

# Annapolis River Watershed Pesticide Risk Ranking

Final Report

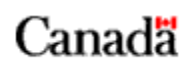


Report Prepared For:  
Environment Canada



Clean Annapolis River Project  
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July 2006

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**Table of Contents**

Acknowledgements	ii
Executive Summary	iii
1.0 Introduction	1
Annapolis River Watershed Pesticide Inventory	1
Risk Ranking of Pesticides Used in PEI	2
2.0 Methodology	2
Overview of Risk Ranking Model	2
Determining Individual Active Ingredient Quantities From Agricultural Information	3
Active Ingredient Selection for Risk Ranking	4
Applying the Risk Ranking Model to Active Ingredient Data	4
Modifications to the Release Weighting Factor	6
3.0 Results	6
4.0 Discussion	10
5.0 Limitations	12
6.0 Conclusions	12
References	13
Glossary	16
Appendices	19
Appendix A: Raw Data and References	19
Appendix B: Active Ingredients Excluded from the Risk Ranking Analysis	55
Appendix C: Active Ingredient Loading Percentages	56

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## Executive Summary

In past years, growing debates on pesticides, their appropriate use patterns and effects on human and ecosystem health have been causes for concern in Nova Scotia. Because of these concerns, in 2006, Clean Annapolis River Project (CARP) conducted the first relative risk ranking of pesticides used in Nova Scotia's Annapolis River watershed. This analysis was conducted by combining the results of CARP's pesticide inventory (Comeau, 2006), with the relative risk ranking model developed by Dunn (2004) of Environment Canada.

The model developed by Dunn (2004) was based on the CHEMs model originally developed at the University of Tennessee based on the general risk equation of:

$$\text{Risk} = \text{Toxicity} \times \text{Exposure}$$

Her model incorporated environmental, human and exposure data as well as weighted factors based on application quantity and dispersal throughout the atmosphere, water and land systems. This provided a relative risk ranking of active ingredients analyzed.

For the 189 active ingredients used in the watershed in 2004, the necessary toxicity and exposure data were identified in order to perform the analysis. For the three active ingredients applied in the greatest quantity (calcium hypochlorite, mineral oil and chlorine), not all the required data could be located. Therefore, default values were assigned to these active ingredients, allowing them to be included in the analysis. Overall, 71 active ingredients were evaluated. It is recommended that if the missing data for these and other active ingredients identified in the watershed become available, that the risk ranking be recalculated.

The 71 active ingredients examined were ranked according to their potential risk to the Annapolis River watershed and grouped into levels of high, medium and low potential risk. The active ingredients comprising the high relative risk level were diazinon, calcium hypochlorite, chlorothalonil, metiram, chlorine, azinphos-methyl, captan, mancozeb, tributyltin oxide, carbaryl and endosulfan. It is CARP's hope that this report will promote greater dialogue between the general public, pesticide users and pesticide regulators on the appropriate use of pesticides and, where pesticides are required, encourage the use of lower risk pesticides in the Annapolis River watershed.



## 1.0 Introduction

In recent years there has been a growing debate over the appropriate use of pesticides and their effect on human and ecosystem health. While much of this debate has taken place in the popular media, there has been relatively little factual information on the actual quantities of pesticides used and a quantification of the risk they pose.

It is against this backdrop that Clean Annapolis River Project (CARP) initiated a project in late 2004 to better understand pesticide use in Nova Scotia's Annapolis River watershed. The first component of the study inventoried all pesticide use within the watershed in 2004. The second part, which is reported here, examined the list of active ingredients used, ranking them on the risk that they pose to humans and the environment.

Through this work, CARP's goal was to provide members of the public, elected officials, pesticide regulators and pesticide users with clear, factual and unbiased information on the relative risk of pesticides used in the Annapolis River watershed. It is hoped that this will stimulate a more informed debate on the appropriate use of pesticides within our communities, and where pesticide use is necessary, encourage the substitution of higher risk to lower risk pesticides as identified in this report.

### Annapolis River Watershed Pesticide Inventory

In January of 2006, CARP completed the first inventory on pesticides used in the Annapolis River watershed (Comeau, 2006). By incorporating different methods of data collection including questionnaires, interviews with farmers and pesticide experts, as well as consulting 2004 sales data from pesticide vendors in the area, Comeau (2006) was able to estimate the amount of pesticide active ingredient applied within the Annapolis River watershed. Estimates were developed for a number of sectors including agricultural, domestic, forestry, large facilities and institutions, marine, miscellaneous and municipal. Agriculture was found to be the sector using the greatest quantity of pesticides (29 136 kg). The inventory identified 189 different active ingredients being used. It was estimated that approximately 55 400 kilograms of active ingredients were applied to areas within the Annapolis River watershed in 2004. Table 1 presents the ten active ingredients applied in the greatest quantity within the watershed.

Table 1: The ten active ingredients applied in the greatest quantity in the Annapolis River watershed (Comeau, 2006).

Active Ingredient	Quantity Applied in Watershed (kg)
Calcium Hypochlorite	11 198
Mineral Oil	9732
Chlorine	6139
Captan	4686
Glyphosate	2143
Mancozeb	2122
Glyphosate (Trimethylsulfonium Salt)	1625
Metiram	1609
Chlorothalonil	1058
Atrazine	1041

### Risk Ranking of Pesticides Used in PEI

As a result of concerns over pesticide use within Prince Edward Island’s agriculture industry, Environment Canada developed a methodology to provide a relative risk ranking of the active ingredients used in pesticides, based on environmental, human and exposure data (Dunn, 2004). By applying her modified version of the CHEMs risk ranking model (originally developed at the University of Tennessee) (Swanson *et al*, 1997), Dunn was able to calculate which pesticides posed the greatest risk to the region. The model included release weighted factors based on their application quantity and dispersal throughout the atmosphere, water and land systems. The report found that the new model resulted in an improvement in the credibility of the results and was especially helpful in determining which pesticides required more attention than others.

## 2.0 Methodology

### Overview of Risk Ranking Model

The model developed by Dunn (2004) is characterized by the general risk equation of:

$$\text{Risk} = \text{Toxicity} \times \text{Exposure}$$

By applying weighted toxicity and exposure scores, a value is calculated representing an active ingredient’s risk to an area. Once all substances have a calculated risk score, they can be ranked accordingly. Theoretically, those with high risk scores would pose a greater threat to the environment than those with lower risk scores.

The methodology required the input of four toxicity endpoints that represented human health effects, two toxicity endpoints representing environmental effects and three endpoints for potential exposure. The following table lists the endpoints and provides a brief description of what they signify. For a more in depth overview of the risk ranking model used in this report, refer to the 2004 report titled “A Relative Risk Ranking of Pesticides Used in Prince Edward Island”.

Table 2: Endpoints used in the application of the risk ranking model to active ingredients (Dunn, 2004).

Human Health Effects Endpoint	Description
Rat Oral LD <sub>50</sub>	- Represents an acute oral effect - Based on the amount of substance that causes mortality in 50% of test organisms (e.g. rats) within 14 days of being given a single dose
Rat Inhalation LC <sub>50</sub>	- Represents an acute inhalation effect - Based on the concentration inhaled for four hours by test organisms (e.g. rats) that causes 50% mortality
Carcinogenicity Rating	- Represents a chronic effect - Based on classifications appointed to a substance by the United States Environmental Protection Agency and the International Agency for Research on Cancer (IARC)
No-Observed-Adverse-Effects-Level (NOAEL)	- Represents a chronic effect - Based on the highest daily dose given to test organisms over a life-time that causes no observable, harmful effects

Environmental Effects Endpoint	Description
Rainbow Trout 96-hour LC <sub>50</sub>	<ul style="list-style-type: none"> <li>- Represents an acute aquatic effect</li> <li>- Based on the concentration exposed to test organisms (e.g. Rainbow Trout) for 96 hours causing 50% mortality</li> </ul>
<i>Daphnia magna</i> 48-hour LC/EC <sub>50</sub>	<ul style="list-style-type: none"> <li>- Represents an acute aquatic effect</li> <li>- Based on the concentration exposed to test organisms (e.g. <i>Daphnia magna</i>) for 48 hours causing 50% mortality or immobilization</li> </ul>
Exposure Potential Endpoint	Description
Soil Half-Life	<ul style="list-style-type: none"> <li>- Represents a persistence parameter</li> <li>- Based on the time a substance requires to biodegrade in soil under aerobic conditions to half its initial concentration</li> </ul>
Aquatic Bioconcentration Factor (BCF)	<ul style="list-style-type: none"> <li>- Represents a bioaccumulation parameter</li> <li>- Based on the ratio of substance concentration in an aquatic organism to that found in water at steady state</li> <li>- If the value was unavailable, it was estimated using the pesticide's Log K<sub>ow</sub> (partition coefficient) value*</li> </ul>
Release Weighting Factor (RWF)	<ul style="list-style-type: none"> <li>- Represents a release amount parameter</li> <li>- Based on the amount of active ingredient released into air, water and land systems as determined through Fugacity modeling</li> </ul>

\* (Tomlin, 2000)

#### Determining Individual Active Ingredient Quantities from Agricultural Information

The inventory provided by Comeau indicated the type and amount of each active ingredient used within each individual sector in the Annapolis River watershed, with the exception of the agricultural industry. Due to limits in data availability, only the total amount of active ingredients could be estimated for agriculture as opposed to the quantity of each individual active ingredient. Therefore, the first task in conducting the risk ranking was to estimate the amount of each active ingredient used in agricultural practices and then combine these results to the active ingredients for other uses that had already been quantified.

It was reported by Comeau (2006) that of the three vendors contacted for sales information, the first sold 80% of their active ingredient to the Annapolis River watershed with 90% of that going to agricultural businesses. The second and third vendors sold 5% and 10% of active ingredients, respectively, to agricultural businesses in the watershed. In order to estimate the quantity used in the agricultural sector, the amount of each active ingredient was multiplied by the percentage of that sold within the watershed and then by the percentage used in agricultural practices. The procedure can be seen in Table 3 with the active ingredient dimethoate serving as an example.

Table 3: Example - Estimating the amount of the active ingredient dimethoate used in the agricultural sector in the Annapolis River watershed.

Vendor	Total Amount of Active Ingredient Sold (kg)	Total Active Ingredient Sold in Watershed (%)	Total Active Ingredient Sold for Agricultural Practices (%)	Total Active Ingredient Sold in Watershed's Agricultural Sector (kg)
1	43.2	80	90	31
2	206.4	5	100	10
3	323.8	10	100	32
Total Dimethoate Applied in Watershed (kg):				73

#### Active Ingredient Selection for Risk Ranking

In order to keep this study within manageable limits and focus on high volume active ingredients that pose the greatest potential risk, only active ingredients used in quantities greater than 10 kilograms were analyzed. Of the 189 substances that were applied in the Annapolis River watershed in 2004, 98 were considered within the risk ranking model, comprising 52% of those applied and 99% of the total volume of active ingredient used in the watershed.

#### Applying the Risk Ranking Model To Active Ingredient Data

The methodology followed for the risk ranking was based on that developed by Dunn (2004). In order to develop dependable toxicity data for each active ingredient, many different sources were consulted. Appendix A refers to the sources used in compiling the raw toxicity data needed for the risk ranking of pesticides used in the Annapolis River watershed.

Data searching and collecting proved to be a very time consuming task and although each database was searched thoroughly, some data gaps remained for several active ingredients. Because of this, 27 had to be excluded from the risk ranking due to insufficient data availability. Appendix B lists those ingredients that were identified in the watershed but were eliminated. Of the 98 active ingredients applied in quantities of 10 kilograms or greater, sufficient data was identified for 68.

Three of the active ingredients applied in the greatest quantity did not have sufficient toxicity data available. As can be seen in Table 1, these included calcium hypochlorite; a disinfectant estimated to be used in quantities of over 11 000 kg in the domestic and municipal sectors of the watershed, mineral oil; an adjuvant applied by the agricultural industry in quantities of almost 10 000 kg and chlorine; a disinfectant used in municipal wastewater treatment in quantities of approximately 6000 kg (Comeau, 2006). An adjuvant is a substance intended to enhance the effectiveness of other active ingredients (PSD, 2006).

The information available for each active ingredient varied between the three. Because of their significant use throughout the watershed, default values were used for the missing data to allow the active ingredients to be assessed by the model. The following table presents the data that was available and information gaps for each substance as well as the default values used to accommodate the risk ranking (Allison Dunn, personal communications, June 29, 2006).

Table 4: Data availability for calcium hypochlorite, mineral oil and chlorine for risk ranking analysis as well as default values used.

Active Ingredient	Available Data	Source	Default Values Used	Estimation Methods
Calcium Hypochlorite	Rat Oral LD <sub>50</sub>	Hazardous Substances Data Bank (HSDB) ChemIDplus Lite Database	NOAEL (HV <sub>NCAR</sub> = 2.5)	Rat Inhalation LC <sub>50</sub> * Soil Half-Life** Log BCF***
	Carcinogenicity Rating	Hazardous Substances Data Bank (HSDB)		
	Rainbow Trout LC <sub>50</sub>	ECOTOXicology Database System		
	<i>Daphnia magna</i> EC/LC <sub>50</sub>	ECOTOXicology Database System USEPA Reregistration Eligibility Decision Documents		
	Log K <sub>ow</sub>	SRC Interactive Log K <sub>ow</sub> (K <sub>ow</sub> Win) Demo		
Mineral Oil	Rat Inhalation LC <sub>50</sub>	ChemIDplus Lite Database	Rat Oral LD <sub>50</sub> (HV <sub>OR</sub> = 2.5) NOAEL (HV <sub>NCAR</sub> = 2.5) Rainbow Trout LC <sub>50</sub> (HV <sub>AAT</sub> = 2.5) <i>Daphnia magna</i> EC/LC <sub>50</sub> (HV <sub>AAD</sub> = 2.5) Log K <sub>ow</sub> , Log BCF (HV <sub>BCF</sub> = 1.75)	Not Applicable
	Carcinogenicity Rating	IARC: Agents Reviewed on the IARC Monographs		
	Soil Half-Life	OSU Extension Pesticide Properties Database		
Chlorine	Rat Oral LD <sub>50</sub>	Handbook of Pesticide Toxicology Principles	Not Applicable	Soil Half-Life** Log BCF***
	Rat Inhalation LC <sub>50</sub>	ChemIDplus Lite Database		
	Carcinogenicity Rating	USEPA Reregistration Eligibility Decision Documents		
	NOAEL	USEPA Reregistration Eligibility Decision Documents		
	Rainbow Trout LC <sub>50</sub>	ECOTOXicology Database System		
	<i>Daphnia magna</i> EC/LC <sub>50</sub>	ECOTOXicology Database System		
	Log K <sub>ow</sub>	SRC Interactive Log K <sub>ow</sub> (K <sub>ow</sub> Win) Demo		

\* estimated using equation used by Green Seal Environmental Standards (2005)

\*\* estimated using the Episuite Biowin Ultimate Survey Model (2000)

\*\*\* estimated using Log K<sub>ow</sub>

Modifications to the Release Weighting Factor

In the determination of the Release Weighting Factor (RWF) (Dunn, 2004, p 10) for each medium (air, water, and land), fugacity modeling was required for each active ingredient to determine how it dispersed into the environment after application. In her report, Dunn based the fugacity modeling on 100% loading into soil for each pesticide leaving 0% loading into water and air. For the purpose of the active ingredients used in the Annapolis River watershed, the estimated percentages were based on their typical mode of application. Appendix C contains the loading percentages for each medium estimated for each active ingredient.

