UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

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MEMORANDUM **March 1, 2012**

Subject: Registration Review: Preliminary Problem Formulation for Environmental Fate and Ecological Risk, Endangered Species, and Drinking Water Assessments for Cypermethrin and Zeta-Cypermethrin (Case No.2130)

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The Environmental Fate and Effects Division (EFED) has completed the preliminary problem formulation (attached) for the environmental fate and ecological risk, endangered species, and drinking water assessments to be conducted as part of the Registration Review of the insecticides Cypermethrin and Zeta-Cypermethrin (PC Codes 109702 and 129064, respectively). Functioning as the first stage of the risk assessment process for Registration Review, this problem formulation provides an overview of what is currently known about the environmental fate and ecological effects associated with cypermethrin, zeta-cypermethrin and their degradates. It also describes the preliminary ecological risk hypothesis and analysis plan for evaluating and characterizing risk to non-target species and the environment in support of registration review.

Data Gaps

The available environmental fate and transport data are considered incomplete for the purposes of risk assessment. The following data gaps exist:

1) Aerobic soil metabolism (OCSPP guideline # 835.4100). Acceptable data are available for only one aerobic soil metabolism study. The guideline stipulates that studies using at least four soils that are similar to the potential use sites in the United States be submitted.

In the absence of these data, the aerobic soil metabolism half-life is tripled to conservatively estimate the model input for aerobic soil metabolism.

2) Aerobic aquatic metabolism (OCSPP guideline # 835.4300). Acceptable data are available for only one aerobic aquatic metabolism study. The guideline stipulates that studies using at least two sediment-water systems that are similar to the potential use sites in the United States be submitted. In the absence of these data, the aerobic aquatic metabolism half-life is tripled to conservatively estimate the model input for aerobic aquatic metabolism.

3) Anaerobic aquatic metabolism (OCSPP guideline # 835.4400). Acceptable data are available for only one anaerobic aquatic metabolism study. The guideline stipulates that studies using at least two sediment-water systems that are similar to the potential use sites in the United States be submitted. In the absence of these data, the anaerobic aquatic metabolism half-life is tripled to conservatively estimate the model input for anaerobic aquatic metabolism.

4) Terrestrial field dissipation (OCSPP guideline # 835.6100). Given the large number of registered uses for cypermethrin and zeta-cypermethrin, two terrestrial field dissipation studies are insufficient to describe the environmental fate across the entire U.S.

The available effects data are considered incomplete for the purposes of risk assessment. The following data gaps exist:

1) Avian acute oral toxicity (OCSPP guideline # 850.2100). Avian acute oral toxicity data are not available for passerines, which are required under the new 40 CFR Part 158.

2) Avian reproduction (OCSPP guideline # 850.2300). Though reproduction data is available for cypermethrin, the maximum treatment level tested (50 ppm) in the acceptable studies, which did not show adverse effects at the highest treatment level, is below expected exposure from use on cotton (66 ppm on short grass). An additional study is needed to characterize reproductive effects under real world exposure scenarios.

3) Freshwater fish acute toxicity test with TEP (Non-Guideline[1,2]). No acceptable acute studies for cypermethrin TEP with synergists (PBO or MGK) have been submitted for fish. Since cypermethrin can be directly applied to water via application to cattle livestock, EPA needs data on the formulated products containing synergists. Without toxicity data on the range of TEPs produced, the Agency would have to presume acute toxicity to listed and non-listed fish and aquatic-phase amphibians, but would not be able to quantify the risk. The TEP should correspond to those formulated products that are

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[1]The DCI will indicate that TEP studies on freshwater invertebrates and freshwater fish are required on coformulated products containing the highest ratio of the synergist piperonyl butoxide (PBO) to permethrin and the highest ratio of the synergist MGK-264 to permethrin.
[2] The DCI will require that a study protocol be submitted for review and approval by the Agency prior to this study being initiated.

labeled for outdoor uses with the greatest potential for aquatic exposures and contain the highest synergist:a.i. ratio.

4) Freshwater invertebrate acute toxicity test with TEP (Non-Guideline[3,4]). Acute water column tests with *Hyallela azteca* have been requested in pyrethroid problem formulations based on the increased sensitivity of this species to pyrethroid insecticides. The 850.1020 test guideline for Gammarid amphipods is recommended with appropriate modifications to address specific testing needs of *H. azteca*. The registrant should submit a protocol prior to test initiation or submit any open literature studies that may fulfill this data gap. The TEP should correspond to those formulated products that are labeled for outdoor uses with the greatest potential for aquatic exposures and contain the highest synergist:a.i. ratio.

5) Whole sediment chronic invertebrates (in prep OCSPP guideline #s 850.1760, 850.1770, and 850.1780). No chronic or sediment toxicity tests for freshwater or marine invertebrates have been submitted for cypermethrin to satisfy the Agency's updated data requirements for outdoor uses in 40 CFR Part 158 (October 26, 2007). Chronic whole sediment tests on *Hyalella azteca*, *Chironomus tentans*, and *Leptocheirus plumulosus* are requested.

6) Vegetative vigor and seedling emergence (OSCPP guideline #s 850.4150 and 850.4250)[5]. No acceptable toxicity data are currently available to assess the risk of cypermethrin to non-target terrestrial plants. Since cypermethrin has many outdoor uses, vegetative vigor and seedling emergence studies are needed. In addition, four minor terrestrial plant incidents have been reported to the Agency involving cypermethrin. Phytotoxicity data are needed to assess the impact of cypermethrin on non-target terrestrial plants.

7) Aquatic plant growth (OSCPP guideline #s 850.4400 and 850.5400)[5]. No acceptable toxicity data are currently available to assess the risk of cypermethrin to non-target aquatic nonvascular and vascular plants. Since cypermethrin has many outdoor uses, aquatic plant growth toxicity studies are requested with either cypermethrin technical or a typical end-use product.

Additional detail on the current data gaps for environmental fate and effects is provided in Section 7.9.

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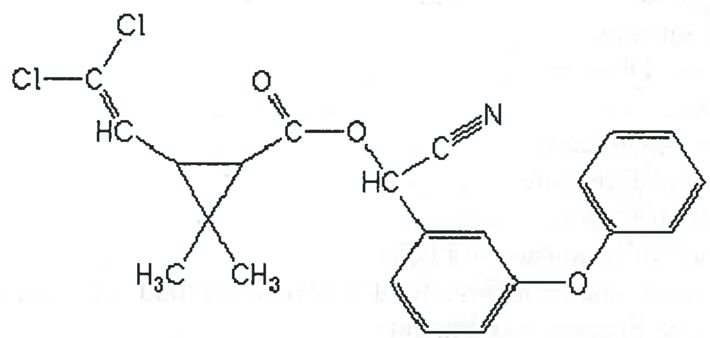
[3] The DCI will indicate that TEP studies on freshwater invertebrates and freshwater fish are required on coformulated products containing the highest ratio of the synergist piperonyl butoxide (PBO) to permethrin and the highest ratio of the synergist MGK-264 to permethrin.

[4] The DCI will require that a study protocol be submitted for review and approval by the Agency prior to this study being initiated.

[5] A Tier II study is required. The DCI will provide that a Tier I plant study may be conducted in lieu of a Tier II study with the understanding that any adverse effects observed by the Tier I study would necessitate conduct and submission of a Tier II study as well.

Office of Chemical Safety and Pollution Prevention

Problem Formulation for the Environmental Fate and Ecological Risk, Endangered Species, and Drinking Water Assessments in Support of the Registration Review of Racemic Cypermethrin and Zeta-Cypermethrin



(*RS*)-α-cyano-3-phenoxybenzyl (1*RS*,3*RS*;1*RS*,3*SR*)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate

CAS Registry Number: 52315-07-8

Racemic cypermethrin: PC Code 109702

Zeta-cypermethrin: PC Code 129064

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March 1, 2012

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1 Purpose

The purpose of this problem formulation is to provide the foundation for the ecological risk assessment being conducted for the registered uses of cypermethrin and zeta-cypermethrin. As such, it articulates the purpose and objectives of the risk assessment, evaluates the nature of the problem, and provides a plan for analyzing the data and characterizing the risk (USEPA, 1998). Additionally, this problem formulation is intended to identify data gaps, uncertainties and potential assumptions needed to address those uncertainties in characterizing the ecological risk associated with the registered uses of racemic cypermethrin (henceforth referred to in this document as "cypermethrin") and zeta-cypermethrin. Since the analytical methods do not distinguish cypermethrin from zeta-cypermethrin, the toxicological endpoints are the same, and the environmental fate data has been bridged, this problem formulation will refer to both chemicals as "cypermethrins", where appropriate.

Cypermethrin and zeta-cypermethrin (PC Codes 109702 and 129064) are broad-spectrum insecticides used in four major sectors: agricultural settings, commercial/industrial/institutional/food & non-food/mosquito abatement, domestic home and garden, and pet care. Agricultural products are restricted use, while residential, commercial, and industrial products are general use. Cypermethrin is a combination of 8 stereoisomers with percentage compositions ranging from 11-14%. Zeta-cypermethrin is an enriched enantiomeric mixture of cypermethrin consisting of 4 stereoisomers at a concentration of 24% each and 4 insecticidally less active stereoisomers at a concentration of 1% each. The mode of action of the cypmerethrins is as a fast-acting neurotoxin in insects. It is now well established that severe neurological symptoms of poisoning with pyrethroids in mammals and insects are the result of modification of sodium (Na^+) channel activity (cellular pores through which sodium ions are permitted to enter the axon to cause excitation) (Matsumura 1985). For the structures of cypermethrin and zeta-cypermethrin and further identification information, refer to **Figures 3-1** and **3-2** and **Table 3.1**.

Cypermethrin is formulated as a pressurized liquid, wettable powder, emulsifiable concentrate and ready-to-use solution. Zeta-cypermethrin is formulated in many granular forms, as emulsifiable, flowable and soluble concentrates, and ready-to-use solution. Based on the Reregistration Eligibility Decision [RED] (USEPA 2006b), application methods in agricultural and non-agricultural uses are diverse, and include: aircraft, chemigation, groundboom, airblast equipment, handheld equipment (e.g., low pressure, handwand sprayers, backpack sprayers, hose end sprayers, and handgun sprayers), paintbrushes, termiticide injectors, ready-to-use (RTU) aerosol cans, indoor foggers, pump-trigger sprayers, impregnated wipes, and eartags.

For agriculture uses, the maximum application rate ranges from 0.4 lb. a.i./acre to 3.4 lbs. a.i./acre with a minimum retreatment interval ranging from 3-7 days and a pre-harvest interval (PHI) ranging from 1 to 14 days. The maximum application rate for non-agricultural uses is 0.44 lb. a.i./acre, for applications to lawns and turf. Cypermethrin may be applied year-round; thus, in some regions of the United States more than one application season per year is possible. Because target species could develop resistance to cypermethrin, it appears that multiple seasons at the maximum seasonal rate are unlikely. According to BEAD's Chemical Profile for cypermethrin and zeta-cypermethrin, "Based on private market pesticide usage data from 1998-2010, [agricultural] usage for cypermethrin averaged approximately 100,000 pounds active ingredient (a.i.) for 1.6 million acres treated. [Agricultural] [u]sage for zeta-cypermethrin averaged approximately 90,000 pounds a.i. for 3.7 million acres. (Proprietary Data, 2005-2010). Furthermore, the usage data indicates that for non-agricultural use, "data are available for usage by pest control operators and lawn care operators, and for uses such as landscape, nursery/greenhouse, and foodhandling establishments. Generally, over the reported years (2000 through 2008), the majority of use was by pest control operators which used more than 500,000 pounds a.i. in 2000, and more than 400,000 pounds a.i. in 2003. Use by lawn care operators was approximately 11,000 pounds a.i. in 2006, while food handling establishments used approximately 3,000 pounds a.i. in 2005, and close to 4,000 pounds a.i. in 2008 (Kline & Co., Inc. 2000-2008)".

2 Problem Formulation

2.1 Nature of Regulatory Action

This report is the Environmental Fate and Effects Division's (EFED) Problem Formulation for the Registration Review of the cypermethrins. Previous risk assessments were completed for the use of these chemicals, which serve as the basis for this document.

The Food Quality Protection Act (FQPA) of 1996 mandated the EPA to implement registration review (http://www.epa.gov/oppsrrd1/registration_review/). All pesticides distributed or sold in the United States generally must be registered by the EPA. The decision to register a pesticide is based on the consideration of scientific data and other factors showing that it will not cause unreasonable risks to human health, workers, or the environment when used as directed on product labeling. In addition, it must not be expected to cause unreasonable adverse effects to human health through the dietary and residential routes of exposure under the Federal Food Drug and Cosmetic Act (FFDCA). The registration review program is intended to ensure that, as the ability to assess risk evolves and as policies and practices change, all registered pesticides continue to meet the statutory standard of no unreasonable adverse effects to human health and the environment. Changes in science, public policy, and pesticide use practices will occur over time. Through the registration review program, the Agency periodically reevaluates pesticides to make sure that as change occurs, products in the marketplace can be used safely.

As part of the implementation of the Registration Review program pursuant to Section 3(g) of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Agency is conducting an evaluation to determine whether the cypermethrins continue to meet the FIFRA standard for registration. This problem formulation for the environmental fate and ecological risk assessment chapter, in support of the registration review, is intended for the initial docket opening the public phase of the review process.

2.2 Previous Risk Assessments and Scientific Advisory Panels

Cypermethrin was first registered in 1984 by FMC Corporation, who also subsequently registered the isomer enriched zeta-cypermethrin in 1992. Current technical registrants for the cypermethrins include FMC, Syngenta, United Phosphorus International, and Valent BioSciences. Data for the two active ingredients are considered interchangeable.

The most recent review performed for the cypermethrins was the national-level EFED chapter of the Reregistration Eligibility Decision Document (EFED RED, dated July 30th 2005; DP Barcode: D289427). The review indicated risk concerns for freshwater and estuarine/ marine organisms, including benthic organisms. The RED evaluated six crop scenarios using the technical grade active ingredient (TGAI) (CA cotton, MS cotton, NC cotton, TX cotton, GA pecans, and CA lettuce (head)). For the agricultural uses, model-generated exposure values suggested that application rates can result in acute risk to fish and aquatic invertebrates (freshwater and estuarine/ marine) with triggers that included acute risk, restricted use and endangered species concern, depending on the crop scenario and endpoint assessed. Although concern for estuarine/ marine endangered invertebrates was triggered, EFED noted there were no listed species under this category. However, it appears that at the present time there are listed estuarine/ marine species. Evaluating chronic risk from this exposure scenario showed that the level of concern (LOC) triggers were exceeded for freshwater and estuarine/ marine invertebrates and freshwater fish, depending on the crop scenario. Estuarine/ marine fish RQs did not exceed the chronic LOC.

In the RED risk assessment, acute and chronic risk estimates did not exceed the LOCs for listed or non-listed mammalian and avian species, except for small birds and mammals feeding primarily on short grass (cotton use only). Although the Agency did not conduct a quantitative risk assessment for beneficial insects at the time, toxicity studies with honey bees show that the cypermethrins are highly toxic on an acute contact basis. This suggests that the cypermethrin are toxic to nontarget beneficial insects, as well as listed insect species.

In addition to the RED, there have been multiple Section 3 New Use Risk Assessments completed for zeta-cypermethrin (e.g., DP Barcodes: D345424, D378755, D378762, D378759, D385091, D385093, D385094, D248635, D258796, D258797, D258798, D258807, D258809, and D258810). Risks identified in these assessments were similar to those identified in the RED.

1999 Scientific Advisory Panel[1]

A FIFRA Scientific Advisory Panel (SAP) in 1999 examined the sediment toxicity and fate of synthetic pyrethroids. In response to a question regarding whether sediment toxicity data on one pyrethroid (cypermethrin) could be used to predict sediment toxicity to all pyrethroids, the panel generally supported the method of using data from a few pyrethroids to extrapolate information on toxicity to other pyrethroids. The panel recommended testing cypermethrin, bifenthrin (relatively non-toxic to freshwater aquatic organisms, very insoluble in water, large bioconcentration factor) and possibly tefluthrin (highly toxic to freshwater aquatic organisms, stable in water, intermediate solubility in water to cypermethrin and bifenthrin). Although this

[1] http://www.epa.gov/scipoly/sap/meetings/1999/022399_mtg.htm.

agreement was made in 1999, the new CFR Part 158 requirements include sediment toxicity tests and these studies are considered particularly important for ecological risk assessment of all synthetic pyrethroids.

While the biota-sediment-accumulation-factor is a widely accepted method of assessment of bioaccumulation in sediment organisms, the Panel indicated that the bioconcentration data for *Daphnia* and *Hyalella* should be sufficient to predict bioconcentration of pyrethroids. Finally, the Panel indicated that use of a solid phase microextraction (SPME) method to determine the dissolved concentration in water could be used to account for sorption of pyrethroids to organic carbon and colloids present in the water column in the measurement of bioconcentration factors.

In 2003 and in response to the comments from the SAP on pyrethroids, EFED requested the following studies on the pyrethroids cyfluthrin, cypermethrins, esfenvalerate and bifenthrin (Rexrode & Meléndez, memorandum dated 12/22/03):

850.1735: Acute Sediment (freshwater)

- Test organism: *Hyalella azteca* and *Chironomus dilutus*.
- Duration: 10 days, endpoint is survival.

EFED has received these studies and is currently in the process of reviewing them.They will be incorporated into the risk assessment.

EPA/600/R01/020: Chronic Estuarine/Marine Sediment Testing

- 28 day test on *Leptocheirus plumulosus*.
- Percentage of neonates that survive as adults.
- Growth rate.
- Reproduction (#eggs/ female, *etc*.).
- Behavior.

A chronic 65-day freshwater test was also requested only for the cypermethrins. This study has not yet been submitted to the Agency.

EPA/600/R-991064: *Chronic Freshwater Sediment Testing*

- 65 day test on *Chironomus dilutus*.
- Survival.
- Growth rate.
- Reproduction (# eggs/ female, time to oviposition, proportion of females ovipositing, % hatch).

This study has not yet been submitted to the Agency.

2009 Scientific Advisory Panel

OPP presented a “Proposed Common Mechanism Grouping for the Pyrethrins and Synthetic Pyrethroids” to a FIFRA SAP in June 2009. OPP proposed two subgroups based on Type I or Type II effects related to sodium current tails and neurobehavioral impact, with esfenvalerate and fenpropathrin showing symptoms of both types. The panel agreed with OPP and indicated that substances with mixed characteristics could be included in both groups (see p. 18 of SAP minutes, USEPA 2009). The cypermethrins are a Type II pyrethroid insecticide, with a cyano-substitution in the *alpha*-position. Other Type II pyrethroids include cyfluthrin, deltamethrin, cyphenothrin, fenvalerate, and fluvalinate. This mechanism of action assessment was performed by OPP/HED and presented to the SAP to determine if a cumulative human health assessment is required for the synthetic pyrethroids. Information on the SAP is available in the docket (with non-copyright material available at http://www.regulations.gov) under EPA-HQ-OPP-2008-0489. HED conducted a conservative screening level cumulative risk assessment in 2011, which is also available in the docket under EPA-HQ-OPP-2011-0746.

EFED does not currently conduct cumulative ecological risk assessments for several reasons. Specifically, the Division does not currently have the methodology to conduct similar cumulative risk assessments for all of the (non-human) biological entities for which EFED has responsibility. In addition to addressing the toxicological aspects of the cumulative effects of multiple pyrethroids to multiple biological entities, a cumulative ecological risk assessment would likely require consideration of exposure at a watershed scale in order to incorporate spatial and temporal variability in pyrethroid applications into cumulative exposure assessment. EFED does not have the modeling tools developed for conducting this type of assessment. However, EFED will consider open literature, currently available models and other lines-of-evidence (*e.g.*, monitoring data) as available, to address the potential for cumulative effects of pyrethroids and pyrethrins in the risk description of the ecological risk assessment for the cypermethrins.

National Water Quality Assessment (NAWQA)

Cypermethrins are included in the NAWQA sampling and analysis program (http://infotrek.er.usgs.gov/apex, accessed 12/09/2011). It was measured in 6.7% of water samples as "code 61586, Cypermethrin_ water_ filtered_ recoverable_ micrograms per liter." Because cypermethrins are expected to partition to sediments (and therefore suspended solids), it is not expected to be found in filtered water samples. Cypermethrins were measured, at a detection limit below 1 ppb, in a combination of surface water and ground water samples in all 50 states except Alaska, Arkansas, the District of Columbia, and North Dakota, **Table 2.1** below gives the total number of samples analyzed in each state.

Table 2.1. Number of NAWQA Water Samples analyzed for Cypermethrins

State	No. of Water Samples	State	No. of Water Samples
AL	62	MO	41
AK	0	MT	35
AZ	64	NE	98
AR	0	NV	65
CA	>500	NH	18
CO	197	NJ	147
CT	87	NM	180
DE	14	NY	119
DC	0	NC	118
FL	215	ND	0
GA	195	OH	79

HI	15	OK	11
ID	124	OR	64
IL	166	PA	15
IN	124	RI	5
IA	200	SC	116
KS	42	SD	2
KY	2	TN	105
LA	89	TX	345
ME	31	UT	99
MD	80	VT	3
MA	81	VA	69
MI	117	WA	240
MN	153	WV	5
MS	62	WI	125
		WY	125

A total of five (5) samples were found to have cypermethrins above the detection limit, as detailed in **Table 2.2** below. Four of the five detections were in surface water. All detections were well below one part-per-billion. However, these concentrations exceed the 96-hour LC_{50} for Mysid shrimp (0.00475 ppb), and the 96-hour EC_{50} (0.0036 ppb) and the 10-day LC_{50} (0.00257 ppb pore water) for *Hyalella azteca* (**Table 4.2**).

Table 2.2. Detections of Cypermethrins in NAWQA Water Samples

State	Location	Station	Cypermethrin, ppb
CA	Merced county, San Joaquin-Tulare Basin	Culvert discharge to Mustang C A Monte Vista Ave, Sta. ID 373115120382801	0.0175
OR	Marion county, Willamette basin	Zollner Creek near Mt. Angel, OR, Sta ID 14201300	0.0062
TN	Cocke county, Tennessee River Basin	Nolichucky River near Lowland, Sta. ID 03467609	0.0125
TX	Montgomery county, Place name TS-60-53-725	Sta. ID 300825095274801 (ground water)	0.0086
UT	Salt Lake county, Great Salt Lake Basin	Little Cottonwood Creek @ Jordan River Nr SLC	0.0094

Aquatic Life Criteria and Aquatic Life Benchmarks

The Clean Water Act requires the Agency to publish water quality criteria that accurately reflect the latest scientific knowledge on the kind and extent of all identifiable effects on health and welfare which might be expected from the presence of pollutants in any body of water, including ground water. While these recommended criteria do not, in themselves, impose any requirements, states and authorized tribes can use them to develop water quality standards. The US EPA Aquatic Life Ambient Water Quality Criteria document may be found at http://www.epa.gov/waterscience/criteria/ (accessed 12/06/11). No criteria for cypermethrin have been published.

For the cypermethrins, OPP has published aquatic life benchmarks for freshwater species, based on the most sensitive species from the most recent risk assessments (refer to the following site http://www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm#benchmarks accessed

12/06/11). The benchmarks are 0.195 ppb (fish acute), 0.14 ppb (fish chronic), 0.21 ppb (invertebrate acute), and 0.069 ppb (invertebrate chronic).

The Water Quality Criteria Report for Cypermethrin, prepared by University of California at Davis for The Central Regional Water Quality Control Board provides aquatic life criteria for freshwater species in the Sacramento River and San Joaquin River basins (report can be found at http://www.swrcb.ca.gov/rwqcb5/water_issues/tmdl/central_valley_projects/central_valley_pesticides/criteria_method/index.shtml accessed 12/19/2011). The report determined that aquatic life should not be impacted if the four-day average concentration of cypermethrins does not exceed 0.002 ppb and if the one-hour average concentration does not exceed 0.001 ppb more than once every three years.

Impaired Water Bodies
The cypermethrins are not identified as a cause of impairment for any water bodies listed as impaired under section 303(d) of the Clean Water Act[2]. In addition, no Total Maximum Daily Loads (TMDL) have been developed for the cypermethrins[3]. More information on impaired water bodies and TMDLs can be found at the Agency's website[4]. The Agency invites submission of water quality data for this pesticide. To the extent possible, data should conform to the quality standards in Appendix A of the *OPP Standard Operating Procedure: Inclusion of Impaired Water Body and Other Water Quality Data in OPP's Registration Review Risk Assessment and Management Process*[5] in order to ensure they can be used quantitatively or qualitatively in pesticide risk assessments.

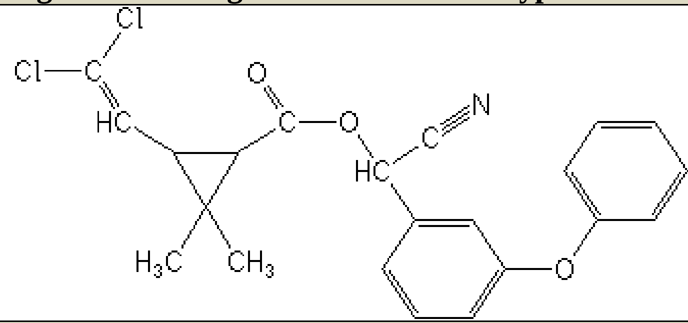
3 Stressor Source and Distribution

Cypermethrin (CAS number 52315-07-8) is a pyrethroid pesticide prepared from the esterification of 3-phenoxybenzaldehyde and 3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylic acid. It consists of a mixture of four diastereoisomers, each of which is present as a pair of enantiomers, resulting in eight geometrical and optical isomers. Cypermethrin is used to control many pests, including those of cotton, fruit, and vegetable crops. It also has several non-agricultural uses, such as for crack, crevice, and spot treatment to control insect pests in stores, warehouses, industrial buildings, houses, apartment buildings, greenhouses, laboratories, and on ships, railcars, buses, trucks, and aircraft. It may also be used in non-food areas in schools, nursing homes, hospitals, restaurants, hotels, in food processing plants, and to control insects on horses. Cypermethrin is usually formulated as an emulsifiable concentrate or wettable powder for agriculatural applications, and is usually applied by ground or aerial application as a foliar spray. Like all pyrethroids, cypermethrin affects insects by acting as a neural toxin that can result in muscle spasms, paralysis and death.

Table 3.1 provides some identification information for cypermethrin and zeta-cypermethrin. The general structures of both compounds are provided in **Figures 3-1** and **3-2**.

[2] http://iaspub.epa.gov/tmdl_waters10/attains_nation_cy.cause_detail_303d?p_cause_group_id=885
[3] http://iaspub.epa.gov/tmdl_waters10/attains_nation.tmdl_pollutant_detail?p_pollutant_group_id=885&p_pollutant_group_name=PESTICIDES
[4] http://www.epa.gov/owow/tmdl/
[5] http://www.epa.gov/oppsrrd1/registration_review/water_quality_sop.htm

Figure 3-1. The general structure of cypermethrin



Cypermethrin is a combination of 8 stereoisomers with percentage compositions ranging from 11-14%, and very low volatility and water solubility. Zeta-cypermethrin is an enriched enantiomer of cypermethrin consisting of the 4 stereoisomers with an “S” configuration at the cyano-bearing carbon at 24% each, and 4 insecticidally less active stereoisomers at a concentration of 1% each. Since the analytical method does not distinguish cypermethrin from zeta-cypermethrin, and the toxicological endpoints are the same, the Agency’s environmental fate assessment considers both cypermethrins.

Figure 3-2. Specific structures of each of the isomers of zeta-cypermethrin

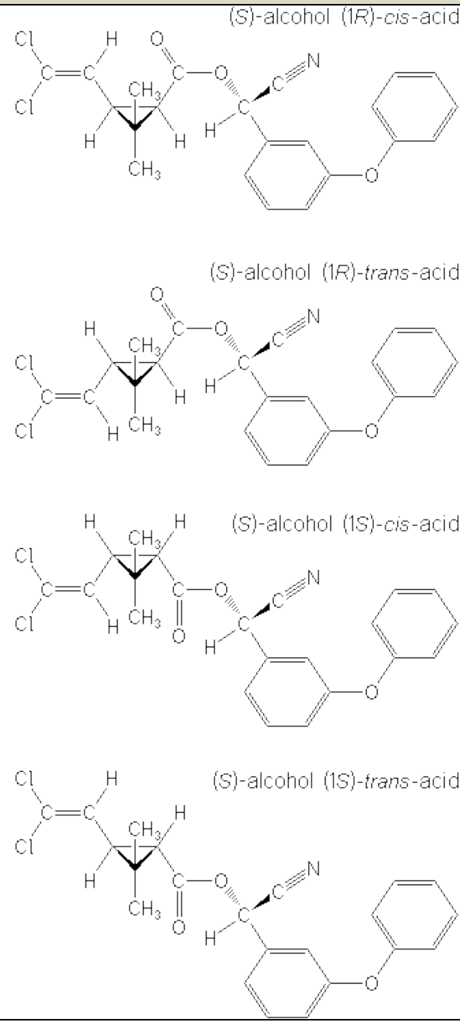


Table 3.1. Identification information for cypermethrin and zeta-cypermethrin

PARAMETER	VALUE(s)	SOURCES
SMILES notation	ClC(Cl)=CC1C(C)(C)C1C(=O)OC(C#N)c2cccc(Oc3ccccc3)c2	
Nomenclature of Cypermethrin (IUPAC Names)	<u>Cypermethrin:</u> (*RS*)-α-cyano-3-phenoxybenzyl (1*RS*,3*RS*,1*RS*,3*SR*)-3-(d,d-dichlorovinyl)-2,2-dimethylcyclopropanecorboxylate <u>Zeta-cypermethrin:</u> mixture of the stereoisomers (*S*)-α-cyano-3-phenoxybenzyl (1*RS*,3*RS*;1*RS*,3*SR*)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate where the ratio of the (*S*);(1*RS*,3*RS*) isomeric pair to the (*S*);(1*RS*,3*SR*) isomeric pair lies in the ratio range 45-55 to 55-45 respectively	USEPA 2006b
Nomenclature of Cypermethrin (CAS Names)	<u>Cypermethrin:</u> cyano(3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate <u>Zeta-cypermethrin:</u> (*S*)-cyano(3-phenoxyphenyl)methyl 3-(2,2-	USEPA 2006b

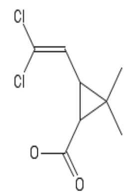
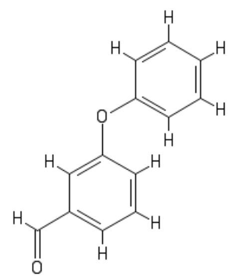
Table 3.1. Identification information for cypermethrin and zeta-cypermethrin		
PARAMETER	**VALUE(s)**	**SOURCES**
	dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate	
PC Code	Cypermethrin: 109702 Zeta-cypermethrin: 129064	USEPA 2006b
CAS Reg. Nos.	52315-07-8	USEPA 2006b
Molecular Formula	$C_{22}H_{19}Cl_2NO_3$	USEPA 2006b
Molecular Weight	416.3	USEPA 2006b
The structures of cypermethrin and zeta-cypermethrin from the chemical's data sheet accessed 12/06/2011 and available at http://www.alanwood.net/pesticides.html .		

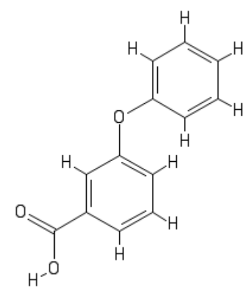
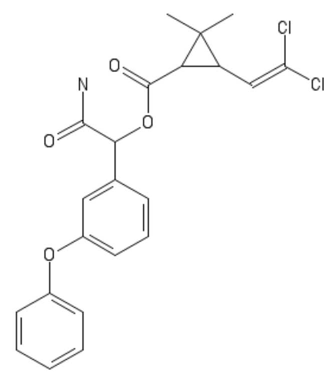
Cypermethrins' water solubility of 4.0×10^{-3} mg/L and its hydrophobic nature leads to strong soil adsorption and a tendency to partition to sediment in aquatic systems. The reported log octanol/water partition coefficient value (6.4) suggests that the cypermethrins have the potential to bioaccumulate in aquatic organisms, assuming that chemical metabolism is negligible. The cypermethrins have a high molecular weight of 416.3 g/mmol. With a vapor pressure of 2.5×10^{-9} mm Hg and a limited solubility, the calculated Henry's Law Constant for the cypermethrins is relativiely low (3.4×10^{-7} atm-m^3/mol). **Table 3.2** lists various important physicochemical characteristics of the chemicals. **Table 3.14** lists available environmental fate characteristics of the cypermethrins, along with information on the major and minor degradates detected in the submitted environmental fate studies.

Table 3.2. Physical and Chemical Properties of the Cypermethrins.		
Property	**Value**	**Reference**
Water solubility	4.0×10^{-3} mg/L	Laskowski (2002)
Melting point	78-81 ^{o}C	Tomlin 1994
Boiling point	200 ^{o}C at 9.3 Pa	Tomlin 1994
Vapor pressure	2.5×10^{-9} mm Hg	Laskowski (2002)
log K_{ow}	6.4	Laskowski (2002)
Henry's Law constant	3.4×10^{-7} atm-m^3/mol	Laskowski (2002)

Cleavage at the ester moiety of the cypermethrins results in two primary degradation products, 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylic acid (DCVA) and 3-phenoxybenzaldehyde, which degrades further to 3-phenoxybenzoic acid (3-PBA). Based on the assumption that cleavage of the ester bond in the parent compound results in biologically inactive degradates, these compounds are not expected to pose greater toxicity to non-target organisms; therefore only the parent compounds were considered for toxicological concern for both aquatic and terrestrial ecosystems. In fact, this assumption is supported by the results of acute toxicity studies in freshwater fish and invertebrates which indicate that the zeta-cypermethrin degradate 3-phenoxy benzoic acid is much less toxic than the parent compound.

Figure 3.3 shows the chemical structures of the cypermethrins' major potential degradation products.

