CANDI

Chemicals/Irrigation Management Software

User's Manual

Beta Test Release 1.0

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Logan, Utah.

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Beta Test Release 2.01

By

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NOTICE

The authors do not warrant the CANDI software for any specific purpose and do not assume any liability resulting from use of the software. The CANDI formulation includes commonly reported procedures and algorithms for simulating pesticide leaching processes and infiltration from both sprinkler and surface irrigation systems. However, misapplication of CANDI may involve parameter combinations that violate assumptions or may require interpretations beyond the limits of various algorithms. The resulting incorrect or inaccurate simulations and numerical instabilities cannot be anticipated by the developers. CANDI is designed to provide relative comparisons of pesticide movement. Because of current uncertainty in knowledge of pesticide parameters and site descriptors, one can not assume that predicted pesticide leaching will actually occur in a certain field, merely that the relative comparisons are valid.

This publication and the CANDI software might contain technical inaccuracies. Changes are periodically made to both and are incorporated in new releases.

Comments and helpful criticism are appreciated. For the present, technical support of the CANDI software is provided via telephone or written responses by:

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INTRODUCTION

This manual describes an interactive computer model, CANDI. CANDI is a decision support tool designed to aid in on-farm pesticides and irrigation management. CANDI simulates downward chemical movement through the soil in response to different irrigation practices. CANDI estimates the relative amount of a non-polar organic chemical which remains in the soil profile by the time it reaches a specified depth. Future releases of CANDI will involve the management of different types of chemicals. CANDI is also able to delineate the wellhead protection areas for domestic wells. For this purpose, CANDI involves USEPA's model (MWCAP). Different versions of CANDI handle either English or Metric systems of units. Both versions are contained in the package.

CANDI presents results in the form of full-screen enhanced graphics. No programming skills are needed for the use of CANDI.

This manual describes required hardware and software, use of CANDI, and operating conventions. It also contains an example of using CANDI.

HARDWARE AND SOFTWARE REQUIREMENTS

CANDI requires an IBM[1] PC or compatible with an 80X86 micro processor and at least 512K of Random Access Memory (RAM). One floppy disk drive and a hard (fixed) disk are needed. CANDI will occupy not more than 3.5 Mega Bytes of space on the hard disk. An EGA graphics card is also needed (a VGA will give better resolution). Either a color or a monochrome monitor is required. A printer is needed if hard copies of the final graphics are desired. If an 80287 or 80387 math coprocessor is present, it will dramatically speed up computations. A math coprocessor must be present to run the MWCAP model.

CANDI has been tested using the following operating systems: PC-DOS and MS-DOS version 3.2 (and later), DR-DOS version 5.00. The DOS program GRAPHICS is needed to be able to obtain a hard copy of the graphics displays.

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[1] IBM is a registered trademark of International Business Machines, Inc.

INSTALLATION

CANDI contains a user-friendly installation utility. To install CANDI, insert Disk 1 into disk drive A or B, log on to this drive, and type INSTALL at the DOS prompt. The installation utility will ask some questions. Respond to the questions and CANDI will be installed on your hard disk. During installation, some directories are created by the installation program. You should notice that CANDI's installation program might change the contents of your CONFIG.SYS file. However, you will be prompted before CANDI makes any changes in your file.

USING CANDI

After you install CANDI successfully on your hard disk, the following sub-directories will be created within the directory you have specified for CANDI:

* SOIL : contains soil data files.
* RAIN : rainfall data files for selected locations in Utah.
* ET : evapotranspiration data files for selected locations and crops in Utah.
* IRR : irrigation schedules data files for selected locations and crops in Utah.

Two versions of CANDI are available in the package, MCANDI and ECANDI. The two versions, respectively, use Metric and English units. To begin using CANDI, go to the directory you have chosen in the installation step. For example, if you chose drive C for CANDI and you specified the directory named CANDI1 to store CANDI, then follow the steps below (DOS prompt is written in **bold** and user's instructions are written in *italic*).

C:> *CD CANDI1* (and press ENTER)
C:\CANDI1> *ECANDI* (and press ENTER, or type MCANDI and press ENTER for the Metric version)

CANDI will display an introductory screen. At the top of the screen, a menu bar with the following options is displayed

Quit Utilities Execute View Help

You can choose any of the options by touching the corresponding hot key (this first letter of each option generally appears red on the color monitors). After you choose one of the hot keys (Q, U, E, V, or H), you can move between selections using the up and down arrow keys. You can move to another sub-menu using the right and left arrow keys. To choose

any of the options in any sub-menu, press the ENTER key. All options of the five sub-menus are explained in the following pages.

Quit

Four options can be chosen from the Quit sub-menu.

1- **Quit** : to abort CANDI and return to DOS.

2- **PE editor** : to access PE text editor, if you have it on your computer. This option is added because this release of CANDI does not include a text editor. However, future releases of CANDI will probably include a text editor. An alternative is to go to the DOS Shell (option 4) and use your text editor.

3- **QDOS** : to access Quick DOS program, if you have it on your computer.

4- **DOS Shell** : to go to the DOS prompt without having to terminate CANDI. When you go to the DOS prompt, you can execute any DOS command. To return to CANDI, type EXIT at the DOS prompt.

Utilities

The purpose of the CANDI Utilities is to enable the user to view the contents of any directory. Two options can be chosen from the Utilities sub-menu.

1- **Help** : to explain how to use the [File Info] option.

2- **File Info** : to view the contents of any sub-directory. First specify the sub-directory. Second, specify the files to be viewed (DOS wild cards ? and * are accepted here). Finally, choose [Display File Names] to view the selected files.

Execute

This sub-menu contains four choices.

1- **Pesticide Comparison :**

This option allows the user to compare four pesticides for their potential contamination of groundwater. CANDI uses a similar procedure to that used in the CMLS model (Nofziger and Hornsby, 1988) for simulating pesticide leaching through soil layers. However, there are some differences between CANDI and CMLS. IN CANDI, the soil can be comprised of as many as 15 layers (compared to 25 in CMLS). Soil properties may vary from layer to layer but they are assumed to be uniform within each layer. CANDI allows a simulation period not exceeding 3 years. CANDI permits pesticides to be applied after the first simulation day (CMLS assumes pesticide is applied on the first day of simulation when the soil moisture is at field capacity).

The user needs to input the following information,

[1] Rainfall file name :
This binary file contains time and corresponding depth of rainfall for a specific region .

