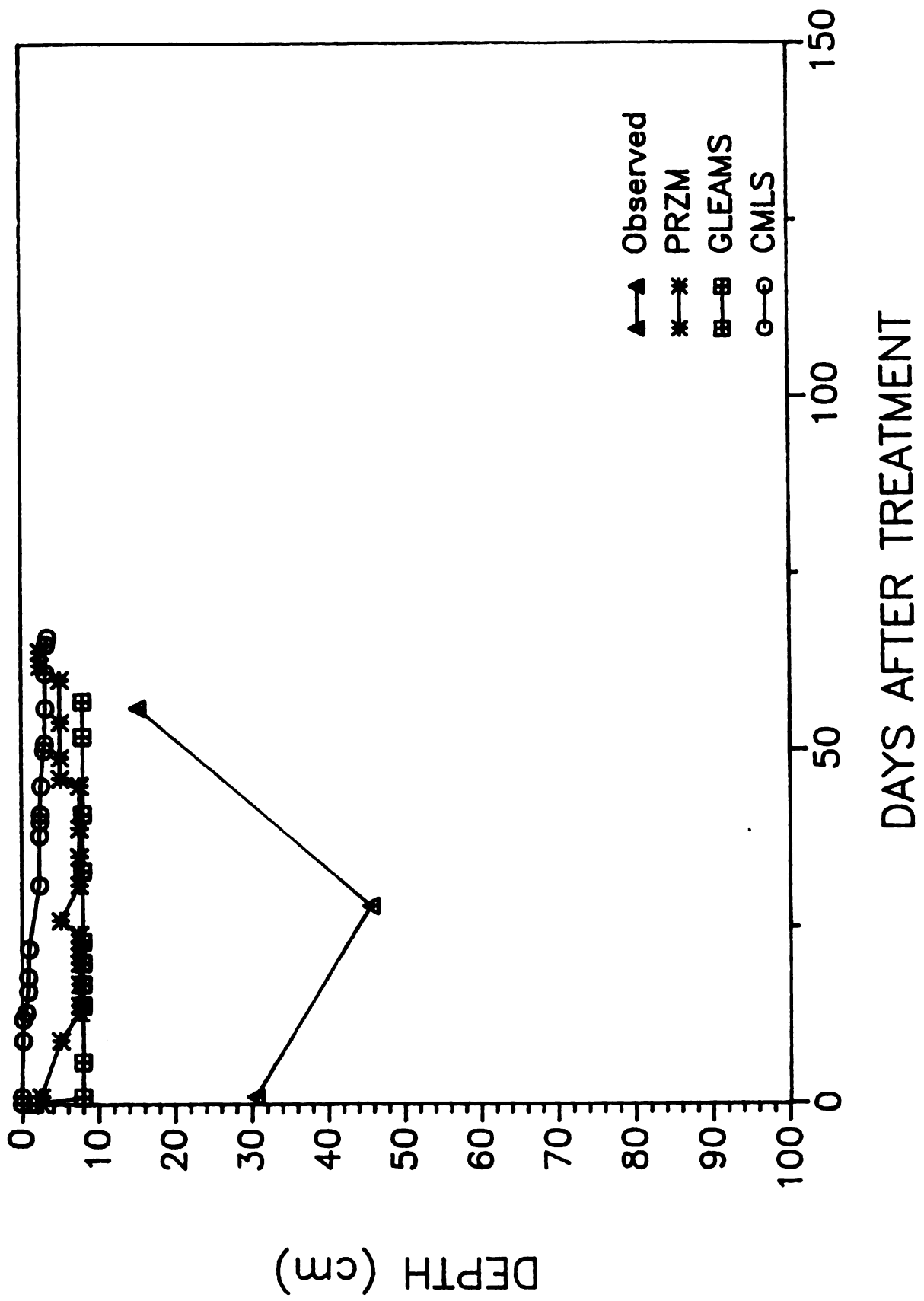
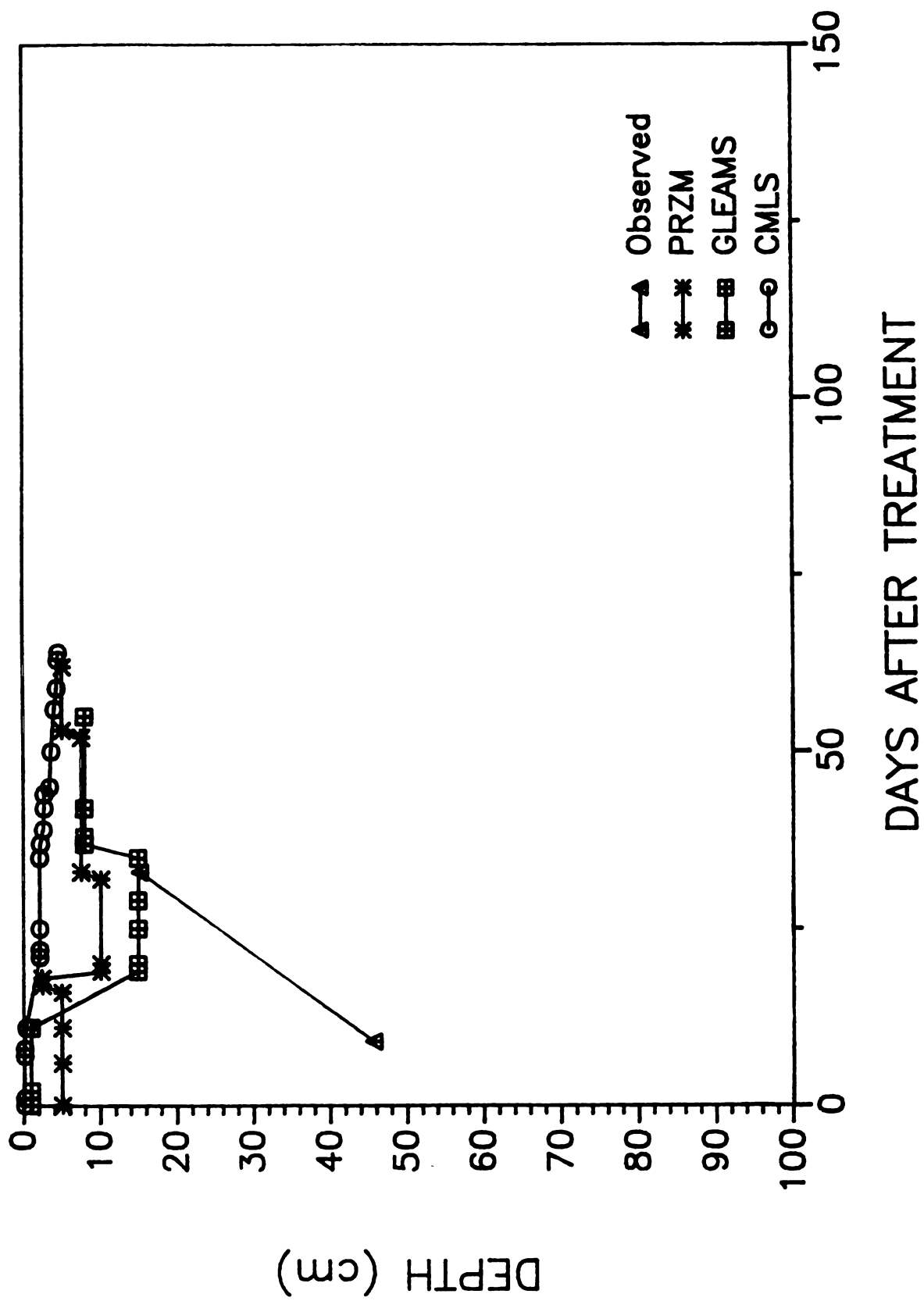


Figure 17. Depth of maximum detectable alachlor residues over time, as observed versus as predicted by CMLS, PRZM and GLEAMS, at Hickory Corners, MI.



concentrations can also be due to experimental error in herbicide application and soil sampling (12).

A comparison of simulated versus measured leaching of metolachlor and alachlor show that the models estimate less leaching than was actually observed (Figures 14 through 17). It is not possible to conclude that the models are more or less accurate, however, without some form of statistical analysis. The differences in leaching depth over time could be due to the way which the models calculate the amount of water available for percolation. All of the models use a hydrology routing routine to drive pesticide movement, and one soil layer must fill to field capacity before water is transferred to the next computational (soil) layer. In addition, PRZM uses a set of partial differential equations solved through finite element methods to calculate pesticide in soil water versus adsorbed to the soil solid (6). Such soil water movement assumes that soil through each layer has homogeneous pore structure.

Field results show greater leaching early in the season than what would be expected, based on model predictions. One theory which may explain this increase in infiltration is preferential flow through macropores (3). This could account for increased herbicide movement at Hickory Corners, since the field was under alfalfa cover for the previous 5 years, and alfalfa roots could have produced macropores

which were still present after plowing. Macropores have been more closely identified with no-till management systems (18). Both sites were plowed and conventionally prepared for seeding prior to herbicide application, however. Further characterization of a field site for identification of macropores is needed.

Another reason for the apparently greater leaching depth is sampling error. Cross-contamination of samples is possible, since residue laden soil could have fallen to greater depths during sampling. Use of dual testing methods such as soil sampling plus water sampling from lysimeters which are established at the field site is a possible method of confirming experimental results from this study.

Finally, although there were differences in predicted concentrations and depths of leaching between models simulations and field data, it should be noted that the field data confirmed the model predictions that no detectable residues of any herbicide would be found below the 91.4-cm level at either field site. Therefore one could make the general statement that the models were successful in their intended purpose and accurately predicted that no leaching below the root zone would occur.

There are many opportunities for further refinement of the submodels in each model. Many of the equations used in the

models, such as the equations used in PRZM and GLEAMS to estimate evapotranspiration, are best used to calculate weekly or monthly averages. Their accuracy decreases when they are used to calculate daily values (15). It is known that soil temperature and moisture conditions have a significant effect on pesticide half-life (2,4,5,41,44,45). Equations need to be developed which can be incorporated into the models to simulate changes in half-life with changes in soil conditions. There will probably be a specific equation found for each chemical and possibly for each soil type. Another area of research needed is improved methods for characterizing soil properties. Spatial variability has been identified as a major limitation in model prediction (37). All models studied assume homogeneous conditions over the entire field. This assumption is very rarely found under Michigan conditions, where glacial action and weathering have produced a wide range of soils in a relatively small area. Statistically-based geological techniques such as co-krieking have been used to better characterize a site (37), but the degree of complexity increases for the model user as a result.

CONCLUSIONS

1. Model output was not in easily comparable form. PRZM output lent itself most easily to day-by-day comparisons of predicted versus observed leaching. GLEAMS output was given on a rain-by-rain basis. CMLS output did not include pesticide concentration by depth, only leaching depth over time.

2. Maximum depth of leaching of metolachlor, as predicted by the three models, differed. PRZM predicted that residues would be present at the 91.4-cm soil depth, though in concentrations which would be below the detection limit of 10 ppb. CMLS predicted maximum depth of leaching at only 15.2 cm, while GLEAMS predicted 30.5 cm as the maximum depth of leaching.

3. Parameters which greatly affect predicted depth and concentrations of herbicide leaching (i.e., sensitive parameters) were pesticide soil half-life, partition coefficient normalized for organic carbon (Koc), and the soil parameters field capacity, wilting point, and porosity. Curve number was sensitive when going from field capacity to

saturated conditions (CN2 to CN3). Coefficient of uptake was not a sensitive parameter.

4. In field studies, metolachlor residues were found at deeper soil layers, and were more persistent, than residues of alachlor. Metolachlor was detected at 61.0 cm at East Lansing, and 76.2 cm at Hickory Corners. Residues were found in the top soil layer throughout the growing season, and detectable residues were found at the sample dates after harvest at both locations. Alachlor residues were found at a maximum depth of 45.7 cm, and persisted until July at both sites.

5. Comparison of predicted versus observed leaching indicates that the models predicted less herbicide leaching than was observed in field studies. However, all models were successful in predicting that no detectable residues of any herbicide would travel below the root zone.