Figure 3.3. Nomenclature and Structures of Potential Degradation Products of the Cypermethrins		
Common Name	**Chemical Name**	**Structure**
DCVA	3-(2,2-dichloroethenyl)-2,2-dimethylcyclo-propane carboxylic acid	
	3-phenoxy-benzaldehyde	

3-PBA	3-phenoxybenzoic acid	
	cyperamide	

3.1 Mechanism of Action

The pyrethroids (including the cypermethrins) share similar modes of action, and are considered axonic poisons that affect both the peripheral and central nervous system. It is now well established that severe neurological symptoms of poisoning with pyrethroids in mammals and insects are the result of modification of sodium (Na^+) channel activity (cellular pores through which sodium ions are permitted to enter the axon to cause excitation) (Matsumura 1985). Advanced electrophysiological experiments using a voltage clamp and a patch clamp, together with ligand-binding and ionic flux experiments, have unveiled unique actions of pyrethroids of keeping the Na^+ channel in the open state for an extremely long period, sometimes as long as several seconds. This modification of Na^+ channel properties leads to hyperactivity of the nervous system. This action leads to spontaneous depolarizations, augmented neurotransmitter secretion rate and neuromuscular block, which ultimately results in paralysis of the insect. Pyrethroids have also been shown to suppress gamma-aminobutyric acid GABA and glutamate receptor-channel complexes and voltage-activated calcium (Ca^{2+}) channels, but the toxicological significance of these actions is uncertain.

Relative to physiological responses, researchers have designated two types of pyrethroids, Type I (e.g., pyrethrins, S-bioallethrin, resmethrin, permethrin) and Type II (e.g., the cypermethrins, deltamethrin, fenvalerate). The cypermethrins are classified as Type II synthetic pyrethroids, with a cyano group at the α-carbon position of the alcohol moiety, and is considered a third generation pyrethroid, that is, more light-stable and persistent in the environment than early pyrethroids like allethrin, phenothrin (also commonly known as sumithrin) and resmethrin. The cypermethrins have three optically active centers and is composed of 8 isomers, and like all pyrethroids, is a contact poison that can quickly penetrate the nervous system and have an effective "knockdown" action (induction of temporary paralysis) for most flying insects.

3.2 Overview of Pesticide Usage

The use information presented in this problem formulation was obtained from the tables in Appendix A-1 and Appendix A-2 dated 10/12/2011 and 05/24/2011, from BEAD's Chemical Profile for Registration Review (USEPA 2011), from various evaluated labels, and from the July 2006 Reregistration Eligibility Decision Document for Cypermethrin. Due to the variable use patterns for cypermethrin and zeta-cypermethrin, the chemical uses will be discussed separately. There are currently 64 Section 3 registered products as well as 13 Special Local Needs (SLN) registrations for cypermethrin. There are currently 47 Section 3 registered products as well as 50 SLN registrations for zeta-cypermethrin.

Cypermethrin has numerous uses. A summary of agricultural use patterns based on maximum application rate per crop group for cypermethrin and zeta-cypermethrin is shown **Table 3.3** and **3.4**, respectively.

Table 3.3. Summary of Agricultural Use Information for the Cypermethrin

Use	Maximum Applic. Rate	Maximum Seasonal Rate	Maximum Number of Applications	Minimum Retreatment Interval (days)
Crop Group 1 (Root and Tuber Vegetables): Carrot **Crop Group 3 (Bulb Vegetables):** Garlic, Leek, Onion, Shallot **Crop Group 4 (Leafy Vegetables (Except Brassica)):** Lettuce (Leaf and Head), Spinach, Chinese Spinach **Crop Group 5 (Leafy Brassica Vegetables):** Broccoli, Broccoli Raab, Chinese Broccoli, Brussels Sprouts, Cabbage, Cauliflower, Collards, Kale, Kohlrabi, Mustard Greens, Mustard Spinach, Rape Greens **Crop Group 14 (Nut Trees):** Pecan **Crop Group 15 (Cereal Grains):** Corn **Crop Group 20 (Oilseed Crops):** Cotton **Crop Group 99 (No Name Group):** Chinese Mustard				
Crop Group 3	0.1 lb a.i./A	0.5 lb a.i./A	NS	7
Crop Group 4	0.1 lb a.i./A	0.6 lb a.i./A	NS	7
Crop Group 5	0.1 lb a.i./A	0.6 lb a.i./A	NS	7
Crop Group 14	0.1 lb a.i./A	0.6 lb a.i./A	NS	7
Crop Group 20	0.1 lb a.i./A	0.6 lb a.i./A	NS	5
Crop Group 99	0.1 lb a.i./A	0.4 lb a.i./A	NS	7

Table 3.4. Summary of Agricultural Use Information for the Zeta-Cypermethrin

Use	Maximum Applic. Rate	Maximum Seasonal Rate	Maximum Number of Applications	Minimum Retreatment Interval (days)
Crop Group 1 (Root and Tuber Vegetables): Arracacha, Arrowroot, Artichoke (Chinese and Jerusalem), Beet (Garden and Sugar), Carrot, Cassava, Celeriac, Chayote, Chicaory, Chufa, Dasheen, Ginseng, Horseradish, Leren, parsley, Parsnip, Potato, Radish, Rutabaga, Salsify (Black and Spanish), Skirret, Sweet Potato, Tanier, Taro, Turnip, Yam (True and Bean) **Crop Group 2 (Leaves of Root and Tuber Vegetables):** Garden Beet, Burdock, Cassava, Chicory **Crop Group 3 (Bulb Vegetables):** Garlic, Leek, Onion (Bulb and Green), Shallot **Crop Group 4 (Leafy Vegetables (Except Brassica)):** Leafy Amaranth, Arugula, Cardoon, Celery, Celtuce, Chervil, Chrysanthemum (Edible Leaved and Garland), Corn Salad, Cress (Garden and Upland), Dandelion, Dock, Endive, Florence Fennel, Lettuce (Head and Leaf), Orach, Parsley, Purslane (Garden and Winter), Radicchio, Rhubarb, Spinach (including Chinese, New Zealand, and Vine), Swiss Chard, Tampala **Crop Group 5 (Leafy Brassica Vegetables):** Broccoli, Broccoli Raab, Chinese Broccoli, Brussels Sprouts, Cabbage (including Bok Choy, Mustard, and Napa), Cauliflower, Collards, Kale, Kohlrabi, Mustard Greens, Mustard Spinach, Rape Greens **Crop Group 6 (Legume Vegetables):** Bean (Adzuki, Broad, Dry, Kidney, lablab, Lima, Moth, Mung, Navy, Pinto Rice, Runner, Snap, Succulent, Tepary, Urd Wax, Yardlong), Catjang, Chickpea, Cowpea, Guar, Jackbean, Lentil, Lupi, Pea (Blackeyed, Crowder, Dry, Dwarf, English, Garden, Green, Pigeon, Snow, Southern, Succulent, Sugar Snap), Soybean **Crop Group 7 (Foliage of Legume Vegetables):** Soybean, Forage **Crop Group 8 (Fruiting Vegetables):** Eggplant, Groundcherry, Okra, Pepino, Pepper (Bell, Nonbell, Sweet Nonbell), Tomatillo, Tomato **Crop Group 9 (Cucurbit Vegetables):** Balsam Pear, Cantaloupe, Chayote, Cucumber, Chinese Cucumber, Cherkin, Edible Gourd, Melon, Muskmelon, Pumpkin, Squash (Summer and Winter), Watermelon, Chinese Waxgourd **Crop Group 10 (Citrus Fruits):** Calamondin., Citron, Citrus, Grapefruit, Kumquat, Lemon, Lime, Satsuma, Mandarin, Orange (Sour and Sweet), Pummelo, Tangelo, Tangerine **Crop Group 11 (Pome Fruits):** Apple, Crabapple, Loquat, Pear, Oriental Pear, Quince **Crop Group 12 (Stone Fruits):** Apricot, Cherry (Sweet and Tart), Nectarine, Peach, Plum, Japanese Plum, Prune **Crop Group 13 (Berry and Small Fruits):** Blackberry, Blueberry, Currant, Elderberry, Gooseberry, Grape, Huckleberry, Loganberry, Raspberry **Crop Group 14 (Nut Trees):** Almond, Beechnut, Butternut, Cashew, Chestnut, Chinquapin, Hazelnut, Brazil Nut, Hickory Nut, Macadamia Nut, Pecan, Walnut **Crop Group 15 (Cereal Grains):** Corn (Field, Pop, and Sweet), Millet, Wild Rice, Grain Sorghum, Triticale, Wheat **Crop Group 16 (Cereal Grans, Forage, Fodder, and Straw):** Field Corn, Grass hay, Millet, Rice, Sorghum, Wheat **Crop Group 17 (Grass, Forage, Fodder, and Hay):** Bahiagrass, Bentgrass, Bermudagrass, Bluegrass, Big Bluestem, Buffalograss, Canary Grass (Annual and Reed), Dallisgrass, Foxtail (Creeping and Meadow), Rangeland Grass, Indiangrass, Lovegrass, Orchardgrass, Pangolagrass, Pasture, Sudangrass, Timothy **Crop Group 18 (Nongrass Animal Feed):** Alfalfa, Clover, Crownvetch, Kudzu, Lespedeza, Lupin, Sweet Lupin, Sainfoin, Trefoil, Velvetbean, Vetch, Milk Vetch **Crop Group 19 (Herbs and Spices):** Borage, Chervil, Fennel, Marigold, Mustard, Poppy **Crop Group 20 (Oilseed Crops):** Canola, Castorbean, Cotton, Crambe, Flax, Jojoba, Lesquerella, Meadowfoam, Rapeseed, Safflower, Sesame, Sunflower **Crop Group 99 (No Name Group):** Asparagus, Chinese Mustard, Peanut, Sugarcane, Tea				
Crop Group 1	0.05 lb a.i./A	0.3 lb a.i./A	NS	4
Crop Group 2	0.025 lb a.i./A	0.11 lb a.i./A	2	7
Crop Group 3	0.05 lb a.i./A	0.25 lb a.i./A	NS	7
Crop Group 4	0.05 lb a.i./A	0.3 lb a.i./A	NS	7
Crop Group 5	0.05 lb a.i./A	0.3 lb a.i./A	NS	7
Crop Group 6	0.05 lb a.i./A	0.3 lb a.i./A	NS	5
Crop Group 7	0.05 lb a.i./A	0.3 lb a.i./A	NS	7
Crop Group 8	0.05 lb a.i./A	0.3 lb a.i./A	NS	7
Crop Group 9	0.05 lb a.i./A	0.3 lb a.i./A	NS	7
Crop Group 10	0.05 lb a.i./A	0.2 lb a.i./A	NS	14
Crop Group 11	0.05 lb a.i./A	0.3 lb a.i/A	NS	7
Crop Group 12	0.05 lb a.i./A	0.3 lb a.i/A	NS	7
Crop Group 13	0.05 lb a.i./A	0.3 lb a.i./A	NS	7
Crop Group 14	0.05 lb a.i./A	0.25 lb a.i./A	NS	7
Crop Group 15	0.05 lb a.i./A	0.3 lb a.i./A	NS	3 to 5
Crop Group 16	0.05 lb a.i./A	0.3 lb a.i./A	NS	7
Crop Group 17	0.05 lb a.i./A	0.25 lb a.i./A	NS	7 for forage and hay

				17 days for straw and seed
Crop Group 18	0.05 lb a.i./A	0.15 lb a.i./A	NS	7
Crop Group 19	0.05 lb a.i./A	0.3 lb a.i./A	NS	7
Crop Group 20	0.05 lb a.i./A	0.3 lb a.i./A	NS	7
Crop Group 99	0.1 lb a.i./A	0.4 lb a.i./A	NS	7

Cypermethrin and zeta-cypermethrin are Restricted Use Pesticides (RUP) for agricultural uses because of their acute toxicity to aquatic organisms. For agricultural products, application methods include aerial, air blast, ground spray, or chemigation. As per requirements from the Reregistration Eligibility Decision (USEPA 2006b, revised in 2008), the following labeling statements were required for agricultural products to avoid spray drift and contamination of aquatic environments.

BUFFER ZONE REQUIREMENTS for AGRICULTURAL CROPS

- **Vegetative Buffer Strip**:
  - Construct and maintain a minimum 10-foot-wide vegetative filter strip of grass of other permanent vegetation between the field edge and down gradient aquatic habitat (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or natural ponds; estuaries; and commercial fish farm ponds).
  - Only apply products containing Cypermethrin/Zeta-cypermethrin onto fields where a maintained vegetative buffer strip of at least 10 feet exists between the field and down gradient aquatic habitat.
- **Buffer Zone for Ground Application (groundboom, overhead chemigation, or airblast):**
  - Do not apply within 25 feet of aquatic habitats (such as but not limited to, lakes, reservoirs, rivers, streams, marshes, ponds, estuaries, and commercial fish ponds).
- **Buffer Zone for ULV Aerial Application:**
  - Do not apply within 450 feet of aquatic habitats (such as but not limited to, lakes, reservoirs, rivers, streams, marshes, ponds, estuaries, and commercial fish ponds).
- **Buffer Zone for Non-ULV Aerial Application:**
  - Do not apply within 150 feet of aquatic habitats (such as but not limited to, lakes, reservoirs, rivers, streams, marshes, ponds, estuaries, and commercial fish ponds).

SPRAY DRIFT MANAGEMENT for AGRICULTURAL CROPS

- **Wind Direction and Speed:**
  - Only apply this product if the wind direction favors on-target deposition.
  - Do not apply when the wind velocity exceed 15 mph.
- **Temperature Inversion**
  - Do not make aerial or ground applications into temperature inversions.
  - Inversions are characterized by stable air and increasing temperatures with height above the ground. Mist or fog may indicate the presence of an inversion in humid

areas. The applicator may detect the presence of an inversion by producing smoke and observing a smoke layer near the ground surface.

- **Droplet Size:**
  - Use only Medium or coarser spray nozzles (for ground and non-ULV aerial application) according to ASAE (S572) definition for standard nozzles. In conditions of low humidity and high temperatures, applicators should use a coarser droplet size.
- **Additional Requirements for Ground Applications:**
  - Wind speed must be measured adjacent to the application site on the upwind side, immediately prior to application.
  - For ground boom applications, apply using a nozzle height of no more than 4 feet above the ground or crop canopy.
  - For airblast applications, turn off outward pointing nozzles at row ends and when spraying the outer two rows. To minimize spray loss over the top in orchard applications, spray must be directed into the canopy.
- **Additional Requirements for Aerial Applications:**
  - The spray boom should be mounted on the aircraft as to minimize drift caused by wingtip or rotor vortices. The minimum practical boom length should be used and must not exceed 75% of the wing span or 80% rotor diameter.
  - Flight speed and nozzle orientation must be considered in determining droplet size.
  - Spray must be released at the lowest height consistent with pest control and flight safety. Do not release spray at a height greater than 10 feet above the crop canopy unless a greater height is required for aircraft safety.
  - When applications are made with a cross-wind, the swath will be displaced downwind. The applicator must compensate for this displacement at the downwind edge of the application area by adjusting the path of the aircraft upwind.

Cypermethrin is toxic to fish, aquatic invertebrates and beneficial insects. The following Environmental Hazards statements are required for products labeled for outdoor uses (USEPA 2006b):

<u>ENVIRONMENTAL HAZARD STATEMENTS</u>

- This pesticide is toxic to fish, aquatic invertebrates, oysters and shrimp. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean water mark. Do not apply when weather conditions favor drift from treated areas. Drift and runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Do not contaminate water when disposing of equipment wash waters.
- This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area.

Cypermethrin and zeta-cypermethrin also have multiple non-agricultural uses, as described in

Tables 3.5 and **3.6**.

Table 3.5. Summary of Non-Agricultural Uses for the Cypermethrin				
Use	**Single App. Rate**	**Number of Apps.**	**Seasonal App. Rate (lb a.i./A)**	**Interval Between Apps. (days)**
Non-food Crops Grown Outside: Ornamentals, Flowering and Foliage Plants, and Lawn				
Surface applications (including fire ants and turf diagnostic aid)	Residential: 1.8 lbs. a.i./A	NS	NS	7
NS = Not specified				

Table 3.6. Summary of Non-Agricultural Uses for the Zeta-Cypermethrin				
Use	**Single App. Rate**	**Number of Apps.**	**Seasonal App. Rate (lb a.i./A)**	**Interval Between Apps. (days)**
Non-food Crops in Greenhouse: Ornamental, Flowering and Foliage Plants				
Surface applications	0.15 lb a.i/A	NS	NS	NS
Non-food Crops Grown Outside: Ornamentals, Flowering and Foliage Plants, and Lawn				
Surface applications (including fire ants and turf diagnostic aid)	Residential: 0.5 lb a.i./A Non-residential 0.1 lb. a.i./A	NS	0.5 lb. a.i./A	NS
NS = Not specified				

The agricultural usage of cypermethrin and zeta-cypermethrin, from the Screening Level Usage Analysis (SLUA), is provided in **Tables 3.7** and **3.8**, respectively. The table is arranged by crop in alphabetical order. According to the table, the major agricultural use for cypermethrin is cotton, with 80,000 lbs a.i. applied annually, on average, and the major agricultural crop for zeta-cypermethrin is oranges, with 20,000 lbs. a.i. applied.

Table 3.7. Screening-Level Estimates of Agricultural Uses of Cypermethrin (SLUA)[6]			
		Percent Crop Treated	
Crop	**Lbs. A.I.**	**Avg.**	**Max.**
Broccoli	1,000	5	10
Brussels Sprouts*	<500	N/C	N/C
Cabbage	<500	<2.5	5
Cauliflower	<500	5	10
Cotton	80,000	10	15
Garlic	<500	10	15
Lettuce	1,000	5	10
Onions	2,000	10	15
Pecans	5,000	10	10
Spinach	<500	<1	<2.5

[6] Dated 01/21/2011

Sorted alphabetically. All numbers rounded.

<500 Less than 500 pounds of active ingredient
<2.5 Less than 2.5 percent of crop treated
<1 Less than 1 percent of crop treated
N/C Only Lbs. A.I. available
* CA data only (95% or more of U.S. acres in California)

SLUA data sources include:
- USDA-NASS (United States Department of Agriculture's National Agricultural Statistics Service) (pesticide usage data from 2001 to 2008)
- Private Pesticide Market Research (pesticide usage data from 2001 to 2008)
- California DPR (Department of Pesticide Regulation) (data for 2000 to 2008)

Table 3.8. Screening-Level Estimates of Agricultural Uses of Zeta-Cypermethrin (SLUA)[7]

		Percent Crop Treated	
Crop	**Lbs. A.I.**	**Avg.**	**Max.**
Alfalfa	15,000	<2.5	5
Almonds	<500	<1	<2.5
Apples	<500	<1	<2.5
Beans, Green	2,000	15	20
Broccoli	2,000	20	30
Brussels Sprouts *	<500	N/C	N/C
Cabbage	<500	15	30
Caneberries	<500	25	40
Canola/Rapeseed	<500	<1	<2.5
Cantaloupes	<500	5	15
Carrots	<500	<2.5	10
Cauliflower	<500	15	25
Celery	1,000	35	60
Cherries	<500	5	5
Chicory *	<500	N/C	N/C
Corn	10,000	<1	<2.5
Cotton	15,000	5	10
Cucumbers	<500	<2.5	5
Dry Beans/Peas	2,000	5	10
Garlic	<500	25	55
Grapefruit	2,000	35	50
Lemons	<500	<1	<2.5
Lettuce	15,000	55	65
Onions	2,000	25	30
Oranges	20,000	35	45

[7] Dated 01/21/2011

Peaches	<500	<2.5	5
Peanuts	<500	<1	5
Peas, Green	<500	10	15
Pecans	1,000	5	10
Peppers	1,000	15	30
Potatoes	<500	<1	5
Pumpkins	<500	<2.5	5
Rice	6,000	10	10
Sorghum	2,000	<2.5	<2.5
Soybeans	15,000	<2.5	<2.5
Spinach	1,000	30	45
Squash	<500	5	10
Sugar Beets	4,000	15	20
Sugarcane	<500	<2.5	<2.5
Sunflowers	2,000	<2.5	5
Sweet Corn	5,000	15	20
Tomatoes	1,000	5	10
Walnuts	<500	<1	<2.5
Watermelons	<500	<2.5	10
Wheat	5,000	<2.5	5
Sorted alphabetically. All numbers rounded.			
<500 Less than 500 pounds of active ingredient <2.5 Less than 2.5 percent of crop treated <1 Less than 1 percent of crop treated N/C Only Lbs. A.I. available * CA data only (95% or more of U.S. acres in California)			
SLUA data sources include: USDA-NASS (United States Department of Agriculture's National Agricultural Statistics Service) (pesticide usage data from 2001 to 2008) Private Pesticide Market Research (pesticide usage data from 2001 to 2008) California DPR (Department of Pesticide Regulation) (data for 2000 to 2008)			

BEAD provided agricultural information by state in its Cypermethrin and Zeta-Cypermethrin Chemical Profile for Registration Review (USEPA 2011). For cypermethrin, the BEAD report states: “In 1998-2000, Georgia was the state with the highest use (20%), followed by Texas (19%), California (14%) and Louisiana (12%). Other states (18%) include Arkansas, South Carolina, Alabama, North Carolina, Tennessee, and Missouri. In 2008-2010, the state with the highest use was again Georgia (27%), followed by Louisiana (20%), and Mississippi (16%), and the “other” states accounted for (10%) and included South and North Carolina, Florida, California, and Missouri.” For zeta-cypermethrin, the BEAD report states: “[From 1998-2000] Arkansas was the state with the highest use (21%) followed by Missouri (16%), and Texas (11%), with the “other” states (26%) being Louisiana, California, Arizona, Oklahoma, Alabama, and Florida. In 2008-2010, Florida (18%) was the state with the highest use, followed by

California (12%), and Missouri, Illinois, and Texas each at 6%. The “other” states accounted for 33% of use and included Iowa, Minnesota, Arkansas, Montana, Tennessee, Washington, and Indiana.” **Figures 3-4** and **3-5** show the 2002 estimated annual agricultural use of cypermethrin and zeta-cypermethrin according to the USGS-NAWQA data.

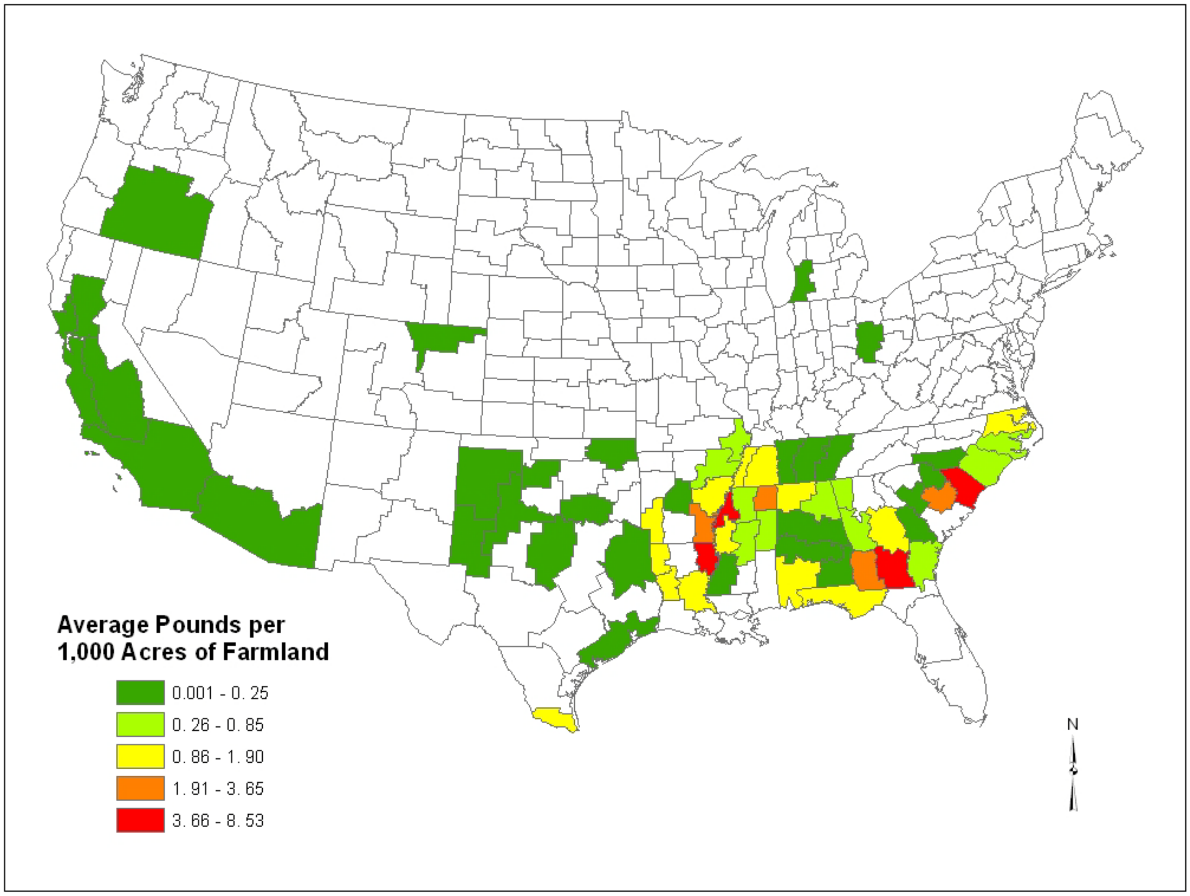


Figure 3-4. Cypermethrin Usage by Crop Reporting District (2006-2010)

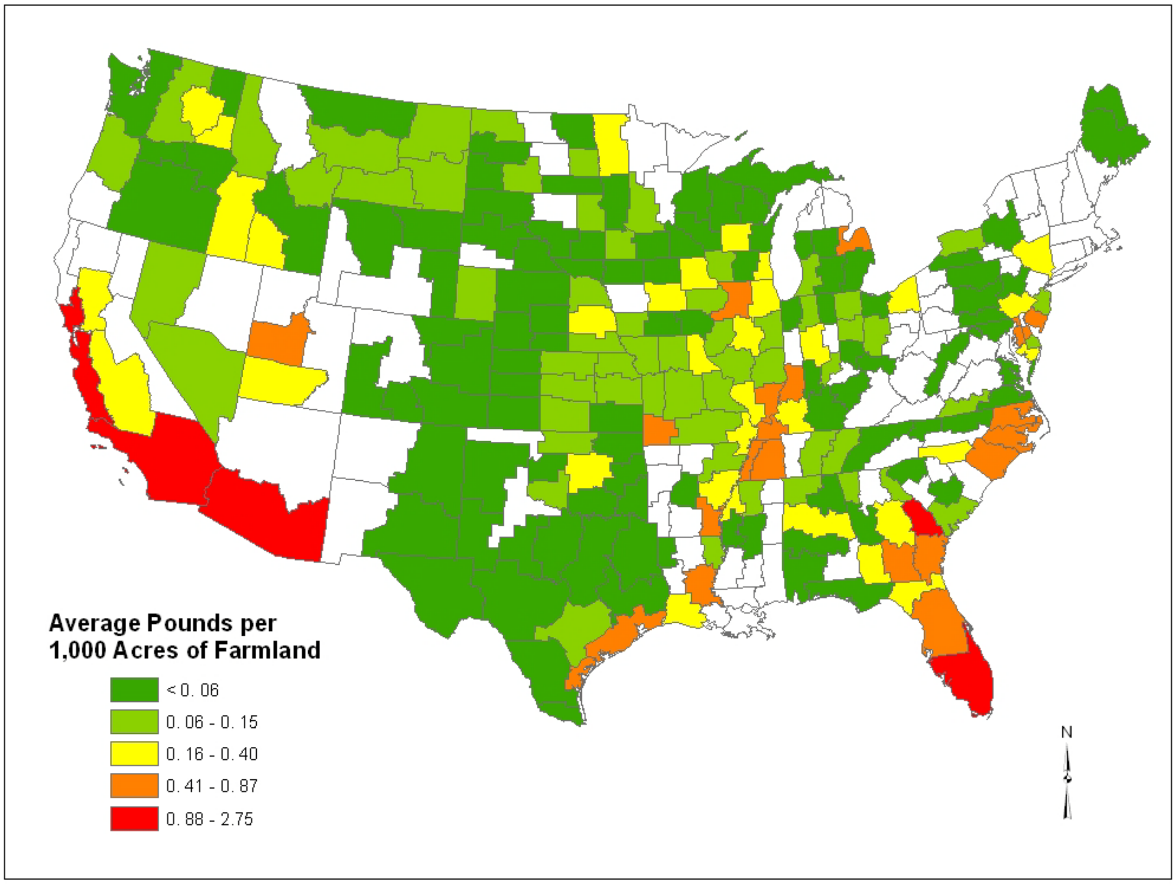


Figure 3-5. Zeta-cypermethrin Usage by Crop Reporting District (2006-2010)

Tables 3.9 and **3.10** provide a summary of several nonagricultural (terrestrial/ outdoor) or non-crop uses for cypermethrin and zeta-cypermethrin, respectively. The uses are classified by broad categories as follows: commercial animal housing, outdoor agricultural premises, residential sites – outdoors, and outdoor eating establishments. For various uses, the maximum application rate is expressed in units other than "lb a.i./A". Many of the uses may well involve substantive exposure to wildlife, especially aquatic organisms, and they will be assessed accordingly (*e.g.*, surface applications).

Table 3.9. Non-Crop Outdoor Uses for Cypermethrin

Use	Max. App. Rate/ units	Max. No. Applications/ Year	Max. App. Rate per Year	Min. App. Interval (days)
Commercial Animal Housing Animal areas and quarters; Animal shelters; Catteries; Dog runs; Kennels; Pet grooming shops; Pet stores; Research animal quarters; Zoos. (Animals are not present during application)				
Surface - Crack and crevice or spot	0.017 lb. a.i./gal	NS	NS	NS
Space – General	0.0032 lb a.i/1,000 ft^3	NS	NS	NS

Table 3.9. Non-Crop Outdoor Uses for Cypermethrin				
Use	**Max. App. Rate/ units**	**Max. No. Applications/ Year**	**Max. App. Rate per Year**	**Min. App. Interval (days)**
Outdoor Agricultural Premises Empty Uncultivated Agricultural Areas: Corrals; Dairy areas; Farms; Goat holding areas; Hog operations; Rights-of-way; Sheep holding areas. Empty Cattle Feedlots: Beef cattle operations; Feedlots; Holding lots; Livestock lots; Swine lots and yards				
Surface - Crack and crevice or spot	0.017 lb. a.i./gal	NS	NS	NS
Residential Sites – Outdoor Ant hills; Ant nests; Ant trails; Backyards; Doors; Driveways; Entranceways; Mud dauber, wasp, and yellow jacket nests; Outside surfaces of buildings; Patio furniture; Picnic areas; Residential areas; Screens; Siding; Spigots; Storage areas; Tree holes; Under eaves; Under siding; Wall voids; Windows. Nonagricultural Outdoor Buildings/Structures: Atriums; Carports; Decks; Fences; Gazebos; Lanais; Porches; Sheds; Tree houses; Tunnels and cavities in wood; Verandas; Tents. Fencerows; Hedgerows; Nonagricultural Rights-of-way; Paths; Patios; Paved Areas: Private Roads; Sidewalks; Garbage bins; Dumpsters; Meter boxes; Electrical equipment; Electrical fittings; Manure; Compost piles.				
Surface - Crack and crevice or spot	0.017 lb. a.i./gal	NS	NS	NS

Table 3.10. Non-Crop Outdoor Uses for Zeta-Cypermethrin				
Use	**Max. App. Rate/ units**	**Max. No. Applications/ Year**	**Max. App. Rate per Year**	**Min. App. Interval (days)**
Commercial Animal Housing Animal areas and quarters; Animal shelters; Catteries; Dog runs; Kennels; Pet grooming shops; Pet stores; Research animal quarters; Zoos. (Animals are not present during application)				
Surface – General	5.12 fl oz a.i./gal	NS	NS	NS
Surface - Crack and crevice or spot	0.5 fl oz a.i./1000 ft^2	NS	NS	NS
Surface- perimeter	0.5 fl oz a.i./1000 ft^2	NS	NS	NS
Outdoor Agricultural Premises Empty Uncultivated Agricultural Areas: Corrals; Dairy areas; Farms; Goat holding areas; Hog operations; Rights-of-way; Sheep holding areas. Empty Cattle Feedlots: Beef cattle operations; Feedlots; Holding lots; Livestock lots; Swine lots and yards				
Surface - General	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Surface - Crack and crevice or spot	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Surface- perimeter	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Residential Sites – Outdoor Ant hills; Ant nests; Ant trails; Backyards; Doors; Driveways; Entranceways; Mud dauber, wasp, and yellow jacket nests; Outside surfaces of buildings; Patio furniture; Picnic areas; Residential areas; Screens; Siding; Spigots; Storage areas; Tree holes; Under eaves; Under siding; Wall voids; Windows. Nonagricultural Outdoor Buildings/Structures: Atriums; Carports; Decks; Fences; Gazebos; Lanais; Porches; Sheds; Tree houses; Tunnels and cavities in wood; Verandas; Tents. Fencerows; Hedgerows; Nonagricultural Rights-of-way; Paths; Patios; Paved Areas: Private Roads; Sidewalks; Garbage bins; Dumpsters; Meter boxes; Electrical equipment; Electrical fittings; Manure; Compost piles.				
Surface – General	0.003 lb a.i./gal	NS	NS	NS
Surface - Crack and crevice or spot	0.003 lb a.i./gal	NS	NS	NS
Surface- Perimeter	0.003 lb a.i./gal	NS	NS	7

Other uses for zeta-cypermethrin (**Table 3.11**) are classified as indoor. They include several broad categories as follows: application to agricultural premises and equipment – indoor, residential – indoor, commercial/ industrial/ institutional establishments – indoor, eating establishments – indoor, food handling and processing establishments – indoor, retail and storage

– indoor, transportation – indoor, and pet premise treatment.