[2] ET file name :
This binary file contains time and corresponding evapotranspiration depth for a specific region and crop.

[3] Irr. Schedule file name :
This text file contains a typical irrigation schedule for a specific site and crop.

[4] Soil data file name :
This file contains soil data for a specific region. It is also a text file.

[5] Chemicals names :

The user can specify four different pesticides selected for comparison.

[6] Chemical Half life and Partition Coefficient :

This specifies the half life of the pesticide in soil (days) and the partition coefficient of the pesticide (ml/g OC).

[7] Irrigation Application Efficiency :

If you have estimated the soil storage efficiency for the considered irrigation system, then you should enter it to CANDI. You can compute this efficiency by executing either the furrow irrigation comparison or the sprinkler irrigation comparison.

[8] Beginning and Last day of Simulation :

This specifies the simulation period.

[9] Pesticide Application Day :

This allows the user to specify the day during the simulation period on which to start the pesticide movement and degradation simulation.

[10] Depth of Roots :

The depth of the fully developed root zone for the considered crop is input.

[11] Pesticide Application Depth :

The depth at which the pesticide is applied. This depth is equal to zero for pesticides applied on the soil surface.

[12] Depth for Comparison :

The depth for which the relative amount of pesticide remaining beneath the soil surface is calculated.

2- **Furrow Irrigation/Pesticide Interaction :**

This option is used to compare the effect of furrow irrigation parameters (Furrow length and Inflow rate) on relative amount of the pesticide reaching a certain depth (typically, the depth to groundwater). CANDI uses a comprehensive model for simulating the hydraulics of surface irrigation system, SIRMOD (Walker and Humpherys, 1983). A special version of SIRMOD was developed by Dr. Wynn R. Walker to facilitate the estimation of soil storage efficiency in an automated manner. Three different furrow lengths and a range of inflow rates are used for comparison. The user needs to input the following information,

[1] Rainfall file name.
[2] ET file name.
[3] Irrigation Schedule file name.
[4] Soil data file name.
[5] 1st, 2nd, and 3rd furrow lengths :
These furrow lengths are used for comparing different furrow irrigation systems.
[6] Maximum and Minimum inflow rate :
This specifies the range of inflow rates used for comparison.
[7] Chemical Half-life and Partition Coefficient :
[8] Beginning and Last day of Simulation.
[9] Pesticide Application Day.
[10] Depth of Roots.
[11] Pesticide Application Depth.
[12] Depth for Comparison.
[13] Kostiakov-Lewis infiltration equation parameters (k, a, fo) :
Parameters of the infiltration equation for different kinds of soils are given in appendix (A).

Note : Some items are explained above in option (1).

3- **Sprinkler Irrigation/Pesticide Interaction :**

This option is used to compare the effect of sprinkler irrigation parameters (Christiansen's Uniformity Coefficient and Percent of Area Adequately Irrigated) on relative amount of the pesticide that will reach a certain depth (typically, the depth to groundwater). Infiltration is estimated using the approach of Hart and Reynolds (1965). Three different Uniformity Coefficients and a range of areas are used for comparison. The user needs to input the following information,

[1] Rainfall file name.
[2] ET file name.
[3] Irrigation Schedule file name.
[4] Soil data file name.
[5] 1st, 2nd, and 3rd Uniformity Coefficients :
These Coefficients are used for comparing different sprinkler irrigation systems.
[6] Maximum and Minimum areas adequately irrigated :
This specifies the range of areas used for comparison.
[7] Chemical Half-life and Partition Coefficient :
[8] Beginning and Last day of Simulation.
[9] Pesticide Application Day.
[10] Depth of Roots.
[11] Pesticide Application Depth.
[12] Depth for Comparison.

Note : Some items are explained above in option (1).

4- **Sprinkler Irrigation Discretization Module :**

This option is used to enable the user to evaluate the effect of variability of applied water depths by a sprinkler system over the field on the chemical leaching over the field. The user needs to input the following information,

[1] Rainfall file name.
[2] ET file name.
[3] Irrigation Schedule file name.
[4] Soil data file name.
[5] Uniformity coefficient of the sprinkler system.
[6] Fraction of area adequately irrigated.
[7] Chemical Half-life and Partition Coefficient :
[8] Beginning and Last day of Simulation.
[9] Pesticide Application Day.
[10] Depth of Roots.
[11] Pesticide Application Depth.
[12] 1^{st}, 2^{nd}, and 3^{rd} Depth for Comparison.

Note : Some items are explained above in option (1).

5- **Wellhead Protection Area Delineation :**

This option allows the user to delineate wellhead protection areas for domestic wells. For this purpose, CANDI uses the USEPA's model named MWCAP. A copy of the directions for using MWCAP (obtained from USEPA's WHPA User's Manual) is included in this manual.

View

This sub-menu has five choices. Each choice corresponds to a similar choice in the Execute sub-menu. The purpose of these choices is to view the results calculated previously in the Execute sub-menu. After you view any graph, touch any key to return to the CANDI main menu.

Notes :

(1) MWCAP plotting program is terminated by touching (E).

(2) If a hard copy of any graph is required you must do the following :

- Go to the Quit menu and choose [DOS Shell]
- At the DOS prompt, type GRAPHICS and press ENTER (provided that the DOS directory is defined in the PATH. Otherwise you need to go to the DOS directory to execute the GRAPHICS program and return again to the CANDI directory).
- type EXIT and press ENTER to return to CANDI.
- Now you can print any graph displayed on the screen by touching the Print Screen key.

Help

CANDI provides the user with an easy-to-use help facility. From the Help sub-menu, you can get all the information required for using CANDI.

EXAMPLE

In his farm, farmer Jones has two wells. Farmer Jones uses the first well's water to irrigate his land. The second well is used for domestic and minor gardening purposes. The farm is rectangular (8 miles by 5 miles) and there is a stream running from north to south. The stream is in hydraulic contact with the aquifer from which the two wells extract water. The groundwater flows from east to west. From well drilling data, we know that the hydraulic properties of the aquifer are as follow,

Transmissivity = 10,000 ft^2/day

Saturated Thickness = 50 ft.

Porosity = 0.25

hydraulic gradient of water table = 0.001

The first well pumps at a rate of 500 gpm and the second well pumps at the rate of 20 gpm. Figure (1) shows a general layout of the farm.