**3.0 Results**

Table 5 lists the active ingredients and their corresponding application quantity, weighted risk score, ordinal risk ranks, sectors of use with the percentage used and pesticide type.

Table 5: The risk ranking of the active ingredients identified in the Annapolis River watershed.

Active Ingredient	Quantity Applied to Watershed (kg)	Weighted Risk Score (WRS)	Ordinal Rank	Sectors Used*	Pesticide Type*
Diazinon	458	352	1	Miscellaneous (10%), Municipal (1%), Agriculture (89%)	Insecticide
Calcium Hypochlorite	11 198	332	2	Domestic (98%), Municipal (2%)	Disinfectant
Chlorothalonil	1058	300	3	Large Facilities and Institutions (11%), Agriculture (89%)	Fungicide
Metiram	1609	300	4	Agriculture (100%)	Fungicide
Chlorine	6139	296	5	Municipal (100%)	Disinfectant
Azinphos-Methyl	319	278	6	Agriculture (100%)	Insecticide
Captan	4686	274	7	Agriculture (100%)	Fungicide
Mancozeb	2122	249	8	Agriculture (100%)	Fungicide
Tributyltin Oxide	13	238	9	Domestic (100%)	Fungicide/Molluscicide
Carbaryl	717	227	10	Domestic (9%), Large Facilities and Institutions (3%), Miscellaneous (32%), Agriculture (56%)	Insecticide
Endosulfan	68	217	11	Agriculture (100%)	Insecticide
Methomyl	115	187	12	Agriculture (100%)	Insecticide
Carbofuran	55	185	13	Agriculture (100%)	Insecticide
Phorate	94	185	14	Agriculture (100%)	Insecticide

Active Ingredient	Quantity Applied to Watershed (kg)	Weighted Risk Score (WRS)	Ordinal Rank	Sectors Used*	Pesticide Type*
Mecoprop	272	182	15	Domestic (51%), Large Facilities and Institutions (23%), Municipal (0.0003%), Miscellaneous (10%), Agriculture (16%)	Herbicide
Folpet	33	175	16	Domestic (39%), Agriculture (61%)	Fungicide
Atrazine	1041	173	17	Agriculture (100%)	Herbicide
Chlorpyrifos	161	172	18	Large Facilities and Institutions (1%), Agriculture (99%)	Insecticide
Paraquat	27	171	19	Agriculture (100%)	Herbicide
Mineral Oil	9732	167	20	Agriculture (100%)	Adjuvant
Trifluralin	85	155	21	Agriculture (100%)	Herbicide
Cypermethrin	21	153	22	Agriculture (100%)	Insecticide
Linuron	217	153	23	Agriculture (100%)	Herbicide
Methamidophos	73	152	24	Agriculture (100%)	Insecticide
Metolachlor	345	150	25	Agriculture (100%)	Herbicide
Phosalone	38	144	26	Agriculture (100%)	Insecticide
Phosmet	196	142	27	Agriculture (100%)	Insecticide
Dimethoate	74	141	28	Domestic (1%), Agriculture (99%)	Insecticide
Dodine	66	133	29	Agriculture (100%)	Fungicide
Fenbuconazole	31	131	30	Agriculture (100%)	Fungicide
Triclopyr	83	128	31	Forestry (78%), Agriculture (22%)	Herbicide
Pyridaben	22	127	32	Agriculture (100%)	Insecticide/Miticide
2,4-D	899	127	33	Domestic (30%), Large Facilities and Institutions (6%), Municipal (1%), Miscellaneous (6%), Agriculture (52%)	Herbicide
Naled	57	124	34	Agriculture (100%)	Insecticide
Pirimicarb	46	121	35	Agriculture (100%)	Insecticide
Iprodione	80	121	36	Large Facilities and Institutions (44%), Agriculture (56%)	Fungicide
MCPA	538	119	37	Agriculture (100%)	Herbicide
Diquat Dibromide	29	119	38	Agriculture (100%)	Herbicide
Propiconazole	48	115	39	Large Facilities and Institutions (38%), Agriculture (62%)	Fungicide

Active Ingredient	Quantity Applied to Watershed (kg)	Weighted Risk Score (WRS)	Ordinal Rank	Sectors Used*	Pesticide Type*
Dazomet	42	110	40	Agriculture (100%)	Soil Fumigant
Imidacloprid	29	109	41	Domestic (55%), Agriculture (45%)	Insecticide
Quintozene	24	107	42	Large Facilities and Institutions (100%)	Herbicide
Permethrin	16	104	43	Domestic (6%), Miscellaneous (56%), Agriculture (38%)	Insecticide
Hexazinone	283	102	44	Agriculture (100%)	Herbicide
Triazine	46	102	45	Agriculture (100%)	Herbicide
Metribuzin	38	101	46	Agriculture (100%)	Herbicide
Malathion	102	96	47	Domestic (0.5%), Agriculture (99.5%)	Insecticide
Prometryn	29	92	48	Agriculture (100%)	Herbicide
Thiram	28	92	49	Large Facilities and Institutions (71%), Agriculture (29%)	Fungicide
Simazine	35	87	50	Agriculture (100%)	Herbicide
Isoxaflutole	96	84	51	Agriculture (100%)	Herbicide
Bromoxynil	27	83	52	Agriculture (100%)	Herbicide
Diphenylamine	11	82	53	Agriculture (100%)	Fungicide
EPTC	42	81	54	Agriculture (100%)	Herbicide
Glyphosate	2143	81	55	Domestic (0.04%), Forestry (84%), Large Facilities and Institutions (3%), Municipal (0.06%), Agriculture (13%)	Herbicide
Dinocap	11	79	56	Agriculture (100%)	Fungicide/Miticide
Thiophanate-Methyl	11	77	57	Agriculture (100%)	Fungicide
Dicamba	180	76	58	Domestic (1%), Large Facilities and Institutions (4%), Municipal (1%), Miscellaneous (2%), Agriculture (92%)	Herbicide
Fluazifop-p-Butyl	21	75	59	Agriculture (100%)	Herbicide
Dichlobenil	44	72	60	Agriculture (100%)	Herbicide
Picloram	15	72	61	Large Facilities and Institutions (100%)	Herbicide
Azoxystrobin	32	68	62	Large Facilities and Institutions (100%)	Fungicide

Active Ingredient	Quantity Applied to Watershed (kg)	Weighted Risk Score (WRS)	Ordinal Rank	Sectors Used*	Pesticide Type*
Myclobutanil	26	67	63	Large Facilities and Institutions (3%), Agriculture (97%)	Fungicide
Napropamide	79	63	64	Agriculture (100%)	Herbicide
Piperonyl Butoxide	10	55	65	Domestic (100%)	Insecticide
Clopyralid	12	53	66	Agriculture (100%)	Herbicide
Cymoxanil	13	46	67	Agriculture (100%)	Fungicide
Glufosinate Ammonium	11	44	68	Agriculture (100%)	Herbicide
Fosetyl Aluminum	52	35	69	Agriculture (100%)	Fungicide
Terbacil	17	33	70	Agriculture (100%)	Herbicide
Triforine	11	30	71	Domestic (12%), Agriculture (88%)	Fungicide

\* (Comeau, 2006)

#### 4.0 Discussion

Due to the relative nature of the risk ranking model, the results should not be interpreted based on the individual weighted risk scores assigned to each active ingredient. Due to the many estimated values associated in conducting this analysis, the difference in risk between active ingredients with a score of 110 and 119 may not be as significant as one would expect. The results, therefore, are best suited for grouping active ingredients into groups of high, medium and low risk levels. For the purpose of this analysis, the levels were determined arbitrarily. Table 6 presents the levels developed and the active ingredients falling within the limits of each.

Table 6: The groupings of active ingredients into high, medium and low levels based on the results of the risk ranking model.

Risk Level	Weighted Risk Score (WRS) Range	Active Ingredients
High	> 200	Diazinon, Calcium Hypochlorite, Chlorothalonil, Metiram, Chlorine, Azinphos-Methyl, Captan, Mancozeb, Tributyltin Oxide, Carbaryl, Endosulfan
Medium	100 – 200	Methomyl, Carbofuran, Phorate, Mecoprop, Folpet, Atrazine, Chlorpyrifos, Paraquat, Mineral Oil, Trifluralin, Cypermethrin, Linuron, Methamidophos, Metolachlor, Phosalone, Phosmet, Dimethoate, Dodine, Fenbuconazole, Triclopyr, Pyridaben, 2,4-D, Naled, Pirimicarb, Iprodione, MCPA, Diquat Dibromide, Propiconazole, Dazomet, Imidacloprid, Quintozene, Permethrin, Hexazinone, Triazine, Metribuzin
Low	< 100	Malathion, Prometryn, Thiram, Simazine, Isoxaflutole, Bromoxynil, Diphenylamine, EPTC, Glyphosate, Dinocap, Thiophanate-Methyl, Dicamba, Fluazifop-p-Butyl, Dichlobenil, Picloram, Azoxystrobin, Myclobutanil, Napropamide, Piperonyl Butoxide, Clopyralid, Cymoxanil, Glufosinate Ammonium, Fosetyl Aluminum, Terbacil, Triforine

The above table illustrates that 11 active ingredients are considered to pose the greatest risk to the environment and communities contacted in the watershed. Further information on these 11 active ingredients is presented in Table 7, including use sector, associated commercial brand names and uses. These substances would generally be expected to have highly toxic aquatic and terrestrial outcomes, require great amounts of time to biodegrade in soil and have a greater potential to bioconcentrate in exposed organisms. The release amounts for each of the high risk active ingredients varied greatly from one another with substances applied in quantities as low as tributyltin oxide with an amount of 13 kilograms, to as high as calcium hypochlorite, applied in quantities exceeding 11 000 kilograms. The high ranking of the lesser used active ingredients can be attributed to exceptionally high toxicity and exposure characteristics.

Table 7: Active ingredients composing the high risk level to the watershed with pesticide type and commercial brand name indicated.

Active Ingredient	Pesticide Type and Use Sector*	Commercial Brand Name	Uses
Diazinon	Insecticide (Miscellaneous, Municipal and Agriculture)	Diazinon*	Protects against insects such as mites, caterpillars, moths, etc.**
Calcium Hypochlorite	Disinfectant (Domestic, Municipal)	Pulsar Plus**	Controls bacteria and algae in swimming pools**
Chlorothalonil	Fungicide (Agriculture and Large Facilities and Institutions)	Bravo, Daconil*	Protects crops against foliar diseases***
Metiram	Fungicide (Agriculture)	Polyram*	Used to protect against foliar diseases in potatoes, tomatoes, celery and grape crops**
Chlorine	Disinfectant (Municipal)	Busan, Drewchlor**	Used for wastewater treatment and pool water maintenance*
Azinphos-Methyl	Insecticide (Agriculture)	Azinphos-Methyl**	Protects against insects on field, fruit, vegetable and ornamental crops**
Captan	Fungicide (Agriculture)	Captan, Maestro*	Controls fungal diseases in vegetable, fruit and ornamental crops**
Mancozeb	Fungicide (Agriculture)	Dithane, Manzate, Penncozeb*	Protects against fungal disease in fruits, vegetables, potato and corn seeds**
Tributyltin Oxide	Fungicide/Molluscicide (Domestic)	Osmose**	Used as a water repellent wood preservative**
Carbaryl	Insecticide (Domestic, Large Facilities and Institutions, Miscellaneous, Agriculture)	Bug-B-Gon, Sevin*	Protects plants, fruits, vegetables, poultry and livestock from insects**
Endosulfan	Insecticide (Agriculture)	Thiodan*	Protects crops from mite and insect damage**

\* (Comeau, 2006)

\*\* (PMRA, 2004)

\*\*\* (Syngenta Corporation, 2006)

## 5.0 Limitations

The most prominent limitation in conducting this analysis was the unavailability of toxicity data for many of the active ingredients identified in the watershed. As was discussed earlier, this resulted in many active ingredients being excluded from the risk ranking analysis. This issue may be the result of many active ingredients failing to undergo sufficient toxicity testing, the failure of toxicity results to be effectively communicated or the failure to locate appropriate data. It is recommended that when and if this information becomes available for excluded active ingredients, that they be analyzed and incorporated into the final list.

In her report, Dunn (2004) noted many limitations in the development and application of the risk ranking model. These limitations, therefore, would affect the results presented in this report. The limitations expressed by Dunn are as follows:

1. The majority of the toxicity endpoints only considered the immediate, acute effects rather than the long term effects that many pesticides have the capability of producing.
2. Environmental effects were only represented by two aquatic species and failed to include toxicity information on other aquatic species and terrestrial species
3. Since information wasn't available for the exact amount of active ingredient applied in the watershed, quantities were determined from vendor sales data, expert opinion and questionnaires. Because of this, it is possible that the quantities resulting are either overestimated or underestimated.
4. Since no models exist that are an exact replica of natural systems, the environmental distribution determined from fugacity modeling for active ingredients throughout air, water and land may not precisely represent how it interacts with the environment in the Annapolis River watershed

## 6.0 Conclusions

The implementation of the risk ranking model was successfully applied to the active ingredients identified in the Annapolis River watershed. The 71 active ingredients analyzed were assigned weighted risk scores and divided into groups of high, medium and low potential risk.

The high risk active ingredients identified were diazinon, calcium hypochlorite, chlorothalonil, metiram, chlorine, azinphos-methyl, captan, mancozeb, tributyltin oxide, carbaryl and endosulfan. Based on the CHEMs risk ranking, these active ingredients would be expected to pose the greatest risk to the watershed.

Although the pesticides calculated to pose the greatest risk to the Annapolis River watershed were identified, the aim of this report is to contribute to the health and improvement of the Annapolis River watershed in terms of pesticide use. It is hoped that the results of this analysis will promote discussion between different sectors and government officials on the appropriate use of pesticides in the area and, where pesticide use is necessary, support substitution of higher risk to lower risk pesticides as suggested by the report's risk ranking results.

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## Glossary

The following definitions were derived from many different sources including the Canadian Pest Management Regulatory Agency, the United States Environmental Protection Agency and the Pesticide Safety Directorate.