Table 3.11. Indoor Uses for Zeta-Cypermethrin				
Use	**Max. App. Rate/ units**	**Max. No. Applications/ Year**	**Max. App. Rate per Year**	**Min. App. Interval (days)**
Residential – Indoor Household/Domestic Dwellings: Apartments; Cabins; Campers; Condominiums; Dwellings; Homes; Mobile homes; Recreational vehicles; Residences; Public housing; Sheds; Toolsheds; Townhouses. Household/Domestic Dwelling Contents: Beds (cracks, crevices, framework); Bedding; Bookcases; Box springs; Boxes; Cabinets; Carpet; Cooking equipment; Cut Flowers; Drawers; Dressers; Draperies; Dryers; Equipment; Fabrics; Flowering plants; Foliage plants; Formica; Furniture; Furniture bases; Furniture legs; Glass; Light fixtures; Linoleum; Machinery; Mattresses; Picture frames; Plastic fabric bags; Refrigerator; Rugs; Shelves; Shrubs; Sofas and Chairs; Sofa and Chair surfaces; Soffits; Stainless steel; Storage drawers; Stored items; Stoves; Tables; Tiles; Trees; Upholstered furniture; Upholstery; Vinyl tile; Washers. Household/Domestic Dwellings Indoor Food Handling Areas (food covered): Cupboards; Kitchens; Sinks; Underneath sinks; Food areas. Household/Domestic Dwellings Indoor Nonfood Handling Areas: Attics; Basements; Bedrooms; Closets; Closed porches; Crawl spaces; Dining rooms; Garages; Pantries; Porches; Solariums; Storage areas; Sun porches; Utility rooms; Bathrooms. Household Domestic Dwellings Indoor Premises: Baseboards; Closed void areas; Cracks and crevices; Dark corners; Doorframes; Door jambs; Doors; Door sills; Drains; Equipment voids; False ceilings; Floors; Foundations; Moldings; Moist places; Niches; Pipes; Screens; Soffits; Tunnels and cavities in wood; Walls; Windows; Window frames; Window sills; Weep holes; Woodwork; Voids in attics, walls, ceilings, and equipment. Electrical Supplies/Equipment: Meter boxes; Electrical equipment; Electrical fittings. Human Clothing (Insect and Mold/Mildew Control): Clothing; Clothing (outerwear); Clothing (in storage); Woolens. Garbage cans and Garbage/trash compactors.				
Surface applications	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Crack/crevice or spot surface	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Brush on	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Void treatment	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Foam treatment	0.5 fl oz a.i./1000 ft^2	NS	NS	7
Commercial/Industrial/Institutional Establishments – Indoor Apartments; Auditoriums; Buildings; Churches; Commercial buildings; Correctional facilities; Communications centers; Courthouses; Day care centers; Dormitories; Drugstores; Elevators; Equipment voids; Factories; Fake ceilings; Florists; Food service storage and preparation areas; Gas stations; Hotels; Industrial buildings; Industrial installations; Institutions; Interiorscapes; Jails; Kitchens; Laboratories; Laundry areas; Lavatories; Libraries; Locker rooms; Lathhouses; Missions; Motels; Movie Theatres; Museums; Non-food areas of commercial buildings; Non-residential buildings; Offices and office buildings; Other commercial, industrial, and governmental sites; Parking garages; Prisons; Public buildings; Resorts; Schools; Shadehouses; Sheds; Stores; Textile mills & warehouses; Theaters; Universities; Utilities/utility rooms; Health care facilities; Hospices; Hospitals; Nursing homes; Veterinary clinics.				
Surface applications	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Crack/crevice or spot surface	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Brush on	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Eating Establishments –Indoor Eating Establishments (Food Contact) [Equipment/Utensils; Food Handling Areas; Food Serving Areas]: Cafeterias; Restaurants; Mess halls				
Surface applications	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Crack/crevice or spot surface	0.4 fl oz a.i./1000 ft^2	NS	NS	7

Table 3.11. Indoor Uses for Zeta-Cypermethrin				
Use	**Max. App. Rate/ units**	**Max. No. Applications/ Year**	**Max. App. Rate per Year**	**Min. App. Interval (days)**
Food Handling and Processing Establishments – Indoor Food Handling and Processing Plant Premises and Equipment (Food Contact): Bakeries; Bottling plants; Beverage plants; Canneries; Conveying Equipment; Dried fruit processing plants; Feed areas of commercial buildings; Food areas of commercial buildings; Food processing plants; Fruit packing sheds; Mushroom processing plants; Peanut processing plants; Processing areas of dried food products; Tobacco processing plants; Wineries Meat Processing Plant Premises and Equipment (Food Contact): Conveying equipment; Edible product areas of official establishments operating under the meat; poultry; shell egg grading and egg products inspection operations; Meat packing plants; Poultry processing plants; Rabbit processing plants; USDA inspected meat and poultry plants Dairies/Cheese Processing Plant Premises and Equipment (Food Contact): Dairies Egg Processing Plants Tobacco Processing Plants Feed Mills/Feed Processing Plants: Conveying equipment; Feed processing and handling sites; Flour mills; Grain mills; Mills; Milling operations; Roll housing and hoppers; Stored grain mills; Rice mills Feed/Food Treatment - Storage/Processing/Handling Equipment: Conveying equipment; Grain handling equipment				
Surface applications	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Crack/crevice or spot surface	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Brush on	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Void treatment	0.07 oz a.i./sq yd	NS	NS	7
Retail and Storage – Indoor Commercial Storage/Warehouses Premises: Brandy storage warehouses; Dried fruit warehouses; Elevators; Food storage areas; Freight containers; Peanut storage warehouses; Spirit storage; Storage areas; Storage areas of dried food products; Stored seed warehouses; Warehouses; Wine storage warehouses; Tobacco warehouses Food Stores/Markets/Supermarkets Premises and Equipment: Food marketing - storage- distribution; Grocery and convenience stores; Stores; Supermarkets; Conveying equipment; Freight containers; Stored product areas Food/Feed Storage Areas-Full: Stored product areas.				
Surface applications	0.4 fl oz a.i./1000 ft^2	NS	NS	NS
Crack/crevice or spot surface	0.4 fl oz a.i./1000 ft^2	NS	NS	NS
Transportation – Indoor Commercial Transportation Facilities: Airplanes; Boats; Box cars; Buses; Cabins and holds of aircraft; Commercial transportation centers; Freight containers; Ocean fright containers; Pallets; Passenger rail cars; Railroad cars; Recreational vehicles; Ships & ships' holds; Trains; Trucks; Trailers; Truck trailers; Livestock hauling equipment; Horse trailers. Commercial Transportation Facilities – Empty: Grain transportation containers (truck beds; planes; box cars; cargo ship holds); Pallets. Commercial Shipping Containers- Empty: Grain transportation containers (truck beds; planes; box cars; cargo ship holds); Pallets. Trunks of Automobiles, Taxis, Limousines.				
Surface applications	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Crack/crevice or spot surface	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Brush on	0.4 fl oz a.i./1000 ft^2	NS	NS	7
Void treatment	0.07 oz a.i./sq yd	NS	NS	7
Pet Premise Treatment Pet Living/Sleeping Quarters: Areas of floors & floor coverings where pets may be present; areas where female insects may crawl to lay eggs, and similar hiding places; Dog houses and other sleeping quarters; Dog runs; Pet bedding and premises; Pet premises; Pet resting areas; Kennels.				
Surface applications	5.12 fl oz a.i./750 ft^2	NS	NS	NS
Crack/crevice or spot surface	0.5 fl oz a.i./1000 ft^2	NS	NS	NS
Perimeter treatment	0.5 fl oz a.i./1000 ft^2	NS	NS	NS

Cypermethrin and zeta-cypermethrin also have numerous uses on pets and other animals, as indicated in **Tables 3.12** and **3.13**, respectively. Uses include cattle (beef/range/feeder and dairy), dairy goats (meat, dairy), dogs/ canines, cats, hogs/ pig/ swine treatments, horses, livestock, poultry, and sheep animal treatment, *etc.* Treatments include direct application to livestock and horses (rub on, spray) and direct application to livestock (collar, dust, eartag). For cattle, the retreatment interval is 3 days while for pets it is not specified. Applied amounts may vary depending on the formulation. **Figure 3-6** shows the cattle and calves inventory as of 2007. Each dot represents 10,000 cattle and calves. Since exposure to water bodies due to treatment of cattle and various other animals is possible, these uses will be assessed in the ecological risk assessment to estimate potential cypermethrin exposure following application to livestock.

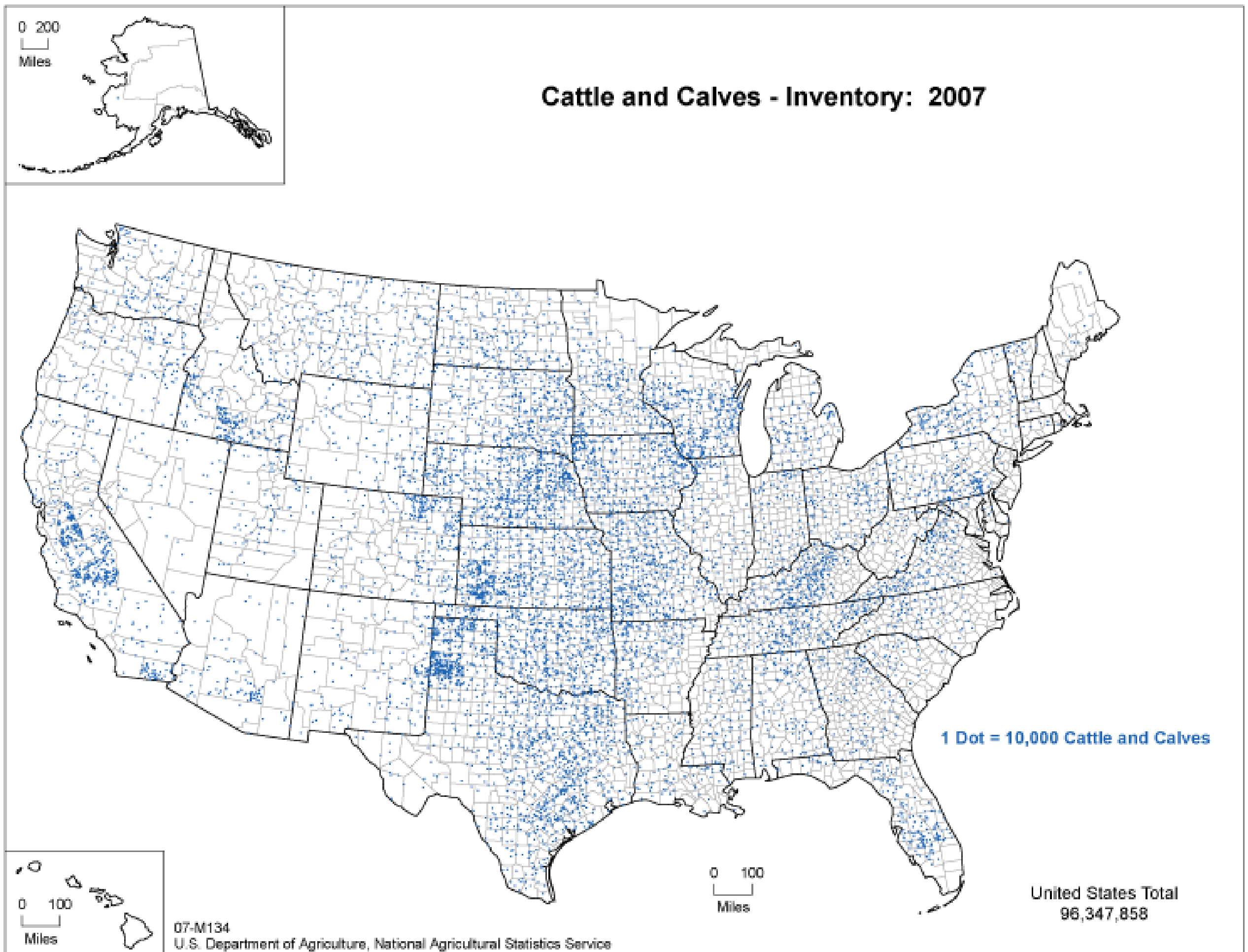


Figure 3-6 Cattle and Calves Inventory as of 2007[8]

Table 3.12. Pet Care, Cattle andOther Animal Treatments of Cypermethrin				
Use	**Max. App. Rate/ units**	**Max. No. Applications/ Year**	**Max. App. Rate per Year**	**Min. App. Interval (days)**

[8]Information obtained from the following website accessed 06/12/2011: http://www.agcensus.usda.gov/Publications/2007/Online_Highlights/Ag_Atlas_Maps/Livestock_and_Animals/Livestock,_Poultry_and_Other_Animals/07-M134.asp

Table 3.12. Pet Care, Cattle andOther Animal Treatments of Cypermethrin				
Use	**Max. App. Rate/ units**	**Max. No. Applications/ Year**	**Max. App. Rate per Year**	**Min. App. Interval (days)**
Birds: Amazon parrots; Budgies; Canaries; Cockatiels; Finches; Love birds; Macaws; Ostrich; Parakeets; Parrots. Cats (including kittens), Dogs (including puppies), Monkeys, Ferrets, Rabbits. Chimpanzees; Chinchillas; Horses; Llamas; Lemurs; Minks; Ponies; Pot bellied pigs. Rodents: Gerbils; Guinea pigs; Hamsters; Mice; Rats.				
Sprays	0.0007 lb. a.i./animal	NS	NS	NS
Package applicator	17.5 % a.i.	NS	NS	21
Rub on	1 % a.i.	NS	NS	NS

Table 3.13. Pet Care, Cattle and Other Animal Treatments of Zeta-Cypermethrin				
Use	**Max. App. Rate/ units**	**Max. No. Applications/ Year**	**Max. App. Rate per Year**	**Min. App. Interval (days)**
Direct Application to Animals Cattle (Beef/Range/Feeder and Dairy); Hogs/Pig/Swine; Goats (Meat and Dairy); Kids; Sheep; Lamb; Rabbits; Game Animals (including Beefalo, Buffalo, Deer, Exotics such as European red deer, Llamas, Moose, Elk); Livestock (including Donkeys, Horses, Ponies, Mules); and Poultry				
Collar	0.003 lb. a.i./animal	NS	NS	3
Dust	0.09 lb. a.i./ 1000 animals	NS	NS	3
Eartag	0.004 lb. a.i./Animal	NS	NS	3

For indoor uses, EFED has conducted environmental risk assessments for a few pyrethroids for Reregistration Eligibility Decisions (*e.g.*, resmethrin and permethrin). Cypermethrin was not one of the assessed chemicals. However, in one study (Weston and Lydy, 2010), several synthetic pyrethroids were observed in effluents after secondary treatment from POTWs in the Sacramento-San Joaquin Delta. In the study, bifenthrin was the most frequently detected pyrethroid from municipal wastewater treatment plant effluents (POTWs) tested in the Sacramento-San Joaquin Delta (18 samples tested), and it exceeded the *Hyalella azteca* EC_{50}. In addition, detectable amounts of cypermethrin have been found in water bodies sampled by USGS during the NAWQA monitoring program. Based on the above information, there is the potential for cypermethrin to reach surface waters via exposure from contaminated drains, even after treatment in wastewater plants (POTWs). An additional study on the potential for pyrethroids to enter water treatment plants and appear in effluent is being developed by the Pyrethroid Working Group (PWG). Eight pyrethroids, including cypermethrin, will be monitored in the study. The other pyrethroids include cyfluthrin, bifenthrin, deltamethrin, esfenvalerate, cyhalothrin, fenpropathrin, and permethrin. Based on available usage information and considering any available and acceptable data in the registration review ecological risk assessment, the Division will evaluate the potential for exposure to aquatic organisms from the indoor uses of cypermethrin (for further details see **Section 6**, Conceptual Model, and **Section 7**, Analysis Plan).

Use with Synergists

Toxicity data on environmental mixtures of the cypermethrins with other pesticides may be evaluated, if available, as part of the ecological risk assessment. It is expected that the toxic effect of the cypermethrins, in combination with other pesticides used in the environment, is likely to be a function of many factors including but not necessarily limited to: (1) the exposed species, (2) the co-formulants in the mixture, (3) the ratio of cypermethrin/zeta-cypermethrin and co-formulants concentrations, (4) differences in the pattern and duration of exposure among formulants, and (5) the differential effects of other physical/ chemical characteristics of the receiving waters, such as organic matter present in sediment and suspended water. Quantitatively predicting the combined effects of all these variables on mixture toxicity to any given taxa with confidence is beyond the capabilities of the available data and methodologies. However, a discussion of implications of the available pesticide mixture effects data regarding the confidence of risk assessment conclusions will be addressed as part of the uncertainty analysis. EFED will consider open literature, currently available models and other lines-of-evidence (*e.g.*, monitoring data), as available to address the potential for cumulative effects of pyrethrins and pyrethroids in the risk description of the ecological assessment for cypermethrin.

Piperonyl butoxide (PBO) and MGK-264 are commonly used in formulations with pyrethrins and pyrethroids (including the cypermethrins). PBO acts as a potentiator (a reagent that increases the toxicity of a chemical) in both mammals and insects because the pyrethroid is not metabolized and excreted as quickly in its presence (Stewart 1998). MGK-264, another potentiator/synergist used with pyrethroids, has similar effects as those observed for piperonyl butoxide (US EPA 2006a).

The need for synergist toxicity enhancement data with insecticides co-formulated and co-applied with synergists is discussed in the *EFED Reregistration Review Problem Formulation for Piperonyl Butoxide*, dated December 13, 2010 (USEPA 2010, D378420)[9]. Currently, data on the extent to which the toxicity of pyrethrins and pyrethroids active ingredients are enhanced by varying concentrations of PBO are needed to address the ecological risk of products when co-applied with PBO. The Agency has reviewed and provided comments[10] on a proposed study protocol that will quantify the enhancement of acute toxicity of pyrethroids to the freshwater amphipod, *Hyalella azteca*, by simultaneous exposure to PBO at varying PBO:pyrethroid ratios. It is expected that this comprehensive testing strategy, when augmented with similar acute toxicity data with freshwater fish and other selected pesticide active ingredients, will facilitate bridging of the synergist toxicity enhancement to other co-formulated or co-applied pesticide/synergist active ingredients that are not tested at varying synergist:active ingredient ratios. With respect to evaluating ecological risks from co-applied cypermethrin and synergists (PBO and MGK-264), the Agency is requesting acute toxicity studies of cypermethrin typical end-use products (TEPs) that are co-formulated with PBO and MGK-264 at the highest synergist:active ingredient ratio. These TEPs should correspond to those formulated products that are labeled for outdoor uses with the greatest potential for aquatic exposures and would be conducted with a freshwater fish and a freshwater invertebrate.

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[9] The PBO Problem Formulation is available in the PBO registration review docket at www.regulations.gov (EPA-HQ-OPP-2010-0498).

[10] "EFED Comments on Pyrethrin Joint Venture and PBTF II Submitted White Paper (including Experimental Design), *Hyalella* protocol and Tank Mix List for Synergism Study Requirements for Piperonyl Butoxide (PBO)," July 19, 2011, DP Barcode: D389864.

3.3 Environmental Fate and Transport

Table 3.14 summarizes the environmental fate/transport properties of the cypermethrins. Structures of the observed degradates are provided in **Figure 3.3**.

Table 3.14. Summary of the environmental fate properties of the cypermethrins.

Property	Value / Degradates observed	Reference
Hydrolysis half-life: pH 5 pH 7 pH 9	stable stable 1.8 (acid labeled) and 2.5 days (alcohol label) cis/trans-DCVA (max. 79% at 120 hr) and 3-phenoxybenzaldehyde (max. 65% at 120 hr)	MRID 42620501
Aqueous photolysis half-life	36.2 days 3-PBA (max. 35% at 35 days)	MRID 42395701
Soil photolysis half-life	sandy loam 55 days cyperamide (steadily increased to a max. of 13.3%)	MRID 42129001
Aerobic soil metabolism half-life	60.7 days (sandy loam, acid label) 59.8 days (sandy loam, alcohol label) cis/trans-DCVA (max. 24% at 62 days, study duration 150 days)	MRID 42156601
Anaerobic soil metabolism half-life	53.3 days (sandy loam, acid label) 63 days (sandy loam, alcohol label) cis/trans-DCVA (max. 33% 30 days after flooding), 3-PBA (max. 26% at 60 days after flooding or end of study)	MRID 42156602
Aerobic aquatic half-life	8.9 days 10.1 days trans-DCVA (max. 49% at 30 days), cis-DCVA (max. 19% at 30 days), 3-PBA (max. 42% at 30 days); study duration, 90 or 183 days.	MRID 45920801
Anaerobic aquatic half-life	13.8 days (clay loam, benzyl label) 16.5 days (clay loam, cyclopropyl label) DCVA (max. 34% at 71 days)	MRID 44876105
Adsorption coefficient K_{oc} (L/Kg) --------------------------------- Aged Column Leaching Study	328,500 (Sand) 134,900 (Sandy loam) 82,600 (Silty loam) 20,800 (Clay loam) --- Degradate cis/trans-DCVA found at up to 13.2% in the leachate	MRID 42129003 ---------------------- MRID 42129002

Table 3.14. Summary of the environmental fate properties of the cypermethrins.		
Property	**Value / Degradates observed**	**Reference**
Terrestrial Field Dissipation Study	13 days (CA soil) 5 days (LA soil)	MRID 42459601
Bioconcentration factor (BCF)	161X edible portion 448X whole fish 883X non-edible moderately slow depuration, with 10-15% of residues remaining after 21 days of depuration	MRID 42868203

The environmental fate data for the cypermethrins was developed mostly with studies on cypermethrin; however, some studies were conducted on zeta-cypermethrin. Zeta-cypermethrin is expected to have a similar fate profile in the environment as cypermethrin.

Laboratory studies have indicated that the cypermethrins degrades through a combination of biotic and abiotic reactions and is moderately persistent in the environment. Under acidic and neutral conditions this compound is relatively stable, but is readily hydrolyzed under alkaline conditions with a half-life of approximately 2 days at pH 9. The cypermethrins are relatively stable to photolysis in laboratory studies using distilled water at pH 7, with a half-life of approximately 36 days. The cypermethrins have been shown to biodegrade in aerobic and anaerobic soils with half-lives on the order of about 2 months and in aerobic and anaerobic aquatic systems with half-lives on the order of one to two weeks. The cypermethrins are considered immobile in soils (Kocs > 20,000 L/Kg) and its potential to leach into groundwater is low. If released to water, the cypermethrins will rapidly partition to the sediment compartment which acts as an environmental sink for this compound. The cypermethrins bioaccumulate moderately in fish (448X in whole fish), with moderate depuration. In terrestrial field dissipation studies the cypermethrins do not appear to be very persistent in soils or leach substantially (half-lives 1-2 weeks). In supplemental aquatic field dissipation studies (zeta-cypermethrin), the chemical appears to persist in the sediment, with reported half-lives of 126 and 181 days in LA and CA, respectively.

Degradation and Metabolism

Cypermethrin labeled with ^{14}C at the cyclopropyl and benzyl moieties was relatively stable at pH 5 and 7 buffered solutions, but degraded rapidly with half-lives of approximately 2 days in pH 9 solutions. The major degradation products of the base catalyzed hydrolysis of cypermethrin were cis- and trans- DCVA (maximum 79% at 120 hours or study duration) and 3-phenoxybenzaldehyde (maximum 65% at 120 hours). Photolysis of cypermethrin in distilled water occurs slowly, but the rate of degradation appears to be enhanced in natural waters, which contain humic and fulvic acids. A photolysis half-life of 36 days was observed for cypermethrin in pH 7 aqueous buffered solution exposed to sunlight in California from March to April. Shorter half-lives on the order of less than 1 to 4 days were observed for cypermethrin dissolved in river water, seawater and distilled water with 1% humic acid exposed to sunlight (Takahashi et al. 1985). The half-life for thin films of cypermethrin in a sandy loam soil matrix was approximately 55 days; however, degradation was also observed in control samples and the dark control corrected half-life is over 100 days. The only transformation product observed was cyperamide, at 13.3% at the end of the study (35 days). Cypermethrin degraded with a half-life of approximately 60 days in a fine sandy loam soil maintained at 25 ^{o}C and held under aerobic conditions. Carbon dioxide and a mixture of cis- and trans- DCVA (maximum 24% at 62 days in a 150 day study) were the major degradation products.

Under aquatic conditions, cypermethrin degraded more rapidly (8.9-10.1 days in a supplemental aerobic aquatic study and 13.8-16.5 days in an anaerobic aquatic study). Degradation products (see **Figure 3.3** for structures) under aerobic aquatic conditions included trans-DCVA (max. 49% at 30 days), cis-DCVA (max. 19% at 30 days) and 3-PBA (max. 42% at 30 days, study duration 183 days). Under anaerobic conditions, the only degradation product was DCVA at 34% at 71 days (study duration 90 days for benzyl label and 183 days for cyclopropyl label).

Additional data are needed for risk assessment under guidelines 835.4100 (Aerobic Soil Metabolism) and 835.6100 (Terrestrial Field Dissipation). Also, because the greatest exposure route of concern is expected to be sediment, additional data are needed for aerobic and anaerobic aquatic metabolism (guidelines 835.4300 and 835.4400, respectively) to describe the variability of the cypermethrins' fate across the entire U.S.

Soil Sorption and Mobility

Cypermethrin is considered immobile in soil. Soil organic carbon adsorption coefficients (K_{oc}) for cypermethrin ranged from approximately 21,000 to 385,000 L/Kg in four soils (sand, sandy loam, silty loam and clay). If released into water, cypermethrin rapidly partitions to the sediment column. The tendency to adsorb to soil and sediment along with the relatively low vapor pressure ($2.5x10^{-9}$ mm Hg) and Henry's law constant ($3.4x10^{-7}$ atm-m^3/mol), indicates that volatilization from water and soil will not be an important transport process. It can be concluded that the cypermethrin degradates 3-PBA and *trans*-DCVA have a high potential for mobility as they were weakly sorbed to four soils tested. 3-PBA was slightly more sorbed (K_{oc} values ranging from 118 to 215) to the tested soils than was *trans*-DCVA (K_{oc} values ranging from 18 to 48).

Field Dissipation

Terrestrial field dissipation studies conducted in Madera, CA and Cheneyville, LA indicated that the field dissipation half-life of formulated cypermethrin is approximately 1 to 2 weeks.

Cypermethrin in the form of Ammo 2.5 EC was applied three times at 0.2 lb ai/acre/application to a bare silt loam soil (78-82% sand, 14-20% silt, 2-4% clay, 0.2-0.6% OM, pH 6.5-7.2) located in Madera, California and soil samples were analyzed for cypermethrin and potential degradates cis-DCVA, trans-DCVA, and 3-phenoxybenzoic acid. Cypermethrin was detected in 3-6" cores collected immediately after each application (18, 8, and 33 µg/kg), and on day 2 (20 µg/kg) and day 4 (29 µg/kg) following the third application. Cypermethrin was detected at 10 µg/kg in one 6-12" core collected 2 days after the final application, but it was not detected in any soil cores collected below this depth (detection limit of 7 µg/kg). The degradate 3-phenoxybenzoic acid was detected in 0-3" cores collected immediately after the second application (8 µg/kg), immediately after the third application (17 µg/kg), and the following days after the third application: day 2 (25 µg/kg), day 4 (32 µg/kg), day 7 (25 µg/kg), day 14 (24 µg/kg), day 21 (8 µg/kg), and day 28 (7 µg/kg). It was not detected above a detection limit of 7 µg/kg in any soil cores collected below 3 inches. Potential degradates cis- and trans-DCVA were not detected above the detection limit of 7 µg/kg in any of the soil cores. An analysis of the cypermethrin concentration as a function of time yielded a field dissipation half-life of 13 days.

In a second study, cypermethrin in the form of Ammo 2.5 EC was applied three times at 0.2 lb a.i./acre/application to a bare loamy sand soil (30% sand, 64% silt, 6% clay, 0.7% OM, pH 7.0) located in Cheneyville, LA. The soil cores were analyzed for cypermethrin and potential degradates cis-DCVA, trans-DCVA, and 3-phenoxybenzoic acid. Based upon dissipation in the top 0-3" soil cores, the dissipation half-life for cypermethrin was 5 days. Cypermethrin was not detected above a detection limit of 7 µg/kg in any cores collected below 3 inches. The degradate trans-DCVA was detected in 0-3" cores collected on the following days after the third application: day 2 (16 µg/kg) and day 7 (8 µg/kg). The degradate 3-phenoxybenzoic acid was detected in 0-3" cores collected immediately after the second application (10 µg/kg), immediately after the third application (20 µg/kg), and 2 days after the 3rd application (44 µg/kg). The degradate cis-DCVA was not detected above a detection limit of 7 µg/kg in any of the soil cores. None of the analytes were detected above a detection limit of 7 µg/kg in any of the soil cores collected below 3 inches.

Given the large number of registered uses, additional data under this guideline (835.6100, Terrestrial Field Dissipation) are needed to describe variability across the U.S.,.

Cypermethrin is not labeled for use in aquatic sites; however, there are two supplemental aquatic field dissipation studies conducted with zeta-cypermethrin in California and Louisiana. The half-lives were 181 days and 126 days, respectively. These half-lives are not similar to those observed in the laboratory studies. Nevertheless, the reported half-lives included the sediments only.

EFED is currently reviewing a “washoff” study that measured cypermethrin washoff from various building materials. Though this study is currently under review it appears that cypermethrin applied to vinyl siding has the highest potential for washoff.
A POTW study to determine the fate of the cypermethrins in sewage treatment works is being requested to to ascertain whether indoor and urban cypermethrin uses contribute to toxicity in receiving waters or sediments after discharge of treated sewage.

4 Receptors

4.1 Aquatic and Terrestrial Effects

The receptor is the biological entity that is exposed to the stressor (EPA, 1998). Due to the outdoor uses of the cypermethrins, the types of receptors that may be exposed include both aquatic and terrestrial receptors, such as birds, reptiles, mammals, amphibians, freshwater and estuarine/marine fish, non-target terrestrial and aquatic invertebrates and terrestrial and aquatic plants. The stressors in this case are the cypermethrins. Spray drift and runoff exposures are expected for both ground and aerial applications of the cypermethrins. Consistent with the process described in the Overview Document (USEPA, 2004), this risk assessment uses a surrogate species approach in its evaluation of the cypermethrins. Toxicological data generated from surrogate test species, which are intended to be representative of broad taxonomic groups, are used to extrapolate to potential effects on a variety of species (receptors) included under these taxonomic groupings.

Tables 4.1 and 4.2 provide a summary of the taxonomic groups and the surrogate species tested to help understand potential acute and chronic ecological effects of the cypermethrins to these non-target taxonomic groups.

4.1.1 Terrestrial Species

For terrestrial species, data were submitted for both cypermethrin and zeta-cypermethrin. Since zeta-cypermethrin has a similar toxicological profile to cypermethrin the available data for both chemicals were considered. A summary of the most sensitive endpoints from the available toxicity studies conducted with terrestrial species is presented in **Table 4.1**. Summaries of the available studies will indicate whether cypermethrin or zeta-cypermethrin was used.

Table 4.1 Summary of most sensitive endpoints from submitted terrestrial toxicity studies for the cypermethrins.

Species (common name)	Taxa Represented	Endpoint	Concentration	Test Substance (% a.i.)	Reference/ Classification	Acute Toxicity Classification
Rattus norvegicus (Laboratory Rat)	Mammals	LD_{50}	86 mg a.i./kg-bw	TGAI	MRID# 41776115 Acceptable	Moderately toxic
		NOAEL	5 mg a.i./kg/day	TGAI	MRID# 00090040 Acceptable	Not Applicable
		LOAEL	25 mg a.i./kg/day			
Bobwhite quail (*Colinus virginianus*)	Birds, terrestrial-phase amphibians, and reptiles	LD_{50}	>2000 mg a.i./kg bw	TGAI	MRID# 44546024 Acceptable	Practically non-toxic
Mallard duck (*Anas platyrhynchos*)		LC_{50}	>2634 mg a.i./kg diet	TGAI	MRID# 00090071 Acceptable	Practically non-toxic
Bobwhite quail (*Colinus*		NOAEL	50 mg a.i./kg-diet	TGAI	MRID# 00090073	Not Applicable

Table 4.1 Summary of most sensitive endpoints from submitted terrestrial toxicity studies for the cypermethrins.						
Species (common name)	**Taxa Represented**	**Endpoint**	**Concentration**	**Test Substance (% a.i.)**	**Reference/ Classification**	**Acute Toxicity Classification**
virginianus)					Acceptable	
Mallard duck (*Anas platyrhynchos*)		LOAEL	> 50 mg a.i./kg-diet	TGAI	MRID# 00090074 Acceptable	Not Applicable
Apis mellifera (Honey bee)	Terrestrial invertebrates	Contact LD_{50}	0.023 µg a.i./bee	TGAI	Acc. No. 260647 Acceptable	Very highly toxic
		Oral LD_{50}	0.172 µg a.i./bee	TGAI		Very highly toxic
	Terrestiral Plants	EC_{50}	No Data	No Data	No Data	No Data

Birds

The results of the single acute oral toxicity study available for the cypermethrins indicate that the chemicals are practically non-toxic to avian species on an acute oral basis. The acute oral LD_{50} value for bobwhite quail (*Colinus virginianus*) is >2000 mg a.i./kg-bw and no clinical signs of toxicity were observed at any treatment level (MRID 44546024).

No acute avian oral studies with the cypermethrins have been submitted for passerine species.

The results of the sub-acute dietary toxicity studies available for the cypermethrins indicate that it can be classified as practically non-toxic to avian species on an acute dietary basis. The LC_{50} is greater than 2,634 mg a.i./kg-diet for mallard duck (*Anas platyrhynchos*) (MRID 00090071). In this study, the LC_{50} value was determined based on the repellent nature of the treated feed, which resulted in decreased food consumption and body weight.

The results of avian reproduction studies available for the cypermethrins indicate that they can be classified as slightly toxic to avian species on a chronic basis. The study showed no adverse effects at 50 mg a.i./kg-diet, which was the highest dose tested.

Mammals

Mammalian toxicity data submitted to the Agency's Health Effects Division (HED) are used to approximate toxicity to wild mammals. These studies are typically conducted with laboratory rats (*Rattus norvegicus*) or mice (*Mus musculus*). No studies evaluating toxicity to wild mammal species are not available, or have been submitted to the Agency for the cypermethrins.

Acute oral, dermal and inhalation mammalian toxicity studies with cypermethrin were submitted to the Agency. In addition, chronic dietary and 3-generation rat reproduction studies have also been submitted for cypermethrin. These studies were presented in the HED chapter of the Reregistration Eligibility Decision Document (RED) for cypermethrin (US EPA, 2006).

The reported laboratory rat acute oral LD_{50} value is 86 mg/kg-bw for cypermethrin (MRID 41776115). The acute dermal LD_{50} >4920 mg/kg /day for cypermethrin, based on a study conducted with rats (MRID 00056800). An acute inhalation conducted with rats resulted in an LC_{50} >2.5 mg/L for cypermethrin (MRID 42395702). Based on these reported laboratory rat LD_{50} values, cypermethrin has moderate acute toxicity to small mammals via the oral, dermal and inhalation exposure routes.