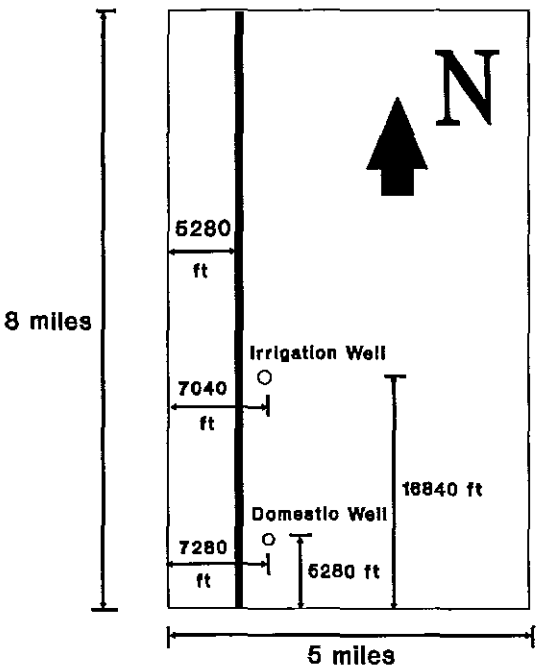

FIGURE 1. Layout of the Farm

Using CANDI's option, the 10-year wellhead protection area for the two wells can be delineated (Figure 2). Realizing that groundwater contamination within those areas will reach a well in 10 years or less, the farmer plans to be more careful when he uses chemicals within the delineated area.

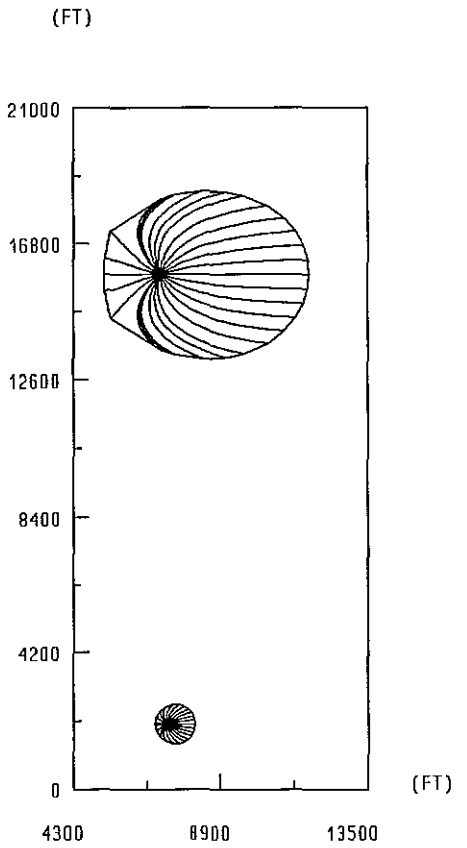

FIGURE 2. 10-Year Wellhead Protection Areas

Assume farmer Jones has an area planted with alfalfa and that area is infested by the green foxtail grass. From the Utah weed control handbook (Dewey, 1991), we find that more than one pesticide are ranked as excellent or good control agents for that grass. Here we consider four herbicides (Treflan, Sencor, Velpar, and Kerb). The pesticide comparison option in CANDI yields the results shown in Figure (3). The following is used as input for the pesticide comparison module.

1. Area : Dixie.
2. Crop : Alfalfa. This means that the rain data file is DIXIE.R and the irrigation schedule data file and Et data file are DIXALF.IRR and DIXALF.ET, respectively.
3. Depth of Root Zone : 6 feet.
4. Irrigation Application Efficiency : 0.75 (assumed).
5. Pesticide Application Depth : Zero. This means that the pesticide is applied over the soil surface.
6. first and End Day of Simulation : 1 and 365. This means a simulation period of one year.
6. Pesticide Application Day : 1. This means that the pesticide is applied on the first day of simulation.
7. Depth for Comparison : 25.00 ft. This represents a deep groundwater aquifer.
8. Pesticides Half lives and Partition Coefficients : obtained from the Utah Weed Control Handbook or the SCS workshop manual, see appendix (B).

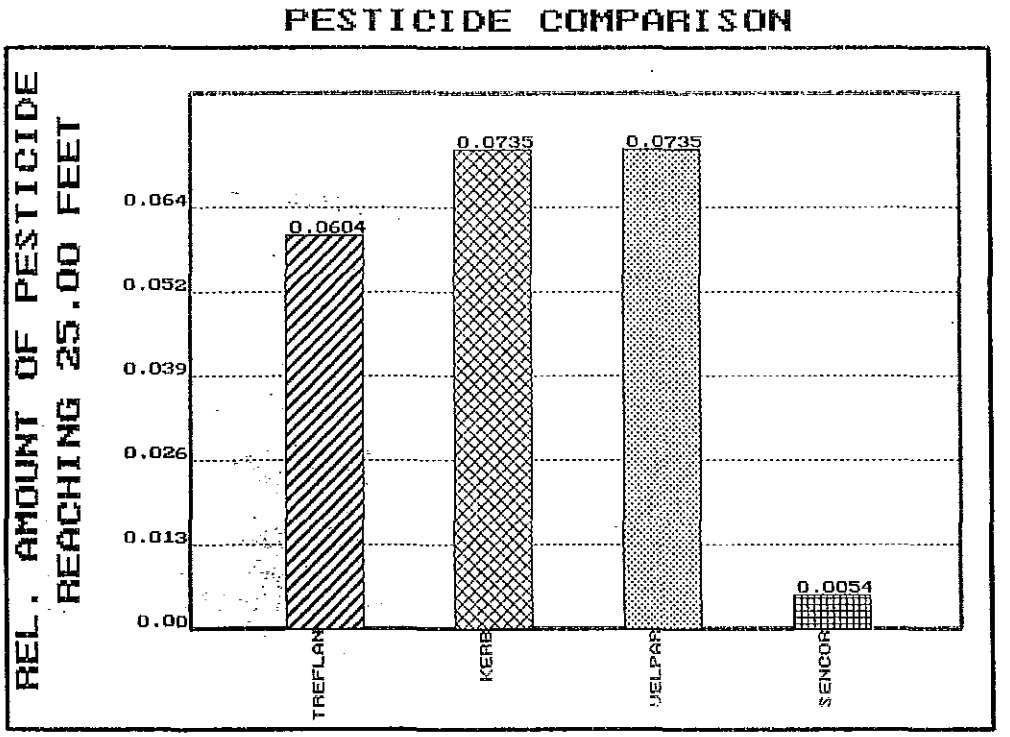

FIGURE 3. Pesticide Comparison

Sometimes, one wants to consider the toxicity of the applied chemicals. For example, both hypothetical pesticides A and B might reach the water table in the same amounts. However, if pesticide A is more toxic than pesticide B, one would want to consider that in the pesticide selection. One way to do so is to develop, for each pesticide, a dimensionless index relating its potential concentration in groundwater to the maximum concentration considered acceptable by the USEPA. The indices for different pesticides are then compared. The process is as follows,