APPENDICES

Appendix A. Sample data used in GLEAMS

Hydrology Parameters - Michigan State University
 Capac sandy clay loam, soybeans, conv. till
 Simulation from 5/14/87 to 9/26/87

87000	1	0	0	1	0	0	0	0	0
1.0	0.2	1.0	4.0	85	0.005	3.3	36.0		
5	6.0	12.0	18.0	24.0	36.0				
.49	.49	.41	.43	.43					
.19	.19	.16	.16	.15					
.06	.06	.11	.11	.10					
2.6	2.0	0.7	0.5	0.4					
31.4	37.0	48.0	59.9	70.8	79.4	85.6	80.1	73.3	55.7
49.5	36.9								
16.9	17.8	26.0	36.2	48.3	57.3	49.1	57.9	49.8	34.3
33.6	25.5								
121.0	210.0	309.0	359.0	483.0	547.0	540.0	466.0	373.0	255.0
136.0	108.0								
1.0									
001	0.0								
134	.00								
148	.12								
161	.33								
175	1.58								
188	2.16								
202	2.49								
215	2.46								
229	2.42								
242	1.91								
256	.95								
269	.41								
366									
-1	0	0							

Erosion/Sediment Yield Michigan State University
 Capac sandy clay loam, soybeans, conv. till.
 Simulation 5/14/87 to 9/26/87

87	87	0	0	1	0
.23	.27	.5	20.0	1000.0	
1	1.0				
30.0	.005				
1	1.0	.32			
1					
001					
1	1.0				
.50					
1.0					
0.014					

Metolachlor 2.2 kg/ha Michigan State University
 PRE application soybeans, conv. till.
 Simulation 5/20/87 to 9/26/87

87000	87365	1	0	4	2	1
1		Dual	0			
1	500.0	3.0	250.0	0.0	.30	1.0
18.0	18.0	18.0	18.0	18.0	0.0	0.0
1140	1					
1	2.2	1.0	0.0	1.0	0	
0						

.5
 0.0

0.0

Alachlor 2.2 kg/ha Michigan State University
 PRE application soybeans, conv. till.
 Simulation 5/20/87 to 10/24/87

87000	87365	1	0	4	0	0
1		Lasso	0			
1	242.0	3.0	190.0	0.0	.40	1.0
18.0	18.0	18.0	18.0	18.0	0.0	0.0
1140	1					
1	2.2	1.0	0.0	1.0	0	
0						

.5
 0.0

0.0

Metolachlor 2.2 kg/ha Kellogg Biological Station

PrE application soybeans, conv. till.

Simulation 6/01/87 to 10/24/87

87000	87365	1	0	4	0	0
1		Dual	0			
1	500.0	3.0	250.0	0.0	.30	1.0
18.0	18.0	18.0	18.0	18.0	0.0	0.0
1152	1				0.0	.5
1	2.2	1.0	0.0	1.0	0	0.0
0						

Alachlor 2.2 kg/ha Kellogg Biological Station

PrE application soybeans, conv. till.

Simulation 6/01/87 to 10/24/87

87000	87365	1	0	4	0	0
1		Lasso	0			
1	242.0	3.0	190.0	0.0	.00	1.0
18.0	18.0	18.0	18.0	18.0	0.0	0.0
1152	1				0.0	.5
1	2.2	1.0	0.0	1.0	0	0.0
0						

Appendix B. Sample data used in PRZM

Simulation Run MSU East Lansing MI 1987

14 587	26 987										
----- Hydrology Parameters -----											
0.765	0.200	2	15.000	1	3						
9.400	10.400	11.700	13.100	14.300	14.900						
14.600	14.000	12.300	10.900	9.700	9.000						
0											
1											
1	0.200	45.000	85.000	1	91	85	91	1.0	1.0	1.0	0.000
1											
23 587	12 987	24 987	1								
----- Pesticide Parameters -----											
1											
20 587	2.200	0.000									
1											
----- Soil Properties -----											
91.200	1.000	36	1	1	1	0					
2	530.0										
6											
1	15.200	1.550	0.000	0.0990	0.260						
	49.840	22.720	1.300								
2	15.200	1.550	0.000	0.0990	0.270						
	41.840	26.720	1.000								
3	15.200	1.500	0.000	0.0990	0.260						
	47.840	26.720	0.350								
4	15.200	1.550	0.000	0.0990	0.260						
	51.840	22.720	0.250								
5	15.200	1.550	0.000	0.0990	0.270						
	50.560	26.720	0.200								
6	15.200	1.550	0.000	0.0990	0.260						
	48.560	24.720	0.250								
0	0										
WATR	YEAR	1	PEST	MNTH	1	CONC	DAY	1			
1											
TPST	TCUM	35	1.0								

Appendix B. (cont.)

Simulation Run Kellogg Biological Station, Hichory Corners MI 1987

1 687	241087	-----Hydrology Parameters-----									
0.765	0.200	2	15.000	1	3						
9.400	10.400	11.700	13.100	14.300	14.900						
14.600	14.000	12.300	10.900	9.700	9.000						
0											
1	0.200	45.000	85.000	3	86	78	82	1.0	1.0	1.0	0.000
1											
5 687	28 987	151087	1	-----Pesticide Parameters-----							
1											
1 687	2.200	0.000	-----Soil Properties-----								
1											
91.200	1.000	36	1	1	1	0					
2	530.000										
6											
1	15.200	1.450	0.000	0.0693	0.270						
	40.000	21.000	0.900								
2	15.200	1.450	0.000	0.0693	0.270						
	40.000	23.000	0.700								
3	15.200	1.550	0.000	0.0693	0.260						
	52.000	31.000	0.300								
4	15.200	1.550	0.000	0.0693	0.210						
	74.000	19.000	0.200								
5	15.200	1.700	0.000	0.0693	0.210						
	82.000	15.000	0.200								
6	15.200	1.650	0.000	0.0693	0.120						
	88.000	11.000	0.100								
0	0										
WATR	YEAR	1	PEST	MNTH	1	CONC	DAY	1			
1											
TPST	TCUM	35	1.0								

Appendix C. Sample data and output for CMLS

Chemical Movement in Layered Soils

Soil Name : CAPAC			Identifier : MI0091			
Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at		
				-0.01 MPa	-1.5 MPa	Saturation
1	0.15	1.51	1.34	19.0	5.8	49.4
2	0.30	1.16	1.35	19.0	5.8	49.0
3	0.46	0.41	1.56	16.0	10.8	41.1
4	0.61	0.29	1.50	16.0	10.8	43.4
5	0.76	0.23	1.51	16.0	10.8	43.0
6	0.91	0.29	1.50	15.0	10.4	43.4

Name of chemical	:METOLACHLOR
Organic carbon partition coefficient, (ml/g OC)	:250
Degradation half-life, (days)	:15
Application depth, (m)	:0.00
Application date, (month/day/year)	:5/20/87
Ending date, (month/day/year)	:9/26/87
Rooting depth, (m)	:0.51
Infiltration or rainfall file name	:MSU87.R
Evapotranspiration file name	:MSU87.ET

Horizon	Maximum Depth (m) of Horizon	Kd (ml/g soil)	Half-Life (days) for
		-----METOLACHLOR-----	
1	0.15	3.775	15
2	0.30	2.900	15
3	0.46	1.025	15
4	0.61	0.725	15
5	0.76	0.575	15
6	0.91	0.725	15

Appendix C. (cont.)

(Metolachlor-Capac)

Total Rainfall: 398.8 millimeters
 Total Evapotranspiration: 439.3 millimeters
 Potential Evapotranspiration: 1256.3 millimeters

Date	Rainfall (mm)	Solute Depth (m)	Relative Amount	Elapsed Time (days)
5-29-1987	9	0.002	0.66	9
6- 1-1987	0	0.002	0.57	12
6- 2-1987	16	0.005	0.55	13
6- 5-1987	12	0.007	0.48	16
6- 7-1987	1	0.007	0.44	18
6-11-1987	6	0.008	0.36	22
6-20-1987	59	0.019	0.24	31
6-25-1987	1	0.019	0.19	36
6-26-1987	1	0.019	0.18	37
6-27-1987	1	0.019	0.17	38
6-29-1987	7	0.020	0.16	40
6-30-1987	1	0.020	0.15	41
7- 4-1987	4	0.020	0.13	45
7- 9-1987	22	0.024	0.10	50
7-10-1987	4	0.025	0.09	51
7-15-1987	7	0.025	0.08	56
7-20-1987	3	0.025	0.06	61
7-24-1987	10	0.027	0.05	65
7-25-1987	8	0.028	0.05	66
7-31-1987	3	0.028	0.04	72
8- 1-1987	2	0.028	0.03	73
8- 3-1987	2	0.028	0.03	75
8- 8-1987	15	0.030	0.02	80
8- 9-1987	1	0.030	0.02	81
8-14-1987	10	0.031	0.02	86
8-16-1987	8	0.032	0.02	88
8-18-1987	3	0.032	0.02	90
8-21-1987	54	0.042	0.01	93
8-25-1987	35	0.047	0.01	97
8-27-1987	3	0.047	0.01	99
8-30-1987	4	0.047	9.0E-003	102
9- 8-1987	11	0.048	5.9E-003	111
9- 9-1987	31	0.053	5.7E-003	112
9-12-1987	22	0.056	4.9E-003	115
9-14-1987	9	0.056	4.5E-003	117
9-16-1987	4	0.056	4.1E-003	119
9-18-1987	2	0.056	3.7E-003	121
9-20-1987	4	0.056	3.4E-003	123
9-22-1987	6	0.056	3.1E-003	125

Appendix C. (cont.)

Chemical Movement in Layered Soils

Soil Name : CAPAC			Identifier : MI0091			
Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at		
				-0.01 MPa	-1.5 MPa	Saturation
1	0.15	1.51	1.34	19.0	5.8	49.4
2	0.30	1.16	1.35	19.0	5.8	49.0
3	0.46	0.41	1.56	16.0	10.8	41.1
4	0.61	0.29	1.50	16.0	10.8	43.4
5	0.76	0.23	1.51	16.0	10.8	43.0
6	0.91	0.29	1.50	15.0	10.4	43.4

Name of chemical	:ALACHLOR
Organic carbon partition coefficient, (ml/g OC)	:190
Degradation half-life, (days)	:7
Application depth, (m)	:0.00
Application date, (month/day/year)	:5/20/87
Ending date, (month/day/year)	:9/26/87
Rooting depth, (m)	:0.51
Infiltration or rainfall file name	:MSU87.R
Evapotranspiration file name	:MSU87.ET

Horizon	Maximum Depth (m) of Horizon	Kd (ml/g soil)	Half-Life (days) for
			-----ALACHLOR-----
1	0.15	2.869	7
2	0.30	2.204	7
3	0.46	0.779	7
4	0.61	0.551	7
5	0.76	0.437	7
6	0.91	0.551	7

Appendix C. (cont.)

(Alachlor-Capac)

Total Rainfall: 398.8 millimeters
 Total Evapotranspiration: 439.3 millimeters
 Potential Evapotranspiration: 1256.3 millimeters

Date	Rainfall (mm)	Solute Depth (m)	Relative Amount	Elapsed Time (days)
5-29-1987	9	0.002	0.41	9
6- 1-1987	0	0.002	0.30	12
6- 2-1987	16	0.006	0.28	13
6- 5-1987	12	0.009	0.21	16
6- 7-1987	1	0.009	0.17	18
6-11-1987	6	0.010	0.11	22
6-20-1987	59	0.024	0.05	31
6-25-1987	1	0.024	0.03	36
6-26-1987	1	0.024	0.03	37
6-27-1987	1	0.024	0.02	38
6-29-1987	7	0.025	0.02	40
6-30-1987	1	0.025	0.02	41
7- 4-1987	4	0.026	0.01	45
7- 9-1987	22	0.030	7.1E-003	50
7-10-1987	4	0.031	6.4E-003	51
7-15-1987	7	0.032	3.9E-003	56
7-20-1987	3	0.032	2.4E-003	61
7-24-1987	10	0.033	1.6E-003	65
7-25-1987	8	0.035	1.5E-003	66
7-31-1987	3	0.035	8.0E-004	72
8- 1-1987	2	0.035	7.3E-004	73
8- 3-1987	2	0.035	6.0E-004	75
8- 8-1987	15	0.037	3.6E-004	80
8- 9-1987	1	0.037	3.3E-004	81
8-14-1987	10	0.039	2.0E-004	86
8-16-1987	8	0.040	1.6E-004	88
8-18-1987	3	0.040	1.3E-004	90
8-21-1987	54	0.052	1.0E-004	93
8-25-1987	35	0.059	6.7E-005	97
8-27-1987	3	0.059	5.5E-005	99
8-30-1987	4	0.059	4.1E-005	102
9- 8-1987	11	0.060	1.7E-005	111
9- 9-1987	31	0.065	1.5E-005	112
9-12-1987	22	0.069	1.1E-005	115
9-14-1987	9	0.069	9.3E-006	117
9-16-1987	4	0.069	7.6E-006	119
9-18-1987	2	0.069	6.3E-006	121
9-20-1987	4	0.069	5.1E-006	123
9-22-1987	6	0.069	4.2E-006	125

Appendix C. (cont.)