In the available 3-generation rat reproduction study, the NOAEL is 5 mg/kg/day based on decreased F1 pup body weight and body weight gain (MRID 00090040). In the submitted chronic mammalian dietary study with cypermethrin, the NOAEL is 6 mg/kg/day based on clinical signs of neurotoxicity and mortality in males at the 20.4 mg/kg/day treatment level and deceased body weights in females at the 18.1 mg/kg/day treatment level (MRID 44536801).

<u>Terrestrial Invertebrates</u>
The Agency guideline terrestrial invertebrate tests are for honey bees (*Apis mellifera*). The acute contact LD_{50} value is 0.023 µg a.i./bee and the oral LD_{50} value is 0.172 µg a.i./bee (Accession Number 260647). Based on these results, the cypermethrins are classified as 'highly toxic' to honey bees on an acute exposure basis.

4.1.2 Aquatic Species

For aquatic species, data were again submitted for both cypermethrin and zeta-cypermethrin. Since zeta-cypermethrin has a similar toxicological profile to cypermethrin the available data for both chemicals were considered. A summary of the most sensitive endpoints from the available toxicity studies conducted with aquatic species is presented in **Table 4.2**.

4.2. Summary of most sensitive endpoints from submitted aquatic toxicity studies for the cypermethrins.

Exposure Scenario	Species	Exposure Duration	Toxicity Reference Value	Effects	Reference	Toxicity Category
Freshwater Fish						
Acute	Rainbow trout (*Oncorhynchus mykiss*)	96 hours	LC_{50} = 0.39 µg a.i./L	Mortality	MRID 44546027 Acceptable	Very Highly Toxic
Chronic	Fathead minnow (*Pimephales promelas*)	30 days	NOAEC = 0.14 µg a.i./L LOAEC = 0.33 µg ai/L	Growth and mortality	MRID 00089039 Acceptable	NA
Freshwater Invertebrates						
Acute	Amphipod	96 hours	EC_{50} = 0.0036	Mortality	MRID 44423501 Acceptable	Very Highly Toxic

4.2. Summary of most sensitive endpoints from submitted aquatic toxicity studies for the cypermethrins.						
Exposure Scenario	**Species**	**Exposure Duration**	**Toxicity Reference Value**	**Effects**	**Reference**	**Toxicity Category**
	(*Hyalella azteca*)		µg a.i./L			
Benthic Organisms						
Acute	Amphipod (*Hyalella azteca*)	10 days	sediment value (experimental data): LC_{50} = 3.6 µg a.i./kg sediment pore water value (derived data) [a]: LC_{50} = 0.00257 µg a.i./L pore water	Mortality and Growth	MRID 44074406 Acceptable	Very Highly Toxic
Estuarine/Marine Fish						
Acute	Sheepshead minnow (*Cyprinidon variegates*)	96 hours	LC_{50} = 0.95 µg a.i./L	Mortality	MRID 00090075 Acceptable	Very Highly Toxic
Estuarine/Marine Invertebrates						
Acute	Mysid shrimp (*Mysidopsis bahia*)	96 hours [b]	LC_{50} = 0.00475 µg a.i./L	Mortality	Acc. No. 070562 Acceptable	Very Highly Toxic
Chronic	Mysid shrimp (*Mysidopsis bahia*)	28 days [c]	NOAEC = 0.000781 µg a.i./L LOAEC = 0.00197 µg/L	Weight of Females reduced	MRID 42725301 Acceptable	Very Highly Toxic
Aquatic Plants						
	No Data	No Data	No Data	No Data	No Data	No Data

[a] For benthic organisms, the LC_{50} value of 0.00257 µg a.i./L pore water was calculated as follows. The LC_{50} value in whole sediment [3.6 µg a.i./kg sediment] is divided by the proportion of organic carbon in the sediment [0.0099 kg OC/kg whole sediment]. Thus, the LC_{50} value in units of OC is 364 µg a.i./kg OC [3.6µg a.i./kg sediment ÷ 0.0099 kg OC/kg sediment]. The equivalent concentration in pore water is based on the definition of the K_{oc},

K_{oc} (L/kg OC) = Sediment Conc in OC (mg/kg OC) ÷ Conc in pore water (mg/L).

By rearrangement,

Conc in water = Sediment Conc in units of OC ÷ K_{oc}.

For the cypermethrins, the K_{oc} is taken as 141,700 [L/kg OC]. Thus, the calculated concentration in pore water corresponding to the LC_{50} value of 364 µg a.i./kg OC is 0.00257 µg a.i./L [364 µg a.i./kg OC ÷ 141,700 L/kg OC].

4.2. Summary of most sensitive endpoints from submitted aquatic toxicity studies for the cypermethrins.						
Exposure Scenario	**Species**	**Exposure Duration**	**Toxicity Reference Value**	**Effects**	**Reference**	**Toxicity Category**
[b] The acute toxicity reference value identified to calculate acute RQs for estuarine/marine invertebrates is for a 96-hour exposure duration, rather than the guideline recommended 48-hour exposure duration. Although 48-hour LC_{50} values have been reported in other studies (see Appendix E), these values are higher than the 96-hour LC_{50} of 0.005 µg a.i./L. Taking the most conservative approach, EFED will use the lowest LC_{50} value reported for estuarine/marine invertebrates. [c] The exposure duration of 28 days was not reported in the DER for this study. Since this study was classified as "Acceptable" by EFED, an exposure duration of 28 days is assumed.						

Freshwater Fish

The acute toxicity of technical grade cypermethrin to freshwater fish was evaluated in several species, with 96-hour LC_{50} values ranging from 0.39 µg a.i./L in rainbow trout (MRID 44546027) to 4.5 µg a.i./L in bluegill sunfish (MRID 44546030). Based on these results, cypermethrin is categorized as very highly toxic to freshwater fish on an acute basis. Taking the most conservative approach, the lowest 96-hour LC_{50} of 0.39 µg a.i./L in rainbow trout is used to evaluate acute toxic exposure to freshwater fish.

Studies assessing the acute toxicity of three cypermethrin formulations in rainbow trout were also submitted. The formulations tested were GFU 061(36% a.i.), and GFU 070 (25.1% a.i.). The 96-hour LC_{50} values reported for GFU 061 and GFU 070 are 4.7 µg formulation/L (MRID 00065813) and 13.0 µg formulation/L (MRID 00088947), respectively, indicating that these cypermethrin formulations are very highly toxic to freshwater fish. Comparison of the 96-hour LC_{50} value for cypermethrin TGAI (0.39 µg a.i./L) and cypermethrin formulations (4.7 to 13.0 µg formulation/L; equivalent to approximately 1.2 to 5.2 µg a.i./L) indicates that the formulated products have a similar order of toxicity to technical grade cypermethrin.

Acute toxicity studies in freshwater fish were also submitted for the cypermethrin degradate 3-phenoxybenzoic acid in rainbow trout (MRID 00089037) and bluegill sunfish (MRID 00089038). Results yield 96-hour LC_{50} values of 13.3 and 36.3 mg degradate/L in rainbow trout and bluegill sunfish, respectively. Based on these 96-hour LC_{50} values, 3-phenoxy benzoic acid is categorized as slightly toxic to freshwater fish on an acute basis and is much less toxic than cypermethrin TGAI to freshwater fish.

An early life-stage study in fathead minnow was submitted by the registrant to establish the chronic toxicity of cypermethrin to freshwater fish (MRID 00089039). Results of this 30-day exposure study showed that survival was significantly reduced compared to controls at 0.33 µg a.i./L, yielding a 30-day NOAEC value for survival of 0.14 µg a.i./L. No treatment-related effects were observed for hatchability or growth. The NOAEC value for survival of 0.14 µg a.i./L is > 0.1 of the 60-day EEC[11], indicating the need for chronic fish studies per 40 CFR part

[11] 60-d EEC of 0.131 µg a.i./L (based on North Carolina Fruit and coarse droplets, from the RED) ÷ rainbow trout ELS NOAEC (0.14 µg a.i./L, MRID 00089039) = 0.9.

158. Chronic studies are also triggered by the direct applications to water for the cattle livestock use. No acceptable chronic toxicity studies for cypermethrin formulations or cypermethrin degradates to freshwater fish were submitted.This is a data gap.

Estuarine/Marine Fish

The acute toxicity of technical grade cypermethrin to estuarine/marine fish was evaluated in sheepshead minnow and Atlantic salmon, with 96-hour LC_{50} values of 0.95 µg a.i./L (MRID 00090075) and 4.3 µg a.i./L (MRID 41968212) respectively, indicating that the cypermethrins TGAI is very highly toxic to estuarine/marine fish on an acute basis. Taking the most conservative approach, the lowest 96-hour LC_{50} value of 0.95 µg a.i./L in sheepshead minnow will be used to evaluate acute toxic exposure to estuarine/marine fish. No acute toxicity studies of cypermethrin formulations or cypermethrin degradates in estuarine/marine fish were submitted.

No valid chronic toxicity studies on technical grade cypermethrin in estuarine/marine fish were submitted. The previous assessment conducted in support of the RED calculated acute-to-chronic ratios based on available acute toxicity data based on the following mathematical relationship:

> *Freshwater LC_{50} (0.39 µg a.i./L) / Freshwater NOAEC (0.14µg a.i./L) = Estuarine/Marine LC_{50} (0.95 µg a.i./L)/ X (estimated value for Estuarine/Marine NOAEC), where X = 0.34 µg a.i./L.*

This estimated NOAEC of 0.34 µg a.i./L is > 0.1 of the 60-day EEC [12], indicating the need for chronic fish studies per 40 CFR Part 158. No chronic toxicity studies for the formulations or degradates of the cypermethrins in estuarine/marine fish were submitted. This is identified as a data gap.

Freshwater Invertebrates

Acute toxicity studies of technical grade cypermethrin to freshwater invertebrates yield toxicity values ranging from a 96-hour LC_{50} value of 0.0036 µg a.i./L in *Hyalella* (MRID 44423501) to a 24-hour LC_{50} value of >5.0 µg a.i./L in *Notonecta, Chironomus thummi,* and *Lymnea peregra* (Acc. No. 070562). Based on these results, the cypermethrins can be categorized as very highly toxic on an acute basis. Taking the most conservative approach, the lowest LC_{50} value reported (96-hour LC_{50} value of 0.0036 µg a.i./L) is used to evaluate acute toxic exposure of freshwater invertebrates to cypermethrin.

Studies assessing the acute toxicity of three cypermethrin formulations to daphnids were submitted. The formulations tested were GFU 034/A (36% a.i.), GFU 061 (36% a.i.), and GFU 070 (24% a.i.). Results of these studies were reported as EC_{50} values (for immobility), rather than LC_{50} values. The 48-hour EC_{50} values ranged from 1.56 µg a.i./L (MRID 62793) to 21.6

[12] 60-d EEC of 0.131 µg a.i./L (based on North Carolina Fruit and coarse droplets, from the RED) ÷ estimated saltwater NOAEC (0.34 µg a.i./L, see calculations above) = 0.4.

μg a.i./L (MRID 89040), indicating that these formulations are very highly toxic to freshwater invertebrates on an acute basis. Comparison of the 48-hour LC_{50}/EC_{50} values for cypermethrin TGAI (0.42 to 2.0 μg a.i./L) and cypermethrin formulations (1.56 to 21.6 μg a.i./L) indicates that the formulated products have a similar order of toxicity to technical grade cypermethrins.

Acute toxicity tests in freshwater invertebrates using the cypermethrins degradate 3-phenoxybenzoic acid to daphnids were also submitted. Results yield 48-hour EC_{50} values of 89.0 mg degradate/L (MRID 152739) and 111 mg degradate/L (Acc. No. 070562). Based on these acute toxicity values, 3-phenoxy benzoic acid is categorized as practically non-toxic to slightly toxic to freshwater invertebrates on an acute basis. Thus, the 3-phenoxy benzoic acid degradate is much less toxic than the cypermethrins TGAI to freshwater invertebrates.

No valid chronic toxicity studies on the technical grade cypermethrins in freshwater invertebrates were submitted. The previous RED calculated acute-to-chronic ratios based on available acute toxicity data based on the following mathematical relationship:

> *Estuarine/marine invertebrate LC_{50} (0.00475μg a.i./L) / Estuarine/marine invertebrate NOAEC (0.000781μg a.i./L) = Freshwater invertebrate LC_{50} (0.42 μg a.i./L)/ X (estimated value for Freshwater invertebrate NOAEC), where X = 0.069 μg a.i./L.*

Chronic studies are triggered in several ways per 40 CFR Par 158, including, the direct applications to water for the cattle livestock use, EECs > 0.1 of the LC/EC_{50}[13] bioconcentration potencial (BCF of 448x, MRID 42868203) and half-life of > 4 days in water (8.9-10.1 days, MRID 45920801). No chronic toxicity studies for the formulations or degradates of the cypermethrins in freshwater invertebrates were submitted. This is identified as a data gap.

Estuarine/Marine Invertebrates

Acute toxicity tests with estuarine/marine invertebrates using the cypermethrin TGAI were conducted in shrimp, molluscs, and crustaceans. Toxicity values (EC_{50} and LC_{50}) reported for shrimp range from the 96-hour LC_{50} value of 0.00475 μg a.i./L (Acc. No. 070562) to the 96-hour LC_{50} value of 0.01 μg a.i./L (MRID 41068003). Similar results were observed in lobster (96-hour LC_{50} = 0.04 μg a.i./L; MRID 41068003) and fiddler crab (96-hour LC_{50} = 0.197 μg a.i./L; MRID 89045). Based on these results, the cypermethrins TGAI is categorized as very highly toxic to estuarine/marine shrimp and crustaceans. Results of acute toxicity tests in molluscs show that the cypermethrins TGAI is moderately to highly toxic in oysters, with a 96-hour EC_{50} value of 0.37 mg a.i./L in Eastern oyster (MRID 89049) and a 48-hour LC_{50} value of >2.27 mg a.i./L in Pacific oyster (Acc. No. 070562). Results of these studies indicate that molluscs are less susceptible than shrimp and crustaceans to the cypermethrins toxicity on an acute basis. Taking the most conservative approach, the 96-hour LC_{50} value of 0.00475 μg a.i./L in mysid shrimp will be used to categorize acute risk to estuarine/marine invertebrates. No acute toxicity studies for the formulations or degradates of the cypermethrins in estuarine/marine invertebrates were

[13] 21-d EEC of 0.256 μg a.i./L (based on North Carolina Fruit and coarse droplets, from the RED) ÷ estimated freshwater NOAEC of 0.069 μg a.i./L (see calculations above) = 3.7.

submitted. This is identified as a data gap.

Three studies involving life-cycle tests in mysid shrimp were submitted by the registrant to establish the chronic toxicity of cypermethrin to estuarine/marine invertebrates. The NOAEC values reported in these studies range from 0.781 ng a.i./L for effects on first generation mortality, male length and weight and female weight (MRID 42725301), to 1.5 ng a.i./L for number of offspring (Acc. No. 070562) and survival and reproduction (MRID 44546035). Taking the most conservative approach, the lowest NOAEC value of 0.781 ng a.i./L will be used to characterize chronic risk to estuarine/marine invertebrates. No chronic toxicity studies for the formulations or degradates of the cypermethrins in estuarine/marine invertebrates were submitted. This is identified as a data gap.

Benthic Organisms

Several studies on the toxicity of cypermethrin TGAI to benthic organisms have been submitted. Studies were conducted using two types of experimental protocols, exposure in a water-only system and exposure in a water-sediment system. In the water system studies, organisms were exposed to cypermethrin in overlying (surface) water; no sediment was present in the test chamber (these studies are discussed with the freshwater invertebrate studies above). For studies conducted using the water-sediment system protocol, cypermethrin was applied to water-sediment systems and allowed to settle for 2 days; organisms were introduced to the above water-sediment systems, and toxicity was assessed after a 10-day exposure period. However, these studies present a degree of uncertainty because of the lack of equilibration of spiked sediments with the pore water (e.g., equilibration should have occurred for at least one month). While compounds bound to the sediment present potential toxicity concerns, those residues that have reached equilibrium in the pore water are considered a greater source of toxic risk to benthic invertebrates (Di Toro *et al.*, 1991). Therefore the studies presented in this assessment may underestimate sediment toxicity.

Two studies on cypermethrin TGAI were conducted using a water-sediment system, one study with midge (MRID 44074402) and one study with amphipod (MRID 44074406). Both studies were conducted using the same protocol, as described above, using sediments from three sources (Florissant, Mississippi, and Duluth). All toxicity values for these studies are expressed in terms of the concentration of cypermethrin in sediment (μg a.i./kg) on Day 0. Measurement of cypermethrin in sediment and surface water on Days 0 and 10 of exposure indicates that the water-sediment system was not at equilibrium, thus adding uncertainty to the results of these studies. Results yield 10-day LC_{50} values ranging from 3.6 μg a.i./kg sediment (Florissant sediment) in amphipods to 67 μg a.i./kg sediment in midge (Mississippi sediment). In general, toxicity decreased (as reflected by higher LC_{50} values), with increasing organic carbon content of the sediment. Taking the most conservative approach, the lowest 10-day LC_{50} value of 3.6 μg a.i./kg sediment in amphipods will be used to characterize the risk of acute exposure of benthic organisms to the cypermethrins TGAI in sediment.

In order to assess the risk of acute exposure to benthic organisms to the cypermethrins TGAI based on pore water concentrations, the equivalent toxicity value in pore water is derived using the lowest 10-day LC_{50} value of 3.6 µg a.i./kg sediment in amphipods. The LC_{50} value in whole sediment [3.6 µg a.i./kg sediment] is divided by the proportion of organic carbon (OC) in the sediment [0.0099 kg OC/kg whole sediment]. Thus, the LC_{50} value in units of OC is 364 µg a.i./kg OC [3.6µg a.i./kg sediment ÷ 0.0099 kg OC/kg sediment]. The equivalent concentration in pore water is based on the definition of the K_{oc},

Koc (L/kg OC) = [sediment (mg/Kg OC)] / [pore water (mg/L)]

By rearrangement,

[water] = [sediment (mg/Kg OC)] / Koc

For the cypermethrins, the K_{oc} is 141,700 [L/kg OC] (MRID 42129003). Thus, the calculated concentration in pore water corresponding to the LC_{50} value of 364 µg a.i./kg OC is 0.00257 µg a.i./L [364 µg a.i./kg OC ÷ 141,700 L/kg OC]. To assess risk of acute exposure to benthic organisms to cypermethrin TGAI in terms of pore water concentrations, the derived LC_{50} value of 0.00257 µg a.i./L is used.

No toxicity studies for the formulations or degradates of the cypermethrins in freshwater benthic organisms were submitted. This is identified as a data gap.

Chronic toxicity studies in benthic organisms were not submitted. To assess chronic risk to benthic organisms, chronic toxicity values were derived for both sediment and pore water. The previous RED calculated acute-to-chronic ratios based on available acute toxicity data based on the following mathematical relationships:

> *Estuarine/marine invertebrate LC_{50} (0.00475µg a.i./L) / Estuarine/marine invertebrate NOAEC (0.000781µg a.i./L) = Benthic LC_{50} in sediment 3.6 µg a.i./kg sediment / X (estimated benthic NOAEC value in sediment), where X = 0.59 µg a.i./kg sediment.*

> *Estuarine/marine invertebrate LC_{50} (0.00475µg a.i./L) / Estuarine/marine invertebrate NOAEC (0.000781µg a.i./L) = Benthic LC_{50} in pore water (0.00257 µg a.i./L / X (estimated benthic NOAEC value in pore water), where X = 0.00042 µg a.i./L pore water. To assess chronic risk to benthic organisms, the estimated NOAEC values of 0.59 µg a.i./kg sediment and 0.00042 µg a.i./L pore water are used.*

No chronic toxicity studies for the formulations or degradates of the cypermethrins in freshwater benthic organisms were submitted. This is identified as a data gap.

4.1.3 Plants

No studies evaluating the toxicity of the cypermethrins to terrestrial plants, aquatic plants or algae have been submitted to the Agency. This is identified as a data gap.

ECOTOX

Iin additiona to submitted data, available open literature will be used to evaluate the potential direct effects of cypermethrin to the terrestrial receptors identified in this section. This includes toxicity data on the technical grade active ingredient, and when available, formulated products.

At this time, a full and complete ECOTOX search has not been performed, but will be conducted prior to the final risk assessment. The open literature studies will be identified through EPA's ECOTOX database (http://cfpub.epa.gov/ecotox/), which employs a literature search engine for locating chemical toxicity data for aquatic life, terrestrial plants, and wildlife. The evaluation of data can also provide insight into the direct and indirect effects of cypermethrin on biotic communities from loss of species that are sensitive to the chemical and from changes in structure and functional characteristics of the affected communities.

Open literature toxicity data for other 'target' insect species (not including bees, butterflies, beetles, and non-insect invertebrates including soil arthropods and worms), which include efficacy studies, are not currently considered in deriving the most sensitive endpoint for terrestrial insects. Efficacy studies do not typically provide endpoint values that are useful for risk assessment (such as NOAEC, EC_{50}, etc.), but rather are intended to identify a dose that maximizes a particular effect (such as EC_{100}). Therefore, efficacy data and non-efficacy toxicological target insect data will not be included in the ECOTOX open literature search.

4.2 Incident Database Review

A review of the Ecological Incident Information System (EIIS, v. 2.1) and Aggregate Incident databases for ecological incidents involving cypermethrin and zeta-cypermethrin was completed on December 8, 2011. This database consists of exposure incident reports submitted to the EPA from 1994 to present. A search for incidents involving cypermethrin and zeta-cypermethrin was also conducted in the American Bird Conservancy's Avian Incident Monitoring System (AIMS).

The reports are listed in order of certainty, from highly probable to unrelated. Incidents listed in EIIS are categorized by the likelihood that a particular pesticide is associated with that particular incident. These classifications include highly probable, probable, possible, unlikely or unrelated. "Highly probable" incidents usually require carcass residues or clear circumstances regarding the exposure. "Probable" incidents include those where residue information was not available or circumstances were less clear than those for "highly probable". "Possible" incidents occur when multiple chemicals may have been involved and the contribution of an individual chemical is not obvious. An "unlikely" incident classification is given when a given chemical is considered nontoxic to the type of organism involved or the chemical was analyzed and not detected in samples. The "unrelated" category is used for incidents confirmed not to involve pesticides.

The number of reports listed in the EIIS database is believed to be only a small fraction of the total incidents involving organism mortality and damage caused by pesticides. Few resources are assigned to incident reporting. Reporting by states is only voluntary, and individuals discovering incidents may not be informed on the procedure of reporting these occurrences. Additionally, much of the database is generated from registrant-submitted incident reports. In addition, incident reports for non-target organisms typically provide information only on mortality events and plant damage incidents. Except for phytotoxic effects in terrestrial plants, sublethal effects for organisms such as reduced growth or impaired reproduction are rarely reported. Because of these logistical difficulties, EIIS is most likely a minimal representation of all pesticide-related ecological incidents.

Registrants are legally required to provide detailed reports of only "major" ecological incidents involving pesticides, while "minor" incidents are reported aggregately. Based on 40 CFR §159.184, an ecological incident is considered major and must be submitted to the Agency by the registrant if any of the following criteria are met:

Fish or wildlife:

(A) Involves any incident caused by a pesticide currently in Formal Review[14] for ecological concerns.

(B) Fish: Affected 1,000 or more individuals of a schooling species or 50 or more individuals of a non-schooling species.

(C) Birds: Affected 200 or more individuals of a flocking species, or 50 or more individuals of a songbird species, or 5 or more individuals of a predatory species.

(D) Mammals, reptiles, amphibians: Affected 50 or more individuals of a relatively common or herding species or 5 or more individuals of a rare or solitary species.

(E) Involves effects to, or illegal pesticide treatment (misuse) of a substantial tract of habitat (greater than or equal to 10 acres, terrestrial or aquatic).

Plants:

(A) The effect is alleged to have occurred on more than 45 percent of the acreage exposed to the pesticide.

The EIIS database contained 22 major incidents involving the cypermethrins. The reports included 15 fish incidents and 2 avian incidents, 3 mammalian incidents, and 2 terrestrial invertebrate incidents. In respect to the likelihood that cypermethrin caused the reported incidents, the certainty ranged from unlikely to highly probable. The majority of reported incidents were identified as probable or highly probable. Four of the incidents resulted from registered uses, seven were misuses and the remaining use patterns are unknown. A summary of ecological incidents involving cypermethrin included in the EIIS database are listed in **Appendix B**.

The AIMS database contains 2 avian incidents involving the cypermethrins, both of which are also captured in EIIS**.**

All other incidents are classified as 'minor'. All ecological incidents classified as 'minor' only

[14] Formal Review means Special Review, Rebuttable Presumption Against Registration (RPAR), FIFRA section 6(c) suspension proceeding, or FIFRA section 6(b) cancellation proceeding, whether completed or not.

need to be aggregately reported as quarterly counts of incidents by the registrant(s). Ecological incidents reported in aggregate reports include those categorized as ‘minor fish and wildlife’ (W-B), ‘minor plant’ (P-B), and ‘other non-target’ (ONT) incidents. ‘Other non-target’ incidents include reports of adverse effects to insects and other terrestrial invertebrates. **For the cypermethrins, the registrants have reported 21 minor fish and wildlife incidents, 4 minor plant incidents, and 1 “other non-target” incdent.** All reported incidents occurred between 1995 and 2010, and involved currently registered products such as Demon WP, Cyper TC Insecticide, Prevail TC Termiticide, Probuild TC, Demon Max, among others. Unless additional information on these aggregated incidents becomes available, they will be assumed to be representative of registered uses of the cypermethrins in the risk assessment.

4.3 Ecosystems Potentially at Risk

The cypermethrin may be applied on a variety of food/feed crops, including (but not limited to), alfalfa, nut trees, corn, leafy vegetables, stone fruits, pome fruits, fruiting vegetables, cucurbit vegetables, cole crops, onion and soybean. In addition, they may be used on numerous non-food sites (*e.g.* ornamentals, commercial animal housing, outdoor agricultural premises, residential sites – outdoors, and outdoor eating establishments) and indoor sites (*e.g.* residential sites-indoors, food handling premises, eating establishments-indoors, and transporation facilities). Thus, the ecosystems at risk may be extensive in scope, and as a result it may not be possible to identify specific ecosystems during the development of a baseline risk assessment. In general terms, terrestrial ecosystems potentially at risk due to the use of the cypermethrins could include the treated field and areas immediately adjacent to the treated field that may receive drift or runoff. Areas adjacent to the treated field could include cultivated fields, fencerows and hedgerows, meadows, fallow fields or grasslands, woodlands, riparian habitats and other uncultivated areas. Current label directions for the cypermethrins require vegetative buffer strips and impose limitations to reduce the potential for spray drift to impact areas adjacent to the treated field. However, due to the potential persistence of the cypermethrins under certain circumstances, it is expected to drift and/ or runoff due to application to food crops and certain non-crop sites, resulting in possible exposure to aquatic ecosystems. In addition, indoor use patterns of the cypermethrins could result in “down-the-drain” exposure to aquatic ecosystems that receive treated waters. Aquatic ecosystems potentially at risk due to the use of the cypermethrins include water bodies adjacent or downstream from the treated field and might include impounded bodies such as ponds, lakes and reservoirs, or flowing waterways such as streams or rivers. For uses in coastal areas, aquatic habitat also includes marine ecosystems, such as estuaries.

5 Assessment Endpoints

Assessment endpoints are defined as “explicit expressions of the actual environmental value that is to be protected.” Defining an assessment endpoint involves two steps: 1) identifying the valued attributes of the environment that are considered to be at risk; and 2) operationally defining the assessment endpoint in terms of an ecological entity (*i.e.*, a community of fish and aquatic invertebrates) and its attributes (*i.e.*, survival and reproduction). Therefore, selection of the assessment endpoints is based on valued entities (*i.e.*, ecological receptors), the ecosystems potentially at risk, the migration pathways of pesticides, and the routes by which ecological receptors are exposed to pesticide-related contamination. The selection of clearly defined assessment endpoints is important because they provide direction and boundaries in the risk assessment for addressing risk management issues of concern. Changes to assessment endpoints are typically estimated from the available toxicity studies, which are used as the measures of effects to characterize potential ecological risks associated with exposure to pesticides, such as the cypermethrins.

To estimate exposure concentrations, the ecological risk assessment considers applications at the maximum application rate to fields that have vulnerable soils. The most sensitive toxicity endpoints are used from surrogate test species to estimate treatment-related direct effects on acute mortality and chronic reproductive, growth and survival assessment endpoints. Toxicity tests are intended to determine effects of pesticide exposure on birds, mammals, fish, terrestrial and aquatic invertebrates, and plants. These tests include short-term acute, sub-acute, and reproduction studies and are typically arranged in a hierarchical or tiered system that progresses from basic laboratory tests to applied field studies. The toxicity studies are used to evaluate the potential of a pesticide to cause adverse effects, to determine whether further testing is needed, and to determine the need for precautionary label statements to minimize the potential adverse effects to non-target animals and plants.

An open literature search will be conducted to determine any relevant endpoints. The search will focus on survival, growth and reproductive effects for aquatic and terrestrial effects of the cypermethrins. More sensitive endpoints from acceptable open literature studies will be included in the ecological risk assessment.

6 Conceptual Model

For a pesticide to pose an ecological risk, it must reach ecological receptors in biologically significant concentrations. An exposure pathway is the means by which a pesticide moves in the environment from a source to an ecological receptor. For an ecological pathway to be complete, it must have a source, a release mechanism, an environmental transport medium, a point of exposure for ecological receptors, and a feasible route of exposure.

A conceptual model provides a written description and visual representation of the predicted relationships between cypermethrin, potential routes of exposure, and the predicted effects for the assessment endpoint. A conceptual model consists of two major components: risk hypothesis and a conceptual diagram (USEPA, 1998).

6.1 Risk Hypothesis

Risk hypotheses are specific assumptions about potential adverse effects (*i.e.*, changes in assessment endpoints) and may be based on theory and logic, empirical data, mathematical models, or probability models (USEPA 1998). For this assessment, the risk is stressor-initiated, where the stressor is the release of the cypermethrins into the environment. The following risk hypotheses are presumed for this screening-level assessment:

> *The cypermethrins, when used outdoors in accordance with registered labels, will likely lead to off-site movement of the compound via agricultural and urban runoff, spray drift, and eroded soil leading to exposure of nontarget plants and animals Based on information on the environmental fate, mode of action, direct toxicity and potential indirect effects, EFED assumes that registered uses of the cypermethrind have the potential to cause reduced survival, growth, and reproduction to non-target terrestrial and/ or aquatic animals and plants.*
>
> *The cypermethrins, when used indoors for uses such as pet shampoos,* etc.*, in accordance with current labels, will likely result in off-site movement of the compound via wash-off into surface waters via drains and municipal wastewater treatment plants, leading to exposure of nontarget aquatic plants and animals. This potential exposure pathway may result in adverse effects upon the survival, growth, and/or reproduction of non-target aquatic animals and plants.*
>
> *The cypermethrins, when used for the treatment of cattle (and certain other animals), in accordance with current labels, may result in off-site movement of the compound via wash-off of cattle and calves into surface waters, leading to exposure of nontarget aquatic plants and animals. This potential exposure pathway may result in adverse effects upon the survival, growth, and/or reproduction of non-target aquatic animals and plants.*

The conceptual model is a generic graphic depiction of the risk hypothesis. It includes the potential pesticide or stressor (the cypermethrins and possible metabolites, as well as synergists), the source of the pesticide and/or transport pathways, exposure media, exposure point, biological receptor types, and attribute changes.

6.2 Conceptual Diagram

The conceptual model is a generic graphic depiction of the risk hypothesis, and assumes that the cypermethrins, which are synthetic pyrethroid insecticide, having multiple outdoor agricultural and non-agricultural uses, is capable of affecting aquatic and terrestrial animals provided that environmental concentrations are sufficiently elevated as a result of proposed label uses. Based on an examination of the physicochemical properties of the cypermethrins, the fate and disposition in the environment, and mode of application, a conceptual model was developed that represents the possible relationships between the stressors, ecological receptors, and the assessment endpoints. Through a preliminary iterative process of examining available data, the conceptual model (*i.e*., the representation of the risk hypothesis) may be refined to reflect the likely exposure pathways and the organisms that are most relevant and applicable to this assessment (**Figures 6-1a** and **6-1b**). They include the potential pesticide or stressor (the cypermethrins, but the presence of toxicologically important metabolites and/ or synergists cannot be ruled out), the sources and/ or transport pathways, exposure media and exposure points, biological receptor types and attribute changes.

In order for a chemical to pose an ecological risk, it must reach ecological receptors in biologically significant concentrations. An exposure pathway is the means by which a pesticide moves in the environment from a source to an ecological receptor. For an ecological exposure pathway to be complete, it must have a source, a release mechanism, an environmental transport medium, a point of exposure for ecological receptors, and a feasible route of exposure. In addition, the potential mechanisms of degradation/ transformation (*i.e.*, which degradation/ transformation products may form in the environment, in which media, and how much) must be understood, especially if for the chemical, its metabolites/ transformation products are of greater toxicological concern than the parent compound. The assessment of ecological exposure pathways, therefore, includes an examination of the source and potential migration pathways for constituents, and the determination of potential exposure routes.

Under the possible uses of the cypermethrins, the sources and mechanisms of release of the compounds are from ground or aerial spray or ULV applications. Note that this conceptual model considers agricultural applications as well as certain non-agricultural applications. Surface runoff from the areas of application is assumed to depend on factors such as topography, irrigation, and rainfall events. Direct deposition may result in contamination of food items that may be consumed by terrestrial organisms. Spray drift results in contaminated adjacent areas, including bodies of water. Leaching to groundwater is not considered an important source because the cypermethrins, like many other pyrethroids, show low mobility in a variety of soils. The cypermethrins appear to have a low potential for volatilization, with a low vapor pressure and Henry's Law Constants. The low vapor pressure ($\sim 10^{-9}$torr) and relatively low Henry's Law constant ($\sim 10^{-7}$ atm/m^3-mol), and its binding capacity, suggest that the potential for atmospheric transport for the cypermethrins is relatively low and that this source of the chemical is of low importance, compared to spray drift, runoff and/ or direct contact after application.