1. Calculate a hypothetical concentration[2] of chemical in the groundwater. Assume that the pesticide will mix in the water in top 10 ft of the saturated zone[3].

$$Amount\ of\ Chemical = RA \times Amount\ Applied\ (lb/acre)$$

$$Mixing\ Volume = 43500\ (ft^2/Acre) x 10\ (ft) x 0.25 (porosity)$$

$$Conc.\ (ppb) = \frac{Amount\ of\ Chemical}{6.79 x 10^{-3}}$$

2. Divide the hypothetical concentration by the Health Advisory (HA) (published by the USEPA) to get a dimensionless index. The higher the index, the more hazardous is the chemical. For example, an index of 3 means that the hypothetical concentration is 3 times greater than that considered acceptable by USEPA.

The calculated concentration might overestimate the actual concentration in groundwater because neither degradation with time nor dilution with horizontally moving groundwater in the saturated zone are considered. Also, the actual mixing mechanics are not considered. Thus, an index value greater than one does not necessarily mean a hazardous situation exists.

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[2]The concentration is transformed from lb/ft^3 to parts per billion to match the units reported by USEPA (see Comment at the end of this section).

[3]This will correspond to different volumes of mixing water depending on the porosity of the aquifer. The selection of 10 ft of saturated thickness is purely arbitrary and serves merely to facilitate making a relative comparison between different chemicals.

Continuing with the example, table (1) shows the potential concentration calculations for the four pesticides.

TABLE 1. Pesticide Comparison Calculations

Pesticide	RA	Applied (lb/A)	Conc. (ppb)	HA (ppb)	INDEX
TREFLAN	0.0604	2.0	17.79	2	8.895
SENCOR	0.0054	1.0	0.80	175	0.005
VELPAR	0.0735	1.5	16.24	210	0.077
KERB	0.0735	2.0	21.65	52	0.416

From table (1), we can see that Sencor is the most favorable pesticide to use. However, we can still consider the use of Velpar and Kerb.

If farmer Jones has a furrow irrigation system, he can reduce the amount of pesticide that will reach groundwater, and possibly the wells, by having shorter furrows and higher inflow rates at the beginning of the furrow. CANDI can be used again to assess the effect of the furrow irrigation parameters on the leaching pesticide.

Let's consider three different furrow lengths (230, 400, and 500 feet) and minimum and maximum inflow rates of 12.3 and 21.8 gpm/ft width of furrow, respectively. Figure (4) shows CANDI's output for the furrow irrigation/pesticide movement response scenario. From figure (4) we can see that a siginificant reduction in the relative amount of Kerb can be achieved by using a more efficient furrow irrigation system.

Comment

Conversion of the concentration from lb/ft^3 to parts per billion is achieved as follows

$$1 \frac{lb}{ft^3} = \frac{453.6\ 10^6\ \mu\ grams}{lb} \frac{1\ ft^3}{28.32\ \ell} = 1.6\ 10^7 \frac{\mu gram}{\ell}$$

$$Conc\ (\frac{lb}{ft^3}) = \frac{Amount\ of\ chemical}{(43500)\ (10)\ (0.25)}$$

$$Conc\ (\frac{\mu grams}{\ell}) = \frac{Amount\ of\ chemical}{(43500)\ (10)\ (0.25)}\ 1.6\ 10^7$$

$$Conc\ (\frac{\mu grams}{\ell}) = \frac{Amount\ of\ chemical}{6.79\ 10^{-3}}$$

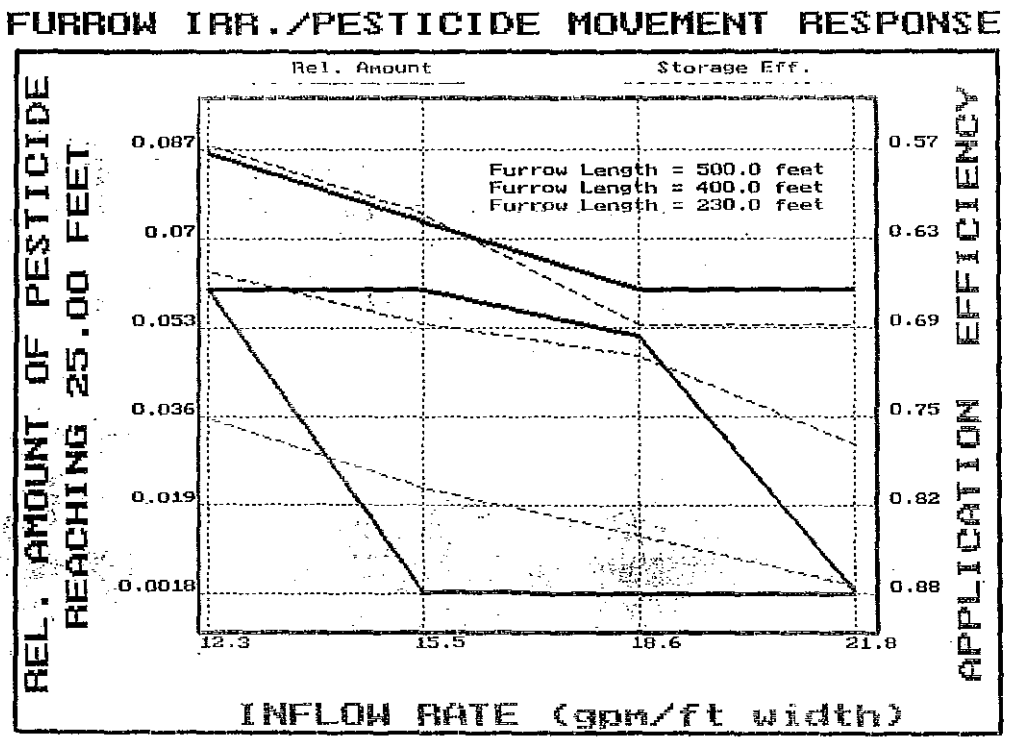

FIGURE 4. Furrow Irrigation/Pesticide Movement Response

MWCAP INSTRUCTIONS

The following pages include a copy of the instructions for the Multiple Well Capture Zone Module (MWCAP) obtained from the WHPA User's Manual (USEPA, 1990).