Chemical Movement in Layered Soils

Soil Name : KALAMAZOO			Identifier : MI0007			
Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at		
				-0.01 MPa	-1.5 MPa	Saturation
1	0.15	0.93	1.52	17.0	3.4	42.6
2	0.30	0.70	1.58	15.0	6.3	40.4
3	0.46	0.23	1.60	18.0	8.4	39.6
4	0.61	0.17	1.60	18.0	8.4	39.6
5	0.76	0.17	1.53	11.0	2.7	42.3
6	0.91	0.06	1.53	11.4	2.7	42.3

Name of chemical	:METOLACHLOR
Organic carbon partition coefficient, (ml/g OC)	:250
Degradation half-life, (days)	:10
Application depth, (m)	:0.00
Application date, (month/day/year)	:6/01/87
Ending date, (month/day/year)	:10/24/87
Rooting depth, (m)	:0.51
Infiltration or rainfall file name	:KBS87.R
Evapotranspiration file name	:KBS87.ET

Horizon	Maximum Depth (m) of Horizon	Kd (ml/g soil)	Half-Life (days) for
			-----METOLACHLOR-----
1	0.15	2.325	10
2	0.30	1.750	10
3	0.46	0.575	10
4	0.61	0.425	10
5	0.76	0.425	10
6	0.91	0.150	10

Appendix C. (cont.)

(Metolachlor-Kalamazoo)

Total Rainfall: 416.6 millimeters
 Total Evapotranspiration: 394.7 millimeters
 Potential Evapotranspiration: 485.4 millimeters

Date	Rainfall (mm)	Solute Depth (m)	Relative Amount	Elapsed Time (days)
6- 1-1987	6	0.002	1.00	0
6- 2-1987	0	0.002	0.93	1
6- 8-1987	1	0.002	0.62	7
6- 9-1987	0	0.002	0.57	8
6-12-1987	3	0.003	0.47	11
6-22-1987	53	0.017	0.23	21
6-23-1987	0	0.017	0.22	22
6-26-1987	1	0.017	0.18	25
6-30-1987	1	0.017	0.13	29
7- 1-1987	2	0.017	0.12	30
7- 6-1987	2	0.018	0.09	35
7- 8-1987	2	0.018	0.08	37
7-10-1987	13	0.021	0.07	39
7-13-1987	4	0.022	0.05	42
7-14-1987	1	0.022	0.05	43
7-15-1987	0	0.022	0.05	44
7-16-1987	21	0.028	0.04	45
7-21-1987	9	0.029	0.03	50
7-27-1987	17	0.033	0.02	56
7-30-1987	10	0.035	0.02	59
8- 3-1987	6	0.036	0.01	63
8- 4-1987	5	0.037	0.01	64
8-10-1987	24	0.042	7.8E-003	70
8-14-1987	1	0.042	5.9E-003	74
8-17-1987	52	0.055	4.8E-003	77
8-24-1987	14	0.058	3.0E-003	84
8-27-1987	56	0.073	2.4E-003	87
8-28-1987	4	0.074	2.2E-003	88
9- 1-1987	1	0.074	1.7E-003	92
9- 2-1987	1	0.074	1.6E-003	93
9- 8-1987	2	0.074	1.0E-003	99
9-15-1987	19	0.076	6.4E-004	106
9-16-1987	2	0.077	6.0E-004	107
9-17-1987	3	0.077	5.6E-004	108
9-18-1987	12	0.081	5.2E-004	109
9-21-1987	15	0.085	4.3E-004	112
9-22-1987	3	0.086	4.0E-004	113
9-23-1987	1	0.086	3.7E-004	114
9-29-1987	19	0.090	2.4E-004	120
10- 2-1987	4	0.091	2.0E-004	123
10- 5-1987	3	0.092	1.6E-004	126
10- 6-1987	2	0.092	1.5E-004	127
10- 7-1987	1	0.092	1.4E-004	128
10- 9-1987	1	0.092	1.2E-004	130
10-12-1987	3	0.093	9.9E-005	133
10-22-1987	13	0.093	5.0E-005	143
10-23-1987	4	0.094	4.6E-005	144

Appendix C. (cont.)

Chemical Movement in Layered Soils

Soil Name : KALAMAZOO			Identifier : MI0007			
Horizon	Depth (m)	Organic Carbon (%)	Bulk Density (Mg/cu meter)	Volumetric Water Content, (%) at		
				-0.01 MPa	-1.5 MPa	Saturation
1	0.15	0.93	1.52	17.0	3.4	42.6
2	0.30	0.70	1.58	15.0	6.3	40.4
3	0.46	0.23	1.60	18.0	8.4	39.6
4	0.61	0.17	1.60	18.0	8.4	39.6
5	0.76	0.17	1.53	11.0	2.7	42.3
6	0.91	0.06	1.53	11.4	2.7	42.3

Name of chemical	:ALACHLOR
Organic carbon partition coefficient, (ml/g OC)	:190
Degradation half-life, (days)	:7
Application depth, (m)	:0.00
Application date, (month/day/year)	:6/01/87
Ending date, (month/day/year)	:10/24/87
Rooting depth, (m)	:0.51
Infiltration or rainfall file name	:KBS87.R
Evapotranspiration file name	:KBS87.ET

Horizon	Maximum Depth (m) of Horizon	Kd (ml/g soil)	Half-Life (days) for -----ALACHLOR-----
1	0.15	1.767	7
2	0.30	1.330	7
3	0.46	0.437	7
4	0.61	0.323	7
5	0.76	0.323	7
6	0.91	0.114	7

Appendix C. (cont.)

(Alachlor-Kalamazoo)

Total Rainfall: 416.6 millimeters
 Total Evapotranspiration: 394.7 millimeters
 Potential Evapotranspiration: 485.4 millimeters

Date	Rainfall (mm)	Solute Depth (m)	Relative Amount	Elapsed Time (days)
6- 1-1987	6	0.002	1.00	0
6- 2-1987	0	0.002	0.91	1
6- 8-1987	1	0.002	0.50	7
6- 9-1987	0	0.002	0.45	8
6-12-1987	3	0.004	0.34	11
6-22-1987	53	0.022	0.13	21
6-23-1987	0	0.022	0.11	22
6-26-1987	1	0.022	0.08	25
6-30-1987	1	0.022	0.06	29
7- 1-1987	2	0.022	0.05	30
7- 6-1987	2	0.022	0.03	35
7- 8-1987	2	0.023	0.03	37
7-10-1987	13	0.027	0.02	39
7-13-1987	4	0.028	0.02	42
7-14-1987	1	0.028	0.01	43
7-15-1987	0	0.028	0.01	44
7-16-1987	21	0.035	0.01	45
7-21-1987	9	0.037	7.1E-003	50
7-27-1987	17	0.041	3.9E-003	56
7-30-1987	10	0.044	2.9E-003	59
8- 3-1987	6	0.045	2.0E-003	63
8- 4-1987	5	0.046	1.8E-003	64
8-10-1987	24	0.053	9.8E-004	70
8-14-1987	1	0.053	6.6E-004	74
8-17-1987	52	0.068	4.9E-004	77
8-24-1987	14	0.072	2.4E-004	84
8-27-1987	56	0.091	1.8E-004	87
8-28-1987	4	0.093	1.6E-004	88
9- 1-1987	1	0.093	1.1E-004	92
9- 2-1987	1	0.093	1.0E-004	93
9- 8-1987	2	0.093	5.5E-005	99
9-15-1987	19	0.095	2.8E-005	106
9-16-1987	2	0.095	2.5E-005	107
9-17-1987	3	0.096	2.3E-005	108
9-18-1987	12	0.101	2.1E-005	109
9-21-1987	15	0.106	1.5E-005	112
9-22-1987	3	0.107	1.4E-005	113
9-23-1987	1	0.108	1.3E-005	114
9-29-1987	19	0.113	6.9E-006	120
10- 2-1987	4	0.113	5.1E-006	123
10- 5-1987	3	0.115	3.8E-006	126
10- 6-1987	2	0.115	3.5E-006	127
10- 7-1987	1	0.115	3.1E-006	128
10- 9-1987	1	0.115	2.6E-006	130
10-12-1987	3	0.116	1.9E-006	133
10-22-1987	13	0.116	7.1E-007	143
10-23-1987	4	0.117	6.4E-007	144

Appendix D. PRZM sample output

1PESTICIDE CONCENTRATION PROFILE (Metolachlor-East Lansing MI)

DATE (DAY-MONTH-YEAR) 20 MAY , 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	6.066	5.439	3.019
1	2	0.0000E+00	0.0000E+00	0.0000E+00
1	3	0.0000E+00	0.0000E+00	0.0000E+00
1	4	0.0000E+00	0.0000E+00	0.0000E+00
1	5	0.0000E+00	0.0000E+00	0.0000E+00
1	6	0.0000E+00	0.0000E+00	0.0000E+00
2	7	0.0000E+00	0.0000E+00	0.0000E+00
2	8	0.0000E+00	0.0000E+00	0.0000E+00
2	9	0.0000E+00	0.0000E+00	0.0000E+00
2	10	0.0000E+00	0.0000E+00	0.0000E+00
2	11	0.0000E+00	0.0000E+00	0.0000E+00
3	14	0.0000E+00	0.0000E+00	0.0000E+00
3	15	0.0000E+00	0.0000E+00	0.0000E+00
3	16	0.0000E+00	0.0000E+00	0.0000E+00
3	17	0.0000E+00	0.0000E+00	0.0000E+00
3	18	0.0000E+00	0.0000E+00	0.0000E+00
4	19	0.0000E+00	0.0000E+00	0.0000E+00
4	20	0.0000E+00	0.0000E+00	0.0000E+00
4	21	0.0000E+00	0.0000E+00	0.0000E+00
4	22	0.0000E+00	0.0000E+00	0.0000E+00
4	23	0.0000E+00	0.0000E+00	0.0000E+00
4	24	0.0000E+00	0.0000E+00	0.0000E+00
5	25	0.0000E+00	0.0000E+00	0.0000E+00
5	26	0.0000E+00	0.0000E+00	0.0000E+00
5	27	0.0000E+00	0.0000E+00	0.0000E+00
5	28	0.0000E+00	0.0000E+00	0.0000E+00
5	29	0.0000E+00	0.0000E+00	0.0000E+00
5	30	0.0000E+00	0.0000E+00	0.0000E+00
6	31	0.0000E+00	0.0000E+00	0.0000E+00
6	32	0.0000E+00	0.0000E+00	0.0000E+00
6	33	0.0000E+00	0.0000E+00	0.0000E+00
6	34	0.0000E+00	0.0000E+00	0.0000E+00
6	35	0.0000E+00	0.0000E+00	0.0000E+00
6	36	0.0000E+00	0.0000E+00	0.0000E+00

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Metolachlor-East Lansing MI)