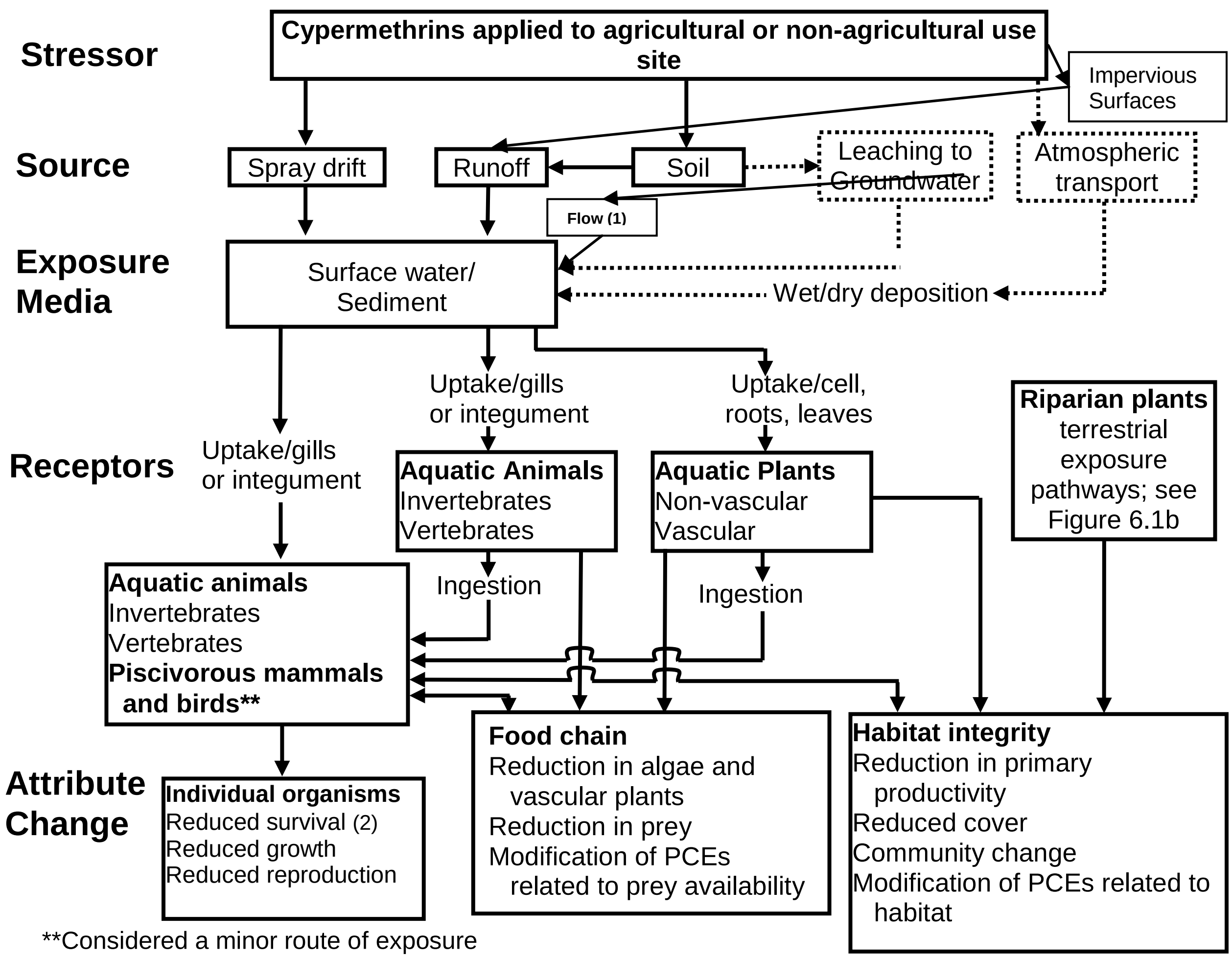
For aquatic receptors, the major point of exposure is through direct contact with the water column, sediment, and pore water (gill/ integument) contaminated with spray drift (from spray application) and/or runoff and flow (*e.g.*, piped storm drains) from treated areas. Indirect effects to aquatic organisms (both fish and aquatic invertebrates) can also occur through impact to various food chains. The representative aquatic receptors are certain freshwater and estuarine/ marine fish, invertebrates, and, in certain cases, aquatic plants. The major point of exposure for terrestrial animals is consumption of food contaminated with residues such as grass, foliage, and small insects. For plants, the point of exposure is direct contact or root uptake. The representative terrestrial receptors are mammals, birds and terrestrial plants. The attribute changes used to assess risk to terrestrial receptors depend on the type of test (*e.g.*, reduced survival, growth, or reproduction for animals and seedling emergence and vegetative vigor for plants). It should be noted, that these species do not cover all the possible species in the animal and plant kingdoms; certain taxa are considered as surrogates for other taxa. For example, fish are considered surrogates for aquatic phase amphibians.

This conceptual model also shows information about the potential for biomagnification for the cypermethrins (see piscivorous birds and mammals in **Fig. 6-1b**). The reported value of log octanol/ water partition coefficient of 6.4 suggests that the cypermethrins have the potential to bioaccumulate in aquatic organisms assuming that chemical metabolism is negligible. Maximum

BCFs for the cypermethrins are 161x for edible tissue, 883x for viscera, and 448x for whole fish. Depuration appeared to be moderately slow, with ~10-15% of the initial residues remaining after 21 days. Thus, it appears that there is potential for bioaccumulation/ bioconcentration in aquatic organisms and biomagnification in terrestrial organisms.

The cypermethrins have a solubility of 4.0 ppb and a very high K_{OW}. These properties suggest that the chemicals could partition with the sediments and particulate suspended in bodies of water. The cypermethrins are likely to concentrate in the sediments, especially after repeated exposures (applications), where they could persist. Such sediments could serve as repositories of the chemicals for extended periods of time and could potentially be toxic to sediment dwelling organisms, affecting the food chain. These issues will also be assessed in the risk assessment for the cypermethrins.

Figure 6-1a. Aquatic conceptual model depicting stressors, exposure pathways, and potential effects to aquatic organisms from the use of the cypermethrins on agricultural and certain non-agricultural sites

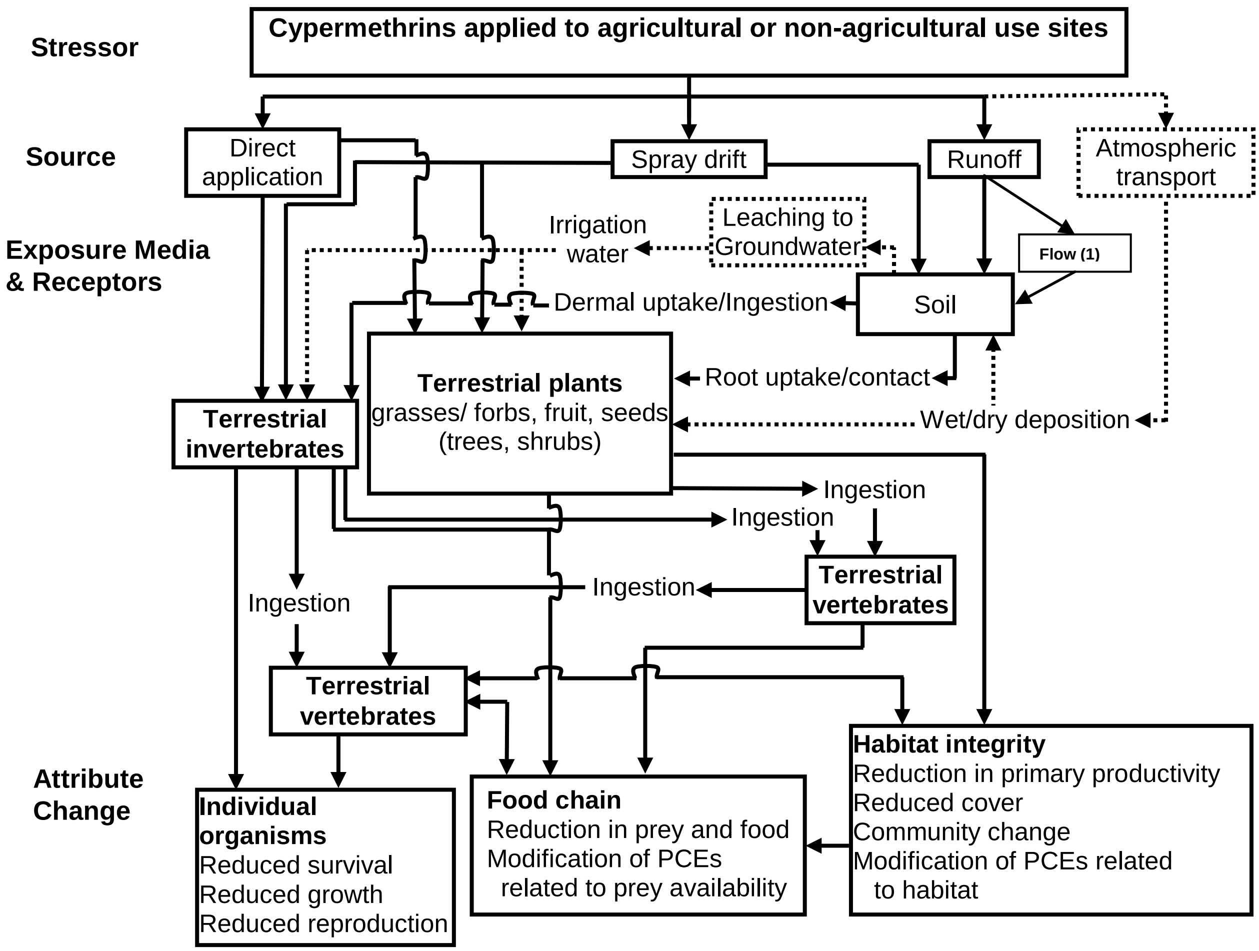


[1] Includes flow across vegetation and vegetated drainage systems (*e.g.*, swales) and flow across impervious surfaces and through impervious (piped) storm drains.

[2] Immobilization is considered equivalent to mortality in toxicity tests for aquatic invertebrates.

Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk.

Figure 6-1b. Terrestrial conceptual model depicting stressors, exposure pathways, and potential effects to terrestrial organisms from the use of the cypermethrins on agricultural and certain non-agricultural sites



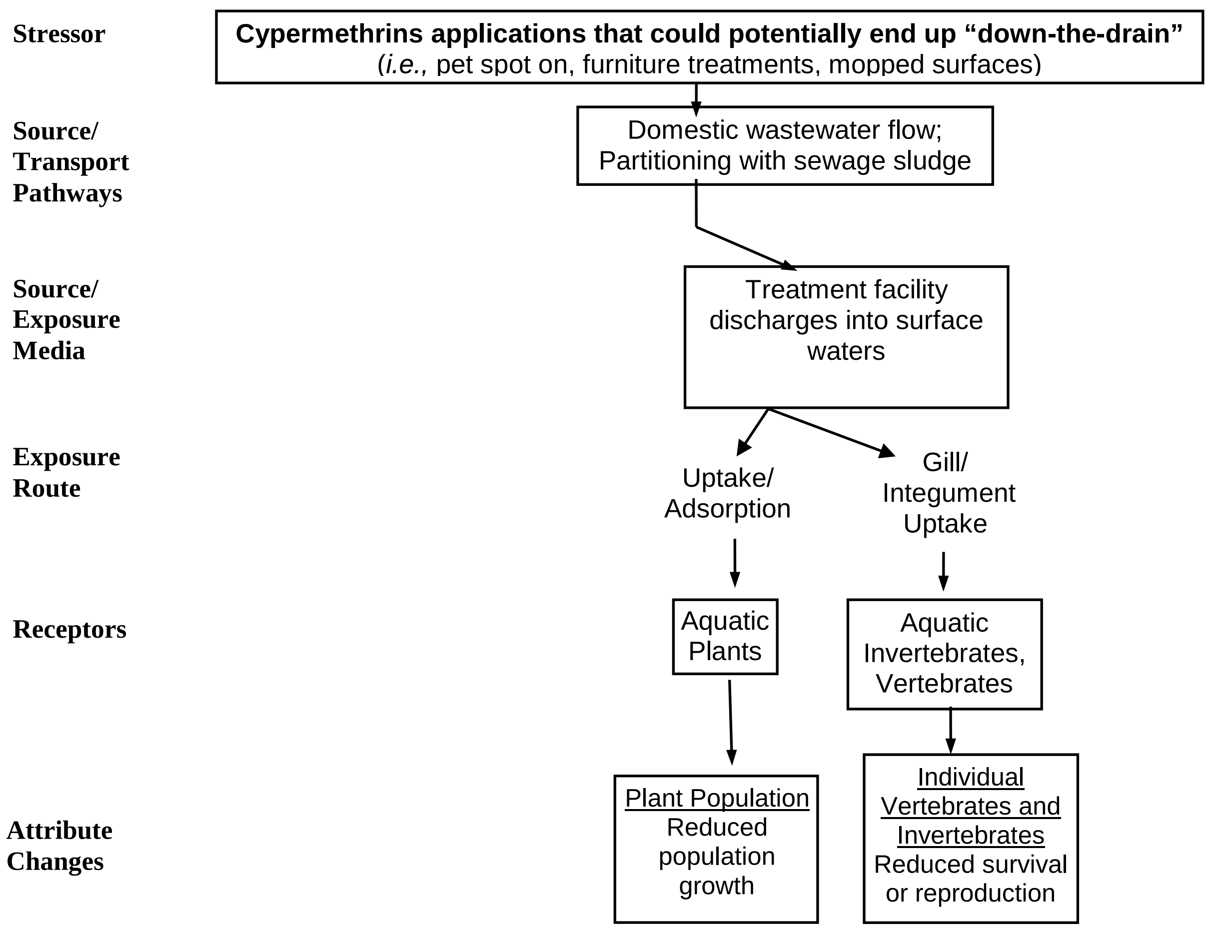
Dotted lines indicate exposure pathways that have a low likelihood of contributing to ecological risk.
[1] Includes flow across vegetation and vegetated drainage systems (*e.g.*, swales) and flow across impervious surfaces and through impervious (piped) storm drains.

The conceptual model for potential risks of the cypermethrins to aquatic organisms due to various indoor uses of the chemical that could potentially end up in a "drain" and disposed through domestic wastewater is depicted in **Fig. 6-2**. The stressors are the chemicals of concern, the cypermethrins. It is noted that the transport pathway is wastewater flow, the exposure media is the treatment facility and the exposure route, receptor, and attribute changes for aquatic organisms are similar to the conceptual model for agricultural applications.

EFED will perform an assessment of the "down-the-drain" uses, using available usage information and new endpoints (if any are developed, from newly submitted studies) in the

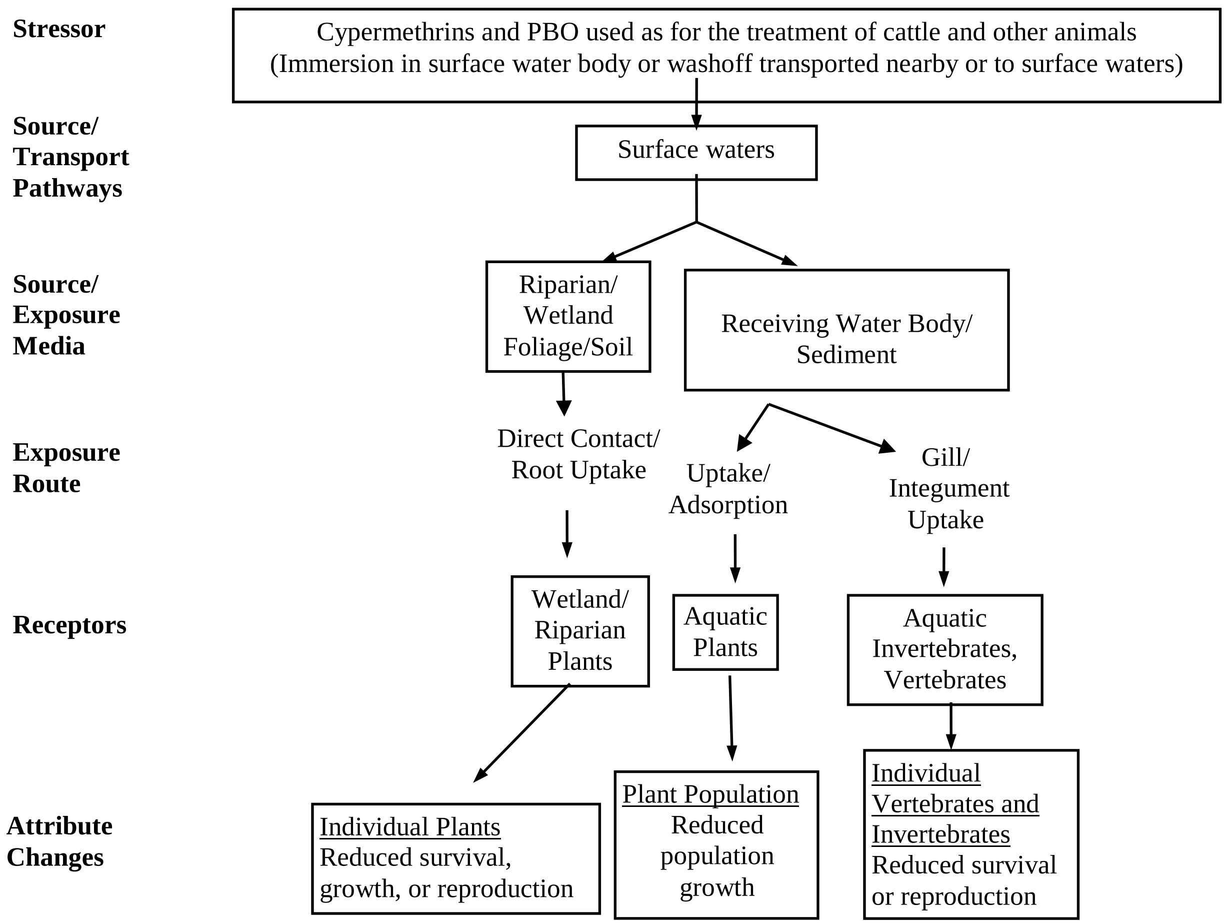
Registration Review ecological risk assessment.

Figure 6-2. Conceptual model for potential risks of the cypermethrins to aquatic organisms for various indoor uses of the chemical that could potentially end up in the "drain"



The conceptual model for potential risks of the cypermethrins to terrestrial and aquatic organisms as a result of the treatment on cattle or calves is depicted in **Fig. 6-3**. The stressors are the chemicals of concern, the cypermethrins, and potentially interactions caused by applications with the synergists PBO and MGK-264. The organisms that could be expected to be affected are terrestrial plants, aquatic plants and aquatic animals. It is noted that the potential transport pathway, the exposure media and the exposure point or route, receptor, and attribute changes for plant and aquatic organisms are similar to the conceptual model for agricultural applications **Fig. 6-1a**.

Figure 6-3: Conceptual model for potential risks of the cypermethrins to aquatic organisms as a result of the treatment on cattle or calves.



7 Analysis Plan

In order to address the risk hypothesis, the potential for adverse effects on the environment is estimated. Usage, environmental fate and transport, and ecological effects of the cypermethrins are characterized and integrated to assess the risks. This is accomplished using a risk quotient (ratio of exposure concentration to effects concentration) approach. Although risk is often defined as the likelihood and magnitude of adverse ecological effects, the risk quotient-based approach does not provide a quantitative estimate of likelihood and/ or magnitude of an adverse effect. However, as outlined in the Overview Document (USEPA 2004), the likelihood of effects to individual organisms from particular uses of a chemical is estimated using the probit dose-response slope and either the level of concern (discussed below) or the actual calculated risk quotient value.

This analysis plan will be revisited and may be revised depending on the data available in the open literature and the information submitted by the public or the registrant in response to the opening of the Registration Review docket.

7.1 Stressors of Concern

The focus of this assessment is on the parent materials, the cypermethrins. However, the Agency will review open literature to identify degradate(s) of potential toxicological concern (*e.g.* DCVA and 3-PBA). Also, risk resulting from use of the cypermethrins and synergists will be assessed for cattle treatments.

Toxicity data for environmental mixtures of the cypermethrins with other pesticides (those mixtures occurring in the environment following application), if available, may be presented as part of the ecological risk assessment. The cypermethrins may be applied in tank mixtures with other products approved for use on registered crops. It is expected that the toxic effect of the cypermethrins, in combination with other pesticides used in the environment, is likely to be a function of many factors including, but not necessarily limited to (1) the exposed species, (2) the co-formulants in the mixture, (3) the ratio of the cypermethrins and co-formulants concentrations, (4) differences in the pattern and duration of exposure among formulants, and (5) the differential effects of other physical/ chemical characteristics of the receiving waters (*e.g.* organic matter present in sediment and suspended water). A discussion of implications of the available pesticide mixture effects data on the confidence of risk assessment conclusions will be addressed in the risk description of the final ecological assessment.

7.2 Measures of Exposure

In order to estimate risks of the cypermethrins exposures in aquatic and terrestrial environments, all exposure modeling and resulting risk conclusions will be made based on maximum application rates for the current use patterns. Available monitoring data will also be considered when describing potential environmental exposure to non-target organisms.

Measures of exposure are based on aquatic and terrestrial models that predict estimated environmental concentrations of the cypermethrins using maximum labeled application rates and methods, as well as any mitigation measures specifically indicated on the label.

Additional information on the terrestrial exposure models and screening tools employed in EPA ecological risk assessments for pesticides can be found at http://www.epa.gov/oppefed1/models/terrestrial/.

More information on aquatic pesticide exposure models can be found at http://www.epa.gov/oppefed1/models/water/index.htm.

Dietary exposure to terrestrial organisms

Measures of exposure for terrestrial mammals, birds, reptiles and amphibians similarly incorporate maximum proposed use rates but rely less on fate properties. Terrestrial exposures are estimated using a number of methods. For the cypermethrins, acute and chronic terrestrial exposure estimates are derived directly from empirically determined observations of pesticide residues on various terrestrial food items. The Kenaga nomogram, as modified by Fletcher *et al*, (Kenaga and Hoerger, 1972; Fletcher *et al*, 1994) is used to relate pesticide application rates to residues on terrestrial food items. The surface residue concentration (ppm) is estimated by multiplying the application rate (pounds active ingredient per acre) by a value specific to each food item. For numerous applications for a given use, the exposure model incorporates a first-order decay rate dependent on the foliar dissipation half-life of the chemical. In the absence of foliar dissipation data, a default foliar dissipation half-life of 35 days is used.

Inhalation, drinking water and dermal exposure

Two screening tools were utilized to assess the potential for exposure of the cypermethrins to terrestrial organisms via inhalation and drinking water exposure. The Screening Tool for Inhalation Risk (STIR v.1.0, November 19, 2010) was used to calculate an upper bound estimate of exposure using vapor pressure and molecular weight of the cypermethrins for vapor phase exposure, as well as the maximum application rate and method of application for spray drift. STIR incorporates results from several toxicity studies including acute oral and inhalation rat toxicity (oral LD_{50} = 86 mg/kg-bw and LC_{50} >2.5 mg/L, respectively) as well as the most sensitive acute oral avian toxicity endpoint (bobwhite quail, LD_{50} > 2000 mg ai/kg bw). Based on the results of the STIR model, inhalation exposure alone was determined not to be a potential pathway of concern for avian and mammalian species on an acute basis.

Inhalation exposure via spray drift and vapor-phase of the cypermethrins alone does not appear to be of concern. The analysis of the inhalation route of in STIR does not consider that aggregation with other exposure pathways such as dietary, dermal, or drinking water may contribute to a total exposure that has a potential for effects to non-target animals. However, the Agency does consider the relative importance of other routes of exposure in situations where data indicate that pesticide exposures through other routes may be potentially significant contributors to wildlife risk (US EPA, 2004).

The Screening Imbibition Program (SIP v.1.0, Released June 15, 2010) was used to calculate an upper bound estimate of exposure using the cypermethrins solubility (4.0×10^{-3} mg/L), the most sensitive acute and chronic avian oral toxicity endpoint (bobwhite quail, LD_{50} > 2000 mg ai/kg bw and NOEL = 50 mg/kg-bw, respetively) and the most sensitive acute and chronic mammalian toxicity endpoints (oral LD_{50} = 86 mg/kg-bw and NOAEL = 5 mg/kg-bw, respectively). Drinking water exposure alone was determined not to be a potential pathway of concern for avian and mammalian species on an acute or chronic basis.

Although drinking water exposure alone does not appear to be of concern, this does not take into account that when aggregated with other exposure pathways (dietary food sources, dermal, inhalation) drinking water may contribute to a total exposure that has a potential for effects on non-target animals and should be explored further. Because there is a high degree of conservatism in the SIP 1.0 exposure estimate, there is limited expectation that use scenarios not triggering a SIP 1.0 concern would contribute significantly to aggregate risks from water plus diet when a refined water exposure model is incorporated in the actual quantitative risk assessment.

Although not available at this time, the Agency is actively pursuing modeling techniques to account for dermal exposure via direct application of spray and by incidental contact with contaminated vegetation, soil and water.

Exposure to terrestrial plants

TerrPlant is used by EFED as a Tier 1 model for screening level assessments of pesticides. The purpose of TerrPlant is to provide screening level estimates of exposure to terrestrial plants from single pesticide applications. The model does not consider exposures to plants from multiple pesticide applications. TerrPlant derives pesticide EECs in runoff and in drift. RQs are developed for non-listed and listed species of monocots and dicots inhabiting dry and semi-aquatic areas which are adjacent to treatment sites. Once suitable terrestrial plant data are submitted to the Agency, this model will be used to determine the potential risks to terrestrial plants following applications of the cypermethrins.

Aquatic exposure modeling

The models used to predict aquatic EECs are the Pesticide Root Zone Model coupled with the Exposure Analysis Model System (PRZM/EXAMS). Also, to estimate aquatic exposure related to releases of the cypermethrins from domestic wastewater treatment plants, the Exposure and Fate Assessment Screening Tool's (E-FAST2) down-the-drain module will be used. For the treatment of cattle, measures of exposure will be calculations assuming direct applications to water considering living habits of cattle livestock.

PRZM (v.3.12.2, May 2005) and EXAMS (v.2.98.4.6, April 2005) are simulation models coupled with the input shell PE5.pl (August, 2007) to generate daily exposures and 1-in-10 year EECs of the cypermethrins, that may occur from spray drift and runoff to surface water bodies adjacent to application sites. PRZM simulates pesticide application, movement and transformation on an agricultural field and the resultant pesticide loadings to a receiving water body via runoff, erosion and spray drift. The EXAMS model simulates the fate of the pesticide and resulting concentrations in the water body. The standard scenario used for ecological pesticide assessments assumes application to a 10-hectare agricultural field that drains into an adjacent 1-hectare water body that is 2 meters deep (20,000 cubic meters volume) with no outlet. PRZM/ EXAMS is used to estimate screening-level exposure of aquatic organisms to the cypermethrins and/ or their transformation products, should they be of concern. The measure of exposure for aquatic species is the 1-in-10 year return peak or rolling mean concentration. The 1-in-10 year peak is used for estimating acute exposures of direct effects to aquatic organisms. The 1-in-10-year 60-day mean is used for assessing chronic exposure to fish and aquatic-phase amphibians. The 1-in-10-year 21-day mean is used for assessing aquatic invertebrate chronic exposure.

At the present time, EFED considers the use of the impervious scenario (a PRZM modeling scenario) as the most suitable available modeling approach for simulating runoff from impervious surfaces such as roads, sidewalks, patios and parking lots. The PRZM impervious scenario may be used in the Tier 2 coupled aquatic models PRZM/EXAMS along with the residential or other suitable scenario such as rights-of-way (ROW) to obtain EECs. The conceptual model for the residential scenario integrates simultaneous modeling of the individual use scenario with an impervious scenario. This approach assumes that no watershed is completely covered by either the ¼ acre lot (the basis for the residential scenario) or undeveloped land (the basis for the ROW scenario) for residential and ROW use patterns; therefore, differential amounts of runoff will occur within the watershed. The impervious scenario was developed to represent the paved areas within a watershed not including roads, parking lots, sidewalks, and buildings outside the ¼ acre lot (the ¼ acre lot scenario accounts for impervious surfaces such as buildings within the represented area). By modeling a separate scenario for impervious surfaces, it is also possible to estimate that amount of exposure that could occur when the pesticide is oversprayed onto this surface. Using two scenarios in tandem requires post-processing of the modeled output in order to derive a weighted EEC that represents the contribution of both the pervious (*i.e.*, residential and ROW scenarios) and the impervious surfaces.

In general, incorporation of impervious surfaces into the exposure assessment results in increasing runoff volume in the watershed, which tends to reduce overall pesticide exposure. For the purposes of risk assessment alternate assumptions for percent impervious surfaces, percentage of use site treated, and percentage of overspray may be considered in order to characterize the assumptions of the ecological risk assessment in the context of the individual exposure assessment and risk conclusions. For example, previously tested assumptions used in the endangered species assessments may be considered for characterization (*i.e.*, 10% and 30% impervious surfaces, 10% lot treated, and 0%, 1% and 10% overspray) unless other relevant values can be determined (*i.e.*, modeling may be completed for the impervious surface with 0%, 1% and 10% overspray to provide lower and upper bound values). The results of these alternate modeling exercises may be discussed in the assessment.

Given the aquatic toxicity of the cypermethrins and their likelihood to occur in sediment, the Agency will also consider the potential exposures resulting from benthic/ sediment concentrations. Pore water concentrations are commonly used to predict toxicity of non-ionic substances in sediments and characterize exposure to organisms that spend time in or near sediments (Di Toro *et al.* 1991; US EPA 2002). PRZM/ EXAMS estimates 1-in-10-year peak and 21-day mean EECs for pore water.

To estimate exposure related to releases of the cypermethrins from domestic wastewater treatment plants, the Agency will rely on the Office of Pollution Prevention and Toxics (OPPT) model, Exposure and Fate Assessment Screening Tool (EFAST, version 2.0, or EFAST2, 2007). From this model, the Agency will use the “Down-the-Drain” module, which is designed for releases to domestic wastewater treatment. It is suitable for all the sources of cypermethrin that could potentially be exposed through a “down-the-drain” scenario (*i.e.*, disposed through domestic wastewaters). The model provides screening level estimate concentrations of chemicals in surface water that may result from household uses and the disposal of consumer products into wastewater using a few simple input parameters (production volume and fraction of the chemical removed during wastewater treatment). At the present time, the Agency does not anticipate requiring a POTW treatability study but will include an analysis of the "down-the-drain" scenario using more refined production volume values provided by BEAD or the registrant and any new endpoints (if any), developed during Registration Review.

Since the cypermethrins have uses on rice, the screening-level Tier 1 Rice Model v.1.0 will be utilized to obtain estimated exposure concentrations (EECs) related to that use. The Tier I Rice Model v1.0 relies on an equilibrium partitioning concept to provide conservative estimates of environmental concentrations resulting from application of pesticides to rice paddies. When a pesticide is applied to a rice paddy, the model assumes that it will instantaneously partition between a water phase and a sediment phase. Among the assumptions of this model, the degradation of the pesticide and the mass transfer from the aqueous phase to the sediment are not considered. Also, volatilization and other dissipation processes are not considered. If LOCs are exceeded using the Tier 1 rice model, estimates may be made using a provisional model, Pesticides in Flooded Applications Model (PFAM), to better characterize the risk. However, PFAM is not yet approved for general use for calculating pesticide EECs by the Agency.

There are two possible scenarios whereby residues of the cypermethrins can enter the aquatic ecosystem due to treatment of cattle. First, multiple cattle that are treated with the cypermethrins can directly enter a water body, and second, rainfall can cause washoff of residues of the cypermethrins to be transported from multiple treated cattle to water bodies via runoff. For these cases, surface water concentrations will be calculated using the maximum mass of the cypermethrins per animal, spilling into a standard farm pond of 1 ha area and 2 m depth or a volume of 2.0×10^7 L. Surface water EECs will be calculated utilizing a suitable program which considers the soil-water partition coefficient and the depth of the sediment layer, such as the KdCalc (v.1.0 10/02/02). Certain assumptions are required for these scenarios. For example, for the first scenario, 20 treated cattle may be assumed to enter the water and for the second scenario, a 1000 treated cattle feedlot may be assumed (USDA NASS data).[15] A maximum of 100% of the active ingredient is assumed to wash-off cow hide for pour on products.

Bioaccumulation

The potential for bioaccumulation for the chemical is assessed using the KABAM model, as well the results from bioconcentration in fish studies (*e.g.*, the bioconcentration factors). This model is parameterized using relevant reviewed registrant-submitted environmental fate and transport data.

As indicated in **Table 3.1** and its associated text in **Section 3**, the cypermethrins appear to have some potential to bioconcentrate in aquatic organisms and it appears that there is also some potential to biomagnify in terrestrial organisms. The potential for bioaccumulation of the cypermethrins will also be examined in the risk assessment. Because the cypermethrins have a fairly high K_{OW} (2.0×10^5) and the chemical may be persistent in water (aqueous photolysis

[15] http://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Cattle_On_Feed/index.asp (accessed 02/01/11) "Feedlots with 1,000 or more head capacity represent about 85 percent of all fed cattle in the U.S."

half-life of 36.2 days) and sediments (>10 days of aquatic metabolism), there could be a potential for bioaccumulation. The maximum bioconcentration factor is 448x for whole fish and the depuration rate is fairly slow (MRID 42868203). Bioaccumulation will be assessed using the results from bioaccumulation in fish studies, as well as the KABAM model (K_{OW} (based) Aquatic BioAccumulation Model, version 1.0, 2009), adjusting for biotransformation rates. KABAM is used to estimate potential bioaccumulation of hydrophobic organic pesticides in freshwater aquatic ecosystems and risks to mammals and birds consuming aquatic organisms which have bioaccumulated these pesticides. Monitoring data and biotransformation rates in terrestrial species will also be evaluated, to assess the potential for bioaccumulation in terrestrial food webs.

7.3 Measures of Effect

Ecological effects data are used as measures of direct and indirect effects to biological receptors. Data are typically obtained from registrant-submitted studies or from literature studies identified by ECOTOX. The ECOTOX database provides more ecological effects data in an attempt to bridge existing data gaps. ECOTOX is a source for locating single chemical toxicity data and potential chemical mixture toxicity data for aquatic life, terrestrial plants, and wildlife. ECOTOX was created and is maintained by the USEPA, Office of Research and Development, and the National Health and Environmental Effects Research Laboratory's Mid-Continent Ecology Division.