7.0 Multiple Well Capture Zone Module (MWCAP)

7.1 Capabilities

MWCAP is designed to provide efficient delineation of steady-state, time-related and hybrid capture zones for one or more pumping wells in homogeneous aquifers. Each well specified may be operating in an aquifer without a lateral boundary (an areally infinite aquifer), or in an aquifer with a stream or a barrier boundary (semi-infinite aquifer). If a stream or barrier boundary is present, the angle of ambient flow in relation to the boundary, as well as the orientation of the boundary itself, may be completely arbitrary. MWCAP requires that stream or barrier boundaries be represented by straight lines in plan view.

Although multiple wells within a study area may be specified, MWCAP assumes that the wells operate independently of one another. Therefore, physical processes such as increased drawdown due to well interference effects are ignored.

MWCAP is very efficient due to the small number of pathlines required to delineate steady-state or hybrid capture zones. If a stream boundary is present and the capture zone intersects the stream, the zone of induced recharge from the stream to the well will be delineated automatically. MWCAP can also be used to delineate time-related capture zones.

7.2 Assumptions and Limitations

Capture zones delineated using MWCAP are valid for fully penetrating pumping wells screened in aquifers that are essentially homogeneous. Ground-water flow must be two-dimensional in the areal x-y plane, and therefore the aquifer may be confined or unconfined if the drawdown-to-initial saturated thickness ratio is small (less than about 0.1). A steady-state ground-water flow field is assumed.

If a stream or a barrier boundary is present, the boundary is assumed to be linear and fully penetrating. The latter assumption is often violated in cases where stream

boundaries exist. The effect of a partially penetrating stream may be an important one and each application should be examined on a site-by-site basis. In general, the greater the depth and breadth of the stream in relation to the aquifer thickness, the more valid the fully penetrating stream assumption. Also, stream boundary partial penetration effects decrease as the distance from the stream to the well increases. The stream and the aquifer are assumed to be in perfect hydraulic connection: the effects of a "clogging layer" between the streambed and the aquifer are not considered.

If, in actuality, the stream is partially penetrating and/or there is a clogging layer of fine grained material that lines the streambed, the capture zones obtained using MWCAP will be smaller than the "true" capture zones. The amount of error incurred will be dependent upon the degree to which the above assumptions are violated.

Capture zones for multiple pumping wells within a study area may be delineated with one run of MWCAP, but each well is assumed to operate independently of every other well. Therefore, each well may have a potentially unique set of input parameters. The effects of well interference (increased drawdown due to overlapping cones of depression) are neglected.

7.3 Input Requirements

The input requirements for MWCAP are outlined in Table 7.1. Note that the well-specific parameters must be input for each well specified in the study area.

7.4 Example Applications

In this section, four examples of capture zones delineated using MWCAP are presented. The first example compares steady-state and time-related capture zones; the second example illustrates the effects of boundary conditions (stream or barrier) on capture zone morphology; and the third and fourth examples demonstrate the application of MWCAP to actual field sites near Albuquerque, New Mexico and Seattle, Washington, respectively.

7.4.1 Time-Related and Steady-State Capture Zone Comparison

Figure 7.1 shows the steady-state, 10-year and 25-year capture zones delineated using MWCAP for a hypothetical set of input parameters. The time-related capture zones are enclosed entirely by the steady-state capture zone. However, as the specified time

Input Requirements for MWCAP Module

Program Variable	Description
For each problem --	
IUNIT:	Default units of input parameters (feet and days or meters and days)
NWELL:	Number of pumping wells for which capture zones are to be delineated
XMIN:	Minimum x-coordinate of study area (ft or m)
XMAX:	Maximum x-coordinate of study area (ft or m)
YMIN:	Minimum y-coordinate of study area (ft or m)
YMAX:	Maximum y-coordinate of study area (ft or m)
DLMAX:	Largest allowable step length, $d\ell$ (see section 4.1)
For each well (I=1, NWELL) --	
XWELL(I):	x-coordinate of well (ft or m)
YWELL(I):	y-coordinate of well (ft or m)
QWELL(I):	Well discharge rate[a/] (ft^3/day or m^3/d)
TRAN(I):	Transmissivity of the aquifer (ft^2/d or m^2/d)
GRAD(I):	Regional hydraulic gradient (ft/ft or m/m)
ANGLE(I):	Angle of ambient ground-water flow (0-360°)
POR(I):	Aquifer effective porosity (dimensionless)
THICK(I):	Aquifer saturated thickness (ft or m)
IBOUND(I):	Associated boundary type (no boundary, stream boundary, or barrier boundary)
DSW(I):	Perpendicular distance from stream or barrier boundary to the well (ft or m)
THETA(I):	Orientation of stream or barrier boundary (0-360°)
ICZTYP(I):	Capture zone type option (steady-state, time-related, or hybrid)
TMCZ(I):	Time value associated with capture zone (days); time-related and hybrid capture zones only
NSTLIN(I):	Number of pathlines to be computed for the well in addition to pathlines delineated automatically by the code
ICZPLT(I):	Flag indicating if capture zone boundary is to be plotted

[a/] The sign (+,-) of the discharge rate does not need to be specified.