DATE (DAY-MONTH-YEAR) 16 JUNE, 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	1.220	1.144	0.6350
1	2	0.4371	0.4097	0.2274
1	3	0.7385E-01	0.6923E-01	0.3843E-01
1	4	0.7519E-02	0.7049E-02	0.3913E-02
1	5	0.3961E-03	0.3709E-03	0.2059E-03
1	6	0.9135E-05	0.8190E-05	0.4547E-05
2	7	0.2552E-06	0.2209E-06	0.1594E-06
2	8	0.8843E-08	0.7656E-08	0.5525E-08
2	9	0.1899E-09	0.1644E-09	0.1187E-09
2	10	0.1498E-11	0.1304E-11	0.9414E-12
2	11	0.0000E+00	0.0000E+00	0.0000E+00
2	12	0.0000E+00	0.0000E+00	0.0000E+00
3	13	0.0000E+00	0.0000E+00	0.0000E+00
3	14	0.0000E+00	0.0000E+00	0.0000E+00
3	15	0.0000E+00	0.0000E+00	0.0000E+00
3	16	0.0000E+00	0.0000E+00	0.0000E+00
3	17	0.0000E+00	0.0000E+00	0.0000E+00
3	18	0.0000E+00	0.0000E+00	0.0000E+00
4	19	0.0000E+00	0.0000E+00	0.0000E+00
4	20	0.0000E+00	0.0000E+00	0.0000E+00
4	21	0.0000E+00	0.0000E+00	0.0000E+00
4	22	0.0000E+00	0.0000E+00	0.0000E+00
4	23	0.0000E+00	0.0000E+00	0.0000E+00
4	24	0.0000E+00	0.0000E+00	0.0000E+00
5	25	0.0000E+00	0.0000E+00	0.0000E+00
5	26	0.0000E+00	0.0000E+00	0.0000E+00
5	27	0.0000E+00	0.0000E+00	0.0000E+00
5	28	0.0000E+00	0.0000E+00	0.0000E+00
5	29	0.0000E+00	0.0000E+00	0.0000E+00
5	30	0.0000E+00	0.0000E+00	0.0000E+00
6	31	0.0000E+00	0.0000E+00	0.0000E+00
6	32	0.0000E+00	0.0000E+00	0.0000E+00
6	33	0.0000E+00	0.0000E+00	0.0000E+00
6	34	0.0000E+00	0.0000E+00	0.0000E+00
6	35	0.0000E+00	0.0000E+00	0.0000E+00
6	36	0.0000E+00	0.0000E+00	0.0000E+00

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Metolachlor-East Lansing MI)

DATE (DAY-MONTH-YEAR) 15 JULY, 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.1321	0.1184	0.6574E-01
1	2	0.1437	0.1290	0.7160E-01
1	3	0.7074E-01	0.6627E-01	0.3679E-01
1	4	0.2400E-01	0.2246E-01	0.1247E-01
1	5	0.6345E-02	0.5925E-02	0.3289E-02
1	6	0.1323E-02	0.1230E-02	0.6827E-03
2	7	0.2266E-03	0.2043E-03	0.1474E-03
2	8	0.5390E-04	0.4753E-04	0.3430E-04
2	9	0.1424E-04	0.1233E-04	0.8895E-05
2	10	0.3711E-05	0.3213E-05	0.2319E-05
2	11	0.9610E-06	0.8319E-06	0.6004E-06
2	12	0.2414E-06	0.2090E-06	0.1508E-06
3	13	0.4306E-07	0.3112E-07	0.6418E-07
3	14	0.1819E-07	0.1314E-07	0.2710E-07
3	15	0.7621E-08	0.5509E-08	0.1136E-07
3	16	0.3169E-08	0.2290E-08	0.4723E-08
3	17	0.1307E-08	0.9447E-09	0.1948E-08
3	18	0.5347E-09	0.3865E-09	0.7969E-09
4	19	0.1863E-09	0.1278E-09	0.3690E-09
4	20	0.8625E-10	0.5919E-10	0.1709E-09
4	21	0.3994E-10	0.2741E-10	0.7912E-10
4	22	0.1849E-10	0.1269E-10	0.3664E-10
4	23	0.8563E-11	0.5877E-11	0.1697E-10
4	24	0.3965E-11	0.2721E-11	0.7856E-11
5	25	0.1725E-11	0.1074E-11	0.3874E-11
5	26	0.8505E-12	0.5294E-12	0.1910E-11
5	27	0.4194E-12	0.2611E-12	0.9421E-12
5	28	0.2068E-12	0.1287E-12	0.4646E-12
5	29	0.1020E-12	0.6349E-13	0.2291E-12
5	30	0.5030E-13	0.3131E-13	0.1130E-12
6	31	0.2662E-13	0.1795E-13	0.5182E-13
6	32	0.1221E-13	0.8232E-14	0.2376E-13
6	33	0.5600E-14	0.3775E-14	0.1090E-13
6	34	0.2568E-14	0.1732E-14	0.4998E-14
6	35	0.1178E-14	0.7941E-15	0.2292E-14
6	36	0.5402E-15	0.3642E-15	0.1051E-14

Appendix D. (cont.)

PESTICIDE CONCENTRATION PROFILE (Metolachlor-East Lansing)

DATE (DAY-MONTH-YEAR) 20 AUG., 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.1632E-01	0.1499E-01	0.8323E-02
1	2	0.2440E-01	0.2239E-01	0.1243E-01
1	3	0.1730E-01	0.1595E-01	0.8852E-02
1	4	0.6685E-02	0.6150E-02	0.3414E-02
1	5	0.1491E-02	0.1383E-02	0.7677E-03
1	6	0.2582E-03	0.2420E-03	0.1344E-03
2	7	0.4391E-04	0.4021E-04	0.2902E-04
2	8	0.1023E-04	0.9366E-05	0.6760E-05
2	9	0.2654E-05	0.2431E-05	0.1754E-05
2	10	0.6930E-06	0.6336E-06	0.4573E-06
2	11	0.1806E-06	0.1640E-06	0.1184E-06
2	12	0.4610E-07	0.4117E-07	0.2971E-07
3	13	0.8275E-08	0.6130E-08	0.1264E-07
3	14	0.3560E-08	0.2587E-08	0.5333E-08
3	15	0.1499E-08	0.1084E-08	0.2235E-08
3	16	0.6234E-09	0.4506E-09	0.9291E-09
3	17	0.2571E-09	0.1859E-09	0.3832E-09
3	18	0.1052E-09	0.7603E-10	0.1568E-09
4	19	0.3664E-10	0.2515E-10	0.7260E-10
4	20	0.1697E-10	0.1164E-10	0.3362E-10
4	21	0.7857E-11	0.5392E-11	0.1557E-10
4	22	0.3638E-11	0.2497E-11	0.7208E-11
4	23	0.1685E-11	0.1156E-11	0.3338E-11
4	24	0.7801E-12	0.5354E-12	0.1545E-11
5	25	0.3393E-12	0.2112E-12	0.7621E-12
5	26	0.1673E-12	0.1042E-12	0.3758E-12
5	27	0.8251E-13	0.5136E-13	0.1853E-12
5	28	0.4069E-13	0.2533E-13	0.9140E-13
5	29	0.2006E-13	0.1249E-13	0.4507E-13
5	30	0.9895E-14	0.6159E-14	0.2223E-13
6	31	0.5238E-14	0.3531E-14	0.1019E-13
6	32	0.2402E-14	0.1619E-14	0.4675E-14
6	33	0.1102E-14	0.7427E-15	0.2144E-14
6	34	0.5053E-15	0.3406E-15	0.9833E-15
6	35	0.2317E-15	0.1562E-15	0.4510E-15
6	36	0.1063E-15	0.7165E-16	0.2068E-15

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Metolachlor-East Lansing MI)

DATE (DAY-MONTH-YEAR) 26 SEP., 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.5212E-03	0.4844E-03	0.2689E-03
1	2	0.1821E-02	0.1685E-02	0.9355E-03
1	3	0.2785E-02	0.2566E-02	0.1424E-02
1	4	0.2534E-02	0.2321E-02	0.1288E-02
1	5	0.1579E-02	0.1436E-02	0.7974E-03
1	6	0.7325E-03	0.6616E-03	0.3673E-03
2	7	0.2383E-03	0.2096E-03	0.1512E-03
2	8	0.8113E-04	0.7155E-04	0.5163E-04
2	9	0.2327E-04	0.2049E-04	0.1479E-04
2	10	0.5601E-05	0.4923E-05	0.3553E-05
2	11	0.1143E-05	0.1003E-05	0.7236E-06
2	12	0.2017E-06	0.1767E-06	0.1275E-06
3	13	0.2582E-07	0.1904E-07	0.3925E-07
3	14	0.7412E-08	0.5445E-08	0.1123E-07
3	15	0.2042E-08	0.1494E-08	0.3081E-08
3	16	0.5836E-09	0.4254E-09	0.8771E-09
3	17	0.1851E-09	0.1343E-09	0.2770E-09
3	18	0.6562E-10	0.4743E-10	0.9779E-10
4	19	0.2157E-10	0.1480E-10	0.4273E-10
4	20	0.9686E-11	0.6648E-11	0.1919E-10
4	21	0.4405E-11	0.3023E-11	0.8726E-11
4	22	0.2016E-11	0.1383E-11	0.3994E-11
4	23	0.9261E-12	0.6356E-12	0.1835E-11
4	24	0.4265E-12	0.2927E-12	0.8450E-12
5	25	0.1849E-12	0.1151E-12	0.4153E-12
5	26	0.9094E-13	0.5661E-13	0.2043E-12
5	27	0.4477E-13	0.2787E-13	0.1006E-12
5	28	0.2205E-13	0.1373E-13	0.4953E-13
5	29	0.1086E-13	0.6763E-14	0.2441E-13
5	30	0.5355E-14	0.3333E-14	0.1203E-13
6	31	0.2833E-14	0.1910E-14	0.5514E-14
6	32	0.1299E-14	0.8758E-15	0.2528E-14
6	33	0.5956E-15	0.4016E-15	0.1159E-14
6	34	0.2731E-15	0.1841E-15	0.5316E-15
6	35	0.1253E-15	0.8445E-16	0.2438E-15
6	36	0.5744E-16	0.3873E-16	0.1118E-15

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Alachlor - East Lansing MI)

DATE (DAY-MONTH-YEAR) 20 MAY , 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	5.774	5.372	1.938
1	2	0.0000E+00	0.0000E+00	0.0000E+00
1	3	0.0000E+00	0.0000E+00	0.0000E+00
1	4	0.0000E+00	0.0000E+00	0.0000E+00
1	5	0.0000E+00	0.0000E+00	0.0000E+00
1	6	0.0000E+00	0.0000E+00	0.0000E+00
2	7	0.0000E+00	0.0000E+00	0.0000E+00
2	8	0.0000E+00	0.0000E+00	0.0000E+00
2	9	0.0000E+00	0.0000E+00	0.0000E+00
2	10	0.0000E+00	0.0000E+00	0.0000E+00
2	11	0.0000E+00	0.0000E+00	0.0000E+00
2	12	0.0000E+00	0.0000E+00	0.0000E+00
3	13	0.0000E+00	0.0000E+00	0.0000E+00
3	14	0.0000E+00	0.0000E+00	0.0000E+00
3	15	0.0000E+00	0.0000E+00	0.0000E+00
3	16	0.0000E+00	0.0000E+00	0.0000E+00
3	17	0.0000E+00	0.0000E+00	0.0000E+00
3	18	0.0000E+00	0.0000E+00	0.0000E+00
4	19	0.0000E+00	0.0000E+00	0.0000E+00
4	20	0.0000E+00	0.0000E+00	0.0000E+00
4	21	0.0000E+00	0.0000E+00	0.0000E+00
4	22	0.0000E+00	0.0000E+00	0.0000E+00
4	23	0.0000E+00	0.0000E+00	0.0000E+00
4	24	0.0000E+00	0.0000E+00	0.0000E+00
5	25	0.0000E+00	0.0000E+00	0.0000E+00
5	26	0.0000E+00	0.0000E+00	0.0000E+00
5	27	0.0000E+00	0.0000E+00	0.0000E+00
5	28	0.0000E+00	0.0000E+00	0.0000E+00
5	29	0.0000E+00	0.0000E+00	0.0000E+00
5	30	0.0000E+00	0.0000E+00	0.0000E+00
6	31	0.0000E+00	0.0000E+00	0.0000E+00
6	32	0.0000E+00	0.0000E+00	0.0000E+00
6	33	0.0000E+00	0.0000E+00	0.0000E+00
6	34	0.0000E+00	0.0000E+00	0.0000E+00
6	35	0.0000E+00	0.0000E+00	0.0000E+00
6	36	0.0000E+00	0.0000E+00	0.0000E+00