The acute measures of effect used for animals in this assessment are the LD_{50}, LC_{50} and EC_{50}. LD stands for "Lethal Dose", and LD_{50} is the amount of a material, given all at once, that is estimated to cause the death of 50% of the test organisms. LC stands for "Lethal Concentration" and LC_{50} is the concentration of a chemical that is estimated to kill 50% of the test organisms. EC stands for "Effective Concentration" and the EC_{50} is the concentration of a chemical that is estimated to produce a specific effect in 50% of the test organisms. Endpoints for chronic measures of exposure for listed and non-listed animals are the NOAEL/NOAEC and NOEC. NOAEL stands for "No Observed-Adverse-Effect-Level" and refers to the highest tested dose of a substance that has been reported to have no harmful (adverse) effects on test organisms. The NOAEC (*i.e.*, "No-Observed-Adverse-Effect-Concentration") is the highest test concentration at which none of the observed effects were statistically different from the control. For non-listed plants, only acute exposures are assessed (*i.e.*, EC_{25} for terrestrial plants and EC_{50} for aquatic plants); for listed plants either the NOAEC or EC_{05} is used.

At the time of the risk assessment, updated information on the potential effects of the cypermethrins on non-target animals will also collected from the Ecological Incident Information System (EIIS), Aggregrate Incident Reports and the Avian Monitoring Information System (AIMS).

Where available, sub-lethal effects observed in both registrant-submitted and open literature studies will be evaluated qualitatively. Such effects may include behavioral changes (*e.g.*, lethargy and changes in coloration). Quantitative assessments of risks, though, are limited to those endpoints that can be directly linked to the Agency's assessment endpoints of impaired survival, growth and reproduction.

The assessment of risk for direct effects to non-target organisms makes the assumption that the toxicity of cypermethrin to birds is similar to that of the cypermethrins' toxicity toterrestrial-phase amphibians and reptiles. The same assumption is made for fish and aquatic-phase amphibians.

7.4 Integration of Exposure and Effects

Risk characterization is the integration of exposure and ecological effects to determine the potential ecological risk from the use of pesticides and the likelihood of direct and indirect effects to non-target organisms in aquatic and terrestrial habitats. The exposure and toxicity effects data are integrated in order to evaluate the risks of adverse ecological effects on non-target species. For the assessment of risks, the risk quotient (RQ) method is used to compare exposure and measured toxicity values. EECs are divided by acute and chronic toxicity values. The resulting RQs are then compared to the Agency's Levels of Concern (LOCs) (USEPA 2004). These criteria will be used to indicate when cypermethrin uses, as directed on the label, have the potential to cause adverse direct or indirect effects to non-target organisms. In addition, incident data from the EIIS will be considered as part of the risk characterization.

7.5 Deterministic and Probabilistic Assessment Methods

The quantitative assessment of risk will primarily depend on the deterministic point-estimate based approach described in the risk assessment. An effort may also be made to further qualitatively describe risk using probabilistic tools that the Agency has developed. These tools have been reviewed by FIFRA Scientific Advisory Panels (http://www.epa.gov/scipoly/sap/index.htm) and have been deemed as appropriate means of refining assessments where deterministic approaches have identified risks.

7.6 Endangered Species Assessments

Consistent with the Agency's responsibility under the Endangered Species Act (ESA), the Agency will evaluate risks to Federally-listed threatened and/or endangered (listed) species from registered uses of the cypermethrins. This assessment will be conducted in accordance with the Overview Document (USEPA 2004), provisions of the ESA, and the Services' *Endangered Species Consultation Handbook* (USFWS/NMFS, 1998).

The assessment of effects associated with the registration of the cypermethrins are based on an action area. The action area is considered to be the area directly or indirectly affected by the federal action, as indicated by the exceedance of Agency LOCs used to evaluate direct or indirect effects. The Agency's approach to defining the action area under the provisions of the Overview Document (USEPA 2004) considers the results of the risk assessment process to establish boundaries for that action area with the understanding that exposures below the Agency's defined LOCs constitute a no-effect threshold. For the purposes of this assessment, attention will be focused on the footprint of the action (*i.e.*, the area where cypermethrin application occurs), plus all areas where offsite transport may result in potential exposure that exceeds the Agency's LOCs. Specific measures of ecological effect that define the action area for listed species include any direct and indirect effects and/ or potential modification of its critical habitat, including reduction in survival, growth, and reproduction as well as the full suite of sub-lethal effects available in the effects literature. Therefore, the action area extends to a point where environmental exposures are below any measured lethal or sub-lethal effect threshold for any biological entity at the whole organism, organ, tissue, and/ or cellular level of organization. In situations where it is not possible to determine the threshold for an observed effect, the action area is not spatially limited and is assumed to be the entire United States.

7.7 Drinking Water Assessment

Drinking water assessments have been conducted to support human health risk assessments of the cypermethrins, based on all the available environmental fate information. Any further drinking water assessments will incorporate model estimates of the cypermethrins in surface and ground waters. Concentrations in surface waters will be estimated using FQPA Index Reservoir Screening Tool (FIRST, v.1.1.1, 12/18/07) (or subsequently using PRZM/ EXAMS, with the Index Reservoir if refinements are required). Ground water estimates of concentrations will be obtained using the Screening Concentration In GRound Water (SCI-GROW) model (v.2.3, July 2003). Further drinking water assessments will also include a summary of available surface and ground water monitoring data.

7.8 Endocrine Disruptor Screening Program

As required by FIFRA and the Federal Food, Drug, and Cosmetic Act (FFDCA), EPA reviews numerous studies to assess potential adverse outcomes from exposure to chemicals. Collectively, these studies include acute, subchronic and chronic toxicity, including assessments of carcinogenicity, neurotoxicity, developmental, reproductive, and general or systemic toxicity. These studies include endpoints which may be susceptible to endocrine influence, including effects on endocrine target organ histopathology, organ weights, estrous cyclicity, sexual maturation, fertility, pregnancy rates, reproductive loss, and sex ratios in offspring. For ecological hazard assessments, EPA evaluates acute tests and chronic studies that assess growth, developmental and reproductive effects in different taxonomic groups. As part of its reregistration decision, EPA reviewed these data and selected the most sensitive endpoints for relevant risk assessment scenarios from the existing hazard database. However, as required by FFDCA section 408(p), cypermethrin is subject to the endocrine screening part of the Endocrine Disruptor Screening Program (EDSP).

EPA has developed the EDSP to determine whether certain substances (including pesticide active and other ingredients) may have an effect in humans or wildlife similar to an effect produced by a "naturally occurring estrogen, or other such endocrine effects as the Administrator may designate." The EDSP employs a two-tiered approach to making the statutorily required determinations. Tier 1 consists of a battery of 11 screening assays to identify the potential of a chemical substance to interact with the estrogen, androgen, or thyroid (E, A, or T) hormonal systems. Chemicals that go through Tier 1 screening and are found to have the potential to interact with E, A, or T hormonal systems will proceed to the next stage of the EDSP where EPA will determine which, if any, of the Tier 2 tests are necessary based on the available data. Tier 2 testing is designed to identify any adverse endocrine-related effects caused by the substance, and establish a dose-response relationship between the dose and the E, A, or T effect.

Under FFDCA section 408(p), the Agency must screen all pesticide chemicals. Accordingly, as part of registration review, EPA will issue future EDSP orders/data call-ins, requiring the submission of EDSP screening assays for cypermethrin. For further information on the status of the EDSP, the policies and procedures, the current and future chemical lists, the test guidelines and the Tier 1 screening battery, please visit our website: http://www.epa.gov/endo/.

7.9 Preliminary Identification of Data Gaps

7.9.1 Environmental Fate Data Gaps

Given the large number of registered uses for the cypermethrins, the current database of one aerobic soil metabolism study and two terrestrial field dissipation studies is insufficient to describe the variability of environmental fate across the entire United States. Additional data are needed for guidelines 835.4100 (Aerobic Soil Metabolism) and 835.6100 (Terrestrial Field Dissipation). Also, because the greatest exposure route of concern is expected to be sediment, additional data are needed for aerobic and anaerobic aquatic metabolism (guidelines 835.4300 and 835.4400, respectively) to describe the variability of the cypermethrins fate across the entire U.S.

Table 7.1 lists the status of the environmental fate data requirements for the cypermethrins.

Table 7.1. Summary of Environmental Fate Data Requirements for the Cypermethrins

Guideline #	Data Requirement	MRID #	Study Classification	Are Additional Data Needed for Risk Assessment?
835.2130	Hydrolysis	42620501	Acceptable	no
835.2210	Photodegradation in Water	42395701	Supplemental	no
835.2410	Photodegradation on Soil	42129001	Supplemental	no
835.2370	Photodegradation in Air	No Data	Waived	no
835.4100	Aerobic Soil Metabolism	42156601	Acceptable	**Yes**
835.4200	Anaerobic Soil Metabolism	42156602	Acceptable	no
835.4400	Anaerobic Aquatic Metabolism	44876105	Acceptable	**Yes**

Table 7.1. Summary of Environmental Fate Data Requirements for the Cypermethrins				
Guideline #	Data Requirement	MRID #	Study Classification	Are Additional Data Needed for Risk Assessment?
835.4300	Aerobic Aquatic Metabolism	45920801	Acceptable	**Yes**
835.1230	Leaching-Adsorption/Desorption	42129003, 42124002	Acceptable	no
835.1410	Laboratory Volatility	No Data	Waived	no
835.8100	Field Volatility	No Data	Waived	no
835.6100	Terrestrial Field Dissipation	42459601	Acceptable	**Yes**
835.6200	Aquatic Field Dissipation	44876107	Supplemental	no aquatic uses
835.6300	Forestry Dissipation	No Data	N/A	no
Non-Guideline	Washoff Study	48072902	In Review	No
Non-Guideline	Study of fate in Publicly-Owned Treatment Works (POTW)	No Data	N/A	Yes

7.9.2 Effects

For registration review, the following studies are requested to resolve uncertanties in the risk assessment:

Guideline Number: 850.2100
Study Title: Avian acute oral toxicity test (passerine species) with TGAI
Acute avian oral toxicity data are needed for either one waterfowl or one upland game species and one passerine species under the Part 158 data requirements (CFR 40 2008) for conventional pesticides. Because passerine species have higher metabolic rates due to their smaller sizes than either waterfowl or upland game bird species, and because they may utilize different metabolic pathways, they may be more or less sensitive to cypermethrin. A recent study reported that at least one passerine species (canary, *Serinus sp*) is sensitive to a formulated pyrethroid, *beta* cyfluthrin, with a calculated LD_{50} of 170 mg/kg bw (Addy-Orduna *et al* 2011). The other two species tested in this study, shiny cowbird (Order Passeriformes) and eared doves (Order Columbiformes), showed decreased sensitivity to *beta* cyfluthrin (LD_{50} of 2234 mg/kg bw and 2271 mg/kg bw, respectively). Based on a preliminary screen using the highest agricultural application scenario for cypermethrin (see **Table 3.3**), the highest peak dose-based EEC is 96

mg/kg bw. This level of acute exposure could be environmentally-relevant if cypermethrin shows the same increase in toxicity to passerine species that is indicated by the study with *beta* cyfluthrin. An additional line of evidence from reported bird incidents (I000103-010 and I011348-001, **Appendix** B), shows that most of the birds affected were passerines (although the causes were uncertain). In order to properly characterize risk to passerines, an avian oral toxicity test is requested. A passerine study protocol should be submitted for review by the Agency prior to initiation of the study.

Guideline Number: 850.2300
Study Title: Avian reproduction test with TGAI
Though reproduction data is available for the cypermethrins, the maximum treatment level tested (50 ppm) in the acceptable studies was below expected exposure in cotton (66 ppm on short grass). There were no treatment related effects observed at 50 ppm.

Non-Guideline[16,17]
Study Title: Acute Freshwater Invertebrate Toxicity (*Hyalella azteca*) with TEP

Acute water column tests with *Hyallela azteca* have been requested in pyrethroid problem formulations based on the increased sensitivity of this species to pyrethroid insecticides. The 850.1020 test guideline for Gammarid amphipods is recommended with appropriate modifications to address specific testing needs of *H. azteca*. The registrant should submit a protocol prior to test initiation or submit any open literature studies that may fulfill this data gap. The TEP should correspond to those formulated products that are labeled for outdoor uses with the greatest potential for aquatic exposures and contain the highest synergist:a.i. ratio.

Guideline Number: OCSPP 850.1760 (in prep), OCSPP 850.1770 (in prep.) and OCSPP 850.1780 (in prep.) with TGAI
Study Title: Whole sediment: chronic invertebrates freshwater and marine

No chronic sediment toxicity tests for freshwater or marine invertebrates have been submitted for the cypermethrins to satisfy the Agency's updated data requirements for outdoor uses in 40 CFR Part 158 (October 26, 2007). For cypermethrin, available information indicates that benthic organisms may be exposed via run-off or spray drift applications used in agricultural, forest, and residential settings. Based on calculations in the most recent EFED assessment, the 21-day sediment porewater EECs predicted for cypermethrin ranged from 0.0036 to 0.0253 µg a.i./L (USEPA 2006b). The upper end of this range exceeds 0.1 of the most sensitive acute LC/EC_{50} (0.0036 µg a.i./L for amphidpod), which satisfies one of the criteria for requiring chronic whole sediment toxicity testing under 40 CFR Part 158. Furthermore, chronic reproductive effects were seen in water column studies with aquatic invertebrates (mysid shrimp), with a NOAEC = 0.000781 µg a.i./L and LOAEC = 0.00197 µg a.i./L.

The cypermethrins are expected to persist in sediments, based on half-lives in submitted soil

[16] The DCI will indicate that TEP studies on freshwater invertebrates and freshwater fish are required on coformulated products containing the highest ratio of the synergist piperonyl butoxide (PBO) to permethrin and the highest ratio of the synergist MGK-264 to permethrin.
[17] The DCI will require that a study protocol be submitted for review and approval by the Agency prior to this study being initiated.

metabolism and aquatic metabolism studies (aerobic soil ~60 days; aerobic aquatic metabolism, 10 days) (MRIDs 42156601 and 45920801). These half-life values exceed the 40 CFR Part 158 criterion of 10 days.

The third set of trigger criteria for needing chronic testing (K_d > 50 or log K_{OW} >3 or K_{OC} > 1000) is also met for the cypermethrins (log K_{OW} is 6.4, and the mean K_{OC} value is ~141,700. The physicochemical property triggers (K_d, K_{OW} and K_{OC}) reflect the propensity of the chemical to partition onto the particulate or organic matter phases of sediments. Exceeding any one of the physicochemical property triggers listed above is sufficient for indicating the pesticide has reasonable potential for partitioning to the sediment compartment.

Chronic whole sediment tests on *Hyalella azteca*, *Chironomus tentans*, and *Leptocheirus plumulosus* are requested. Although both are freshwater species, *Hyalella* and *Chironomus* differ substantially in their morphology (crustacean vs. insect), ecological niche (epibenthic v. infaunal species), and physiology. Evidence also suggests that *Hyalella* is among the more sensitive invertebrates to pyrethroids based on water column tests (Maund *et al.*, 2002; Weston and Jackson, 2009). The cypermethrins have the potential to enter estuarine/marine water bodies based on current usage patterns that include coastal areas. Therefore, testing is also needed for an estuarine/marine sediment-dwelling invertebrate species.

Until the final OCSPP guidelines for chronic sediment toxicity tests are published, the registrant should submit a protocol to EFED for approval prior to test initiation, considering the following methods:

- Test Method 100.4: *Hyalella azteca* 42-d Test for Measuring the Effects of Sediment Associated Contaminants on Survival, Growth, and Reproduction in USEPA 2000 Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates EPA 600/R-99/064 (**OCSPP 850.1770, in prep.**);
- Test Method 100.5: Life-cycle Test for Measuring the Effects of Sediment-associated Contaminants on *Chironomus dilutus* (formerly known as *C. tentans*) in USEPA 2000 Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates EPA 600/R-99/064 (**OCSPP 850.1760, in prep.**); and
- *Leptocheirus plumulosus* in USEPA 2001 Method for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-associated Contaminants with the Amphipod *Leptocheirus plumulosus* EPA 600/R-01/020 (**OCSPP 850.1780, in prep.**).

Non-Guideline [18,19]
Study Title: Fish Acute Toxicity Test (freshwater) with TEP.
No acceptable acute studies for the cypermethrins TEP with synergists (PBO or MGK) have

[18] The DCI will indicate that TEP studies on freshwater invertebrates and freshwater fish are required on coformulated products containing the highest ratio of the synergist piperonyl butoxide (PBO) to permethrin and the highest ratio of the synergist MGK-264 to permethrin.
[19] The DCI will require that a study protocol be submitted for review and approval by the Agency prior to this study being initiated.

been submitted for fish. Since the cypermethrins can reach aquatic habitats via run-off or spray drift applications used in agricultural, forest, and residential settings and can be directly applied to water via application to cattle livestock, EPA needs data on the formulated products containing synergists. Without toxicity data on the range of TEPs produced, the Agency would have to presume acute toxicity to listed and non-listed fish and aquatic-phase amphibians, but would not be able to quantify the risk. The TEP should correspond to those formulated products that are labeled for outdoor uses with the greatest potential for aquatic exposures and contain the highest synergist:a.i. ratio.

Guideline Numbers: 850.4150 and 850.4250
Study Title: Vegetative vigor and Seedling emergence, TierII[20] with TEP
No acceptable toxicity data are currently available to assess the risk of the cypermethrins to non-target terrestrial plants. Since the cypermethrins have many outdoor uses, vegetative vigor and seedling emergence studies are needed. In addition, four minor terrestrial plant incidents have been reported to the Agency involving cypermethrin. Phytotoxicity data are needed to assess the impact of the cypermethrins on non-target terrestrial plants.

Guideline Number: 850.4400 and 850.5400
Study Title: Aquatic Plant Growth (algal and aquatic vascular plant toxicity) TierII[21] with TEP or TGAI
No acceptable toxicity data are currently available to assess the risk of the cypermethrins to non-target aquatic nonvascular and vascular plants. Since the cypermethrins have many outdoor uses, aquatic plant growth toxicity studies are requested with either technical or a typical end-use product.

The Agency is aware that additional data on the cypermethrins are available for the European Food Safety Authority reports (EFSA, 2006). It is recommended that any applicable data generated for the European review process be submitted to EPA.

Table 7.2 lists the status of the ecological effects data requirements for cypermethrin.

Table 7.2. Ecological Effects Data Requirements for the Cypermethrins.

Data Requirement	Does EPA Have Data To Satisfy This Requirement?	Bibliographic Citation (MRID)	Must Additional Data Be Submitted Under FIFRA 3(c)(2)(B)?
§158.630 TERRESTRIAL ORGANISM TESTING			
850.2100 Acute Avian Oral, Quail/Duck/Passerine	**Partially**	**44546024**	**Yes[1]**

[20] A Tier II study is required. The DCI will provide that a Tier I plant study may be conducted in lieu of a Tier II study with the understanding that any adverse effects observed by the Tier I study would necessitate conduct and submission of a Tier II study as well.
[21] A Tier II study is required. The DCI will provide that a Tier I plant study may be conducted in lieu of a Tier II study with the understanding that any adverse effects observed by the Tier I study would necessitate conduct and submission of a Tier II study as well.

Table 7.2. Ecological Effects Data Requirements for the Cypermethrins.			
Data Requirement	**Does EPA Have Data To Satisfy This Requirement?**	**Bibliographic Citation (MRID)**	**Must Additional Data Be Submitted Under FIFRA 3(c)(2)(B)?**
850.2200 Acute Avian Diet, Quail	Yes	00090072	No
850.2200 Acute Avian Diet, Duck	Yes	00090071	No
850.2300 Avian Reproduction Quail	Yes	00090074	No
850.2300 Avian Reproduction Duck	Yes	00090073	No
§158.630 AQUATIC ORGANISM TESTING			
850.1075 Acute Fish Toxicity Bluegill	Yes	44546029	No
850.1075 Acute Fish Toxicity Rainbow Trout	Yes	44546027	No
Non-Guideline Acute Fish Toxicity (TEP)[2]	**No**	**00088947**	**Yes[3,4]**
850.1010 Acute Aquatic Invertebrate	Yes	44423501	No
Non-Guideline Acute Aquatic Invertebrate (TEP) [2]	**No**	**00062793/92027014**	**Yes[3,4]**
850.1075 Acute Est/Mar Toxicity Fish	Yes	00090075, 41968211, 44546033	No
850.1075 Acute Est/Mar Toxicity Fish (TEP)	No	N/A	No
850.1035 Acute Est/Mar Toxicity Shrimp	Yes	4070532, 4244601, 00089043, 44561209	No
850.1035 Acute Est/Mar Toxicity Shrimp (TEP)	No	N/A	No
850.1025 Acute Est/Mar Toxicity Mollusk	Yes	89049	No
850.1025 Acute Est/Mar Toxicity Mollusk (TEP)	No	N/A	No
850.1400 Early Life Stage Fish	Yes	89039	No
7.10 850.1300 Life Cycle Aquatic Invertebrate (freshwater)	**No**	**N/A**	**Yes[5]**
7.11 850.1350 Life Cycle Aquatic Invertebrate (saltwater)	Yes	42725301	No
850.1500 Life Cycle Freshwater Fish	No	N/A	No[6]
850.1730 Bioaccumulation in Fish	Yes	42868203	No

Table 7.2. Ecological Effects Data Requirements for the Cypermethrins.			
Data Requirement	**Does EPA Have Data To Satisfy This Requirement?**	**Bibliographic Citation (MRID)**	**Must Additional Data Be Submitted Under FIFRA 3(c)(2)(B)?**
OCSPP 850.1760 (in prep.), 850.1770 (in prep.) and 850.1780 (in prep.) Whole sediment: chronic invertebrates freshwater & marine	**No**	**N/A**	**Yes[7]**
7.12 850.1020 Aquatic Invertebrate Acute Toxicity (*Hyalella*)	Yes	44074406	No
§158.660 PLANT PROTECTION TESTING			
850.4100 Seed Germ, Seedling Emergence	**No**	**NA**	**Yes[8]**
850.4150 Vegetative Vigor	**No**	**NA**	**Yes[9]**
850.4400, 850.5400 Aquatic Plant Growth	**No**	**NA**	**Yes[10]**
§158.490 INSECT POLLINATOR TESTING			
850.3020 Honey Bee Acute Contact	Yes	260647	No
850.3030 Honey Bee Residue on Foliage	No	N/A	No
850.3040 Field Test for Pollinators	No	N/A	No

N/A = Not applicable because no citation is available.

[1] Data are needed for a passerine species. The registrant should submit a protocol prior to conducting this study.

[2]TEP should correspond to those formulated products that are labeled for outdoor uses with the greatest potential for aquatic exposure, and containing the highest synertist:a.i. ratio. Invertebrate test should be with *Hyalella*.

[3] The DCI will indicate that TEP studies on freshwater invertebrates and freshwater fish are required on coformulated products containing the highest ratio of the synergist piperonyl butoxide (PBO) to permethrin and the highest ratio of the synergist MGK-264 to permethrin.

[4] The DCI will require that a study protocol be submitted for review and approval by the Agency prior to this study being initiated.

[5] Study needed for chronic freshwater invertebrate.

[6] No additional data is needed at this time. The results from the fish early-life stage studies will be used in the upcoming risk assessment to evaluate the chronic risk of cypermethrin to fish species.

[7] Until the final OCSPP guidelines for chronic sediment toxicity tests are published, the registrant should submit a protocol to EFED for approval prior to test initiation.

[8] Tier II tests needed if a tested terrestrial species exhibits a statistically significant detrimental effect in the Tier I study.

[9]Tier II tests needed if a tested aquatic species exhibits a statistically significant detrimental effect in a Tier I study.

[10] Studies required for aquatic nonvascular and vascular plants. Test may be conducted with technical grade cypermethrin or a typical end-use product.

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MRID		Citation Reference
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71-2 Avian Dietary Toxicity

MRID		Citation Reference
90071	2016164	Roberts, N.L.; Fairley, C.; Woodhouse, R.N. (1980) The Subacute Dietary Toxicity (LCI50^) of Cypermethrin to the Mallard Duck: ICI 330/WL/80812; 55 1(a)/3. (Unpublished study received Dec 30, 1981 under 10182-64; prepared by Hungtindon Research Centre, England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL: 070561-C)
90072	2016165	Roberts, N.L.; Fairley, C.; Woodhouse, R.N. (1981) The Subacute Di- etary Toxicity (LCI50^) of Cypermethrin to the Bobwhite Quail: ICI 331 WL/80811; 5E.1(a)/4. (Unpublished study received Dec 30, 1981 under 10182-64; prepared by Huntingdon Research Centre, England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL: 070561-D)
44546025	2016184	Johnson, A. (1998) Dietary (LC50) to the Mallard Duck: Betacypermethrin: Lab Project Number: PWT 128: PWT 128/962075. Unpublished study prepared by Huntingdon Life Sciences Ltd. 40 p.
44546026	2016185	Johnson, A. (1998) Dietary LC(50) to the Bobwhite Quail: Betacypermethrin: Lab Project Number: PWT 127: PWT 127/962074. Unpublished study prepared by Huntingdon Life Sciences Ltd. 40 p.
92027003 **Of** 90072	Registrant Summary	Edwards, P. (1990) ICI Americas Inc. Phase 3 Summary of MRID 00090072. The Subacute Dietary Toxicity (LC50) of Cypermethrin (PP383) to the Bobwhite Quail: Report No. ICI331WL/80811; Study No. ICI331WL/80811. Prepared by Huntingdon Research Centre 11 p.

92027004 **Of** 90071	Registrant Summary	Edwards, P. (1990) ICI Americas Inc. Phase 3 Summary of MRID 00090071. The Subacute Dietary Toxicity (LC50) of Cypermethrin (PP383) to the Mallard Duck: Report No. ISK/ICIWL284/79835. Prepared by Huntingdon Research Centre 11 p.

71-4 Avian Reproduction

MRID		Citation Reference
90073	DER not located-reviewed in 1981	Roberts, N.L.; Fairley, C.; Chanter, D.O.; et al. (1981) The Effect of the Dietary Inclusion of Cypermentrin on Reproduction in the Mallard Duck: ICI 341/8164; CTL/C/1091. (Unpublished study re- ceived Dec 30, 1981 under 10182-64; prepared by Huntingdon Re- search Centre, England, submitted by ICI Americas, Inc., Wil- mington, Del.; CDL:070561-E)
90074	2016144	Roberts, N.L.; Fairley, C.; Chanter, D.O.; et al. (1981) The Effect of Dietary Inclusion of Cypermethrin on Reproduction in the Bob- white Quail: ICI 342/81341; CTL/C/1105. (Unpublished study re- ceived Dec 30, 1981 under 10182-64; prepared by Huntingdon Re- search Centre, England, submitted by ICI Americas, Inc., Wil- mington, Del.; CDL:070561-F)
92027005	Registrant Summary	Edwards, P. (1990) ICI Americas Inc. Phase 3 Summary of MRID 00090074. The Effect of Dietary Inclusion of Cypermethrin on Reproduction in Bobwhite Quail: Report No. CTL/C/1105; Study No.: ICI342/81341.: 15 p.
92027006	Registrant Summary	Edwards, P. (1990) ICI Americas Inc. Phase 3 Summary of MRID 00090073. The Effect of the Dietary Inclusion of Cypermethrin on Reproduction in the Mallard Duck: Report No. CTL/C/1091; Study No.: ICI341/8164.: 15 p.

72-1 Acute Toxicity to Freshwater Fish

MRID		Citation Reference
62791	See 65812	Hill, R.W.; Maddock, B.G.; Harland, B.J. (1980) Determination of the Acute Toxicity of Cypermethrin (PP 383) to Bluegill Sunfish (Lepomis macrochirus): BL/B/2011. (Unpublished study received Dec 5, 1980 under 279-EX-86; prepared by Imperial Chemical Industries, Ltd., England, submitted by FMC Corp., Philadelphia, Pa.; CDL:243861-AE)
62792	DER not located-Reviewed in 1982	Hill, R.W.; Maddock, B.G.; Harland, B.J. (1980) Determination of the Acute Toxicity of Cypermethrin (PP 383) to Rainbow Trout (Salmo gairdneri): BL/B/2006. (Unpublished study received Dec 5, 1980 under 279-EX-86; prepared by Imperial Chemical Industries, Ltd., England, submitted by FMC Corp., Philadelphia, Pa.; CDL:243861-AF)
65812	2016475	Hill, R.W.; Maddock, B.G.; Harland, B.J. (1980) Determination of the Acute Toxicity of Cypermethrin (PP 383) to Bluegill Sunfish (Lepomis macrochirus): BL/B/2011. (Unpublished study received Dec 29, 1980 under 10182-EX-19; prepared by Imperial Chemical Industries, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:244017-D)
65813	DER not located-	Hill, R.W.; Maddock, B.G.; Harland, B.J. (1980) Determination of the Acute Toxicity of GFU 061, a 36% w/v Formulation of Cypermethrin to Rainbow Trout

	reviewed in 1981	(Salmo gairdneri): BL/B/2016. (Unpublished study received Dec 29, 1980 under 10182-EX-19; prepared by Imperial Chemical Industries, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:244017-E)
65814	DER not l.ocated	Hill, R.W.; Maddock, B.G.; Harland, B.J. (1980) Determination of the Acute Toxicity of GFU 061, a 36% w/v Formulation of Cypermethrin to Bluegill Sunfish (Lepomis macrochirus): BL/B/ 2017. (Unpublished study received Dec 29, 1980 under 10182-EX- 19; prepared by Imperial Chemical Industries, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:244017-F)
65816	Permethrin study	Hill, R.W.; Young, B.E. (1978) The Acute Toxicity of **Permethrin Acid and 3-Phenoxy Benzyl Alcohol** to Rainbow Trout (Salmo gairdneri): BL/B/1918. (Unpublished study received Dec 29, 1980 under 10182-EX-19; prepared by Imperial Chemical Industries, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:244017-J)
88947	2016176 2079552 = contract draft	Hill, R.W.; Maddock, B.G.; Comber, M.H.I. (1981) Cypermethrin: Determination of the Acute Toxicity of Formulation GFU 070 to Rainbow Trout (?~Salmo gairdneri~?): BL/B/2093. (Unpublished study received Dec 30, 1981 under 10182-64; prepared by Imperial Chemical Industries, Ltd., submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070558-C)
88948	2016177	Hill, R.W.; Maddock, B.G.; Comber, M.H.I. (1981) Cypermethrin. Determination of the Acute Toxicity of Formulation GFU 070 to Bluegill Sunfish (?~Lepomis macrochirus~?): BL/B/2099. (Unpub- lished study received Dec 30, 1981 under 10182-64; prepared by Imperial Chemical Industries, Ltd., submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070558-D)
89036	DER not located	Reiff, B.; Pearson, N.; Rees, H.J.; et al. (1978) The Effect of Suspended Solids on the Toxicity of WL 43467 to Rainbow Trout (?~Salmo gairdneri~?): Group Research Report TLGR.0007.78. (Un- published study received Dec 30, 1981 under 10182-64; prepared by Shell Research, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-A)
89037	2016146	Hill, R.W.; Young, B.E.; Comber, M.H.I. (1981) Determination of the Acute Toxicity of 3-Phenoxy Benzoic Acid to Rainbow Trout (?~Salmo gairdneri~?): Brixham Report No. Bl/B/2038. (Unpub- lished study received Dec 30, 1981 under 10182-64; prepared by Imperial Chemical Industries, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-B)
89038	2016147	Hill, R.W.; Young, B.E.; Comber, M.H.I. (1981) Determination of the Acute Toxicity of 3-Phenoxy Benzoic Acid to Bluegill Sunfish (?~Lepomis macrochirus~?): Brixham Report No. BL/B/2086. (Un- published study received Dec 30, 1981 under 10182-64; prepared by Imperial Chemical Industries, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-C)
41068002	Open lit	Coats, J.; O'Donnell-Jeffery, N. (1979) Toxicity of four synthetic pyrethroid insecticides to rainbow trout. **Bulletin of Enviro- mental Contamination and Toxicology 23:250-255.**
41068003	Open lit	McLeese, D.; Metcalfe, C.; Zitko, V. (1980) Lethality of permethrin, cypermethrin and fenvalerate to salmon, lobster and shrimp. **Bulletin of Environmental Contamination and Toxicology 25:950-955.**
41068004	Open lit	Stephenson, R. (1981) Aquatic toxicology of cypermethrin: I acute toxicology to some freshwater fish and invertebrates in labora- tory tests. **Aquatic Toxicology 2:175-185.**
41968208	2016167	Overman, M.; Barron, M.; Vaishnav, D. (1990) Cypermethrin-S (FMC 56701):

		Acute Toxicity to Rainbow Trout (Oncorhynchus mykiss) Under Flow-through Test Conditions: Lab Project Number: 3903026- 0700-3140. Unpublished study prepared by Environmental Science and Engineering, Inc. 48 p.
41968209	2016173	Vaishnav, D.; Yurk, J. (1990) Cypermethrin (FMC 45806): Acute Toxi- city to Rainbow Trout (Oncorhynchus mykiss) Under Flow-through Test Conditions: Lab Project Number: 3903026-0750-3140. Unpub- lished study prepared by Environmental Science and Engineering, Inc. 46 p.
44546027	2016194	Sousa, J. (1998) (Carbon 14)-Cypermethrin--Acute Toxicity to Rainbow Trout (Oncorhynchus mykiss) Under Flow-Through Conditions: Final Report: Lab Project Number: 97-11-7166: 12442.1096.6223.108. Unpublished study prepared by Springborn Labs., Inc. 91 p.
44546028	2016196	Sousa, J. (1998) Cypermethrin Technical--Acute Toxicity to Rainbow Trout (Oncorhynchus mykiss) Under Flow-Through Conditions: Final Report: Lab Project Number: 98-1-7213: 12442.1096.6222.108. Unpublished study prepared by Springborn Labs., Inc. 78 p.
44546029	2016186	Sousa, J. (1998) (Carbon 14)(Beta)-Cypermethrin--Acute Toxicity to Bluegill Sunfish (Lepomis macrochirus) Under Flow-Through Conditions: Final Report: Lab Project Number: 97-12-7177: 12442.1096.6225.105. Unpublished study prepared by Springborn Labs., Inc. 91 p.
44546030	2016187	Sousa, J. (1998) Cypermethrin Technical--Acute Toxicity to Bluegill Sunfish (Lepomis macrochirus) Under Flow-Through Conditions: Final Report: Lab Project Number: 97-12-7195: 12442.1096.6224.105. Unpublished study prepared by Springborn Labs., Inc. 76 p.
92027007	Registrant summary	Adams, D. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00065812.** Cypermethrin Technical PP383: Determination of the Acute Toxicity to Bluegill Sunfish (Lepomis macrochirus): Report No. BL/B/2011; Study No.: F342/D. Prepared by ICI Brixham Laboratory 13 p.
92027008	Registrant Summary	Adams, D. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00089038**. 3-Phenoxybenzoic Acid: Determination of the Acute Toxicity to Bluegill Sunfish (Lepomis macrochirus): Report No. BL/2086; Study No.: G145/D.: 12 p
92027009	Registrant Summary	Adams, D. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00088948.** Cypermethrin (PP383): Determination of the Acute Toxicity of a 2lb/US gallon formulation to Bluegill Sunfish (Lepomis macrochirus): Report No. BL/B/2099; Study No.: G244/C. Prepared by ICI Brixham Laboratory 13 p.
92027010	Registrant Summary	Hill, R. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00089037**. 3-Phenoxybenzoic Acid: Determination of the Acute Toxicity of the Active Ingredient (99% Purity w/w) to Rainbow Trout (Salmo gairdneri): Report No. BL/B/2038; Study No.: G 145/C. Prepared by ICI Brixham Laboratory 12 p.
92027011	Registrant Summary	Treacy, C. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00062792.** Cypermethrin (PP383): Determination of the Acute Toxicity of Active Ingredient (91. 5% purity) to Rainbow Trout (Salmo gairdneri) Report No. BL/B/2006; Study No.: F342/B.: 12 p.
92027012	Registrant Summary	Coleman, C. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00088947**. Cypermethrin: Determination of the Acute Toxicity of a 25% w/w Formulation to Rainbow Trout (Salbo gairdneri): Report No. BL/B/2093; Study No.: G244/B.: 12 p.
92027013	Registrant	Treacy, C. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00065813**.