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APPENDICES

Appendix A. Infiltration Equation Parameters

Soil Type	Curve No.	K (m/min**a)	a	fo (m/min)
Clay	0.05	0.00426	0.258	0.000022
	0.10	0.00383	0.317	0.000035
	0.15	0.00360	0.357	0.000046
	0.20	0.00346	0.388	0.000057
	0.25	0.00337	0.415	0.000068
Clay Loam	0.30	0.00330	0.437	0.000078
	0.35	0.00326	0.457	0.000088
	0.40	0.00323	0.474	0.000098
	0.45	0.00321	0.490	0.000107
	0.50	0.00320	0.504	0.000117
Silty Loam	0.60	0.00320	0.529	0.000136
	0.70	0.00321	0.550	0.000155
	0.80	0.00324	0.568	0.000174
Sandy Loam	0.90	0.00328	0.584	0.000193
	1.00	0.00332	0.598	0.000212
	1.50	0.00361	0.642	0.000280
Sand	2.00	0.00393	0.672	0.000337

Appendix B. Pesticide Library

		Type[1]	Health Advisory (ppb)
Common Name	:2,4-D ACID	H	70
Partition Coefficient	:20 ml/g OC		
Half-Life	:10 days		
Trade Name	:DACAMINE		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:2,4-D ESTER	H	70
Partition Coefficient	:1000 ml/g OC		
Half-Life	:10 days		
Trade Name	:AQUA KLEEN		
Trade Name	:WEEDONE		
Trade Name	:EMULSAMINE		
Trade Name	:.		
Common Name	:2,4-D AMINE SALT	H	70
Partition Coefficient	:109 ml/g OC		
Half-Life	:10 days		
Trade Name	:WEEDAR		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:2,4-DB ESTER	H	70
Partition Coefficient	:1000 ml/g OC		
Half-Life	:10 days		
Trade Name	:BUTYRAC ESTER		
Trade Name	:BUTOXONE		
Trade Name	:.		
Trade Name	:.		
Common Name	:2,4-DB AMINE	H	70
Partition Coefficient	:20 ml/g OC		
Half-Life	:10 days		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:ALACHLOR	H	1.5
Partition Coefficient	:170 ml/g OC		
Half-Life	:15 days		
Trade Name	:ALANEX		
Trade Name	:PILLARZO		
Trade Name	:LASSO		
Trade Name	:.		

[1] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

	Type[2]	Health Advisory (ppb)
Common Name :ALDICARB	I	10
Partition Coefficient :10 ml/g OC		
Half-Life :30 days		
Trade Name :TEMIK		
Trade Name :TEMIK15G		
Trade Name :OMS 771		
Trade Name :UC21149		
Common Name :ASSERT	H	
Partition Coefficient :35 ml/g OC		
Half-Life :35 days		
Trade Name :.		
Trade Name :.		
Common Name :ATRAZINE	H	3
Partition Coefficient :100 ml/g OC		
Half-Life :60 days		
Trade Name :AATREX		
Trade Name :GRIFFEX		
Trade Name :ATRANEX		
Trade Name :VECTAL SC		
Common Name :AZINPHOS-METHYL	I	
Partition Coefficient :1000 ml/g OC		
Half-Life :40 days		
Trade Name :GUTHION		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :BARBAN	I	
Partition Coefficient :30 ml/g OC		
Half-Life :30 days		
Trade Name :CARBYNE		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :BENEFIN	H	
Partition Coefficient :9000 ml/g OC		
Half-Life :40 days		
Trade Name :BATAN		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :BENOMYL	F	
Partition Coefficient :190 ml/g OC		
Half-Life :240 days		
Trade Name :BENLATE		
Trade Name :.		

[2] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

		Type[3]	Health Advisory (ppb)
Common Name	:BENSULIDE	H	
Partition Coefficient	:10000 ml/g OC		
Half-Life	:120 days		
Trade Name	:PREFAR		
Trade Name	:.		
Trade Name	:.		
Common Name	:BENTAZON	H	
Partition Coefficient	:35 ml/g OC		
Half-Life	:20 days		
Trade Name	:BASAGRAN		
Trade Name	:.		
Trade Name	:		
Common Name	:BROMACIL ACID	H	
Partition Coefficient	:32 ml/g OC		
Half-Life	:60 days		
Trade Name	:HYVAR XL		
Trade Name	:BOROCIL		
Trade Name	:UREABOR		
Trade Name	:HYVAR X		
Common Name	:BROMOXYNIL	H	
Partition Coefficient	:190 ml/g OC		
Half-Life	:5 days		
Trade Name	:BROMINAL		
Trade Name	:.		
Trade Name	:.		
Common Name	:BUTYLATE	H	
Partition Coefficient	:126 ml/g OC		
Half-Life	:12 days		
Trade Name	:SUTAN PLUS		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:CAPTAN	F	
Partition Coefficient	:100 ml/g OC		
Half-Life	:3 days		
Trade Name	:CAPTAN		
Trade Name	:ORTHOCIDE		
Trade Name	:PILLARCAP		
Trade Name	:VONDCAPTAN		
Common Name	:CARBARYL	I	700
Partition Coefficient	:200 ml/g OC		
Half-Life	:10 days		
Trade Name	:SEVIN		
Trade Name	:.		

[3] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

	Type[4]	Health Advisory (ppb)
Common Name :CARBOFURAN	I	36
Partition Coefficient :22 ml/g OC		
Half-Life :50 days		
Trade Name :FURADAN		
Trade Name :BAY 70143		
Trade Name :YALTOX		
Trade Name :CURATERR		
Common Name :CHLORDANE	I	
Partition Coefficient :38000 ml/g OC		
Half-Life :3500 days		
Trade Name :CHLORDAN		
Trade Name :ORTHO-KLOR		
Trade Name :BELT		
Trade Name :.		
Common Name :CHLOROTHALONIL	F	1.5
Partition Coefficient :1380 ml/g OC		
Half-Life :30 days		
Trade Name :BRAVO		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :CHLORPYRIFOS	I	
Partition Coefficient :6070 ml/g OC		
Half-Life :30 days		
Trade Name :LORSBAN		
Trade Name :BRODAN		
Trade Name :DURSBAN		
Trade Name :ERADEX		
Common Name :CHLORSULFURON	H	
Partition Coefficient :1 ml/g OC		
Half-Life :160 days		
Trade Name :GLEAN		
Trade Name :TELAR		
Trade Name :.		
Trade Name :.		
Common Name :CLOPYRALID	H	
Partition Coefficient :1 ml/g OC		
Half-Life :30 days		
Trade Name :STRINGER		
Trade Name :.		
Trade Name :.		
Trade Name :.		