**Active Ingredient:** That ingredient of a pesticide that actually controls the targeted pest.<sup>1</sup>

**Acute Effect:** Adverse effect on a human or animal body that takes place soon after exposure.<sup>5</sup>

**Adjuvant:** A substance other than water, which enhances or is intended to enhance the effectiveness of a pesticide product.<sup>3</sup>

**Aerobic:** Requiring molecular oxygen.<sup>8</sup>

**Agricultural Sector:** A sector contacted in conducting the Annapolis River watershed pesticide inventory project that included poultry, dairy, livestock and fruit and vegetable farms, Christmas tree plantations, nurseries and greenhouses.<sup>4</sup>

**Antifouling Agent:** Kills or repels organisms that attach to underwater surfaces, such as boat bottoms.<sup>2</sup>

**BCF:** (Bioconcentration Factor) A unitless value describing the degree to which a chemical can be concentrated in the tissues of an organism in the aquatic environment.<sup>6</sup>

**Bioconcentrate (Bioconcentration):** Process leading to a higher concentration of a substance in an organism than in environmental media to which it is exposed.<sup>8</sup>

**Carcinogenicity (Carcinogen):** The causal agents that induce tumors. They include external factors (chemicals, physical agents, viruses) and internal factors such as hormones.<sup>3</sup>

**Chronic Effect:** Adverse effect on a human or animal body with symptoms that develop slowly over a long period of time or that recur frequently.<sup>5</sup>

**Disinfectant:** Kills or inactivates disease-producing microorganisms or inanimate objects.<sup>2</sup>

**Domestic Sector:** A sector contacted in conducting the Annapolis River watershed pesticide inventory project that consisted of households located in the watershed.<sup>4</sup>

**EC<sub>50</sub>:** (Median Effective Concentration) Effective concentration for 50% of the organisms tested and used when the effect other than death is the observed endpoint (e.g. immobilization in *Daphnia magna*).<sup>6</sup>

**Ecosystem:** Grouping of organisms (microorganisms, plants, animals) interacting together, with and through their physical and chemical environments, to form a functional entity.<sup>8</sup>

**Exposure:** State of being open and vulnerable to a hazardous chemical by inhalation, ingestion, skin contact, absorption or any other course.<sup>5</sup>

**Forestry Sector:** A sector contacted in conducting the Annapolis River watershed pesticide inventory project that consisted of contacting forestry companies located within the watershed.<sup>4</sup>

**Fugacity Model:** A model used to estimate how a chemical disperses throughout the environment through the input of chemical and environmental variables. A Level III fugacity model was used in this analysis.<sup>7</sup>

**Fungicide:** Kills fungi (including blights, mildews, molds and rusts).<sup>2</sup>

**Fumigant:** Produce gas or vapor intended to destroy pests in buildings or soil.<sup>2</sup>

**Herbicide:** Kills weeds and other plants that grow where they are not wanted.<sup>2</sup>

**Insecticide:** Kills insects and other arthropods.<sup>2</sup>

**Large Facilities and Institutions Sector:** A sector contacted in conducting the Annapolis River watershed pesticide inventory project that included health care facilities, schools, government departments, national and provincial parks, golf courses, amusement parks and large industries.<sup>4</sup>

**LC<sub>50</sub>:** (Median Lethal Concentration) The concentration of a substance that on the basis of laboratory tests is expected to kill 50% of a group of test animals when administered as a single exposure in a specific time period.<sup>5</sup>

**LD<sub>50</sub>:** (Lethal Dose 50) The single dose of a substance that causes the death in 50% of an animal population from exposure to the substance.<sup>5</sup>

**Loading Percentage Value:** The estimated amount of active ingredient that is released into soil, air or water during application.<sup>7</sup>

**Log K<sub>ow</sub>:** (Partition Coefficient) The ratio of the distribution of a substance between two phases when the heterogeneous system (of two phases) is in equilibrium. The partition coefficient most commonly used in acute toxicology is octan-1-ol/water distributions. It is used to estimate how readily substances will bioconcentrate in an organism.<sup>8</sup>

**Marine Sector:** A sector contacted in conducting the Annapolis River watershed pesticide inventory project that included boatyards and aquaculture industries.<sup>4</sup>

**Medium:** Specific environments (air, water, soil) which are the subject of regulatory concern and activities.<sup>9</sup>

**Miscellaneous Sector:** A sector contacted in conducting the Annapolis River watershed pesticide inventory project that included lawn care companies and pest control companies.<sup>4</sup>

**Miticide:** Kills mites that feed on plants and animals.<sup>2</sup>

**Molluscicide:** Kills snails and slugs.<sup>2</sup>

**Municipal Sector:** A sector contacted in conducting the Annapolis River watershed pesticide inventory project that consisted of contacting the officials for the towns, villages and municipalities within the watershed to inquire about how they used pesticides in such places as public swimming pools, spas and wastewater treatment plants.<sup>4</sup>

**No-Observed-Adverse-Effects-Level (NOAEL):** The highest exposure level in a toxicity study at which there are no statistically significant and/or biologically significant increases in the frequency of adverse effects between the group of animals exposed to the test substance and its respective control group.<sup>3</sup>

**Pesticide:** Any product, device, organisms or substance that is used as a means for directly or indirectly controlling, preventing or repelling any pest.<sup>1</sup>

**Release Weighting Factor (RWF):** A value based on the amount of active ingredient released into air, water and land systems as determined through Fugacity modeling.<sup>7</sup>

**Repellant:** Repel pests, including insects (such as mosquitoes) and birds.<sup>2</sup>

**Soil Half-life:** The time a substance requires to biodegrade in soil to half its initial concentration.<sup>7</sup>

**Surfactant:** A detergent compound that promotes lathering.<sup>9</sup>

**Toxicity:** Sum of adverse effects resulting from exposure to a material, generally by the mouth, skin or respiratory tract.<sup>5</sup>

**Watershed:** The land area that drains into a stream. The watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.<sup>9</sup>

**Weighted Risk Score (WRS):** The final value calculated for each active ingredient representing its potential risk to the environment. It is calculated through the mathematical combination of weighted human, environmental and exposure effect values.<sup>7</sup>

**Wood Preservative:** Active ingredients used in treatment of wood to protect it from insects, fungi and other pests.<sup>4</sup>

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<sup>1</sup> (PMRA, 2004a), <sup>2</sup> (USEPA, 2006a), <sup>3</sup> (PSD, 2006a), <sup>4</sup> (Comeau, 2006), <sup>5</sup> (OSU, 2005), <sup>6</sup> (USEPA, 2006b), <sup>7</sup> (Dunn, 2004), <sup>8</sup> (US National Library of Medicine, 2005), <sup>9</sup> (USEPA, 2006c)

## Appendix A: Raw Data and References

The following tables contain the raw data collected to perform the pesticide risk ranking of the Annapolis River watershed. The following abbreviations symbolize those sources from which the data was retrieved.

- CALC:** Calculated Log BCF from the estimated Log  $K_{ow}$  based on the equation:  
 $\log BCF = 0.91 * \log K_{ow} - 1.975 * \log(6.8e-07 * K_{ow} + 1.0) - 0.786$  (Bintein, 1993).
- CECP:** United States Environmental Protection Agency (USEPA). 2004. Chemicals Evaluated for Carcinogenic Potential. <[http://npic.orst.edu/chemicals\\_evaluated\\_July2004.pdf](http://npic.orst.edu/chemicals_evaluated_July2004.pdf)>, Accessed April 2006.
- CHEM:** United States National Library of Medicine: National Institute of Health. 2006. Environmental Health and Toxicology Specialized Information Systems: ChemIDplus Lite Database. <<http://sis.nlm.nih.gov/enviro/databasetable.html>>, Accessed April 2006.
- CICAD:** International Programme on Chemical Safety. 1999. Concise International Chemical Assessment Document. United Nations Environment Programme, the International Labour Organization and the World Health Organization, Geneva. <<http://www.inchem.org/pages/cicads.html>>, Accessed April 2006.
- DUNN:** Dunn, Allison M. 2004. A Relative Risk Ranking of Pesticides Used in Prince Edward Island. Environment Canada, Environmental Protection Branch, Atlantic Region. EPS-5-AR-04-03, March.
- ECOTOX:** United States Environmental Protection Agency (USEPA). 2003. ECOTOXicology Database System. <<http://www.epa.gov/ecotox/>>, Accessed March 2006.
- ETN:** Extension Toxicology Network. 1996. Pesticide Information Profiles. <<http://extoxnet.orst.edu/pips/ghindex.html>>, Accessed April 2006.
- FAO:** Food and Agriculture Organization and the World Health Organization. 2002. Pesticide Residues in Food — 2001: Evaluations — 2001: Part 1: Residues. Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group, Geneva, September 2001.
- HPTP:** Kreiger, Robert Ed. 2001. Handbook of Pesticide Toxicology Principles: 2<sup>nd</sup> Edition — Volumes 1 and 2. New York: Academic Press.
- HSDB:** United States National Library of Medicine. 2004. Hazardous Substances Data Bank (HSDB). <<http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB>>, Accessed March 2006.
- IARC:** International Agency for Research on Cancer (IARC). 2006. Agents Reviewed on the IARC Monographs: Volumes 1 to 88. <<http://www-cie.iarc.fr/monoeval/Listagentsalphaorder.pdf>>, Accessed March 2006.
- IGCDS:** Dikshith, T.S.S. and Prakash V. Diwan. 2003. Industrial Guide to Chemical and Drug Safety. Canada: John Wiley and Sons.

- IH:** Mackay, D. and W. Shui. 2000. Illustrated Handbook of Physical-Chemical Properties and Environmental Fate of Organic Chemicals. Boca Raton, Florida: Lewis Publishers.
- IRIS:** United States National Library of Medicine. 2004. Integrated Risk Information System (IRIS). <<http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?irisb.htm>>, Accessed March 2006.
- JMPR:** Joint Meeting of the FAO Committee on Pesticides in Agriculture and the WHO Expert Committee on Pesticide Residues. 1996. Monographs and Evaluations. <<http://www.inchem.org/pages/jmpr.html>>, Accessed April 2006.
- NPIC:** National Pesticide Information Center. 2002. Pesticide Fact Sheets. <<http://npic.orst.edu/npicfact.htm>>, Accessed April 2006.
- OSU:** Vogue, P.A., E.A. Kerle and J.J. Jenkins. 1994. OSU Extension Pesticide Properties Database. <<http://npic.orst.edu/ppdmove.htm>>, Accessed April 2006.
- PAN:** Pesticide Action Network. 2006. PAN Pesticides Database. <<http://www.pesticideinfo.org/Index.html>>, Accessed April 2006.
- PC:** Environment Canada. 2004. A Compendium of Information on Pesticides Used in Atlantic Canada. Environmental Protection Branch, Atlantic Region.
- PIP:** Extoxnet. 1995. Pesticide Information Profiles. <<http://pmep.cce.cornell.edu/profiles/extoxnet>>, Accessed April 2006.
- PM:** Tomlin, C.D.S. Ed. 2000. A World Compendium: The Pesticide Manual, 12<sup>th</sup> Edition. United Kingdom: The British Crop Protection Council.
- PMRA:** Canadian Pest Management Regulatory Agency
- PP:** Kamrin, Michael A. 1997. Pesticide Profiles: Toxicity, Environmental Impact and Fate. United States: CRC Press, LLC.
- PPD:** United States Department of Agriculture. 2003. The ARS Pesticide Properties Database. <<http://www.ars.usda.gov/services/docs.htm?docid=6433>>, Accessed March 2006.
- SRC:** Syracuse Research Corporation. 2004. Interactive Log  $K_{ow}$  ( $K_{ow}$  Win) Demo. <<http://www.syrres.com/esc/kowdemo.htm>>, Accessed April 2006.
- USEPA:** United States Environmental Protection Agency
- WHO:** The World Health Organization. 2004. The WHO Recommended Classification of Pesticides by Hazards. <[http://www.who.int/ipcs/publications//pesticides\\_hazard\\_rev\\_3.pdf](http://www.who.int/ipcs/publications//pesticides_hazard_rev_3.pdf)>, Accessed April 2006.

Rat Oral LD<sub>50</sub>

Active Ingredient	Geometric Mean LD <sub>50</sub> (mg/kg)	LD <sub>50</sub> Range	N	Reference
2,4-D	558	400 – 764	6	1) JMPR 2) PM 3) PC
Atrazine	2403	1869 – 3090	2	1) PM
Azinphos-Methyl	11	4.4 – 25.4	19	1) JMPR 2) USEPA. 1999. Human Health Risk Assessment: Azinphos-Methyl. Health Effects Division (HED), Office of Pesticide Programs. May.
Azoxystrobin	5000		1	1) PM 2) WHO 3) HSDB
Bromoxynil	237	81 – 779	8	1) PC 2) PM 3) USEPA. 1998. Reregistration Eligibility Decision (RED): Bromoxynil. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-013, December. 4) HSDB
Calcium Hypochlorite	850		1	1) HSDB 2) CHEM
Captan	10911	8400 – 15000	4	1) PC 2) PM 3) USEPA. 1999. Reregistration Eligibility Document (RED): Captan. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-015, November. 4) HSDB
Carbaryl	400	225 – 850	7	1) PM 2) PC 3) USEPA. 2002. Updated Toxicology Disciplinary Chapter for the Reregistration Eligibility Decision (RED): Carbaryl. Prevention, Pesticides and Toxic Substances. PC Code 056801, May.
Carbofuran	10	5 – 13.8	9	1) JMPR 2) PM 3) PC
Chlorine	1200		1	1) HPTP
Chlorothalonil	5000		1	1) PM 2) USEPA. 1999. Reregistration Eligibility Decision (RED): Chlorothalonil. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-004, April.
Chlorpyrifos	143	82 – 223	5	1) PC 2) USEPA. 2000. Toxicology Chapter for Chlorpyrifos. Prevention, Pesticides and Toxic Substances. PC Code 059101, Case No 818975, April. 3) PM 4) HSDB
Clopyralid	3829	2675 – 5000	4	1) PM 2) HSDB

Cymoxanil	1080	960 – 1196	3	1) PM 2) WHO 3) HSDB
Cypermethrin	648	160 – 4150	8	1) The International Programme on Chemical Safety. Environmental Health Criteria 82: Cypermethrin. < <a href="http://www.inchem.org/documents/ehc/ehc/ehc82.htm">http://www.inchem.org/documents/ehc/ehc/ehc82.htm</a> > , Accessed March 2006. 2) PC 3) PM 4) USEPA. 2003. Cypermethrin: Toxicology Disciplinary Chapter for the Reregistration Eligibility Decision Document. Prevention, Pesticides and Toxic Substances. PC Code 109702, Case No 819433, November. 5) HSDB
Dazomet	512	520 – 650	4	1) PC 2) PM 3) HSDB
Diazinon	317	66 – 1340	12	1) The International Programme on Chemical Safety. Environmental Health Criteria 198: Diazinon. < <a href="http://www.inchem.org/documents/ehc/ehc/ehc198.htm">http://www.inchem.org/documents/ehc/ehc/ehc198.htm</a> > , Accessed March 2006. 2) PC 3) USEPA. 2000. Diazinon: Toxicology Chapter for the RED as Revised 3/30/00 in Response to the Novartis Crop Protection, Inc. Responses Submitted February 9, 2000 to the RED. Prevention, Pesticides and Toxic Substances. PC No 057801, Case No 333-41-5, March. 4) PM 5) HSDB
Dicamba	1495	757 – 2740	4	1) PC 2) USEPA. 2005. Dicamba: HED Chapter of the Reregistration Eligibility Decision Document. Prevention, Pesticides and Toxic Substances. EPA-HQ-OPP-2005-0479-0002, September. 3) PM 4) HSDB
Dichlobenil	2729	1014 – 4460	6	1) PC 2) PM 3) USEPA. 1998. Reregistration Eligibility Decision (RED): Dichlobenil. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-003, October. 4) HSDB
Dimethoate	364	180 – 600	6	1) PM 2) PC 3) JMPR 4) USEPA. 1999. The Updated, Revised Health Effects Division (HED) Chapter of the Reregistration Eligibility Decision (RED): Dimethoate. Prevention, Pesticides and Toxic Substances. PC Code 035001, Case No. 0088, December.
Dinocap	1034	950 – 1190	3	1) PC 2) PM 3) HSDB