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Alachlor - East Lansing MI)

DATE (DAY-MONTH-YEAR) 16 JUNE, 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.3509	0.3363	0.1213
1	2	0.8381E-01	0.8033E-01	0.2897E-01
1	3	0.8987E-02	0.8613E-02	0.3107E-02
1	4	0.5919E-03	0.5673E-03	0.2046E-03
1	5	0.2017E-04	0.1932E-04	0.6969E-05
1	6	0.3023E-06	0.2812E-06	0.1014E-06
2	7	0.5485E-08	0.4983E-08	0.2337E-08
2	8	0.1243E-09	0.1129E-09	0.5296E-10
2	9	0.1738E-11	0.1579E-11	0.7403E-12
2	10	0.8893E-14	0.8113E-14	0.3804E-14
2	11	0.0000E+00	0.0000E+00	0.0000E+00
2	12	0.0000E+00	0.0000E+00	0.0000E+00
3	13	0.0000E+00	0.0000E+00	0.0000E+00
3	14	0.0000E+00	0.0000E+00	0.0000E+00
3	15	0.0000E+00	0.0000E+00	0.0000E+00
3	16	0.0000E+00	0.0000E+00	0.0000E+00
3	17	0.0000E+00	0.0000E+00	0.0000E+00
3	18	0.0000E+00	0.0000E+00	0.0000E+00
4	19	0.0000E+00	0.0000E+00	0.0000E+00
4	20	0.0000E+00	0.0000E+00	0.0000E+00
4	21	0.0000E+00	0.0000E+00	0.0000E+00
4	22	0.0000E+00	0.0000E+00	0.0000E+00
4	23	0.0000E+00	0.0000E+00	0.0000E+00
4	24	0.0000E+00	0.0000E+00	0.0000E+00
5	25	0.0000E+00	0.0000E+00	0.0000E+00
5	26	0.0000E+00	0.0000E+00	0.0000E+00
5	27	0.0000E+00	0.0000E+00	0.0000E+00
5	28	0.0000E+00	0.0000E+00	0.0000E+00
5	29	0.0000E+00	0.0000E+00	0.0000E+00
5	30	0.0000E+00	0.0000E+00	0.0000E+00
6	31	0.0000E+00	0.0000E+00	0.0000E+00
6	32	0.0000E+00	0.0000E+00	0.0000E+00
6	33	0.0000E+00	0.0000E+00	0.0000E+00
6	34	0.0000E+00	0.0000E+00	0.0000E+00
6	35	0.0000E+00	0.0000E+00	0.0000E+00
6	36	0.0000E+00	0.0000E+00	0.0000E+00

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Alachlor - East Lansing MI)

DATE (DAY-MONTH-YEAR) 15 JULY, 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.1213E-01	0.1128E-01	0.4070E-02
1	2	0.8802E-02	0.8194E-02	0.2956E-02
1	3	0.2868E-02	0.2747E-02	0.9910E-03
1	4	0.6512E-03	0.6235E-03	0.2249E-03
1	5	0.1164E-03	0.1113E-03	0.4015E-04
1	6	0.1660E-04	0.1582E-04	0.5706E-05
2	7	0.2004E-05	0.1871E-05	0.8773E-06
2	8	0.3388E-06	0.3117E-06	0.1462E-06
2	9	0.6352E-07	0.5770E-07	0.2706E-07
2	10	0.1181E-07	0.1073E-07	0.5030E-08
2	11	0.2175E-08	0.1975E-08	0.9263E-09
2	12	0.3873E-09	0.3518E-09	0.1650E-09
3	13	0.5167E-10	0.4136E-10	0.5542E-10
3	14	0.1721E-10	0.1378E-10	0.1846E-10
3	15	0.5680E-11	0.4547E-11	0.6092E-11
3	16	0.1858E-11	0.1487E-11	0.1992E-11
3	17	0.6021E-12	0.4820E-12	0.6457E-12
3	18	0.1933E-12	0.1547E-12	0.2073E-12
4	19	0.5371E-13	0.4141E-13	0.7768E-13
4	20	0.2013E-13	0.1552E-13	0.2911E-13
4	21	0.7542E-14	0.5815E-14	0.1091E-13
4	22	0.2826E-14	0.2179E-14	0.4087E-14
4	23	0.1059E-14	0.8164E-15	0.1531E-14
4	24	0.3968E-15	0.3059E-15	0.5738E-15
5	25	0.1397E-15	0.1002E-15	0.2350E-15
5	26	0.5721E-16	0.4104E-16	0.9622E-16
5	27	0.2343E-16	0.1681E-16	0.3940E-16
5	28	0.9593E-17	0.6882E-17	0.1614E-16
5	29	0.3928E-17	0.2818E-17	0.6607E-17
5	30	0.1609E-17	0.1154E-17	0.2706E-17
6	31	0.7045E-18	0.5361E-18	0.1006E-17
6	32	0.2618E-18	0.1993E-18	0.3737E-18
6	33	0.9731E-19	0.7406E-19	0.1389E-18
6	34	0.3617E-19	0.2752E-19	0.5163E-19
6	35	0.1344E-19	0.1023E-19	0.1919E-19
6	36	0.4996E-20	0.3802E-20	0.7131E-20

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Alachlor - East Lansing MI)

DATE (DAY-MONTH-YEAR) 15 JULY, 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)

1	1	0.1213E-01	0.1128E-01	0.4070E-02
1	2	0.8802E-02	0.8194E-02	0.2956E-02
1	3	0.2868E-02	0.2747E-02	0.9910E-03
1	4	0.6512E-03	0.6235E-03	0.2249E-03
1	5	0.1164E-03	0.1113E-03	0.4015E-04
1	6	0.1660E-04	0.1582E-04	0.5706E-05
2	7	0.2004E-05	0.1871E-05	0.8773E-06
2	8	0.3388E-06	0.3117E-06	0.1462E-06
2	9	0.6352E-07	0.5770E-07	0.2706E-07
2	10	0.1181E-07	0.1073E-07	0.5030E-08
2	11	0.2175E-08	0.1975E-08	0.9263E-09
2	12	0.3873E-09	0.3518E-09	0.1650E-09
3	13	0.5167E-10	0.4136E-10	0.5542E-10
3	14	0.1721E-10	0.1378E-10	0.1846E-10
3	15	0.5680E-11	0.4547E-11	0.6092E-11
3	16	0.1858E-11	0.1487E-11	0.1992E-11
3	17	0.6021E-12	0.4820E-12	0.6457E-12
3	18	0.1933E-12	0.1547E-12	0.2073E-12
4	19	0.5371E-13	0.4141E-13	0.7768E-13
4	20	0.2013E-13	0.1552E-13	0.2911E-13
4	21	0.7542E-14	0.5815E-14	0.1091E-13
4	22	0.2826E-14	0.2179E-14	0.4087E-14
4	23	0.1059E-14	0.8164E-15	0.1531E-14
4	24	0.3968E-15	0.3059E-15	0.5738E-15
5	25	0.1397E-15	0.1002E-15	0.2350E-15
5	26	0.5721E-16	0.4104E-16	0.9622E-16
5	27	0.2343E-16	0.1681E-16	0.3940E-16
5	28	0.9593E-17	0.6882E-17	0.1614E-16
5	29	0.3928E-17	0.2818E-17	0.6607E-17
5	30	0.1609E-17	0.1154E-17	0.2706E-17
6	31	0.7045E-18	0.5361E-18	0.1006E-17
6	32	0.2618E-18	0.1993E-18	0.3737E-18
6	33	0.9731E-19	0.7406E-19	0.1389E-18
6	34	0.3617E-19	0.2752E-19	0.5163E-19
6	35	0.1344E-19	0.1023E-19	0.1919E-19
6	36	0.4996E-20	0.3802E-20	0.7131E-20

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Alachlor - East Lansing MI)

DATE (DAY-MONTH-YEAR) 20 AUG., 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.2992E-03	0.2830E-03	0.1021E-03
1	2	0.3012E-03	0.2846E-03	0.1027E-03
1	3	0.1344E-03	0.1274E-03	0.4594E-04
1	4	0.3273E-04	0.3097E-04	0.1117E-04
1	5	0.4700E-05	0.4472E-05	0.1613E-05
1	6	0.5519E-06	0.5290E-06	0.1908E-06
2	7	0.6633E-07	0.6259E-07	0.2935E-07
2	8	0.1107E-07	0.1044E-07	0.4897E-08
2	9	0.2051E-08	0.1935E-08	0.9076E-09
2	10	0.3817E-09	0.3598E-09	0.1687E-09
2	11	0.7057E-10	0.6622E-10	0.3105E-10
2	12	0.1270E-10	0.1178E-10	0.5525E-11
3	13	0.1700E-11	0.1385E-11	0.1855E-11
3	14	0.5733E-12	0.4606E-12	0.6171E-12
3	15	0.1899E-12	0.1520E-12	0.2036E-12
3	16	0.6210E-13	0.4971E-13	0.6660E-13
3	17	0.2012E-13	0.1611E-13	0.2158E-13
3	18	0.6461E-14	0.5172E-14	0.6929E-14
4	19	0.1795E-14	0.1384E-14	0.2597E-14
4	20	0.6728E-15	0.5187E-15	0.9729E-15
4	21	0.2521E-15	0.1944E-15	0.3646E-15
4	22	0.9446E-16	0.7283E-16	0.1366E-15
4	23	0.3540E-16	0.2729E-16	0.5119E-16
4	24	0.1326E-16	0.1023E-16	0.1918E-16
5	25	0.4670E-17	0.3350E-17	0.7854E-17
5	26	0.1912E-17	0.1372E-17	0.3216E-17
5	27	0.7831E-18	0.5617E-18	0.1317E-17
5	28	0.3207E-18	0.2300E-18	0.5393E-18
5	29	0.1313E-18	0.9420E-19	0.2209E-18
5	30	0.5377E-19	0.3857E-19	0.9044E-19
6	31	0.2355E-19	0.1792E-19	0.3361E-19
6	32	0.8752E-20	0.6660E-20	0.1249E-19
6	33	0.3253E-20	0.2475E-20	0.4643E-20
6	34	0.1209E-20	0.9200E-21	0.1726E-20
6	35	0.4493E-21	0.3419E-21	0.6413E-21
6	36	0.1670E-21	0.1271E-21	0.2384E-21

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Alachlor - East Lansing MI)

DATE (DAY-MONTH-YEAR) 26 SEP., 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.2732E-05	0.2604E-05	0.9392E-06
1	2	0.6067E-05	0.5765E-05	0.2080E-05
1	3	0.5890E-05	0.5580E-05	0.2013E-05
1	4	0.3432E-05	0.3238E-05	0.1168E-05
1	5	0.1380E-05	0.1296E-05	0.4676E-06
1	6	0.4151E-06	0.3881E-06	0.1400E-06
2	7	0.8999E-07	0.8264E-07	0.3875E-07
2	8	0.2054E-07	0.1889E-07	0.8859E-08
2	9	0.3926E-08	0.3608E-08	0.1692E-08
2	10	0.6275E-09	0.5760E-09	0.2701E-09
2	11	0.8491E-10	0.7785E-10	0.3650E-10
2	12	0.9975E-11	0.9134E-11	0.4283E-11
3	13	0.8948E-12	0.7266E-12	0.9735E-12
3	14	0.1903E-12	0.1542E-12	0.2065E-12
3	15	0.3959E-13	0.3197E-13	0.4284E-13
3	16	0.8799E-14	0.7086E-14	0.9493E-14
3	17	0.2218E-14	0.1781E-14	0.2386E-14
3	18	0.6276E-15	0.5024E-15	0.6731E-15
4	19	0.1665E-15	0.1283E-15	0.2407E-15
4	20	0.6095E-16	0.4699E-16	0.8815E-16
4	21	0.2254E-16	0.1738E-16	0.3260E-16
4	22	0.8379E-17	0.6461E-17	0.1212E-16
4	23	0.3124E-17	0.2408E-17	0.4517E-17
4	24	0.1167E-17	0.8995E-18	0.1687E-17
5	25	0.4099E-18	0.2940E-18	0.6894E-18
5	26	0.1676E-18	0.1202E-18	0.2819E-18
5	27	0.6858E-19	0.4919E-19	0.1153E-18
5	28	0.2806E-19	0.2013E-19	0.4720E-19
5	29	0.1149E-19	0.8241E-20	0.1932E-19
5	30	0.4703E-20	0.3374E-20	0.7910E-20
6	31	0.2059E-20	0.1567E-20	0.2939E-20
6	32	0.7652E-21	0.5823E-21	0.1092E-20
6	33	0.2844E-21	0.2164E-21	0.4059E-21
6	34	0.1057E-21	0.8043E-22	0.1509E-21
6	35	0.3928E-22	0.2989E-22	0.5606E-22
6	36	0.1460E-22	0.1111E-22	0.2084E-22