Summary	Cypermethrin: Determination of the Acute Toxicity of Formulation GFU 061 to Rainbow Trout (Salmo gairdneri): Report No. BL/B/2016; S No. F617/B.: 12 p.

72-2 Acute Toxicity to Freshwater Invertebrates

MRID		Citation Reference
62793 **Or** 92027014	2016162	Edwards, P.J.; Brown, S.M.; Sapiets, A.S. (1980) Cypermethrin (PP383): Toxicity of Technical and Formulated Material to First Instar Daphnia magna: Report Series RJ 0110B. (Unpublished study received Dec 5, 1980 under 279-EX-86; prepared by Imperial Chemical Industries, Ltd., England, submitted by FMC Corp., Philadelphia, Pa.; CDL:243861-AG)
65815	See 62793	Edwards, P.J.; Brown, S.M.; Sapiets, A.S.; et al. (1980) Cypermethrin (PP383): Toxicity of Technical and Formulated Material to First Instar Daphnia magna: Report Series RJ 0110B. (Unpublished study received Dec 29, 1980 under 10182-EX-19; prepared by Imperial Chemical Industries, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:244017-H)
65817	Permethrin study	Getty, C.; Wilkinson, W.; Davies, P.J.; et al. (1978) **Permethrin Acid and 3-Phenoxybenzyl Alcohol**: Toxicity to First Instar Daphnia magna: Report Series RJ 0042B. (Unpublished study received Dec 29, 1980 under 10182-EX-19; prepared by Imperial Chemical Industries, Ltd., submitted by ICI Americas, Inc., Wilmington, Del.; CDL:244017-K)
88949	DER not located	Edwards, P.J.; Brown, S.M.; Swaine, H.; et al. (1981) Cypermethrin (PP383): Toxicity of Formulation GFU070 to First Instar ?~Daphnia magna~?: Report Series RJ 0199B. (Unpublished study received Dec 30, 1981 under 10182-64; prepared by Imperial Chemical Industries, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070558-E)
89040	2016162	Edwards, P.J.; Brown, S.M.; Swaine, H.; et al. (1980) Cypermethrin (PP383): Toxicity of Formulation GFU061 to First Instar~Daphnia~ ?~magna~?: Report Series RJ 0149B. (Unpublished study received Dec 30, 1981 under 10182-64; prepared by Imperial Chemical In- dustries, Ltd., submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-E)
89041	2016150	Stephenson, R.R.; Bennett, D.; Francis, W.H.P.; et al. (1980) The Acute Toxicity of Cypermethrin (WL 43467) to the Freshwater Shrimp (?~Gammarus pulex~?) and Larvae of the Mayfly, (?~Cloeon~ ?~dipterum~?), in Continuous-flow Tests: Group Research Report TLGR.80.079. (Unpublished study received Dec 30, 1981 under 10182-64; prepared by Shell Research, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-G)
89042	DER nor located-reviewed in 1982-core	Jaber, M.J.; Hawk, R.E. (1981) The Acute Toxicity of Cypermethrin to Crayfish (?~Orconectes sp~?.): Report Series TMUE0008/B. (Unpublished study received Dec 30, 1981 under 10182-64; sub- mitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-H)
89046	2016153	Edwards, P.J.; Brown, S.M.; Swaine, H.; et al. (1980) 3-Phenoxy- benzoic Acid: Toxicity to First Instar~Daphnia magna~?:Report Series RJ 0148B. (Unpublished study received Dec 30, 1981 under 10182-64; prepared by Imperial Chemical Industries, Ltd., submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-L)

89048	2016155	Edwards, P.J.; Brown, S.M.; Hamer, M.J.; et al. (1980) Cyper- methrin: Acute Toxicity to the Mayfly, Baetis rhodani: Report Series RJ 0173B. (Unpublished study received Dec 30, 1981 under 10182-64; prepared by Imperial Chemical Industries, Ltd., sub- mitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-N)
140833	2016149	Stephenson, R.R.; Sherwood, C.M.; Bennett, D.; et al. (1980) The Acute Toxicity of WL 43467 to Some Freshwater Invertebrates in Static Water Tests: Group Research Report TLGR.80.040. (Un- published study received Dec 30, 1981 under 10182-64; prepared by Shell Research, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-F)
41068004	Open lit	Stephenson, R. (1981) Aquatic toxicology of cypermethrin: I acute toxicology to some freshwater fish and invertebrates in labora- tory tests**. Aquatic Toxicology 2:175-185.**
41968210	2016168	Ward, T.; Boeri, R. et al. (1991) Acute Toxicity of FMC 56701 Tech- nical and Cypermethrin Technical to the Daphnid, Daphnia magna: Lab Project Number: 90186-FMC: A90-3310. Unpublished study prepared by Resource Analysts, Inc. 46 p.
43293501	DER not located-contract draft available	Wheat, J.; Evans, J. (1994) Zetacypermethrin Technical and Cypermethrin Technical: Comparative Acute Toxicity to the Water Flea (Daphnia magna), under Flow-Through Test Conditions: Lab Project Number: J9210001B: A92/3636. Unpublished study prepared by Toxikon Environmental Sciences. 76 p.
44074401	DER not located	Rapley, J.; Hamer, M. (1996) Cypermethrin: Toxicity to Chironomus riparius and Hyalella azteca: Lab Project Number: RC0002: 95JH082. Unpublished study prepared by Zeneca Agrochemicals. 15 p.
44074402	2063977	Gentle, W.; Goggin, U.; Rapley, J.; et al. (1996) Cypermethrin: Toxicity to Chironomus tentans in Sediment-Water Systems: Lab Project Number: RC0001: 96JH007. Unpublished study prepared by Zeneca Agrochemicals. 31 p.
44074406	2063978	Farrelly, E.; Gentle, W.; Goggin, U.; et al. (1996) Cypermethrin: Toxicity to Hyalella azteca in Sediment-Water Systems: Lab Project Number: RC0006: 95JH228. Unpublished study prepared by Zeneca Agrochemicals. 30 p.
44423501	DER not located	Hamer, M. (1997) Cypermethrin: Acute Toxicity of Short-Term Exposures to Hyalella Azteca: Lab Project Number: TMJ3904B. Unpublished study prepared by Zeneca Agrochemicals. 10 p.
44546031	2016188	Putt, A. (1998) (Carbon 14)(Beta)Cypermethrin--Acute Toxicity to Daphnids (Daphnia magna) Under Flow-Through Conditions: Final Report: Lab Project Number: 97-9-7079: 12442.1096.6227.115. Unpublished study prepared by Springborn Labs., Inc. 95 p.
44546032	2016189	Putt, A. (1998) Cypermethrin Technical--Acute Toxicity to Daphnids (Daphnia magna) Under Flow-Through Conditions: Final Report: Lab Project Number: 97-11-7138: 12442.1096.6226.115. Unpublished study prepared by Springborn Labs., Inc. 74 p.
92027014	Registrant Summary	Hamer, M. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00062793**. Cypermethrin (PP383): Toxicity of Technical and Formulated Material to First Instar Daphna (sic) magna: Report No.: RJ011OB; Study No.: PP383/CN/01. Prepared by ICI Agrochemicals, Jealott's Hill Research Station. 17 p.
92027015	Registrant Summary	Hamer, M. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00089046.** 3-Phenoxybenzoic Acid: Toxicity to First Instar Daphna (sic) magna: Report No.:

		RJ0148B; Study No.: PP383/CN/03. Prepared by ICI Agrochemicals, Jealott's Hill Research Station. 14 p.
92027016	Registrant Summary	Hamer, M. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00065817**. Permethrin Acid and 3-Phenoxybenzyl Alcohol: Toxicity to First Instar Daphnia Magna: Report No.: RJ0042B; Study No.: PP557/CN/01. Prepared by ICI Agrochemicals Jealott's Hill Research Station 18 p.
92027017	Registrant Summary	Hamer, M. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00152739**. 3 Phenoxybenzoic Acid: Toxicity to First Instar Daphnia magna (II): Report No.: RJ0318B; PP563/CN/01. Prepared by ICI Agrochemicals Jealott's Hill Research Station 14 p.
31225	DER not located	Leblanc, G.A. (1976) Acute Toxicity of **FMC-30980** to Daphnia magna: ACT 011.12. (Unpublished study received Sep 28, 1976 under 279-EX-63; prepared by EG&G, Bionomics, submitted by FMC Corp., Philadelphia, Pa.; CDL:227762-E)
152739	2016175	Everett, C.J., M.J. Hamer and I.R. Hill (1983) 3-Phenoxybenzoic Acid: Toxicity to First Instar Daphnia magna (II). Report Series RJ 0318B. Prepared and Submitted by ICI Plant Protection Division, Bracknell, Berkshire, England. EPA MRID No. 152739.

72-3 Acute Toxicity to Estuarine/Marine Organisms

MRID		Citation Reference
89043	2016151 2016161	Jaber, M.J.; Hawk, R.E. (1981) The Acute Toxicity of Cypermethrin to Pink Shrimp (Penaeus duorarum): Report Series TMUE004/B. (Unpublished study received Dec 30, 1981 under 10182-64; sub- mitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-I)
89044	2016166	Jaber, M.J.; Hawk, R.E. (1981) The Acute and Chronic Toxicity of Cypermethrin to Mysid Shrimp (?~Mysidopsis bahia~?): Report Series TMUE0005/B. (Unpublished study received Dec 30, 1981 under 10182-64; submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-J)
89045	2016152	Jaber, M.J.; Hawk, R.E. (1981) The Acute Toxicity of Cypermethrin to Fiddler Crabs (?~Uca pugilator~?): Report Series TMUE0003/B. (Unpublished study received Dec 30, 1981 under 10182-64; sub- mitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-K)
89049	2016154	Jaber, M.J.; Hawk, R.E. (1981) The Acute Toxicity of Cypermethrin to Eastern Oysters (Crassostrea virginica): Report Series TMUE0009/B. (Unpublished study received Dec 30, 1981 under 10182-64; submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-O)
89050	2016143	Hill, R.W.; Thompson, R.S.; Comber, M.H.I. (1981) Investigation of the Acute Toxicity of PP 383 to Larvae of the Pacific Oyster (Crassostrea gigas): Brixham Report No. BL/B/2088. (Unpub- lished study received Dec 30, 1981 under 10182-64; prepared by Imperial Chemical Industries, Ltd., England, submitted by ICI Americas, Inc.; Wilmington, Del.; CDL:070562-P)
90075	DER not located	Jaber, M.J.; Hawk, R.E. (1981) The Acute Toxicity of Cypermethrin to Sheepshead Minnows (?~Cyprinodon variegatus?~): Report Series TMUE0002/B. (Unpublished study received Dec 30, 1981 under 10182-64; submitted by ICI Americas, Inc., Wilmington, Del.; CDL:079561-G)

41968211	2016171	Overman, M.A., M.G. Barron and D.D. Vaishnav (1990) **Cypermethrin-S** (FMC 56701): Acute Toxicity to Sheepshead Minnow (*Cyprinodon variegates*) under Flow-Through Test Conditions. Laboratory Project No. 3903026-0600-3140. Study Performed by Environmental Science and Engineering, Inc., Gainesville, FL. Submitted by FMC Corporation, Philadelphia, PA. EPA MRID No. 31968211.
41968212	2016170	Chandler, A. (1990) FMC 45806: Acute Toxicity to Sheepshead Minnow (Cyprinodon variegatus) Under Flow-through Test Conditions: Lab Project Number: 3903026-0350-3140. Unpublished study prepared by Environmental Science and Engineering(ESE), Inc. 43 p.
41968213	2016169	Ward, T.; Boeri, R. (1991) Acute Toxicity of FMC 56701 Technical and Cypermethrin Technical to the Mysid, Mysidopsis bahia: Lab Project Number: 90187-FMC: A90-3309. Unpublished study prepared by Resource Analysts, Inc. 52 p.
42364701	Registrant rebuttal	Anon. (1992) **Response to the EPA's Review of MRID 41968212** Cypermethrin: Acute Toxicity to Sheepshead Minnows Under Flow-Through Test Conditions: Unpublished study prepared by FMC Corp. 8 p.
44546033	2016195	Dionne, E. (1998) Cypermethrin Technical--Acute Toxicity to Sheepshead Minnow (Cyprinodon variegatus) Under Flow-Through Conditions: Final Report: Lab Project Number: 97-12-7197: 12442.1096.6230.505. Unpublished study prepared by Springborn Labs., Inc. 75 p.
44546034	2016187	Sousa, J. (1998) (Carbon 14)(Beta)-Cypermethrin--Chronic Toxicity to Sheepshead Minnow (Cyprinodon variegatus) Under Flow-Through Conditions: Final Report: Lab Project Number: 97-1-7212: 12442.1096.6231.505. Unpublished study prepared by Springborn Labs., Inc. 91 p.
44561209	2016191	Putt, A. (1998) (Carbon-14) Beta-Cypermethrin--Acute Toxicity to Mysids (Mysidopsis bahia) Under Flow-Through Conditions: Final Report: Lab Project Number: 97-11-7153: 12442.1096.6229.515. Unpublished study prepared by Springborn Laboratories, Inc. 79 p.
44561210	2016190	Putt, A. (1998) Cypermethrin Technical--Acute Toxicity to Mysids (Mysidopsis bahia) Under Flow-through Conditions: Final Report: Lab Project Number: 98-1-7224: 12442.1096.6228.815. Unpublished study prepared by Springborn laboratories, Inc. 76 p.
92027018	Registrant Summary	Royal, P. (1990) ICI Americas Inc. Phase 3 Summary of MRID 00090075. Cypermethrin: Acute Toxicity of Technical Material for Sheepshead Minnow (Cyprinodon variegatus): Report No.: TMUE 0002/B.: 15 p.
92027019	Registrant Summary	Royal, P. (1990) ICI Americas Inc. Phase 3 Summary of MRID 00089049. Cypermethrin: The Acute Toxicity to Eastern Oysters (Crassostrea virginica): Report No. TMUE 0009/B. Prepared by Springborn Laboratories, Inc. 13 p.
92027020	Registrant Summary	Royal, P. (1990) Ici Americas Inc. Phase 3 Summary of MRID 00089043. Cypermethrin: Determination of the Acute Toxicity of Technical Material to Pink Shrimp (Penaeus duorarum): Report No. TMUE 0004/B. Prepared by Springborn Laboratories, Inc. 15 p.
92027021	2016166 Registrant Summary	Royal, P. (1990) ICI Americas Inc. Phase 3 Summary of MRID 00089044. Cypermethrin: Determination of Acute Toxicity to Mysid Shrimp (Mysidopsis bahia): Report No. TMUE 0005/B. Prepared by Springborn Laboratories, Inc. 12 p.
92027022	Registrant Summary	Royal, D. (1990) ICI Americas Inc. Phase 3 Summary of MRID 00089045. Cypermethrin: Determination of the Acute Toxicity of Technical Material to the

		Fiddler Crab (Uca pugilator): Report No. TMUE 0003/B. Prepared by Springborn Laboratories, Inc. 15 p.
89051	Stability test	Ussary, J.P.; Fitzpatrick, R.D.; Foreman, L.A.; et al. (1981) Cy- permethrin Stability in Marine Laboratory Test Systems: Report Series TMU0558/B. (Unpublished study received Dec 30, 1981 under 10182-64; submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-Q)
46591503	Contract draft available	Putt, A. (2005) Cypermethrin - Toxicity to Estuarine Amphipods (Leptocheirus plumulosus) During a 28-Day Sediment Exposure. Project Number: 13656/6111. Unpublished study prepared by Springborn Smithers Laboratories. 85 p.
Accession No. 070562	2016143 2016156	Thompson, R.S. (1981) Investigation of the Acute Toxicity of PP383 to Larvae of the Pacific Oyster (Crassostrea gigas). Unpublished Report by the Brixham Laboratory of Imperial Chemical Industries, Ltd., Submitted 12/28/81 by ICI Americas Inc., Wilmington, Delaware.
42444601	2016178 2016179	Ward, Timothy J., Robert L. Boeri and Mark A. Palmieri (1992) Acute Toxicity of FMC 56701 Technical and Cypermethrin Technical to the Mysid, Mysidopsis bahia. FMC Study Number A91-3454. Submitted by FMC Corporation. Performed by EnviroSystems Division, Resource Analysts, Inc. Hampton, New Hampshire. MRID No. 42444601.

72-4 Fish Early Life Stage/Aquatic Invertebrate Life Cycle Study

MRID		Citation Reference
25770	2016141	Hill, R.W.; Maddock, B.G.; Hart, B. (1976) Determination of the Acute Toxicity of PP383 to Rainbow Trout (Salmo gairdnerii): Report No. BL/B/1711. (Unpublished study received Dec 31, 1979 under 10182-EX-19; prepared by Imperial Chemical Industries, Ltd., submitted by ICI Americas, Inc., Wilmington, Del.; CDL: 241598-H)
25771	2016142	Hill, R.W.; Maddock, B.G.; Hart, B.; et al. (1977) Determination of the Acute Toxicity of PP 383 to Bluegill Sunfish (Lepomis macrochirus): Report No. BL/B/1775. (Unpublished study received Dec 31, 1979 under 10182-EX-19; prepared by Imperial Chemical Industries, Ltd., submitted by ICI Americas, Inc., Wilmington, Del.; CDL:241598-I)
31224	DER not located	Bentley, R.E. (1976) Acute Toxicity of **FMC-30980** to Bluegill (Lepomis macrochirus): NCT 634.61. (Unpublished study received Sep 28, 1976 under 279-EX-63; prepared by EG&G, Bionomics, submitted by FMC Corp., Philadelphia, Pa.; CDL:227762-D)
89039	2016148	Jaber, M.J.; Hawk, R.E. (1981) The Toxicity of Cypermethrin to Fathead Minnow (Pimephales promelas) Embryos and Larvae: Report Series TMUE0007/B. (Unpublished study received Dec 30, 1981 under 10182-64; submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-D)
89047	2016163	Edwards, P.J.; Hamer, M.J.; Bull, J.M.; et al. (1981) Cypermethrin: 21 Day~Daphnia magna~Life Cycle Study: Report Series RJ 0177B. (Unpublished study received Dec 30, 1981 under 10182-64; pre- pared by Imperial Chemical Industries, Ltd., submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070562-M)

42725301	2016180	Wheat, J. (1993) FMC-30980(carbon 14)-Cypermethrin: Chronic Toxicity to the Mysid, Mysidopsis bahia, Under Flow-Through Test Conditions: Lab Project Number: J9205004A. Unpublished study prepared by Toxikon Environmental Sciences. 63 p.
42898301	2016182	Wheat, J. (1993) FMC-30980 ((carbon 14) labeled Cypermethrin): Chronic Life-Cycle Toxicity to the Water Flea, Daphnia magna, Under Flow-through Test Conditions: Lab Project Number: J9205004B: A91-3479. Unpublished study prepared by Toxikon Environmental Sciences. 71 p.
44546035	2016192	Sousa, J. (1998) (Carbon 14)(Beta)-Cypermethrin--Chronic Toxicity to Mysids (Mysidopsis bahia) Under Flow-Through Conditions: Final Report: Lab Project Number: 97-12-7170: 12442.1096.6232.530. Unpublished study prepared by Springborn Labs., Inc. 101 p.
92027023	Registrant Summary	Royal, P. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00089039**. Cypermethrin: Early Life Stages Test Fathead Minnow (Pimephales promelas): Report No. TMUE 0007/B. Prepared by Springborn Laboratories, Inc. 14 p.
92027024	Registrant Summary	Royal, P. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00089044**. Cypermethrin: Invertebrate Life-Cycle Test in Mysid Shrimp (Mysidopsis bahia): SLI TMUE 0005/B.: 16 p
92027025	Registrant Summary	Hamer, M. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 00089047**. Cypermethrin: 21 Day Daphnia magna Life-cycle Study: Report No.: RJ0177B; PP383/CN/04. Prepared by ICI Agrochemicals Jealott's Hill Research Station 17 p.
46591503	2086352	Marine Amphipod 28 Day Whole Sediment toxicity

850.1300 Daphnid chronic toxicity test

MRID		Citation Reference
47885103	Contract draft available	Cafarella, M. (2008) Cypermethrin: Full Life Cycle Toxicity Test with Water Fleas, Daphnia magna under Flow-Through Conditions: Reformatted Final Report. Project Number: 1084/012/231, A2007/6309. Unpublished study prepared by Springborn Smithers Laboratories (Europe). 87 p.
47944027	DER not located	Garforth, B. (1982) WL 85871 and Cypermethrin: Chronic Toxicity to Daphnia magna. Project Number: AL/523/001/OCR, AL/523/001, SBGR/82/119. Unpublished study prepared by Sittingbourne Research Center. 46 p.

72-5 Life cycle fish

MRID		Citation Reference
40102101	Status report	Hill, R.; Tapp, J. (1987) Status Report at Day 30 Post-hatch Cypermethrin (PP383) Fathead Minnow Lifecycle Study: Lab. Pro- ject ID: (P171/C). Unpublished study prepared by Imperial Chem- ical Industries PLC, Brixham Laboratory. 7 p.

40427901	Status report	Hill, R.; Tapp, J. (1987) Status Report on Cypermethrin (PP383) Fathead Minnow Lifecycle Study (P171/C): Laboratory Project ID P171/C. Unpublished study prepared by Imperial Chemicals Industries PLC. 13 p.
40529601	Status report	Hill, R.; Tapp, J. (1988) Status Report of Cypermethrin (PP383) Fathead Minnow Lifecycle Study (P171/c). Laboratory Project ID P171/C. Unpublished study prepared by Imperial Chemicals Industries PLC, England. 4 p.
40641701	DER not located	Tapp, J.; Hill, R.; Maddock, B.; et al. (1988) "Cypermethrin: Determination of Chronic Toxicity to Fathead Minnow (Pimephales promelas) Full Lifecycle": Laboratory Project ID BL/B/3173. Unpublished study prepared by ICI PLC, Brixham Laboratory. 189 p.
41092101	addendum	Tapp, J. (1988) Cypermethrin: Determination of Chronic Toxicity to Fathead Minnow (Pimephales Promelas) Full Lifecycle. Addendum to Brixham Laboratory Report No. BL/B/3173: Laboratory ID No. FT5/86/P171/C. Unpublished study prepared by ICI Brixham Labor- atory. 12 p.
92027026	Registrant summary	Adams, D. (1990) ICI Americas Inc. Phase 3 **Summary of MRID 40641701**. Cypermethrin: Determination of the Chronic Toxicity to Fathead Minnow (Pimephales promelas): Report Nos. BL/B/3173/3507; Study No. P171/C.: 19 p.
40102100	Interim report	Imperial Chemical Industries PLC (1987) Interim Report on Fish Lifecycle Study of Cypermethrin in Response to Data Call-in Notice. Compilation of 1 study.

72-6 Aquatic org. accumulation

MRID		Citation Reference
42868203	Check Fate Data	Giroir, E.; Stuerman, L. (1993) Cypermethrin (carbon 14) Bioconcentration by Bluegill Sunfish (Lepomis macrochirus): Lab Project Number: 191E5491E1: 40018: PC-0189. Unpublished study prepared by ABC Labs, Inc. 311 p.

72-7 Simulated or Actual Field Testing

MRID		Citation Reference
40125601	Suitability evaluation	Cole, J.; Brantly, T.; Hodges, J.; et al. (1987) Cypermethrin: Evaluation during 1986 of "Speir II" (Alabama, USA) Farm Pond Drainage Basin and Ecosystem for Suitability for a 1987 Cyper- methrin Study: I: Laboratory Project ID: RJ0553B. Unpublished study prepared by Imperial Chemical Industries. 382 p.
40125602	Suitability evaluation	Cole, J.; Brantly, T.; Hodges, J.; et al. (1987) Cypermethrin: Evaluation during 1986 of "Mayo" (Alabama, USA) Farm Pond Drain- age Basin and Ecosystem for Suitability for a 1987 Cypermethrin Study: I: Laboratory Project ID: RJ0557B. Unpublished study prepared by Imperial Chemical Industries. 376 p.
40125603	Suitability evaluation	Hill, I.; Cole, J. (1987**) Comparison of "Speir II" and "Mayo" Farm Ponds** (Alabama) USA: Laboratory Project ID: M4428B. Unpublished study prepared by

		Imperial Chemical Industries. 20 p.
40804501	2016160	Rea, D.; Brantly, T.; Grimmett, J.; et al. (1988) Cypermethrin: Evaluation of the Impact of Aerially Sprayed Cypermethrin on the Aquatic Ecosystem of a Farm Pond in the Drainage Basin of a Cotton Crop: 1987: Laboratory Project ID RH0629B. Unpublished study prepared by ICI Agrochemicals. 744 p.
40804502	Suitability evaluation	Cole, J.; Brantly, T.; Hodges, J.; et al. (1988) Cypermethrin: Evaluation during 1986 of "Speir II" (Alabama, USA) Farm Pond Drainage Basin and Ecosystem for Suitability for a 1987 Cypermethrin Study: II: Laboratory Project ID RJ0591B. Unpub- lished study prepared by ICI Agrochemicals. 508 p.
41011501	addendum	Sadler, J. (1989) Cypermethrin: Addendum to RJ0629B: Evaluation of the Impact of Aerially Sprayed Cypermethrin on the Aquatic Eco- system of a Farm Pond in the Drainage Basin of a Cotton Crop: 1987: Project ID: PP383-CF-04/2. Unpublished study prepared by Jeallot's Hill Research Station. 14 p.
41218801	Progress report	Palmieri, M. (1989) Aquatic Mesocosm Study of Pesticide Products Containing the Active Ingredient Cypermethrin: Progress Rept. 1: Study No. A89-2847. Unpublished study prepared by Wildlife International, Ltd. 17 p.
41336201	Progress report	Palmieri, M. (1989) Aquatic Mesocosm Study of Pesticide Products Containing the Active Ingredient Cypermethrin: Progress Report 3: FMC Study No. A89-2847. Unpublished study prepared by Wildlife International, Ltd. and FMC Corp. 5 p.
41403101	Progress report	Palmieri, M. (1990) Aquatic Mesocosm Study of Pesticide Products Containing the Active Ingredient Cypermethrin: Progress Report 4: Lab Project Number: A89-2847. Unpublished study prepared by Wildlife International, Ltd. in association with FMC Corp. 55 p.
41466301	Progress report	Palmieri, M. (1990) Aquatic Mecocosm Study of Pesticide Products Containing the Active Ingredient Cypermethrin: Progress Report. Unpublished study prepared by Wildlife International, Ltd. 7 p.
41541101	Progress report	Palmieri, M. (1990) Aquatic Mesocosm Study of Pesticide Products Containing the Active Ingredient Cypermethrin: Progress Report 6: Lab Project No. A89-2847. Unpublished study prepared by Wildlife International, Ltd. 14 p.
41616201	Progress report	Palmieri, M. (1990) Aquatic Mesocosm Study of Pesticide Products Containing the Active Ingredient Cypermethrin: Progress Report 7: Project Number: A89-2847. Unpublished study prepared by Wildlife International, Ltd., and FMC Corp. 14 p.
41670701	Progress report	Palmeri, M. (1990) Aquatic Mesocosm Study of Pesticide Products Containing the Active Ingredient Cypermethrin: Progress Report 8: Lab Project Number: A89-2847. Unpublished study prepared by Wildlife International, Ltd., and FMC Corp. 14 p.
41732501	Progress report	Palmieri, M. (1990) Aquatic Mesocosm Study of Pesticide Product Containing the Active Ingredient Cypermethrin: Progress Report 9: Project Number: A89-2847. Unpublished study prepared by Wildlife International, Ltd and FMC Corp. 13 p.
41800601	Progress report	Palmieri, M. (1991) Aquatic Mesocosm Study of Pesticide Products Containing the Active Ingredient Cypermethrin: Progress Report 10. Lab Project Number: A89-2847. Unpublished study prepared by Wildlife International, Ltd. and FMC Corp. 12 p.
41862501	Progress report	Palmieri, M. (1991) Aquatic Mesocosm Study of Pesticide Products Containing the Active Ingredient Cypermethrin: Progress Report 11: Lab Project Number: A89-2847. Unpublished study prepared by Wildlife International, Ltd. & FMC Corp. 58 p.

42148201	DER not located	Palmieri, M.; Freda, J.; Krueger, H.; et al. (1991) An Evaluation of the Impact of Cypermethrin Exposure on Managed Aquatic Ecosystems: Lab Project Number: 104-160: A89-2847. Unpublished study prepared by Wildlife International Ltd. **1612 p.**
40125604	Protocol	Hill, I. (1987) **Protocol**--Cypermethrin: A Study of the Impact of Aerially Sprayed Cypermethrin on the Aquatic Ecosystem of a Farm Pond in the Drainage Basin of a Cotton Crop: Laboratory Project ID: 383/CF/04. Unpublished study prepared by Imperial Chemical Industries. 31 p.
40967301	Addendum	Sadler, J.; Hill, I. (1989) Cypermethrin: Addendum to RJ0629B ...; Evaluation of the Impact of Aerially Sprayed Cypermethrin on the Aquatic Ecosystem of a Farm Pond in the Drainage Basin of a Cotton Crop; 1987: Project ID; PP383-CT-04/1. Unpublished study prepared by ICI Agrochemicals. 11 p.
41293901	Progress report	Palmieri, M. (1989) Aquatic Mesocosm Study of Pesticide Products Containing the Active Ingredient Cypermethrin: Progress Report 2: Lab Project Number: A89/2847. Unpublished study prepared by Wildlife International, Ltd. in Association with FMC Corp. 5 p.
42081101	Progress report	Palmieri, M. (1991) Aquatic Mesocosm Study of Pesticide Products Containing the Active Ingredient Cypermethrin: Progress Report 14: Lab Project Number: A89-2847. Unpublished study prepared by Wildlife International, Ltd. and FMC Corp. 8 p.
Acc No. 250506 128704	2016157	Jaber, M.; Hawk, R. (1983) Cypermethrin: Aquatic Ecological Effects under Field Use Conditions in Cotton: Selma, Alabama, 1980: Re- port Series TMUE0026/B. (Unpublished study received Mar 24, 1983 under 10182-65; submitted by ICI Americas, Inc., Wilming- ton, DE; CDL:250506-A)
152737	DER not located	Getty, C.; Wilkinson, W.; Swaine, H.; et al. (1983) Cypermethrin: Effects of Multiple Low Rate Applications on Experimental Ponds: Report No. RJ0182B. Unpublished study prepared by Imperial Chemical Industries PLC. 62 p.
155770	Open lit	Crossland, N. (1982) Aquatic toxicology of cypermethrin. II. Fate and biological effects in pond experiments. **Aquatic Toxicology 2:205-222**.
155772	Open lit	Crossland, N.; Shires, S.; Bennett, D. (1982) Aquatic toxicolofy of cypermethrin. III. Fate, and biological effects of spray drift deposits in fresh water adjacent to agricultural land. **Aquatic Toxicology 2:253-270**.

141-1 Honey bee acute contact

MRID		Citation Reference
155740	2016158	Bull, J.; Wilkinson, W. (1980) Cypermethrin: Laboratory Determina- tion of the Acute Toxicity to Honeybees of Technical Material and an Emulsifiable Concentrate (GFU 061): Report Series: RJ 0169B. Unpublished study prepared by ICI Plant Protection Div. 35 p.
44544208	2016183	Halsall, N. (1998) Betacypermethrin 10 EC: Acute Toxicity to Honey Bees (Apis mellifera): Lab Project Number: PWT 131/963589: PWT 131. Unpublished study prepared by Huntingdon Life Sciences Ltd. 29 p.
92027047	Registrant Summary	Lewis, G. (1990) ICI Americas Inc. Phase 3 Summary of MRID 00155740. Cypermethrin: Acute Contact and Oral Toxicity to Honey Bees (Apis mellifera:

		Report No. RJ0169B; Study No.: PP383/CM/01. Prepared by ICI Agrochemicals Jealott's Hill Research Station. 14 p.
92027048	Registrant Summary	Lewis, G. (1990) ICI Americas Inc. Phase 3 Summary of MRID 40274001. Cypermethrin: Toxicity of Residues on Foliage to Honey Bees (Apis mellifera): Report No. RJ0587B; Study No.: PP383CM03. Prepared by ICI Agrochemicals Jealott's Hill Research Station. 13 p.
47800504	Open lit- DER not located	Decourtye, A.; Devillers, J.; Genecque, E.; et al. (2005) Comparative Sublethal Toxicity of Nine Pesticides on Olfactory Learning Performances of the Honeybee Apis mellifera. **Archives of Environmental Contamination and Toxicology 48:242-250.**
47800530	Open lit- DER not located	Chauzat, M.; Carpentier, P.; Martel, A.; et al. (2009) Influence of Pesticide Residues on Honey Bee (Hymenoptera: Apidae) Colony Health in France. **Environ. Entomol. 38(3):514-523.**

141-2 Honey bee residue on foliage

MRID		Citation Reference
40274001	2016159	Gough, H.; Jackson, D.; Wilkinson, W. (1987) Cypermethrin: Toxicity of Residues on Foliage to Honey Bees (Apis mellifera): Laborato- ry Project ID: RJ0587B. Unpublished study prepared by ICI Plant Protection Division. 27 p.
41699401	Registrant summary	Lewis, G. (1990) Phase 3 **Summary of MRID 40274001**: Cypermethrin: Toxicity of Residues on Foliage to Honey Bees (Apis mellifera): Lab Project Number: RJ0587B: PP383CM03. Unpublished study pre- pared by ICI Agrochemicals, Jealotts Hill Research Station. 13 p.