Diphenylamine	1130	300 – 2720	4	1) PM 2) USEPA. 1998. Reregistration Eligibility Decision (RED): Diphenylamine. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-010, April. 3) HSDB
Diquat Dibromide	360	214 – 810	5	1) JMPR 2) PM 3) USEPA. 2001. Tolerance Reassessment Eligibility Decision (TRED) Document: Diquat Dibromide. Prevention, Pesticides and Toxic Substances. PC Code 032201, December.
Dodine	1132	566 – 1931	5	1) PM 2) USEPA. 2005. Reregistration Eligibility Decision (RED): Dodine. Prevention, Pesticides and Toxic Substances. EPA 738-R-05-013, September. 3) HSDB
Endosulfan	43	9.6 – 110	12	1) JMPR 2) PM 3) USEPA. 2002. Reregistration Eligibility Decision (RED): Endosulfan. Prevention, Pesticides and Toxic Substances. EPA 738-R-02-013, November.
EPTC	1630	916 – 2550	7	1) PC 2) PM 3) USEPA. 1999. Reregistration Eligibility Decision (RED): EPTC. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-006, December. 4) HSDB
Fenbuconazole	2000		1	1) WHO 2) JMPR 3) PM
Fluazifop-p-Butyl	3003	2451 – 3680	2	1) PM
Folpet	14211	7540 – 43800	5	1) PC 2) PM 3) USEPA. 1999. Reregistration Eligibility Decision (RED): Folpet. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-011, November. 4) HSDB
Fosetyl Aluminum	3971	2000 – 5800	3	1) PM 2) PC 3) HSDB 4) USEPA. 1990. Reregistration Eligibility Document (RED): Aluminum Tris (q-ethylphosphonate) (referred to as Fosetyl-Al). Office of Pesticide Programs Special Reviews and Reregistration Division, December.
Glufosinate Ammonium	1800	1620 – 2000	2	1) PM 2) HSDB
Glyphosate	5600		1	1) PM
Hexazinone	1424	1200 – 1690	2	1) PM 2) USEPA. 1994. Reregistration Eligibility Decision (RED): Hexazinone. Prevention, Pesticides and Toxic Substances. EPA 738-R-94-022, September.

Imidacloprid	449	424 – 475	3	1) PC
Iprodione	3150	2000 – 4468	3	1) PC 2) PM 3) USEPA. 1998. Reregistration Eligibility Decision (RED): Iprodione. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-019, November. 4) HSDB
Isoxaflutole	5000		1	1) PM 2) HSDB 3) PMRA. 2005. Proposed Regulatory Decision Document. Alternative Strategies and Regulatory Affairs Division. PRDD2005-03, September.
Linuron	2499	1500 – 4000	3	1) PM 2) USEPA. 1995. Reregistration Eligibility Decision (RED): Linuron. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-003, March.
Malathion	1907	290 – 5700	6	1) PC 2) USEPA. 2005. Malathion: Updated Revised Human Health Risk Assessment for the Reregistration Eligibility Decision Document (RED). Prevention, Pesticides and Toxic Substances. PC Code 057701, Case No 0248, September. 3) PM 4) HSDB
Mancozeb	6324	5000 – 8000	2	1) USEPA. 2003. Environmental Fate and Ecological Risk Assessment for Mancozeb. Prevention, Pesticides and Toxic Substances. EPA-HQ-OPP-2005-0176, June. 2) PM 3) HSDB
MCPA	901	700 – 1160	2	1) PM
Mecoprop	1047	930 – 1166	3	1) PC 2) PM 3) HSDB
Methamidophos	17	13 – 21	5	1) JMPR 2) PM 3) USEPA. 1998. EFED Risk Assessment for the Reregistration Eligibility Decision (RED) Document: Methamidophos. Prevention, Pesticides and Toxic Substances. PC Code 101201, Case No. 0043, January.
Methomyl	28	17 – 45	5	1) The International Programme on Chemical Safety. Environmental Health Criteria 178: Methomyl. < <a href="http://www.inchem.org/documents/ehc/ehc/ehc178.htm">http://www.inchem.org/documents/ehc/ehc/ehc178.htm</a> > , Accessed March 2006. 2) PC 3) PM 4) HSDB
Metiram	8518	6500 – 10000	4	1) JMPR

Metolachlor	2577	2200 – 2800	3	1) PC 2) PM 3) USEPA. 1995. Reregistration Eligibility Decision (RED): Metolachlor. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-006, April. 4) HSDB
Metribuzin	1827	1100 – 2300	4	1) PM 2) PC 3) USEPA. 1998. Reregistration Eligibility Decision (RED): Metribuzin. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-006, February.
Mineral Oil	No Information			Default Value (HV <sub>OR</sub> = 2.5)
Myclobutanil	1914	1600 – 2290	2	1) PM 2) HSDB
Naled	311	250 – 430	3	1) PM 2) HSDB
Napropamide	4837	4680 – 5000	2	1) PC 2) PM 3) USEPA. 2005. Reregistration Eligibility Decision (RED): Napropamide. Prevention, Pesticides and Toxic Substances. Case No 2450, September. 4) HSDB
Paraquat	171	100 – 344	9	1) JMPR 2) PM 3) USEPA. 1997. Reregistration Eligibility Decision (RED): Paraquat Dichloride. Prevention, Pesticides and Toxic Substances. EPA 738-F-96-018, August.
Permethrin	1404	430 – 4000	8	1) PC 2) PM 3) USEPA. 2005. Permethrin: HED Chapter of the Reregistration Eligibility Decision Document (RED). Prevention, Pesticides and Toxic Substances. PC Code 109701, Case No 52645-53-1, July. 4) HSDB
Phorate	1.79	1.1 – 3.7	5	1) PC 2) USEPA. 1998. Phorate: The HED Chapter on the Reregistration Eligibility Decision Document (RED). Prevention, Pesticides and Toxic Substances. PC Code 057201, Case No 0103, April. 3) PM 4) HSDB
Phosalone	142	120 – 170	2	1) PC 2) PM 3) HSDB
Phosmet	151	93 – 310	7	1) JMPR 2) PM
Picloram	2690	686 – 8200	6	1) PC 2) PM 3) USEPA. 1995. Reregistration Eligibility Decision (RED): Picloram. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-019, August. 4) HSDB

Piperonyl Butoxide	10520	7500 – 115000	3	1) PM 2) JMPR 3) HSDB
Pirimicarb	133	68 – 221	4	1) PC 2) PM 3) HSDB
Prometryn	2712	1802 – 5233	5	1) PM 2) PC 3) USEPA. 1996. Reregistration Eligibility Decision (RED): Prometryn. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-033, February. 4) HSDB
Propiconazole	1601	1211 – 2233	3	1) JMPR 2) PM
Pyridaben	945	570 – 1350	3	1) PM 2) HSDB
Quintozene	5503	1650 – 30000	5	1) The International Programme on Chemical Safety. Environmental Health Criteria 41: Quintozene. < <a href="http://www.inchem.org/documents/ehc/ehc/ehc41.htm">http://www.inchem.org/documents/ehc/ehc/ehc41.htm</a> > , Accessed March 2006. 2) PM 3) HSDB 4) PC
Simazine	6656	500 – 34000	5	1) PC 2) PM 3) USEPA. 2005. Interim Reregistration Eligibility Decision: Environmental Fate and Ecological Risk Assessment for Simazine. Environmental Fate and Effects Division. May. 4) HSDB
Terbacil	3271	934 – 7500	3	1) PC 2) PM 3) USEPA. 1998. Reregistration Eligibility Decision (RED): Terbacil. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-011, January. 4) HSDB
Thiophanate-Methyl	6640		1	1) JMPR 2) PM
Thiram	2654	1800 – 4000	5	1) JMPR 2) PM
Triazine	3779	2700 – 5000	3	1) HSDB 2) JMPR
Tributyltin Oxide	151	94 – 234	4	1) The International Programme on Chemical Safety. Environmental Health Criteria 116: Tributyltin Compounds. < <a href="http://www.inchem.org/documents/ehc/ehc/ehc116.htm">http://www.inchem.org/documents/ehc/ehc/ehc116.htm</a> > , Accessed March 2006. 2) HSDB

Triclopyr	654	577 – 729	4	1) PC 2) PM 3) USEPA. 1998. Reregistration Eligibility Decision (RED): Triclopyr. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-011, October. 4) HSDB
Trifluralin	4586	1930 – 10000	3	1) PC 2) PM 3) USEPA. 1996. Reregistration Eligibility Decision (RED): Trifluralin. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-040, April. 4) HSDB
Triforine	16000		1	1) PC 2) PM 3) HSDB

Rat 4-hour Inhalation LC<sub>50</sub>

Active Ingredient	Geometric Mean LC <sub>50</sub> (mg/L)	LC <sub>50</sub> Range	N	Reference
2,4-D	1.8		1	1) PM 2) JMPR
Atrazine	5.8		1	1) PM 2) USEPA. 2001. Revised Toxicology Chapter of the Reregistration Eligibility Decision (RED): Atrazine. Prevention, Pesticides and Toxic Substances. January.
Azinphos-Methyl	0.2	0.13 – 0.21	3	1) JMPR 2) USEPA. 1999. Human Health Risk Assessment: Azinphos-Methyl. Health Effects Division (HED), Office of Pesticide Programs. May.
Azoxystrobin	819	698 – 962	2	1) PIP
Bromoxynil	0.4	0.15 – 0.81	5	1) PM 2) USEPA. 1998. Reregistration Eligibility Decision (RED): Bromoxynil. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-013, December.
Calcium Hypochlorite	4.43 (estimated)		1	1) Green Seal Inc. 2005. Green Seal Environmental Standard for General-Purpose, Bathroom, Glass and Carpet Cleaners Used for Industrial and Institutional Purposes. March 16.
Captan	0.9	0.72 – 1.21	5	1) NPIC 2) HPTP
Carbaryl	3.4		1	1) USEPA. 2002. Updated Toxicology Disciplinary Chapter for the Reregistration Eligibility Decision (RED): Carbaryl. Prevention, Pesticides and Toxic Substances. PC Code 056801, May.
Carbofuran	0.1		1	1) PM 2) JMPR
Chlorine	293		1	1) CHEM
Chlorothalonil	0.1		1	1) USEPA. 1999. Reregistration Eligibility Decision (RED): Chlorothalonil. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-004, April.

Chlorpyrifos	0.2		1	1) PM 2) ETN 3) HSDB
Clopyralid	0.4		1	1) PM
Cymoxanil	5.1		1	1) PM 2) ETN 3) USEPA. 1998. Pesticide Fact Sheet: Cymoxanil. Prevention, Pesticides and Toxic Substances. < <a href="http://www.epa.gov/opprd001/factsheets/cymoxanil.pdf">http://www.epa.gov/opprd001/factsheets/cymoxanil.pdf</a> > , Accessed April 2006.
Cypermethrin	4.4	2.5 – 7.889	2	1) PM 2) HSDB 3) CHEM
Dazomet	8.4		1	1) PM 2) HSDB 3) CHEM
Diazinon	2.9	2.33 – 3.5	2	1) USEPA. 2000. Diazinon: Toxicology Chapter for the RED as Revised 3/30/00 in Response to the Novartis Crop Protection, Inc. Responses submitted February 9, 2000 to the RED. Prevention, Pesticides and Toxic Substances. PC No 057801, Case No 333-41-5, March. 2) ETN 3) PM
Dicamba	43.8	9.6 – 200	2	1) PM 2) IGCDs 3) PP
Dichlobenil	0.9	0.25 – 3.3	2	1) PM 2) USEPA. 1998. Reregistration Eligibility Decision (RED): Dichlobenil. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-003, October.
Dimethoate	2.0		1	1) USEPA. 1999. The Updated, Revised HED Chapter of the Reregistration Eligibility Decision (RED): Dimethoate. Prevention, Pesticides and Toxic Substances. PC Code 035001, Case No 0088, December.
Dinocap	0.4		1	1) ETN 2) PM 3) PP
Diphenylamine	1.5		1	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Diphenylamine. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-010, April.
Diquat Dibromide	0.3	0.121 – 1.09	4	1) JMPR 2) USEPA. 2001. Tolerance Reassessment Eligibility Decision (TRED) Document: Diquat Dibromide. Prevention, Pesticides and Toxic Substances. PC Code 032201, December.
Dodine	1.1		1	1) USEPA. 2005. Reregistration Eligibility Decision (RED): Dodine. Prevention, Pesticides and Toxic Substances. EPA 738-R-05-013, September.
Endosulfan	0.1	0.0126 – 0.5	4	1) PM 2) USEPA. 2002. Reregistration Eligibility Decision (RED): Endosulfan. Prevention, Pesticides and Toxic Substances. EPA 738-R-02-013, November.