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Metolachlor-Hickory Corners MI)
 DATE (DAY-MONTH-YEAR) 1 JUNE, 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	6.052	5.183	4.022
1	2	0.4008E-01	0.3533E-01	0.2742E-01
1	3	0.0000E+00	0.0000E+00	0.0000E+00
1	4	0.0000E+00	0.0000E+00	0.0000E+00
1	5	0.0000E+00	0.0000E+00	0.0000E+00
1	6	0.0000E+00	0.0000E+00	0.0000E+00
2	7	0.0000E+00	0.0000E+00	0.0000E+00
2	8	0.0000E+00	0.0000E+00	0.0000E+00
2	9	0.0000E+00	0.0000E+00	0.0000E+00
2	10	0.0000E+00	0.0000E+00	0.0000E+00
2	11	0.0000E+00	0.0000E+00	0.0000E+00
2	12	0.0000E+00	0.0000E+00	0.0000E+00
3	13	0.0000E+00	0.0000E+00	0.0000E+00
3	14	0.0000E+00	0.0000E+00	0.0000E+00
3	15	0.0000E+00	0.0000E+00	0.0000E+00
3	16	0.0000E+00	0.0000E+00	0.0000E+00
3	17	0.0000E+00	0.0000E+00	0.0000E+00
3	18	0.0000E+00	0.0000E+00	0.0000E+00
4	19	0.0000E+00	0.0000E+00	0.0000E+00
4	20	0.0000E+00	0.0000E+00	0.0000E+00
4	21	0.0000E+00	0.0000E+00	0.0000E+00
4	22	0.0000E+00	0.0000E+00	0.0000E+00
4	23	0.0000E+00	0.0000E+00	0.0000E+00
4	24	0.0000E+00	0.0000E+00	0.0000E+00
5	25	0.0000E+00	0.0000E+00	0.0000E+00
5	26	0.0000E+00	0.0000E+00	0.0000E+00
5	27	0.0000E+00	0.0000E+00	0.0000E+00
5	28	0.0000E+00	0.0000E+00	0.0000E+00
5	29	0.0000E+00	0.0000E+00	0.0000E+00
5	30	0.0000E+00	0.0000E+00	0.0000E+00
6	31	0.0000E+00	0.0000E+00	0.0000E+00
6	32	0.0000E+00	0.0000E+00	0.0000E+00
6	33	0.0000E+00	0.0000E+00	0.0000E+00
6	34	0.0000E+00	0.0000E+00	0.0000E+00
6	35	0.0000E+00	0.0000E+00	0.0000E+00
6	36	0.0000E+00	0.0000E+00	0.0000E+00

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Metolachlor-Hickory Corner MI)

DATE (DAY-MONTH-YEAR) 9 JUNE, 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	3.541	3.209	2.490
1	2	0.2345E-01	0.2151E-01	0.1669E-01
1	3	0.0000E+00	0.0000E+00	0.0000E+00
1	4	0.0000E+00	0.0000E+00	0.0000E+00
1	5	0.0000E+00	0.0000E+00	0.0000E+00
1	6	0.0000E+00	0.0000E+00	0.0000E+00
2	7	0.0000E+00	0.0000E+00	0.0000E+00
2	8	0.0000E+00	0.0000E+00	0.0000E+00
2	9	0.0000E+00	0.0000E+00	0.0000E+00
2	10	0.0000E+00	0.0000E+00	0.0000E+00
2	11	0.0000E+00	0.0000E+00	0.0000E+00
2	12	0.0000E+00	0.0000E+00	0.0000E+00
3	13	0.0000E+00	0.0000E+00	0.0000E+00
3	14	0.0000E+00	0.0000E+00	0.0000E+00
3	15	0.0000E+00	0.0000E+00	0.0000E+00
3	16	0.0000E+00	0.0000E+00	0.0000E+00
3	17	0.0000E+00	0.0000E+00	0.0000E+00
3	18	0.0000E+00	0.0000E+00	0.0000E+00
4	19	0.0000E+00	0.0000E+00	0.0000E+00
4	20	0.0000E+00	0.0000E+00	0.0000E+00
4	21	0.0000E+00	0.0000E+00	0.0000E+00
4	22	0.0000E+00	0.0000E+00	0.0000E+00
4	23	0.0000E+00	0.0000E+00	0.0000E+00
4	24	0.0000E+00	0.0000E+00	0.0000E+00
5	25	0.0000E+00	0.0000E+00	0.0000E+00
5	26	0.0000E+00	0.0000E+00	0.0000E+00
5	27	0.0000E+00	0.0000E+00	0.0000E+00
5	28	0.0000E+00	0.0000E+00	0.0000E+00
5	29	0.0000E+00	0.0000E+00	0.0000E+00
5	30	0.0000E+00	0.0000E+00	0.0000E+00
6	31	0.0000E+00	0.0000E+00	0.0000E+00
6	32	0.0000E+00	0.0000E+00	0.0000E+00
6	33	0.0000E+00	0.0000E+00	0.0000E+00
6	34	0.0000E+00	0.0000E+00	0.0000E+00
6	35	0.0000E+00	0.0000E+00	0.0000E+00
6	36	0.0000E+00	0.0000E+00	0.0000E+00

Appendix D. (cont.)

PESTICIDE CONCENTRATION PROFILE (Metolachlor-Hickory Corners MI)

DATE (DAY-MONTH-YEAR) 3 JULY, 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.3418	0.3081	0.2391
1	2	0.1955	0.1793	0.1392
1	3	0.8499E-01	0.7796E-01	0.6050E-01
1	4	0.3166E-01	0.2903E-01	0.2253E-01
1	5	0.9878E-02	0.8994E-02	0.6980E-02
1	6	0.2792E-02	0.2391E-02	0.1856E-02
2	7	0.6946E-03	0.5706E-03	0.5883E-03
2	8	0.2154E-03	0.1769E-03	0.1824E-03
2	9	0.6597E-04	0.5419E-04	0.5586E-04
2	10	0.2007E-04	0.1648E-04	0.1699E-04
2	11	0.6081E-05	0.4995E-05	0.5150E-05
2	12	0.1840E-05	0.1511E-05	0.1558E-05
3	13	0.3720E-06	0.2384E-06	0.7480E-06
3	14	0.1786E-06	0.1144E-06	0.3591E-06
3	15	0.8571E-07	0.5492E-07	0.1723E-06
3	16	0.4113E-07	0.2636E-07	0.8270E-07
3	17	0.1974E-07	0.1265E-07	0.3969E-07
3	18	0.9471E-08	0.6069E-08	0.1904E-07
4	19	0.3801E-08	0.2523E-08	0.1071E-07
4	20	0.2138E-08	0.1419E-08	0.6023E-08
4	21	0.1202E-08	0.7979E-09	0.3387E-08
4	22	0.6761E-09	0.4488E-09	0.1905E-08
4	23	0.3802E-09	0.2524E-09	0.1071E-08
4	24	0.2138E-09	0.1419E-09	0.6026E-09
5	25	0.1090E-09	0.8029E-10	0.3408E-09
5	26	0.6168E-10	0.4541E-10	0.1928E-09
5	27	0.3489E-10	0.2569E-10	0.1090E-09
5	28	0.1973E-10	0.1453E-10	0.6168E-10
5	29	0.1116E-10	0.8219E-11	0.3489E-10
5	30	0.6314E-11	0.4649E-11	0.1974E-10
6	31	0.2213E-11	0.1207E-11	0.1451E-10
6	32	0.1628E-11	0.8874E-12	0.1067E-10
6	33	0.1197E-11	0.6526E-12	0.7850E-11
6	34	0.8804E-12	0.4800E-12	0.5773E-11
6	35	0.6475E-12	0.3530E-12	0.4246E-11
6	36	0.4762E-12	0.2596E-12	0.3123E-11

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Metolachlor-Hickory Corners MI)

DATE (DAY-MONTH-YEAR) 8 AUG., 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.1114E-01	0.9536E-02	0.7400E-02
1	2	0.1705E-01	0.1460E-01	0.1133E-01
1	3	0.1259E-01	0.1144E-01	0.8879E-02
1	4	0.5514E-02	0.5055E-02	0.3922E-02
1	5	0.1645E-02	0.1507E-02	0.1170E-02
1	6	0.3412E-03	0.3126E-03	0.2426E-03
2	7	0.7422E-04	0.6589E-04	0.6794E-04
2	8	0.2296E-04	0.2002E-04	0.2064E-04
2	9	0.7209E-05	0.6110E-05	0.6299E-05
2	10	0.2251E-05	0.1858E-05	0.1915E-05
2	11	0.6862E-06	0.5636E-06	0.5811E-06
2	12	0.2077E-06	0.1706E-06	0.1759E-06
3	13	0.4203E-07	0.2693E-07	0.8452E-07
3	14	0.2018E-07	0.1293E-07	0.4058E-07
3	15	0.9687E-08	0.6207E-08	0.1948E-07
3	16	0.4649E-08	0.2979E-08	0.9348E-08
3	17	0.2231E-08	0.1430E-08	0.4486E-08
3	18	0.1071E-08	0.6861E-09	0.2153E-08
4	19	0.4296E-09	0.2852E-09	0.1211E-08
4	20	0.2416E-09	0.1604E-09	0.6809E-09
4	21	0.1359E-09	0.9020E-10	0.3829E-09
4	22	0.7643E-10	0.5073E-10	0.2154E-09
4	23	0.4298E-10	0.2853E-10	0.1211E-09
4	24	0.2417E-10	0.1604E-10	0.6811E-10
5	25	0.1233E-10	0.9076E-11	0.3853E-10
5	26	0.6972E-11	0.5134E-11	0.2179E-10
5	27	0.3944E-11	0.2904E-11	0.1233E-10
5	28	0.2231E-11	0.1642E-11	0.6973E-11
5	29	0.1262E-11	0.9291E-12	0.3944E-11
5	30	0.7138E-12	0.5255E-12	0.2231E-11
6	31	0.2502E-12	0.1364E-12	0.1641E-11
6	32	0.1840E-12	0.1003E-12	0.1207E-11
6	33	0.1353E-12	0.7378E-13	0.8874E-12
6	34	0.9952E-13	0.5426E-13	0.6526E-12
6	35	0.7319E-13	0.3990E-13	0.4800E-12
6	36	0.5383E-13	0.2935E-13	0.3530E-12