[4] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

	Type[5]	Health Advisory (ppb)
Common Name :CYANAZINE	H	9
Partition Coefficient :190 ml/g OC		
Half-Life :14 days		
Trade Name :BLADEX		
Trade Name :FORTROL		
Trade Name :SD 15418		
Trade Name :WL 19805		
Common Name :DAMINOZIDE	G	
Partition Coefficient :10 ml/g OC		
Half-Life :7 days		
Trade Name :ALAR		
Trade Name :ALAR		
Trade Name :.		
Common Name :DCPA	H	3500
Partition Coefficient :5000 ml/g OC		
Half-Life :100 days		
Trade Name :DACTHAL		
Trade Name :.		
Trade Name :.		
Common Name :DEMENTON	I	35
Partition Coefficient :51 ml/g OC		
Half-Life :30 days		
Trade Name :METASYSTOX		
Trade Name :.		
Trade Name :.		
Common Name :DIAZINON	I	0.63
Partition Coefficient :500 ml/g OC		
Half-Life :40 days		
Trade Name :BASUDIN		
Trade Name :DIANON		
Trade Name :SPECTRACIDE		
Trade Name :.		
Common Name :DICAMBA	H	9
Partition Coefficient :2 ml/g OC		
Half-Life :14 days		
Trade Name :BANVEL D		
Trade Name :BANEX		
Trade Name :DIANAT		
Trade Name :WEEDMASTER		
Common Name :DICLOFOP-METHYL	H	
Partition Coefficient :48500 ml/g OC		
Half-Life :2 days		
Trade Name :HOELON		
Trade Name :.		

[5] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

	Type[6]	Health Advisory (ppb)
Common Name :DIELDRIN Partition Coefficient :8400 ml/g OC Half-Life :1000 days Trade Name :ALVIT Trade Name :DIELDREX Trade Name :DIELDRITE Trade Name :OCTALOX	I	
Common Name :DIFENZOQUAT Partition Coefficient :54500 ml/g OC Half-Life :100 days Trade Name :AVENGE Trade Name :. Trade Name :.	H	
Common Name :DIMETHOATE Partition Coefficient :8 ml/g OC Half-Life :7 days Trade Name :CYGON Trade Name :.	I	
Common Name :DINOSEB Partition Coefficient :120 ml/g OC Half-Life :30 days Trade Name :DNBP Trade Name :BASANITE Trade Name :KILOSEB Trade Name :CHEMOX	I	
Common Name :DISULFOTON Partition Coefficient :1600 ml/g OC Half-Life :5 days Trade Name :DISYSTON Trade Name :DITHIOSYSTOX Trade Name :THIODEMETON Trade Name :DITHIODEMETON	I	0.3
Common Name :DIURON Partition Coefficient :480 ml/g OC Half-Life :90 days Trade Name :KARMEX Trade Name :UROX D Trade Name :DIREX 4L Trade Name :DIUROL	H	
Common Name :ENDOSULFAN Partition Coefficient :2040 ml/g OC Half-Life :120 days Trade Name :THIODAN Trade Name :.	I	

[6] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

	Type[7]	Health Advisory (ppb)
Common Name :ENDRIN	I	
Partition Coefficient :8100 ml/g OC		
Half-Life :4300 days		
Trade Name :ENDREX		
Trade Name :HEXADRIN		
Trade Name :.		
Trade Name :.		
Common Name :EPTC	H	
Partition Coefficient :280 ml/g OC		
Half-Life :30 days		
Trade Name :EPTAM		
Trade Name :.		
Trade Name :.		
Common Name :ESFENVALERATE	I	
Partition Coefficient :5300 ml/g OC		
Half-Life :35 days		
Trade Name :ASANA		
Trade Name :.		
Trade Name :.		
Common Name :ETHOPROP	I	
Partition Coefficient :70 ml/g OC		
Half-Life :50 days		
Trade Name :MOCAP		
Trade Name :.		
Trade Name :.		
Common Name :FENVALERATE		I
Partition Coefficient :5300 ml/g OC		
Half-Life :35 days		
Trade Name :PYDRIN		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :FLUAZIFOP-P-BUTYL	H	
Partition Coefficient :3000 ml/g OC		
Half-Life :20 days		
Trade Name :FUSILADE		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :FONOFOS	I	14
Partition Coefficient :532 ml/g OC		
Half-Life :45 days		
Trade Name :DYFONATE		
Trade Name :N-2790		

[7] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

	Type[8]	Health Advisory (ppb)
Common Name :GLYPHOSATE	H	700
Partition Coefficient :24000 ml/g OC		
Half-Life :47 days		
Trade Name :ROUNDUP		
Trade Name :.		
Trade Name :.		
Common Name :HEPTACHLOR	I	
Partition Coefficient :24000 ml/g OC		
Half-Life :2000 days		
Trade Name :DRINOX		
Trade Name :HEPTOX		
Trade Name :HEPTAMUL		
Trade Name :.		
Common Name :HEXAZINONE	H	210
Partition Coefficient :54 ml/g OC		
Half-Life :90 days		
Trade Name :VELPAR		
Trade Name :.		
Common Name :LINDANE	I	
Partition Coefficient :1100 ml/g OC		
Half-Life :400 days		
Trade Name :GAMMA BHC		
Trade Name :ISOTOX		
Trade Name :LINTOX		
Trade Name :SILVANOL		
Common Name :LINURON	H	
Partition Coefficient :370 ml/g OC		
Half-Life :60 days		
Trade Name :AFALON		
Trade Name :HOE 2810		
Trade Name :LOROX L		
Trade Name :LINUREX		
Common Name :MALATHION	I	140
Partition Coefficient :1800 ml/g OC		
Half-Life :1 days		
Trade Name :MERCAPTOTHION		
Trade Name :CALMATHION		
Trade Name :CARBOFOS		
Trade Name :CYTHION		
Common Name :MANEB	F	
Partition Coefficient :1000 ml/g OC		
Half-Life :60 days		
Trade Name :DITHANE		
Trade Name :MANEB		

[8] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

	Type[9]	Health Advisory (ppb)
Common Name :MCPA ESTER	H	3.6
Partition Coefficient :1000 ml/g OC		
Half-Life :14 days		
Trade Name :WEEDONE		
Trade Name :.		
Trade Name :.		
Common Name :METHAMIDOPHOS	I	
Partition Coefficient :1 ml/g OC		
Half-Life :6 days		
Trade Name :MONITOR		
Trade Name :.		
Trade Name :.		
Common Name :METHIDATHION	I	
Partition Coefficient :400 ml/g OC		
Half-Life :21 days		
Trade Name :SUPRACIDE		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :METHYL PARATHION	I	2
Partition Coefficient :5100 ml/g OC		
Half-Life :5 days		
Trade Name :METAFOS		
Trade Name :PARATHION-METHYL		
Trade Name :DEVITHION		
Trade Name :NITROX 80		
Common Name :METOLACHLOR	H	10
Partition Coefficient :200 ml/g OC		
Half-Life :20 days		
Trade Name :DUAL		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :METHOMIL	I	
Partition Coefficient :72 ml/g OC		
Half-Life :33 days		
Trade Name :LANNATE		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :METRIBUZIN	H	175
Partition Coefficient :41 ml/g OC		
Half-Life :30 days		
Trade Name :LEXONE		
Trade Name :SENCOR		