EPTC	2.8	1.39 – 4.3	3	1) PM 2) USEPA. 1999. Reregistration Eligibility Decision (RED): EPTC. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-006, December.
Fenbuconazole	2.1		1	1) PM 2) CHEM
Fluazifop-p-Butyl	5.2		1	1) PM
Folpet	3.1	1.89 – 5.0	2	1) PM 2) HSDB 3) HPTP 4) IGCDS
Fosetyl Aluminum	1.7		1	1) PM 2) USEPA. 1990. Reregistration Eligibility Decision (RED): Aluminum Tris (q-ethylphosphonate) (referred to as Fosetyl-Al). Prevention, Pesticides and Toxic Substances. List A, December.
Glufosinate Ammonium	1.3	0.62 – 2.60	3	1) PM 2) HSDB
Glyphosate	4.9		1	1) PM
Hexazinone	3.9		1	1) USEPA. 1994. Reregistration Eligibility Decision (RED): Hexazinone. Prevention, Pesticides and Toxic Substances. EPA 738-R-94-022, September.
Imidacloprid	0.1		1	1) JMPR 2) PM
Iprodione	5.2		1	1) PM 2) USEPA. 1998. Reregistration Eligibility Decision (RED): Iprodione. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-019, November. 3) HSDB
Isoxaflutole	5.2		1	1) PM 2) HSDB 3) PMRA. 2001. Proposed Regulatory Decision Document: Isoxaflutole. Submission Management and Information Division. PRDD2001-03, July.
Linuron	6.2		1	1) PM
Malathion	43.8		1	1) HSDB 2) CHEM
Mancozeb	5.1		1	1) PM
MCPA	6.4		1	1) PM
Mecoprop	12.5		1	1) ETN 2) PM
Methamidophos	0.1	0.0632 – 0.2	3	1) PM 2) JMPR
Methomyl	0.3	0.258 – 0.45	4	1) The International Programme on Chemical Safety. Environmental Health Criteria 178: Methomyl. < <a href="http://www.inchem.org/documents/ehc/ehc/ehc178.htm">http://www.inchem.org/documents/ehc/ehc/ehc178.htm</a> > , Accessed March 2006. 2) PM 3) HSDB
Metiram	5.7		1	1) JMPR 2) PM

Metolachlor	2.7	1.75 – 4.3	2	1) PC 2) ETN 3) PM
Metribuzin	0.6		1	1) PM 2) USEPA. 1998. Reregistration Eligibility Decision (RED): Metribuzin. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-006, February.
Mineral Oil	3.9		1	1) CHEM
Myclobutanil	5.0		1	1) CHEM
Naled	7.7		1	1) PIP
Napropamide	1.0	0.2 – 5.0	2	1) ETN 2) PM 3) IGCDs
Paraquat	0.5	0.001 – 10.0	4	1) JMPR 2) USEPA. 1997. Reregistration Eligibility Decision (RED): Paraquat Dichloride. Prevention, Pesticides and Toxic Substances. EPA 738-F-96-018, August.
Permethrin	7.2	0.685 – 23.5	3	1) ETN 2) IGCDs 3) PM
Phorate	0.03	0.011 – 0.06	2	1) USEPA. 2001. Interim Reregistration Eligibility Decision for Phorate. Prevention, Pesticides and Toxic Substances. Case 0103, March. 2) PM
Phosalone	0.7		1	1) PM
Phosmet	1.1		1	1) PM
Picloram	0.1	0.035 – 0.35	2	1) ETN 2) IGCDs 3) PM
Piperonyl Butoxide	5.9		1	1) HPTP 2) PM
Pirimicarb	0.5	0.3 – 0.86	2	1) PM 2) IGCDs
Prometryn	5.1	4.96 – 5.2	3	1) PM 2) ETN 3) USEPA. 1996. Reregistration Eligibility Decision (RED): Prometryn. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-033, February.
Propiconazole	5.8		1	1) PM
Pyridaben	0.6	0.62 – 0.66	2	1) PM 2) CHEM
Quintozene	2.5	1.4 – 6.49	3	1) ETN 2) PM 3) CHEM
Simazine	3.8	2.0 – 5.5	3	1) ETN 2) PM 3) IGCDs

Terbacil	4.4		1	1) PM 2) USEPA. 1998. Reregistration Eligibility Decision (RED): Terbacil. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-011, January.
Thiophanate-Methyl	1.7		1	1) PM 2) JMPR 3) USEPA. 2001. Revised Toxicology Chapter for Reregistration Eligibility Decision (RED): Thiophanate-Methyl. Prevention, Pesticides and Toxic Substances. Case No 2680, March.
Thiram	4.4		1	1) PM
Triazine	0.4	0.228 – 0.906	3	1) HSDB 2) HPTP 3) CHEM
Tributyltin Oxide	0.1	0.064 – 0.077	2	1) The International Programme on Chemical Safety. Environmental Health Criteria 116: Tributyltin Compounds. < <a href="http://www.inchem.org/documents/ehc/ehc/ehc116.htm">http://www.inchem.org/documents/ehc/ehc/ehc116.htm</a> > , Accessed March 2006. 2) CHEM 3) CICAD
Triclopyr	25.8	2.6 – 256	2	1) PM 2) HSDB 3) USEPA. 1998. Reregistration Eligibility Decision (RED): Triclopyr. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-011, October.
Trifluralin	3.9	2.8 – 4.8	3	1) PM 2) USEPA. 1996. Reregistration Eligibility Decision (RED): Trifluralin. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-040, April. 3) PP
Triforine	4.5		1	1) PM 2) PC 3) CHEM

### Carcinogenicity Rating

Active Ingredient	Carcinogenicity Rating	Reference
2,4-D	D	1) DUNN
Atrazine	3	1) IARC 2) USEPA. 2001. Revised Toxicology Chapter of the Reregistration Eligibility Decision (RED): Atrazine. Prevention, Pesticides and Toxic Substances. January.
Azinphos-Methyl	E	1) JMPR 2) USEPA. 1999. Human Health Risk Assessment: Azinphos-Methyl. Health Effects Division (HED), Office of Pesticide Programs. May.
Azoxystrobin	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Bromoxynil	C	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Bromoxynil. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-013, December.
Calcium Hypochlorite	3	1) HSDB
Captan	B2	1) USEPA. 1999. Reregistration Eligibility Decision (RED): Captan. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-015, November.

Carbaryl	B2	1) JMPR 2) USEPA. 2002. Updated Toxicology Disciplinary Chapter for the Reregistration Eligibility Decision (RED): Carbaryl. Prevention, Pesticides and Toxic Substances. PC Code 056801, May.
Carbofuran	D	1) JMPR
Chlorine	D	1) USEPA. 1999. Reregistration Eligibility Decision (RED): Chlorine Gas. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-001, February.
Chlorothalonil	B2	1) JMPR 2) IARC 3) USEPA. 1999. Reregistration Eligibility Decision (RED): Chlorothalonil. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-004. April.
Chlorpyrifos	E	1) NPIC
Clopyralid	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Cymoxanil	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Cypermethrin	C	1) USEPA. 2005. Cypermethrin/zeta-Cypermethrin: Phase 2 Acute (Probabilistic) and Chronic Dietary Exposure Assessments for the Reregistration Eligibility Decision. Prevention, Pesticides and Toxic Substances. PC Code 109702 and 129064, November.
Dazomet	D	1) USEPA. 2005. Overview of the Preliminary Dazomet Risk Assessment. EPA-HQ-OPP-2005-0128, July.
Diazinon	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Dicamba	D	1) NPIC
Dichlobenil	C	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Dichlobenil. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-003, October.
Dimethoate	C	1) JMPR 2) USEPA. 1999. The Updated, Revised Health Effects Division (HED) Chapter of the Reregistration Eligibility Decision (RED): Dimethoate. Prevention, Pesticides and Toxic Substances. PC Code 035001, Case No 0088, December.
Dinocap	E	1) USEPA. 2003. Reregistration Eligibility Decision (RED): Dinocap. Prevention, Pesticides and Toxic Substances. EPA 738-R-03-002, May.
Diphenylamine	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Diquat Dibromide	E	1) USEPA. 1995. Reregistration Eligibility Decision (RED): Diquat Dibromide. Prevention, Pesticides and Toxic Substances. EPA-R-95-016. July. 2) JMPR 1993
Dodine	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Endosulfan	D	1) JMPR
EPTC	E	1) USEPA. 1999. Reregistration Eligibility Decision (RED): EPTC. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-006, December.
Fenbuconazole	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Fluazifop-p-Butyl	D	1) USEPA. 2000. Cancer Assessment Document: Evaluation of the Carcinogenic Potential of Diclofop-Methyl. Cancer Assessment Review Committee, Health Effects Division (HED), Office of Pesticide Programs. PC Code 110902, May.
Folpet	B2	1) USEPA. 1999. Reregistration Eligibility Decision (RED): Folpet. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-011, November. 2) HSDB 3) IRIS

Fosetyl Aluminum	C	1) USEPA. 1990. Reregistration Eligibility Document: Aluminum Tris (q-ethylphosphonate) (referred to as Fosetyl-Al). Office of Pesticide Programs Special Reviews and Registration Division, December. 2) HSDB 3) IRIS
Glufosinate Ammonium	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Glyphosate	E	1) USEPA. 1993. Reregistration Eligibility Decision (RED): Glyphosate. Prevention, Pesticides and Toxic Substances. EPA 738-R-93-014, September.
Hexazinone	D	1) USEPA. 1994. Reregistration Eligibility Decision (RED): Hexazinone. Prevention, Pesticides and Toxic Substances. EPA 738-R-94-022, September.
Imidacloprid	D	1) JMPR
Iprodione	B2	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Iprodione. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-019, November.
Isoxaflutole	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Linuron	C	1) IRIS 2) USEPA. 1995. Reregistration Eligibility Decision (RED): Linuron. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-003, March.
Malathion	3	1) HSDB 2) IARC
Mancozeb	B2	1) USEPA. 2005. Reregistration Eligibility Decision (RED): Mancozeb. Prevention, Pesticides and Toxic Substances. EPA 738-R-04-012, September.
MCPA	D	1) DUNN
Mecoprop	2B	1) HSDB
Methamidophos	D	1) JMPR
Methomyl	E	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Methomyl. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-021, December.
Metiram	B2	1) JMPR 2) USEPA. 1996. Reregistration Eligibility Decision (RED): Nabam. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-035, January.
Metolachlor	C	1) USEPA. 1995. Reregistration Eligibility Decision (RED): Metolachlor. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-006, April. 2) HSDB 3) IRIS
Metribuzin	D	1) IRIS 2) USEPA. 1998. Reregistration Eligibility Decision (RED): Metribuzin. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-006, February.
Mineral Oil	3	1) IARC
Myclobutanil	E	1) CECF
Naled	E	1) USEPA. 2002. Interim Reregistration Eligibility Decision for Naled. Prevention, Pesticides and Toxic Substances. EPA 738-R-02-008, January.
Napropamide	E	1) USEPA. 2005. Reregistration Eligibility Decision (RED): Napropamide. Prevention, Pesticides and Toxic Substances. Case No 2450, September.
Paraquat	E	1) USEPA. 1997. Reregistration Eligibility Decision (RED): Paraquat Dichloride. Prevention, Pesticides and Toxic Substances. EPA 738-F-96-018, August.
Permethrin	3	1) HSDB 2) IARC

Phorate	E	1) CECP
Phosalone	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Phosmet	C	1) USEPA. 1998. Toxicology Chapter for the Reregistration Eligibility Decision (RED): Phosmet. Prevention, Pesticides and Toxic Substances. PC Code 059201, January.
Picloram	3	1) HSDB 2) IARC
Piperonyl Butoxide	3	1) HSDB 2) IARC
Pirimicarb	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Prometryn	E	1) CECP
Propiconazole	C	1) JMPR
Pyridaben	E	1) CECP
Quintozene	3	1) HSDB 2) IARC
Simazine	3	1) HSDB 2) IARC
Terbacil	E	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Terbacil. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-011, January.
Thiophanate-Methyl	C	1) JMPR 2) USEPA. 2001. Revised Toxicology Chapter for Reregistration Eligibility Decision (RED): Thiophanate-Methyl. Prevention, Pesticides and Toxic Substances. Case No 2680, March.
Thiram	3	1) IARC 2) JMPR
Triazine	No Information	Default Value ( $HV_{CAR} = 1.5$ )
Tributyltin Oxide	D	1) HSDB 2) IRIS
Triclopyr	D	1) NPIC
Trifluralin	C	1) USEPA. 1996. Reregistration Eligibility Decision (RED): Trifluralin. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-040, April. 2) HSDB 3) IRIS
Triforine	No Information	Default Value ( $HV_{CAR} = 1.5$ )

### No Observed Adverse Effect Level (NOAEL)

Active Ingredient	NOAEL (mg/kgbw/d)	Supporting Study	Additional Uncertainly Factor Applied to NOAEL	Justification	Reference
2,4-D	1	1-year Dog/2-year Rat			1) JMPR
Atrazine	1.8	6-month Luteinizing Hormone Surge	10	Increased Sensitivity of Young	1) USEPA. 2001. Revised Toxicology Chapter of the Reregistration Eligibility Decision. Atrazine (RED): Atrazine. Prevention, Pesticides and Toxic Substances. January.

Azinphos-Methyl	0.15	1-year Dog			1) USEPA. 1999. Human Health Risk Assessment: Azinphos-Methyl. Health Effects Division (HED), Office of Pesticide Programs. May.
Azoxystrobin	18	Unidentified Study			1) PM
Bromoxynil	1.5	1-year Dog			1) HPTP
Calcium Hypochlorite	No Information				Default Value ( $HV_{NCR} = 2.5$ )
Captan	10	Prenatal Developmental Toxicity Study in Rabbits			1) USEPA. 1999. Reregistration Eligibility Decision (RED): Captan. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-015, November.
Carbaryl	3.1	1-year Dog	3	LOAEL to NOAEL Extrapolation	1) USEPA. 2002. Toxicology Disciplinary Chapter for the Reregistration Eligibility Decision (RED): Carbaryl. Prevention, Pesticides and Toxic Substances. PC Code 056801, May.
Carbofuran	0.22	4-week Dog			1) JMPR
Chlorine	14.4	2-year Rat			1) USEPA. 1999. Reregistration Eligibility Decision (RED): Chlorine Gas. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-001, February.
Chlorothalonil	2	2-year Rat			1) USEPA. 1999. Reregistration Eligibility Decision (RED): Chlorothalonil. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-004, April.
Chlorpyrifos	1	2-year Rat			1) PM
Clopyralid	15	2-year Rat			1) PM
Cymoxanil	4.1	2-year Rat			1) PM
Cypermethrin	10	Acute Mammalian Neurotoxicity	10	Less Than Chronic Study	1) USEPA. 2005. Cypermethrin/zeta-Cypermethrin: Phase 2 Acute (Probalistic) and Chronic Dietary Exposure Assessments for the Reregistration Eligibility Decision. Prevention, Pesticides and Toxic Substances. PC Code 109702 and 1290644, November.
Dazomet	1.5	Subchronic Toxicity in Rats	10	Less Than Chronic Study	1) USEPA. 2005. Overview of the Preliminary Dazomet Risk Assessment. EPA-HQ-OPP-2005-0128, July.
Diazinon	0.02	2-year Rat			1) USEPA. 2004. Interim Reregistration Eligibility Decision (RED): Diazinon. Prevention, Pesticides and Toxic Substances. EPA 738-R-04-006, May.
Dicamba	45	2-generation Rat			1) USEPA. 2005. Dicamba: HED Chapter of the Reregistration Eligibility Decision Document. Prevention, Pesticides and Toxic Substances. EPA-HQ-OPP-2005-0479-0002, September.
Dichlobenil	50	2-year Rat			1) PM

Dimethoate	0.05	2-year Rat			1) USEPA. 1999. Dimethoate: The Updated, Revised HED Chapter of the Reregistration Eligibility Decision (RED): Dimethoate. Prevention, Pesticides and Toxic Substances. PC Code 035001, Case No. 0088, December.
Dinocap	7	2-year Rat			1) PM
Diphenylamine	7.5	90-day Rat	10	Less Than Chronic Study	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Diphenylamine. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-010, April.
Diquat Dibromide	0.19	2-year Rat			1) JMPR 2) IRIS
Dodine	2	Chronic Dog Toxicity			1) USEPA. 2005. Reregistration Eligibility Decision (RED): Dodine. Prevention, Pesticides and Toxic Substances. EPA 738-R-05-013, September.
Endosulfan	0.6	2-year Rat	10	Evidence for Increased Susceptibility of Young, Endocrine Disruption, Uncertainty Regarding Neuroendocrine Effects in the Young, need for a Developmental Neurotoxicity Study	1) USEPA. 2002. Reregistration Eligibility Decision (RED): Endosulfan. Prevention, Pesticides and Toxic Substances. EPA 738-R-02-013, November. 2) IRIS 3) JMPR
EPTC	2.5	2-generation Rat			1) USEPA. 1999. Reregistration Eligibility Decision (RED): EPTC. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-006, December.
Fenbuconazole	1.28	78-week Mouse			1) PMRA. 2005. Proposed Regulatory Decision Document. Alternative Strategies and Regulatory Affairs Division. PRDD2005-03, September.
Fluazifop-p-Butyl	1	2-year Rat			1) PM
Folpet	10	Rabbit Developmental Toxicity	3	3 For Food Quality Protection Act	1) USEPA. 1999. Reregistration Eligibility Decision (RED): Folpet. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-011, November.
Fosetyl Aluminum	5000	90-day Rat	10	Less Than Chronic Study	1) PM
Glufosinate Ammonium	2	2-year Rat			1) PM
Glyphosate	175	Developmental rabbit			1) USEPA. 1993. Reregistration Eligibility Decision (RED): Glyphosate. Prevention, Pesticides and Toxic Substances. EPA 738-R-93-014, September.
Hexazinone	5	1-year Dog			1) USEPA. 1994. Reregistration Eligibility Decision (RED): Hexazinone. Prevention, Pesticides and Toxic Substances. EPA 738-R-94-022, September.