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Metolachlor-Hickory Corners MI)
 DATE (DAY-MONTH-YEAR) 24 OCT., 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.2737E-05	0.2351E-05	0.1825E-05
1	2	0.1212E-04	0.1041E-04	0.8077E-05
1	3	0.2925E-04	0.2509E-04	0.1947E-04
1	4	0.4431E-04	0.3800E-04	0.2949E-04
1	5	0.4641E-04	0.3977E-04	0.3087E-04
1	6	0.3591E-04	0.3075E-04	0.2386E-04
2	7	0.1862E-04	0.1552E-04	0.1600E-04
2	8	0.1045E-04	0.8853E-05	0.9127E-05
2	9	0.5226E-05	0.4418E-05	0.4555E-05
2	10	0.2309E-05	0.1947E-05	0.2007E-05
2	11	0.9220E-06	0.7752E-06	0.7992E-06
2	12	0.3431E-06	0.2876E-06	0.2965E-06
3	13	0.7652E-07	0.5037E-07	0.1580E-06
3	14	0.3991E-07	0.2614E-07	0.8202E-07
3	15	0.2064E-07	0.1345E-07	0.4221E-07
3	16	0.1077E-07	0.6978E-08	0.2190E-07
3	17	0.5707E-08	0.3678E-08	0.1154E-07
3	18	0.3066E-08	0.1965E-08	0.6165E-08
4	19	0.1356E-08	0.9000E-09	0.3821E-08
4	20	0.8430E-09	0.5596E-09	0.2375E-08
4	21	0.5247E-09	0.3483E-09	0.1478E-08
4	22	0.3266E-09	0.2168E-09	0.9204E-09
4	23	0.2033E-09	0.1350E-09	0.5729E-09
4	24	0.1265E-09	0.8398E-10	0.3565E-09
5	25	0.7131E-10	0.5250E-10	0.2229E-09
5	26	0.4457E-10	0.3281E-10	0.1393E-09
5	27	0.2784E-10	0.2050E-10	0.8703E-10
5	28	0.1739E-10	0.1280E-10	0.5436E-10
5	29	0.1086E-10	0.7995E-11	0.3394E-10
5	30	0.6779E-11	0.4991E-11	0.2119E-10
6	31	0.2520E-11	0.1374E-11	0.1653E-10
6	32	0.1966E-11	0.1072E-11	0.1289E-10
6	33	0.1533E-11	0.8358E-12	0.1005E-10
6	34	0.1196E-11	0.6518E-12	0.7840E-11
6	35	0.9323E-12	0.5083E-12	0.6113E-11
6	36	0.7269E-12	0.3963E-12	0.4767E-11

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Alachlor - Hickory Corners MI)

DATE (DAY-MONTH-YEAR) 1 JUNE, 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	5.902	5.322	2.683
1	2	0.2602E-01	0.2393E-01	0.1206E-01
1	3	0.0000E+00	0.0000E+00	0.0000E+00
1	4	0.0000E+00	0.0000E+00	0.0000E+00
1	5	0.0000E+00	0.0000E+00	0.0000E+00
1	6	0.0000E+00	0.0000E+00	0.0000E+00
2	7	0.0000E+00	0.0000E+00	0.0000E+00
2	8	0.0000E+00	0.0000E+00	0.0000E+00
2	9	0.0000E+00	0.0000E+00	0.0000E+00
2	10	0.0000E+00	0.0000E+00	0.0000E+00
2	11	0.0000E+00	0.0000E+00	0.0000E+00
2	12	0.0000E+00	0.0000E+00	0.0000E+00
3	13	0.0000E+00	0.0000E+00	0.0000E+00
3	14	0.0000E+00	0.0000E+00	0.0000E+00
3	15	0.0000E+00	0.0000E+00	0.0000E+00
3	16	0.0000E+00	0.0000E+00	0.0000E+00
3	17	0.0000E+00	0.0000E+00	0.0000E+00
3	18	0.0000E+00	0.0000E+00	0.0000E+00
4	19	0.0000E+00	0.0000E+00	0.0000E+00
4	20	0.0000E+00	0.0000E+00	0.0000E+00
4	21	0.0000E+00	0.0000E+00	0.0000E+00
4	22	0.0000E+00	0.0000E+00	0.0000E+00
4	23	0.0000E+00	0.0000E+00	0.0000E+00
4	24	0.0000E+00	0.0000E+00	0.0000E+00
5	25	0.0000E+00	0.0000E+00	0.0000E+00
5	26	0.0000E+00	0.0000E+00	0.0000E+00
5	27	0.0000E+00	0.0000E+00	0.0000E+00
5	28	0.0000E+00	0.0000E+00	0.0000E+00
5	29	0.0000E+00	0.0000E+00	0.0000E+00
5	30	0.0000E+00	0.0000E+00	0.0000E+00
6	31	0.0000E+00	0.0000E+00	0.0000E+00
6	32	0.0000E+00	0.0000E+00	0.0000E+00
6	33	0.0000E+00	0.0000E+00	0.0000E+00
6	34	0.0000E+00	0.0000E+00	0.0000E+00
6	35	0.0000E+00	0.0000E+00	0.0000E+00
6	36	0.0000E+00	0.0000E+00	0.0000E+00

Appendix D. (cont.)

PESTICIDE CONCENTRATION PROFILE (Alachlor - Hickory Corners MI)

DATE (DAY-MONTH-YEAR) 9 JUNE, 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	2.773	2.599	1.310
1	2	0.1223E-01	0.1155E-01	0.5823E-02
1	3	0.0000E+00	0.0000E+00	0.0000E+00
1	4	0.0000E+00	0.0000E+00	0.0000E+00
1	5	0.0000E+00	0.0000E+00	0.0000E+00
1	6	0.0000E+00	0.0000E+00	0.0000E+00
2	7	0.0000E+00	0.0000E+00	0.0000E+00
2	8	0.0000E+00	0.0000E+00	0.0000E+00
2	9	0.0000E+00	0.0000E+00	0.0000E+00
2	10	0.0000E+00	0.0000E+00	0.0000E+00
2	11	0.0000E+00	0.0000E+00	0.0000E+00
2	12	0.0000E+00	0.0000E+00	0.0000E+00
3	13	0.0000E+00	0.0000E+00	0.0000E+00
3	14	0.0000E+00	0.0000E+00	0.0000E+00
3	15	0.0000E+00	0.0000E+00	0.0000E+00
3	16	0.0000E+00	0.0000E+00	0.0000E+00
3	17	0.0000E+00	0.0000E+00	0.0000E+00
3	18	0.0000E+00	0.0000E+00	0.0000E+00
4	19	0.0000E+00	0.0000E+00	0.0000E+00
4	20	0.0000E+00	0.0000E+00	0.0000E+00
4	21	0.0000E+00	0.0000E+00	0.0000E+00
4	22	0.0000E+00	0.0000E+00	0.0000E+00
4	23	0.0000E+00	0.0000E+00	0.0000E+00
4	24	0.0000E+00	0.0000E+00	0.0000E+00
5	25	0.0000E+00	0.0000E+00	0.0000E+00
5	26	0.0000E+00	0.0000E+00	0.0000E+00
5	27	0.0000E+00	0.0000E+00	0.0000E+00
5	28	0.0000E+00	0.0000E+00	0.0000E+00
5	29	0.0000E+00	0.0000E+00	0.0000E+00
5	30	0.0000E+00	0.0000E+00	0.0000E+00
6	31	0.0000E+00	0.0000E+00	0.0000E+00
6	32	0.0000E+00	0.0000E+00	0.0000E+00
6	33	0.0000E+00	0.0000E+00	0.0000E+00
6	34	0.0000E+00	0.0000E+00	0.0000E+00
6	35	0.0000E+00	0.0000E+00	0.0000E+00
6	36	0.0000E+00	0.0000E+00	0.0000E+00

Appendix D. (cont.)

1PESTICIDE CONCENTRATION PROFILE (Alachlor - Hickory Corners MI)

DATE (DAY-MONTH-YEAR) 3 JULY, 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.1721	0.1607	0.8102E-01
1	2	0.7326E-01	0.6920E-01	0.3489E-01
1	3	0.2294E-01	0.2167E-01	0.1092E-01
1	4	0.6062E-02	0.5726E-02	0.2887E-02
1	5	0.1363E-02	0.1281E-02	0.6458E-03
1	6	0.2782E-03	0.2509E-03	0.1265E-03
2	7	0.5081E-04	0.4452E-04	0.2982E-04
2	8	0.1174E-04	0.1028E-04	0.6889E-05
2	9	0.2681E-05	0.2349E-05	0.1574E-05
2	10	0.6090E-06	0.5336E-06	0.3574E-06
2	11	0.1379E-06	0.1208E-06	0.8094E-07
2	12	0.3118E-07	0.2732E-07	0.1830E-07
3	13	0.4903E-08	0.3594E-08	0.7328E-08
3	14	0.1963E-08	0.1439E-08	0.2933E-08
3	15	0.7854E-09	0.5757E-09	0.1174E-08
3	16	0.3143E-09	0.2304E-09	0.4697E-09
3	17	0.1258E-09	0.9220E-10	0.1880E-09
3	18	0.5034E-10	0.3690E-10	0.7523E-10
4	19	0.1738E-10	0.1308E-10	0.3607E-10
4	20	0.8331E-11	0.6268E-11	0.1729E-10
4	21	0.3994E-11	0.3005E-11	0.8289E-11
4	22	0.1915E-11	0.1441E-11	0.3974E-11
4	23	0.9180E-12	0.6907E-12	0.1905E-11
4	24	0.4401E-12	0.3311E-12	0.9134E-12
5	25	0.1942E-12	0.1575E-12	0.4344E-12
5	26	0.9235E-13	0.7491E-13	0.2066E-12
5	27	0.4392E-13	0.3563E-13	0.9828E-13
5	28	0.2089E-13	0.1695E-13	0.4675E-13
5	29	0.9936E-14	0.8060E-14	0.2223E-13
5	30	0.4726E-14	0.3834E-14	0.1057E-13
6	31	0.1411E-14	0.9153E-15	0.7153E-14
6	32	0.9547E-15	0.6191E-15	0.4838E-14
6	33	0.6457E-15	0.4188E-15	0.3273E-14
6	34	0.4368E-15	0.2833E-15	0.2214E-14
6	35	0.2954E-15	0.1916E-15	0.1497E-14
6	36	0.1998E-15	0.1296E-15	0.1013E-14

Appendix D. (cont.)

PESTICIDE CONCENTRATION PROFILE (Alachlor - Hickory Corners MI)

DATE (DAY-MONTH-YEAR) 8 AUG., 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.2877E-02	0.2594E-02	0.1308E-02
1	2	0.3166E-02	0.2855E-02	0.1440E-02
1	3	0.1546E-02	0.1451E-02	0.7316E-03
1	4	0.4482E-03	0.4231E-03	0.2134E-03
1	5	0.8986E-04	0.8482E-04	0.4277E-04
1	6	0.1302E-04	0.1229E-04	0.6199E-05
2	7	0.2078E-05	0.1920E-05	0.1286E-05
2	8	0.4761E-06	0.4347E-06	0.2912E-06
2	9	0.1105E-06	0.9893E-07	0.6627E-07
2	10	0.2554E-07	0.2245E-07	0.1504E-07
2	11	0.5807E-08	0.5088E-08	0.3408E-08
2	12	0.1314E-08	0.1151E-08	0.7712E-09
3	13	0.2067E-09	0.1515E-09	0.3088E-09
3	14	0.8273E-10	0.6064E-10	0.1236E-09
3	15	0.3311E-10	0.2427E-10	0.4948E-10
3	16	0.1325E-10	0.9714E-11	0.1980E-10
3	17	0.5303E-11	0.3887E-11	0.7926E-11
3	18	0.2122E-11	0.1556E-11	0.3172E-11
4	19	0.7327E-12	0.5513E-12	0.1521E-11
4	20	0.3513E-12	0.2643E-12	0.7290E-12
4	21	0.1684E-12	0.1267E-12	0.3495E-12
4	22	0.8073E-13	0.6074E-13	0.1675E-12
4	23	0.3871E-13	0.2912E-13	0.8032E-13
4	24	0.1856E-13	0.1396E-13	0.3851E-13
5	25	0.8186E-14	0.6640E-14	0.1832E-13
5	26	0.3893E-14	0.3158E-14	0.8712E-14
5	27	0.1852E-14	0.1502E-14	0.4144E-14
5	28	0.8808E-15	0.7145E-15	0.1971E-14
5	29	0.4189E-15	0.3398E-15	0.9374E-15
5	30	0.1993E-15	0.1616E-15	0.4459E-15
6	31	0.5950E-16	0.3859E-16	0.3016E-15
6	32	0.4025E-16	0.2610E-16	0.2040E-15
6	33	0.2723E-16	0.1766E-16	0.1380E-15
6	34	0.1842E-16	0.1194E-16	0.9333E-16
6	35	0.1246E-16	0.8078E-17	0.6313E-16
6	36	0.8426E-17	0.5464E-17	0.4270E-16

Appendix D. (cont.)