[9] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

		Type[10]	Health Advisory (ppb)
Common Name	:METSULFURON	H	
Partition Coefficient	:61 ml/g OC		
Half-Life	:120 days		
Trade Name	:ALLY		
Trade Name	:ESCORT		
Trade Name	:.		
Trade Name	:.		
Common Name	:MEVINPHOS	I	
Partition Coefficient	:1 ml/g OC		
Half-Life	:3 days		
Trade Name	:PHOSDRIN		
Trade Name	:.		
Trade Name	:.		
Common Name	:NAPTALAM	H	
Partition Coefficient	:30 ml/g OC		
Half-Life	:14 days		
Trade Name	:ALANAP		
Trade Name	:.		
Trade Name	:.		
Common Name	:OXAMYL	I	
Partition Coefficient	:25 ml/g OC		
Half-Life	:4 days		
Trade Name	:VYDATE		
Trade Name	:VYDATE L		
Trade Name	:VYDATE G		
Trade Name	:HA-2214		
Common Name	:OXYDEMETON-METHYL	I	
Partition Coefficient	:1 ml/g OC		
Half-Life	:10 days		
Trade Name	:MSR		
Trade Name	:METASYSTOX		
Trade Name	:.		
Trade Name	:.		
Common Name	:OXYFLUORFEN	H	
Partition Coefficient	:100000 ml/g OC		
Half-Life	:35 days		
Trade Name	:GOAL		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:PARAQUAT	H	
Partition Coefficient	:100000 ml/g OC		
Half-Life	:500 days		
Trade Name	:GRAMOXONE		
Trade Name	:GRAMOXONE		

[10] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

	Type[11]	Health Advisory (ppb)
Common Name :PARATHION	H	35
Partition Coefficient :5000 ml/g OC		
Half-Life :14 days		
Trade Name :THIOPHOS		
Trade Name :BLADAN		
Trade Name :ORTHOPHOS		
Trade Name :PANTHION		
Common Name :PENDIMETHALIN	H	
Partition Coefficient :24300 ml/g OC		
Half-Life :90 days		
Trade Name :PROWL		
Trade Name :.		
Trade Name :.		
Common Name :PERMETHRIN	I	
Partition Coefficient :86000 ml/g OC		
Half-Life :32 days		
Trade Name :POUNCE		
Trade Name :AMBUSH		
Trade Name :.		
Trade Name :.		
Common Name :PHORATE	I	
Partition Coefficient :2000 ml/g OC		
Half-Life :90 days		
Trade Name :THIMET		
Trade Name :RAMPART		
Trade Name :AGRIMET		
Trade Name :GEOMET		
Common Name :PHOSPHAMIDON	I	
Partition Coefficient :1 ml/g OC		
Half-Life :17 days		
Trade Name :SWAT		
Trade Name :.		
Trade Name :.		
Common Name :PHOSMET	I	
Partition Coefficient :612 ml/g OC		
Half-Life :12 days		
Trade Name :IMIDAN		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :PICLORAM	H	
Partition Coefficient :16 ml/g OC		
Half-Life :908 days		
Trade Name :TORDON		
Trade Name :TORDON 22K		

[11] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

		Type[12]	Health Advisory (ppb)
Common Name	:PROMETON	H	100
Partition Coefficient	:300 ml/g OC		
Half-Life	:120 days		
Trade Name	:PRAMITOL		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:PRONAMID	H	52
Partition Coefficient	:990 ml/g OC		
Half-Life	:60 days		
Trade Name	:KERB		
Trade Name	:.		
Trade Name	:.		
Common Name	:PROPARGITE	M	
Partition Coefficient	:8000 ml/g OC		
Half-Life	:56 days		
Trade Name	:COMITE		
Trade Name	:OMITE		
Trade Name	:.		
Trade Name	:.		
Common Name	:SETHOXYDIM	H	
Partition Coefficient	:50 ml/g OC		
Half-Life	:10 days		
Trade Name	:POAST		
Trade Name	:.		
Trade Name	:.		
Common Name	:SIMAZINE	H	35
Partition Coefficient	:138 ml/g OC		
Half-Life	:75 days		
Trade Name	:AQUAZINE		
Trade Name	:PRINCEP		
Trade Name	:SIMADEX		
Trade Name	:SIM-TROL		
Common Name	:TERBACIL	H	
Partition Coefficient	:55 ml/g OC		
Half-Life	:120 days		
Trade Name	:SINBAR		
Trade Name	:.		
Trade Name	:.		
Trade Name	:.		
Common Name	:TERBUFOS	I	0.18
Partition Coefficient	:3000 ml/g OC		
Half-Life	:5 days		
Trade Name	:COUNTER		
Trade Name	:.		

[12] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide

	Type[13]	Health Advisory (ppb)
Common Name :TRIALLATE	H	
Partition Coefficient :2400 ml/g OC		
Half-Life :82 days		
Trade Name :FARGO		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :TRIADIMEFON	F	
Partition Coefficient :273 ml/g OC		
Half-Life :21 days		
Trade Name :BAYLETON		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :TRIFLURALIN	H	2
Partition Coefficient :7000 ml/g OC		
Half-Life :60 days		
Trade Name :ELANCOLAN		
Trade Name :TREFANOCIDE		
Trade Name :TREFLAN		
Trade Name :TRIM		
Common Name :TRIMETHACARB	I	
Partition Coefficient :200 ml/g OC		
Half-Life :10 days		
Trade Name :BROOT		
Trade Name :.		
Trade Name :.		
Trade Name :.		
Common Name :VERNOLATE	H	
Partition Coefficient :330 ml/g OC		
Half-Life :12 days		
Trade Name :SAFER		
Trade Name :SURPASS		

[13] I-Insecticide; H-Herbicide; F-Fungicide; G-Growth Regulator; M-Miticide