Imidacloprid	5.7	2-year Rat			1) JMPR
Iprodione	18	1-year Dog			1) PM
Isoxaflutole	5	Rabbit Developmental Toxicity			1) PMRA. 2001. Proposed Regulatory Decision Document: Isoxaflutole. Alternative Strategies and Regulatory Affairs Division. PRDD2005-03, September.
Linuron	0.77	1-year Dog			1) USEPA. 1995. Reregistration Eligibility Decision (RED): Linuron. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-003, March.
Malathion	50	1-year Dog			1) NPIC
Mancozeb	4.83	Rat Toxicity			1) USEPA. 2005. Environmental Fate and Ecological Risk Assessment for Mancozeb. Prevention, Pesticides and Toxic Substances. EPA-HQ-OPP-2005-0176, June.
MCPA	0.15	1-year Dog	3	Lack of a Complete Data Base on Chronic Toxicity	1) IRIS
Mecoprop	1.1	2-year Rat			1) PM
Methamidophos	0.05	1-year Dog	10	No NOAEL Established	1) IRIS
Methomyl	3	2-year Dog			1) The International Programme on Chemical Safety. Environmental Health Criteria 178: Methomyl. < <a href="http://www.inchem.org/documents/ehc/ehc/ehc178.htm">http://www.inchem.org/documents/ehc/ehc/ehc178.htm</a> >, Accessed March 2006.
Metiram	2.5	1-year Dog			1) JMPR
Metolachlor	15	2-generation Rat			1) HPTP
Metribuzin	1.3	2-year Rat			1) USEPA. 1998. Reregistration Eligibility Decision (RED): Metribuzin. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-006, February.
Mineral Oil	No Information				Default Value ( $HV_{NCR} = 2.5$ )
Myclobutanil	100	90-day Rat	10	Less Than Chronic Study	1) PM
Naled	0.2	2-year Rat			1) PMRA. 2004. Proposed Regulatory Decision Document: Re-evaluation of Naled. Alternative Strategies and Regulatory Affairs Division. PACR2004-33, August.
Napropamide	30	2-year Rat			1) PM
Paraquat	0.45	1-year Dog			1) USEPA. 1997. Reregistration Eligibility Decision (RED): Paraquat Dichloride. Prevention, Pesticides and Toxic Substances. EPA 738-F-96-018, August. 2) IRIS 3) JMPR

Permethrin	25	Rat Acute Neurotoxicity	10	Less Than Chronic Study	1) USEPA. 2005. Overview of Permethrin Risk Assessment. EPA-HQ-OPP-2004-0385, August.
Phorate	0.05	Chronic Dog			1) USEPA. 2001. Interim Reregistration Eligibility Decision (RED): Phorate. Prevention, Pesticides and Toxic Substances. Case No 0103, March.
Phosalone	0.2	2-year Rat			1) USEPA. 2001. Report on FQPA Tolerance Reassessment Progress and Interim Risk Management Decision for Phosalone. Prevention, Pesticides and Toxic Substances. EPA 738-R-01-001, January.
Phosmet	1.1	2-year Rat	3	Incomplete Database, Lack of Acute and Subchronic Neurotoxicity Studies in Rats.	1) USEPA. 1998. Toxicology Chapter for the Reregistration Eligibility Decision (RED): Phosmet. Prevention, Pesticides and Toxic Substances. PC Code 059201, January.
Picloram	20	2-year Rat			1) PM
Piperonyl Butoxide	3	1-year Dog			1) NPIC
Pirimicarb	4.2	Rat-Unidentified Time			1) PM
Prometryn	1.5	21-month Mouse			1) PM
Propiconazole	3.6	1-year Dog/2-year Rat			1) JMPR
Pyridaben	0.5	52-week Dog			1) PM
Quintozene	0.75	Dog-Unidentified Time			1) The International Programme on Chemical Safety. Environmental Health Criteria 41: Quintozenne. < <a href="http://www.inchem.org/documents/ehc/ehc/ehc41.htm">http://www.inchem.org/documents/ehc/ehc/ehc41.htm</a> >, Accessed March 2006.
Simazine	0.52	2-year Rat			1) IRIS
Terbacil	250	2-year Rat			1) PM
Thiophanate-Methyl	8	1-year Dog			1) USEPA. 2001. Revised Anticipated Residues, Acute and Chronic Dietary Risk Assessments for Thiophanate-Methyl (TM) and its Metabolites Methyl 2-benzimidazole carbamate (MBC) and 2-Amine-1-H-benzimidazole (2-AB). Prevention, Pesticides and Toxic Substances. Chemical No 102001, March.
Thiram	1	2-year Rat/ 1-year Dog			1) JMPR
Triazine	0.2	2-year Rat			1) HPTP
Tributyltin Oxide	0.19	2-year Rat			1) IRIS
Tripropyr	3	2-year Rat			1) PM

Trifluralin	2.4	1-year Dog			1) USEPA. 1996. Reregistration Eligibility Decision (RED): Trifluralin. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-040, April.
Triforine	100	2-year Dog			1) PM

Rainbow Trout 96-hour LC<sub>50</sub>

Active Ingredient	Geometric Mean LC <sub>50</sub> (mg/L)	LC <sub>50</sub> Range	N	Reference
2,4-D	5.50	1.4 – 47	5	1) ECOTOX
Atrazine	10.70	4.5 – 24	6	1) ECOTOX
Azinphos-Methyl	0.01	0.0029 – 0.028	15	1) ECOTOX 2) PM
Azoxystrobin	6.92	0.47 – 150	3	1) ECOTOX 2) PM
Bromoxynil	1.07	0.05 – 18	6	1) ECOTOX 2) USEPA. 1998. Reregistration Eligibility Decision (RED): Bromoxynil. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-013, December.
Calcium Hypochlorite	0.085	0.06 – 0.095	7	1) ECOTOX
Captan	0.50	0.066 – 126	10	1) PC 2) ECOTOX 3) USEPA. 1999. Reregistration Eligibility Decision (RED): Captan. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-015, November. 4) HSDB
Carbaryl	1.58	0.32 – 5.4	41	1) ECOTOX
Carbofuran	0.48	0.38 – 0.60	2	1) ECOTOX
Chlorine	0.185	0.132 – 0.291	4	1) ECOTOX
Chlorothalonil	0.03	0.0076 – 0.103	13	1) ECOTOX 2) PM
Chlorpyrifos	0.02	0.01 – 2.0	13	1) ECOTOX 2) PM 3) HSDB
Clopyralid	103		1	1) PM 2) HSDB
Cymoxanil	61		1	1) ECOTOX 2) PM 3) PAN
Cypermethrin	0.01	0.0005 – 13.3	8	1) PC 2) ECOTOX 3) PM
Dazomet	2.14	0.16 – 16.2	4	1) ECOTOX

Diazinon	1.69	0.09 – 16.0	12	1) HSDB 2) PC 3) ECOTOX 4) PM
Dicamba	100	28 – 153	5	1) PC 2) ECOTOX 3) PM 4) HSDB
Dichlobenil	13.74	4.93 – 140	5	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Dichlobenil. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-003, December. 2) HSDB 3) ECOTOX
Dimethoate	7.40	6.2 – 8.6	3	1) ECOTOX
Dinocap	0.04	0.013 – 0.0485	5	1) ETN 2) PC 3) PAN
Diphenylamine	2.2		1	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Diphenylamine. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-010, April.
Diquat Dibromide	24	14.83 – 39	2	1) ECOTOX 2) PM
Dodine	18	0.57 – 570	2	1) ECOTOX 2) USEPA. 2005. Reregistration Eligibility Decision (RED): Dodine. Prevention, Pesticides and Toxic Substances. EPA 738-R-05-013, September. 3) PAN
Endosulfan	0.0007	0.00017 – 0.0029	37	1) ECOTOX
EPTC	29	19 – 180	6	1) PC 2) ECOTOX 3) PM 4) HSDB
Fenbuconazole	1.45	1.4 – 1.5	2	1) ECOTOX 2) PMRA. 2005. Proposed Regulatory Decision Document: Fenbuconazole. Alternative Strategies and Regulatory Affairs Division. PRDD2005-03, September. 3) PAN
Fluazifop-p-Butyl	1.3		1	1) PM
Folpet	0.14	0.015 – 49	9	1) PC 2) ECOTOX 3) USEPA. 1999. Reregistration Eligibility Decision (RED): Folpet. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-011, November. 4) HSDB
Fosetyl Aluminum	190	75.8 – 428	4	1) PC 2) ECOTOX 3) PM 4) HSDB

Glufosinate Ammonium	182.38	26.7 – 710	3	1) ECOTOX 2) PM 3) HSDB
Glyphosate	20.2	1.3 – 240	22	1) ECOTOX 2) PM
Hexazinone	453	146 – 1964	6	1) ECOTOX 2) PM
Imidacloprid	211		1	1) PC
Iprodione	4.4	4.1 – 4.8	3	1) PC 2) ECOTOX 3) PM 4) USEPA. 1998. Reregistration Eligibility Decision (RED): Iprodione. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-019, November. 5) HSDB
Isoxaflutole	20.27	1.7 – 160	3	1) ECOTOX
Linuron	3		1	1) ECOTOX
Malathion	0.1	0.0028 – 0.68	21	1) PC 2) HSDB 3) ECOTOX
Mancozeb	0.64	0.46 – 0.91	3	1) USEPA. 2005. Environmental Fate and Ecological Risk Assessment for Mancozeb. Prevention, Pesticides and Toxic Substances. EPA-HQ-OPP-2005-0176, June.
MCPA	145	91 – 232	2	1) ECOTOX 2) PM
Mecoprop	159	124 – 220	3	1) PC 2) PIP
Methamidophos	25		1	1) ECOTOX
Methomyl	2.04	0.86 – 32.0	17	1) PC 2) ECOTOX 3) PM 4) HSDB
Metiram	0.50	0.229 – 1.1	2	1) ECOTOX 2) PM
Metolachlor	2.79	2 – 3.9	2	1) PC 2) ECOTOX 3) PM 4) HSDB
Metribuzin	83	42 – 147	4	1) ECOTOX
Mineral Oil	No Information			Default Value ( $HV_{AAT} = 2.5$ )
Myclobutanil	4.2		1	1) ECOTOX 2) PM 3) HSDB
Naled	0.2	0.049 – 0.9	9	1) ECOTOX 2) HSDB
Napropamide	12	9.4 – 16.6	4	1) PC 2) ECOTOX 3) PM
Paraquat	20	15 – 26	2	1) ECOTOX 2) PM

Permethrin	0.01	0.00062 – 0.314	27	1) International Programme on Chemical Safety. Environmental Health Criteria 94: Permethrin. < <a href="http://www.inchem.org/documents/ehc/ehc/ehc94.htm">http://www.inchem.org/documents/ehc/ehc/ehc94.htm</a> > , Accessed March 2006. 2) PC 3) ECOTOX 4) PM
Phorate	0.02	0.0013 – 0.13	7	1) PC 2) ECOTOX 3) PM 4) HSDB
Phosalone	0.31	0.15 – 0.63	2	1) ECOTOX 2) PM 3) HSDB
Phosmet	0.58	0.105 – 10	17	1) ECOTOX
Picloram	13.9	3.1 - 310	20	1) PC 2) ECOTOX 3) PM 4) HSDB
Piperonyl Butoxide	0.58	0.0024 – 11.2	8	1) ECOTOX 2) HSDB
Pirimicarb	77	29 – 129	4	1) PC 2) ECOTOX 3) PM 4) HSDB
Prometryn	4.1	2.5 – 7.2	4	1) PC 2) PM 3) USEPA. 1996. Reregistration Eligibility Decision (RED): Prometryn. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-033, February. 4) ECOTOX 5) HSDB
Propiconazole	6.87	0.83 – 506	4	1) ECOTOX 2) PM
Pyridaben	0.02	0.00072 – 3.1	6	1) ECOTOX 2) PM 3) HSDB
Quintozene	0.54	0.31 – 1.6	4	1) PC 2) ECOTOX 3) PM
Simazine	28.7	2.5 – 100	11	1) PC 2) ECOTOX 3) PM 4) USEPA. 2005. Interim Reregistration Eligibility Decision: Environmental Fate and Ecological Risk Assessment for Simazine. Environmental Fate and Effects Division. EPA-HQ-OPP-2005-0151, May. 5) HSDB

Terbacil	52.9	39.7 – 79.0	4	1) PC 2) ECOTOX 3) PM 4) USEPA. 1998. Reregistration Eligibility Decision (RED): Terbacil. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-011, January.
Thiophanate-Methyl	25.2		1	1) ECOTOX
Thiram	0.07	0.048 – 0.13	4	1) ECOTOX
Triazine	0.17	0.14 – 0.202	2	1) ECOTOX 2) HSDB
Tributyltin Oxide	0.02	0.00128 – 32.0	6	1) ECOTOX
Triclopyr	4.36	0.74 – 117	5	1) PC 2) ECOTOX 3) PM 4) HSDB
Trifluralin	0.07	0.01 – 1.6	28	1) PC 2) ECOTOX 3) PM 4) HSDB
Triforine	146	21.4 – 1000	2	1) PC 2) ECOTOX 3) PM 4) HSDB

***Daphnia magna* 48-hour LC/EC<sub>50</sub>**

Active Ingredients	Geometric Mean EC/LC <sub>50</sub> (mg/L)	EC/LC <sub>50</sub> Range	N	Reference
2,4-D	152	25 – 389	3	1) HSDB 2) ECOTOX
Atrazine	33.9	6.9 – 115	3	1) PM 2) ECOTOX
Azinphos-Methyl	0.0018	0.0011 – 0.0044	5	1) ECOTOX 2) PM
Azoxystrobin	13.5	0.259 – 190	3	1) PM 2) USEPA. 1997. Pesticide Fact Sheet: Azoxystrobin. Prevention, Pesticides and Toxic Substances. 7501C, February.
Bromoxynil	0.3186	0.011 – 19.22	29	1) ECOTOX 2) PM 3) USEPA. 1998. Reregistration Eligibility Decision (RED): Bromoxynil. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-013, December.
Calcium Hypochlorite	0.1616	0.037 – 2.3	4	1) ECOTOX 2) USEPA. 1992. Reregistration Eligibility Document: Sodium and Calcium Hypochlorite Salts. Office of Pesticide Programs Special Review and Reregistration Divisions. List A, Case No 0029, February.