141-3 Toxicity to Non Target Insects

5009995	Open lit 2079040	Waddill, V.H. (1978) Contact toxicity of four synthetic pyrethroids and methomyl to some adult insect parasites. Florida Entomologist 61(1):27-30.
127368	Open lit	Harris, C.; Turnbull, S. (1978) Laboratory studies on the contact toxicity and activity in soil of four pyrethroid insecticides**. Canadian Entomologist 110(Mar):285-288.** (Submitter AW-81-0099; also In unpublished submission received Apr 8, 1983 under 39398- 16; submitted by Sumitomo Chemical America, Inc., New York, NY; CDL:249939-B)

850.1790 Chironomid Sediment Toxicity Test

MRID		Citation Reference
46871501	Summary of multiple studies	Giddings, J. (2006) Overview of Sediment Toxicity Studies with Synthetic Pyrethroids. Project Number: 06723, 06273. Unpublished study prepared by

Compliance Services International. 62 p.

850.7100 Data reporting for environmental chemistry methods

MRID		Citation Reference
47053001	DER not located	Robinson, N. (2007) Residue Analytical Method for the Determination of Residues of Bifenthrin, Cypermethrin, Cyfluthrin, Deltamethrin, Esfenvalerate, Fenpropathrin, Lambda-cyhalothrin and Permethrin in Sediment. Unpublished study prepared by Syngenta Jealotts Hill International. 185 p.
47053002	DER not located	Reed, R. (2006) Laboratory Validation: Validation of the Residue Analytical Method: Residue Analytical Method for the Determination of Residues of Bifenthrin, Cypermethrin, Cyfluthrin, Deltamethrin, Esfenvalerate, Fenpropathrin, Lambda - Cyhalothrin and Permethrin in Sediment: Final Report. Project Number: MLI/06/02, ML06/1286/PWG. Unpublished study prepared by Morse Laboratories Inc. 418 p.

850.1735 Whole sediment: acute freshwater invertebrates

MRID		Citation Reference
47946601	Contract draft available	Picard, C. (2009) 10-Day Toxicity Test Exposing Freshwater Amphipods (Hyalella azteca) to Cypermethrin Applied to Glen Charlie Pond Sediment Under Static-Renewal Conditions. Project Number: 13656/6130, 100808/OPPTS/10/DAY/HYALELLA/MA/SED. Unpublished study prepared by Springborn Smithers Laboratories. 117 p.
47946602	Contract draft available	Picard, C. (2009) 10-Day Toxicity Test Exposing Freshwater Amphipods (Hyalella azteca) to Cypermethrin Applied to Formulated Sediment Under Static-Renewal Conditions. Project Number: 13656/6129. Unpublished study prepared by Springborn Smithers Laboratories. 118 p.
47946603	Contract draft available	Picard, C. (2009) 10-Day Toxicity Test Exposing Freshwater Amphipods (Hyalella azteca) to Cypermethrin Applied to California Sediment 2 Under Static-Renewal Conditions. Project Number: 13656/6127. Unpublished study prepared by Springborn Smithers Laboratories. 119 p.
47946604	Contract draft available	Picard, C. (2009) 10-Day Toxicity Test Exposing Freshwater Amphipods (Hyalella azteca) to Cypermethrin Applied to CA Sediment 1 Under Static-Renewal Conditions. Project Number: 13656/6126. Unpublished study prepared by Springborn Smithers Laboratories. 118 p.
47946605	Contract draft available	Picard, C. (2009) 10-Day Toxicity Test Exposing Freshwater Amphipods (Hyalella azteca) to Cypermethrin Applied to California Sediment 3 Under Static-Renewal Conditions. Project Number: 13656/6128, 100808/OPPTS/10/DAY/HYALELLA/CAS3. Unpublished study prepared by Springborn Smithers Laboratories. 116 p.

46591504	2086351	Putt, A. (2005) Cypermethrin - Toxicity to Midge (Chironomus tentans) During a 10-Day Sediment Exposure. Project Number: 13656/6110. Unpublished study prepared by Springborn Smithers Laboratories. 88 p.
46725701	2086353	Putt, A. (2005) Cypermethrin - Life-Cycle Toxicity Test with Midge (Chironomus tentans) During a 60-Day Sediment Exposure. Project Number: 13656/6112. Unpublished study prepared by Springborn Smithers Laboratories. 117 p.

Non Guideline Selections

90000	2016265 summary pg 29	Brown, S.M.; Edwards, P.J. (1980) Cypermethrin (PP383): Effects on Earthworms,~Lumbricidae?~: Report Series RJ 0151B. (Unpublished study received Dec 30, 1981 under 10182-64; prepared by Imperial Chemical Industries, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070559-O)
90001	2016265 summary pg 29	Cole, J.F.H.; Wilkinson, W. (1980) Cypermethrin (PP383): Effects on Soil Microarthropods: Report Series RJ 0150B; 5B 4/6. (Unpub- lished study received Dec 30, 1981 under 10102-64; prepared by Imperial Chemical Industries, Ltd., England, submitted by ICI Americas, Inc., Wilmington, Del.; CDL:070559-P)
90059	2016265 summary pg 56 2016265 summary pg 57	Curl, E.A.; Milner, S.D. (1980) Cypermethrin: Accumulation and De- pletion of Radioactive Residues in the Tissues of Mallard Duck and Bobwhite Quail following Daily Dosing: Report Series RJ 0147B. (Unpublished study received Dec 30, 1981 under 10182-64; prepared by Imperial Chemical Industries Ltd., England, submit- ted by ICI Americas, Inc., Wilmington, Del.; CDL:070560-K) Leahey 1977. Similar study with Permethrin and Mallard and Japanese Quail
138935	DER not located	Hill, I. (1984) A Review of the Effects of Pyrethrum and Synthetic Pyrethroids on Non-target Organisms in Terrestrial and Aquatic Environments: Report Series RJ0349B. (Unpublished study re- ceived Jan 30, 1984 under 10182-65; prepared by Imperial Chemi- cal Industries, Ltd., Eng., submitted by ICI Americas, Inc., Wilmington, DE; CDL:252348-A)
149692	DER not located	Rajakulendran, S.; Plapp, F. (1982) [Comparative Toxicities of Five Synthetic Pyrethroids to Various Parasites and Predators]. Un- published compilation. 8 p.
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155785	Open lit	Stephenson, R.; Choi, S.; Olmos-Jerez, A. (1984) Determining the toxicity and hazard to fish of a rice insecticide. **Crop Protec- tion 3(2):151-165.**
155797	Check SETAC publications	Hill, I.; Hamer, M. (1984) The Influence of Adsorption and Degradation on the Toxicity of Permethrin, Cyperthrin and Cyhalothrin to Aquatic Organisms. Unpublished documents **presented at the SETAC Fifth Annual Meeting, November, 1984; Washington, D.C. 2 p.**
40135801	DER not located	Kaminski, B. (1987) Cypermethrin: Effect on Earthworms and Bio-accumulation Potential of Residues. Unpublished study prepared by ICI Americas. 7 p.
40135802	DER not located	Arnold, J.; Edwards, P. (1983) Cypermethrin: Effects on Earthworms Lumbricidae of Repeated Annual Field Applications: Lab Project ID: RJ0311B.

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40135803	DER not located	Curl, E.; Leahey, J. (1984) Permethrin and Cypermethrin: Character- isation of Radioactive Residues Found in Earthworms Which Have Been Exposed to Soil Treated with [Carbon 14]-Permethrin and [Carbon 14]-Cypermethrin: Lab Project ID: RJ0343B. Unpublished study prepared by ICI Plant Protection Division. 36 p.
40135804	DER not located	Edwards, P.; Arnold, J. (1984) Cypermethrin and Permethrin: Accumu- lation of [Carbon 14]-Cypermethrin and [Carbon 14]-Permethrin Equivalents by the Earthworms Allolobophora calliginosa and Lum- bricus terrestris: Lab Project ID: RJ0341B. Unpublished study prepared by ICI Plant Protection Division. 30 p.
40135805	DER not located	Collis, W.; Leahey, J. (1984) Cypermethrin: Evaluation of Bio- accumulation Potential in Quail Dosed with Earthworms Containing Cypermethrin Derived Residues: Lab Project ID: RJ0330B. Unpub- lished study prepared by ICI Plant Protection Division. 35 p.
40135806	DER not located	Cavell, R.; Leahey, J.; Lloyd, S. (1984) Cypermethrin: Evaluation of Bioaccumulation Potential in Rats Dosed with Earthworms Con- taining Cypermethrin Derived Residues: Lab. Project ID: RJ0352B. Unpublished study prepared by ICI Plant Protection Division. 35 p.
40135807	DER not located	Leahey, J.; Curl, E.; Edington, C.; et al. (1985) Permethrin and Cypermethrin: Identification of a Major Component of the Radio- active Residue in Earthworms Exposed to Soil Treated with [Carbon-14]-Benzyl-labeled Cypermethrin (Addendum to RJ0343B): Lab Project No.: RJ0391B. Unpublished study prepared by ICI Plant Protection Division. 21 p.
40359505	Open lit DER not located	Watters, F.; White, N.; Cote, D. (1983) Effect of temperature on toxicity and persistence of three pyrethroid insecticides applied to fir plywood for the control of the red flour beetle (coleoptera: Tenebrionidae. **Journal of Economic Entomology 76: 11-16.**
44388401	Registrant Assessment	Maund, S.; Travis, K.; Hendley, P.; et al. (1997) Evaluation of the Ecological Risks of Cotton Pyrethroids to Aquatic Ecosystems: Lab Project Number: RC0009B. Unpublished study prepared by Zeneca Agrochemical (Zeneca Ltd.). 30 p.
44396501	Registrant Assessment	Solomon, K. (1997) Review of the Laboratory Aquatic Organism Toxicity Data for the Cotton Pyrethroids: Distributional Analysis of the Acute Toxicity Data. Unpublished study prepared by University of Guelph. 76 p.
44396502	Registrant Assessment	Travis, K. (1997) A Modified Tier II Aquatic Exposure Analysis of Cotton Pyrethroids, Incorporating Landscape-Level Exposure Factors: Lab Project Number: PYRETHROIDS\3. Unpublished study prepared by Zeneca Agrochemical (Zeneca Ltd). 221 p.
44396503	Registrant Assessment	Giddings, J. (1997) Aquatic Mesocosm and Field Studies with Cotton Pyrethroids: Observed Effects and Their Ecological Significance: Lab Project Number: 97-6-7014: 13656.0497.6100.900. Unpublished study prepared by Springborn Labs., Inc. 102 p.
44396504	Registrant Assessment	Ritter, A.; Williams, W.; Cheplick, J. (1997) Tier 1 and Tier 2: Modeling of Pyrethroid Exposure to Aquatic Nontarget Organisms Associated with Use on Cotton: Lab Project Number: WEI 794.01: PWG. Unpublished study prepared by Waterborne Environmental, Inc. (WEI). 80 p.

45245501	Registrant Assessment	Soderlund, D.; Clark, J.; Mullin, L. et al. (2000) Pyrethroid Insecticides: Is there a Common Mechanism of Mammalian Toxicity?: Lab Project Number: PWG FQPA 2000-01. Unpublished study prepared by Pyrethroid Working Group. 144 p.
45867701	DER not located - not a cypermethrin study	Smith, E.; Du Preez, L.; Solomon, K. (2003) Field Exposure of Xenopus laevis to Atrazine and Other Triazines in South Africa: Exposure Characterization and Assessment of Laryngeal and Gonadal Responses: Final Report: Lab Project Number: SA-01B: 109-02: C1. Unpublished study prepared by The Institute of Environmental and Human Health, Texas Tech University and School of Environmental Sciences and Development Potchefstroom, University for CHE. 91 p.
45867709	DER not located – not a cypermethrin study	Smith, E.; Du Preez, L.; Solomon, K. (2003) Field Exposure of Xenopus laevis to Atrazine and Other Triazines in South Africa: Feasibility Study for Site Characterization and Assessment of Laryngeal and Gonadal Responses: Final Report: Lab Project Number: SA-01A: 2011-02: C1. Unpublished study prepared by The Institute of Environmental and Human Health Texas Tech University and School of Environmental Sciences and Development Potchefstroom University for CHE. 104 p.
46051301	Registrant Assessment	Ritter, A.; Williams, W. (2003) Tier 2 Modeling of Pyrethroid Compounds Exposure to Aquatic Nontarget Organisms Associated with Use on Cotton: Final Report. Project Number: WEI/794/03. Unpublished study prepared by Waterborne Environmental, Inc. (WEI). 180 p.
47050501	Registrant Assessment	Breckenridge, C.; Holden, L. (2007) Evidence for Separate Mechanism of Action for Type I and Type II Pyrethroid Insecticides. Project Number: PWG/TOX/2007/01. **Unpublished study prepared by Pyrethroid Working Group. 144 p.**
47050502	Open lit	Burr, S.; Ray, D. (2004) Structure-Activity and Interaction Effects of 14 different Pyrethroids on Voltage-Gated Chloride Ion Channels. **Toxicological Sciences 77(2):341-346.**
47506602	DER not located	Hall, L.; Killen, W.; Anderson, R. (2008) A Comparison of Sediment Sampling Methods for Pyrethroids in Urban/Residential Sediments of California Streams and Additional Pyrethroid Sampling in Pleasant Grove Creek Backwater Surrogate Sites- Pyrethroid: Assessment. Project Number: T001584/08. Unpublished study prepared by Wye Research and Education Center. 62 p.
47506603	DER not located	Hall, L.; Killen, W.; Anderson, R.; et. al. (2008) An Assessment of Benthic Communities with Concurrent Physical Habitat, Pyrethroid, and Metals Analysis in an Urban and Residential Stream in California in 2006 and 2007- Pyrethroid: Assessment. Project Number: T001523/08. Unpublished study prepared by Wye Research and Education Center and Northern Illinois University. 229 p.
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47929401	Progress report	Giddings, J. (2009) Pyrethroid Working Group Sediment Toxicity Testing Program: Progress Report #1: (Hyalella azteca). Project Number: 09713. Unpublished study prepared by Compliance Services International. 26 p.
47929402	Overview	Giddings, J. (2009) Pyrethroid Working Group Sediment Toxicity Testing Program: Overview of Part 1 (Comparison of Sediments with Different Organic Content): (Hyalella azteca). Project Number: 09718. Unpublished study

		prepared by Compliance Services International. 25 p.
47929403	Progress report	Giddings, J. (2009) Pyrethroid Working Group Sediment Toxicity Testing Program: Progress Report #2: (Hyalella azteca). Project Number: 09744. Unpublished study prepared by Compliance Services International. 11 p.
47929404	Registrant Assessment	Hall, L.; Killen, W.; Anderson, R.; et al. (2009) An Assessment of the Potential Influence of Physical Habitat, Pyrethroids and Metals of Benthic Communities in a Residential Stream in California in 2008: (Tubificidae, Paratanytarsus sp., Hyalella sp., Physa sp., Dugesia tigrina and Dero digatata): Final Report. Project Number: T001605/09. Unpublished study prepared by Compliance Services International. 126 p.
47929405	DER not located	Hall, L.; Killen, W.; Alden, R. (2007) An Assessment of Benthic Communities with Concurrent Physical Habitat, Pyrethroid, Metals and PAH Analysis in an Urban and Residential Stream in California: (Seed Shrimp, Snails, Chironomids, Oligochaetes and Black Flies). Unpublished study prepared by Wye Research and Education Center, and Northern Illinois University. 173 p.
47929406	DER not located	Hall, L.; Killen, W.; Anderson, R. (2009) A Comparison of Targeted Sedimemt Sampling Methods for Pyrethroids in Urban/Residential Sediments of a California Stream in 2008: (Hyalella azteca): Final Report. Project Number: T001763/09. Unpublished study prepared by Wye Research and Education Center. 56 p.
47944033	Comparison summary	Wisk, J. (2010) Comparison of Ecotoxicology Endpoints for Alpha-Cypermethrin and Cypermethrin. Project Number: 2010/7002965/OCR, 2010/7002965. Unpublished study prepared by BASF Agricultural Products Center. 9 p.
41068006	Open lit-different chemical	Bradbury, S.; Coats, J.; McKim, J. (1985) Differential toxicity and uptake of two **fenvalerate** formulations in fathead minnows (Pimepholes promelas). Environmental Toxicology and Chemistry 4:531- 541.

Appendix A. PRD Data Request Justification Tables

The following proposed Data Call-in tables include rationales for requiring the data requested in this problem formulation, explanations of the utility of the data, and explanations for how the data might impact risk assessment, following the format provided by PRD.

Guideline Numbers and Study Titles: • **Test Method 100.4 (OCSPP 850.1770, in prep.); Whole sediment: chronic invertebrates freshwater (*Hyalella azteca*)** • **Test Method 100.5 (OCSPP 850.1760, in prep.); Whole sediment: chronic invertebrates freshwater (*Chironomus dilutus*) US EPA 2001,** • **EPA 600/R-01/020 (OCSPP 850.1780, in prep.); Whole sediment: chronic invertebrates marine (*Leptocheirus plumulosus*)**
Rationale for Requiring the Data
No chronic sediment toxicity tests for freshwater or marine invertebrates have been submitted for cypermethrin to satisfy the Agency's updated data requirements for outdoor uses in 40 CFR Part 158 (October 26, 2007). For cypermethrin, available information indicates that benthic organisms may be exposed via run-off or spray drift applications used in agricultural, forest, and residential settings. Based on calculations in the most recent EFED assessment, the 21-day sediment porewater EECs predicted for cypermethrin ranged from 0.0036 to 0.0253 µg a.i./L (USEPA 2006b). The upper end of this range exceeds 0.1 of the most sensitive acute LC/EC_{50} (0.0036 µg a.i./L for amphidpod), which satisfies one of the criteria for requiring chronic whole sediment toxicity testing under 40 CFR Part 158. Furthermore, chronic reproductive effects were seen in water column studies with aquatic invertebrates (mysid shrimp), with a NOAEC = 0.000781 µg a.i./L and LOAEC = 0.00197 µg a.i./L. PCypermethrin is expected to persist in sediments, based on half-lives in submitted soil metabolism and aquatic metabolism studies (aerobic soil ~ 60 days; aerobic aquatic metabolism, 10 days; anaerobic aquatic metabolism, 15 days) (MRIDs 42156601, 45920801 and 44876105). These half-life values exceed the 40 CFR Part 158 criterion of 10 days. The third set of trigger criteria for requiring chronic testing (K_d > 50 or log K_{OW} >3 or K_{OC} > 1000) is also met for cypermethrin (log K_{OW} is 6.4, the mean K_{OC} value is ~141,700. The physicochemical property triggers (K_d, K_{OW} and K_{OC}) reflect the propensity of the chemical to partition onto the particulate or organic matter phases of sediments. Exceeding any one of the physicochemical property triggers listed above is sufficient for indicating the pesticide has reasonable potential for partitioning to the sediment compartment. Chronic whole sediment tests on *Hyalella azteca*, *Chironomus tentans*, and *Leptocheirus plumulosus* are requested. Although both are freshwater species, *Hyalella* and *Chironomus* differ substantially in their ecological niche (epibenthic v. infaunal species), physiology, and there is some evidence suggesting *Hyalella* is among the more sensitive invertebrates to pyrethroids based on water column tests (Maund *et al.*, 2002; Weston and Jackson, 2009). Pyrethrins have the potential to enter estuarine/marine water bodies based on current usage patterns that include coastal areas. Therefore, testing is also needed for an estuarine/marine sediment-dwelling invertebrate species. Until the final OCSPP guidelines for chronic sediment toxicity tests are published, the registrant should

submit a protocol to EFED for approval prior to test initiation.

- Test Method 100.4: *Hyalella azteca* 42-d Test for Measuring the Effects of Sediment Associated Contaminants on Survival, Growth, and Reproduction in USEPA 2000 Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates EPA 600/R-99/064 (**OCSPP 850.1770, in prep.**);
- Test Method 100.5: Life-cycle Test for Measuring the Effects of Sediment-associated Contaminants on *Chironomus dilutus* (formerly known as *C. tentans*) in USEPA 2000 Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates EPA 600/R-99/064 (**OCSPP 850.1760, in prep.**); and
- *Leptocheirus plumulosus* in USEPA 2001 Method for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-associated Contaminants with the Amphipod *Leptocheirus plumulosus* EPA 600/R-01/020 (**OCSPP 850.1780, in prep.**).

Practical Utility of the Data

How will the data be used?
Data from sediment toxicity studies will be used to estimate potential risks to benthic organisms associated with uses of cypermethrin. The data will reduce uncertainties associated with the current risk assessment for benthic species and will improve our understanding of the potential effects of cypermethrin.

How could the data impact the Agency's future decision-making?
Although there was uncertainty in estimating the effect of pyrethrins on benthic organisms in previous assessments, there was a potential risk associated with adverse effects identified for other aquatic organisms. Acceptable data for benthic organisms will reduce the uncertainty from the previous assessment If the data indicates that registered cypermethrin usage may pose a risk of adverse effects to non-target benthic organisms above the Agency Level of Concern, the Agency may explore decision options to mitigate this risk. The lack of these data will limit the flexibility the Agency and registrants have in coming into compliance with the Endangered Species Act, and could result in use restrictions which may otherwise be avoided, or which are unnecessarily severe.

Appendix B. Reported Cypermethrins Ecological Incident Summaries in the EIIS Database

Table B-1. Cypermethrin and Zeta-Cypermethrin Incident Report Summaries				
Incident #	**Organism(s) Affected**	**Certainty of Involvement**	**Legality of Use**	**Description**
I008737-001	Lobster (Decapoda)	Probable	Registered Use	In a 5000 gal. saltwater tank in Cocoa Beach, FL 32931, an owner, Rancher/Breeder/Farmer found 800 lobsters dead and another 25 lobsters still alive in the tank. He used a product (EPA Reg. No. 4822-452): RAID Concentrate - Deep Reach Fogger in a room adjacent to the tank room then closed the tank room door for the night, but did not place a towel under the door. An air conditioner was turned off. He does not have UV/ozone sterilization. He has added another 200-300 lobsters to this same tank and they seem fine. He has tested water, ammonia nitrites, nitrate, pH and all are within normal limits. He could not locate the EPA Reg. No. on the container.
I009966-002	Bass (*Micropterus spp.*) Bluegill (*Lepmis macrochirus*) Carp (*Cyprinus carpio*) Catfish (Ictaluridae) Crappie (Centrarchidae) Minnow (Cyprinidae) Shad (Clupeidae)	Probable	Misuse	A fish kill was reported on February 9, 1998 in Chattanooga, the result of a termiticide containing cypermethrin entering Rogers Branch and its un-named tributaries. The Tennessee Wildlife Resources Association assessed the cost of the dead fish at $609.33. Civil penalties and damages were assessed, suggesting misuse of the pesticide. Further information was provided by a 6(a)(2) report from Zenaca Ag Products (I006971-001). They claim that their investigation indicate that the kill was not likely the result of any labeled use of Demon TC or of the minor spill reported on the property in November - December 1997. They claim the exposure characteristics suggest "introduction of relatively massive amounts of chemical directly into the water course.
I011346-001	Crayfish (Decapoda)	Highly probable	Misuse	According to a report from the Environment Agency - UK, thousands of crayfish had been killed in the Sherston Avon at Pinkney, upstream of Malmesbury, Wiltshire. Within 24 hours of the first report, the Environment Agency's Exeter laboratory pinpointed cypermethrin as the cause. An investigation led to the

Table B-1. Cypermethrin and Zeta-Cypermethrin Incident Report Summaries				
Incident #	**Organism(s) Affected**	**Certainty of Involvement**	**Legality of Use**	**Description**
				Badminton sewage treatment works and, ultimately, to a kennel where a sheep dip called Crovert (containing cypermethrin) had been used to treat hounds for mange. After treatment, the Crovert was washed off and entered the river through the effluent of the sewage treatment plant.
I001031-001	Bluegill (*Lepmis macrochirus*) Carp (*Cyprinus carpio*) Catfish (Ictaluridae) Largemouth bass (*Micropterus salmoides*)	Highly probable	Undetermined	This fish kill resulted from the application of Demon TC as a termite barrier around a home in Henderson, Kentucky. Underground drainage tile had been installed around the home to divert water to a pond 50 feet away, and the night following the application of Demon there was a heavy rainfall which resulted in dumping some of the Demon into the pond. Approximately 44 fish we re killed.
I018158-017	Koi (*Cyprinus carpio*)	Probable	Undetermined	Koi allegedly died from a drift exposure caused by an Eagle Pest Control technician performing a routine quarterly perimeter treatment using the labeled rate of Probuild TC (a.i. cypermethrin). Koi fish pond was located at the backyard of the treatment location.
I017029-001	Unknown fish	Highly probable	Misuse (Accidental)	This is an update of a previous incident that occurred in Takoma Park, MD, in which a cypermethrin-based pesticide called "Prevail" spilled from one of the company's pesticide application trucks onto a driveway while an employee was attempting to repair or replace a pump. The employee used a hose to wash off the driveway, causing the pesticide to drain into a creek and, subsequently, into Chesapeake Bay. A large number of fish were killed as the result of this incident.The pest control company was fined $7,300 and its license was suspended for 4 years as a part of the consent agreement with the Maryland Department of Agriculture.
I006971-001	Unknown fish	Highly probable	Undetermined	Zeneca reported that Tennessee Dept. of Agriculture was contacted about fish kill in several small ponds fed by a small stream. State investigators estimated 2,200 dead fish (i.e., bass, bluegill, shad) were impacted along with various other unspecified aquatic organisms. Soil and water samples

Table B-1. Cypermethrin and Zeta-Cypermethrin Incident Report Summaries				
Incident #	**Organism(s) Affected**	**Certainty of Involvement**	**Legality of Use**	**Description**
				were obtained. Analysis showed trace levels of chlorpyrifos and permethrin, and exceptionally high levels of cypermethrin. Initial investigation focused on a local pest control applicator. A multi-agency investigation team later focused its attention to alternative explanations.
I007107-003	Minnow (Cyprinidae)	Highly probable	Undetermined	This incident is one of the incidents stated on a consolidated report submitted by the Pesticide Investigation Unit, California Dept. of Fish and Game for the year 1997. One thousand Gambusia (minnows) reported dead in Placer County on 2-7-1997. The PIU confirmed that Cypermethrin was the cause of this fish kill.
I010444-004	N/R	Probable	Misuse (Accidental)	To comply with 6(a)2 regulations, FMC reported an incident that occurred in Silver Spring, MD (the location was not given in the report but was known to this writer). A treatment tank was being cleaned out by an applicator and the washings entered Rock Creek, causing a fish kill extending from an area near Walter Reed Hospital to the Potomac River. Initial estimates that there were between 1000 and 150,000 dead fish but later, the estimate was revised to 10,000. The Maryland Dept. of Agricuoture found 50 ppb cypermethrin in the water.
I013857-011	Unknown fish	Probable	Misuse (Intentional)	To comply with 6(a)2 requirements, Syngenta reported that the February 25, 2003, issue of the Independent (London) carried an account of a large fish kill in the river Slea, in Lincolnshire. According to this newspaper, someone had dumped Cypermethrin into surface water drains at an industrial site, infecting 13 miles of the river and causing the death of 100,000 fish.
I004876-011	Crayfish (Decapoda) Stonefly (Plecoptera)	Highly probable	Misuse (Accidental)	This information was sent in response to a letter from Gerard Desir, EPA. It concerns a fish kill in the Salmon River as the result of cypermethrin poisoning.
I000011-001	N/R	Possible	Registered	Pond fishkill via alleged underground

Table B-1. Cypermethrin and Zeta-Cypermethrin Incident Report Summaries				
Incident #	**Organism(s) Affected**	**Certainty of Involvement**	**Legality of Use**	**Description**
			Use	stream under home, after termite control.
I015094-001	Unknown fish	Possible	Registered Use	FMC 6(a)(2) incident report stated that a contractor applied Prevail (cypermethrin) on a horizontal soil surface where a concert slab was to be poured. Dead fish were found in a stream 1/2 to 1 mile from the construction site. No analyses were given.
I017984-001	Crayfish (Decapoda)	Possible	Misuse (Accidental)	A web site from the UK reports that the joint mater of the Duke of Beaufort appeared at Avon magistrates on 10/20/1998. He pleaded guilty to allowing hounds treated with cypermethrin, which is used to treat mange, to enter the River Avon. The pesticide killed around 10,000 endangered white clawed crayfish in the river.
I011348-001	Sparrow (Fringillidae)	Unlikely	Undetermined	A report on the Internet (Third World Network) described a massive killing of sparrows in a small village in Bangladesh as the result of a massive use of cypermethrin. In eggplant and pointed gourd fields there was a spraying of Ustad the night before. The sparrows ate insects that had died from the spraying and they, in turn, died by the thousands. An original estimate was that 5000 had died but later indications were that the number was much higher. Residents were shocked by the massive kill of these birds and protests were made against the use of pesticides.
I021456-001	Bluegill (*Lepomis macrochirus*) Largemouth bass (*Micropterus salmoides*)	Possible	Undetermined	Iowa Departmewnt of Natural Resources reported an incident on dozens of fish kill in a private pond surrounded by soybean field on three sides and live pasture field to the south in Iowa. There was aerial spraying of pesticides onto the soybean field.
I000340-009	Goat (Bovidae)	Possible	Undetermined	The report implied that an unspecified number of goats may have suffered illness due to nearby application of cypermethrin.
I000103-010	Barred owl (*Strix varia*) Mockingbird (*Mimus polyglottos*) White-throated sparrow	Unlikely	Undetermined	According to the investigative report 11 dead birds were found near a private dwelling (9 sparrows, a mockingbird, and a barred owl). It

Table B-1. Cypermethrin and Zeta-Cypermethrin Incident Report Summaries				
Incident #	**Organism(s) Affected**	**Certainty of Involvement**	**Legality of Use**	**Description**
	(*Zonotrichea albicollis*)			was suspected that the mortality was due to toxicosis. Four birds were selected for necropsy (1 mockingbird and 3 sparrows). The premises had been periodically sprayed for termites for 8 years, the most recent being 2 month prior to the event with cypermethrin. Earlier treatments had been done with lindane. Analysis of brain ChE activity gave normal results. Residue analysis of gizzard/crop contents revealed the presence of Heptachlor Epoxide and a significant amount of Dieldrin. there was an insufficient amount of brain tissue left to make a residue analysis of the brain for Dieldrin. According to the report brain tissue residue of 1ppm is considered significant but body residues are usually many times greater than brain residue. The birds were observed to undergo convulsions just before dying. Crop/gizzard content residue analysis revealed Dieldrin at 7480 ppb and Hrptachlor Epoxide at 710 ppb. There was no evidence of organophosphate, carbamate, lindane, or cypermethrin pesticides.
I000340-006	Dog (*Canis familiaris*)	Possible	Undetermined	According to the investigative report, a dog was dipped and also exposed to pyrethroid products. The dog's illness was suspected to be due to one of these exposures.
I000340-002	Cat (*Felix domesticus*)	Probable	Registered Use	According to the report A cat was exposed to toxic fumes of cypermethrin by following applicator around as he worked.
I014202-007	Honey Bee (*Apis millifera*)	Possible	Registered Use	On Aug 9, 2002, a bee keeper reported that queenless hives was observed on Aug 8, 2002. Yard was inspected where there use to be 32 hives, but has declined to 26 hives. All 26 hives were open and inspected. 8 of the hives were queenless or failing. No diseases were found, but Varroa mite was positive for one hive. An erratic or spotty brood pattern was common. Pesticide exposure was suspected. One hybrid poplar field was identified 3.5 miles from the yard, and this field had not been treated in 2002. An alfalfa field 2.75 miles from the yard

Table B-1. Cypermethrin and Zeta-Cypermethrin Incident Report Summaries				
Incident #	**Organism(s) Affected**	**Certainty of Involvement**	**Legality of Use**	**Description**
				was identified and it was sprayed with zeta-cypermethrin 23 days prior to the observation in the bee yard. Samples of pollen were taken and analyzed with no detection of zeta-cypermethrin, carbaryl, 1-naphthol and carbofuran. The insecticide coumaphos was detected. It is used in Check Mite Strips used to control Varroa mites. Note: The insecticide used on the alfalfa field was identified by the name Mustang and the EPA Reg. # 279-3126 was also given. Mustang is a pyrethin pesticide cancelled in 1983. The Reg. # identified the product Fury and its active ingredient is zeta-cypermethrin.
I014202-008	Honey Bee (*Apis millifera*)	Unlikely	Registered Use	A bee keeper reported on Sept 4, 2002 that there were dead bees in his bee yard. It was also stated that on Aug. 27, 2002, the bee keeper removed honey and that the hives were fine. The inspector opened and examined 20 of the twenty hives. Colonies appeared to be disease free, except for two hives with normal chalkbrood. Two hybrid poplar fields, 3,25 and 8 miles from the bee yard, were identified. There were no insecticide treatments to these fields in 2002. An alfalfa field had been treated with zeta-cypermethrin about 50 days before symptoms were reported. Bee tissue and pollen samples were obtained. Analyses of the samples did not detect any carbaryl, 1-naphthol or carborfuran. Coumaphos was detected in both the bee tissue and pollen samples. Level were not given. Test for Varroa mites was negative.