PESTICIDE CONCENTRATION PROFILE (Alachlor - Hickory Corners MI)

DATE (DAY-MONTH-YEAR) 24 OCT., 87

HORIZON	COMPARTMENT	TOTAL (MG/KG)	ADSORBED (MG/KG)	DISSOLVED (MG/L)
1	1	0.2235E-06	0.2020E-06	0.1019E-06
1	2	0.7083E-06	0.6398E-06	0.3226E-06
1	3	0.1142E-05	0.1031E-05	0.5199E-06
1	4	0.1142E-05	0.1031E-05	0.5198E-06
1	5	0.7917E-06	0.7142E-06	0.3601E-06
1	6	0.4090E-06	0.3688E-06	0.1860E-06
2	7	0.1488E-06	0.1317E-06	0.8825E-07
2	8	0.5956E-07	0.5333E-07	0.3572E-07
2	9	0.2122E-07	0.1897E-07	0.1271E-07
2	10	0.6702E-08	0.5979E-08	0.4005E-08
2	11	0.1927E-08	0.1716E-08	0.1149E-08
2	12	0.5206E-09	0.4626E-09	0.3099E-09
3	13	0.8911E-10	0.6663E-10	0.1358E-09
3	14	0.3843E-10	0.2863E-10	0.5837E-10
3	15	0.1658E-10	0.1231E-10	0.2509E-10
3	16	0.7273E-11	0.5377E-11	0.1096E-10
3	17	0.3257E-11	0.2398E-11	0.4888E-11
3	18	0.1481E-11	0.1086E-11	0.2214E-11
4	19	0.5734E-12	0.4314E-12	0.1190E-11
4	20	0.3093E-12	0.2327E-12	0.6418E-12
4	21	0.1670E-12	0.1256E-12	0.3465E-12
4	22	0.9018E-13	0.6785E-13	0.1871E-12
4	23	0.4870E-13	0.3664E-13	0.1011E-12
4	24	0.2629E-13	0.1978E-13	0.5457E-13
5	25	0.1307E-13	0.1060E-13	0.2925E-13
5	26	0.7006E-14	0.5683E-14	0.1568E-13
5	27	0.3754E-14	0.3045E-14	0.8400E-14
5	28	0.2011E-14	0.1631E-14	0.4500E-14
5	29	0.1077E-14	0.8739E-15	0.2410E-14
5	30	0.5770E-15	0.4680E-15	0.1291E-14
6	31	0.1851E-15	0.1200E-15	0.9380E-15
6	32	0.1345E-15	0.8720E-16	0.6815E-15
6	33	0.9769E-16	0.6335E-16	0.4951E-15
6	34	0.7097E-16	0.4602E-16	0.3597E-15
6	35	0.5156E-16	0.3343E-16	0.2613E-15
6	36	0.3745E-16	0.2429E-16	0.1898E-15

Appendix E. GLEAMS sample output

(Metolachlor - East Lansing MI)

DATE	RAIN CM	STORM INPUT RUNOFF CM	PERC. CM	SOIL LOSS KG/HA	ENRICH. RATIO	
87140	.91	.00	.00	.00	.000	
STORM SUMMARY PEST. NO.	CONC MG/L	RUNOFF G/HA	MASS G/HA	SEDIMENT CONC UG/G	MASS G/HA	PERCOLATION CONC MG/L
1	.0000	.0000	.0000	.0000	.0000	.0000
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM						
LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6	LAY. 7
DEPTH, CM	0 - 1	1 - 8	8 - 15	15 - 30	30 - 45	45 - 60
1 BEFORE	16.2782	.0000	.0000	.0000	.0000	.0000
1 AFTER	12.4528	.5340	.0000	.0000	.0000	.0000
DATE	RAIN CM	STORM INPUT RUNOFF CM	PERC. CM	SOIL LOSS KG/HA	ENRICH. RATIO	
87163	.56	.00	.00	.00	.000	
STORM SUMMARY PEST. NO.	CONC MG/L	RUNOFF G/HA	MASS G/HA	SEDIMENT CONC UG/G	MASS G/HA	PERCOLATION CONC MG/L
1	.0000	.0000	.0000	.0000	.0000	.0000
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM						
LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6	LAY. 7
DEPTH, CM	0 - 1	1 - 8	8 - 15	15 - 30	30 - 45	45 - 60
1 BEFORE	3.0473	.3259	.0000	.0000	.0000	.0000
1 AFTER	2.9995	.3259	.0000	.0000	.0000	.0000
DATE	RAIN CM	STORM INPUT RUNOFF CM	PERC. CM	SOIL LOSS KG/HA	ENRICH. RATIO	
87195	.20	.00	.00	.00	.000	
STORM SUMMARY PEST. NO.	CONC MG/L	RUNOFF G/HA	MASS G/HA	SEDIMENT CONC UG/G	MASS G/HA	PERCOLATION CONC MG/L
1	.0000	.0000	.0000	.0000	.0000	.0000
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM						
LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6	LAY. 7
DEPTH, CM	0 - 1	1 - 8	8 - 15	15 - 30	30 - 45	45 - 60
1 BEFORE	.1520	.1363	.0104	.0000	.0000	.0000
1 AFTER	.1520	.1362	.0104	.0000	.0000	.0000

(Alachlor - East Lansing MI)

DATE	RAIN	STORM INPUT		PERC.		SOIL LOSS		ENRICH.	
87140	CM	RUNOFF	CM	PERC.	CM	KG/HA	RATIO		
	.91	.00	.00	.00	.00	.00	.000		
STORM SUMMARY									
PEST.	CONC	MASS	SEDIMENT		PERCOLATION				
NO.	MG/L	G/HA	CONC	MASS	CONC	MASS			
1	.0000	.0000	UG/G	G/HA	MG/L	G/HA			
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM									
DEPTH, CM	LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6	LAY. 7	LAY. 7	LAY
1 BEFORE	0 - 1	1 - 8	8 - 15	15 - 30	30 - 45	45 - 60	60 - 76	60 - 76	76 -
1 AFTER	16.2782	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	11.6184	.6504	.0000	.0000	.0000	.0000	.0000	.0000	.0000
STORM INPUT									
DATE	RAIN	RUNOFF	PERC.	SOIL LOSS		ENRICH.			
87163	CM	CM	CM	KG/HA	RATIO				
	.56	.00	.00	.00	.000				
STORM SUMMARY									
PEST.	CONC	MASS	SEDIMENT		PERCOLATION				
NO.	MG/L	G/HA	CONC	MASS	CONC	MASS			
1	.0000	.0000	UG/G	G/HA	MG/L	G/HA			
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM									
DEPTH, CM	LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6	LAY. 7	LAY. 7	LAY
1 BEFORE	0 - 1	1 - 8	8 - 15	15 - 30	30 - 45	45 - 60	60 - 76	60 - 76	76 -
1 AFTER	.7762	.1132	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	.7610	.1132	.0000	.0000	.0000	.0000	.0000	.0000	.0000
STORM INPUT									
DATE	RAIN	RUNOFF	PERC.	SOIL LOSS		ENRICH.			
87195	CM	CM	CM	KG/HA	RATIO				
	.20	.00	.00	.00	.000				
STORM SUMMARY									
PEST.	CONC	MASS	SEDIMENT		PERCOLATION				
NO.	MG/L	G/HA	CONC	MASS	CONC	MASS			
1	.0000	.0000	UG/G	G/HA	MG/L	G/HA			
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM									
DEPTH, CM	LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6	LAY. 7	LAY. 7	LAY
1 BEFORE	0 - 1	1 - 8	8 - 15	15 - 30	30 - 45	45 - 60	60 - 76	60 - 76	76 -
1 AFTER	.0038	.0079	.0008	.0000	.0000	.0000	.0000	.0000	.0000
	.0035	.0079	.0008	.0000	.0000	.0000	.0000	.0000	.0000

Appendix E. (cont.)

(Metolachlor - Hickory Corners MI)

DATE	RAIN CM	STORM INPUT RUNOFF CM	PERC. CM	SOIL LOSS KG/HA	ENRICH. RATIO	
87152	.25	.00	.00	.00	.000	
STORM SUMMARY						
PEST. NO.	CONC MG/L	RUNOFF MASS G/HA	SEDIMENT CONC UG/G	MASS G/HA	PERCOLATION CONC MG/L	MASS G/HA
1	.0000	.0000	.0000	.0000	.0000	.0000
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM						
DEPTH, CM	LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6
0 - 1	1	8	8-15	15-30	30-45	45-60
1 BEFORE	14.3136	.0000	.0000	.0000	.0000	.0000
1 AFTER	14.3018	.0000	.0000	.0000	.0000	.0000
DATE	RAIN CM	STORM INPUT RUNOFF CM	PERC. CM	SOIL LOSS KG/HA	ENRICH. RATIO	
87163	.28	.00	.00	.00	.000	
STORM SUMMARY						
PEST. NO.	CONC MG/L	RUNOFF MASS G/HA	SEDIMENT CONC UG/G	MASS G/HA	PERCOLATION CONC MG/L	MASS G/HA
1	.0000	.0000	.0000	.0000	.0000	.0000
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM						
DEPTH, CM	LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6
0 - 1	1	8	8-15	15-30	30-45	45-60
1 BEFORE	6.6473	.0000	.0000	.0000	.0000	.0000
1 AFTER	6.6090	.0000	.0000	.0000	.0000	.0000
DATE	RAIN CM	STORM INPUT RUNOFF CM	PERC. CM	SOIL LOSS KG/HA	ENRICH. RATIO	
87181	.30	.00	.00	.00	.000	
STORM SUMMARY						
PEST. NO.	CONC MG/L	RUNOFF MASS G/HA	SEDIMENT CONC UG/G	MASS G/HA	PERCOLATION CONC MG/L	MASS G/HA
1	.0000	.0000	.0000	.0000	.0000	.0000
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM						
DEPTH, CM	LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6
0 - 1	1	8	8-15	15-30	30-45	45-60
1 BEFORE	.4319	.1776	.0196	.0006	.0000	.0000
1 AFTER	.4264	.1776	.0196	.0006	.0000	.0000

DATE	RAIN CM	STORM INPUT RUNOFF CM	PERC. CM	SOIL LOSS KG/HA	ENRICH. RATIO	
87152	.25	.00	.00	.00	.000	
STORM SUMMARY						
PEST. NO.	CONC MG/L	MASS G/HA	CONC UG/G	SEDIMENT MASS G/HA	PERCOLATION CONC MG/L	MASS G/HA
1	.0000	.0000	.0000	.0000	.0000	.0000
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM						
DEPTH, CM	LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6
1 BEFORE	0 - 1	1 - 8	8 - 15	15 - 30	30 - 45	45 - 60
1 AFTER	14.3136	.0000	.0000	.0000	.0000	.0000
	14.2987	.0000	.0000	.0000	.0000	.0000
STORM INPUT						
DATE	RAIN CM	STORM INPUT RUNOFF CM	PERC. CM	SOIL LOSS KG/HA	ENRICH. RATIO	
87163	.28	.00	.00	.00	.000	
STORM SUMMARY						
PEST. NO.	CONC MG/L	MASS G/HA	CONC UG/G	SEDIMENT MASS G/HA	PERCOLATION CONC MG/L	MASS G/HA
1	.0000	.0000	.0000	.0000	.0000	.0000
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM						
DEPTH, CM	LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6
1 BEFORE	0 - 1	1 - 8	8 - 15	15 - 30	30 - 45	45 - 60
1 AFTER	4.7884	.0000	.0000	.0000	.0000	.0000
	4.7535	.0000	.0000	.0000	.0000	.0000
STORM INPUT						
DATE	RAIN CM	STORM INPUT RUNOFF CM	PERC. CM	SOIL LOSS KG/HA	ENRICH. RATIO	
87181	.30	.00	.00	.00	.000	
STORM SUMMARY						
PEST. NO.	CONC MG/L	MASS G/HA	CONC UG/G	SEDIMENT MASS G/HA	PERCOLATION CONC MG/L	MASS G/HA
1	.0000	.0000	.0000	.0000	.0000	.0000
PESTICIDE CONCENTRATION (UG/G) IN 8 SOIL LAYERS BEFORE AND AFTER STORM						
DEPTH, CM	LAY. 1	LAY. 2	LAY. 3	LAY. 4	LAY. 5	LAY. 6
1 BEFORE	0 - 1	1 - 8	8 - 15	15 - 30	30 - 45	45 - 60
1 AFTER	.1402	.0771	.0109	.0004	.0000	.0000
	.1379	.0771	.0109	.0004	.0000	.0000

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