Captan	7.14	3.25 – 10	7	1) PC 2) PM 3) USEPA. 1999. Reregistration Eligibility Decision (RED): Captan. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-015, November. 4) HSDB
Carbaryl	0.0151	0.0056 – 0.73	6	1) ECOTOX 2) PM
Carbofuran	0.045	0.029 – 0.086	5	1) ECOTOX 2) PM
Chlorine	0.1182	0.085 – 0.15	5	1) ECOTOX
Chlorothalonil	0.12	0.07 – 0.18	4	1) ECOTOX 2) PM
Chlorpyrifos	0.002	0.0001 – 0.344	5	1) PC 2) ECOTOX
Clopyralid	225		1	1) PM
Cymoxanil	27.5	27 – 28	2	1) ECOTOX 2) PM 3) PAN
Cypermethrin	0.0307	0.00015 – 111	6	1) ECOTOX 2) PM 3) PC
Dazomet	1.03	0.3 – 11.9	3	1) ECOTOX 2) PM
Diazinon	0.001	0.0005 – 0.00239	13	1) ECOTOX 2) PM
Dicamba	202	100 – 750	2	1) PC 2) ECOTOX 3) HSDB
Dichlobenil	7.8	6.2 – 10	2	1) PC 2) PM 3) ECOTOX
Dimethoate	1.075	0.560 – 2.90	8	1) ECOTOX
Dinocap	0.0042		1	1) PAN
Diphenylamine	0.91	0.31 – 2	3	1) ECOTOX 2) USEPA. 1998. Reregistration Eligibility Decision (RED): Diphenylamine. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-010, April.
Diquat Dibromide	0.0507	0.0022 – 1.17	2	1) ECOTOX 2) PM
Dodine	0.0394	0.0178 – 0.086	3	1) ECOTOX 2) USEPA. 2005. Reregistration Eligibility Decision (RED): Dodine. Prevention, Pesticides and Toxic Substances. EPA 738-R-05-013, September.
Endosulfan	0.322	0.158 – 0.72	11	1) ECOTOX
EPTC	9.87	6.4 – 14.15	4	1) PC 2) ECOTOX 3) PM

Fenbuconazole	2.3			1) PMRA. 2005. Proposed Regulatory Decision Document: Fenbuconazole. Alternative Strategies and Regulatory Affairs Division. PRDD2005-03, September.
Fluazifop-p-Butyl	499	412.4 – 553.9	3	1) ECOTOX
Folpet	0.25	0.02 – 1.5	5	1) USEPA. 1999. Reregistration Eligibility Decision (RED): Folpet. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-011, November. 2) PAN
Fosetyl Aluminum	239	189 – 304	2	1) ECOTOX 2) PM 3) PAN
Glufosinate Ammonium	135	15 – 1000	7	1) ECOTOX 2) PM
Glyphosate	66	2.95 – 780	4	1) ECOTOX 2) PM
Hexazinone	179	85 – 442	3	1) ECOTOX 2) PM
Imidacloprid	85		1	1) PM
Iprodione	0.58	0.24 – 7.2	5	1) PC 2) ECOTOX 3) PM 4) USEPA. 1998. Reregistration Eligibility Decision (RED): Iprodione. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-019, November.
Isoxaflutole	23.8	1.5 – 150	3	1) ECOTOX
Linuron	0.45	0.12 – 1.91	6	1) ECOTOX 2) PM
Malathion	0.0026	0.01 – 0.033	7	1) PC 2) ECOTOX
Mancozeb	0.91	0.58 – 1.3	3	1) USEPA. 2005. Environmental Fate and Ecological Risk Assessment for Mancozeb. Prevention, Pesticides and Toxic Substances. EPA-HQ-OOP-2005-0176, June. 2) PAN
MCPA	180		1	1) ECOTOX
Mecoprop	420		1	1) PC
Methamidophos	0.071	0.026 – 0.27	3	1) ECOTOX 2) PM
Methomyl	0.0883	0.0076 – 28.7	4	1) PC 2) ECOTOX 3) HSDB
Metiram	2.55		1	1) PM
Metolachlor	22.6	15.4 – 26	5	1) PC 2) ECOTOX 3) PM
Metribuzin	7.25	4.18 – 35	4	1) ECOTOX 2) PM
Mineral Oil	No Information			Default Value ( $HV_{AAD} = 2.5$ )

Myclobutanil	11		1	1) ECOTOX 2) PM 3) HSDB
Naled	0.0011	0.0003 – 0.0029	5	1) ECOTOX
Napropamide	20.4	14.3 – 24.7	3	1) PC 2) ECOTOX 3) PM
Paraquat	2.7	1.2 – 6.1	2	1) ECOTOX 2) PM
Permethrin	0.0015	0.000112 – 0.022	15	1) ECOTOX 2) PM
Phorate	0.0237	0.01823 – 0.037	4	1) ECOTOX
Phosalone	0.0009	0.00074 – 0.0012	2	1) PC 2) ETN 3) PM
Phosmet	0.008	0.0056 – 0.0109	3	1) ECOTOX 2) PM
Picloram	54.9	34.4 – 76	4	1) PC 2) ECOTOX 3) PM
Piperonyl Butoxide	0.52	0.01 – 2.83	3	1) ECOTOX
Pirimicarb	0.0146	0.0065 – 0.021	6	1) ECOTOX 2) PM
Prometryn	13.2	9.7 – 18.59	3	1) PC 2) PM 3) ECOTOX
Propiconazole	5.6	3.2 – 11.3	3	1) ECOTOX 2) PM
Pyridaben	0.0007	0.00053 – 0.00102	3	1) ECOTOX 2) PM
Quintozene	0.77		1	1) PC 2) ECOTOX 3) PM
Simazine	5.2	1.0 – 100	5	1) PC 2) ECOTOX 3) PM 4) USEPA. 2005. Interim Reregistration Eligibility Decision: Environmental Fate and Ecological Risk Assessment for Simazine. Environmental Fate and Effects Division. EPA-HQ-OPP-2005-015, May 5) HSDB
Terbacil	65.3	63 – 68	3	1) PC 2) ECOTOX 3) PM 4) USEPA. 1998. Reregistration Eligibility Decision (RED): Terbacil. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-011, January.

Thiophanate-Methyl	10.4	5.4 – 20.2	2	1) ECOTOX 2) PM
Thiram	0.21		1	1) PM
Triazine	0.79	0.49 – 1.1	3	1) ECOTOX 2) PAN
Tributyltin Oxide	0.0049	0.00075 – 0.07	7	1) The International Programme on Chemical Safety. Environmental Health Criteria 116: Tributyltin Compounds. < <a href="http://www.inchem.org/documents/ehc/ehc/ehc116.htm">http://www.inchem.org/documents/ehc/ehc/ehc116.htm</a> > , Accessed March 2006. 2) ECOTOX
Triclopyr	132.95	132.9 – 133	2	1) PC 2) ECOTOX 3) PAN
Trifluralin	0.298	0.193 – 0.56	3	1) PC 2) ECOTOX 3) PM 4) HSDB
Triforine	43	25 – 117	3	1) PC 2) ECOTOX 3) PM 4) HSDB

### Soil Half-Life

Active Ingredient	Soil Half-Life (days)	Reference
2,4-D	7	1) PPD
Atrazine	120	1) USEPA. 2003. Interim Reregistration Eligibility Decision (IREL): Atrazine. Prevention, Pesticides and Toxic Substances. Case No 0062, January.
Azinphos-Methyl	32	1) USEPA. 1998. Preliminary Environmental Fate and Effects Risk Assessment for Azinphos-Methyl. Prevention, Pesticides and Toxic Substances. Case No 0234, January.
Azoxystrobin	72	1) HPTP
Bromoxynil	2	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Bromoxynil. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-013, December.
Calcium Hypochlorite	15 (estimated)	1) USEPA. 2000. Episuite Biowin Ultimate Survey Model v.4.02. < <a href="http://www.epa.gov/oppt/exposure/docs/episuitel1.htm">http://www.epa.gov/oppt/exposure/docs/episuitel1.htm</a> > , Accessed June 2006.
Captan	6.5	1) PC
Carbaryl	5	1) USEPA. 2003. Interim Reregistration Eligibility Decision (IREL): Carbaryl. Prevention, Pesticides and Toxic Substances. Case No 0080, June.
Carbofuran	11	1) PPD
Chlorine	15 (estimated)	1) USEPA. 2000. Episuite Biowin Ultimate Survey Model v.4.02. < <a href="http://www.epa.gov/oppt/exposure/docs/episuitel1.htm">http://www.epa.gov/oppt/exposure/docs/episuitel1.htm</a> > , Accessed June 2006.

Chlorothalonil	18.8	1) USEPA. 1999. Reregistration Eligibility Decision (RED): Chlorothalonil. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-004, April.
Chlorpyrifos	30.5	1) PPD
Clopyralid	26	1) PPD
Cymoxanil	1.1	1) PPD
Cypermethrin	60	1) PPD
Dazomet	4	1) PC
Diazinon	39	1) PPD
Dicamba	20	1) HSDB
Dichlobenil	91	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Dichlobenil. Prevention, Pesticides and Toxic Substances. EPA 738-R-98-003, October.
Dimethoate	2.4	1) USEPA. 1999. Environmental Fate and Effects Division (EFED) Revised Chapter for the Reregistration Eligibility Decision (RED): Dimethoate. Prevention, Pesticides and Toxic Substances. February.
Dinocap	5.3	1) PC
Diphenylamine	1	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Diphenylamine. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-010, April.
Diquat Dibromide	1000	1) PPD
Dodine	19.9	1) USEPA. 2005. Reregistration Eligibility Decision (RED): Dodine. Prevention, Pesticides and Toxic Substances. EPA 738-R-05-013, September.
Endosulfan	99	1) USEPA. 2001. Environmental Fate and Effects Division (EFED) Risk Assessment for the Reregistration Eligibility Decision (RED): Endosulfan. Prevention, Pesticides and Toxic Substances. PC Code 079401, April.
EPTC	55.5	1) HSDB
Fenbuconazole	367	1) PMRA. 2005. Proposed Regulatory Decision Document. Alternative Strategies and Regulatory Affairs Division. PRDD2005-03, September.
Fluazifop-p-Butyl	20	1) PPD
Folpet	75.4	1) USEPA. 1999. Reregistration Eligibility Decision (RED): Folpet. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-011, November.
Fosetyl Aluminum	0.1	1) PPD
Glufosinate Ammonium	3.7	1) PPD
Glyphosate	1.9	1) USEPA. 1993. Reregistration Eligibility Decision (RED): Glyphosate. Prevention, Pesticides and Toxic Substances. EPA 738-R-93-014, September.
Hexazinone	216	1) USEPA. 1994. Reregistration Eligibility Decision (RED): Hexazinone. Prevention, Pesticides and Toxic Substances. EPA 738-R-94-022, September.
Imidacloprid	426	1) PMRA. 2001. Regulatory Note: Imidacloprid. Submission Coordination and Documentation Division. REG2001-11, September.
Iprodione	22	1) HSDB

Isoxaflutole	1.9	1) PMRA. 2001. Regulatory Decision Document. Alternative Strategies and Regulatory Affairs Division. PRDD2005-03, September.
Linuron	49	1) USEPA. 1995. Reregistration Eligibility Decision (RED): Linuron. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-003, March.
Malathion	1	1) PPD
Mancozeb	2	1) PPD
MCPA	25	1) PPD
Mecoprop	12	1) PC
Methamidophos	4	1) PPD
Methomyl	17.5	1) PPD
Metiram	20	1) PPD
Metolachlor	67	1) USEPA. 1995. Reregistration Eligibility Decision (RED): Metolachlor. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-006, April.
Metribuzin	106	1) USEPA. 1998. Reregistration Eligibility Decision (RED): Metribuzin. Prevention, Pesticides and Toxic Substances. EPA 738-R-97-006, February.
Mineral Oil	10	1) OSU
Myclobutanil	66	1) HSDB
Naled	4	1) PPD
Napropamide	270	1) PC
Paraquat	1067	1) PPD
Permethrin	37	1) USEPA. 2005. Permethrin: HED Chapter of the Reregistration Eligibility Decision Document (RED). Prevention, Pesticides and Toxic Substances. PC Code 109701, Case No 52645-53-1, July.
Phorate	3	1) PPD
Phosalone	5	1) PPD
Phosmet	3	1) USEPA. 1998. Environmental Fate and Effects Division (EFED) for the Reregistration Eligibility Decision (RED): Phosmet. Prevention, Pesticides and Toxic Substances. PC Code 059201, April.
Picloram	29	1) PPD
Piperonyl Butoxide	14	1) HSDB
Pirimicarb	10	1) OSU
Prometryn	227	1) HSDB
Propiconazole	53	1) PPD
Pyridaben	21	1) HPTP
Quintozene	60	1) PPD
Simazine	91	1) USEPA. 2005. Overview of the Simazine Risk Assessments. EPA-HQ-OPP-2005-0151, July.
Terbacil	356	1) HSDB
Thiophanate-Methyl	320	1) USEPA. 2001. Environmental Fate and Effects Division (EFED) Document for the Reregistration Eligibility Decision (RED): Thiophanate-Methyl and its major degradate MBC (methyl 2-benzimidazolycarbamate). Prevention, Pesticides and Toxic Substances. May.

Thiram	15.2	1) PPD
Triazine	0.625	1) PPD
Tributyltin Oxide	60.5	1) PP
Triclopyr	87	1) PPD
Trifluralin	169	1) PPD
Triforine	19	1) HSDB

### Log K<sub>ow</sub>

Active Ingredient	Geometric Mean Log K <sub>ow</sub>	Log K <sub>ow</sub> Range	N	Reference
2,4-D	0.33		1	1) PM
Atrazine	2.58	2.05 – 2.80	21	1) IH
Azinphos-Methyl	2.96		1	1) PM
Azoxystrobin	2.50		1	1) PM 2) HSDB
Bromoxynil	3.93	2.8 – 5.06	2	1) PM 2) HSDB 3) PPD
Calcium Hypochlorite	-2.46		1	1) SRC
Captan	2.80		1	1) PM
Carbaryl	2.34	1.59 – 2.81	10	1) IH
Carbofuran	1.90	1.23 – 2.32	8	1) IH
Chlorine	-0.85		1	1) SRC
Chlorothalonil	2.92		1	1) PM
Chlorpyrifos	4.85	4.7 – 5.0	2	1) PM 2) PPD
Clopyralid	1.30	-1.81 – 2.63	4	1) PM 2) PPD
Cymoxanil	0.63	0.59 – 0.67	2	1) PM 2) HSDB 3) PPD
Cypermethrin	6.60		1	1) PM 2) PPD
Dazomet	0.15		1	1) PM 2) HSDB 3) PPD
Diazinon	3.28	3.02 – 3.81	5	1) PM 2) PPD
Dicamba	0.73	-0.55 – 2.21	3	1) PM 2) HSDB 3) PPD
Dichlobenil	2.70		1	1) PM 2) PPD
Dimethoate	0.64	-0.294 – 0.79	6	1) IH
Dinocap	4.54		1	1) PM
Diphenylamine	3.60		1	1) FAO
Diquat Dibromide	-4.60		1	1) PM

Dodine	1.32		1	1) SRC
Endosulfan	4.74		1	1) PM
EPTC	3.25	3.2 – 3.3	2	1) PM 2) PPD
Fenbuconazole	3.23		1	1) PM
Fluazifop-p-Butyl	4.50		1	1) PM
Folpet	3.11		1	1) PM
Fosetyl Aluminum	-2.57	-2.77 – -2.28	4	1) PM 2) PPD
Glufosinate Ammonium	0.10		1	1) PM 2) HSDB 3) PPD
Glyphosate	-1.70		1	1) IH
Hexazinone	1.20		1	1) PM
Imidacloprid	0.57		1	1) PM
Iprodione	3.05	3.0 – 3.1	2	1) PM 2) HSDB 3) PPD
Isoxaflutole	2.32		1	1) PM 2) HSDB
Linuron	3.00		1	1) PM
Malathion	2.60	2.36 – 2.75	3	1) PM 2) HSDB 3) PPD
Mancozeb	1.33		1	1) HSDB 2) PPD
MCPA	-0.71		1	1) PM
Mecoprop	1.62	0.1004 – 3.13	2	1) PM 2) HSDB
Methamidophos	-0.80		1	1) PM
Methomyl	0.42	0.093 – 0.6	3	1) PM 2) HSDB 3) PPD
Metiram	0.30		1	1) PM
Metolachlor	2.95	2.6 – 3.28	5	1) PM 2) PPD
Metribuzin	1.60		1	1) PM
Mineral Oil	No Information			
Myclobutanil	2.94		1	1) PM 2) HSDB 3) PPD
Naled	1.49	1.38 – 1.6	2	1) SRC
Napropamide	3.33	3.3 – 3.36	2	1) PM 2) HSDB 3) PPD
Paraquat	-4.50		1	1) PM
Permethrin	6.10		1	1) PM 2) PPD

Phorate	3.61	2.92 – 4.26	4	1) PM 2) PPD
Phosalone	3.89	3.77 – 4.01	2	1) PM 2) PPD
Phosmet	2.95		1	1) PM
Picloram	0.93	-0.05 – 1.9	2	1) PM 2) PPD
Piperonyl Butoxide	4.75		1	1) PM 2) HSDB
Pirimicarb	1.70		1	1) PM 2) HSDB 3) PPD
Prometryn	3.31	3.1 – 3.51	2	1) PM 2) PPD 3) HSDB
Propiconazole	3.72		1	1) PM
Pyridaben	5.92	5.47 – 6.37	2	1) SRC
Quintozene	5.30	5.1 – 5.5	2	1) PM 2) PPD
Simazine	2.10		1	1) PM 2) PPD
Terbacil	1.90	1.89 – 1.91	3	1) PM 2) HSDB 3) PPD
Thiophanate-Methyl	1.50		1	1) PM
Thiram	1.73		1	1) PM
Triazine	3.45	3.02 – 3.88	2	1) HSDB 2) PPD
Tributyltin Oxide	3.95	3.84 – 4.05	2	1) SRC
Triclopyr	1.48	0.42 – 2.53	2	1) PM 2) HSDB
Trifluralin	4.78	3.97 – 5.33	6	1) PM 2) PPD
Triforine	2.20		1	1) PM 2) HSDB 3) PPD

## Log BCF

Active Ingredient	Geometric Mean Log BCF	Log BCF Range	N	Reference
2,4-D	0.80	-5 – 1.3	6	1) IH
Atrazine	1.16	0.50 – 2	11	1) IH
Azinphos-Methyl	1.91			CALC
Azoxystrobin	1.23			1) HSDB
Bromoxynil	1.04			1) HSDB
Calcium Hypochlorite	-3.02			CALC
Captan	2.05			1) HSDB

Carbaryl	1.26	0.0-1.53	4	1) IH
Carbofuran	2.07	2.07	2	1) IH
Chlorine	-1.56			CALC
Chlorothalonil	2.24	0.97 – 2.70	5	1) USEPA. 1999. Reregistration Eligibility Decision (RED): Chlorothalonil. Prevention, Pesticides and Toxic Substances. EPA 738-R-99-004, April.
Chlorpyrifos	2.67			1) HSDB
Clopyralid	0.39			CALC
Cymoxanil	0.48			1) HSDB
Dazomet	0.48			1) HSDB
Diazinon	2.19			CALC
Dicamba	1.45			1) HSDB
Dichlobenil	1.67			CALC
Dimethoate	-0.30			CALC
Dinocap	3.33			CALC
Diphenylamine	2.49			CALC
Diquat Dibromide	-0.06	-0.16	2	1) USEPA. 1995. Reregistration Eligibility Decision (RED): Diquat Dibromide. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-016. July.
Dodine	0.42			CALC
Endosulfan	3.38	1.91 – 4.04	6	1) IH 2) USEPA. 2002. Reregistration Eligibility Decision (RED): Endosulfan. Prevention, Pesticides and Toxic Substances. EPA 738-R-02-013, November.
EPTC	2.17			CALC
Fenbuconazole	2.15			CALC
Fluazifop-p-Butyl	3.29			CALC
Folpet	2.04			CALC
Fosetyl Aluminum	-3.12			CALC
Glufosinate Ammonium	0.51			1) HSDB
Glyphosate	-0.26	-0.42 – -0.28	2	1) USEPA. 1993. Reregistration Eligibility Decision (RED): Glyphosate. Prevention, Pesticides and Toxic Substances. EPA 738-R-93-014, September.
Hexazinone	0.31			CALC
Imidacloprid	-0.27			CALC
Iprodione	1.61			1) HSDB
Isoxaflutole	1.53			1) HSDB
Linuron	1.61	1.53 – 1.69	3	1) USEPA. 1995. Reregistration Eligibility Decision (RED): Linuron. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-003, March.
Malathion	1.12			1) HSDB
Mancozeb	0.32			1) HSDB
MCPA	-1.43			CALC
Mecoprop	2.15			1) HSDB

Methamidophos	-1.05		1	1) USEPA. 1998. Revision of Environmental Fate and Effects (EFED) Risk Assessment for the Reregistration Eligibility Decision (RED) Document to Include Registrant's Comments: Methamidophos. Prevention, Pesticides and Toxic Substances. PC Code 101201, Case No 0043, January.
Methomyl	0.48			1) HSDB
Metiram	-0.51			CALC
Metolachlor	1.90			CALC
Metribuzin	0.67			CALC
Mineral Oil	No Information			Default Value ( $HV_{BCF} = 1.75$ )
Myclobutanil	2.00			1) HSDB
Naled	0.57			CALC
Napropamide	1.89			1) HSDB
Paraquat	-4.88			CALC
Permethrin	4.23			CALC
Phorate	2.49			CALC
Phosalone	2.75			CALC
Phosmet	1.15	0.23 – 1.56	4	1) IH
Picloram	0.06			CALC
Piperonyl Butoxide	1.95			1) HSDB
Pirimicarb	0.60			1) HSDB
Prometryn	2.43			1) HSDB
Propiconazole	2.60			CALC
Pyridaben	4.22			CALC
Quintozene	3.93			CALC
Simazine	1.12			CALC
Terbacil	1.20			1) HSDB
Thiophanate-Methyl	0.58			CALC
Thiram	0.79			CALC
Triazine	1.97			1) HSDB
Tributyltin Oxide	2.80			CALC
Triclopyr	0.48			1) HSDB
Trifluralin	3.53			CALC
Triforine	1.00			1) HSDB

## Appendix B: Active Ingredients Excluded from the Risk Ranking Analysis

The active ingredients that were excluded from the risk ranking analysis due to insufficient data availability are presented in the following table. Their application quantity, pesticide type and use sectors are also identified.

Table B1: Active ingredients that were excluded from the Annapolis River watershed pesticide risk ranking analysis.

Active Ingredient	Quantity Applied in Watershed (kg)	Pesticide Type*	Use Sector(s)*
Glyphosate (Trimethylsulfonium Salt)	1625	Herbicide	Agriculture (100%)
Chromic Acid	752	Wood Preservative	Miscellaneous (100%)
Ferrous Sulfate	593	Herbicide	Domestic (100%)
Pendimethalin	591	Herbicide	Agriculture (100%)
Cuprous Oxide	572	Antifouling Agent	Marine (100%)
Arsenic Pentoxide	527	Wood Preservative	Miscellaneous (100%)
Cupric Oxide	290	Wood Preservative	Miscellaneous (100%)
Sodium Hypochlorite	273	Disinfectant	Municipal (97%), Agriculture (3%)
Silicon Dioxide	225	Insecticide	Domestic (100%)
Sulfur	192	Fungicide	Agriculture (100%)
Lime Sulfur (Calcium Polysulfide)	155	Fungicide/Insecticide	Domestic (21%), Agriculture (79%)
DEET	144	Insect Repellent	Domestic (100%)
Copper	124	Fungicide	Domestic (8%), Agriculture (92%)
Octylphenoxyethoxyethanol	118	Adjuvant	Agriculture (100%)
S-Metolachlor	90	Herbicide	Agriculture (100%)
Insecticidal Soap (Potassium Salts of Fatty Acids)	80	Insecticide	Agriculture (1%), Domestic (99%)
Surfactant Blend	70	Surfactant	Agriculture (100%)
Bentazon	64	Herbicide	Agriculture (100%)
Abamectin	27	Insecticide/Miticide	Agriculture (100%)
Copper Sulfate	20	Fungicide	Agriculture (100%)
Ferbam	18	Fungicide	Agriculture (100%)
Kaolin	16	Crop Protectant	Agriculture (100%)
Boscalid	14	Fungicide	Agriculture (100%)
Acetamiprid	14	Insecticide	Agriculture (100%)
<i>Bacillus thuringiensis (ssp. Tenebrionis)</i>	13	Insecticide	Agriculture (100%)
Metaldehyde	12	Molluscicide	Domestic (62%), Agriculture (38%)
Fenhexamid	10	Fungicide	Agriculture (100%)

\* (Comeau, 2006)

## Appendix C: Active Ingredient Loading Percentages

The following table presents the loading percentages into soil, air or water for each active ingredient, estimated by their typical mode of application and use sector. These values were input into the Level III Fugacity model in order to determine the Release Weighting Factor for each active ingredient. The estimates were based primarily on the labels available to the public from the Canadian Pest Management Regulatory Agency (PMRA) and the primary use sectors indicated by Dunn (2004) and Comeau (2006).

Table C1: Loading percentages assigned to each active ingredient for submission into the Fugacity model.

Active Ingredient	Loading Percentage(s)
2,4-D	100% soil*
Atrazine	100% soil*
Azinphos-Methyl	100% soil*
Azoxystrobin	100% soil**
Bromoxynil	100% soil***
Calcium Hypochlorite	100% water***
Captan	100% soil***
Carbaryl	100% soil*
Carbofuran	100% soil*
Chlorine	100% water***
Chlorothalonil	100% soil*
Chlorpyrifos	50% soil, 50% air**
Clopyralid	100% soil***
Cymoxanil	100% soil***
Cypermethrin	100% soil***
Dazomet	100% soil***
Diazinon	50% soil, 50% water**
Dicamba	50% soil, 50% water**
Dichlobenil	100% soil***
Dimethoate	100% soil*
Dinocap	100% soil***
Diphenylamine	100% soil***
Diquat Dibromide	100% soil*
Dodine	100% soil***
Endosulfan	100% soil*
EPTC	100% soil***
Fenbuconazole	100%***
Fluazifop-p-Butyl	100% soil*
Folpet	20% air, 40% water, 40% soil**
Fosetyl Aluminum	100% soil*
Glufosinate Ammonium	100% soil***
Glyphosate	100% soil*
Hexazinone	100% soil*

Imidacloprid	100% soil*
Iprodione	50% soil, 50% air**
Isoxaflutole	100% soil***
Linuron	100% soil*
Malathion	50% soil, 25% water, 25% air**
Mancozeb	100% soil*
MCPA	100% soil*
Mecoprop	50% soil, 50% air**
Methamidophos	100% soil*
Methomyl	100% soil***
Metiram	100% soil*
Metolachlor	100% soil***
Metribuzin	100% soil*
Mineral Oil	Default Value (RWF = 5.5 for each medium)****
Myclobutanil	50% soil, 50% air**
Naled	100% soil***
Napropamide	100% soil***
Paraquat	100% soil*
Permethrin	50% soil, 50% air**
Phorate	100% soil***
Phosalone	100% soil***
Phosmet	100% soil*
Picloram	50% soil, 50% air**
Piperonyl Butoxide	100% air**
Pirimicarb	100% soil***
Prometryn	100% soil***
Propiconazole	100% soil*
Pyridaben	100% soil***
Quintozene	50% soil, 25% air, 25% water**
Simazine	100% soil***
Terbacil	100% soil***
Thiophanate-Methyl	100% soil*
Thiram	100% soil*
Triazine	100% soil***
Tributyltin Oxide	50% soil, 50% water**
Triclopyr	50% soil, 50% air**
Trifluralin	100% soil***
Triforine	50% soil, 50% air**

\* (Dunn, 2004) \*\* (PMRA, 2006) \*\*\* (Comeau, 2006) \*\*\*\* (Allison Dunn, personal communications, June 29, 2006)